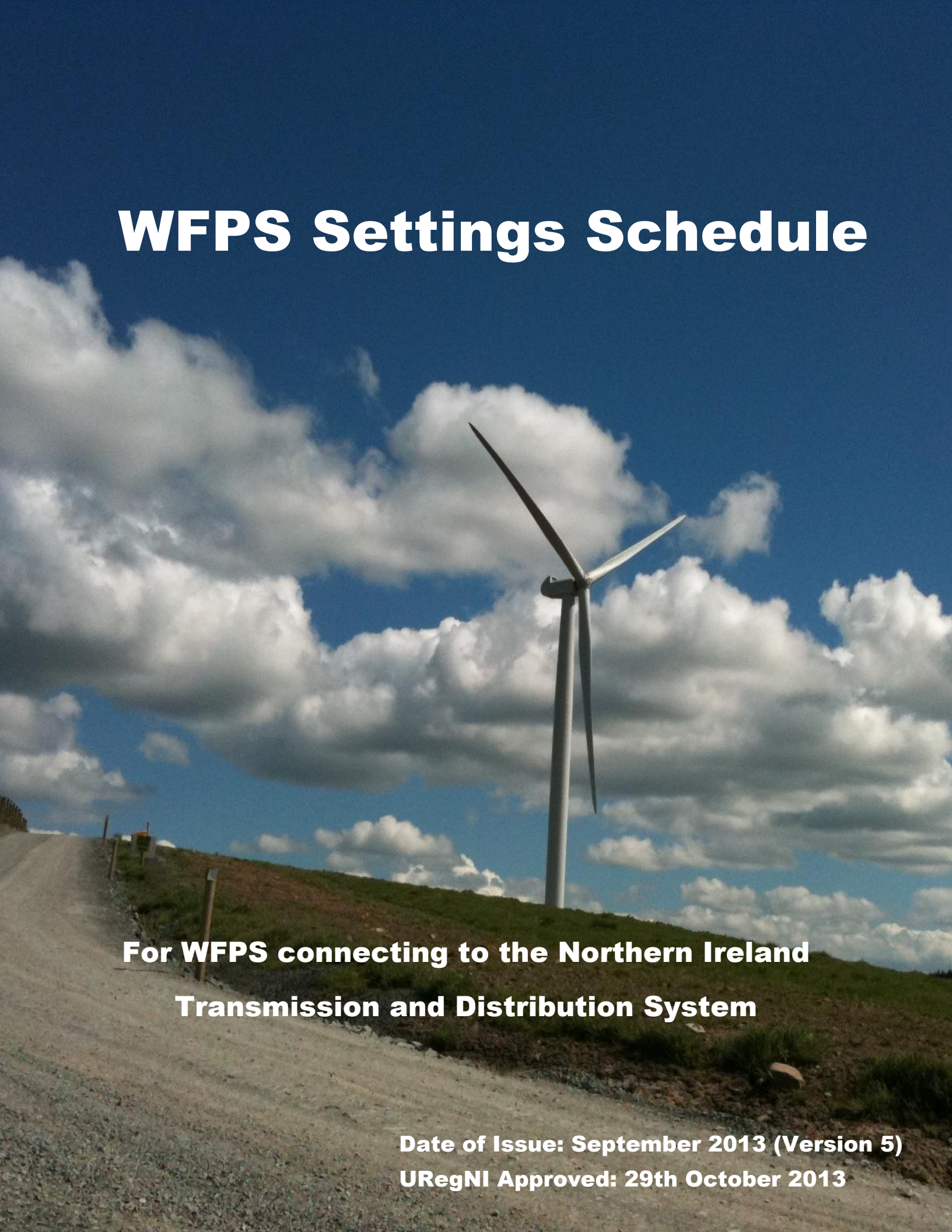
# WFPS Settings Schedule



**For WFPS connecting to the Northern Ireland Transmission and Distribution System**

**Date of Issue: September 2013 (Version 5)**
**URegNI Approved: 29th October 2013**

*DOCUMENT HISTORY*

Version 1: Guidance Notes for **Wind Farm Power Station** (**WFPS**) **Generator**s was released for consultation in March 2011

Version 2: **WFPS Settings Schedule** released March 2012

Version 3: **WFPS Settings Schedule** released July 2012

Version 4: **WFPS Settings Schedule** released February 2013

Version 5: **WFPS Settings Schedule** released September 2013, (Approved by URegNI 29 October 2013)

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Foreword

The **WFPS Settings Schedule** sets out certain technical criteria that **Generator**s must comply with in respect of their **Wind Farm Power Station**s in accordance with CC.7.2 and the **WFPS Settings Schedule** is deemed to form part of the **Grid Code Connection Conditions**.

As set out further in this **WFPS Settings Schedule**, the **WFPS Settings Schedule** is intended to meet obligations of both SONI and NIE under the **Grid Code** and **Distribution Code**, as applicable. Accordingly, this foreword outlines in brief the obligations of SONI and NIE under their respective licences as relevant for the purposes of this **WFPS** Setting Schedule.

This Foreword is provided to **User**s and to prospective **User**s for information only and does not constitute part of the **Grid Code**.

# SONI Ltd

SONI is the **Transmission System Operator** (**TSO**) in NI. On 11 March 2009, SONI Ltd, became a wholly owned subsidiary of Eirgrid plc. SONI's responsibility as the **TSO** in NI is to ensure the safe, secure, reliable, economic, and efficient operation of the Transmission **System** in its area of operation. This includes:

- The scheduling and **Dispatch** of generating plant,
- Management of transmission network outages,
- Levying **System** support services charges,
- Market Operation,
- Managing the power flow on the Transmission **System** and Moyle Interconnector,
- Managing the NI **Grid Code**
- Meeting demand for electricity in NI while maintaining the operating security standard.

As stipulated in Condition 20 of SONI's **TSO Licence**, SONI are responsible for operating the Transmission **System** and under Condition 25, it is obliged on application by any person to offer to enter into a Connection Agreement, or modify an existing agreement, for connection to the Transmission **System**.

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# NIE Ltd

Northern Ireland Electricity (NIE) is responsible for the planning, development, construction and maintenance of the transmission and distribution network in Northern Ireland, and for the operation of the distribution network.

The NI electricity network comprises a number of interconnected networks of overhead line and underground cables, which are used for the transfer of electricity to customers via a number of substations. There are approximately 2,100km of transmission network (275 kV & 110 kV), of which some 80km are underground, and approximately 42,900km of the **Distribution System** (33 kV, 11 kV & 6.6 kV), of which some 13,100km are underground. There are currently over 790,000 customers connected to the **Distribution System**.

One of NIE's main responsibilities is to ensure that the communities served have a safe and reliable supply of electricity, and that everything is done to restore supplies as safely and quickly as possible following interruptions.

NIE holds a license "to transmit electricity for the purpose of giving a supply" to demand customers or **Generator**s.

## 1.0 GLOSSARY OF TERMS

Defined **Grid Code** terms within this document are in bold.
Defined **WFPS Settings Schedule** terms within this document are capitalised.

| Term | Definition |
|---|---|
| Compliance | Compliance with the Grid Code and (if applicable) the Distribution Code. |
| Commissioning/Acceptance Test Panel | The panel made up of representatives from SONI and NIE that will agree the Compliance testing program, provide direction on technical requirements, assess the test results and decide if Compliance has been achieved by the **WFPS**. The **Generator** may be asked to attend meetings to provide input into the connection process. |
| Designed Minimum Operating Level (DMOL) | The **Output** below which a **WFPS** cannot operate without shutting down **Generating Unit**s. |
| Final Compliance Certificate | The final Compliance certificate as may be issued by SONI in accordance with CC.S2.1.10.2 (for a Transmission-**System** connected **WFPS**) or CC.S2.2.7.2 (for a distribution-**System** connected **WFPS**). |
| FRT | Fault Ride Through |
| MIO | Maximum Instantaneous **Output** - MIO is the **MW** figure a **WFPS** is capable of generating at any instant if there is no SONI action present. |
| NIE | Northern Ireland Electricity |
| PF | Power Factor |
| pu | Per unit |
| Restricted Compliance Certificate | If a non Compliance arises at any point from energisation throughout the full operational life of the **WFPS**, SONI/NIE may issue the **Generator** with a Restricted Compliance Certificate, which will detail the level of non Compliance of the **WFPS**, the time frame to rectify the non Compliance and the MVA restriction to which the **WFPS** will be capped until the non Compliance is resolved. |
| SEMO | **Single Electricity Market** Operator |
| SONI | **System** Operator of Northern Ireland |
| T&D **System** | Transmission and **Distribution System** |
| Temporary Compliance Certificate | A temporary Compliance certificate as may be issued by SONI in accordance with CC.S2.1.10.2 (for a Transmission-**System** connected **WFPS**) or CC.S2.2.7.2 (for a distribution-**System** connected **WFPS**). |
| TUoSA | **Transmission Use of System Agreement** |
| VPT | Variable Price Taker |

## 2.0 INTRODUCTION

This **WFPS Settings Schedule** should be used in conjunction with the SONI **Grid Code** (CC7.2, CC7.3, CC.S2.1.1 and CC.S2.2.1) which is available from the SONI website[1] and the **Distribution Code** (CC1.1, CC1.2, CC1.3, CC11.1, CC11.4.1) which is available on the NIE website. This **WFPS Settings Schedule** is a subsidiary document to both the **Grid Code** and **Distribution Code** and will be under the governance of the respective Review Panels. It will provide a **Wind Farm Power Station** (hereafter called **WFPS**) clarity with regard to the technical requirements of the Codes, where certain aspects of the Codes are not detailed.

It explains a process to manage crucial interactions and data exchange. The process also involves plant testing and reporting to demonstrate Compliance with the SONI **Grid Code** and the NIE **Distribution Code**. Where the **WFPS** Connection Agreement specifically requires additional conditions or tests, a schedule shall be agreed between the parties.

It is intended to inform the **WFPS** of the necessary process and reference should be made to the **Grid Code**, **Distribution Code**, the Connection Agreement and the Connection Agreement application process for a complete set of provisions relating to connection of generation.

A **WFPS** with a capacity greater than 100kW is required to comply with the NIE **Distribution Code**. A **WFPS** with a capacity greater than 5**MW** will also be required to comply with the SONI **Grid Code**, in particular the **Connection Conditions**. It is recommended that a **Generator** make contact with SONI and NIE at an early stage of the project, prior to signing a contract with **Generating Unit** manufacturers. SONI and NIE will provide guidance on technical issues and plant performance requirements.

The **WFPS Settings Schedule** has been updated to clarify the process to be followed by a person or party wishing to connect a **WFPS** with a **Registered Capacity** greater than 5**MW** to the T&D **System**.

SONI and NIE's role will be to facilitate the Compliance for the **WFPS**. SONI and NIE's licence obligation is to ensure that the connection of **WFPS** does not conflict with its responsibilities mentioned in the foreword of this document.

## 2.1 SINGLE ELECTRICITY MARKET (SEM) ARRANGEMENTS

A **WFPS** with a capacity greater than 10**MW** is required under the terms of their Generation license to participate in the **SEM**. With a **Registered Capacity** between 5-10**MW**, a **WFPS** has the option to participate in the **SEM**. Information relating to the differences in participating in the **SEM** is contained in the Trading and Settlement Code, available from the **SEM** website[2].

[1] Welcome to the **System** Operators Northern Ireland (SONI) Website
[2] www.**SEM**-o.com

Upon energisation of the **WFPS**, a **WFPS** will remain as an Autonomous **Generator** operating in the **SEM**. Upon successful completion of:

1) the **Active Power** Control Test
2) **MW Availability** Test (this will be based on observation of the **MW Availability** signal throughout the **Active Power** Control test and continuous **Monitoring** of **MW Availability** by SONI).

SONI will issue Operational Readiness Confirmation to the **WFPS**. Upon receipt of this, a **WFPS** with a **Registered Capacity** greater than 10**MW** must contact SEMO and change its status in the **SEM** to a Variable Price Taker (VPT), a **WFPS** with a **Registered Capacity** of between 5-10**MW** may elect to contact SEMO to change its status in the **SEM** to a VPT.

## 3.0 PRIOR TO ENTERING INTO A BI-LATERAL AGREEMENT

Studies shall be carried out to ensure that any new network additions or modifications do not result in unacceptable or unstable conditions on the T&D **System**. This will be done by undertaking a number of **System** studies replicating the **WFPS** proposed development and the effect it may have on the NI T&D **System**.

The cost (which are included in the Connection Offer) of such studies shall be charged to the prospective **WFPS**, who shall be liable to meet the costs in full whether or not the **WFPS** proceeds with any or all of the project(s) under investigation.

Initial studies may only be indicative until the **WFPS** is in a position to confirm machine and transformer data accuracy. The costs of further studies and witness testing shall be agreed between the **TSO**/**DNO** and the **WFPS** and shall be met in full by the **WFPS**. The costs may reflect the **TSO**/**DNO** work or work carried out by external consultants.

Costs that are attributable to **WFPS** shall be met by the **WFPS** as per SONI's or NIE's connection charging methodology statement as applicable.

## 4.0 BI-LATERAL AGREEMENTS

### 4.1 CONNECTION AGREEMENT

A Connection Agreement to the Transmission or **Distribution System** is an agreement specifying the capacity and characteristics of the **WFPS**, which may be connected to the T&D **System**. The Agreement will show the configuration of the **WFPS** and NIE equipment and will identify the point(s) of connection. SONI will offer Connection Agreements for all Transmission connected **WFPS**. NIE will offer Connection Agreements for all Distribution connected **WFPS**. [The entry into a Connection Agreement is part of the requirements on a **WFPS** of accepting a Connection Offer from SONI or NIE]

### 4.2 TRANSMISSION USE OF SYSTEM AGREEMENT (TUoSA)

Under the terms of the Trading and Settlement Code, a TUoSA is required by all **WFPS** in order to participate in the **SEM**. If the **WFPS** is greater than 5**MW** it is required to pay TUoS. A **WFPS** with a capacity greater than 10**MW** will be obliged to participate in the **SEM**. For further information consult the **SEM**-11-078 paper.

The TUoSA will be between the **WFPS** and SONI. Among other things it places obligations on the **WFPS** to comply with the entire **Grid Code**. The **Grid Code Connection Conditions** outline SONI's requirement for interfacing with **WFPS** and this **WFPS Settings Schedule** outlines SONI's/NIE's requirement for interfacing with **WFPS**. This **WFPS Settings Schedule** details the full range of tests that are required to assess Compliance

with the **Connection Conditions**; it also outlines SONI/NIE's requirements on certain aspects of a **WFPS** performance.

## 4.3 GRID CODE COMPLIANCE AGREEMENT (GCCA)

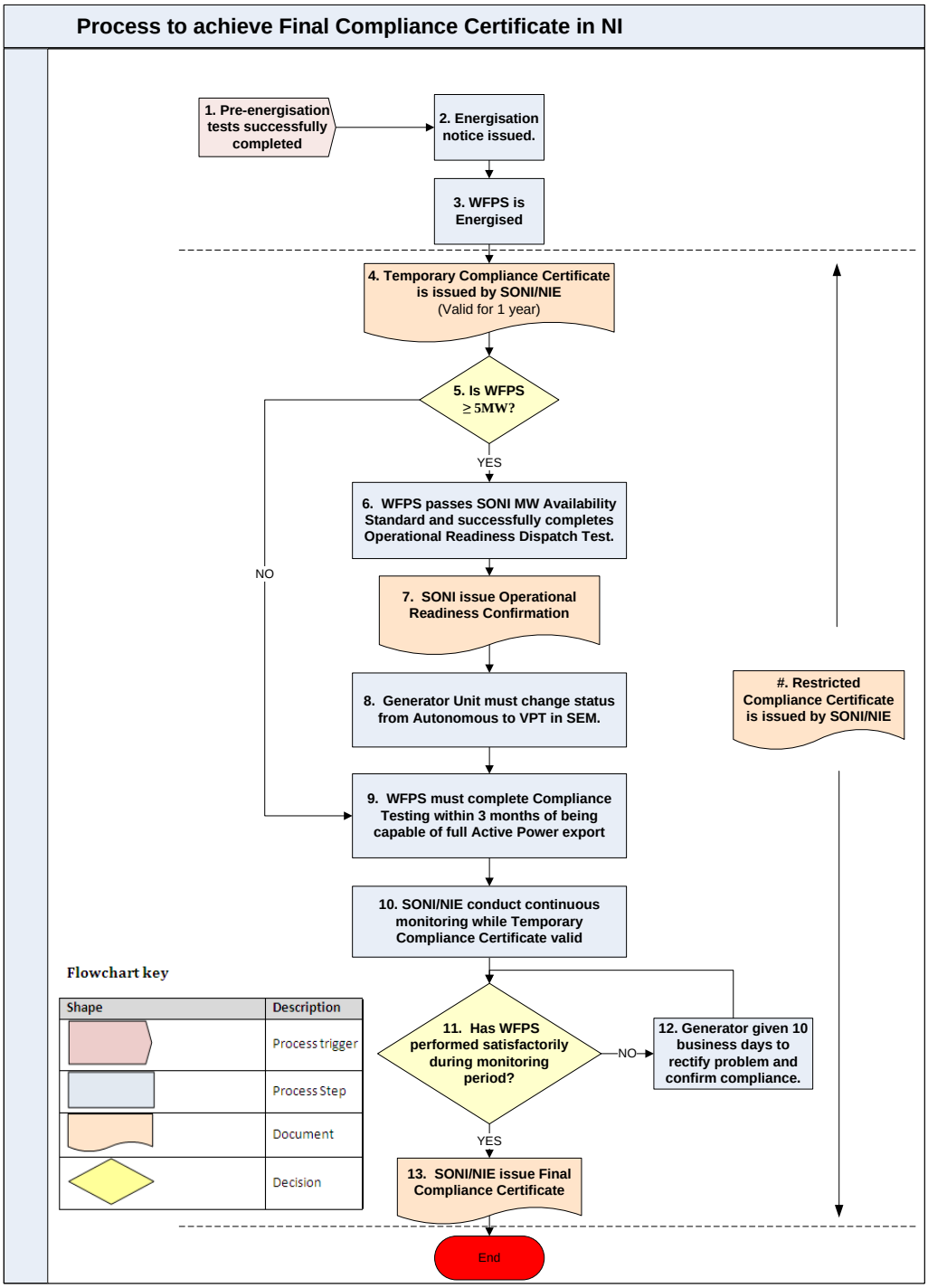
**WFPS** with a **Registered Capacity** between 5-10**MW** will be required pursuant to its Connection Agreement with the **DNO** to enter into a GCCA if the **WFPS** is not a **SEM** participant.

The GCCA places obligations on the **WFPS** to comply with the **Grid Code Connection Conditions**. The **Grid Code Connection Conditions** outlines SONI's requirement for interfacing with **WFPS** and this **WFPS Settings Schedule** outline SONI's/NIE's requirement for interfacing with **WFPS**. This **WFPS Settings Schedule** details the full range of tests that will be required to assess Compliance with the **Connection Conditions**; it also outlines SONI/NIE's requirements on certain aspects of a **WFPS** performance.

## 5.0 COMPLIANCE PROCEDURES

The flow chart in Figure 1 below explains the connection/Compliance processes that will be involved from pre-energisation to the issuing of a Final Compliance Certificate in accordance with CC.S2.1.10.2 and CC.S2.2.7.2 of the **Grid Code**. Each step in the flow chart is described in the table on page 11.

*Figure 1: Connection/Compliance Processes for Transmission & Distribution Connected* ***WFPS***



| Step No. | Step | Description |
|---|---|---|
| 1 | Pre-energisation tests successfully completed | As per the pre-energisation checklist (included in Appendix B1 of this document). |
| 2 | Energisation notice issued | NIE will confirm to the **Generator** that the **WFPS** is ready to be energised. |
| 3 | **WFPS** Is Energised | **WFPS** is Energised (NIE Circuit Breaker at the **WFPS Connection Point** is closed). |
| 4 | Temporary Compliance Certificate issued | A Temporary Compliance Certificate[3] is issued when the **WFPS** is energized. The Temporary Compliance Certificate is valid for 1 year from when the **WFPS** is due to begin exporting **Active Power**. |
| 5 | Is **WFPS** ≥5**MW**? | If the **WFPS** is <5**MW** the **Generator** can skip to step 9.<br>If the **WFPS** is ≥5**MW** the **Generator** must proceed to step 6. |
| 6 | **WFPS** passes SONI **MW Availability** Standard and successfully completes Operational Readiness Dispatch Test | Once the **WFPS** is capable of full **Active Power** export and the **WFPS** is continuously passing the SONI MW Availability standard (Appendix C) for 2 weeks SONI will carry out a Operational Readiness Dispatch test (Section 6.2.1 of this **WFPS Settings Schedule**). On the successful completion of this test, SONI will issue an Operational Readiness Confirmation to the **WFPS** |
| 7 | Operational Readiness Confirmation issued | The Operation Readiness Confirmation is issued by SONI to the **WFPS**. |
| 8 | The **WFPS** must change its status in the **SEM** to VPT unit. | The Operation Readiness Confirmation issued by SONI to the **WFPS** will allow the **Generator** unit to change its status in the **SEM** from Autonomous Unit to Variable Price Taker Unit |
| 9 | **WFPS** must complete Compliance testing | From the date the **WFPS** is capable of full **Active Power** export, the **WFPS** will have a period of 3 months to complete Compliance Testing (wind levels permitting) and submit to SONI an updated UDL containing a satisfactory "Final Report". |
| 10 | SONI/NIE conduct Continuous **Monitoring** | For the full duration of the validity of the Temporary Compliance Certificate the **WFPS** shall be subject to continuous **Monitoring** by SONI/NIE. SONI/NIE may extent the validity of the Temporary Compliance Certificate beyond 1 year if it is deemed necessary. |
| 11 | Has **WFPS** performed satisfactorily during **Monitoring** period? | SONI/NIE shall confirm if the **WFPS** has performed satisfactorily for the full duration of the **Monitoring** period. If the **WFPS** has performed satisfactorily, SONI shall issue the **WFPS** with a Final Compliance Certificate[4]. If the **WFPS** has not performed satisfactorily, SONI/NIE will engage with the **WFPS** to resolve the issue. This may require some retesting or an extension of the continuous **Monitoring** period. |
| 12 | SONI issue Full Compliance Certificate | |
| # | SONI/NIE issue Restricted Compliance Certificate | If a non Compliance arises at any point from energisation throughout the full operational life of the **WFPS**, SONI/NIE may issue the **Generator** with a Restricted Compliance Certificate, which will detail the level of non Compliance of the **WFPS**, the time frame to rectify the non Compliance and the MVA restriction to which the **WFPS** will be capped until the non Compliance is resolved. |

[3] The Temporary Compliance Certificate that will be issued to the **WFPS** is a joint SONI/NIE certificate that will cover the SONI requirements that are stipulated in **Grid Code** CC.S2.1.10.2 and CC.S2.2.7.2 regarding Temporary **Grid Code** Compliance Certification and also cover the Temporary **Distribution Code** Compliance Certification.

[4] The Final Compliance Certificate that will be issued to the **WFPS** is a joint SONI/NIE certificate that will cover the SONI requirements that are stipulated in **Grid Code** CC.S2.1.10.2 and CC.S2.2.7.2 regarding Final **Grid Code** Compliance Certification and also cover the Final **Distribution Code** Compliance Certification.

## 5.1 PRE-ENERGISATION

A Commissioning/Acceptance Test Panel will be set up in advance of energisation of the **WFPS**. This panel will be made up of representatives from SONI and NIE (the **Generator** may be asked to attend meetings to provide input to the connection process).

In advance of any **WFPS** commissioning tests, the Commissioning/Acceptance Test Panel will act as the interface with the **WFPS**. The **WFPS** should be aware that this interface would normally be available in weekday working hours only.

Energisation cannot take place prior to all relevant agreements (as described in section 4 of this **WFPS Settings Schedule**) being signed.

The **Generator** must submit a commissioning program to SONI/NIE at least six weeks prior to energisation. If the commissioning program changes, the **Generator** must submit a revised commissioning program to SONI/NIE immediately; this may impact on testing timelines.

Prior to energisation on to the NIE T&D **System**, pre-energisation test CC11.3 of the **Distribution Code** of this document must be completed as per pre-energisation check list included in Appendix B1. If SONI/NIE accept that all pre-energisation criteria have been met then an energisation notice will be issued.

At least 6 weeks in advance of the proposed energisation date (or such longer period as SONI may reasonably consider to be appropriate in the circumstances), the **Generator** must provide SONI with all the information requested under **Distribution Code** CC10, **Grid Code** CC10 (for **User**s connecting to the Transmission **System**) or CC11 (for **User**s connecting to the **Distribution System**) including updated Planning Code Data, connection date, type test reports, details of Protection arrangements and the Statement of Compliance. This information shall be provided in the format described in Section 6.8 – **User** Data Library (UDL). SONI will make this UDL available to NIE.

SONI/NIE's objective in seeking this information is to establish from the **WFPS** the schedule of commissioning tests which may have an impact on the NI T&D **System**. In some occasions it may be necessary to carry out specific network studies using the data provided by the **WFPS**. The purpose of these operational studies is to determine if any of the proposed **WFPS** will have a detrimental effect on the NI T&D **System**. The costs incurred by this report will be met by the **WFPS**.

### 5.1.1 METERING ARRANGEMENTS

*(This section 5.1.1 (Metering Arrangements) has been included for information only)*

All **WFPS** main meters will be connected using IP (Internet Protocol) over NIE's OTN (Operational Telecoms Network), check meters will be connected via IP over VPN (Virtual Private Network) on a broadband connection. The broadband connection for the VPN will be supplied by the **Generator** and will be supplied on dedicated equipment with a public routable static IP address solely allocated for SONI/metering use. Please note site broadband / IP phones are not acceptable. The termination of the broadband connection should be at the metering / comms cabinets where the Cable and Wireless routers will be installed. To ensure security of the broadband connection, a Universal Power Supply (UPS) will be installed.

### 5.1.2 METERING RELIABILITY TESTS

*(This section 5.1.2 (Metering Reliability Tests) has been included for information only)*

Testing will only commence following successful connection of both primary and backup communications. Testing of the main communication link to **WFPS** will last for a minimum of 10 days before communications reliability will be confirmed and the **WFPS** will be allowed to enter the **SEM** (Back-up comms links will also be spot-checked during this period). Registration to the SEM will only be approved by SONI once there has been 10 days of successful consecutive comms to meters.

The **Generator** must ensure the meter has a working power supply to ensure that the communication to the meter can be tested. Reliability testing can commence prior to energisation, i.e. an on-site diesel generator can be used to energise meters. If the **Generator** does not wish to power the meter for testing prior to energisation then the test phase will begin once the site/meter has been energised. Please note that the market does not settle in retrospect and payment for exported energy is only from approved registration date.

### 5.1.3 SCADA FUNCTIONALITY TEST

*(This section 5.1.3 (SCADA Functionality Test) has been included for information only)*

Prior to energisation, the **Generator** must prove the functionality of all SCADA signals from each **Generating Unit** right though to Castlereagh House Control Centre (some functionality will have to be proven to the Distribution Control Centre for Distribution connected **WFPS**).

This functionality test is required to ensure that when the **WFPS** is energised that SONI/NIE will have full control from the instant that the site is capable of **Active Power** export.

When all **WFPS** SCADA is in place, the **Generator** must contact SONI SCADA (and NIE SCADA for Distribution connected **WFPS**) to carry out this SCADA functionality test. To ensure security of the power supply to the RTU, a UPS will be installed (for Transmission connected **WFPS** one UPS will be sufficient for both the RTU and the metering comms).

## 6.2 CONTROLLABILITY & COMPLIANCE CERTIFICATION

The Commissioning/Acceptance Test Panel will co-ordinate and agree the Compliance testing program, provide direction on technical requirements, assess the test results and decide if Compliance has been achieved by the **WFPS**.

Upon energisation of the **WFPS** (i.e. closing of the NIE circuit breaker), as per **Grid Code** CC.S2.1.10.2 and CC.S2.2.7.2, SONI/NIE will issue the **WFPS** with a Temporary Compliance Certificate which will be valid for a period of one year from the date that the **WFPS** is due to begin **Active Power** export. The **WFPS** must be fully remotely controllable by SONI/NIE from energisation. SONI will perform **Active Power** control tests when the **WFPS** begins **Active Power** export. Until controllability has been proven,

the **Generator** must restrict the Apparent Power export of the **WFPS** to 5MVA. The **Active Power Output** control may need to be demonstrated at other Apparent Power output levels (to be agreed by the Commissioning/Acceptance Test Panel) as the **WFPS** ramps up **Active Power** export to its **Registered Capacity**. The **WFPS** will be capped at each pre-agreed level until controllability has been demonstrated.

From the date when the **WFPS** is capable of full **Active Power** export, the **WFPS** will have a period of three months to complete Compliance testing (wind levels permitting) and submit an updated **User** Data Library containing a satisfactory Final Report to SONI. For the full duration of the validity of the Temporary Compliance Certificate, the **WFPS** will be subject to continuous **Monitoring** by SONI/NIE (the validity of the Temporary Compliance Certificate can be extended if it is deemed necessary to so). Upon confirmation from SONI and NIE that the **WFPS** has performed satisfactorily for the full duration of the **Monitoring** period, SONI/NIE will issue the **WFPS** with a Full Compliance Certificate. Continuous **Monitoring** of the **WFPS** will be conducted by SONI/NIE throughout the operational lifetime of the **WFPS**. Should a non-Compliance arise, SONI/NIE may revoke the Final Compliance Certificate until the issue is resolved (CC.S2.1.10.2 for Transmission **System** connected **WFPS** and CC.S2.2.7.2 for **Distribution System** connected **WFPS**).

The **Generator** must fully complete all the applicable Compliance tests included in Section 6.0 of this **WFPS Settings Schedule** in the timelines stipulated. Failure to complete Compliance testing in the stipulated timelines while conditions were suitable for testing will result in the Temporary Compliance Certificate for the **WFPS** being revoked and the **Generator** will be disconnected from the **NI System** until the **Generator** is in a position to resume Compliance testing. If an updated version of the **WFPS Settings Schedule** is released during this period, the Commissioning/Acceptance Test Panel will insist that the **Generator** carry out testing as per the criteria specified in the most recent version.

For **WFPS** greater than 30**MW** it may be necessary to split the testing up into the manageable **Active Power** blocks; this will be agreed by the Commissioning/Acceptance Test Panel during the Connection Process. Whereby full Compliance must be demonstrated at each **Active Power** block before another 30**MW** block is commissioned.

As mentioned previously, the purpose of this **WFPS Settings Schedule** is for the **WFPS** to demonstrate Compliance with SONI **Grid Code**, the NIE **Distribution Code** and the requirements of other Bilateral Agreements which may exist (see section 4).

All tests will need to be planned into the **WFPS** Commissioning Programme on dates agreed by the Commissioning/Acceptance Test Panel. This includes Compliance tests and any other tests that the **Generator** needs to carry out at the **WFPS**. All Compliance tests must be carried out to the procedures laid out in this document. The Commissioning/Acceptance Test Panel will verify that the proposed tests will comply with **Grid Code** and **Distribution Code** requirements.

It should be noted by the **Generator** that if SONI/NIE deem the **WFPS** to be of a **Registered Capacity** which may have an impact on **NI System** during Compliance testing, we have the right to insist the **Generator** follow the procedures laid out in **Grid Code OC10 System Tests** in addition to what is laid out in this **WFPS Settings Schedule**.

### 5.2.1 OPERATIONAL READINESS CONFIRMATION

As per Step No.6 of Section 5.0 of this **WFPS Settings Schedule**, when the **WFPS** is capable of full **Active Power** export and the **Generator** confirms to SONI that the **MW Availability** is of an accuracy level which ,will pass the SONI **MW Availability** Standard (detailed in Appendix C), SONI will begin continuous monitoring of the **MW Availability** signal that the **WFPS** is submitting via SCADA. If the **WFPS** passes the SONI **MW Availability** standard continuously for two weeks, then when wind conditions allow (**WFPS Output** ≥ 50% **Registered Capacity**) SONI will carry out a **Dispatch** Test to verify that the **WFPS** is remotely **Controllable** via SCADA. The **Generator** will not be informed of when this test is taking place. The format of the **Dispatch** Test conducted by SONI will be as follows:

| **Dispatch** Test Sequence | |
|---|---|
| Step No. | Action |
| 1 | SONI will send the **WFPS** a **MW** set point which equates to 10% **Registered Capacity**. |
| 2 | The **WFPS** will send SONI/NIE confirmation of the **MW** set point. |
| 3 | SONI will send **WFPS** a Curtailment Time Interval set point of 1 minute. |
| 4 | The **WFPS** will send SONI/NIE confirmation of the Curtailment Time Interval set point. |
| 5 | SONI will turn on 'Emergency Action' mode. |
| 6 | The **WFPS** will ramp at the **Active Power Control Set-Point Ramp Rate** |
| 7 | When the **WFPS** has achieved the specified **MW** set point in the specified Curtailment Time Interval, the **WFPS** is required to remain at that set point for 5 minutes. |
| 8 | SONI will send the **WFPS** a 0 **MW** set point |
| 9 | The **WFPS** will send SONI/NIE confirmation of the **MW** set point. |
| 10 | SONI will send **WFPS** a Curtailment Time Interval set point of 3 minutes. |
| 11 | The **WFPS** will send SONI/NIE confirmation of the Curtailment Time Interval set point. |
| 12 | The **WFPS** will ramp at the **Active Power Control Set-Point Ramp Rate** |
| 13 | When the **WFPS** has achieved the 0 **MW** set point in the specified Curtailment Time Interval, the **WFPS** is required to remain at that set point for 5 minutes. |
| 14 | SONI will send the **WFPS** a **MW** set point which equates to 50% **Registered Capacity**. |
| 15 | The **WFPS** will send SONI/NIE confirmation of the **MW** set point. |
| 16 | SONI will send **WFPS** a Curtailment Time Interval set point of 1 minute. |
| 17 | The **WFPS** will send SONI/NIE confirmation of the Curtailment Time Interval set point. |
| 18 | The **WFPS** will ramp at the **Active Power Control Set-Point Ramp Rate** |
| 19 | When the **WFPS** has achieved the specified **MW** set point in the specified Curtailment Time Interval, the **WFPS** is required to remain at that set point for 5 minutes. |
| 20 | SONI will turn off 'Emergency Action' mode. |
| 21 | The **WFPS** is allowed to ramp up to MIO at the **Wind Following Ramp Rate** |

If SONI deems the **WFPS** to have performed satisfactorily in the **Dispatch** Test then Operational Readiness Confirmation will be issued to the **WFPS**.

## 5.3 CONTROLLABILITY TESTING

Some of the tests mentioned will be carried out remotely from the SONI Control Centre or the NIE Distribution Control Centre. An engineer will be allocated to coordinate these tests at the appropriate Control Centre and arrange a witnessing engineer. During these controllability tests it is the responsibility of the **WFPS** to record the specified results and present them in the format described in section 5.5.

## 5.4 TEST WITNESSING

The Commissioning/Acceptance Test Panel will decide whether test witnessing as described in CC10.1.5 (and for **WFPS**s connected to the distribution-**System**, CC11) will be carried out, how witnessing shall be carried out (by remote monitoring, by presence at the **WFPS** or by recording agreed parameters) and arrange witnessing if required. The Commissioning/Acceptance Test Panel will inform the **WFPS** of the schedule of tests to be witnessed and may vary this by reasonable notice. (CC10.1.5).

Where the Commissioning/Acceptance Test Panel decides to witness any test, this shall not relieve the **WFPS** of any responsibility for Compliance with the **Grid Code**, the **Distribution Code** or other standard to be used as a fair measure, nor shall the act of witnessing be deemed to transfer any responsibility to the Commissioning/Acceptance Test Panel either for Compliance or for the consequences of failure to comply.

## 5.5 TEST RESULTS

It is the responsibility of the **WFPS** to provide fast speed digital recording equipment for the purpose of analysing test results. Voltage Response Test results (6.7 Automatic **Voltage Control** Test) must have a minimum resolution of 500Hz. **Frequency** Response Tests (6.5 **Frequency Control** Test) must have a minimum resolution of 15Hz. A resolution of 10Hz is sufficient for the remaining tests.

Provided the **Generator** can guarantee in advance that no data will be lost for the duration of testing, SONI/NIE may allow the **Generator** to record and conduct some tests remotely. This will be agreed with the Commissioning/Acceptance Test Panel in advance of testing.

It is the responsibility of the **WFPS** to produce credible results for each test to the Commissioning/Acceptance Test Panel. Failure to do so may require the **WFPS** to repeat certain tests. The format of the results, for example in graphical and tabular form, should be agreed with the Commissioning/Acceptance Test Panel 6 weeks in advance of the tests taking place. The Commissioning/Acceptance Test Panel may require the **WFPS** to calculate and present the **Frequency** droop characteristics.

It is important that results are legible, clearly labelled and graphs appropriately scaled in engineering units. The Commissioning/Acceptance Test Panel require that all tests are appropriately annotated. Annotated Microsoft Excel ® Compliance test examples are included in Appendix E. The **Generator** should ensure all graphs to be submitted are annotated with at least that shown in Appendix E.

Test results must be submitted to SONI/NIE within 2 weeks after the completion of the tests. The Commissioning/Acceptance Test Panel will require at least 6 weeks to fully analyse the content of the UDL and the test results contained within it to determine whether or not the **WFPS** is compliant.

## 5.6 POST ENERGISATION MONITORING

Upon satisfactory completion of Compliance Testing, the **WFPS** will be subject to a **Monitoring** period by SONI/NIE. Data sent via the Energy Management System (EMS), and retrieved from **Event Recorder**s, is interrogated to determine whether or not the **WFPS** is performing adequately.

The data collected is used to assess the **WFPS** performance in a number of key areas which are outlined in the criteria below. For the items below, the relevant data is downloaded from the appropriate source and transferred into tabular and graphical form along with the limits. The data is then compared against any limits or set points to confirm continued Compliance with the **Grid Code** and **WFPS Settings Schedule**.

### 5.6.1 DISTURBANCE RESPONSE ANALYSIS

1. **Low Voltage Ride Through Capability of the WFPS**
   The ability to retain voltage during a disturbance is checked by ensuring the voltage transient keeps within the limits set out in the following sections of the **Grid Code**:
   For Transmission Connected **WFPS**: CC.S2.1.3.6 (a).
   For Distribution Connected **WFPS**: CC.S2.2.3.3 (a).

2. **High Voltage Ride Through Capability of the WFPS**
   The **WFPS** voltage during a disturbance will be monitored and investigated against the high voltage limits stated in the **Grid Code** section as follows:
   For Transmission Connected **WFPS**: CC.S2.1.3.6 (f).
   For Distribution Connected **WFPS**: CC.S2.2.3.3 (e).

3. **Active and Reactive Power Recovery of the WFPS post fault**
   Active and **Reactive Power** capability post fault is measured against the limits set out in the following sections of the **Grid Code**:
   For Transmission Connected **WFPS**: CC.S2.1.3.6 (c) & (d).
   For Distribution Connected **WFPS**: CC.S2.2.3.3 (c).

4. **Behaviour of the WFPS during low and high Frequency excursions**
   In the event of low/high **Frequency** excursions, the **WFPS** shall comply with the criteria as per the **Grid Code** sections below:
   For Transmission Connected **WFPS**: CC.S2.1.3.4, CC.S2.1.3.7 (b), CC.S2.1.5.2 (a) & (b) and CC.S2.1.9.3.
   For Distribution Connected **WFPS**: CC.S2.2.3.1, CC.S2.2.3.4 (b), CC.S2.2.5.2 (a) & (b) and CC.S2.2.6.3.

5. **Any significant change in rate of change of Frequency**
   During a disturbance, the **WFPS** should be able to withstand the levels of Rate of Change of **Frequency** (RoCoF) as set out in the following **Grid Code** sections:
   For Transmission Connected **WFPS**: CC5.3.3.
   For Distribution Connected **WFPS**: CC5.3.3.

6. **Negative Phase Sequence Loadings**
   This parameter will not be actively monitored however if an applicable event occurs, where negative phase sequence loading could be a possible cause, the loadings will be investigated and compared to the limits stated in the Connection Agreement.
   For Transmission Connected **WFPS**: CC.S2.1.7.
   For Distribution Connected **WFPS**: N/A.

7. **Harmonic Distortion**
   Total Harmonic Distortion must be kept under a percentage of the fundamental voltage. The limits of harmonic distortion are specified in the below document:
   For all **WFPS**: Engineering Recommendation G5/4.

8. **Voltage Control and Reactive Power Capability of the WFPS**
   Whilst in pf mode: Historical data will be investigated to ensure that, for any given time, the power factor the **WFPS** is operating at is staying consistent with the power factor set point sent to the **WFPS** at that time.
   Whilst in **Voltage Control:** Historical data will be investigated to ensure that, for any given time, the voltage setpoint at the **Connection Point** as instructed by SONI via SCADA is being achieved by the **WFPS** (if it has the reactive capability to do so).
   Whilst in **Reactive Power Dispatch** Control**:** Historical data will be investigated to ensure that, for any given time, the **Mvar** setpoint at the **Connection Point** as instructed by SONI via SCADA is being achieved by the **WFPS** (if it has the reactive capability to do so).

   These capabilities are quantified in the following **Grid Code** section:
   For Transmission Connected **WFPS**: CC.S2.1.3.2.
   For Distribution Connected **WFPS**: N/A.

### 5.6.2 GENERAL PERFORMANCE ANALYSIS

1. **Response of the WFPS during High Wind Speed Shutdown events**
   The **WFPS** high wind speed shut down alarm events are validated by comparing the following parameters: wind speed, shut down set point of **Generating Unit**s, **MW Availability** signal and percentage shut down signal at the time of the event.
   The number of shut down **Generating Unit**s should correspond to the wind speed at the time of the event. The number of shut down **Generating Unit**s, **MW Availability** signal and percentage shut down signal should also correlate. For example if a 10MW **WFPS** has 20 0.5MW **Generating Unit**s, and it loses 2 **Generating Unit**s in high speed, the MW Availability should show 9MW and the percentage shut down should state 10%. This confirms whether or not a **WFPS** is responding sufficiently to high wind speed shut down events. For reference in the **Grid Code** see below:
   For Transmission Connected **WFPS**: CC.S2.1.3.7 (d).
   For Distribution Connected **WFPS**: CC.S2.2.3.4 (d).

2. **Accuracy of the MW Availability Signal being provided to SONI by the WFPS**
   The **MW Availability** is continuously monitored using a normalised root mean square deviation (NRMSD). The NRMSD for a **WFPS** for a given day will be calculated. This will use one minute MW Availability data averaged over the half hour period recorded and the 30 minute metered output for the **WFPS**.
   The rolling 14-day NRMSD must be less than or equal to 8% and the number of days where the daily NRMSD exceeds the 5% standard must not exceed 2 days in any 14-day period. This criterion is not used for periods where the **WFPS** was dispatched away from its MW Availability by SONI. See below reference to MW availability in the **Grid Code**:
   For all **WFPS**: SDC1.4.3.2

3. **Meeting Dispatch Instructions and Ramp Rates**
   As part of a daily check, the **WFPS** are monitored on their previous days performance. Their performance is measured against the following:
   - Compliance with a **Dispatch** instruction as required in this **WFPS Settings Schedule**.
   - Performing an instruction within the agreed ramp rates.

## 5.7 SOFTWARE/HARDWARE UPGRADES OR MODIFICATIONS AFFECTING COMPLIANCE

If the **Generator** plans to introduce software modifications, hardware modifications or upgrades to the **WFPS** that may affect Compliance, both SONI and NIE must be informed at least six weeks in advance. The **Generator** must provide a detailed description of the proposed modification and inform SONI and NIE if aspects of the control functionality with respect to **Grid Code** or **Distribution Code** Compliance have changed. All aspects of the control functionality of the **WFPS** must still be compliant with both the **Grid Code** and the **Distribution Code**. If SONI and NIE feel that retesting will be required to check any software/hardware modification then the **Generator** will be required to retest any functionality that SONI and NIE stipulate in order to demonstrate Compliance.

At all times SONI and NIE must be in possession of an up-to-date full and accurate parameter listing of the **WFPS**. This parameter listing must cover all operational control functionality including **Frequency**, voltage and all the **WFPS** parameters relating the control and operation of the **WFPS**. This parameter listing should be forwarded to SONI six weeks before Compliance Testing commences. There should be no prior modification of control parameters until they have been agreed with SONI/NIE. Should this parameter listing change at any stage, the **Generator** must reissue the revised parameter listing to SONI and NIE.

## 5.8 THE USER DATA LIBRARY

The **User** Data Library (UDL) provides a common directory structure where information in support of Compliance statements and technical data can be submitted. The empty directory structure of the UDL will be provided by SONI. The structure of UDL is given in Appendix A of this document.

The UDL structure provided by SONI (Appendix A) should be used as a guide for the **User** to provide **Grid Code** data; it should be noted that certain **WFPS** may be required to provide further technical information as per PC.A3.4.1 and PC.B3.3.1.

Six weeks prior to energisation a **User** shall submit to SONI an interim version of this report with all relevant/applicable sections at that date fully completed. The final version of the UDL is to be submitted to SONI in an agreed format within two months of completion of **Grid Code** Compliance testing. Please note it is recommended that the Modelling section of the UDL should be provided to SONI at least six months prior to energisation. Further detail on modelling is included in Appendix D of the **Planning Code**.

At the end of this Compliance process the UDL should contain data as per the installed and tested plant. Consequently the UDL can only be completed at the end of this process. In the beginning the UDL will have signed legal agreements and the Committed Project Planning Data required by the **Planning Code** of the **Grid Code**. As the process develops it will be updated. The nature of the data required at each stage of the process is described later in this document.

All data in relation to the UDL will be jointly accessible by SONI and NIE.

*Format of Data*
**Generator**s are requested to submit all data in standard formats for incorporation into SONI's Data Library.

Unless otherwise agreed submissions should be in the following file formats.

- Specifications, Statements, Agreements and Technical Reports in PDF format
- Signed Documents in scanned PDF format.
- Test result data points in XLS format (e.g. Excel ®)
- Performance Charts/Plots PDF and/or XLS format.
- Drawings in PDF or JPEG format.
- Simulation Models in the form of transfer function block diagrams (using PDF or DWG format)

Where documents and diagrams are provided as supporting information, they should be legible and should include all relevant data assumptions (for example **Generator** base, p.u., percentage values etc).

Where testing and **Monitoring** results are provided they should be legible, appropriately sized, scaled and labelled.

*Media Formats*
At the time of writing the preferred format for submitting this information to SONI is Compact Disk or an encrypted USB storage device. Submitted compact disks should

have the version number printed or written on them and should contain a revision history indicating what has changed from version to version.

## 5.9 FAULT RIDE THROUGH

Current **Grid Code** requirements for the Fault Ride Through capability of Transmission and Distribution connected **WFPS** are specified in CC.S2.1.3.6 and CC.S2.2.3.3 respectively.

*This section (5.9 Fault Ride Through) has been included for information for the* ***Generator*** *only.*

At present, the **Grid Code** and **Distribution Code** do not specify **WFPS** performance in terms of Active and **Reactive Power** response during faults. SONI/NIE are currently researching this area so that optimum performance is attained from all **WFPS** on the All Island **System**.

The performance of the **WFPS** must be described accurately in type test results and dynamic model performance. The mode of operation during Fault Ride Through will depend on a number of **System** characteristics e.g. **System** fault level, network configuration, network voltage level etc. It is important in advance of commissioning that the **Generator** and the **TSO**/**DNO** fully discuss the operational requirements of the specific **WFPS** connection for fault performance.

Performance criteria which are important are Active and Reactive current injections for various voltage depressions on the network. It is also important to understand when the **WFPS** will go into zero Active and **Reactive Power** export.

## 6.0 COMPLIANCE TESTS

The following section details the Compliance tests for Transmission and Distribution connected **WFPS**. The **Generator** must fully complete all the applicable Compliance tests included in this section in the timelines stipulated. Failure to complete Compliance testing in the stipulated timelines even though conditions were suitable for testing will result in the Temporary Compliance Certificate for the **WFPS** being revoked and the **Generator** will be disconnected from the **NI System** until the **Generator** is in a position to resume Compliance testing. If an updated version of the **WFPS Settings Schedule** is released during this period, the Commissioning/Acceptance Test Panel will insist that the **Generator** carry out testing as per the criteria specified in the most recent version.

A Distribution Connected **Generator** must complete the following Compliance tests with SONI:

6.1 **Active Power** Control Test
6.2 Ramp Blocking Test
6.3 **MW Availability** Test
6.5 **Frequency Control** Test
6.10 **Shutdown** Request Test
6.11 **Start-Up** Sequence & Ramp Rate Test

A Distribution Connected **Generator** must complete the following Compliance tests with NIE:

6.6 **Voltage Control** Mode and Reactive Capability Tests
6.7 Automatic **Voltage Control** Test
6.8 Power Factor Control Test
6.9 **Reactive Power Dispatch** Test
6.12 Project Specific Tests

A Distribution Connected **Generator** must complete the following Compliance tests with both SONI and NIE (tests will be carried out once with SONI and/or NIE present as witnesses):

6.4 **WFPS** Control System Tests

A Transmission Connected **Generator** must complete the following Compliance tests with SONI:

6.1 **Active Power** Control Test
6.2 Ramp Blocking Test
6.3 **MW Availability** Test
6.4 **WFPS** Control System Tests
6.5 **Frequency Control** Test
6.6 **Voltage Control** Mode and Reactive Capability Tests
6.7 Automatic **Voltage Control** Test
6.8 Power Factor Control Test
6.9 **Reactive Power Dispatch** Test
6.10 **Shutdown** Request Test
6.11 **Start-Up** Sequence & Ramp Rate Test

A Transmission Connected **Generator** must complete the following Compliance tests with NIE:

6.12 Project Specific Tests

## 6.1 ACTIVE POWER CONTROL TEST

| Compliance Testing/**Monitoring** | |
|---|---|
| Title of Test: **Active Power** Control | Test Number: 1 |

*Purpose of Tests*:

The **Active Power** Control Test will be carried out by the **Generator** to assess the ability of the **WFPS** controller to achieve any **Output** at or below the **MW Availability** figure in a specified time, as instructed by SONI/NIE.

This test will be carried out at a time when the actual **MW Output** of the **WFPS** is greater than 50% of **Registered Capacity** and 100% of the **WFPS Generating Unit**s are in service. SONI may require the **Generator** to repeat the tests on a day where the **MW Output** of the **WFPS** is >80% **Registered Capacity** to fully test this functionality, this will be agreed with the **Generator** on the day of the test.

*Results Required*:

Time series record and Microsoft Excel Plot (Appendix E) showing:

- **MW Output**
- **MW Availability**
- **MW** set point received via SONI/NIE SCADA
- **WFPS** Active Set Point
- Emergency Action On/Off
- Wind Speed

*Test Assessment*:
This test is required to show Compliance with CC.S2.1.3.7 (d) for Transmission Connected **WFPS** and CC.S2.2.3.4 (d) for Distribution Connected **WFPS**.

*Criteria of Assessment*:

- The **MW Output** of the **WFPS** should be within 3% (based on **Registered Capacity**) of the **MW** set point calculated by the **WFPS** Controller at all times. SONI will assess wind conditions for the duration of testing and take any wind gusting or wind drops into account.
- The **WFPS** should reach the '**MW** set point' within ±10 seconds of the specified 'Curtailment Time Interval'.
- Whilst 'Emergency Action' mode is on, the **WFPS** will ramp at the **Active Power Control Set-Point Ramp Rate**. The **MW** change should be at a continuous linear ramp down or up rate over the time frame given.
- The **WFPS** response will be assessed from the time the Emergency Action Mode is engaged.
- Upon removal of the 'Emergency Action' mode by SONI, the **WFPS** should ramp up at the **Wind Following Ramp Rate**; this ramp shall be a percentage of **Registered Capacity** of the **WFPS** per minute which equates to 5**MW**/min (if a different ramp rate was agreed between SONI/NIE and the **Generator** then SONI will require the agreed ramp rate being implemented). The ramp rate is the average rate of change in **Output** measured over any 10 minute period.

### 6.1.1 ACTIVE POWER CONTROL TEST PROCEDURE

The **WFPS** shall be able to reduce or increase **Output** to a **MW** set point between 0**MW** and the Maximum Instantaneous **Output** (MIO) of the **WFPS**. The change in **Output** should take place in a specified 'Curtailment Time Interval' between 1 and 30 minutes.

***Active Power*** *Control Compliance Tests*

**Active Power** Control testing should be carried out when 100% of the **WFPS Generating Unit**s are in service. The available power on the day of testing should be greater than 50% of **Registered Capacity** for the full duration of the tests. (SONI may require the **Generator** to repeat the tests on a day where the **MW Output** of the **WFPS** is >80% **Registered Capacity** to fully test this functionality over the full operating range of the **WFPS**. This will be agreed with the **Generator** on the day of the test. Failure to complete this test at the higher **MW Output** will not prevent the **WFPS** from becoming Compliant but the test must be completed within 6 months of obtaining a Temporary Compliance Certificate).

| Test | Time Interval to Reach Required Set point | | |
|---|---|---|---|
| | Test No.1 | Test No.2 | Test No.3 |
| SONI will reduce the **WFPS MW Output** from MIO to DMOL (DMOL to be agreed with the **Generator** prior to testing). The **WFPS** will ramp at the **Active Power Control Set-Point Ramp Rate**. The **WFPS** will remain at this agreed figure for 10 min before commencing Test No.2. | 1 Min | | |
| SONI will increase the **MW Output** of the **WFPS** from DMOL (DMOL to be agreed with the **Generator** prior to testing) to a MW set point that is half of MIO. The **WFPS** will ramp at the **Active Power Control Set-Point Ramp Rate**. The **WFPS** will remain at this agreed figure for 10 min before being allowed to ramp back up to MIO at the **Wind Following Ramp Rate**. | | 15 Mins | |
| SONI will reduce the **WFPS** from MIO to DMOL (DMOL to be agreed with the **Generator** prior to testing). The **WFPS** will ramp at the **Active Power Control Set-Point Ramp Rate**. The **WFPS** will remain at this agreed figure for 10 min before being allowed to ramp back up to MIO at the **Wind Following Ramp Rate.** | | | 30 Mins |

| **Active Power** Control Test Sequence for Test No.1-3 | |
|---|---|
| Step No. | Action |
| 1 | SONI will send **WFPS** a Curtailment Time Interval set point. |
| 2 | The **WFPS** will send SONI/NIE confirmation of the Curtailment Time Interval set point. |
| 3 | SONI will send the **WFPS** a **MW** set point. |
| 4 | The **WFPS** will send SONI/NIE confirmation of the **MW** set point. |
| 5 | SONI will turn on 'Emergency Action' mode. |
| 6 | The **WFPS** will ramp at the **Active Power Control Set-Point Ramp Rate** |
| 7 | When the **WFPS** has achieved the specified **MW** set point in the specified Curtailment Time Interval, the **WFPS** is required to remain at that set point for 10 minutes. |
| 8 | SONI will turn off 'Emergency Action' mode. |
| 9 | The **WFPS** is allowed to ramp up to MIO at the **Wind Following Ramp Rate** |

## 6.2 RAMP BLOCKING TEST

| Compliance Testing/**Monitoring** | |
|---|---|
| Title of Test: Ramp Blocking Test | Test Number: 2 |

*Purpose of Tests*:

The Ramp Blocking Test will be carried out by the **Generator** to assess the ability of the **WFPS** controller to restrain the **WFPS** from ramping above the previous 10 minute average **MW Output** level at the time of receiving the signal.

This test will be carried out at a time when the actual **MW Output** of the **WFPS** is greater than 50% of **Registered Capacity** and 100% of the **WFPS Generating Unit**s are in service (can be carried out in conjunction with the **Active Power** Control Test).

*Results Required*:

Time series record and Microsoft Excel Plot (Appendix E) showing:

- **MW Output**
- **MW Availability**
- **MW** set point
- Emergency Action On/Off
- 'Ramp Block' Signal On/Off
- **WFPS** Active Set Point
- Wind Speed

*Test Assessment*:

This test is required to show Compliance with CC.S2.1.3.7 (c) for Transmission Connected **WFPS** and CC.S2.2.3.4 (c) for Distribution Connected **WFPS**

*Criteria of Assessment:*

- The **WFPS** controller does not allow the **WFPS MW Output** to ramp above the previous 10 minute average **MW Output** level at the time of receiving the signal.
- The **WFPS** should be within 3% (based on **Registered Capacity**) of the '10 Min Average **MW**' set point for the full duration that the 'Ramp Block' signal is being sent.
- The **WFPS** response will be assessed from the time the Ramp Mode is engaged.
- Upon removal of the 'Emergency Action' or 'Ramp Block' modes by SONI/NIE, **WFPS** should ramp up at the **Wind Following Ramp Rate**; this ramp shall be a percentage of **Registered Capacity** of the **WFPS** per minute which equates to 5**MW**/min (if a different ramp rate was agreed between SONI and the **Generator** then SONI requires the agreed ramp rate to be implemented). The ramp rate is the average rate of change in **Output** measured over any 10 minute period.

### 6.2.1 RAMP BLOCK TEST PROCEDURE

The 'Ramp Block' **MW** set point is defined as the previous 10 minute average **MW** of the **WFPS** upon receipt of the 'Ramp Block' signal. The **WFPS** shall be capable of a zero ramp rate setting when a 'SONI/NIE ramp blocking signal' is present.

*Ramp Block Compliance Tests*

Ramp Block testing will be carried out when 100% of the **WFPS Generating Unit**s are in service. The available power on the day of testing should be greater than 50% of **Registered Capacity**.

| Ramp Block Test Sequence - Test Stage 1 (SONI/NIE will reduce the **WFPS** from MIO (>50% **Registered Capacity**) to 10% **Registered Capacity**) | |
|---|---|
| Step No. | Action |
| 1 | SONI will send the **WFPS** a **MW** set point. |
| 2 | The **WFPS** will send SONI confirmation of the **MW** set point. |
| 3 | SONI will send **WFPS** a Curtailment Time Interval set point. |
| 4 | The **WFPS** will send SONI confirmation of the Curtailment Time Interval set point. |
| 5 | SONI will turn on 'Emergency Action' mode. |
| 6 | When the **WFPS** has achieved the specified **MW** set point in the specified Curtailment Time Interval, the **WFPS** is required to remain at that set point for 10 minutes |
| Ramp Block Test Sequence - Test Stage 2 | |
| Step No. | Action |
| 7 | SONI will turn off 'Emergency Action' mode. |
| 8 | The **WFPS** will be allowed to ramp up to MIO at the **Wind Following Ramp Rate** |
| 9 | SONI will send the **WFPS** a 'Ramp Block' signal (When the 'Ramp Block' signal will be sent will depend on the **WFPS** size and will be at the discretion of SONI) |
| 10 | The **WFPS** will remain at the 'Ramp Block' **MW** set point for 10 mins. |
| 11 | SONI will remove the 'Ramp Block' signal and the **WFPS** will be allowed to ramp up to MIO at the **Wind Following Ramp Rate**. |

## 6.3 MW AVAILABILITY TEST

| | |
|---|---|
| Compliance Testing/**Monitoring** | |
| Title of Test: **MW Availability** Test | Test Number: 3 |

***MW Availability*** *Definition* - "The amount of **Active Power** that the **Controllable WFPS** could produce based on current wind conditions, network conditions and **System** conditions. The **MW Availability** *shall only differ from the* **MW Output** *if the* **Controllable WFPS** *has been curtailed, constrained or is operating in a Curtailed* **Frequency** *Response mode, as instructed by SONI via the SCADA interface*. By way of clarification, limitations placed on **WFPS Output** due to 33kV Dynamic Line Rating schemes are NIE actions only and these should be reflected in the **MW Availability**."

The **MW Availability** signal provided by the **Generator** should be a continuously calculated value. The **Generator** should NOT let the **MW Availability** figure equal the **MW Output** figure when there is no SONI action and only start calculating the **MW Availability** figure when there is SONI action as SONI will have no way of assessing the accuracy of the calculated signal. SONI will require a detailed explanation of exactly how the **MW Availability** signal is being calculated by the **Generator**. SONI also require that the **Generator** submit a power curve diagram for the **Generating Unit** type at the **WFPS**.

*Purpose of Test:*
The **MW Availability** Test is carried out by the **Generator** to verify that the **MW Availability** signal is comparable at all times to the **MW Output** signal unless the **WFPS** is curtailed by SONI. There will be both **MW Availability** Compliance tests and ongoing continuous **Monitoring** of this signal to ensure that the **MW Availability** being provided by the **Generator** satisfies SONI's accuracy requirements.

***MW Availability*** *Tests (Test 1 – 7)*
These tests will be carried out at a time when the **MW Output** of the **WFPS** is greater than 50% of **Registered Capacity** and 100% of the **WFPS Generating Unit**s are in service (with the exception of Test 7 which will require the **MW Output** of the **WFPS** to be greater that 90% of Rated Capacity and 100% of the **WFPS Generating Unit**s are in service to fully test correct Temperature Dependent Dynamic Line Rating (TDLR) operation), unless otherwise agreed by the **Generator** with SONI in advance of the test.

*Continuous* ***Monitoring*** *of* ***MW Availability***
The **WFPS** will also be subject to continuous **Monitoring** of the **MW Availability** signal by SONI, during testing and into the ongoing **Monitoring** period.

*Results Required*:
Time series record and Microsoft Excel Plot (Appendix E) showing:

- **MW Output**
- **MW Availability**
- **MW** set point
- **WFPS** Active Set Point
- % **Generating Unit**s Available
- Simulated High Wind Speed ON/OFF
- Injected High Wind Speed signal
- Wind Speed
- Indication of **Generating Unit**s placed in 'Pause' Mode
- Line Current (for **MW Availability** Test 7)
- Line Temperature (for **MW Availability** Test 7)

*Test Assessment*:
This test will be subject passing both the In Day **MW Availability** Tests and Continuous **Monitoring** of **MW Availability** test criteria specified.
This test is required to show Compliance with **SDC**1.4.3.2

### 6.3.1 MW AVAILABILITY TEST PROCEDURE (FOR TESTS 1-7)

Pursuant to **SDC**1.4.3.2, each **Generator** in the case of its **Controllable WFPS**, shall use reasonable endeavours to ensure that the **MW Availability** is declared at levels or values that the **Controllable WFPS** can achieve at the relevant time. The **MW Availability** signal should reflect the amount of **Active Power** that the **Controllable WFPS** could produce based on current wind conditions, network conditions and **System** conditions. The **MW Availability** shall only differ from the **MW Output** if the **Controllable WFPS** has been curtailed, constrained or is operating in a Curtailed **Frequency** Response mode.

Some issues that will impact the "**MW Availability**" are:

a) The **MW Availability** signal should accurately reflect the wind resource level available.

b) If **Generating Unit**s **Shutdown** due to high wind speeds, they are not available and the "**MW Availability**" should be reduced accordingly;

c) If **Generating Unit**s are out of service for maintenance, repair, placed in a 'Pause' mode etc. they are not available and the "**MW Availability**" should be reduced accordingly;

d) If **Generating Unit**s have entered into any form of error mode e.g. 'Safety Chain Activation' etc. they are not available and the "**MW Availability**" should be reduced accordingly;

e) If the **Generating Unit**s are responding to a set point other than that received by SONI SCADA e.g. a temperature dependent dynamic line rating (TDLR) set point or SPS set point, the "**MW Availability**" should be reduced accordingly to reflect the **MW Output** level the **WFPS** is controlling to;

f) Only actions by SONI to reduce the **WFPS MW Output** (as described in the **MW Availability** definition above) should result in a difference between actual **MW Output** and the **MW Availability** signals.

***MW Availability*** *Compliance Tests*

**MW Availability** testing will be carried out when 100% of the **WFPS Generating Unit**s are in service. The available power on the day of testing should be greater than 50% of **Registered Capacity**.

| **MW Availability** Test Sequence - Test 1<br>**Generator** Shutting Down **Generating Unit**s | |
|---|---|
| Step No. | Action |
| 1 | At MIO, the **Generator** will **Shutdown** one **Generating Unit** |
| 2 | The **MW Output** and the **MW Availability** decreases and settles to reflect the loss of one **Generating Unit**. |
| 3 | The **WFPS** will remain at this the new **MW** value for 1 min after settling. |
| 4 | The **Generator** repeats steps 1-3 until the **WFPS** is completely shut-down |

| **MW Availability** Test Sequence - Test 2<br>**Generator** Starting Up **Generating Unit**s | |
|---|---|
| Step No. | Action |
| 1 | When the **WFPS** is **Shutdown**, the **Generator** will **Start-Up** one **Generating Unit** |
| 2 | The **MW Output** and the **MW Availability** increases and settles to reflect one **Generating Unit** being available. |
| 3 | The **WFPS** will remain at this the new **MW** value for 1 min after settling. |
| 4 | The **Generator** repeats steps 1-3 until the **WFPS** is at MIO. |

| **MW Availability** Test Sequence - Test 3<br>SONI Action<br>(At MIO, SONI will curtail the **WFPS MW Output** to 10% of **Registered Capacity** in a Curtailment Time Interval of one minute. The **WFPS** will remain curtailed for 10 mins. ) | |
|---|---|
| Step No. | Action |
| 1 | SONI will send **WFPS** a **MW** set point. |
| 2 | The **WFPS** will send SONI confirmation of the **MW** set point. |
| 3 | SONI will send **WFPS** a Curtailment Time Interval set point. |
| 4 | The **WFPS** will send SONI confirmation of the Curtailment Time Interval set point. |
| 5 | SONI will turn on 'Emergency Action' mode. |
| 6 | The **WFPS** will ramp at the **Active Power Control Set-Point Ramp Rate** |
| 7 | When the **WFPS** has achieved the specified **MW** set point (10% **Registered Capacity**) in the specified Curtailment Time Interval (1 min), the **WFPS** will be required to remain at that set point for 10 mins. |
| 8 | SONI will turn off 'Emergency Action' mode. |
| 9 | The **WFPS** will be allowed to ramp up to MIO a the **Wind Following Ramp Rate** |

| **MW Availability** Test Sequence - Test 4<br>High Wind Speed **Shutdown** | |
|---|---|
| Step No. | Action |
| 1 | The **Generator** will change the high wind speed setting either remotely or at each **Generating Unit** to a value lower than the wind speed on the day of the test so that the each **Generating Unit** shuts down at a lower wind speed than shown on the power curve for the **Generating Unit** type. SONI require that this is carried out for all **Generating Unit**'s at the **WFPS**. |
| 2 | SONI must receive a 'High Wind Speed **Shutdown**' Alarm |
| 3 | The **WFPS Output** should shut-down upon receipt of the high wind speed signal. |
| 4 | SONI should receive a '**WFPS** % **Shutdown**' indication (i.e. the % of **Generating Unit**s at the **WFPS Shutdown** due to high wind speed). |

| **MW Availability** Test Sequence - Test 5<br>Pause/Maintenance Mode | |
|---|---|
| Step No. | Action |
| 1 | The **Generator** will place one **Generating Unit** in a 'Pause' mode (or any form of maintenance mode that exists for the particular **Generating Unit** type, that allows power to go the **Generating Unit** auxiliaries but the **Generating Unit** is not exporting **Active Power**). |
| 2 | The **MW Output** and the **MW Availability** decreases and settles to reflect the fact that one **Generating Unit** is in a 'Pause or Maintenance' mode. |
| 3 | The **WFPS** will remain at this the new **MW** value for 1 min after settling. |
| 4 | The **Generator** repeats steps 1-3 until the **WFPS** is completely shut-down |

| **MW Availability** Test Sequence - Test 6<br>Error Condition | |
|---|---|
| Step No. | Action |
| 1 | The **Generator** will place one **Generating Unit** in an error condition (e.g. 'Safety Chain Activation'') |
| 2 | The **MW Output** and the **MW Availability** decreases and settles to reflect the fact that one **Generating Unit** has entered an error condition. |
| 3 | The **WFPS** will remain at this the new **MW** value for 1 min after settling. |
| 4 | The **Generator** repeats steps 1-3 until the **WFPS** is completely shut-down |
| 5 | The **Generator**/**Generating Unit** manufacturer must make SONI aware of all error modes that exist at the **WFPS** under test so that the accuracy of the **MW Availability** checked in all error conditions. |

| **MW Availability** Test Sequence - Test 7<br>Temperature Dependant Dynamic Line Rating (TDLR) (If applicable at the **WFPS**) | |
|---|---|
| Step No. | Action |
| 1 | The **Generator** must supply SONI with the P27 Current/Temperature Profile for the **WFPS** which will show Temperature versus Current for a given conductor type. The profile should show the **WFPS** controller profile and the NIE back up relay profile (there will be a temperature differential between the two profiles). |
| 2 | Based on the P27 Current/Temperature Profile supplied to SONI, the **Generator** will show by secondary injection, the capability of moving its set point to align with the P27 plus offset as agreed with NIE, this injection should take in at least 12 points on the curve and cover the temperature range from 0-22°C. The results should show Temperature versus Current in both tabular and graphical form. The graphs should also show plots of the **MW Output** and the **MW Availability**. |
| 3 | The **WFPS** will simulate a step change in temperature and measure the performance of the **WFPS** to react to this step change in seconds. The following step changes should be tested but do not exclude the use of more test points -- one degree, two degrees, five degrees, ten degrees, eighteen degrees. The results should show step change versus seconds to reach steady state **Output** in both tabular and graphical form. The graphs should also show plots of the **MW Output** and the **MW Availability**. |

The tests will be regarded as supporting Compliance on the day of testing if the following conditions are met:

- For Test 1:
    1. SONI requires both the **MW Output** figure and the **MW Availability** figure drop in steps to zero from MIO.
- For Test 2:

    SONI requires both the **MW Output** figure and the **MW Availability** figure increase in steps from zero to MIO.
- For Test 3:
    1. SONI requires the calculated **MW Availability** signal accurately reflecting the MIO of the site had the **WFPS** not been curtailed. The **MW Output** of the **WFPS** should drop to 10% of **Registered Capacity** in one minute.
    2. **WFPS** is within 3% of the '**MW** set point'
    3. The **WFPS** should reach the '**MW** set point' within ±10 seconds of the specified 'Curtailment Time Interval'.
    4. The **WFPS** will calculate the **Active Power Control Set-Point Ramp Rate**. The **MW** reduction should be at a continuous linear ramp down rate over the time frame given.
    5. The **WFPS** response will be assessed from the time the 'Emergency Action' Mode is engaged.
    6. Upon removal of the 'Emergency Action' mode by SONI, the **WFPS** should ramp up at the **Wind Following Ramp Rate**; this ramp shall be a percentage of

**Registered Capacity** of the **WFPS** per minute which equates to 5**MW**/min (if a different ramp rate is agreed between SONI and the **Generator** then SONI will requires the agreed ramp rate being implemented). The ramp rate is the average rate of change in **Output** measured over any 10 minute period.

- For Test 4:
    1. SONI requires a 'High Wind Speed **Shutdown**' alarm from the **WFPS** and an indication of the % of **Generating Unit**s **Shutdown** due to high wind speed (the '**WFPS** % **Shutdown**' signal)
    2. The **WFPS Generating Unit**s will be expected to **Shutdown** as per the high wind speed shutdown parameter setting installed for the purpose of this test.
    3. SONI requires both the **MW Output** indication and the **MW Availability** indication drop from MIO to reflect the number of **Generating Unit**s in service and the wind resource available.
- For Test 5:
    1. SONI requires both the **MW Output** figure and the **MW Availability** figure drop in steps to zero from MIO as each **Generating Unit** is placed into Pause/Maintenance mode.
    2. SONI will require screenshots of each **Generating Unit** being placed in Pause/Maintenance mode.
- For Test 6:
    1. SONI requires both the **MW Output** figure and the **MW Availability** figure drop in steps to zero from MIO as each **Generating Unit** is placed into any **Generating Unit** error condition which exists at the **WFPS** (e.g Safety Chain Activation)
    2. SONI will require screenshots of each **Generating Unit** being placed in this error condition.

- For Test 7:
    1. For test step 2: SONI requires both correct **MW Output** figure and the **MW Availability** figure at the **WFPS** Based on the P27 Current/Temperature Profile supplied to SONI. The results should show Temperature versus Current in both tabular and graphical form. The graphs should also show plots of the **MW Output** and the **MW Availability**.
    2. For test step 3: The results should show step change versus seconds to reach steady state **Output** in both tabular and graphical form. The graphs should also show plots of the **MW Output** and the **MW Availability**.

### 6.3.2 CONTINUOUS MONITORING OF MW AVAILABILITY (CARRIED OUT BY SONI)

Following the issue of the Temporary Compliance Certificate and in accordance with CC.S2.1.10.1 and CC.S2.2.7.1, continuous **Monitoring** of the **WFPS** by SONI will take place after the signal has been tested, the **WFPS** must adhere to the following:

*Standard*

The quality of the calculated **MW Availability** signal will be subject to the following test:

A normalised root mean square deviation ($NRMSD$) for a **WFPS** for a given day will be calculated. This will use one minute **MW Availability** quantities averaged over the half hour period recorded in Castlereagh House Control Centre CHCC and the 30 minute metered **Output** for the **Generator** under analysis.

*Assessment Criteria:*

- The rolling 14-day NRMSD must be less than or equal to 8%, excluding periods where the **WFPS** was **Dispatch**ed away from its **MW Availability** by SONI.
- The daily NRMSD values are to be calculated. The number of days where the daily NRMSD exceeds the 5% standard must not exceed 2 days in any 14-day period, except for periods where the **WFPS** was dispatched away from its **MW Availability** by SONI.

Further detail on the Proposed Continuous **Monitoring** of **MW Availability** standard can be found in Appendix C.

## 6.4 WFPS CONTROL SYSTEM TESTS

| Compliance Testing/**Monitoring** | |
|---|---|
| Title of Test: **WFPS** Control System Tests | Test Number: 4 |

*Purpose of Test:*
Great reliance is placed on the reliability of **WFPS** control systems. Normal controller operation and operation in the event of a controller or plant malfunction/failure is of particular importance.

The suite of tests to be carried out will examine the following scenarios:

- **WFPS** Controller Failure
- **WFPS** Controller Mode
- **WFPS** Transducer Failure
- Power Supply Failure

After a **WFPS** control system has failed, the **WFPS** must contact the SONI control centre before recommencing **Active Power** export following the controller becoming operational again. This is to ensure that the NI network can facilitate the additional generation.

**WFPS** Controller Failure Compliance Test will be carried out by the **Generator** to verify that; in the event of **WFPS** controller failure, SONI will receive a 'Grid Controller Fail' alarm and the **WFPS** will operate as per i) below.

**WFPS** Controller Mode Compliance Tests will be carried out by the **Generator** to verify that; in the event of **WFPS** controller being put into 'Local Control' that SONI receives an alarm. SONI will also be testing to make sure it has no control functionality when the **WFPS** is operating in this mode.

**WFPS** Transducer Failure Compliance Tests will be carried out by the **Generator** to verify that; in the event of **WFPS** controller loss of:

1. Voltage transformer input(s)
2. Current transformer input(s)
3. Transducer output

should all result in the **WFPS** operating as per i) below. Loss of any primary inputs should result in the initiation of an alarm.

Power Supply Failure Compliance Tests will be carried out by the **Generator** to verify that; in the event of power failure to any of the control functionality, SONI will receive a 'Grid Controller Fail' alarm and the **WFPS** will operate as per i) below

The Commissioning/Acceptance Test Panel require detailed explanation from the **Generator** as to how each control system failures are to be carried out at the **WFPS** during Compliance testing.

If any other modes of failure exist for a particular **Generating Unit** type that will result in a loss of remote control/comms via SCADA, then the **Generator** must make the Commissioning/Acceptance Test Panel aware of this. This is to ensure that a test can be created to check if the **WFPS** operates as per the SONI/NIE requirement below:

**i)** For all failure scenarios, the **WFPS** should hold its last known set point for 10mins, after which if the failure still exists the **WFPS** should **Shutdown** to 0**MW** in a controlled manner within 1 minute. However, if there are DLR schemes in place for the connection then for all failure scenarios, the **WFPS** should **Shutdown** to 0**MW** in a controlled manner within 1 minute.

The available power on the day of testing should be greater than 50% of **Registered Capacity** and 100% of the **WFPS Generating Unit**s are in service.

| |
|---|
| *Results Required:*<br>Time series record and Microsoft Excel Plot (Appendix E) showing:<br>• **MW Output**<br>• **MW Availability**<br>• **WFPS** Controller Operational/ **WFPS** Controller Fail<br>• **WFPS** Active Set Point<br>• **WFPS** Controller mode (Local Control/Grid Control)<br>• Wind Speed |
| *Test Assessment:*<br>• The test results should show the **WFPS** will operate as per the test scenarios above |

### 6.4.1 WFPS CONTROL SYSTEM TEST PROCEDURE

**WFPS** Control System Tests will be carried out when 100% of the **WFPS Generating Unit**s are in service. The available power on the day of testing should be greater than 50% of **Registered Capacity**.

#### 6.4.1.1 WFPS Controller Failure Compliance Tests

| **WFPS** Controller Failure Compliance Test Sequence - Test 1 | |
|---|---|
| Step No. | Action |
| 1 | The **Generator** will disable the outputs of the **WFPS** controller. |
| 2 | SONI will receive a 'Grid Controller Fail' alarm. |
| 2 | The **WFPS** will hold its last known set point for 10mins, after which if the failure still exists the **WFPS** must **Shutdown** to 0**MW** in a controlled manner within 1 minute. However, if there are DLR schemes in place for the connection then for all failure scenarios, the **WFPS** must **Shutdown** to 0**MW** in a controlled manner within 1 minute. |

| **WFPS** Controller Failure Compliance Test Sequence - Test 2<br>(SONI will **Shutdown** the **WFPS**. The **Generator** will then disable the outputs of the **WFPS** controller.) | |
|---|---|
| Step No. | Action |
| 1 | SONI will send **WFPS** a **MW** set point of 0**MW** |
| 2 | The **WFPS** will send SONI confirmation of the **MW** set point. |
| 3 | SONI will send **WFPS** a Curtailment Time Interval set point of 1 min. |
| 4 | The **WFPS** will send SONI confirmation of the Curtailment Time Interval set point. |
| 5 | SONI will turn on 'Emergency Action' mode. |
| 6 | When the **WFPS** has achieved the specified **MW** set point in the specified Curtailment Time Interval, the **WFPS** will be required to remain at that set point for 1 minute. |
| 7 | The **Generator** will disable the outputs of the **WFPS** controller. |
| 8 | SONI will receive a 'Grid Controller Fail' alarm. |
| 9 | The **WFPS** should remain **Shutdown** |

| **WFPS** Controller Failure Compliance Test Sequence - Test 3<br>(SONI will instruct the **WFPS** to go to a **MW** set point. The **Generator** will then disable the outputs of the **WFPS** controller.) | |
|---|---|
| Step No. | Action |
| 1 | SONI will send **WFPS** a **MW** set point (to be agreed with the Commissioning/Acceptance Test Panel) |
| 2 | The **WFPS** will send SONI confirmation of the **MW** set point. |
| 3 | SONI will send **WFPS** a Curtailment Time Interval set point of 1 min. |
| 4 | The **WFPS** will send SONI confirmation of the Curtailment Time Interval set point. |
| 5 | SONI will turn on 'Emergency Action' mode. |
| 6 | When the **WFPS** has achieved the specified **MW** set point in the specified Curtailment Time Interval, the **WFPS** will be required to remain at that set point for 1 minute. |
| 7 | The **Generator** will disable the outputs of the **WFPS** controller. |
| 8 | SONI will receive a 'Grid Controller Fail' alarm. |
| 9 | The **WFPS** will hold its last known set point for 10mins, after which if the failure still exists the **WFPS** must **Shutdown** to 0**MW** in a controlled manner within 1 minute. However, if there are DLR schemes in place for the connection then for all failure scenarios, the **WFPS** must **Shutdown** to 0**MW** in a controlled manner within 1 minute. |

The tests will be regarded as supporting Compliance if the following conditions are met:

- For Test 1, upon loss of outputs from the controller:
    a. The **WFPS** should hold its last known set point for 10mins, after which if the failure still exists the **WFPS** should **Shutdown** to 0**MW** in a controlled manner within 1 minute. However, if there are DLR schemes in place for the connection then for all failure scenarios, the **WFPS** should **Shutdown** to 0**MW** in a controlled manner within 1 minute.
    b. SONI will receive a 'Grid Controller Fail' alarm.
- For Test 2:
    a. The **MW Output** of the **WFPS** shall drop to 0**MW** when dispatched to that **MW** value by SONI. The **WFPS** should remain at 0**MW Output** upon loss of outputs from the controller.
    b. SONI will receive a 'Grid Controller Fail' alarm.
- For Test 3:
    a. The **MW Output** of the **WFPS** shall drop to the **MW** set point that was agreed in advance with the Commissioning/Acceptance Test Panel when dispatched to that **MW** value by SONI.
    b. Upon loss of outputs from the controller, the **WFPS** should hold its last known set point for 10mins, after which if the failure still exists the **WFPS** should **Shutdown** to 0**MW** in a controlled manner within 1 minute. However, if there are DLR schemes in

place for the connection then for all failure scenarios, the **WFPS** should **Shutdown** to 0**MW** in a controlled manner within 1 minute.

c. SONI will receive a 'Grid Controller Fail' alarm.

#### 6.4.1.2 WFPS Controller Mode Compliance Tests

SONI/NIE must have full control of all the functionality of a **WFPS** when the **WFPS** controller is operating in 'Grid Control' mode i.e. the normal running mode of the **WFPS** controller. However, there may be times when the **Generator** wishes to operate the **WFPS** in 'Local Control' under test, diagnostic or temporary running conditions. The **Generator** must coordinate this with SONI/NIE in advance of changing the **WFPS** controller into 'Local Mode'. When the **WFPS** controller enters 'Local Control', SONI must receive an alarm to alert that the site is no longer remotely controllable via SCADA. When the **WFPS** controller is returned to 'Grid Control' SONI must receive an alarm to alert that normal running mode has resumed.

**WFPS** Controller Mode Compliance Test Sequence - Test 1

| Step No. | Action | Comment |
|---|---|---|
| 1 | At MIO, the **Generator** will change the controller on to 'Local Control'. | SONI will receive an alarm to confirm the **WFPS** controller has changed to 'Local Control'. |
| 2 | SONI will attempt to send the **WFPS** a '**MW**' set point of 0 **MW** and a 'Curtailment Time Interval' set point of 1 min. SONI should not receive back confirmation of these set points from the **Generator**. | SONI will confirm that we have no controllability at the site |
| 3 | SONI will attempt to engage 'Emergency Action' mode. | |

**WFPS** Controller Mode Compliance Test Sequence - Test 2

| Step No. | Action | Comment |
|---|---|---|
| 1 | At MIO, the **Generator** will change the controller on to 'Grid Control'. | SONI will receive an alarm to confirm the **WFPS** controller has changed to 'Grid Control'. |
| 2 | SONI will send the **WFPS** a '**MW**' set point of 80% MIO and a 'Curtailment Time Interval' set point of 1 min. SONI should receive back confirmation of these set points from the **Generator**. | SONI will confirm that we have regained controllability at the site. |
| 3 | SONI will engage 'Emergency Action' mode. SONI will confirm to the **Generator** that the **WFPS** has entered 'Emergency Action' mode. | |
| 4 | The **WFPS** will be allowed to settle at 80% MIO for 1 min. | |
| 5 | SONI will turn off 'Emergency Action' mode. | |

The tests will be regarded as supporting Compliance if:

- For Test 1:
    a. SONI receive an alarm to indicate that the **WFPS** controller is in 'Local Control'.
    b. SONI have no controllability at the site when the **WFPS** is in 'Local Control' mode.
- For Test 2:
    a. SONI receive an alarm to indicate that the **WFPS** controller is in 'Grid Control'.
    b. SONI have full controllability at the site when the **WFPS** is in 'Grid Control' mode.

#### 6.4.1.3 WFPS Transducer Failure Compliance Tests

The **WFPS** transducer acts as the main **Output** measurement for the **WFPS**. Loss of inputs or output from this transducer will result in the **WFPS** being incapable of carrying out any control functionality. SONI and NIE deem transducer failure to be:

- Loss of voltage transformer input(s)Loss of current transformer input(s)
- Loss of output from the transducer
- Loss of any primary inputs must result in the initiation of an alarm.

| **WFPS** Transducer Failure Compliance Test Sequence - Test 1-3 | | |
|---|---|---|
| Test No. | Test | Comment |
| 1 | At MIO, **Generator** disables the signal from the current transformer to the **WFPS** controller. | SONI must receive a 'Transducer Fail' alarm. The **WFPS** should hold its last known set point for 10mins, after which if the failure still exists the **WFPS** must **Shutdown** to 0**MW** in a controlled manner within 1 minute. However, if there are DLR schemes in place for the connection then for all failure scenarios, the **WFPS** must **Shutdown** to 0**MW** in a controlled manner within 1 minute. |
| 2 | At MIO, **Generator** disables the signal from the voltage transformer to the **WFPS** controller. | |
| 3 | At MIO, **Generator** disables the signal from the transducer to the **WFPS** controller. | |

The tests will be regarded as supporting Compliance if:

- The test results must show that upon failure of any of the primary inputs or output from the transducer that the **WFPS** should hold its last known set point for 10mins, after which if the failure still exists the **WFPS** should **Shutdown** to 0**MW** in a controlled manner within 1 minute. However, if there are DLR schemes in place for the connection then for all failure scenarios, the **WFPS** should **Shutdown** to 0**MW** in a controlled manner within 1 minute.
- The loss of any of the primary inputs must result in a 'Transducer Fail' alarm being received by SONI.

### 6.4.1.4 Power Supply Failure Compliance Tests

| Power Supply Failure Compliance Test Sequence - Test 1 | | |
|---|---|---|
| Test No. | Test | Comment |
| 1 | At MIO, the **Generator** disconnects the power supply to the control functions at the **WFPS**. | SONI must receive a 'Grid Controller Fail' alarm. The **WFPS** should hold its last known set point for 10mins, after which if the failure still exists the **WFPS** should **Shutdown** to 0**MW** in a controlled manner within 1 minute. However, if there are DLR schemes in place for the connection then for all failure scenarios, the **WFPS** should **Shutdown** to 0**MW** in a controlled manner within 1 minute. |

The tests will be regarded as supporting Compliance if, upon loss of power to any of the control functionality:

- SONI receive a 'Grid Controller Fail' alarm
- The **WFPS** will hold its last known set point for 10mins, after which if the failure still exists the **WFPS** should **Shutdown** to 0**MW** in a controlled manner within 1 minute. However, if there are DLR schemes in place for the connection then for all failure scenarios, the **WFPS** should **Shutdown** to 0**MW** in a controlled manner within 1 minute.

## 6.5 FREQUENCY CONTROL TEST

| Compliance Testing/**Monitoring** | |
|---|---|
| Title of Test: **Frequency Control** Test | Test Number: 5 |

*Purpose of Test:*
The **WFPS** must always operate in **Frequency Sensitive Mode**, whereby its **Active Power Output** is varied automatically to compensate for variations in the **Frequency** of the **System**.

Whilst responding to **Frequency** deviations on the **NI System** the **WFPS** shall ramp at the **Frequency Response Ramp Rate**, this ramp rate shall be the maximum ramp of the **WFPS Generating Unit**s and as a minimum shall be:

- Primary Response capability of the **WFPS** (Available by 5s and sustained to 15s): 60% of expected **MW Output** change value based on droop characteristic. (This is an absolute minimum and if **Generating Unit**s can offer a larger response within 5 seconds they should do so)
- Secondary Response capability of the **WFPS** (Available by 15s and sustained to 90s): 100% of expected **MW Output** change value based on droop characteristic. (This is an absolute minimum and if **Generating Unit**s can offer a larger response within 15 seconds they should do so)

It should be noted that if the **WFPS** has received a **MW** set point and an Emergency Action 'ON' digital signal from SONI, the **WFPS** should not increase its **Active Power Output** beyond the figure that has been instructed in response to low **Frequency** deviations, however the **WFPS** must respond to high **Frequency** deviations and reduce **Active Power Output** according to the droop when Emergency Action 'ON' digital signal is being received via SCADA. This mode of operation is different from % **MW** Curtailment in which the **WFPS** must always respond to high and low **Frequency** deviations and be operating on the required droop setting.

Under normal operating conditions, the **WFPS** % **MW** Curtailment Controller is OFF (digital signal sent via SONI SCADA). The **Frequency** Response of the **WFPS** will be based on **Registered Capacity**. Therefore whilst the **WFPS** is operating on a nominal droop characteristic of 3.7%, a 27% change of **MW Output** will occur for a 0.5Hz **Frequency** Deviation.

The % **MW** Curtailment Set Point figure (50 – 100%) that SONI send to the **WFPS** via SONI SCADA will be based on MIO. The **Frequency** Response of the **WFPS** will be based on **Registered Capacity**. Therefore, whilst the **WFPS** is operating on a nominal droop characteristic of 4%, a 25% change of **MW Output** will occur for a 0.5Hz **Frequency** Deviation.

Whilst the **WFPS** % **MW** Curtailment Control is ON a 49.985Hz - 50.015Hz deadband exists in which the **WFPS** is not required to provide **Frequency Control** to the **System**.

The **Frequency Control** Test, for **Grid Code** Compliance purposes, should:

- Demonstrate the capability of the **WFPS** to continuously modulate **Active Power** to contribute to **Frequency Control**;
- Assess dead-band, overall and incremental droop, steady-state/dynamic stability of the governor

The **Frequency** response of the **WFPS** will be demonstrated for:

1. Normal Operating Conditions (% **MW** Curtailment Controller is OFF)
2. When the **WFPS** is curtailed by SONI and is providing **System** reserve (% **MW** Curtailment Set Point figure between 50-100% of MIO is sent via SONI SCADA).

A Ramp **Frequency Control** Test (Test 4) will be carried out by the **Generator** to verify that; when the **System Frequency** increases above the 'ramp **Frequency** blocking setting' of 50.1Hz, the **WFPS** will prevent positive ramping of **MW Output**. The **MW Output** of the **WFPS** will be capped to the **MW Output** value at the instant the **Frequency** excursion occurs. A pre-test **MW Output** curtailment is required to clearly demonstrate the 'Ramp **Frequency** Blocking set point' is operating correctly.

All **Frequency Control** Tests will be carried out at a time when the **MW Output** of the **WFPS** is greater than 65% of **Registered Capacity**, unless otherwise agreed by the **Generator** with SONI in advance of the test.

*Results Required:*

The following data must be submitted to SONI in the format of a time series record and Microsoft Excel Plot (Appendix E):

- **MW Output**
- **MW Availability**
- **WFPS** Active Set Point
- Ramp **Frequency** Set Point
- Simulated **System Frequency**
- Actual **System Frequency**
- Wind Speed
- Curtailment Control (on/off)
- % MW Curtailment Set Point

*Test Assessment:*

The test results will be assessed against:

- Performance specifications agreed as part of the Connection Agreement conditions.
- The **WFPS Settings Schedule** further describes and clarifies the application of CC.S2.1.5.2 for Transmission Connected **WFPS** and CC.S2.2.5.2 (a) for Distribution Connected **WFPS**

*Criteria of Assessment:*

- **Frequency Control** dead band between 50.1Hz – 50.15Hz during normal operating conditions (% **MW** Curtailment Control is OFF)
- **Frequency Control** dead band between 49.985Hz – 50.015Hz when % **MW** Curtailment Control is ON
- **Frequency Control** device capable of operating with a nominal droop characteristic of 3.7% under normal operating conditions and a nominal droop characteristic of 4% when a % **MW** Curtailment Set Point figure is being applied to the **WFPS MW Output**
- Final steady state droop figure should be based on **Registered Capacity** of the **WFPS**
- The **TSO** deems Fast acting with regards to **Frequency Control** response as being:
    - The change in **Active Power Output** commences within 0.2 seconds of the application of the **Frequency** injection
    - **WFPS** shall respond to **Frequency** deviations as per **Frequency Response Ramp Rate**:
        - Primary Response capability of the **WFPS** (Available by 5s and sustained to 15s): 60% of expected **MW Output** change value based on droop characteristic. (This is an absolute minimum and if **Generating Unit**s can offer a larger response within 5 seconds they should do so)
        - Secondary Response capability of the **WFPS** (Available by 15s and sustained to 90s): 100% of expected **MW Output** change value based on droop characteristic. (This is an absolute minimum and if **Generating Unit**s can offer a larger response within 15 seconds they should do so)
- The **MW Output** of the **WFPS** should be within 3% (based on **Registered Capacity**) of the **MW** set point calculated by the **WFPS** Controller at all times. The Commissioning/Acceptance Test Panel will assess wind conditions for the duration of the test and take any wind gusting into account
- High **Frequency** trip facility enabled at a **System Frequency** of 52Hz
- Stable operation from DMOL to MIO
- Continuous **Frequency** modulation capability across full **WFPS** operating range

### 6.5.1 FREQUENCY CONTROL TEST PROCEDURE

Simulated **Frequency** deviation signals should be injected into the **Frequency** controller reference/feedback summing junction. If the injected **Frequency** signal replaces rather than sums with the real **System Frequency** signal then SONI will require confirmation that the response of the **WFPS** to **Frequency** injections under test conditions is an accurate reflection of how the **WFPS** will respond to **System Frequency** variations.

***Frequency*** *Response under Normal Operating Conditions*

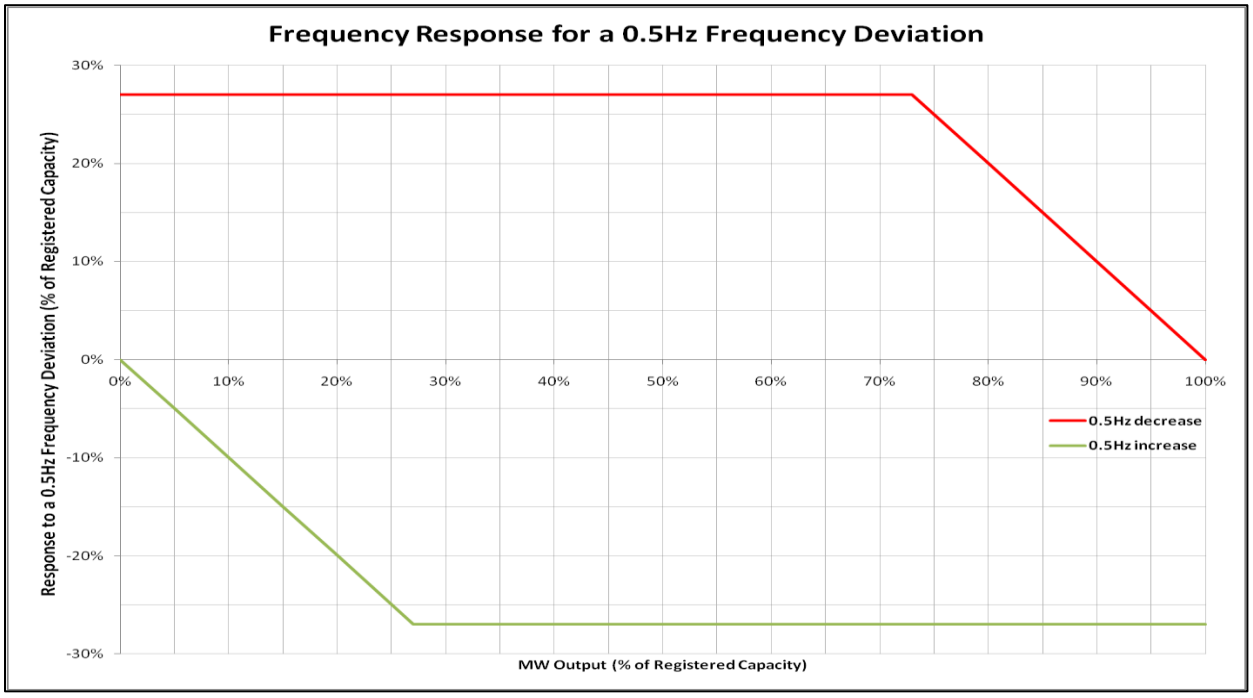
Under normal operating conditions the **WFPS** % **MW** Curtailment Controller is OFF (signal sent via SONI SCADA). Under normal operating conditions the **WFPS** will cap its **Output** at 50.1Hz and will start operating on droop at 50.15Hz. The **Frequency** Response of the **WFPS** will be based on **Registered Capacity** of the **WFPS**. Therefore whilst the **WFPS** is operating on a nominal droop characteristic of 3.7%, a 27% change of **MW Output** will occur for a 0.5Hz **Frequency** deviation.

$$Droop = \frac{(\Delta\ Freq/Freq_{Ref})}{(\Delta\ MW\ Output)/RC}$$

| | |
|---|---|
| Droop | Droop setting the **WFPS** is operating on |
| ∆Freq | Change in **Frequency** i.e. difference between deadband setting and measured **Frequency** |
| $Freq_{Ref}$ | Nominal **System Frequency** i.e. 50Hz |
| ∆ **MW Output** | Change in **MW Output** due to the change in **Frequency** |
| RC | **Registered Capacity** of the **WFPS** |

An interpretation of these results is illustrated diagrammatically in Figure 2. The green line shows the response due to a 0.5Hz increase in **Frequency** i.e. the **WFPS** should reduce its **MW Output** by 27% of RC if the capacity is available. The red line shows the response when this **Frequency** deviation is removed i.e. the **WFPS** is now not operating at MIO and has the capability to increase its **MW Output**.

*Figure 2:* ***Frequency*** *Response for a 0.5Hz* ***Frequency*** *Deviation under Normal Operating Conditions*



***Frequency*** *Response under Curtailed Operating Conditions*

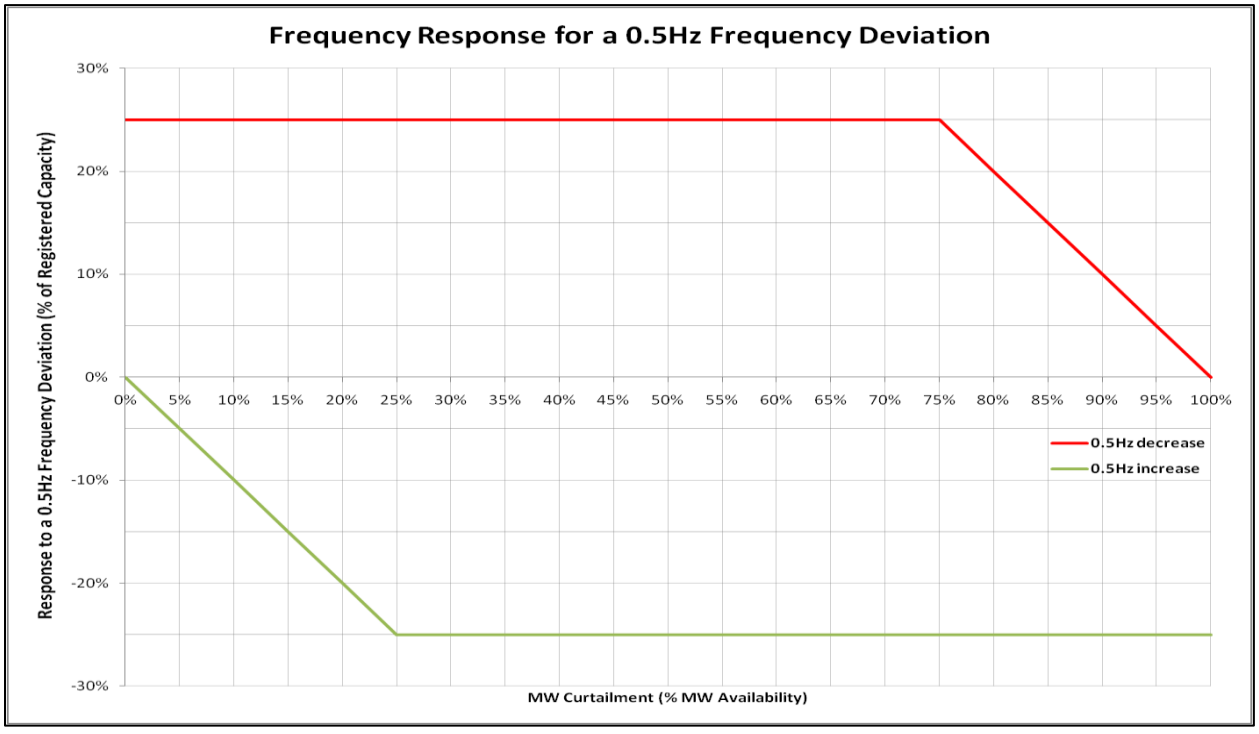
The **Frequency** response for a **Frequency** deviation for curtailed **WFPS** is shown in Figure 3, operating on a continuous 4% droop characteristic, e.g. a 0.5Hz **Frequency** deviation will result in a 25% change of **MW Output**. The **Frequency** response of the **WFPS** will be based on the **Registered Capacity** of the **WFPS**. A **Frequency Control** deadband exists between 49.985Hz - 50.015Hz in which the **WFPS** is not required to provide **Frequency Control** to the **System**.

The **Frequency** response requirement profile is shown diagrammatically in Figure 5. In accordance with CC.S2.1.5.2 (b) for Transmission Connected **WFPS** and CC.S2.2.5.2 (b) for Distribution Connected **WFPS**, the **Controllable WFPS** or **Dispatchable WFPS** controller must be capable of being set to operate in a constrained manner within the range of at least 50% to 100% of MIO.

$$Droop = \frac{(\Delta\ Freq/Freq_{Ref})}{(\Delta\ MW\ Output)/RC}$$

| | |
|---|---|
| Droop | Droop setting the **WFPS** is operating on |
| ∆Freq | Change in **Frequency** i.e. difference between nominal **System Frequency** (50Hz) and measured **Frequency** |
| $Freq_{Ref}$ | Nominal **System Frequency** i.e. 50Hz |
| ∆ **MW Output** | Change in **MW Output** due to the change in **Frequency** |
| RC | **Registered Capacity** of the **WFPS** |

*Figure 3:* ***Frequency*** *Response for a 0.5Hz* ***Frequency*** *Deviation under Curtailed Operating Conditions*

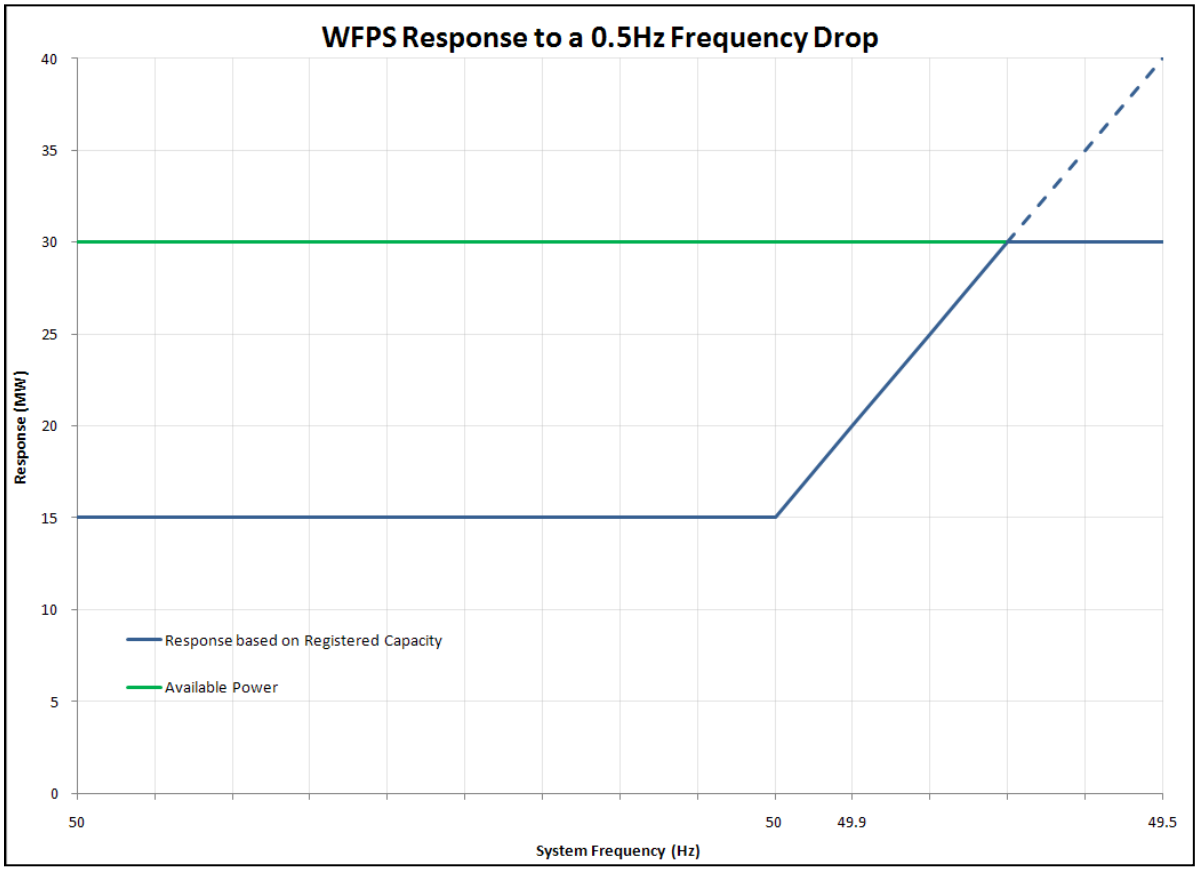


An example of how a **WFPS** must act in **Frequency Control** Mode whilst curtailed is shown below and illustrated in Figures 4 and 5.

Example

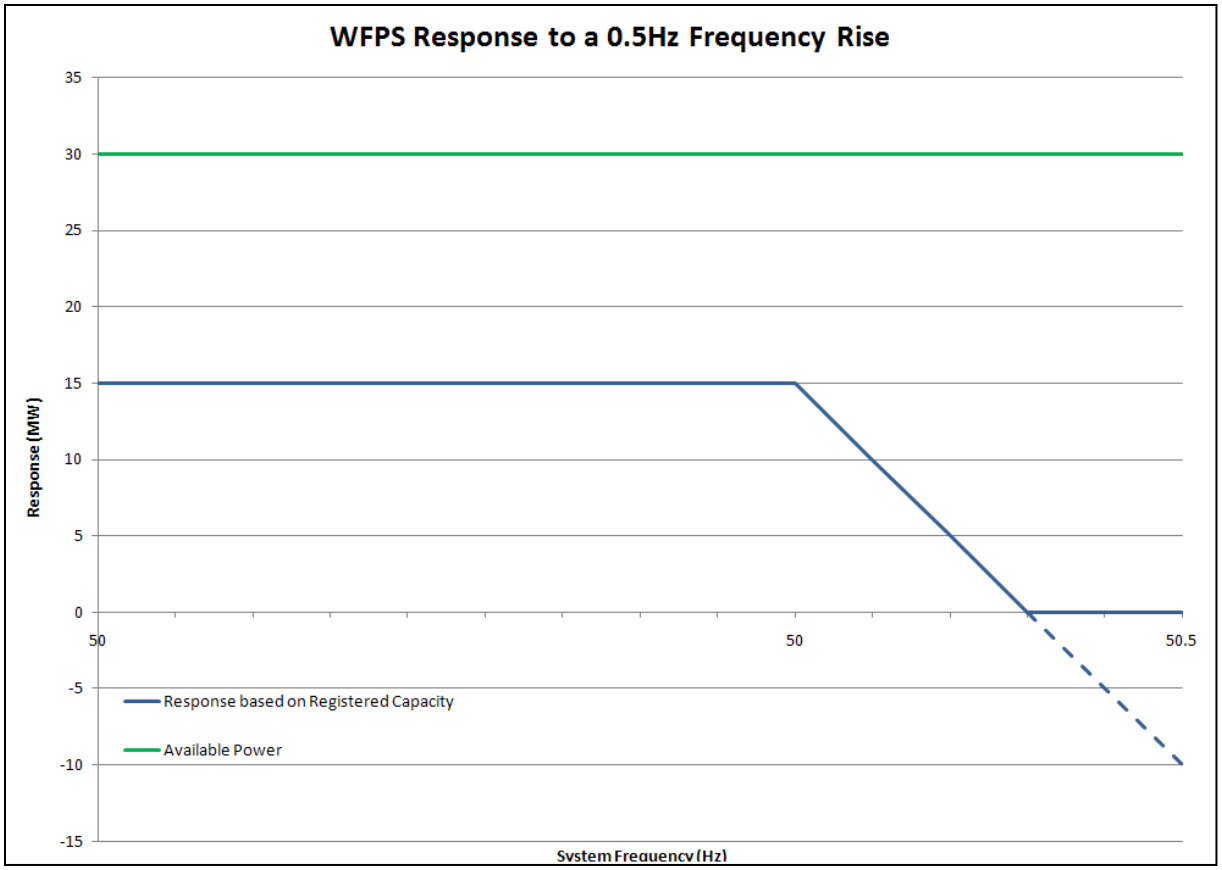
| | |
|---|---|
| **Registered Capacity** of **WFPS** | 100**MW** |
| **MW Availability** | 30**MW** |
| % **MW** Curtailment Set Point | 50% |
| **MW Output** | 15**MW** |
| Governor Droop | 4% |

*Figure 4: **WFPS** Response to a 0.5Hz **Frequency** Drop*




Based on a 0.5Hz **Frequency** drop the **WFPS** should increase its **MW Output** by 25% of **Registered Capacity**. In this case the **WFPS** will aim to increase **MW Output** to 40**MW** (an additional 25**MW** i.e. 25% of 100**MW Registered Capacity**), however this is limited by the **MW Availability** of 30**MW**. The **MW Output** of the **WFPS** should remain equal to **MW Availability** as long as **MW Availability** does not exceed 40**MW** for the duration of the 0.5Hz **Frequency** excursion.

*Figure 5: **WFPS** Response to a 0.5Hz **Frequency** Rise*




Based on a 0.5Hz **Frequency** rise the **WFPS** should decrease its **MW Output** by 25% of **Registered Capacity**. In this case the **WFPS** will aim to decrease its **MW Output** to -10**MW** (a reduction of 25**MW** i.e. 25% of 100**MW Registered Capacity**), this will result in the **WFPS** shutting down and having a **MW Output** of 0**MW**.

***Frequency Control*** *Compliance Tests*
**Frequency** injections will be applied at three loading levels; MIO, 50% of MIO and DMOL (to be agreed between the **Generator** and the Commissioning/Acceptance Test Panel).

An additional test will be carried out to ensure the "Ramp **Frequency** Blocking Setting" of 50.1Hz, which prevents positive ramping of **MW Output**, is operating correctly.

*Test 1 - Injection Tests at MIO*

| Step No. | Action |
|---|---|
| 1 | **WFPS** will be operating at MIO |
| 2 | **Generator** will simulate 50Hz |
| 3 | **Generator** will apply a 50.1Hz ramp **Frequency** injection over 10 seconds |
| 4 | **Frequency** injection will remain at 50.1Hz for 1 minute |
| 5 | **Generator** will apply a 50.2Hz ramp **Frequency** injection over 10 seconds |
| 6 | **Frequency** injection will remain at 50.2Hz for 1 minute |
| 7 | **Generator** will apply a 50.5Hz ramp **Frequency** injection over 10 seconds |
| 8 | **Frequency** injection will remain at 50.5Hz for 1 minute |
| 9 | **Generator** will apply a 51.0Hz ramp **Frequency** injection over 10 seconds |
| 10 | **Frequency** injection will remain at 51Hz for 1 minute |
| 11 | **Generator** will apply a 50.5Hz ramp **Frequency** injection over 10 seconds |
| 12 | **Frequency** injection will remain at 50.5Hz for 1 minute |
| 13 | **Generator** will apply a 50.2Hz ramp **Frequency** injection over 10 seconds |
| 14 | **Frequency** injection will remain at 50.2Hz for 1 minute |
| 15 | **Generator** will apply a 50.1Hz ramp **Frequency** injection over 10 seconds |
| 16 | **Frequency** injection will remain at 50.1Hz for 1 minute |
| 17 | **Generator** will simulate 50Hz and **WFPS** will re-stabilise at MIO for 1 minute. |
| 18 | **Generator** will apply a 50.1Hz **Frequency** injection as a step change |
| 19 | **Frequency** injection will remain at 50.1Hz for 1 minute |
| 20 | **Generator** will apply a 50.2Hz **Frequency** injection as a step change |
| 21 | **Frequency** injection will remain at 50.2Hz for 1 minute |
| 22 | **Generator** will apply a 50.5Hz **Frequency** injection as a step change |
| 23 | **Frequency** injection will remain at 50.5Hz for 1 minute |
| 24 | **Generator** will apply a 51.0Hz **Frequency** injection as a step change |
| 25 | **Frequency** injection will remain at 51.0Hz for 1 minute |

| | |
|---|---|
| 26 | **Generator** will apply a 50.5Hz **Frequency** injection as a step change |
| 27 | **Frequency** injection will remain at 50.5Hz for 1 minute |
| 28 | **Generator** will apply a 50.2Hz **Frequency** injection as a step change |
| 29 | **Frequency** injection will remain at 50.2Hz for 1 minute |
| 30 | **Generator** will apply a 50.1Hz **Frequency** injection as a step change |
| 31 | **Frequency** injection will remain at 50.1Hz for 1 minute |
| 32 | **Generator** will simulate 50Hz and **WFPS** will re-stabilise at MIO for 1 minute |
| 33 | **Generator** will apply a 50.5Hz ramp **Frequency** injection over 10 seconds |
| 34 | **Frequency** injection will remain at 50.5 Hz for 1 minute |
| 35 | **Generator** will apply a 50Hz ramp **Frequency** injection over 5 seconds and **WFPS** will re-stabilise at MIO for 1 minute |
| 36 | **Generator** will apply a 51.0Hz ramp **Frequency** injection over 10 seconds |
| 37 | **Frequency** injection will remain at 51.0 Hz for 1 minute |
| 38 | **Generator** will apply a 50Hz ramp **Frequency** injection over 5 seconds and **WFPS** will re-stabilise at MIO for 1 minute |
| 39 | **Generator** will apply a 50.5Hz **Frequency** injection as a step change |
| 40 | **Frequency** injection will remain at 50.5 Hz for 1 minute |
| 41 | **Generator** will apply a 50Hz ramp **Frequency** injection over 5 seconds and **WFPS** will re-stabilise at MIO for 1 minute |
| 42 | **Generator** will apply a 51.0Hz **Frequency** injection as a step change |
| 43 | **Frequency** injection will remain at 51.0 Hz for 1 minute |
| 44 | **Generator** will apply a 50Hz ramp **Frequency** injection over 5 seconds and **WFPS** will re-stabilise at MIO for 1 minute |
| 45 | **Generator** will apply a 51.5Hz **Frequency** injection as a step change |
| 46 | **Frequency** injection will remain at 51.5 Hz for 1 minute |
| 47 | **Generator** will apply a 50Hz ramp **Frequency** injection over 5 seconds and **WFPS** will re-stabilise at MIO for 1 minute |

*Test 2 – Injection Tests at 50% of MIO*

| Step No. | Action |
|---|---|
| 1 | **WFPS** will be operating at 50% MIO |
| 2 | **Generator** will simulate 50Hz |
| 3 | **Generator** will apply a 50.1Hz ramp **Frequency** injection over 10 seconds |
| 4 | **Frequency** injection will remain at 50.1Hz for 1 minute |
| 5 | **Generator** will apply a 50.2Hz ramp **Frequency** injection over 10 seconds |
| 6 | **Frequency** injection will remain at 50.2Hz for 1 minute |
| 7 | **Generator** will apply a 50.5Hz ramp **Frequency** injection over 10 seconds |
| 8 | **Frequency** injection will remain at 50.5Hz for 1 minute |
| 9 | **Generator** will apply a 51.0Hz ramp **Frequency** injection over 10 seconds |
| 10 | **Frequency** injection will remain at 51.0Hz for 1 minute |
| 11 | **Generator** will apply a 50.5Hz ramp **Frequency** injection over 10 seconds |
| 12 | **Frequency** injection will remain at 50.5Hz for 1 minute |
| 13 | **Generator** will apply a 50.2Hz ramp **Frequency** injection over 10 seconds |
| 14 | **Frequency** injection will remain at 50.2Hz for 1 minute |
| 15 | **Generator** will apply a 50.1Hz ramp **Frequency** injection over 10 seconds |
| 16 | **Frequency** injection will remain at 50.1Hz for 1 minute |
| 17 | **Generator** will simulate 50Hz and **WFPS** will re-stabilise at 50% of MIO for 1 minute |
| 18 | **Generator** will apply a 49.5Hz ramp **Frequency** injection over 10 seconds |
| 19 | **Frequency** injection will remain at 49.5Hz for 1 minute |
| 20 | **Generator** will apply a 49.0Hz ramp **Frequency** injection over 10 seconds |
| 21 | **Frequency** injection will remain at 49.0Hz for 1 minute |
| 22 | **Generator** will apply a 49.5Hz ramp **Frequency** injection over 10 seconds |
| 23 | **Frequency** injection will remain at 49.5Hz for 1 minute |
| 24 | **Generator** will apply a 50Hz ramp **Frequency** injection over 5 seconds and **WFPS** will re-stabilise at 50% of MIO for 1 minute |
| 25 | **Generator** will apply a 50.1Hz **Frequency** injection as a step change |
| 26 | **Frequency** injection will remain at 50.1Hz for 1 minute |
| 27 | **Generator** will apply a 50.2Hz **Frequency** injection as a step change |
| 28 | **Frequency** injection will remain at 50.2Hz for 1 minute |
| 29 | **Generator** will apply a 50.5Hz **Frequency** injection as a step change |

| | |
|---|---|
| 30 | **Frequency** injection will remain at 50.5Hz for 1 minute |
| 31 | **Generator** will apply a 51.0Hz **Frequency** injection as a step change |
| 32 | **Frequency** injection will remain at 51.0Hz for 1 minute |
| 33 | **Generator** will apply a 50.5Hz **Frequency** injection as a step change |
| 34 | **Frequency** injection will remain at 50.5Hz for 1 minute |
| 35 | **Generator** will apply a 50.2Hz **Frequency** injection as a step change |
| 36 | **Frequency** injection will remain at 50.2Hz for 1 minute |
| 37 | **Generator** will apply a 50.1Hz **Frequency** injection as a step change |
| 38 | **Frequency** injection will remain at 50.1Hz for 1 minute |
| 39 | **Generator** will simulate 50Hz and **WFPS** will re-stabilise at 50% of MIO for 1 minute |
| 40 | **Generator** will apply a 49.5Hz **Frequency** injection as a step change |
| 41 | **Frequency** injection will remain at 49.5Hz for 1 minute |
| 42 | **Generator** will apply a 49.0Hz **Frequency** injection as a step change |
| 43 | **Frequency** injection will remain at 49.0Hz for 1 minute |
| 44 | **Generator** will apply a 49.5Hz **Frequency** injection as a step change |
| 45 | **Frequency** injection will remain at 49.5Hz for 1 minute |
| 46 | **Generator** will apply a 50Hz ramp **Frequency** injection over 5 seconds and **WFPS** will re-stabilise at 50% of MIO for 1 minute |
| 47 | **Generator** will apply a 50.5Hz ramp **Frequency** injection over 10 seconds |
| 48 | **Frequency** injection will remain at 50.5 Hz for 1 minute |
| 49 | **Generator** will apply a 50Hz ramp **Frequency** injection over 5 seconds and **WFPS** will re-stabilise at 50% of MIO for 1 minute |
| 50 | **Generator** will apply a 51.0Hz ramp **Frequency** injection over 10 seconds |
| 51 | **Frequency** injection will remain at 51.0 Hz for 1 minute |
| 52 | **Generator** will apply a 50Hz ramp **Frequency** injection over 5 seconds and **WFPS** will re-stabilise at 50% of MIO for 1 minute |
| 53 | **Generator** will apply a 49.5Hz ramp **Frequency** injection over 10 seconds |
| 54 | **Frequency** injection will remain at 49.5 Hz for 1 minute |
| 55 | **Generator** will apply a 50Hz ramp **Frequency** injection over 5 seconds and **WFPS** will re-stabilise at 50% of MIO for 1 minute |
| 56 | **Generator** will apply a 49.0Hz ramp **Frequency** injection over 10 seconds |
| 57 | **Frequency** injection will remain at 49.0 Hz for 1 minute |

| | |
|---|---|
| 58 | **Generator** will apply a 50Hz ramp **Frequency** injection over 5 seconds and **WFPS** will re-stabilise at 50% of MIO for 1 minute |
| 59 | **Generator** will apply a 50.5Hz **Frequency** injection as a step change |
| 60 | **Frequency** injection will remain at 50.5 Hz for 1 minute |
| 61 | **Generator** will apply a 50Hz ramp **Frequency** injection over 5 seconds and **WFPS** will re-stabilise at 50% of MIO for 1 minute |
| 62 | **Generator** will apply a 51.0Hz **Frequency** injection as a step change |
| 63 | **Frequency** injection will remain at 51.0 Hz for 1 minute |
| 64 | **Generator** will apply a 50Hz ramp **Frequency** injection over 5 seconds and **WFPS** will re-stabilise at 50% of MIO for 1 minute |
| 65 | **Generator** will apply a 49.5Hz **Frequency** injection as a step change |
| 66 | **Frequency** injection will remain at 49.5 Hz for 1 minute |
| 67 | **Generator** will apply a 50Hz ramp **Frequency** injection over 5 seconds and **WFPS** will re-stabilise at 50% of MIO for 1 minute |
| 68 | **Generator** will apply a 49.0Hz **Frequency** injection as a step change |
| 69 | **Frequency** injection will remain at 49.0 Hz for 1 minute |
| 70 | **Generator** will apply a 50Hz ramp **Frequency** injection over 5 seconds and **WFPS** will re-stabilise at 50% of MIO for 1 minute |

*Test 3 – Injection Tests at DMOL*

| Step No. | Action |
|---|---|
| 1 | **WFPS** will be operating at Minimum Operating Figure |
| 2 | **Generator** will simulate 50Hz |
| 3 | **Generator** will apply a 49.9Hz ramp **Frequency** injection over 10 seconds |
| 4 | **Frequency** injection will remain at 49.9Hz for 1 minute |
| 5 | **Generator** will apply a 49.8Hz ramp **Frequency** injection over 10 seconds |
| 6 | **Frequency** injection will remain at 49.8Hz for 1 minute |
| 7 | **Generator** will apply a 49.5Hz ramp **Frequency** injection over 10 seconds |
| 8 | **Frequency** injection will remain at 49.5Hz for 1 minute |
| 9 | **Generator** will apply a 49.0Hz ramp **Frequency** injection over 10 seconds |
| 10 | **Frequency** injection will remain at 49.0Hz for 1 minute |
| 11 | **Generator** will apply a 49.5Hz ramp **Frequency** injection over 10 seconds |
| 12 | **Frequency** injection will remain at 49.5Hz for 1 minute |
| 13 | **Generator** will simulate 50Hz and **WFPS** will re-stabilise at DMOL |
| 14 | **Generator** will apply a 49.9Hz **Frequency** injection as a step change |
| 15 | **Frequency** injection will remain at 49.9Hz for 1 minute |
| 16 | **Generator** will apply a 49.8Hz **Frequency** injection as a step change |
| 17 | **Frequency** injection will remain at 49.8Hz for 1 minute |
| 18 | **Generator** will apply a 49.5Hz **Frequency** injection as a step change |
| 19 | **Frequency** injection will remain at 49.5Hz for 1 minute |
| 20 | **Generator** will apply a 49.0Hz **Frequency** injection as a step change |
| 21 | **Frequency** injection will remain at 49.0Hz for 1 minute |
| 22 | **Generator** will apply a 49.5Hz **Frequency** injection as a step change |
| 23 | **Frequency** injection will remain at 49.5Hz for 1 minute |
| 24 | **Generator** will simulate 50Hz and **WFPS** will re-stabilise at DMOL |
| 25 | **Generator** will apply a 49.5Hz ramp **Frequency** injection over 10 seconds |
| 26 | **Frequency** injection will remain until **MW Output** becomes stable |
| 27 | **Generator** will simulate 50Hz and **WFPS** will re-stabilise at DMOL |
| 28 | **Generator** will apply a 49.0Hz ramp **Frequency** injection over 10 seconds |
| 29 | **Frequency** injection will remain until **MW Output** becomes stable |
| 30 | **Generator** will simulate 50Hz and **WFPS** will re-stabilise at DMOL |

| | |
|---|---|
| 31 | **Generator** will apply a 49.5Hz **Frequency** injection as a step change |
| 32 | **Frequency** injection will remain until **MW Output** becomes stable |
| 33 | **Generator** will simulate 50Hz and **WFPS** will re-stabilise at DMOL |
| 34 | **Generator** will apply a 49.0Hz **Frequency** injection as a step change |
| 35 | **Frequency** injection will remain until **MW Output** becomes stable |
| 36 | **Generator** will simulate 50Hz and **WFPS** will re-stabilise at DMOL |
| 37 | **Generator** will apply a 48.5Hz **Frequency** injection as a step change |
| 38 | **Frequency** injection will remain until **MW Output** becomes stable |
| 39 | **Generator** will simulate 50Hz and **WFPS** will re-stabilise at DMOL |

*Test 4 – Ramp **Frequency Control** Test*

**Frequency Control** testing will be carried out when 100% of **WFPS Generating Unit**s are in service. The available power on the day of testing should be greater than 65% of **Registered Capacity**.

A pre-test **MW Output** curtailment is required to clearly demonstrate that the 'Ramp **Frequency** Blocking set point' is operating correctly.

| Step No. | Action |
|---|---|
| 1 | SONI will send the **WFPS** a **MW** set point to reduce the **MW Output** to DMOL |
| 2 | The **WFPS** will send SONI confirmation of the **MW** set point |
| 3 | SONI will send **WFPS** a Curtailment Time Interval set point |
| 4 | The **WFPS** will send confirmation of the Curtailment Time Interval set point |
| 5 | SONI will turn on 'Emergency Action' mode |
| 6 | The **WFPS** shall ramp at the **Active Power Control Set-Point Ramp Rate** |
| 7 | When the **WFPS** has achieved the specified **MW** set point in the specified Curtailment Time Interval, the **WFPS** will be required to remain at that set point for 10 minutes |
| 8 | SONI will turn off 'Emergency Action' mode |
| 9 | The **WFPS** shall ramp at the **Wind Following Ramp Rate**; this ramp shall be a percentage of **Registered Capacity** of the **WFPS** per minute which equates to 5**MW**/min, the ramp rate shall not exceed three times the **Wind Following Ramp Rate** in any one minute |
| 10 | Before the **MW Output** of the **WFPS** reaches MIO the **Generator** will simulate a **Frequency** of 50.1Hz (exact point at which this occurs to be determined by SONI for each **WFPS**). The **MW Output** of the **WFPS** will be capped to the **MW Output** value at the instant the **Frequency** excursion occurred, the **WFPS** will be required to remain at this **MW Output** for 2 minutes |
| 11 | The **Generator** will simulate a **System Frequency** of 50Hz, the **WFPS MW Output** shall increase to MIO at the **Wind Following Ramp Rate** |

## 6.6 VOLTAGE CONTROL MODE and REACTIVE CAPABILITY TESTS

Compliance Testing/**Monitoring**

Title of Test: **Voltage Control** Mode and Reactive Capability Test Test Number: 6

*Purpose of Test:*

The **WFPS** shall have a fast acting, continuously variable, continuously acting, closed loop voltage regulation System with similar response characteristics to a conventional automatic voltage regulator.

SONI/NIE will require the **WFPS** to operate in one of the following modes of **Voltage Control** (SONI/NIE will inform the **Generator** which form of **Voltage Control** that is required prior to energisation):

*1) Direct **Voltage Control** with Feedback*

***Voltage Control** of **WFPS** in response to a Voltage set point received from SONI/NIE:* The **Generator** should ensure the **WFPS** is capable of performing Closed-loop **Voltage Control** (without a slope) wit proportional-integral action with responses in a stable manner. i.e. if a Voltage set point instruction from SONI/NIE is received by the **WFPS** via SCADA, the **WFPS** will achieve the set point if it has the reactive capability to do so.

***Voltage Control** of **WFPS** in response to a **System** Voltage perturbation after a Voltage set point received via SCADA has been achieved:* The **Generator** should ensure the **WFPS** is capable of performing Closed-loop **Voltage Control** (without a slope) with proportional-integral action with responses in a stable manner The **WFPS** will always maintain that set point using direct **Voltage Control** with feed back if there are **System** Voltage perturbations.

*2) Direct **Voltage Control** With Slope:*

Whilst the **WFPS** is operating in this **Voltage Control** mode, SONI/NIE require the **WFPS** to respond as follows:

***Voltage Control** of **WFPS** in response to a Voltage set point received from SONI/NIE:* The **Generator** will ensure the **WFPS** is capable of performing Closed-loop **Voltage Control** (without a slope) with proportional-integral action with responses in a stable manner. i.e. if a Voltage set point instruction from SONI/NIE is received by the **WFPS** via SCADA, the **WFPS** will achieve the set point if it has the reactive capability to do so.

***Voltage Control** of **WFPS** in response to a **System** Voltage perturbation after a Voltage set point received via SCADA has been achieved:* When the required voltage set point has been achieved (if the reactive capability of the **WFPS** is there to do so) the **WFPS** will operate on a reactive slope characteristic to **System** Voltage perturbations.

For *Direct **Voltage Control** with Slope* the **Voltage Control** System of the **WFPS** should have a reactive slope characteristic which must be adjustable over a range of between 2 - 7% with a resolution of 0.5% (normally 3%-SONI/NIE will advise the **Generator** as to what the slope setting should be set at). The **WFPS** must demonstrate the ability to operate on a 3% reactive slope characteristic. Therefore if the **System** voltage drops by 3% below the voltage set point received from SONI/NIE via SCADA, the **WFPS** will go to its maximum lagging **Reactive Power** capability and export the maximum **Reactive Power** of the **WFPS** on to the **System**. Conversely, if the **System** voltage increases by 3% above the voltage set point received from SONI/NIE via SCADA, the **WFPS** will go to its maximum leading Power Factor and absorb the maximum amount of **Reactive Power** possible from the **System**. The magnitude of the **Reactive Power** output response shall vary linearly in proportion to the magnitude of the step change in voltage.

The **Voltage Control** Mode Test will be carried out by the **WFPS** to demonstrate that; upon receipt of a '**Voltage Control**' signal from SONI/NIE, the **WFPS** enters '**Voltage Control**' mode. Depending on the form **Voltage Control** stipulated by SONI/NIE, the **WFPS** should operate as per 1) *Direct **Voltage Control** with Feedback* or 2) *Direct **Voltage Control** With Slope*.

As per **Grid Code** CC.S2.1.3.2 and Figure 6 of this **WFPS Settings Schedule**, as an absolute minimum, the **WFPS** reactive capability must at least be as per the reactive capability characteristic shown when the **WFPS** is attempting to control the voltage at the **Connection Point** when the **WFPS** operating in **Voltage Control** mode. The **DNO** may allow the **Generator**

to relax the requirements for connection to the **Distribution System**, at their discretion, to the characteristic shown in Figure 7. Six weeks prior to energisation the **Generator** must submit a **Generator Performance Chart** showing the full reactive capability of the **WFPS** at the **Connection Point** (this capability must be at least of the range shown in Figure 6).

The functionality of the **Voltage Control** System will be demonstrated at different voltage set points. (The Commissioning/Acceptance Test Panel will confirm the voltage range to avoid unnecessary risk to the **System**.)

This test will be carried out at a time when the **MW Output** of the **WFPS** is greater than 65% of **Registered Capacity** and 100% of the **WFPS Generating Unit**s are in service, unless otherwise agreed by the Commissioning/Acceptance Test Panel in advance of the test.

The **Reactive Power** response provided by the **Generator** must be continuously variable and be provided continuously in time (i.e. should not involve capacitor bank switching).

*Results Required:*
Time series record and Microsoft Excel Plot (Appendix E) showing:

- Wind Speed
- **MW Output**
- **Mvar** output
- Voltage set point
- Voltage at the **Connection Point**

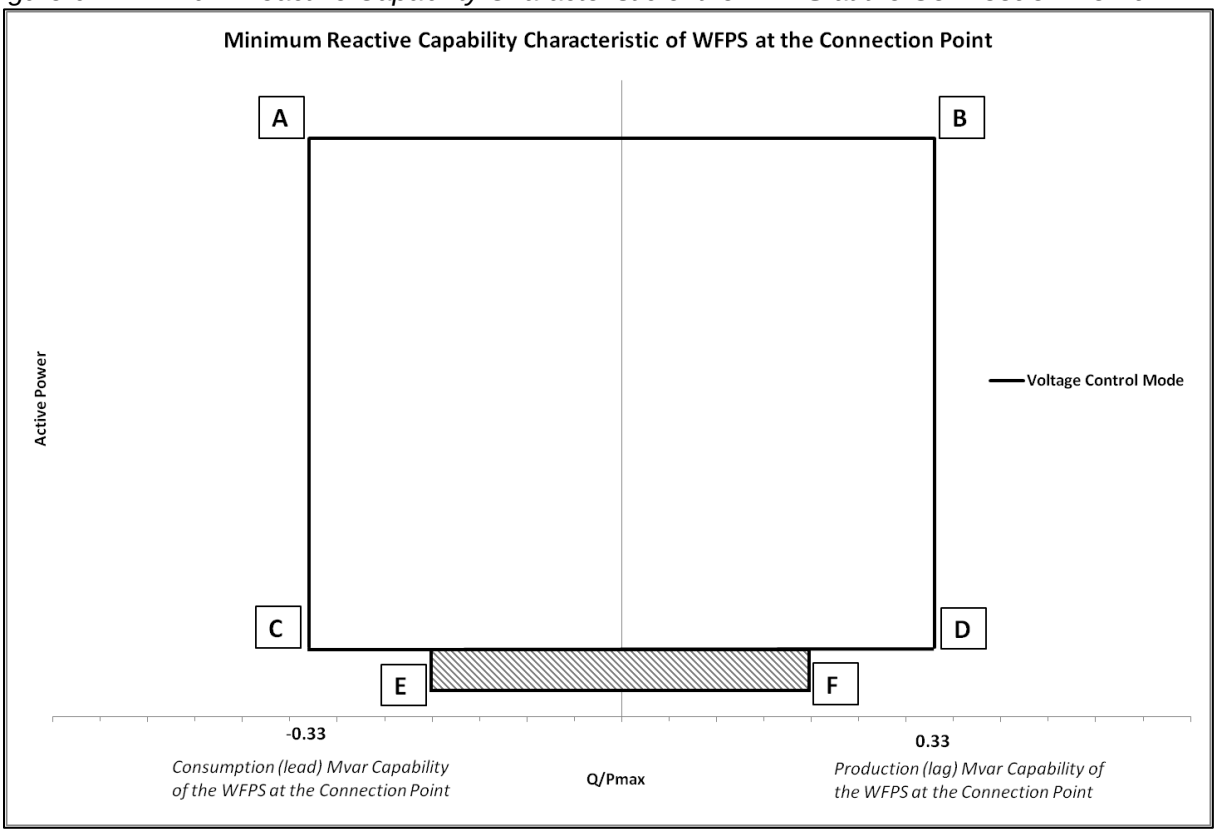
*Test Assessment:*
The test results will be assessed against:

- CC.S2.1.5.3

*Criteria of Assessment:*

- The **TSO** deems fast acting with regards to **Voltage Control** response as being:
  - The speed of response of the voltage regulation System, following a change in voltage setpoint at the **Connection Point** by SONI/NIE via SCADA, shall be such that the **WFPS** shall achieve 90% of its steady-state **Reactive Power** response within 1 second.
  - The change in reactive power commences within 0.2 seconds of the application of the step injection
  - Any oscillations settle to within 5% of the change in steady state **Reactive Power** within 2 seconds of the application of the step injection.
  - The final steady state reactive value is achieved within 5 seconds of the step application.
- The voltage set point will be adjustable over the following ranges:
  10% of nominal with a resolution of better than ±0.25% for Transmission connected **WFPS**
- The voltage set point will be adjustable over the following ranges:
  6% of nominal with a resolution of better than ±0.25% for Distribution connected **WFPS**
- The **WFPS** will hold the required **Connection Point** voltage to within 0.25% of the Set point based on nominal voltage (as instructed via SCADA) if the reactive capability is there to do so
- As an absolute minimum, the reactive capability of the **WFPS** shown in Figure 6 (or Figure 7 for some Distribution connected **WFPS** upon prior agreement with the **DNO**) up to the **Connection Point** will be available to attempt control the voltage at the **Connection Point**.

*Figure 6 – Minimum Reactive Capability Characteristic of the **WFPS** at the **Connection Point***

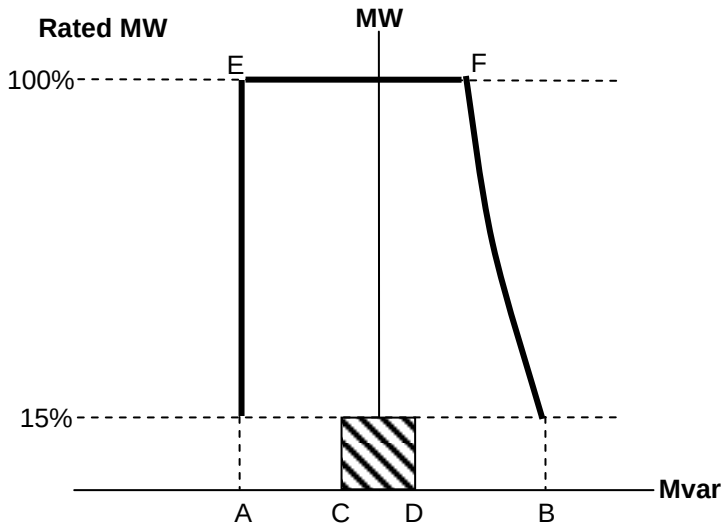



| | |
|---|---|
| *Point A* | ***Mvar** consumption (lead) capability of the **WFPS** at **Registered Capacity** at the **Connection Point*** |
| *Point B* | ***Mvar** production (lag) capability of the **WFPS** at **Registered Capacity** at the **Connection Point*** |
| *Point C* | ***Mvar** consumption (lead) capability of the **WFPS** when **Output** is 12% of **Registered Capacity** at the **Connection Point*** |
| *Point D* | ***Mvar** production (lag) capability of the **WFPS** when **Output** is 12% of **Registered Capacity** at the **Connection Point*** |
| *Point E* | ***Mvar** consumption (lead) capability at cut-in speed of the **Generating Units** at the **Connection Point*** |
| *Point F* | ***Mvar** production (lag) capability at cut-in speed of the **Generating Units** at the **Connection Point*** |

For the avoidance of doubt, whilst the **WFPS** is operating in **Voltage Control** mode the minimum reactive capability shall be as per the envelope ABCDEF in the **Voltage Control** characteristic shown in Figure 6.

The **DNO** may allow the **Generator** to relax the requirements for connection to the **Distribution System**, at its discretion, to the characteristic shown in Figure 7.

*Figure 7 – Alternative Characteristic of Reactive Capability of a Distribution Connected **WFPS** at the **Connection Point***




*Point A is the minimum absorbing **Reactive Power** capability at 15% Rated **MW Output***

*Point B is the minimum producing **Reactive Power** capability at 15% Rated **MW Output***

*Points C and D define the **Reactive Power** Requirement at a **MW Output** below 15% Which is ±5% of rated **MW Output***

*Point E is the minimum absorbing **Reactive Power** capability at 100% rated **MW Output***

*Point F is the maximum producing **Reactive Power** capability at 100% rated **MW Output***

### 6.6.1 VOLTAGE CONTROL MODE TEST PROCEDURE

**Voltage Control** mode testing should be carried out when 100% of **WFPS Generating Unit**s are in service. The available power on the day of testing should be greater than 65% of **Registered Capacity**.

The **Voltage Control** mode tests described below are given indicative of what SONI/NIE requires. However, the **Generator** will have to agree a site specific testing programme with the Commissioning/Acceptance Test Panel who will advise as to the voltage limits that can be tested. This programme is required to be submitted to the Commissioning/Acceptance Test Panel for approval at the early stage of the Compliance process.

The tables below show the possible range of set points that may be sent via SCADA to Transmission or Distribution connected **WFPS**.

**Voltage Control** test sequences 1 and 2 will have to be carried out by the **Generator**.

| **Voltage Control** Test Sequence 1 (For Transmission Connected **WFPS**) | | |
|---|---|---|
| Voltage set points sent by SONI to Transmission Connected **WFPS** | | |
| Test No. | Action | Voltage set point (kV) |
| 1 | SONI will send **WFPS** a 99kV set point. Upon confirmation from the **WFPS** that the set point was received, SONI will engage '**Voltage Control**' mode. Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 99 |
| 2 | SONI will send **WFPS** a 101kV set point. Upon confirmation from the **WFPS** that the set point was received, SONI will engage '**Voltage Control**' mode. Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 101 |
| 3 | SONI will send **WFPS** a 103kV set point. Upon confirmation from the **WFPS** that the set point was received, SONI will engage '**Voltage Control**' mode. Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 103 |
| 4 | SONI will send **WFPS** a 105kV set point. Upon confirmation from the **WFPS** that the set point was received, SONI will engage '**Voltage Control**' mode Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 105 |
| 5 | SONI will send **WFPS** a 107kV set point. Upon confirmation from the **WFPS** that the set point was received, SONI will engage '**Voltage Control**' mode Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 107 |
| 6 | SONI will send **WFPS** a 109kV set point. Upon confirmation from the **WFPS** that the set point was received, SONI will engage '**Voltage Control**' mode Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 109 |
| 7 | SONI will send **WFPS** a 111kV set point. Upon confirmation from the **WFPS** that the set point was received, SONI will engage '**Voltage Control**' mode Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 111 |
| 8 | SONI will send **WFPS** a 113kV set point. Upon confirmation from the **WFPS** that the set point was received, SONI will engage '**Voltage Control**' mode Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 113 |
| 9 | SONI will send **WFPS** a 115kV set point. Upon confirmation from the **WFPS** that the set point was received, SONI will engage '**Voltage Control**' mode Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 115 |
| 10 | SONI will send **WFPS** a 117kV set point. Upon confirmation from the **WFPS** that the set point was received, SONI will engage '**Voltage Control**' mode Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 117 |
| 11 | SONI will send **WFPS** a 119kV set point. Upon confirmation from the **WFPS** that the set point was received, SONI will engage '**Voltage Control**' mode Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 119 |
| 12 | SONI will send **WFPS** a 121kV set point. Upon confirmation from the **WFPS** that the set point was received, SONI will engage '**Voltage Control**' mode Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 121 |

| **Voltage Control** Mode Test Sequence 1 for Test No.1-12 | |
|---|---|
| Step No. | Action |
| 1 | SONI will send the **WFPS** a Voltage set point. |
| 2 | The **WFPS** will send SONI confirmation of the Voltage set point. |
| 3 | SONI will turn on '**Voltage Control**' mode. |
| 4 | Hold until conditions stabilise. |
| 5 | The **WFPS** will be required to remain at this voltage set point for 1 min. |

| **Voltage Control** Test Sequence 1 (for Distribution Connected **WFPS**) | | |
|---|---|---|
| Voltage set points sent by NIE to Distribution Connected **WFPS** | | |
| Test No. | Action | Voltage set point (kV) |
| 1 | NIE will send **WFPS** a 33kV set point. Upon confirmation from the **WFPS** that the set point was received, NIE will engage '**Voltage Control**' mode. Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 33 |
| 2 | NIE will send **WFPS** a 33.5kV set point. Upon confirmation from the **WFPS** that the set point was received, NIE will engage '**Voltage Control**' mode. Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 33.5 |
| 3 | NIE will send **WFPS** a 34kV set point. Upon confirmation from the **WFPS** that the set point was received, NIE will engage '**Voltage Control**' mode. Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 34 |
| 4 | NIE will send **WFPS** a 34.5kV set point. Upon confirmation from the **WFPS** that the set point was received, NIE will engage '**Voltage Control**' mode Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 34.5 |
| 5 | NIE will send **WFPS** a 35kV set point. Upon confirmation from the **WFPS** that the set point was received, NIE will engage '**Voltage Control**' mode Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 35 |
| 6 | NIE will send **WFPS** a 33kV set point. Upon confirmation from the **WFPS** that the set point was received, NIE will engage '**Voltage Control**' mode Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 33 |
| 7 | NIE will send **WFPS** a 32.5kV set point. Upon confirmation from the **WFPS** that the set point was received, NIE will engage '**Voltage Control**' mode Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 32.5 |
| 8 | NIE will send **WFPS** a 32kV set point. Upon confirmation from the **WFPS** that the set point was received, NIE will engage '**Voltage Control**' mode Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 32 |
| 9 | NIE will send **WFPS** a 31.5kV set point. Upon confirmation from the **WFPS** that the set point was received, NIE will engage '**Voltage Control**' mode Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 31.5 |
| 10 | NIE will send **WFPS** a 31kV set point. Upon confirmation from the **WFPS** that the set point was received, NIE will engage '**Voltage Control**' mode Hold until conditions stabilise. The **WFPS** will remain at this set point for 1 min. | 31 |

| **Voltage Control** Mode Test Sequence 1 for Test No.1-10 | |
|---|---|
| Step No. | Action |
| 1 | NIE will send the **WFPS** a Voltage set point. |
| 2 | The **WFPS** will send NIE confirmation of the Voltage set point. |
| 3 | NIE will turn on '**Voltage Control**' mode. |
| 4 | Hold until conditions stabilise. |
| 5 | The **WFPS** will be required to remain at this Voltage set point for 1 min. |

| **Voltage Control** Mode Test Sequence 2 for both Transmission and Distribution Connected **WFPS** | |
|---|---|
| Test Step | Action |
| 1 | The **WFPS** will be sent a power factor set point of 0.95 lead and upon confirmation of the signal being received, the **WFPS** will be switched to Power Factor control. |
| 2 | Upon confirmation that the **WFPS** is at 0.95 lead, the voltage at the **Connection Point** will be measured and called V1 |
| 3 | The **WFPS** will be sent a voltage set point equivalent to V1. On conformation of the signal being received the **WFPS** will be switched to **Voltage Control**. The **WFPS** will remain at this set point for 5 minutes |
| 4 | Similar tests will be carried out as in Test Step 3 above for (V1+ 0.5)kV, (V1 + 1.0) (V1 – 0.5) and (V1 – 1.0)kV. The **WFPS** will be required to remain at each voltage set point for 5 mins |
| 5 | The **WFPS** will be sent a power factor set point of 0.98 lag (for Distribution Connected **WFPS**)/ 0.95 lag (for Transmission Connected **WFPS**) and upon confirmation of the signal being received the **WFPS** will be switched to Power Factor control. |
| 6 | Upon confirmation that the **WFPS** is at 0.98 lag the voltage at the **Connection Point** will be measured and called V2 |
| 7 | The **WFPS** will be sent a voltage set point equivalent to V2 On conformation of the signal being received the **WFPS** will be switched to **Voltage Control**. The **WFPS** will remain at this set point for 5 minutes |
| 8 | Similar tests will be carried out as in Test Step 7 above for (V2 - 0.5)kV, (V2 – 1.0)kV, (V2 + 0.5)kV and (V2 + 1.0)kV. The **WFPS** will be required to remain at each voltage set point for 5 minutes |

### 6.6.2 REACTIVE CAPABILITY TEST PROCEDURE

Reactive Capability testing should be carried out when 100% of **WFPS Generating Unit**s are in service. The available power on the day of testing should be greater than 80% of **Registered Capacity**. This test will be carried out when the **WFPS** is in **Voltage Control** mode.
The Reactive Capability tests described below are given indicative of what SONI/NIE requires. However, the **Generator** will have to agree a site specific testing programme with the Commissioning/Acceptance Test Panel who will advise as to the voltage limits that can be tested. This programme is required to be submitted to the Commissioning/Acceptance Test Panel for approval at the early stage of the Compliance process.

For Transmission connected **WFPS**, the **WFPS** reactive capability must at least be as per the reactive capability characteristic shown in **Grid Code** CC.S2.1.3.2 and Figure 6 of this **WFPS Settings Schedule**,

For Distribution connected **WFPS**, as an absolute minimum, the **WFPS** reactive capability must at least be as per the reactive capability characteristic shown in Figure 6 (in some cases the **DNO** may agree to the **WFPS** providing the reactive capability shown in Figure 7).

Six weeks prior to energisation the **Generator** must submit a **Generator Performance Chart** showing the full reactive capability of the **WFPS** at the **Connection Point** (this capability must be at least of the range shown in Figure 6). SONI/NIE will, through testing, verify if the **WFPS** has the reactive capability that was submitted.

To do this the **WFPS** will be issued with a voltage set point from SONI/NIE at the extremities of the voltage set points that can be issued (up to ±6% of $V_{NOMINAL}$ for Distribution Connected **WFPS** and up to ±10% of $V_{NOMINAL}$ for Transmission Connected **WFPS**). When the **WFPS** is issued a voltage set point at the lower voltage extremity the **Active Power** will then be reduced in steps by SONI/NIE from 80% **Registered Capacity** to DMOL. This will then be repeated at the higher voltage extremity. This will allow a reactive capability chart to be drawn to compare with the chart submitted by the **Generator**.

| Test Step. | Action |
|---|---|
| 1 | **WFPS** at MIO (>80% **Registered Capacity**) |
| 2 | SONI/NIE will send the **WFPS** Voltage Set point which is at the lower voltage extremity |
| 3 | The **WFPS** will send SONI/NIE confirmation of the Voltage set point. |
| 4 | SONI/NIE will turn on '**Voltage Control**' mode. |
| 5 | Hold until conditions stabilise. |
| 6 | In pre-agreed **MW** steps, SONI/NIE will issue the **WFPS MW** set points from MIO to 0**MW** |
| 7 | The **WFPS** will then be allowed to Ramp back up to MIO (>80% of **Registered Capacity**) |
| 8 | SONI/NIE will send the **WFPS** Voltage Set point which is at the higher voltage extremity |
| 9 | The **WFPS** will send SONI/NIE confirmation of the Voltage set point. |
| 10 | SONI/NIE will turn on '**Voltage Control**' mode. |
| 11 | Hold until conditions stabilise. |
| 12 | In pre-agreed **MW** steps, SONI/NIE will issue the **WFPS MW** set points from MIO to the minimum **Active Power** Level that the **WFPS** can import/export **Reactive Power** (to be confirmed by **Generator** in advance of testing). |

| Voltage Set point (issued by SONI/NIE via SCADA) | **Active Power Output** (% **Registered Capacity**) | **Reactive Power** (pu) |
|---|---|---|
| Lower Voltage set point extremity (to be agreed with the Commissioning/Acceptance Test Panel in advance of testing) | 100 | |
| | 80 | |
| | 60 | |
| | 40 | |
| | 20 | |
| | DMOL | |
| | Minimum **Active Power** Level that the **WFPS** can import/ **Reactive Power** | |
| Higher Voltage set point extremity (to be agreed with the Commissioning/Acceptance Test Panel in advance of testing) | 100 | |
| | 80 | |
| | 60 | |
| | 40 | |
| | 20 | |
| | DMOL | |
| | Minimum **Active Power** Level that the **WFPS** can export **Reactive Power** | |

The **Generator** should submit a Reactive Capability Chart to SONI/NIE based on the results recorded in the above test.

## 6.7 AUTOMATIC VOLTAGE CONTROL TEST

Compliance Testing/**Monitoring**

Title of Test: **Voltage Control** Test Test Number: 7

*Purpose of Test*:

The **WFPS** shall have a fast acting**,** continuously variable, closed loop voltage regulation System with similar response characteristics to a conventional automatic voltage regulator.

The Automatic **Voltage Control** Test will be carried out by the **Generator** to verify that the **WFPS** is equipped with a fast-acting automatic **Voltage Control** that meets the requirements of CC.S2.1.5.3 (a) and **Distribution Code** Connection Condition 7.9.2

SONI/NIE will require the **WFPS** to operate in one of the following modes of **Voltage Control** (SONI/NIE will inform the **Generator** which form of **Voltage Control** that is required prior to energisation):

*1)* *Direct **Voltage Control** with Feedback*

***Voltage Control** of **WFPS** in response to a Voltage set point received from SONI/NIE:* The **Generator** should ensure the **WFPS** is capable of performing Closed-loop **Voltage Control** (without a slope) with proportional-integral action with responses in a stable manner. i.e. if a Voltage set point instruction from SONI/NIE is received by the **WFPS** via SCADA, the **WFPS** will achieve the set point if it has the reactive capability to do so.

***Voltage Control** of **WFPS** in response to a **System** Voltage perturbation after a Voltage set point received via SCADA has been achieved:* The **Generator** should ensure the **WFPS** is capable of performing Closed-loop **Voltage Control** (without a slope) with proportional-integral action with responses in a stable manner The **WFPS** will always maintain that set point using direct **Voltage Control** with feed back if there are **System** Voltage perturbations.

2) *Direct **Voltage Control** With Slope*:

Whilst the **WFPS** is operating in this **Voltage Control** mode, SONI/NIE require the **WFPS** to respond as follows:

***Voltage Control** of **WFPS** in response to a Voltage set point received from SONI/NIE:* The **Generator** will ensure the **WFPS** is capable of performing Closed-loop **Voltage Control** (without a slope) with proportional-integral action with responses in a stable manner. i.e. if a Voltage set point instruction from SONI/NIE is received by the **WFPS** via SCADA, the **WFPS** will achieve the set point if it has the reactive capability to do so.

***Voltage Control** of **WFPS** in response to a **System** Voltage perturbation after a Voltage set point received via SCADA has been achieved:* When the required voltage set point has been achieved (if the reactive capability of the **WFPS** is there to do so) the **WFPS** will operate on a reactive slope characteristic to **System** Voltage perturbations.

For *Direct **Voltage Control** with Slope* the **Voltage Control** System of the **WFPS** should have a reactive slope characteristic which must be adjustable over a range of between 2 - 7% with a resolution of 0.5% (normally 3%-SONI/NIE will advise the **Generator** as to what the slope setting should be set at). The **WFPS** must demonstrate the ability to operate on a 3% reactive slope characteristic. Therefore if the **System** voltage drops by 3% below the voltage set point received from SONI/NIE via SCADA, the **WFPS** will go to its maximum lagging **Reactive Power** capability and export the maximum **Reactive Power** of the **WFPS** on to the **System**. Conversely, if the **System** voltage increases by 3% above the voltage set point received from SONI/NIE via SCADA, the **WFPS** will go to its maximum leading Power Factor and absorb the maximum amount of **Reactive Power** possible from the **System**. The magnitude of the **Reactive Power** output response shall vary linearly in proportion to the magnitude of the step change in voltage.

For Transmission connected **WFPS**, the **WFPS** reactive capability for **Voltage Control** must at least be as per the reactive capability characteristic shown in **Grid Code** CC.S2.1.3.2 and Figure 6 of this **WFPS Settings Schedule**,

For Distribution connected **WFPS**, as an absolute minimum, the **WFPS** reactive capability for **Voltage Control** must at least be as per the reactive capability characteristic shown in Figure (in some cases the **DNO** may agree to the **WFPS** providing the reactive capability shown in Figure 7).

i) These tests will be carried out by the **Generator** injecting step changes to the **Connection Point** voltage reference (tests 1-6). Further automatic voltage regulation tests will be carried out by changing the tap position of the upstream transformers, these tests will be carried out at the discretion of the Commissioning/Acceptance Test Panel (tests 7-14).

ii) Further to this, whilst the **WFPS** is operating in power factor mode, SONI will require the **Generator** to inject a step change to the **Connection Point** voltage reference which:

**a)** For Transmission Connected **WFPS** is outside the statutory limits as specified in CC5.4.1 to prove that if the voltage exceeds the specified band (±10%) the **WFPS** will automatically change to **Voltage Control** mode (tests 15-16).
**b)** For Distribution Connected **WFPS** is outside the statutory limits as specified in the **Distribution Code** to prove that if the voltage exceeds the specified band (±6%) the **WFPS** will automatically change to **Voltage Control** mode (tests 15-16).

These tests will be carried out at a time when the **MW Output** of the **WFPS** is greater than 65% of **Registered Capacity** and 100% of the **WFPS Generating Unit**s are in service, unless otherwise agreed by the **Generator** with the Commissioning/Acceptance Test Panel in advance of the test.

For Transmission connected **WFPS**, the Commissioning/Acceptance Test Panel will agree the test procedure in advance of Compliance testing

The **Reactive Power** response provided by the **Generator** must be continuously variable and be provided continuously in time (i.e. should not involve capacitor bank switching).

SONI/NIE can provide examples of what is required in terms of **WFPS** performance in **Voltage Control** if the **Generator** requires more detail on this area.

*Results Required:*
Time series record and Microsoft Excel Plot (Appendix E) showing:

- **MW Output**
- **Mvar** output
- **MW Availability**
- Power Factor Set-Point
- Voltage at the **Connection Point**
- Voltage Step Injection

*Test Assessment:*
The test results will be assessed against:

- **Grid Code** (CC.S2.1.5.3 (a) and CC.5.4.1) and **Distribution Code** (Connection Condition 7.9.2 and Connection Condition 5.3.1)

*Criteria of Assessment:*

- The **TSO** deems fast acting with regards to **Voltage Control** response as being:
  - The speed of response of the voltage regulation System, following a step change in voltage at the **Connection Point**, shall be such that the **WFPS** shall achieve 90% of its steady-state **Reactive Power** response within 1 second.
  - The change in reactive power commences within 0.2 seconds of the application of the step injection
  - Any oscillations settle to within 5% of the change in steady state **Reactive Power** within 2 seconds of the application of the step injection.
  - The final steady state reactive value is achieved within 5 seconds of the step application.
  - If the voltage exceeds the specified band that the power factor control reverts to **Voltage Control** to the **Connection Point** voltage reference whilst the **WFPS** is operating in power factor mode (**Distribution Code** Connection Condition 7.9.2 and **Grid Code** CC.S2.1.5.3(a)).

### 6.7.1 AUTOMATIC VOLTAGE CONTROL TEST PROCEDURE

The **WFPS** shall be capable of operating as per CC.S2.1.5.3 (a) for Transmission Connected **WFPS** and CC.7.9.2 of the **Distribution Code** for Distribution Connected **WFPS**

*Automatic **Voltage Control** Compliance Tests*

Automatic **Voltage Control** testing will be carried out when 100% of **Generating Unit**s at the **WFPS** are in service. The available power on the day of testing should be greater than 65% of **Registered Capacity**.

A comprehensive suite of tests will be carried out to fully explore the behaviour of a **WFPS** following a voltage excursion on the **System**.

The automatic **Voltage Control** tests described below are to be arranged and conducted by the **Generator**; it is their responsibility to propose a test programme to suit their site specific requirements. A typical example of the test programme is given below. This programme is required to be submitted to the Commissioning/Acceptance Test Panel for approval at the early stage of the Compliance process.

Tests 1-12 will require the **Generator** to inject step changes to the **Connection Point** voltage reference.

| Voltage Injections to the **WFPS** Controller | | | |
|---|---|---|---|
| Test No. | Action | Voltage Injection | Notes |
| 1 | Inject +1% step to the **WFPS** Voltage Reference Set point . Hold for 10 sec, remove injection as a step and hold for 10 sec. | +1% | |
| 2 | Inject -1% step to the **WFPS** Voltage Reference Set point . Hold for 10 sec, remove injection as a step and hold for 10 sec. | -1% | |
| 3 | Inject +2% step to the **WFPS** Voltage Reference Set point . Hold for 10 sec, remove injection as a step and hold for 10 sec. | +2% | |
| 4 | Inject -2% step to the **WFPS** Voltage Reference Set point . Hold for 10 sec, remove injection as a step and hold for 10 sec. | -2% | |
| 5 | Inject +3% step to the **WFPS** Voltage Reference Set point . Hold for 10 sec, remove injection as a step and hold for 10 sec. | +3% | |
| 6 | Inject -3% step to the **WFPS** Voltage Reference Set point . Hold for 10 sec, remove injection as a step and hold for 10 sec. | -3% | |
| 7 | Inject +4% step to the **WFPS** Voltage Reference Set point . Hold for 10 sec, remove injection as a step and hold for 10 sec. | +4% | |
| 8 | Inject -4% step to the **WFPS** Voltage Reference Set point . Hold for 10 sec, remove injection as a step and hold for 10 sec. | -4% | |
| 9 | Inject +5% step to the **WFPS** Voltage Reference Set point . Hold for 10 sec, remove injection as a step and hold for 10 sec. | +5% | |
| 10 | Inject -5% step to the **WFPS** Voltage Reference Set point . Hold for 10 sec, remove injection as a step and hold for 10 sec. | -5% | |
| 11 | Inject +6% step to the **WFPS** Voltage Reference Set point . Hold for 10 sec, remove injection as a step and hold for 10 sec. | +6% | |
| 12 | Inject -6% step to the **WFPS** Voltage Reference Set point . Hold for 10 sec, remove injection as a step and hold for 10 sec. | -6% | |

Tests 13-20 will be carried out by changing the tap position of the Upstream transformers.

| Altering the tap position of the Upsteam transformers | | | |
|---|---|---|---|
| Test No. | Action | Tap Change | Notes |
| 13 | Tap up 1 position, hold for 10 sec | +1 Tap | |
| 14 | Tap up 1 position (i.e. up 2 positions from starting position) , hold for 10 sec | +1 Tap | |
| 15 | Tap down 1 position (i.e. up 1 position from starting position) , hold for 10 sec | -1 Tap | |
| 16 | Tap down 1 position (i.e. back to starting position) , hold for 10 sec | -1 Tap | |
| 17 | Tap down 1 position (i.e. down 1 position from starting position) , hold for 10 sec | -1 Tap | |
| 18 | Tap down 1 position (i.e. down 2 positions from starting position) , hold for 10 sec | -1 Tap | |
| 19 | Tap up 1 position (i.e. up 1 position from starting position) , hold for 10 sec | +1 Tap | |
| 20 | Tap up 1 position (i.e. back to starting position) , hold for 10 sec | +1 Tap | |

Tests 21-22 will require the **Generator** to inject step changes which are outside the statutory limits (6% for Distribution Connected **WFPS** and 10% for Transmission Connected **WFPS**) to prove that if the voltage exceeds the specified band that the power factor control reverts to **Voltage Control** to the **Connection Point** voltage reference whilst the **WFPS** is operating in power factor mode.

| Voltage Injections to the **WFPS** Controller | | | |
|---|---|---|---|
| Test No. | Action | Voltage Injection | Notes |
| 21 | Inject step to the **WFPS** Voltage Reference Set point . Hold for 1 min, remove injection as a step and hold for 1 min. | +7% (Distribution Connected **WFPS**)<br>Or<br>+11% (Transmission Connected **WFPS**) | |
| 22 | Inject step to the **WFPS** Voltage Reference Set point . Hold for 1 min, remove injection as a step and hold for 1 min. | -7% (Distribution Connected **WFPS**)<br>Or<br>-11% (Transmission Connected **WFPS**) | |

## 6.8 POWER FACTOR CONTROL TEST

| | |
|---|---|
| Compliance Testing/**Monitoring** | |
| Title of Test: Power Factor Control | Test Number: 8 |

*Purpose of Test:*
The Commissioning/Acceptance Test Panel will require a demonstration of the leading and lagging **Reactive Power** capability of the **WFPS** to demonstrate Compliance with **Grid Code** CC.S2.1.3.2 or Distribution Code CC7.4.1.

- For Transmission Connected **WFPS:** The **WFPS** must demonstrate the ability to operate at 0.95 Leading Power Factor to 0.95 Lagging Power Factor between 0% - 100% Rated **MW**. The requirement only defines the minimum capability.
- For Distribution Connected **WFPS:** The **WFPS** must demonstrate the ability to operate at 0.95 Leading Power Factor to 0.98 Lagging Power Factor between 0% - 100% Rated **MW**. The requirement only defines the minimum capability.

The **WFPS** must be fitted with a fast acting control system capable of providing the Leading and Lagging Power Factors stipulated above.

The Commissioning/Acceptance Test Panel will communicate with each **Generator** prior to testing to discuss each individual **WFPS** technical connection characteristics. Power Factor Control testing will be achieved by operation of the **WFPS** at the required power factor for different **MW Output** levels for an agreed duration. The test duration will be for a minimum period of 1 hour at MIO or a duration stipulated by the Commissioning/Acceptance Test Panel.

This test will be co-ordinated by the Commissioning/Acceptance Test Panel at an agreed time during the reliability/acceptance period of the commissioning process. The test will be to the instruction of the Commissioning/Acceptance Test Panel and should be monitored and recorded both at SONI or NIE Control Centre and by the **Generator**.

These tests will be carried out at a time when the **MW Output** of the **WFPS** is greater than 80% of **Registered Capacity** and 100% of the **WFPS Generating Unit**s are in service, unless otherwise agreed by the **Generator** with the Commissioning/Acceptance Test Panel in advance of the test.

The **Reactive Power** response provided by the **Generator** must be continuously variable and be provided continuously in time (i.e. should not involve capacitor bank switching).

*Results Required:*
Time series record and Microsoft Excel Plot (Appendix E) showing:

- **MW Output**
- **Mvar** output
- Voltage set point
- Voltage at the **Connection Point**
- Power Factor set point

*Test Assessment*:
The test results will be assessed against the criteria below unless varied by the Connection Agreement.

*Criteria of Assessment:*

- The **TSO** deems fast acting with regards to Power Factor Control response as being:
  - The speed of response of the power factor control system, following a change in the power factor setpoint at the **Connection Point** by SONI/NIE via SCADA, shall be such that the **WFPS** shall achieve 90% of its steady-state **Reactive Power** response within 1 second.
  - The change in reactive power commences within 0.2 seconds of the application of the step injection
  - Any oscillations settle to within 5% of the change in steady state **Reactive Power** within 2 seconds of the application of the step injection.
  - The final steady state reactive value according to the slope characteristic is achieved within 5 seconds of the step application.
- The **Reactive Power** transfer at the **WFPS** Terminals equals or exceeds the minimum requirements defined in CC.S2.1.3.2 when generating more than 0% **Active Power**.
- SONI/NIE will be calculating the reactive capability of the **WFPS** by working out the power factor in each test using the following calculation:

$$Power\_Factor = Cos(Tan^{-1}(\frac{Q}{P}))$$

Where:

Q = **Reactive Power** (**Mvar**)

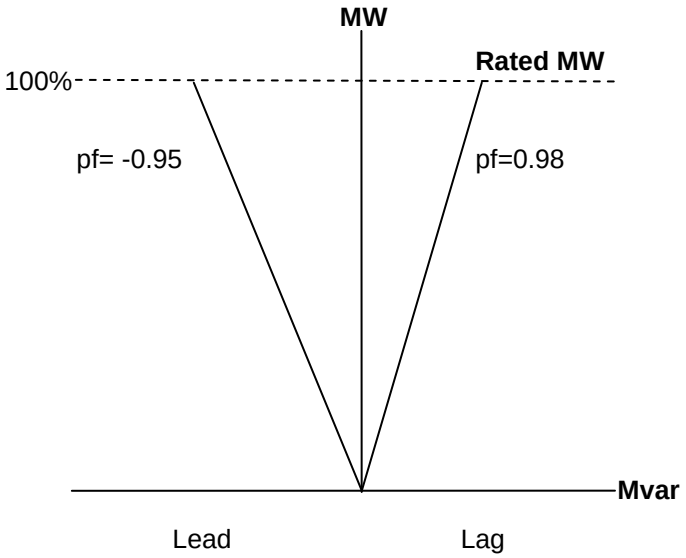
P = **Active Power** (**MW**)

- The calculated power factor figure will be compared to the power factor set point that was sent to the **WFPS** in each case

### 6.8.1 POWER FACTOR CONTROL TEST PROCEDURE

Summary of **Grid Code** Reactive Capability Requirements for Distribution and Transmission Connected **WFPS**

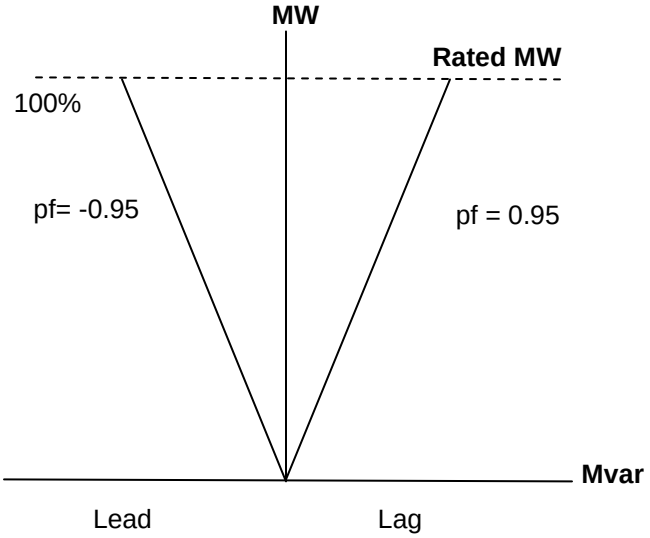
*Figure 8:*
*Minimum Power Factor*
*Performance Chart for Distribution Connected **WFPS***




For clarification:

The **WFPS** must demonstrate the ability to operate at 0.95 Leading Power Factor to 0.98 Lagging Power Factor for a Distribution Connected **WFPS** between 0% - 100% Rated **MW**. The requirement only defines the minimum capability.

*Figure 9:*
*Minimum Power Factor*
*Performance Chart for Transmission Connected **WFPS***




For clarification:

The **WFPS** must demonstrate the ability to operate at 0.95 Leading Power Factor to 0.95 Lagging Power Factor for a Transmission Connected **WFPS** between 0% - 100% Rated **MW**. The requirement only defines the minimum capability.

*Power Factor Control Compliance Tests*

Power Factor testing should be carried out when 100% of **Generating Unit**s at the **WFPS** are in service. The available power on the day of testing should be greater than 80% of **Registered Capacity**.

The required tests should demonstrate the Power Factor capability of the **WFPS** as per Figure 8 (for Distribution connected **WFPS**s) or Figure 9 for (Transmission connected **WFPS**s). Given that the steady state nature of the Reactive Capability requirements under Power Factor control implies that reactive power can be maintained indefinitely, the tests are therefore carried out over a longer period than other Compliance tests. The suite of tests shown in the table below explores the extremes of the Reactive Capability envelope in Power Factor control.

For each test, SONI/NIE will give the **WFPS** a Power Factor set point and turn on Power Factor mode in each case.

| | | Transmission Connected **WFPS** Reactive Capability | |
|---|---|---|---|
| Test No. | Test | 0.95 Leading pf | 0.95 Lagging pf |
| 1 & 2 | **Active Power** 1% **Registered Capacity** | 5 Mins | 5 Mins |
| 3 & 4 | 50% **Registered Capacity** | 5 Mins | 5 Mins |
| 5 & 6 | MIO (>80% of **Registered Capacity**) | 1 Hour | 1 Hour |

| | | Distribution Connected **WFPS** Reactive Capability | |
|---|---|---|---|
| Test No. | Test | 0.95 Leading pf | 0.98 Lagging pf |
| 1 & 2 | **Active Power** 1% **Registered Capacity** | 5 Mins | 5 Mins |
| 3 & 4 | 50% **Registered Capacity** | 5 Mins | 5 Mins |
| 5 & 6 | MIO (>80% of **Registered Capacity**) | 1 Hour | 1 Hour |

| Reactive Capability Test Sequence for Test No.1-6 (For Transmission and Distribution Connected **WFPS**) | |
|---|---|
| Step No. | Action |
| 1 | SONI/NIE will send the **WFPS** a maximum leading/lagging Power Factor set point. |
| 2 | The **WFPS** will send SONI/NIE confirmation of the Power Factor set point. |
| 3 | SONI/NIE will turn on 'PF Control' mode. |
| 4 | When the **WFPS Reactive Power** import/export has settled, indicating the **WFPS** is at its required leading/lagging capability, the **WFPS** will be required to remain at that set point for the specified time. |

## 6.9 REACTIVE POWER DISPATCH TEST

| | |
|---|---|
| Compliance Testing/**Monitoring** | |
| Title of Test: **Reactive Power Dispatch** | Test Number: 9 |

*Purpose of Test:*

The **WFPS** must be fitted with a fast acting control system with the ability to **Dispatch Reactive Power** (both consumption (lead) and production (lag)) to the limits that are stipulated in the **Generator Performance Chart** that the **Generator** will submit to SONI.

The Commissioning/Acceptance Test Panel will communicate with each **Generator** prior to testing to discuss each individual **WFPS** technical connection characteristics.

This test will be co-ordinated by the Commissioning/Acceptance Test Panel at an agreed time during the reliability/acceptance period of the commissioning process. The test will be to the instruction of the Commissioning/Acceptance Test Panel and should be monitored and recorded both at SONI or NIE Control Centre and by the **Generator**.

These tests will be carried out at a time when the **MW Output** of the **WFPS** is greater than 80% of **Registered Capacity** and 100% of the **WFPS Generating Unit**s are in service, unless otherwise agreed by the **Generator** with the Commissioning/Acceptance Test Panel in advance of the test.

The **Reactive Power** response provided by the **Generator** must be continuously variable and be provided continuously in time (i.e. should not involve capacitor bank switching).

*Results Required:*
Time series record and Microsoft Excel Plot (Appendix E) showing:

- **MW Output**
- **Mvar** output
- **Mvar** set point
- Voltage set point
- Voltage at the **Connection Point**

*Test Assessment:*
The test results will be assessed against the criteria below unless varied by the Connection Agreement.

*Criteria of Assessment*:

- The **Mvar** output of the **WFPS** will be within 3% of the **Mvar** set point that is received via SCADA based on the **Registered Capacity** of the **WFPS**
- The **TSO** deems fast acting with regards to **Reactive Power Dispatch** response as being:
  - The speed of response of the control system, following a change in **Reactive Power** setpoint at the **Connection Point** by SONI/NIE via SCADA, shall be such that the **WFPS** shall achieve 90% of its steady-state **Reactive Power** response within 1 second.
  - The change in reactive power commences within 0.2 seconds of the application of the step injection
  - Any oscillations settle to within 5% of the change in steady state **Reactive Power** within 2 seconds of the application of the step injection.
  - The final steady state reactive value is achieved within 5 seconds of the step application.

### 6.9.1 REACTIVE POWER DISPATCH TEST PROCEDURE

**Reactive Power Dispatch** testing should be carried out when 100% of **WFPS Generating Unit**s are in service. The available power on the day of testing should be greater than 80% of **Registered Capacity**. The Reactive Capability tests described below are given indicative of what SONI/NIE requires. However, the **Generator** will have to agree a site specific testing programme with the Commissioning/Acceptance Test Panel who will advise as to the voltage limits that can be tested to at the **WFPS Connection Point**. This programme is required to be submitted to the Commissioning/Acceptance Test Panel for approval at the early stage of the Compliance process.

As per **Grid Code**, the **Generator** must submit a **Generator Performance Chart** showing the full reactive capability of the **WFPS** at the **Connection Point** (this capability must be at least of the range shown in Figure 6) prior to the commencement of the **Reactive Power Dispatch** test.

| Test Step. | Action |
|---|---|
| 1 | **WFPS** at MIO (≥80% **Registered Capacity**) |
| 2 | SONI/NIE will send the **WFPS Mvar** set point |
| 3 | The **WFPS** will send SONI/NIE confirmation of the **Mvar** set point. |
| 4 | SONI/NIE will turn on ''**Mvar Dispatch**' mode |
| 5 | Hold until conditions stabilise and the **WFPS** has achieved the required **Mvar** set point. |

Steps 1-5 above will be repeated until the table below can be populated.

| **Active Power** (**MW**) based on **Registered Capacity** | | **Reactive Power** (**Mvar**) | | | |
|---|---|---|---|---|---|
| | | Consumption (lead) | | Production (Lag) | |
| | | Max | 50% Max | Max | 50% Max |
| >80% | **Mvar** Set point (received via SCADA) | | | | |
| | **Mvar** output | | | | |
| 50% | **Mvar** Set point (received via SCADA) | | | | |
| | **Mvar** output | | | | |
| DMOL | **Mvar** Set point (received via SCADA) | | | | |
| | **Mvar** output | | | | |
| minimum **Active Power** Level that the **WFPS** can import/export **Reactive Power** | **Mvar** Set point (received via SCADA) | | | | |
| | **Mvar** output | | | | |

The max consumption (lead) and max production (lead) **Mvar** values that will be sent from SONI/NIE via SCADA will be taken from the reactive capability chart that is submitted to SONI/NIE by the **Generator**.

## 6.10 SHUTDOWN REQUEST TEST

| | |
|---|---|
| Compliance Testing/**Monitoring** | |
| Title of Test: **Shutdown** Request | Test Number: 10 |

*Purpose of Test*:

The **Shutdown** Request Test will be carried out by the **Generator** to demonstrate;

i) The reduction of power **Output** to zero in a specified time as per CC.S2.1.3.7(d) for Transmission Connected **WFPS** and CC.S2.2.3.4 (a) for Distribution Connected **WFPS**.

ii) The **MW** reduction will be at a continuous linear ramp down rate over the time frame given.

This test will be carried out at a time when the **MW Output** of the **WFPS** is greater than 80% of **Registered Capacity** and 100% of the **WFPS Generating Unit**s are in service, unless otherwise agreed by the Commissioning/Acceptance Test Panel in advance of the test.

*Results Required:*

Time series record and Microsoft Excel Plot (Appendix E) showing:

- **MW Output**
- **MW Availability**
- **MW** set point
- **WFPS** Active Set Point
- Emergency Action ON/OFF
- Wind Speed

*Test Assessment:*

The test results will be assessed against:

- CC.S2.1.3.7(d) for Transmission Connected **WFPS** and CC.S2.2.3.4 (d) for Distribution Connected **WFPS**.
- **WFPS Settings Schedule**

*Criteria of Assessment:*

- The results of the test will demonstrate that the **MW Output** of the **WFPS** reduces dynamically over the requested time interval.
- The **MW Availability** of the **WFPS** will reflect the fact that SONI curtails the **Output** of the **WFPS** (i.e. it should give an indication of the MIO of the **WFPS** had the site not been curtailed by SONI).
- **WFPS** is at 0 **MW Output** within ±10 seconds of the specified 'Curtailment Time Interval'.
- The **MW** reduction will be at a continuous linear ramp down rate over the time frame given.
- The **WFPS** response will be assessed from the time the Emergency Action Mode is engaged.

### 6.10.1 SHUT-DOWN REQUEST TEST PROCEDURE

The **WFPS** shall be able to reduce the **MW Output** of the site to zero. The reduction in **Output** will take place in a specified 'Curtailment Time Period' between 1 and 30 minutes, as per CC.S2.1.3.7(d) for Transmission Connected **WFPS** and CC.S2.2.3.4 (a) for Distribution Connected **WFPS**. The **WFPS** shall calculate the **Active Power Control Set-Point Ramp Rate** accordingly.

*Shut-Down Request Compliance Tests*

**Shutdown** Request testing will be carried out when 100% of the **WFPS Generating Unit**s are in service. The available power on the day of testing should be greater than 80% of **Registered Capacity**.

| Shut-Down Request Test Sequence<br>(At MIO, SONI will reduce the **WFPS MW Output** to zero in a 'Curtailment Time Interval' of 5 mins) | |
|---|---|
| Step No. | Action |
| 1 | SONI will send the **WFPS** a 0**MW** set point. |
| 2 | The **WFPS** will send SONI confirmation of the 0**MW** set point. |
| 3 | SONI will send **WFPS** a Curtailment Time Interval set point. |
| 4 | The **WFPS** will send SONI confirmation of the Curtailment Time Interval set point. |
| 5 | SONI will turn on 'Emergency Action' mode. |
| 6 | The **WFPS** will ramp down at the **Active Power Control Set-Point Ramp Rate** |
| 7 | When the **WFPS** has achieved the 0**MW** set point in the specified Curtailment Time Interval, the **WFPS** will be required to remain at that set point for 5 mins. |

## 6.11 START-UP SEQUENCE & WIND FOLLOWING RAMP RATE TEST

| |
|---|
| Compliance Testing/**Monitoring** |
| Title of Test: **Start-Up** Sequence & Wind Following Ramp Rate Test Test Number: 11 |
| *Ramp Rates*<br>The **WFPS** control system shall be capable of controlling the ramp rate of its **Active Power Output**. There shall be three ramp rate capabilities designated, **Wind Following Ramp Rate**, **Active Power Control Set-Point Ramp Rate** and **Frequency Response Ramp Rate**. The **WFPS** 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**; **Wind Following Ramp Rate**. It shall be possible to vary the **Wind 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.<br><br>*Purpose of Test:*<br>The **Start-Up** Sequence & Wind Following Ramp Rate Test will be carried out by the **Generator** to demonstrate the **Start-Up** or Wind Following Ramp Rate limits are not exceeded.<br><br>This test can be carried out in conjunction with the Shut-Down Request Compliance Test<br><br>This test will be carried out at a time when the **MW Output** of the **WFPS** is greater than 80% of **Registered Capacity** and 100% of the **WFPS Generating Unit**s are in service, unless otherwise agreed by the Commissioning/Acceptance Test Panel in advance of the test. |
| *Results Required:*<br>Time series record and Microsoft Excel Plot (Appendix E) showing:<br><br>• **MW Output**<br>• **MW Availability**<br>• **MW** set point<br>• **WFPS** Active Set Point<br>• Ramp Rate Setting<br>• Emergency Action ON/OFF<br>• Wind Speed |
| Test Assessment:<br>The test results will be assessed against:<br>• CC.S2.1.3.7 for Transmission Connected WFPS and CC.S2.2.3.4 for Distribution Connected WFPS.<br>• WFPS Settings Schedule<br><br>Criteria of Assessment:<br>• Following Shutdown, upon removal of 'Emergency Action' mode by SONI, the WFPS should begin to export Active Power within 90 seconds<br>• The WFPS is able to ramp up at the required Wind Following Ramp Rate. For reference:<br>a) When the WFPS is operating on the Wind Following Ramp Rate of 10% of Registered Capacity/min the WFPS Output will not exceed three times this ramp rate in any one minute. The ramp rate is the average rate of change in Output measured over any 10 minute period.<br>b) When the WFPS is operating on the Wind Following Ramp Rate of 100% of Registered Capacity/min the WFPS Output will not exceed three times this ramp rate in any one minute. The ramp rate is the average rate of change in Output measured over any 10 minute period. |

### 6.11.1 START-UP SEQUENCE & WIND FOLLOWING RAMP RATE TEST PROCEDURE

***Start-Up*** *Sequence & Wind Following Ramp Rate Compliance Tests*

**Start-Up** Sequence testing should be carried out when 100% of the **WFPS Generating Unit**s are in service. The available power on the day of testing should be greater than 80% of **Registered Capacity**.

| **Start-Up** & Ramp Rate Test Sequence for Tests1-2<br>(Test 1:The **Generator** will set the **Wind Following Ramp Rate** at 10% of **Registered Capacity**/min)<br>(Test 2: The **Generator** will set the **Wind Following Ramp Rate** at 100% of **Registered Capacity**/min) | |
|---|---|
| Step No. | Action |
| 1 | SONI perform the Shut-Down Request Test Sequence (detailed in section 6.10.1) |
| 2 | SONI will turn off 'Emergency Action' mode. |
| 3 | The **WFPS** will be allowed to ramp up to 80% **Registered Capacity** at the specified **Wind Following Ramp Rate**. |

## 6.12 PROJECT SPECIFIC TESTS

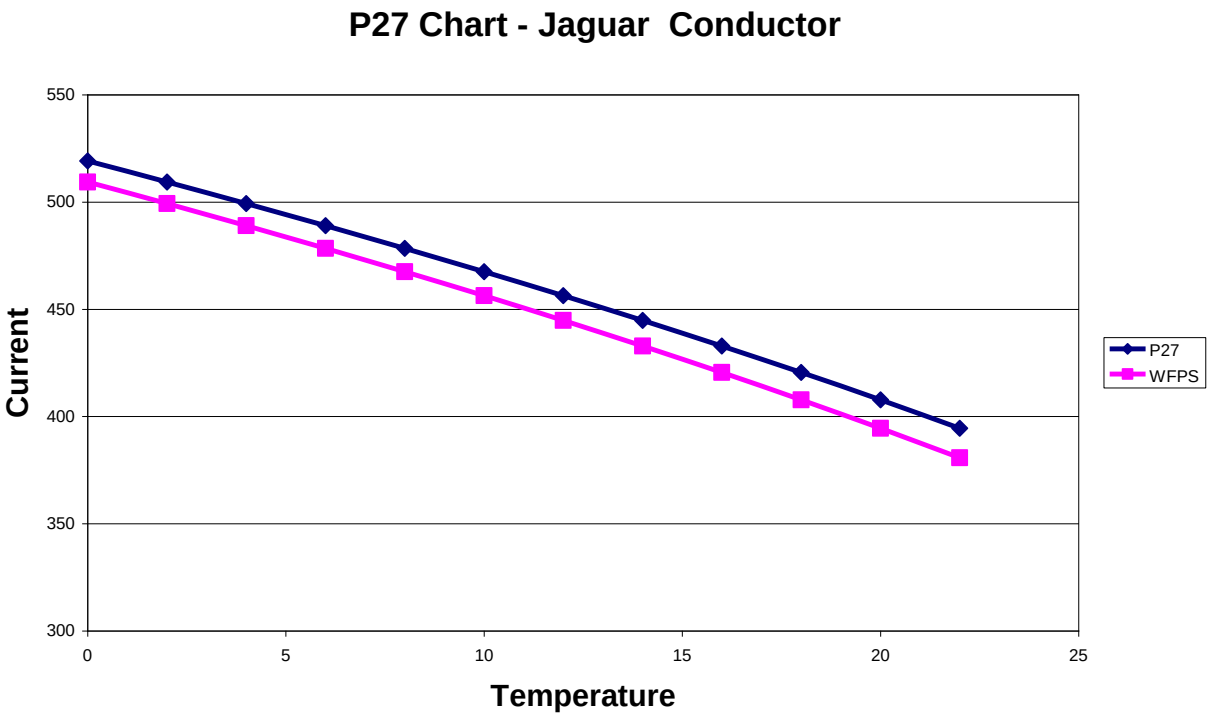
| | |
|---|---|
| Compliance Testing/**Monitoring** | |
| Title of Test: **WFPS** Controller Dynamic Line Rating Mode (If Applicable) | Test Number: 12 |

*Purpose of Test:*
To allow **WFPS** to take advantage of connected line capability the **WFPS** may make use of dynamic line ratings based on temperature range between two degrees and twenty degrees. The ability of the **WFPS** to make use of this facility will form part of the connection agreement.

As this control function would now form part of the overload protection Systems used by NIE, to protect their asset, there will be a more stringent requirement for output control of current from the **WFPS** when using this facility. To match the backup relaying used by NIE the control of current should be based on real time RMS measurement.

To allow discrimination between the **WFPS** controller and the NIE backup relay a temperature differential is used. The **WFPS** controller is offset by the height difference between the lowest point of the connected circuit and the **WFPS** site based on 0.6°C/100m. The applied differential will be specified by NIE prior to commissioning.

The following graph shows a typical expected response of a **WFPS** connected to a 200mm line. This graph is for example purposes only and Compliance values for P27 should be agreed with NIE prior to commissioning




These tests may be simulated by the **WFPS Generator** to allow NIE to have some confidence in the reaction capability to temperature variation of the **WFPS** dynamic controller but finalised acceptance can only be given when tests have been witnessed with the **WFPS** at full **Output** capability Finalised acceptance may not prevent the **WFPS** utilising Dynamic Control at the discretion of NIE.

*Results Required:*
Time series record and Microsoft Excel Plot (Appendix E) showing:

- Line Temperature (°C)
- Line Current (Amps)
- P27 Characteristic

*Test Assessment:*
The dynamic control functionality will be deem acceptable if it does not or could not cause operation of the dynamic backup relay provided by NIE. The settings on this relay will be provided to the **Generator** prior to the commissioning process.

### 6.12.1 WFPS CONTROLLER DYNAMIC LINE RATING MODE TEST PROCEDURE (IF APPLICABLE)

The **WFPS** will show by secondary injection the capability of moving its set point to align with the P27 plus offset as agreed with NIE. This injection will take in at least 12 point on the curve and cover the temperature range from zero degrees to twenty – two degrees Celsius. The results will show temperature versus current in both tabular and graphical form

The **WFPS** will simulate a step change in temperature and measure the performance of the **WFPS** to react to this step change in seconds. The following step changes will be tested but do not exclude the use of more test points -- one degree, two degrees, five degrees, ten degrees, eighteen degrees. The results should show step change versus seconds to reach steady state **Output** in both tabular and graphical form.

## Appendix A User Data Library

The outline structure of the **User** Data Library (UDL) is given below. This document should be used as a guide for the **User** to provide **Grid Code** Data; it should be noted that certain **WFPS** may be required to provide further technical information. Six weeks prior to energisation a **User** shall submit to SONI an interim version of this report with all relevant/applicable sections at that date fully completed. The final version of the UDL is to be submitted to SONI in an agreed format within two months of completion of **Grid Code** Compliance testing.

### *PART 1: Commercial and Legal*

1.1 Introduction

Background information, history of development and any details which the **User** may deem as important.

1.2 Copy of Signed legal agreements

A copy of all signed legal agreements that may exist between the **User** and SONI and the **User** and NIE eg Connection Agreement, TUoS Agreement, Construction Works Agreement, **Grid Code Compliance Agreement**s, the **Generator**'s Generation Licence etc.

1.3 Commissioning and test programs

CC10.1.4/CC11.1.5. The **User** shall provide a proposed commissioning programme, giving at least six weeks notice of the proposed connection date, and detailing all proposed site testing of main and ancillary equipment, together with the names of the organisations which are to carry out such testing and the proposed timetable for such testing.
OC10.4.4 details the Test Program.

1.4 **SEM** registration details

A copy of the final version of the Generation Unit Data provided to SEMO for registration with the wholesale all-island **Single Electricity Market**. For details please visit www.**SEM**-o.com

1.5 Compliance Statement

Signed copy of the Compliance Statement (template included in UDL directory)

1.6 Pre-Energisation Checklist

For details please see Appendix B1

### PART 2: Safety and Operation

2.1 Site Safety Rules

A copy of the **User**'s Local Safety Instructions in Compliance with OC6.4.1

2.2 Site responsibility Schedules

CC9.1.3. For connections to the transmission **System** a Site Responsibility Schedule shall be prepared by the **TSO** detailing the division of responsibilities at interface sites in respect of ownership, control, operation, maintenance and safety. A **User** shall supply to the **TSO** information to enable the **TSO** to prepare a Site Responsibility Schedule. Please see Appendix B2 for required information. (For distribution connected **WFPS**, **User** to provide NIE's Site Responsibility Schedule)

2.3 Ownership Diagram

CC9.1.4. An Ownership Diagram shall be included in the Site Responsibility Schedule. The diagram shall show all **HV** Apparatus and the connections to all external circuits and shall incorporate numbering, nomenclature and labelling as set out in OC9. (For distribution connected **WFPS**, **User** to provide NIE's Site Responsibility Schedule)

2.4 Site Common Drawings

CC10.1.3. A **User** connected or seeking a connection to the Transmission **System** shall supply to the **TSO**, site common drawings as specified in the Connection Agreement including single drawings, communications and earthing arrangements. (For distribution connected **WFPS**, **User** to provide Site Common Drawings provided to NIE)

2.5 Contact detail /control facility

2.5.1 Owner's contact details

To be provided in accordance with PC6.4.1 – Planning Code Initial Data

2.5.2 Operator's contact details (including 24 hour emergency contact)

CC8.5. A **User** is required to provide a continually manned control facility in accordance with CC10.1.3/CC11.1.4. A **User** shall provide to the **TSO** a list of persons appointed by the **User** to undertake operational duties on the **User**'s **System** and to issue and receive operational messages and instructions in relation to the **User**'s **System**.
OC7.6.2. A **User** shall provide a telephone number at which senior management representatives can be contacted day or night for the purposes of this OC7.(Contingency Planning)

2.6 Earthing Arrangements

Earthing arrangements, sizing reports and document supporting the earthing arrangements required in PC.A3.1.10

2.7 Communications Arrangements

Communication Arrangements, Cable Termination Cubicle drawings, SCADA signals and controls.

2.8 Maximum Short Circuit Current Certificate

A certificate declaring the maximum short circuit current in amperes which the **User**'s **System** would contribute to a three-phase short circuit at the connection to the **Distribution System**. (Applicable only to **User**'s seeking a new or modified connection to the **Distribution System**) CC11.1.3.

## PART 3: Connection Technical Data

3.1 **DRC** Schedule 5 – '**User System** Data'

i) **User**s **System** Layout
ii) Reactive Compensation Equipment
iii) Short Circuit Infeed to the **NI System**
iv) Lumped **System** Susceptance
v) **System** Data
vi) Protection Data
vii) Earthing Arrangements
viii) Transient Overvoltage Assessment Data

**DRC** Schedule 5 lists the detailed planning data required from a **User** for new or modified arrangements for connection to or use of the **NI System** in relation to the **User**s **System**.
(All Standard and Detailed Planning Data requirements for **User**s connected to the Transmission **System** are detailed in Appendix A of the Planning Code.
All Standard and Detailed Planning Data requirements for **User**s connected to the **Distribution System** are detailed in Appendix B of the Planning Code.)

3.2 NIE **Event Recorder** Details

CC8.8.2. NIE to provide the following data for the **Event Recorder**: Commissioning date, Commissioning Settings, GPS Time Stamp Capability, Site Telephone Number, Firmware version, Open Access IP Address, Username, Password and any other relevant information. Please note that the IEEE standard Comtrade file format must be used for data storage.

3.3 **User**'s **Event Recorder** Details

It is a **Grid Code** requirement for information of a technical nature to be supplied by **User**s under OC8.4.2 to enable the **TSO** to undertake analysis and validation of policies in the **Grid Code** . For **User**s to comply with this regulation they may provide **TSO** access to the **User**'s **Event Recorder** including Open Access IP Address, Username, Password, Commissioning date, Commissioning Settings, GPS Time Stamp Capability, Firmware version, and any other relevant information.

3.4 Modelling

The **TSO** requires suitable and accurate dynamic models for all **WFPS** connected to, or applying to connect to, the **NI System** in order to assess reliably the impact of the **WFPS** proposed installation on the dynamic performance and the security and stability of the Power **System**. The **User** is to supply **WFPS** models as specified in Appendix D of the **Planning Code.**

3.5 Type Tests Reports and Test Certificates

In accordance with CC10.1.2 and CC11.1.3, SONI require a **User** to provide:-

Type test reports and test certificates produced by Nationally Accredited Laboratories (or other equivalent testing organisations) showing that the Plant and Apparatus specified in the **Connection Conditions** meets the criteria specified;

Copies of the manufacturer's test certificates relating to Plant and Apparatus referred to in the **Connection Conditions**, including measurements of positive and zero sequence impedance of Apparatus which will contribute to the fault current at the **Connection Point**;

3.6 Site Specific Technical Data

3.6.1 Special Automatic Features (e.g. intertrip, SPS, DLR)

PC.A3.1.9. Details of protection schemes associated with this connection

3.6.2 **MW Availability** Signal

Detailed description of **MW Availability** Calculation taking into account all scenarios listed in the **WFPS Settings Schedule**.

3.6.3 SCADA Signals and Controls between **WFPS** and SONI/NIE

The analogue and digital input/output signals list between the **WFPS** and SONI/NIE including signal description, range, units, scale used and display units. This is to ensure CC8.5.3 (a) and (b) can be carried out accurately by the **WFPS**.

3.7 Network Data

SONI require network parameters for connection assets between the point of connection and the existing backbone network (template included in UDL directory).

## PART 4: Generator Technical Data

Note:

4.1 **DRC** Schedule 1 – '**Generating Unit** and Power Station Technical Data'

i) General Power Station Data
ii) General **Generating Unit** Data
iii) Auxiliary Demand

iv) **Generating Unit** parameters
v) Parameters for **Generating Unit** Step-Up Transformers
vi) Power Station Transformer Parameters
vii) Governor parameters (for **WFPS**s)
viii) Plant Flexibility Performance
4.1.1 Additional **Generating Unit** and Power Station Technical Data
ix) **AVR** Parameters
x) Any parameter which will affect Compliance of the **WFPS**

**DRC** Schedule 1 lists the Standard and Detailed Planning Data required from a **User** for new or modified arrangements for connection to or use of the **NI System** in relation to the **Generating Unit** and Power Station.
(All Standard and Detailed Planning Data requirements for **User**s connected to the Transmission **System** are detailed in Appendix A of the Planning Code.
All Standard and Detailed Planning Data requirements for **User**s connected to the **Distribution System** are detailed in Appendix B of the Planning Code.)

4.2 **DRC** Schedule 2 – 'Generation Planning Parameters, Response Capability Data and **SDC**1 Data'

Part 1 of **DRC** Schedule 2 contains the **WFPS** Generation Planning Parameters required by the **TSO** to facilitate studies in Operational Planning timescales.
Part 2 of **DRC** Schedule 2 contains the data required with respect to **Controllable WFPS** to be supplied by **User**s by Gate Closure pursuant to **SDC**1.

4.3 **Generator** Protection

CC6.4. Details of internal or integral **Generator** protection including G59 test witnessed reports (Loss of Mains protection type and setting).

4.4 Final Report

OC10.A.4. Compliance test results as detailed in the **WFPS Settings Schedule**.

4.5 **Generator Performance Chart**

OC2.9 Each **Generator** shall submit to the **Generator Performance Chart** (which shall be within the parameters set out in CC.S2.1.3.2 as detailed in OC2.A.2.2 and in addition shows wind speed against electrical **Output** in **MW**).

4.6 Forecasting Data (template included in UDL directory)

## PART 5: General DRC Schedules

5.1 **DRC** Schedule 3 - '**Generating Unit**/Power Station Equipment/Interconnector outages'

**DRC** Schedule 3 details the Outage Programme Requirements as set out in the Operational Planning Section of the Operating Code (OC2)

5.2 **DRC** Schedule 7 - 'Demand Control and General Data'

**DRC** Schedule 7 Part 1 is applicable to **User**s with Demand and lists Customer Demand Management Details
**DRC** Schedule 7 Part 2 specifies that the **TSO** may require **User**s to supply to it information of a technical (but not commercial) nature to enable the **TSO** to fulfil its obligations relating to the operation of the **NI System**

## PART 6: **WFPS** Continuous **Grid Code** Compliance **Monitoring**

SONI to produce a report for each **WFPS** to cover the **Grid Code** Compliance **Monitoring** period.
In order for the **WFPS** to obtain a **Grid Code** Compliance Certificate the following areas must be satisfied throughout the **Monitoring** period (see CC.S2.1.10.2 and CC.S2.2.7.2);

6.1 Fault Ride Through Capability of the **WFPS**
6.2 Active and **Reactive Power** Recovery of the **WFPS** post fault
6.3 Behaviour of the **WFPS** during low and high **Frequency** excursions
6.4 Any significant rates of change of **Frequency**
6.5 **High Voltage** Ride Through Capability of the **WFPS**
6.6 Harmonics Studies
6.7 Response of the **WFPS** during High Wind Speed **Shutdown** events
6.8 Accuracy of the **MW Availability** Signal being provided to SONI by the **WFPS**.

The requirement to produce the data for this report is covered in OC8.4.2

## Appendix B1 Pre-Energisation Checklist and Supporting Documentation

*Pre-energisation Checklist*

| **WFPS** | |
|---|---|
| Planner | |
| Construction Project Manager | |
| DCC Representative | |
| SONI Representative | |

| Task | Responsibility | Expected Time of completion | Confirmation | Date | Signature |
|---|---|---|---|---|---|
| Connection agreement signed (copy to Planner) | Planner | | | | |
| All supporting information* as per schedule 9 in connection agreement provided | Construction Project Manager | | | | |
| TUoS agreement | SONI | | | | |
| Market Message received | Planner | | | | |
| Construction complete | Construction Project Manager | | | | |
| Construction clearance received | OHL - Project Manager | | | | |
| | Cable - Cable engineer | | | | |
| | Plant - Project Manager | | | | |
| BT undergrounding complete | Construction Project Manager | | | | |
| **HV** Metering complete | Construction Project Manager | | | | |
| **LV** connection card and market message received | **WFPS Generator** | | | | |
| **LV** metering completed | Construction Project Manager | | | | |
| All SCADA to **WFPS Generating Unit**s and SONI/NIE and end to end testing of these SCADA signals complete | CHCC/DCC Representative | | | | |
| Substation lease signed (based on document being available 6 weeks prior to energisation) | Construction Project Manager | | | | |
| Cable easements signed (wayleave in lieu) | Construction Project Manager | | | | |
| DCC informed and approval in writing provided | Construction Project Manager | | | | |
| SONI informed and approval in writing provided | Construction Project Manager | | | | |

*SUPPORTING DOCUMENTATION*

| Ref | Information | Details | Y/N | Expected Time of completion | Date confirmed | Comments |
|---|---|---|---|---|---|---|
| a) | Statement that all relevant sections of the **Grid Code** have been complied with to the best of the information, knowledge and belief of the **Generator**. | Confirmation by SONI | | Min 6 weeks prior to energisation | | |
| b) | Statement that all relevant sections of the **Distribution Code** have been complied with to the best of the information, knowledge and belief of the **Generator**. | Confirmation by DCC | | Min 6 weeks prior to energisation | | |
| c) | Site responsibility schedule. | Schedule 5 of connection agreement | | In connection agreement | | |
| d) | Ownership diagram. | Schedule 5 of connection agreement | | In connection agreement | | |
| e) | Compliance with Regulation 28 of the Electricity Supply Regulations. | Declaration of readiness to connect | | Prior to confirming energisation date | | |
| f) | Safety co-ordinators list. | | | Prior to confirming energisation date | | |
| g) | Telephone and Facsimile Numbers. | | | Prior to confirming energisation date | | |
| h) | Nomenclature. | Switchgear numbering | | Prior to confirming energisation date | | |
| i) | PPA/**SEM** Market Registration Confirmation. | Requires TUOS agreement | | | | |
| j) | **Energy** Supplier. | | | In connection agreement | | |
| k) | Commissioning programme (indicating which, if any, tests are expected to have an impact on the NIE **System**). | | | 6 weeks prior to energisation | | |
| l) | Protection settings. | Schedule 1A of connection agreement | | In connection agreement | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| m) | Protection witness test (copy required). | G59 Tests | | Prior to confirming energisation date | | |
| n) | **Voltage Control** statement of capability and supporting documentation. | Confirmation by DCC | | Prior to confirming energisation date | | |
| p) | The NIE form SRG 4 Appendix C "Authorisation of Customers to operate Northern Ireland Electricity controlled **HV** Switchgear – Standard Form of Indemnity." | Required as Emergency stop located in WF switchroom operates NIE switchgear | | Prior to confirming energisation date | | |
| q) | The NIE form SRG 4 Appendix G "Request for Commissioning of **High Voltage** Supplies", is to be completed by customer and submitted to NIE for approval. | Completed immediately prior to energisation | | Day of energisation | | |
| r) | The NIE form SRG 4 Appendix H "Customers Guarantee and Declaration Form", is to be completed and signed by customer and submitted to NIE. | | | Prior to confirming energisation date | | |

## Appendix B2 Site Responsibility Schedule

| ITEM OF PLANT / APPARATUS | OPERATING VOLTAGE | PLANT LOCATION | PLANT APPARATUS OWNER | SITE MANAGER | SAFETY | | OPERATIONS | | PARTY RESPONSIBLE FOR STATUTORY INSPECTIONS, FAULT INVESTIGATION & MAINTENANCE | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | SAFETY RULES | RESPONSIBLE PERSON (SAFETY COORDINATOR) | OPERATIONAL PROCEDURES | CONTROL ENGINEER | | |
| | | | | | | | | | | |
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## Appendix C Continuous Monitoring of MW Availability

Continuous **Monitoring** of the **WFPS** by SONI will take place; the **WFPS** must adhere to the following:

*Background*

SONI defines **MW Availability** as follows:

"The amount of **Active Power** that the **Controllable WFPS** could produce based on current wind conditions and network conditions. The **MW Availability** shall only differ from the **MW Output** if the **Controllable WFPS** has been curtailed, constrained or is operating in a Curtailed **Frequency** Response mode, as instructed by SONI via the SCADA interface. By way of clarification, limitations placed on **WFPS Output** due to 33kV Dynamic Line Rating schemes are NIE actions only and these should be reflected in the **MW Availability**. "

The **MW Availability** signal provided by the **Generator** will be a continuously calculated value. The **Generator** should NOT let the **MW Availability** figure equal the **MW Output** figure when there is no SONI action. For clarity, the **Generator** must not start calculating the **MW Availability** only when there is SONI action as SONI will have no way of assessing the accuracy of the calculated signal. SONI will require a detailed explanation of exactly how the **MW Availability** signal is being calculated by the **Generator**.

Section **SDC** 1.4.3.2 of the SONI **Grid Code** makes provisions for the **Availability** or Technical Parameters. The **Grid Code** describes these levels or values as follows:

> "Each **Generator**, and where relevant each **Generator** Aggregator, shall, subject to the exceptions in **SDC** 1.4.3.3, use reasonable endeavours to ensure that it does not at any time declare in the case of its CDGU, **Controllable WFPS**, or Aggregated **Generating Unit**, the **Availability** or Technical Parameters at levels or values different from those that the CDGU, **Controllable WFPS**, and/or an Aggregated **Generating Unit** could achieve at the relevant time. The **TSO** can reject declarations to the extent that they do not meet these requirements."

Some issues that will impact the "**MW Availability**" are:

a) The **MW Availability** signal will accurately reflect the wind resource level available.
b) If **Generating Unit**s **Shutdown** due to high wind speeds, they are not available and the "**MW Availability**" will be reduced accordingly;
c) If **Generating Unit**s are out of service for maintenance, repair, placed in a 'Pause' mode etc. they are not available and the "**MW Availability**" will be reduced accordingly;
d) If **Generating Unit**s have entered into any form of error mode e.g. 'Safety Chain Activation' etc. they are not available and the "**MW Availability**" will be reduced accordingly;
e) If the **Generating Unit**s are responding to a set point other than that received by SONI SCADA e.g. a dynamic line rating (DLR) set point or a SPS set point, the **MW Availability** will be reduced accordingly to reflect the **MW Output** level the **WFPS** is controlling to;
f) Only actions by SONI to reduce the **WFPS MW Output** (as described in the **MW Availability** definition above) should result in a difference between actual **MW Output** and the **MW Availability** signals.

The **Grid Code** does not specify a standard to which these levels or values should conform. Experience to date has shown that there is considerable variance in the accuracy of the **MW Availability** for different **WFPS**. A standard of accuracy is required for this level/value which will be included in **Grid Code** Compliance testing and monitored on a continuous basis.

*Standard*
The quality of the calculated **MW Availability** signal will be subject to the following test:
The normalised root mean square deviation ($NRMSD$) for a **WFPS** for a given day will be calculated. This will use one minute **MW Availability** quantities averaged over the half hour period recorded in Castlereagh House Control Centre CHCC and the 30 minute metered **Output** for the **Generator** under analysis.

*Assessment Criteria:*

- The rolling 14-day NRMSD must be less than or equal to 8%, excluding periods where the **WFPS** was **Dispatch**ed away from its **MW Availability** by SONI.
- The daily NRMSD values are to be calculated. The number of days where the daily NRMSD exceeds the 5% standard must not exceed 2 days in any 14-day period, except for periods where the **WFPS** was dispatched away its **MW Availability** by SONI.

Where a unit had not been dispatched down at any period under review and the $NRMSD$ exceeds 5% for a day then the **MW Availability** signal is deemed to be in error for that day.

Where in a rolling continuous period of 14 days there are three or more days that have **MW Availability** signals in error then the **MW Availability** signal is deemed to have failed the standard.

*Issues Arising Upon Failure to Meet Assessment Criteria*
When a **WFPS** fails the **MW Availability** standard, SONI will as soon as practicably possible issue a formal non-Compliance notice to the **WFPS**. This notice will detail the degree of non-Compliance and request information as to how and when it will be corrected.

For the period that a **WFPS** is failing the **MW Availability** standard, SONI may substitute the **WFPS MW Availability** signal with the actual metered **Output** of the **WFPS** for any curtailments in **MW Output** that have come about through SONI action.

*Definitions*
The following quantities will be determined:
Calculate the daily Root Mean Square Error as follows:

$$RMSD = \sqrt{\frac{\sum_{h=1}^{n} (AV - GEN)^2}{n}}$$

The Normalised Root Mean Square Error:

$$NRMSD = \frac{RMSD}{RC_{WFPS}}$$

Where:
*RC* is the **Registered Capacity** of the **WFPS** in **MW**
*AV* is the one minute **MW Availability** quantities averaged over the half hour period recorded in Castlereagh House Control Centre CHCC
*GEN* is the 30 minute metered **Output** for the **Generator** under analysis.
*n* is the number of time periods in the day

## Appendix D SCADA Signals and Controls between WFPS and SONI/NIE

The signals list shown below may be subject to change should SONI/NIE feel that additional controls/indications are required from a **WFPS**.

| *Analogue Input Signals (to SONI/NIE) from **WFPS*** | | | | | |
|---|---|---|---|---|---|
| *Signal Description* | *Description* | *Range* | *Units* | *Scale* | *Display Units* |
| **MW*** | Indication of the **Active Power Output** at **WFPS Connection Point** | 4 - 20 | mA | TBA | **MW** |
| **Mvar*** | Indication of the **Reactive Power** Flow at the **WFPS Connection Point** | 4 - 20 | mA | TBA | **Mvar** |
| Voltage* | Indication of the Voltage at the **WFPS Connection Point** | 4 - 20 | mA | TBA | kV |
| Wind Speed | Indication of the highest wind speed at any instant measured by a **Generating Unit** comprised within a **WFPS**. All measurements shall be at **Generating Unit** hub height. | 4 - 20 | mA | TBA | m/sec |
| Wind Direction | Indication of wind direction at **WFPS** at hub height | 4 - 20 | mA | 0-359[1] | deg |
| Ambient Temperature | Indication of ambient temperature on **WFPS** met mast | 4 - 20 | mA | TBA | °C |
| Atmospheric Pressure | Atmospheric Pressure on **WFPS** met mast | 4 - 20 | mA | 735-1060 | mBar |
| **WFPS MW Availability** | The amount of **Active Power** that the **Controllable WFPS** could produce based on current wind conditions and network conditions. The **MW Availability** shall only differ from the **MW Output** if the **Controllable WFPS** has been curtailed, constrained or is operating in a Curtailed **Frequency** Response mode, as instructed by SONI via the SCADA interface. By way of clarification, limitations placed on **WFPS Output** due to 33kV Dynamic Line Rating schemes are NIE actions only and these should be reflected in the **MW Availability**. | 4 - 20 | mA | TBA | **MW** |
| **WFPS** % **Shutdown** | Indication of the % of **Generating Unit**s **Shutdown** due to high wind speed | 4 - 20 | mA | TBA | % |
| **MW** Set Point | Confirmation of **MW** set point signal | 4 - 20 | mA | TBA | **MW** |
| **Mvar** Set Point | Confirmation of **Mvar** set point signal | 4 - 20 | mA | TBA | **Mvar** |
| Voltage Set Point | Confirmation of voltage set point signal | 4 - 20 | mA | TBA | kV |
| Power Factor Set Point | Confirmation of power factor set point signal | 4 - 20 | mA | TBA | Decimal |
| % **MW** Curtailment Set Point[2] | Confirmation of % curtailment **MW** set point when providing reserve | 4 - 20 | mA | TBA | % |
| Curtailment Time Interval | Confirmation of time to reach set point | 4 - 20 | mA | TBA | Min |
| **WFPS** Active Set Point[3] | Indication of the **MW** set point to which the **WFPS Output** is limited | 4- 20 | mA | TBA | **MW** |
| % **Generating Unit**s Available[4] | Indication of the % Available **Generating Unit**s at the **WFPS** | 4 - 20 | mA | TBA | % |

TBA – Scale to be agreed with SONI/NIE SCADA
*Provided by NIE as part of the connection arrangements, included for completeness. These indications must come directly from the transducers.
[1] 0° is true North and 0-359° in a clockwise direction
[2] Set Point is based on instantaneous **Output**, neglecting constraints imposed by SONI. 100% means **WFPS Active Power Output** has not been reduced by SONI, therefore reserve provision will be 0%.
[3] This set point should reflect the **MW Output** to which the **WFPS Output** is limited i.e. the **WFPS** controller set point. It should take into account the **MW** set point, the Ramp Block setting, DLR schemes (if applicable), SPS operation (if applicable) and the set point if the **WFPS** is operating in a **Frequency** response mode. The **Generator** will provide SONI/NIE with the lowest of these variables as the **WFPS** active set point.
[4] This set point should reflect the % of Available **Generating Unit**s at the **WFPS**. It should take into account **Generating Unit**s that are unavailable due to outages, **Generating Unit**s that are in an error mode etc (i.e. any condition that means the **Generating Unit** is unable to generate **Active Power**). 0% means zero **Generating Unit**s are in service 100% means all **Generating Unit**s are in service.

| *Analogue Output Signals (from SONI/NIE) to **WFPS*** | | | | | |
|---|---|---|---|---|---|
| *Signal Description* | *Description* | *Range* | *Units* | *Scale* | *Display Units* |
| **MW** Set Point | Curtailment **MW** set point under emergency conditions | 4 - 20 | mA | TBA | **MW** |
| **Mvar** Set Point | **Mvar** set point instruction | 4 - 20 | mA | TBA | **Mvar** |
| Voltage Set Point | Voltage set point instruction | 4 - 20 | mA | TBA | kV |
| Power Factor Set Point | Power Factor set point instruction | 4 - 20 | mA | TBA | Decimal |
| % **MW** Curtailment Set Point | % curtailment **MW** set point when providing reserve | 4 - 20 | mA | TBA | % |
| Curtailment Time Interval | Time to reach set point under emergency conditions | 4 - 20 | mA | TBA | Min |

| *Digital Input Signals (to SONI/NIE) from **WFPS** (required dc voltage to be confirmed by SONI/NIE SCADA)* | | |
|---|---|---|
| *Signal Description* | *Description* | *Signal* |
| Common | ??V dc signal provided by SONI to **Generator** | |
| Allow Ramp | Acknowledgement signal to allow positive ramping of **WFPS** | ??V dc |
| Stop Ramp | Acknowledgement signal to stop positive ramping of **WFPS** | ??V dc |
| Emergency Action OFF | Emergency Action OFF | ??V dc |
| Emergency Action ON | Emergency Action ON | ??V dc |
| **Reactive Power Dispatch** ON | **Reactive Power Dispatch** ON | ??V dc |
| **Reactive Power Dispatch** OFF | **Reactive Power Dispatch** OFF | ??V dc |
| PF Control ON | PF Control ON | ??V dc |
| PF Control OFF | PF Control OFF | ??V dc |
| **Voltage Control** ON | **Voltage Control** ON | ??V dc |
| **Voltage Control** OFF | **Voltage Control** OFF | ??V dc |
| **Voltage Control** Auto Change Over[1] | Indication that the control mode has auto changed to **Voltage Control** | ??V dc |
| CB1 Open[2] | Circuit breaker open (controlling the TO or **DNO** circuit at the **Connection Point**) | ??V dc |
| CB1 Closed[2] | Circuit breaker closed (controlling the TO or **DNO** circuit at the **Connection Point**) | ??V dc |
| **Generating Unit Shutdown** Alarm | Alarm that **Generating Unit**s have begun to **Shutdown** due to high wind speed | ??V dc |
| Island Detected Trip | Alarm that the G59 protection has operated | ??V dc |
| % **MW** Curtailment Controller OFF | Acknowledgement signal that % **MW** controller for reserve is OFF | ??V dc |
| % **MW** Curtailment Controller ON | Acknowledgement signal that % **MW** controller for reserve is ON | ??V dc |
| Grid Control Selected | Indication that the **WFPS** is under the control of SONI | ??V dc |
| Local Control Selected | Indication that the **WFPS** is under the control of **Generator** | ??V dc |
| Grid Controller Operational | Indication that the Grid Controller is operational | ??V dc |
| Grid Controller Fail | Indication that power has been lost to the Grid Controller | ??V dc |
| Transducer Operational | Indication that the primary inputs to the Grid Controller are operational | ??V dc |
| Transducer Fail | Indication that the Grid Controller has lost primary Inputs | ??V dc |
| Temperature Curtailment ON[3] | Temperature Curtailment scheme ON | ??V dc |

| | | |
|---|---|---|
| Temperature Curtailment OFF[3] | Temperature Curtailment scheme OFF | ??V dc |
| Special Protection Scheme OFF[4] | Special Protection Scheme OFF | ??V dc |
| Special Protection Scheme ON[4] | Special Protection Scheme ON | ??V dc |

[1]Automatic changeover to **Voltage Control** mode will occur if voltage at the **Connection Point** moves beyond the limits of a deadband agreed between SONI and the **Generator**.

[2]Provided by NIE as part of the connection arrangements, included for completeness.

[3]Only applicable if connected via 200 $mm^2$ line and **WFPS Registered Capacity** is greater than 22 **MW**

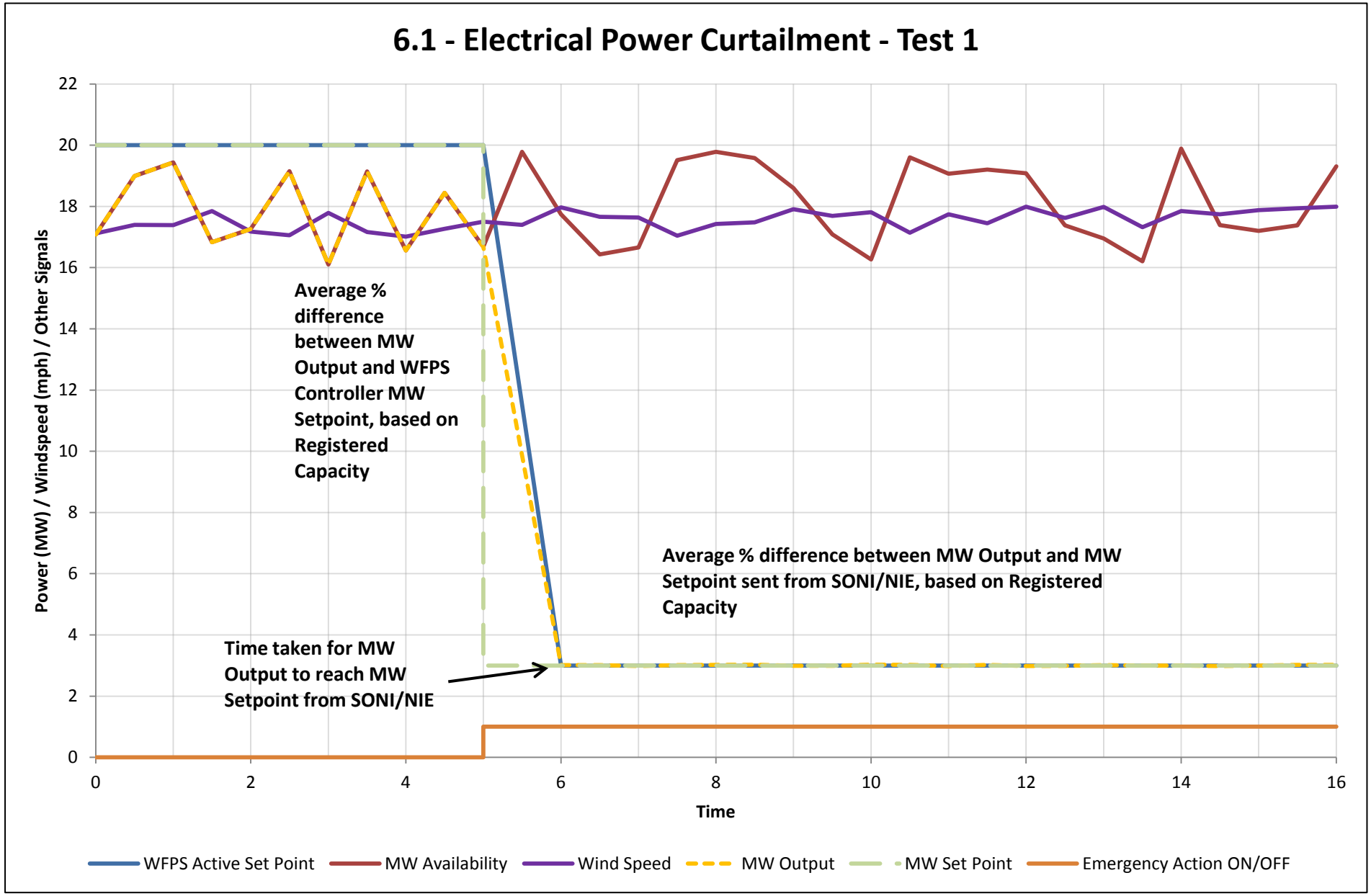
[4]Only applicable if there is a Special Protection Scheme or Remedial Action Scheme in place that involves the **WFPS**

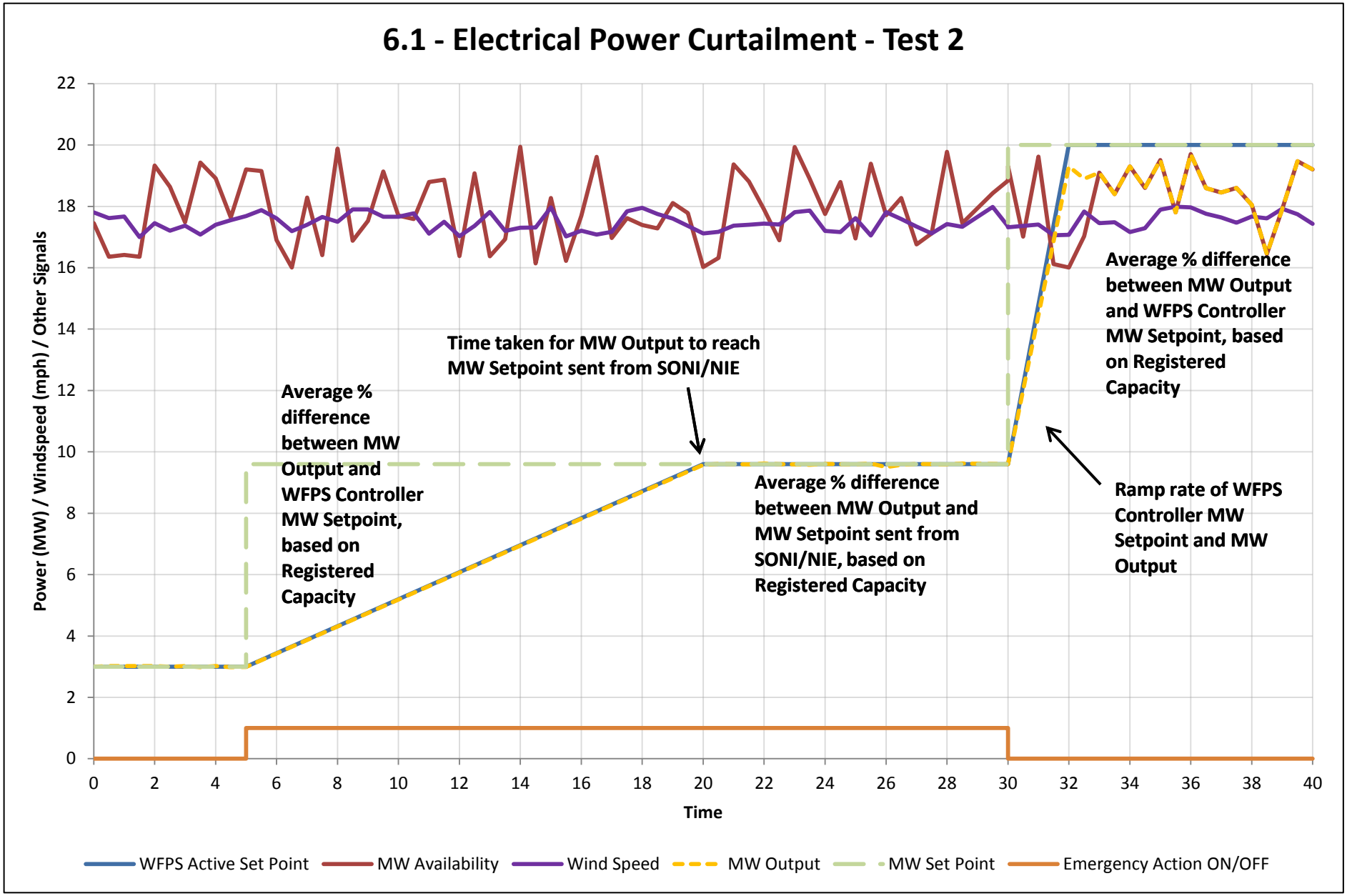
| *Digital Output signals (from SONI/NIE) to **WFPS** (required dc voltage to be confirmed by SONI/NIE SCADA)* | | | | |
|---|---|---|---|---|
| *Signal Description* | *Description* | *Permanent Common Signal* | *5sec pulse Open Signal* | *5sec pulse Close Signal* |
| Stop Ramp<br>Common<br>Allow Ramp | Prevent **WFPS Active Power Output** increase, assisting SONI to manage **System Frequency** rise<br><br>Blocking signal OFF allowing **WFPS** to increase **Active Power Output** | 0V | ??V dc | ??V dc |
| Emergency Action ON<br>Common<br>Emergency Action OFF | Initiate change of **WFPS Output**<br><br>Remove **Output** change command | 0V | ??V dc | ??V dc |
| **Voltage Control** SELECT [1]<br>Common | **Voltage Control** mode selected | 0V | | ??V dc |
| Power Factor Control SELECT [1]<br>Common | Power Factor Control mode selected | 0V | | ??V dc |
| **Reactive Power Dispatch** SELECT [1]<br>Common | **Reactive Power Dispatch** mode select | 0V | | ??V dc |
| % **MW** Curtailment Controller ON<br>Common<br>% **MW** Curtailment Controller OFF | Initiate % **MW** curtailment for reserve<br><br>Cease % **MW** curtailment for reserve | 0V | ??V dc | ??V dc |
| CB1 Close [2]<br>Common<br>CB1 Open [2] | Close the **DNO** Circuit Breaker at the **Connection Point**<br><br>Open the **DNO** Circuit Breaker at the **Connection Point** | 0V | ??V dc | ??V dc |
| The TO or DSO Trip Relay Reset ON[1]<br>Common[1] | Signal to reset the trip relay associated with the TO or **DNO** circuit breaker at the **Connection Point** | 0V | | ??V dc |

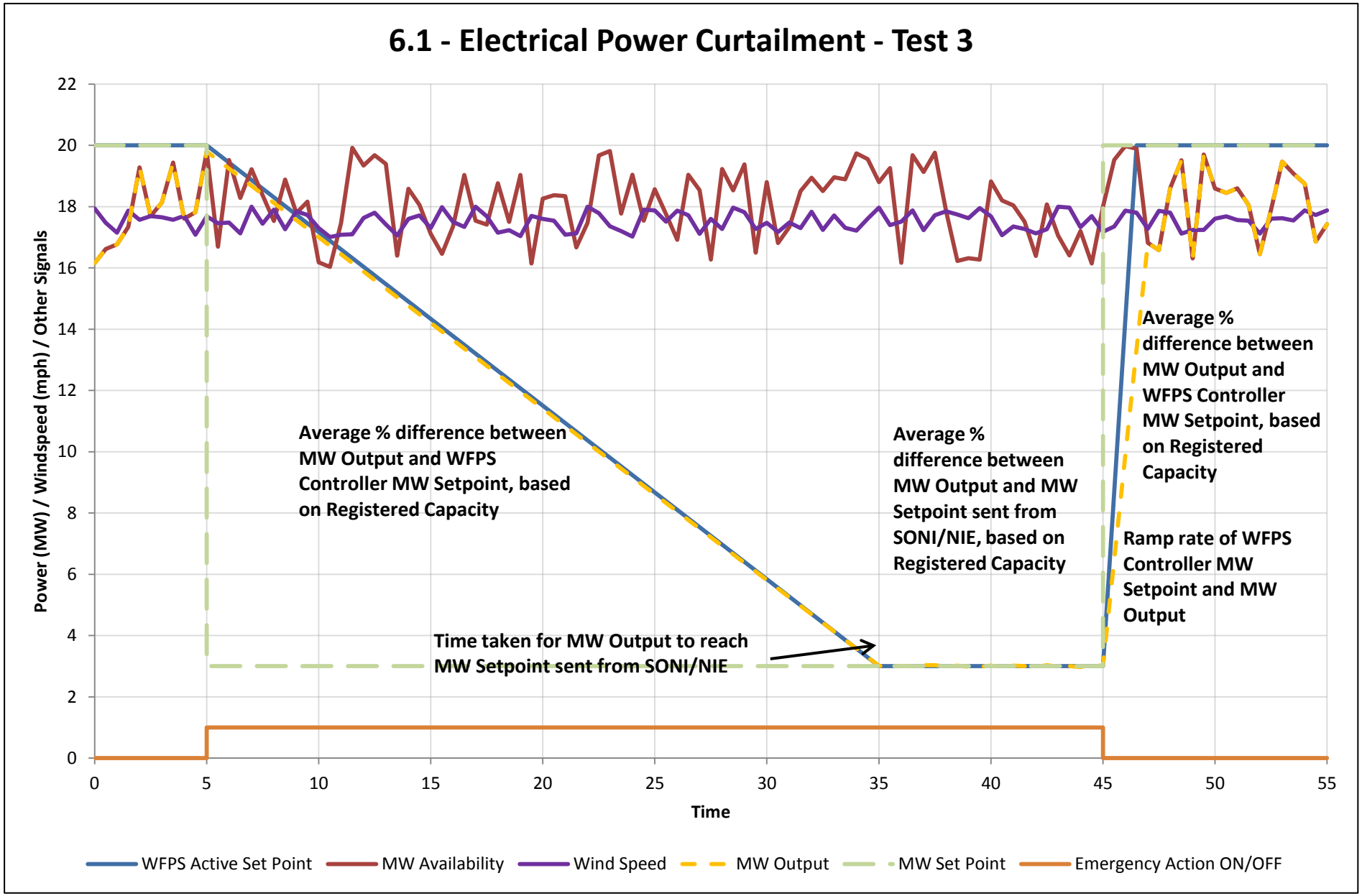
[1] It is the responsibility of the **Generator** to configure **Voltage Control**, Power Factor Control and **Reactive Power Dispatch** such that one of these 3 modes is always ON and not more than one mode is ON at any one time. Thus, if the **WFPS** is operating in Power Factor Control and SONI/NIE wish to change the **WFPS** to operate in **Voltage Control**, SONI/NIE will send a Voltage Control SELECT digital output signal to the **WFPS**. The Generator must ensure Power Factor Control turns OFF as **Voltage Control** turns ON.
[2] Provided by NIE as part of the connection arrangements included for completeness.

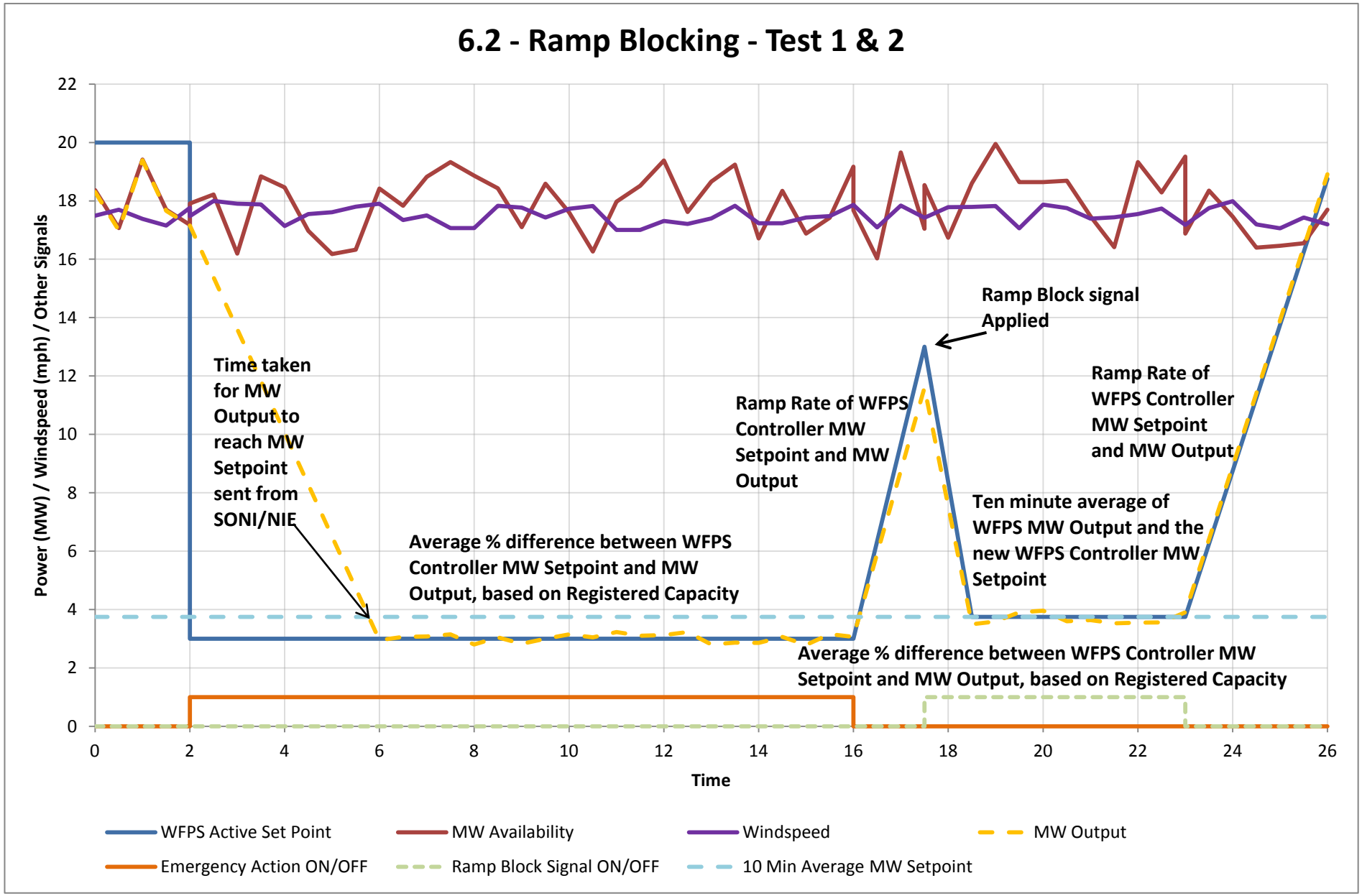
## Appendix E Example MS Excel Plots To Be Submitted by the Generator

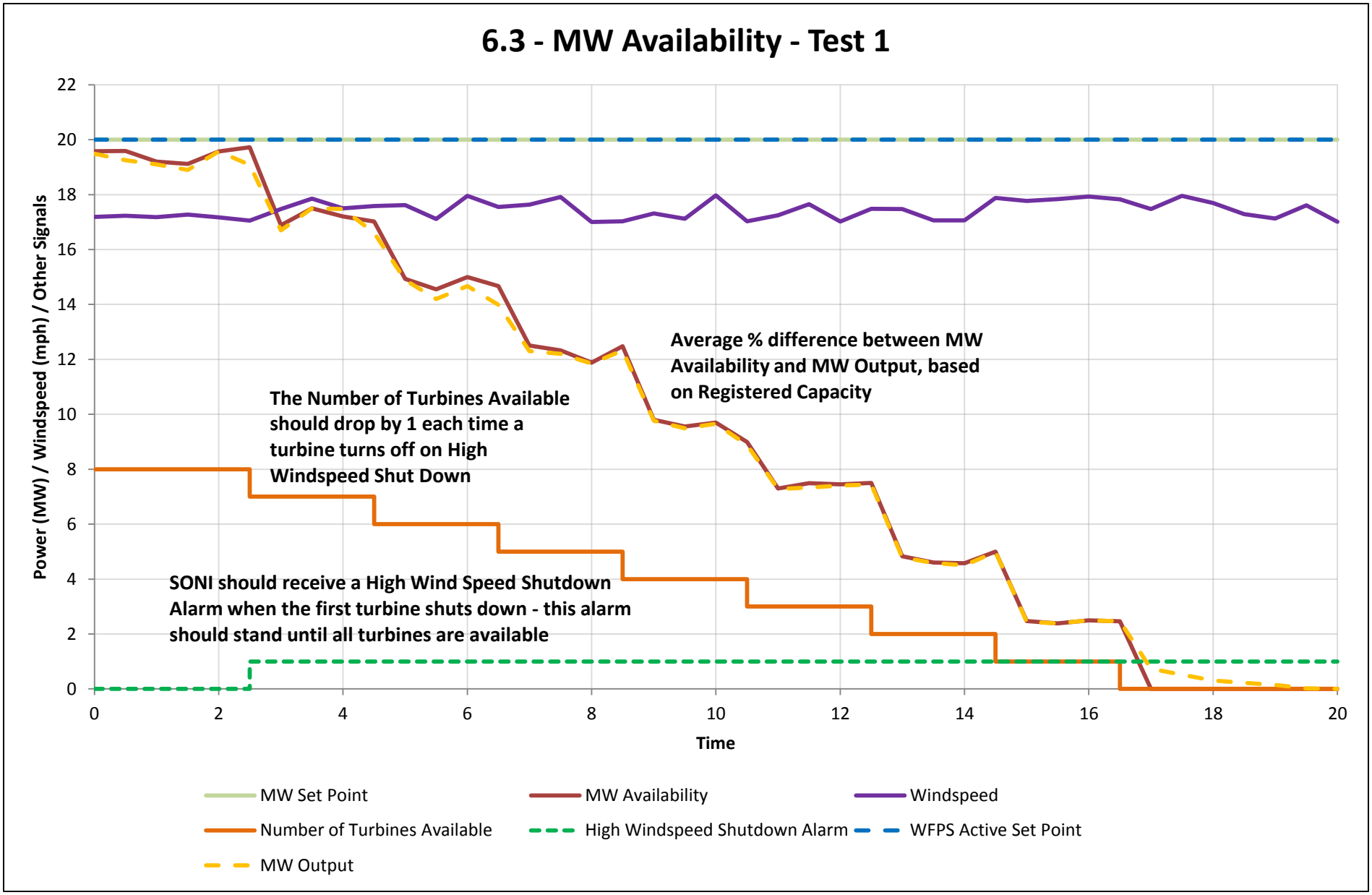
The following graphs are for illustration only, highlighting the traces to be plotted and the annotations to be included by the **Generator**. If the **Generator** feels additional information is required in order to demonstrate Compliance then this documentation should also be included.

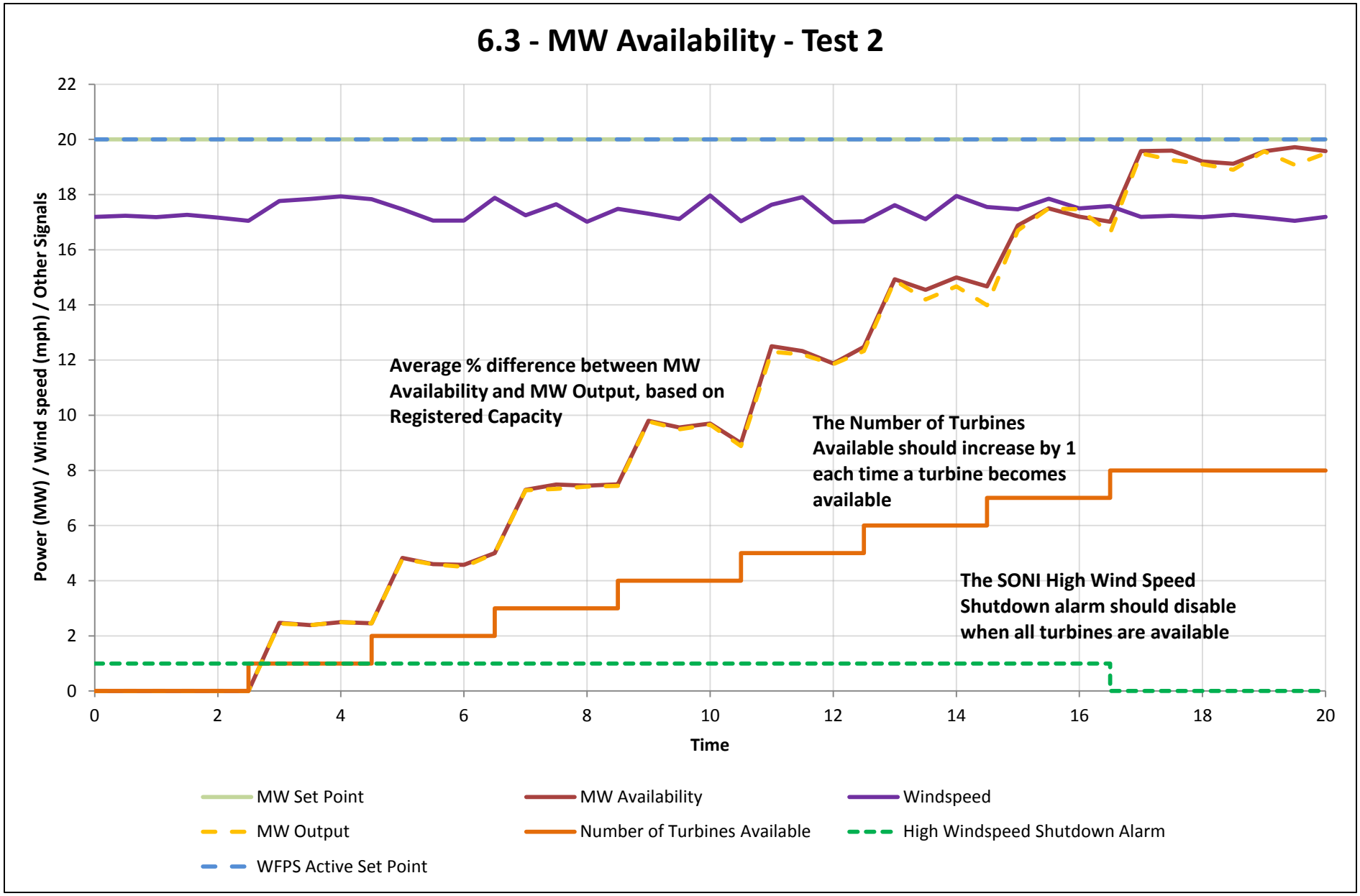

6.1 - Electrical Power Curtailment - Test 1
Power (MW) / Windspeed (mph) / Other Signals
Time
Average % difference between MW Output and WFPS Controller MW Setpoint, based on Registered Capacity
Average % difference between MW Output and MW Setpoint sent from SONI/NIE, based on Registered Capacity
Time taken for MW Output to reach MW Setpoint from SONI/NIE
WFPS Active Set Point
MW Availability
Wind Speed
MW Output
MW Set Point
Emergency Action ON/OFF

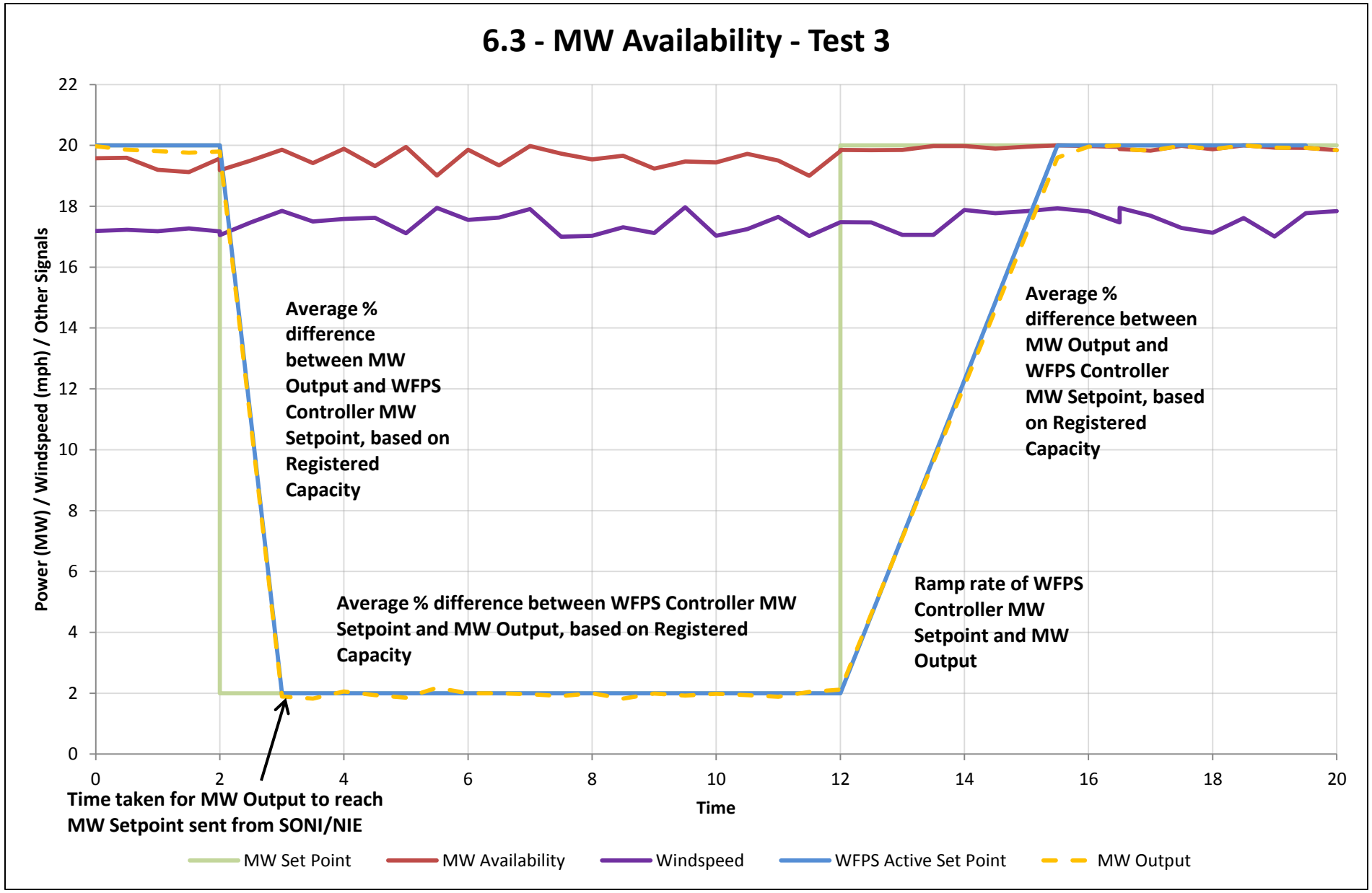

6.1 - Electrical Power Curtailment - Test 2
Power (MW) / Windspeed (mph) / Other Signals
Time
Average % difference between MW Output and WFPS Controller MW Setpoint, based on Registered Capacity
Time taken for MW Output to reach MW Setpoint sent from SONI/NIE
Average % difference between MW Output and MW Setpoint sent from SONI/NIE, based on Registered Capacity
Average % difference between MW Output and WFPS Controller MW Setpoint, based on Registered Capacity
Ramp rate of WFPS Controller MW Setpoint and MW Output
WFPS Active Set Point
MW Availability
Wind Speed
MW Output
MW Set Point
Emergency Action ON/OFF

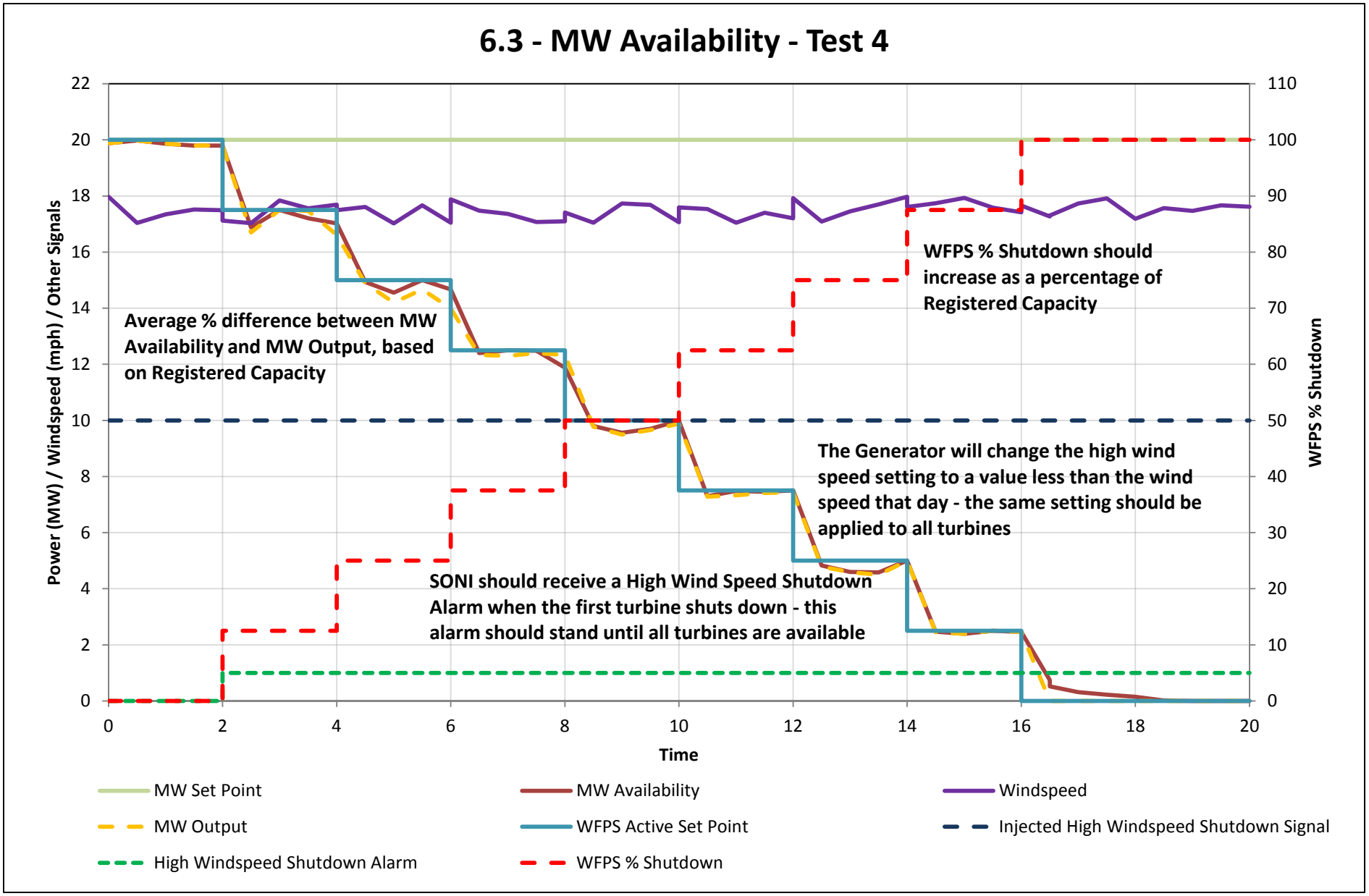

6.1 - Electrical Power Curtailment - Test 3
Power (MW) / Windspeed (mph) / Other Signals
Time
Average % difference between MW Output and WFPS Controller MW Setpoint, based on Registered Capacity
Average % difference between MW Output and MW Setpoint sent from SONI/NIE, based on Registered Capacity
Average % difference between MW Output and WFPS Controller MW Setpoint, based on Registered Capacity
Ramp rate of WFPS Controller MW Setpoint and MW Output
Time taken for MW Output to reach MW Setpoint sent from SONI/NIE
WFPS Active Set Point
MW Availability
Wind Speed
MW Output
MW Set Point
Emergency Action ON/OFF

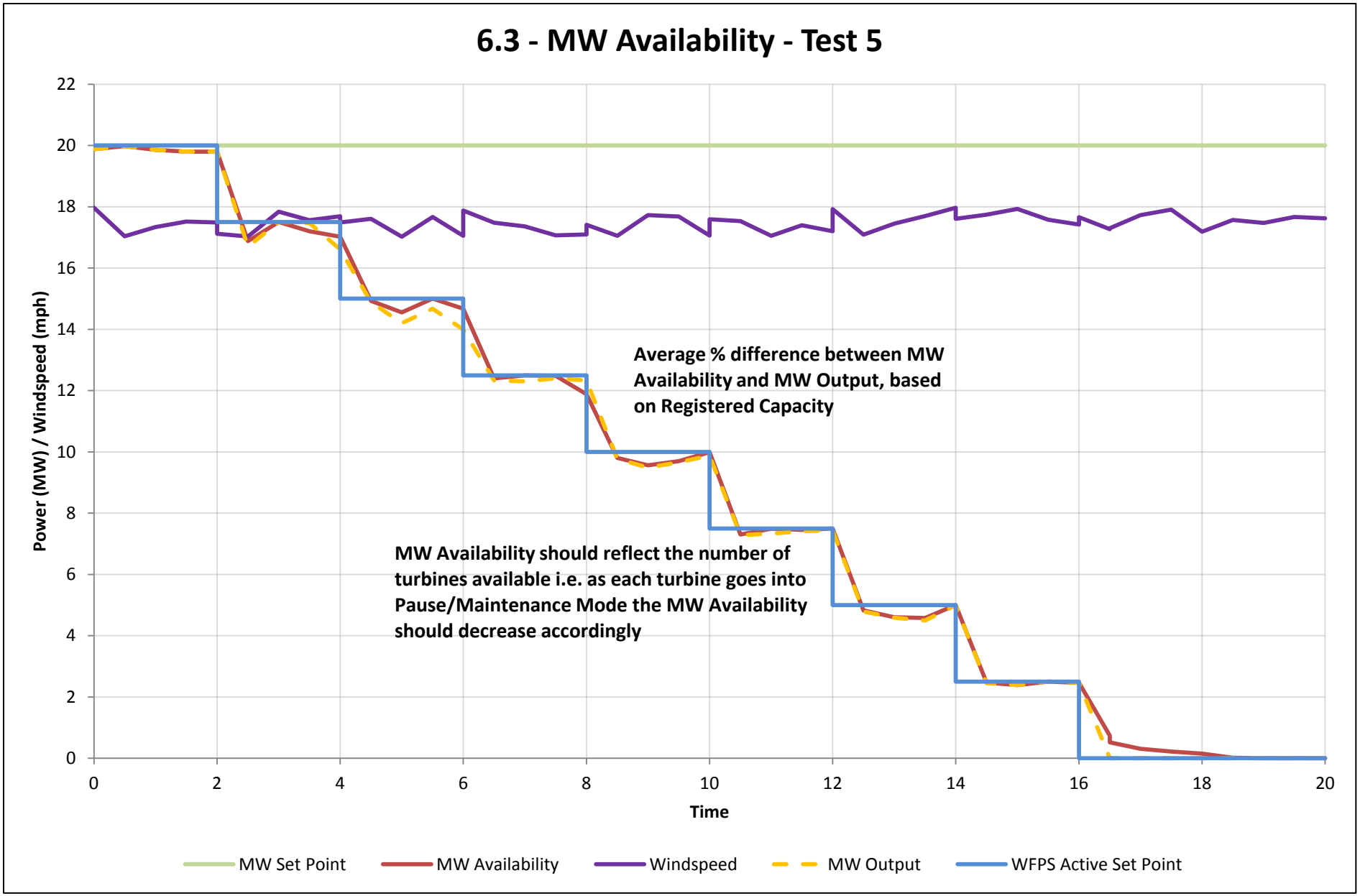

6.2 - Ramp Blocking - Test 1 & 2
Power (MW) / Windspeed (mph) / Other Signals
Time
Time taken for MW Output to reach MW Setpoint sent from SONI/NIE
Average % difference between WFPS Controller MW Setpoint and MW Output, based on Registered Capacity
Ramp Block signal Applied
Ramp Rate of WFPS Controller MW Setpoint and MW Output
Ramp Rate of WFPS Controller MW Setpoint and MW Output
Ten minute average of WFPS MW Output and the new WFPS Controller MW Setpoint
Average % difference between WFPS Controller MW Setpoint and MW Output, based on Registered Capacity
WFPS Active Set Point
MW Availability
Windspeed
MW Output
Emergency Action ON/OFF
Ramp Block Signal ON/OFF
10 Min Average MW Setpoint

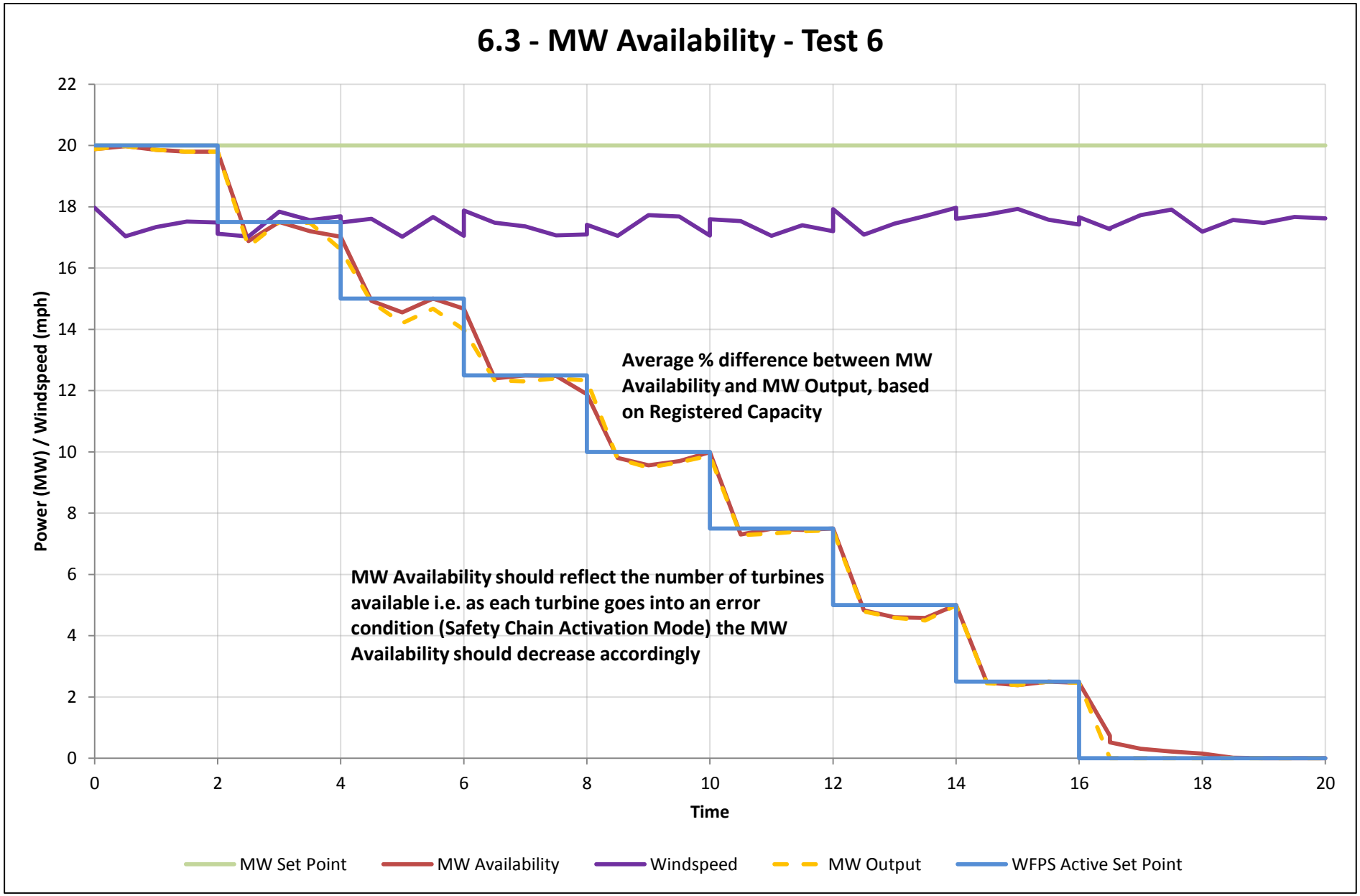

6.3 - MW Availability - Test 1
Power (MW) / Windspeed (mph) / Other Signals
Time
0
2
4
6
8
10
12
14
16
18
20
22
Average % difference between MW Availability and MW Output, based on Registered Capacity
The Number of Turbines Available should drop by 1 each time a turbine turns off on High Windspeed Shut Down
SONI should receive a High Wind Speed Shutdown Alarm when the first turbine shuts down - this alarm should stand until all turbines are available
MW Set Point
MW Availability
Windspeed
Number of Turbines Available
High Windspeed Shutdown Alarm
WFPS Active Set Point
MW Output

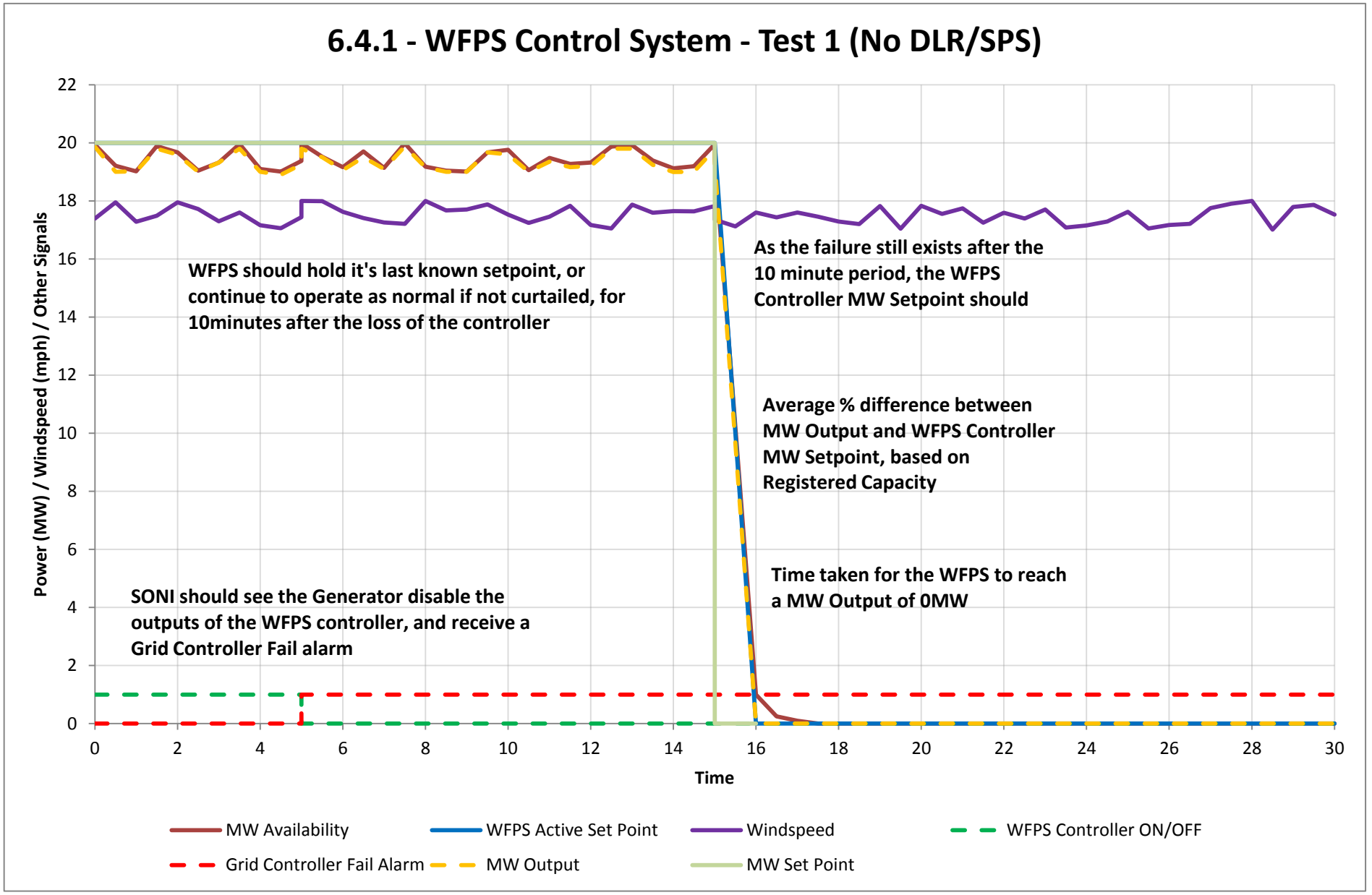

6.3 - MW Availability - Test 2
Power (MW) / Wind speed (mph) / Other Signals
Time
Average % difference between MW Availability and MW Output, based on Registered Capacity
The Number of Turbines Available should increase by 1 each time a turbine becomes available
The SONI High Wind Speed Shutdown alarm should disable when all turbines are available
MW Set Point
MW Availability
Windspeed
MW Output
Number of Turbines Available
High Windspeed Shutdown Alarm
WFPS Active Set Point

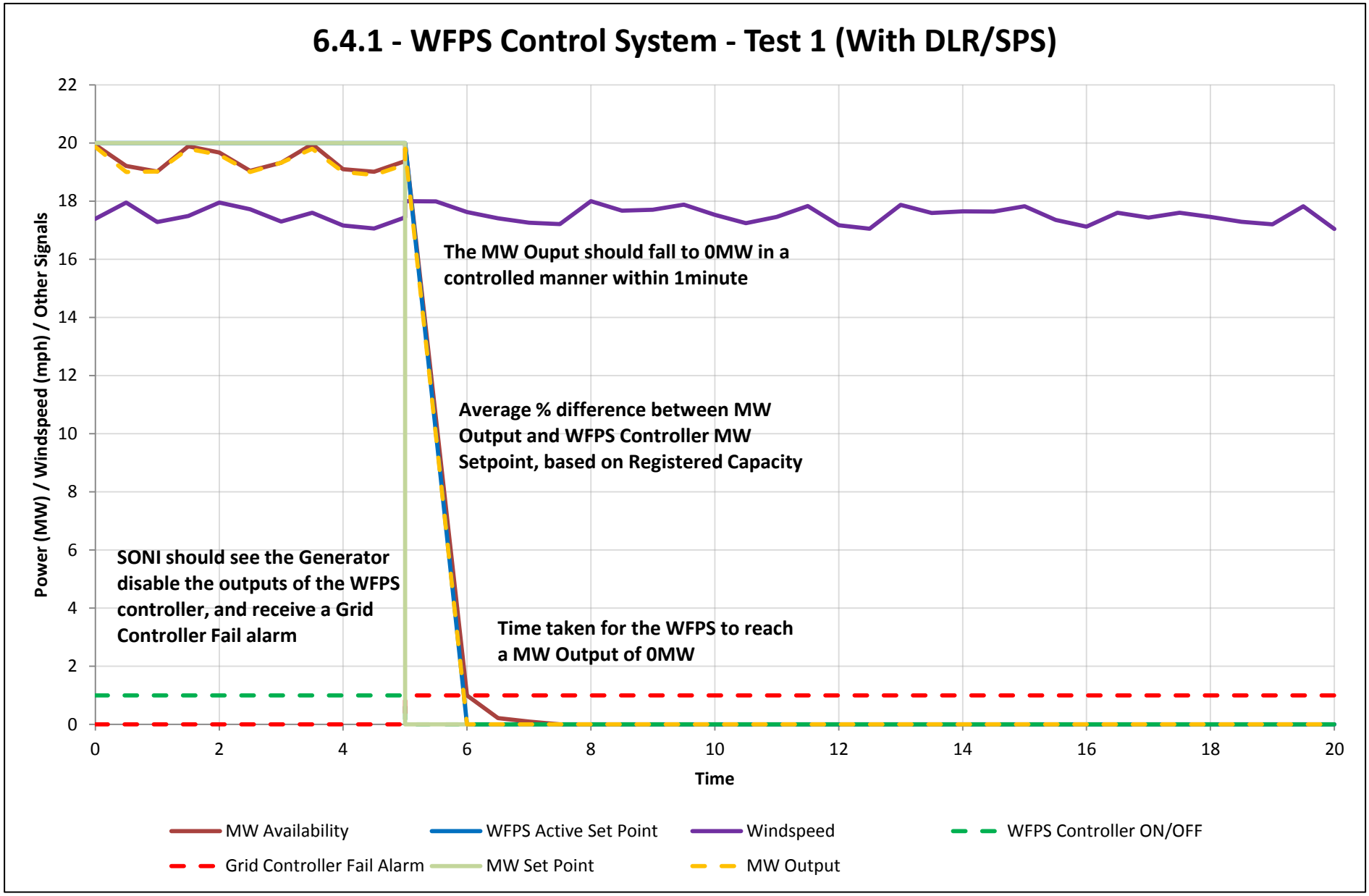

6.3 - MW Availability - Test 3
Power (MW) / Windspeed (mph) / Other Signals
Time
Average % difference between MW Output and WFPS Controller MW Setpoint, based on Registered Capacity
Average % difference between WFPS Controller MW Setpoint and MW Output, based on Registered Capacity
Average % difference between MW Output and WFPS Controller MW Setpoint, based on Registered Capacity
Ramp rate of WFPS Controller MW Setpoint and MW Output
Time taken for MW Output to reach MW Setpoint sent from SONI/NIE
MW Set Point
MW Availability
Windspeed
WFPS Active Set Point
MW Output

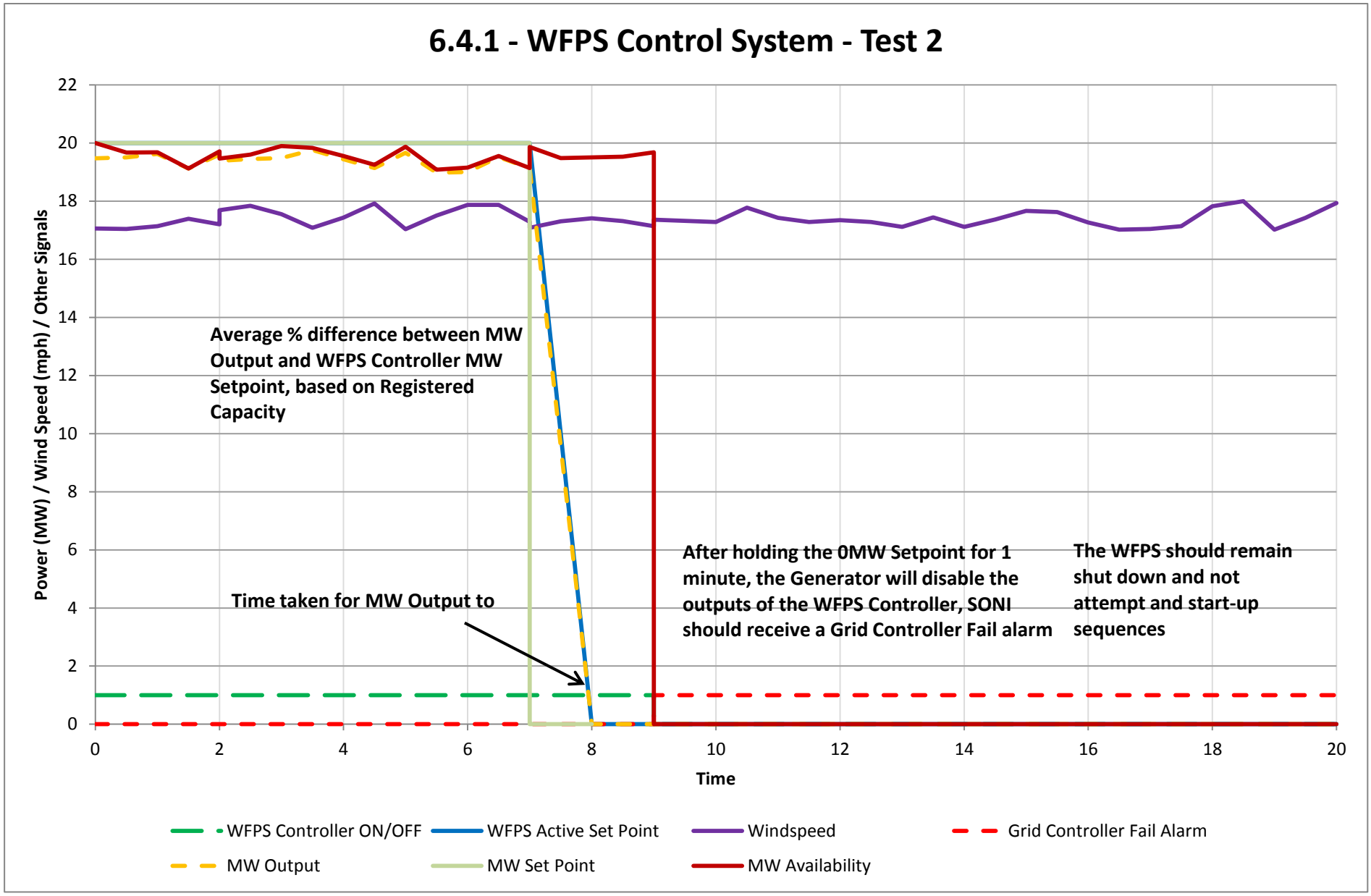

6.3 - MW Availability - Test 4
Power (MW) / Windspeed (mph) / Other Signals
WFPS % Shutdown
Time
Average % difference between MW Availability and MW Output, based on Registered Capacity
WFPS % Shutdown should increase as a percentage of Registered Capacity
The Generator will change the high wind speed setting to a value less than the wind speed that day - the same setting should be applied to all turbines
SONI should receive a High Wind Speed Shutdown Alarm when the first turbine shuts down - this alarm should stand until all turbines are available
MW Set Point
MW Availability
Windspeed
MW Output
WFPS Active Set Point
Injected High Windspeed Shutdown Signal
High Windspeed Shutdown Alarm
WFPS % Shutdown

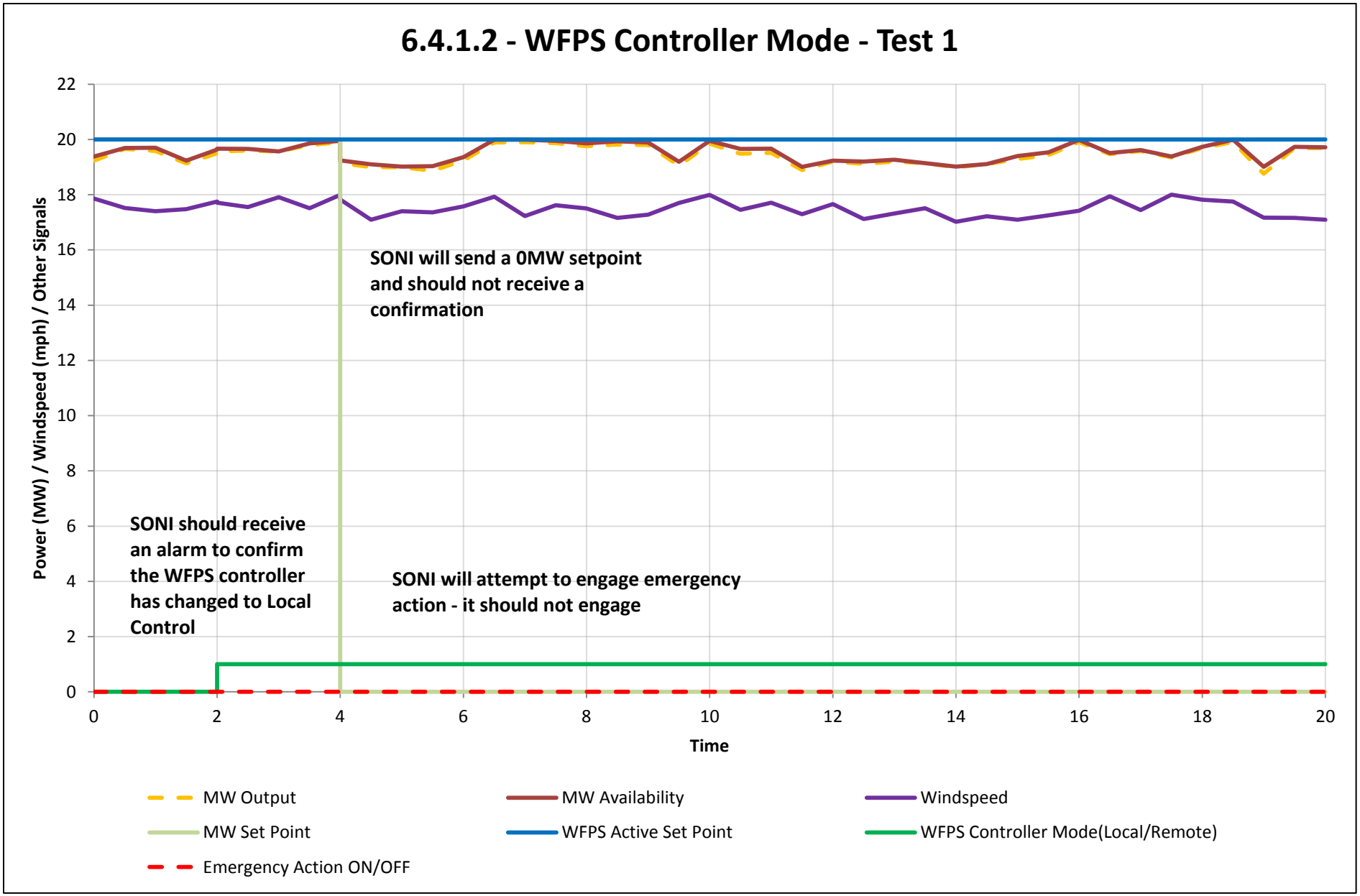

6.3 - MW Availability - Test 5
Power (MW) / Windspeed (mph)
Time
Average % difference between MW Availability and MW Output, based on Registered Capacity
MW Availability should reflect the number of turbines available i.e. as each turbine goes into Pause/Maintenance Mode the MW Availability should decrease accordingly
MW Set Point
MW Availability
Windspeed
MW Output
WFPS Active Set Point

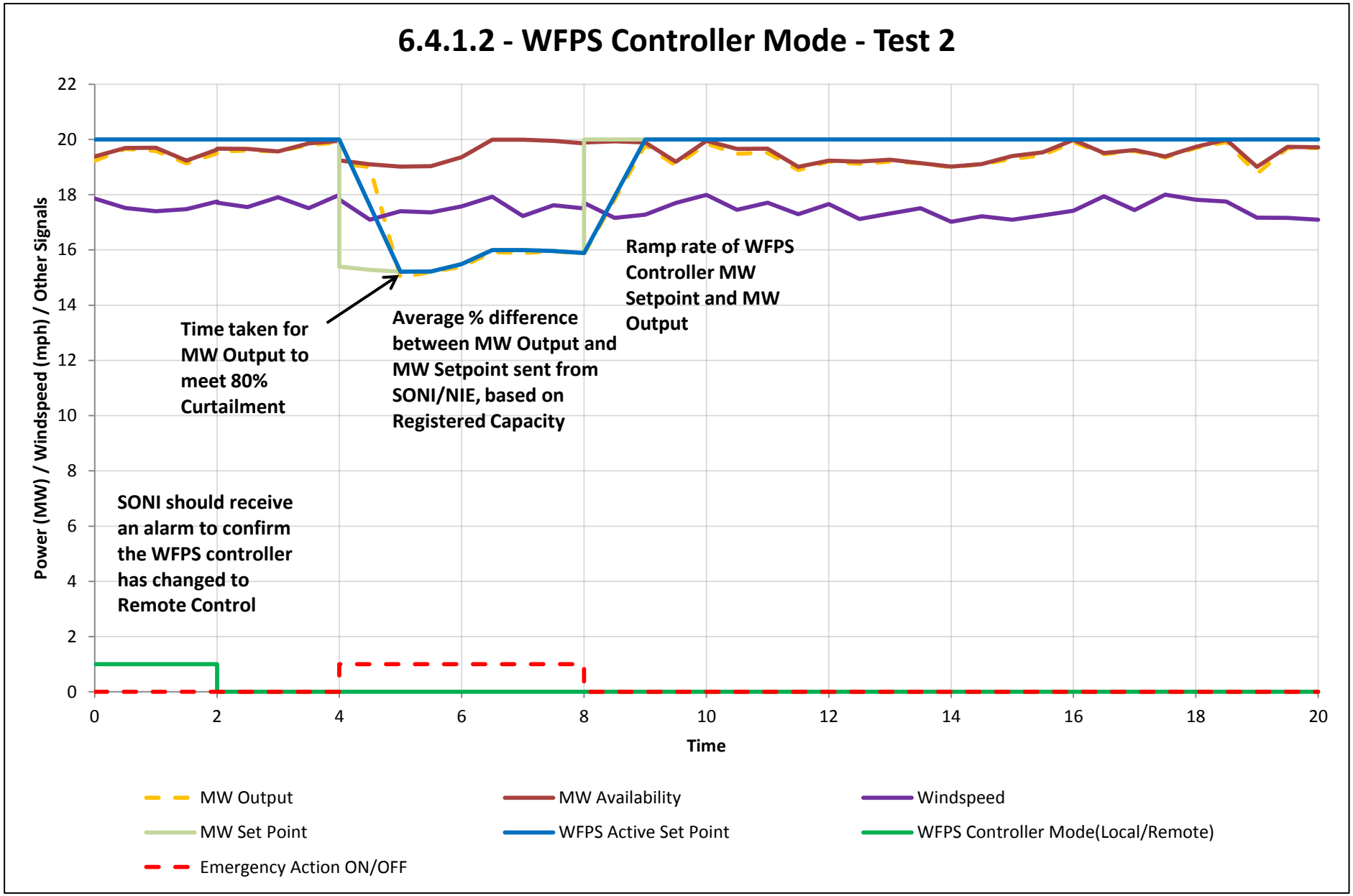

6.3 - MW Availability - Test 6
Power (MW) / Windspeed (mph)
Time
0
2
4
6
8
10
12
14
16
18
20
22
Average % difference between MW Availability and MW Output, based on Registered Capacity
MW Availability should reflect the number of turbines available i.e. as each turbine goes into an error condition (Safety Chain Activation Mode) the MW Availability should decrease accordingly
MW Set Point
MW Availability
Windspeed
MW Output
WFPS Active Set Point

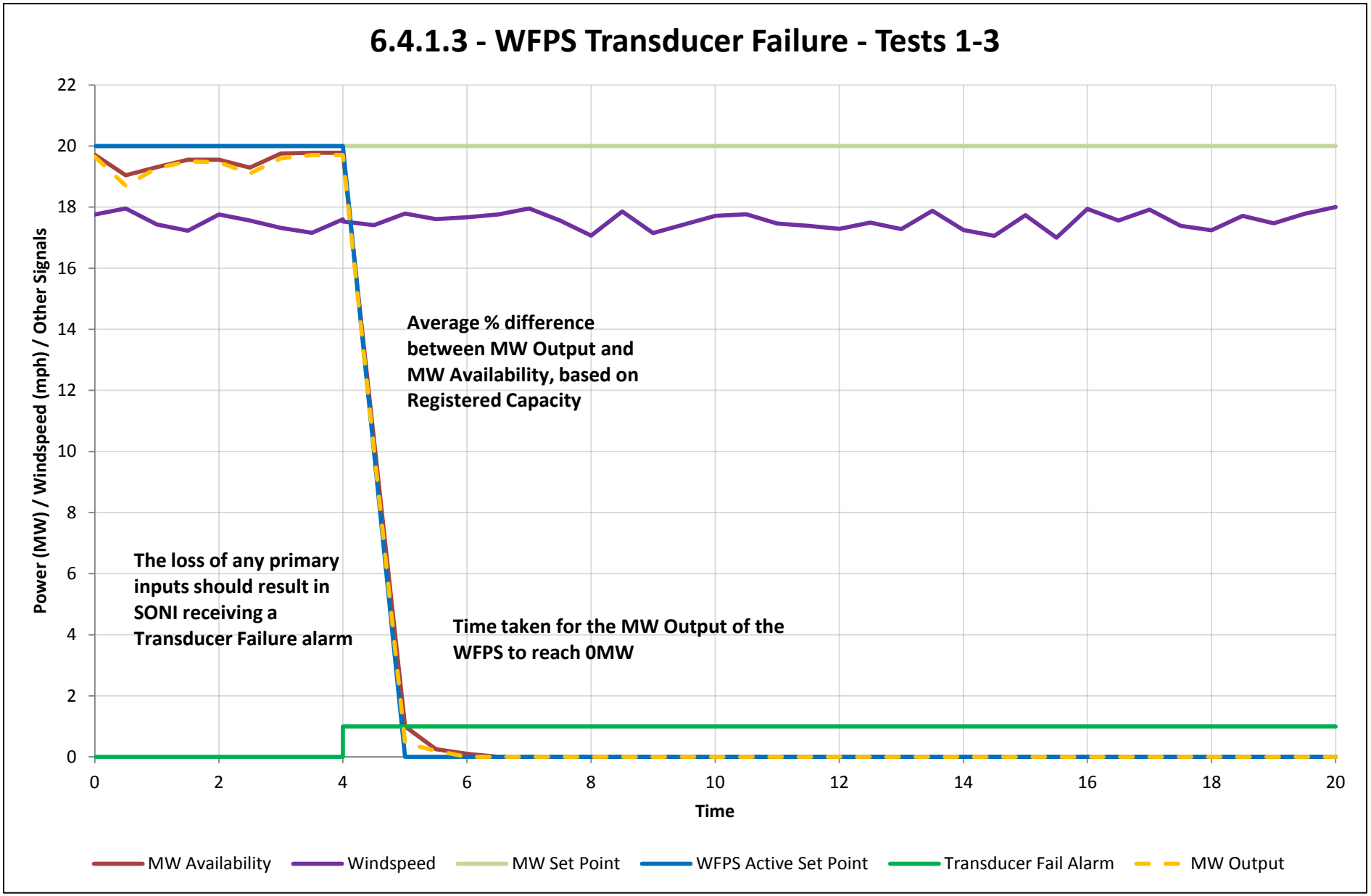

6.4.1 - WFPS Control System - Test 1 (No DLR/SPS)
Power (MW) / Windspeed (mph) / Other Signals
Time
WFPS should hold it's last known setpoint, or continue to operate as normal if not curtailed, for 10minutes after the loss of the controller
As the failure still exists after the 10 minute period, the WFPS Controller MW Setpoint should
Average % difference between MW Output and WFPS Controller MW Setpoint, based on Registered Capacity
Time taken for the WFPS to reach a MW Output of 0MW
SONI should see the Generator disable the outputs of the WFPS controller, and receive a Grid Controller Fail alarm
MW Availability
WFPS Active Set Point
Windspeed
WFPS Controller ON/OFF
Grid Controller Fail Alarm
MW Output
MW Set Point

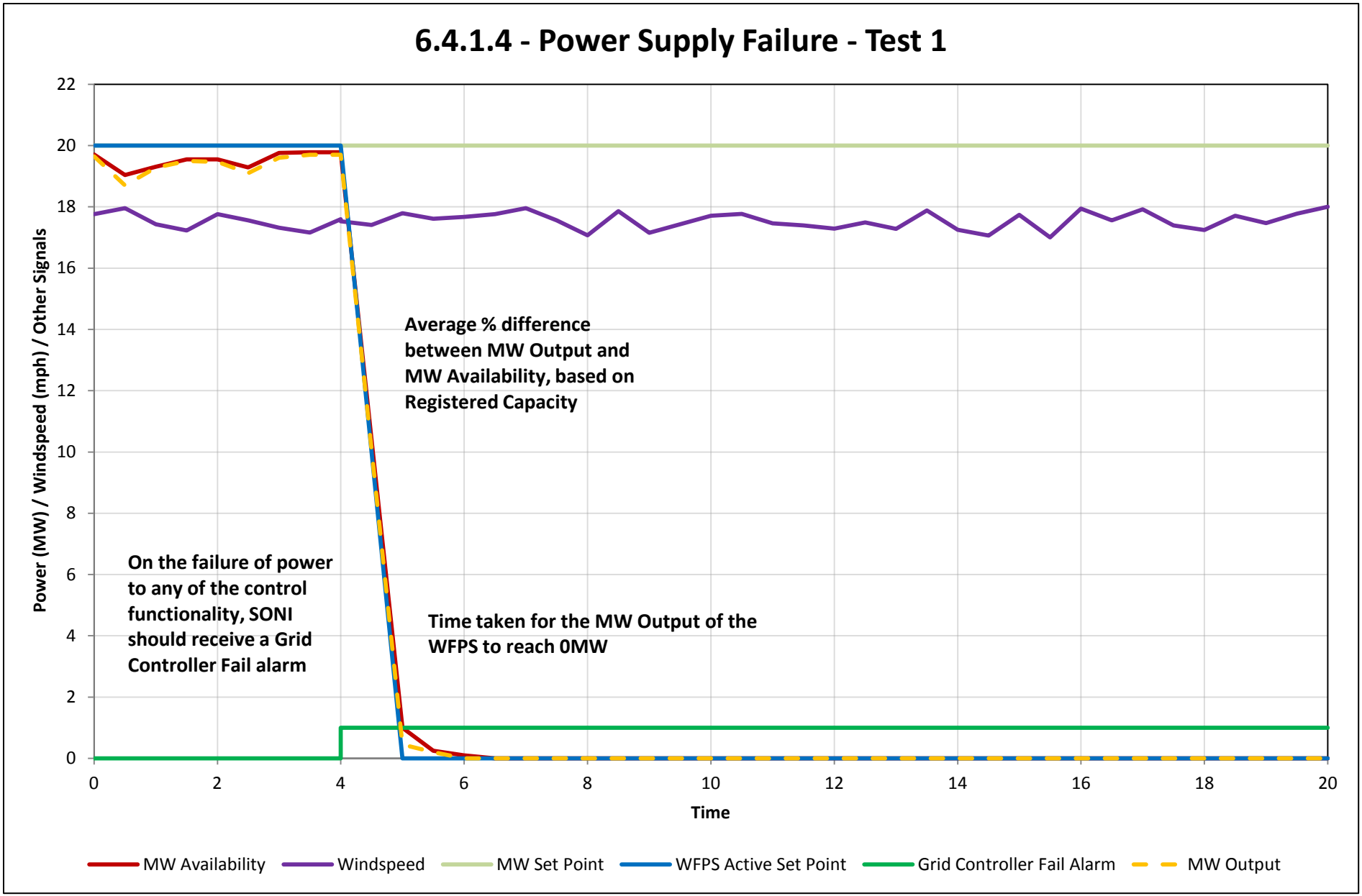

6.4.1 - WFPS Control System - Test 1 (With DLR/SPS)
Power (MW) / Windspeed (mph) / Other Signals
Time
The MW Ouput should fall to 0MW in a controlled manner within 1minute
Average % difference between MW Output and WFPS Controller MW Setpoint, based on Registered Capacity
SONI should see the Generator disable the outputs of the WFPS controller, and receive a Grid Controller Fail alarm
Time taken for the WFPS to reach a MW Output of 0MW
MW Availability
WFPS Active Set Point
Windspeed
WFPS Controller ON/OFF
Grid Controller Fail Alarm
MW Set Point
MW Output

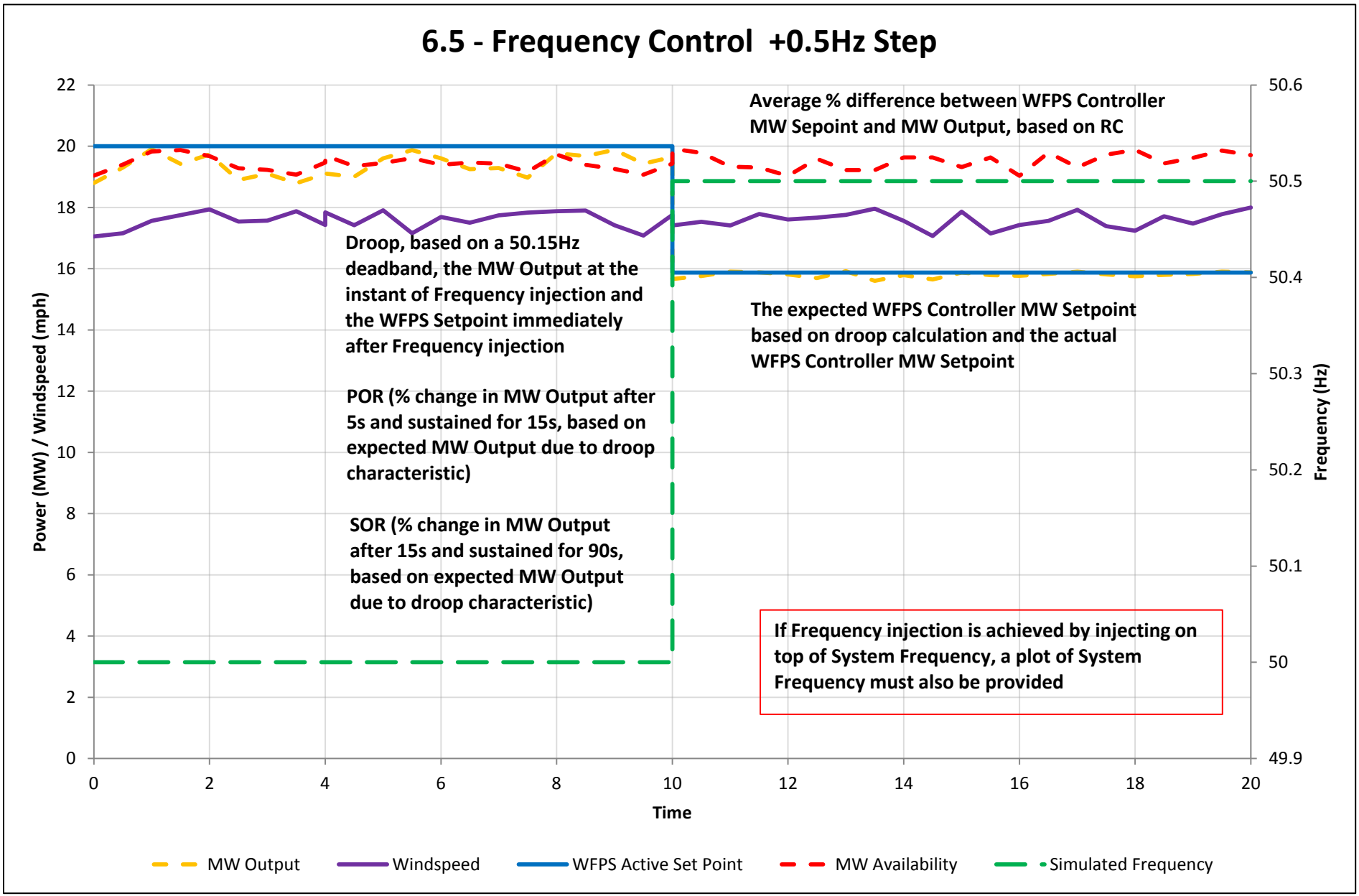

6.4.1 - WFPS Control System - Test 2
Power (MW) / Wind Speed (mph) / Other Signals
Time
Average % difference between MW Output and WFPS Controller MW Setpoint, based on Registered Capacity
Time taken for MW Output to
After holding the 0MW Setpoint for 1 minute, the Generator will disable the outputs of the WFPS Controller, SONI should receive a Grid Controller Fail alarm
The WFPS should remain shut down and not attempt and start-up sequences
WFPS Controller ON/OFF
WFPS Active Set Point
Windspeed
Grid Controller Fail Alarm
MW Output
MW Set Point
MW Availability

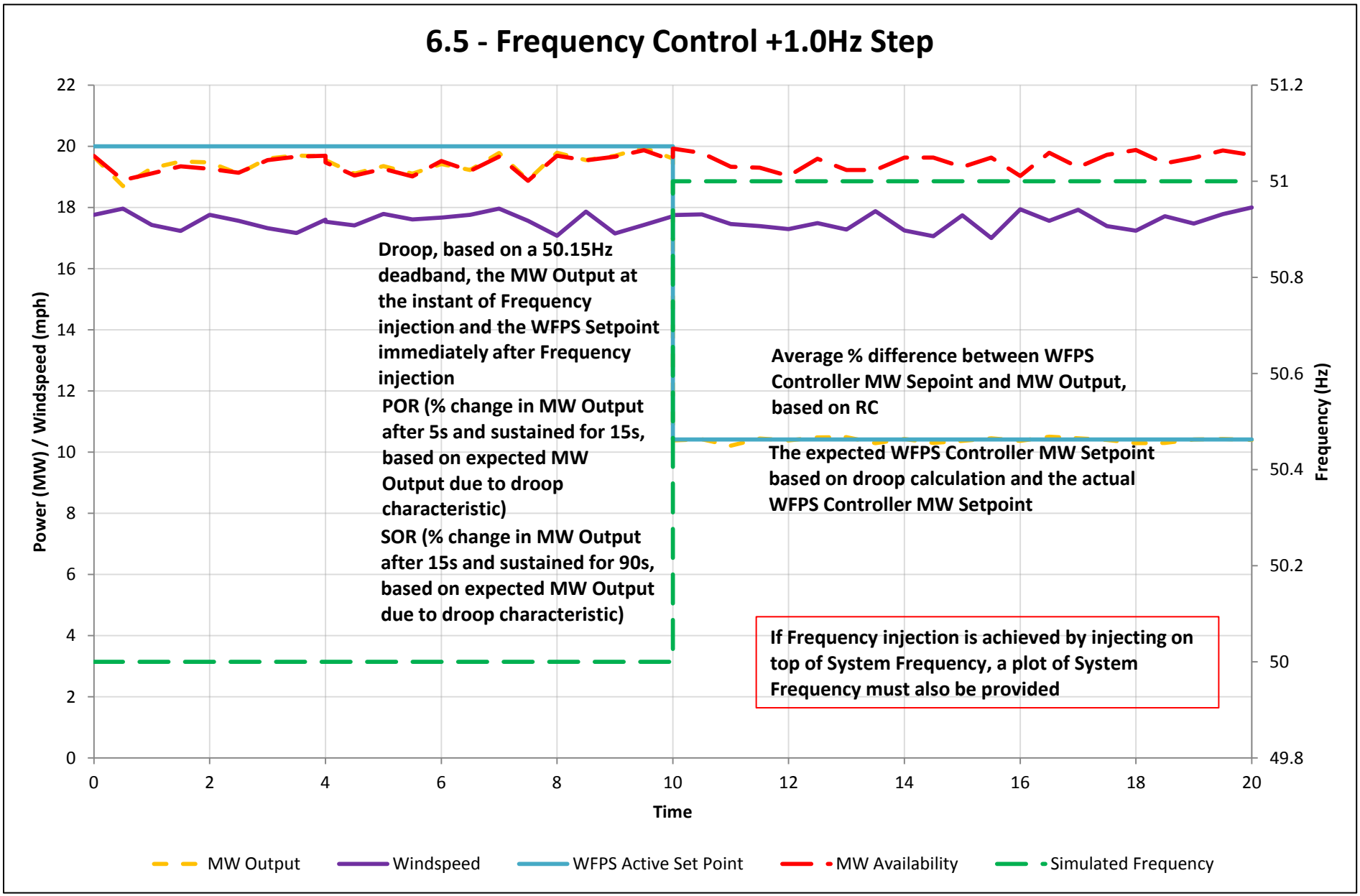

6.4.1.2 - WFPS Controller Mode - Test 1
Power (MW) / Windspeed (mph) / Other Signals
Time
SONI will send a 0MW setpoint and should not receive a confirmation
SONI should receive an alarm to confirm the WFPS controller has changed to Local Control
SONI will attempt to engage emergency action - it should not engage
MW Output
MW Availability
Windspeed
MW Set Point
WFPS Active Set Point
WFPS Controller Mode(Local/Remote)
Emergency Action ON/OFF

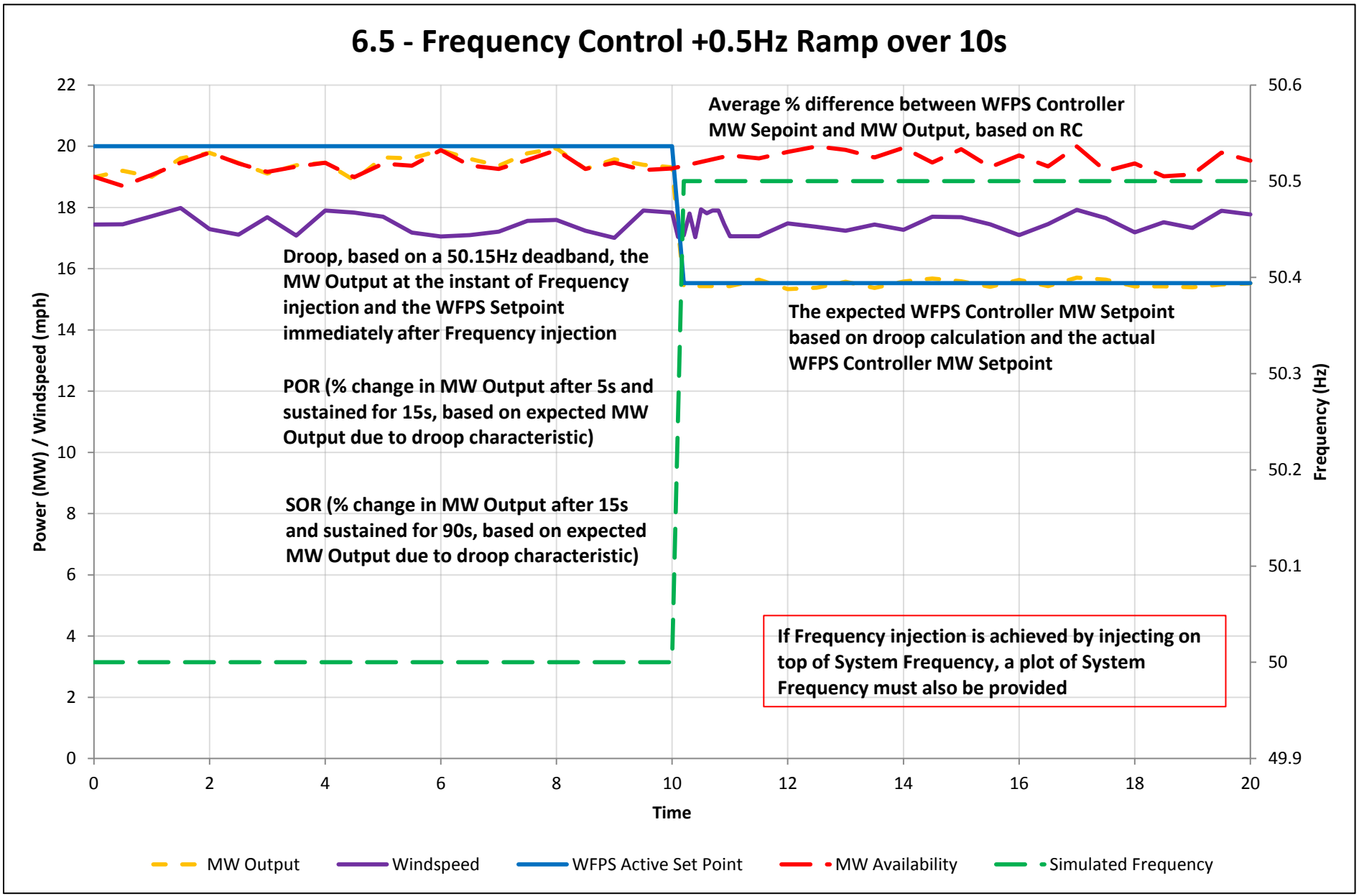

6.4.1.2 - WFPS Controller Mode - Test 2
Power (MW) / Windspeed (mph) / Other Signals
Time
Time taken for MW Output to meet 80% Curtailment
Average % difference between MW Output and MW Setpoint sent from SONI/NIE, based on Registered Capacity
Ramp rate of WFPS Controller MW Setpoint and MW Output
SONI should receive an alarm to confirm the WFPS controller has changed to Remote Control
MW Output
MW Availability
Windspeed
MW Set Point
WFPS Active Set Point
WFPS Controller Mode(Local/Remote)
Emergency Action ON/OFF

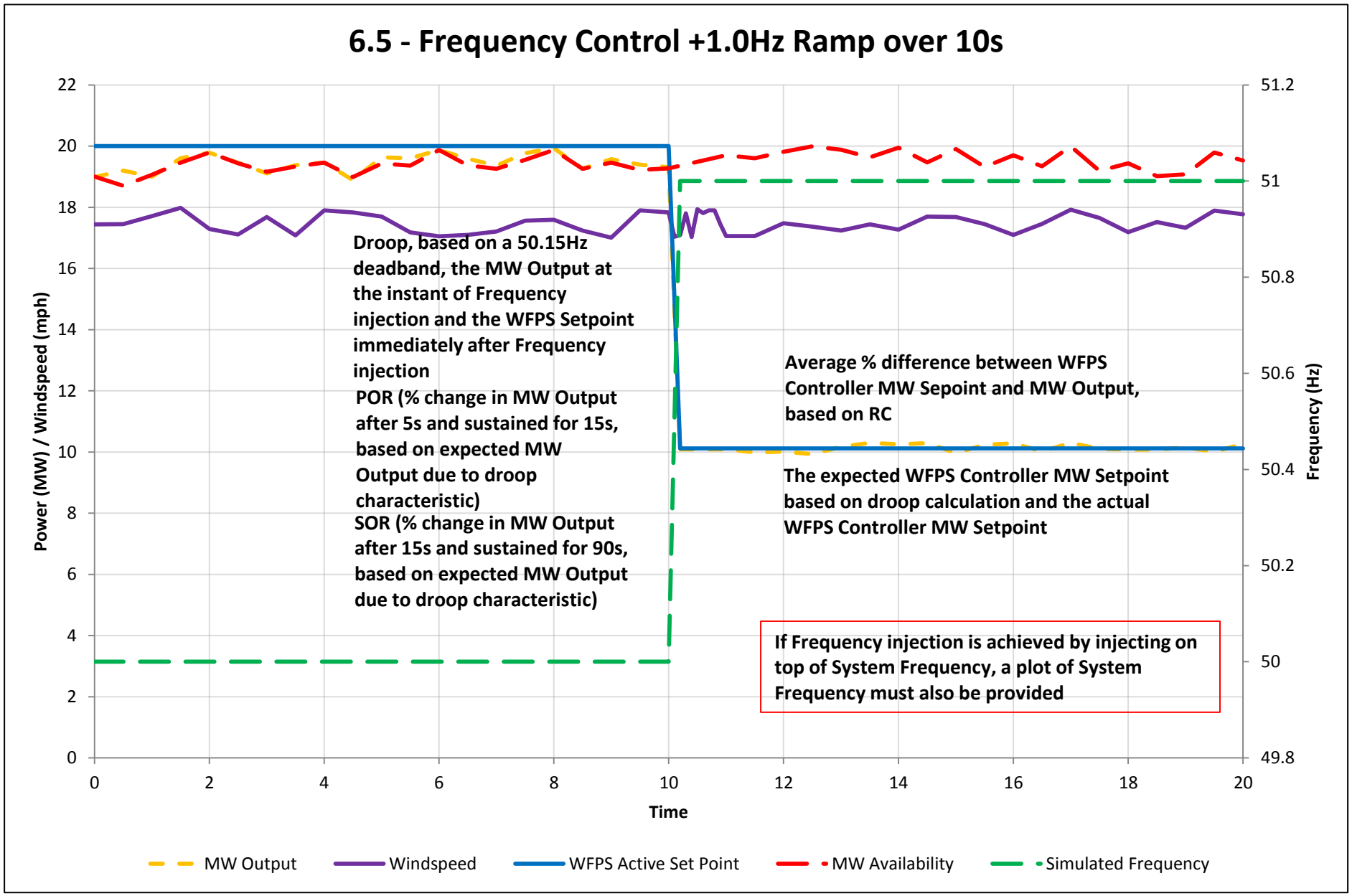

6.4.1.3 - WFPS Transducer Failure - Tests 1-3
Power (MW) / Windspeed (mph) / Other Signals
Time
Average % difference between MW Output and MW Availability, based on Registered Capacity
The loss of any primary inputs should result in SONI receiving a Transducer Failure alarm
Time taken for the MW Output of the WFPS to reach 0MW
MW Availability
Windspeed
MW Set Point
WFPS Active Set Point
Transducer Fail Alarm
MW Output

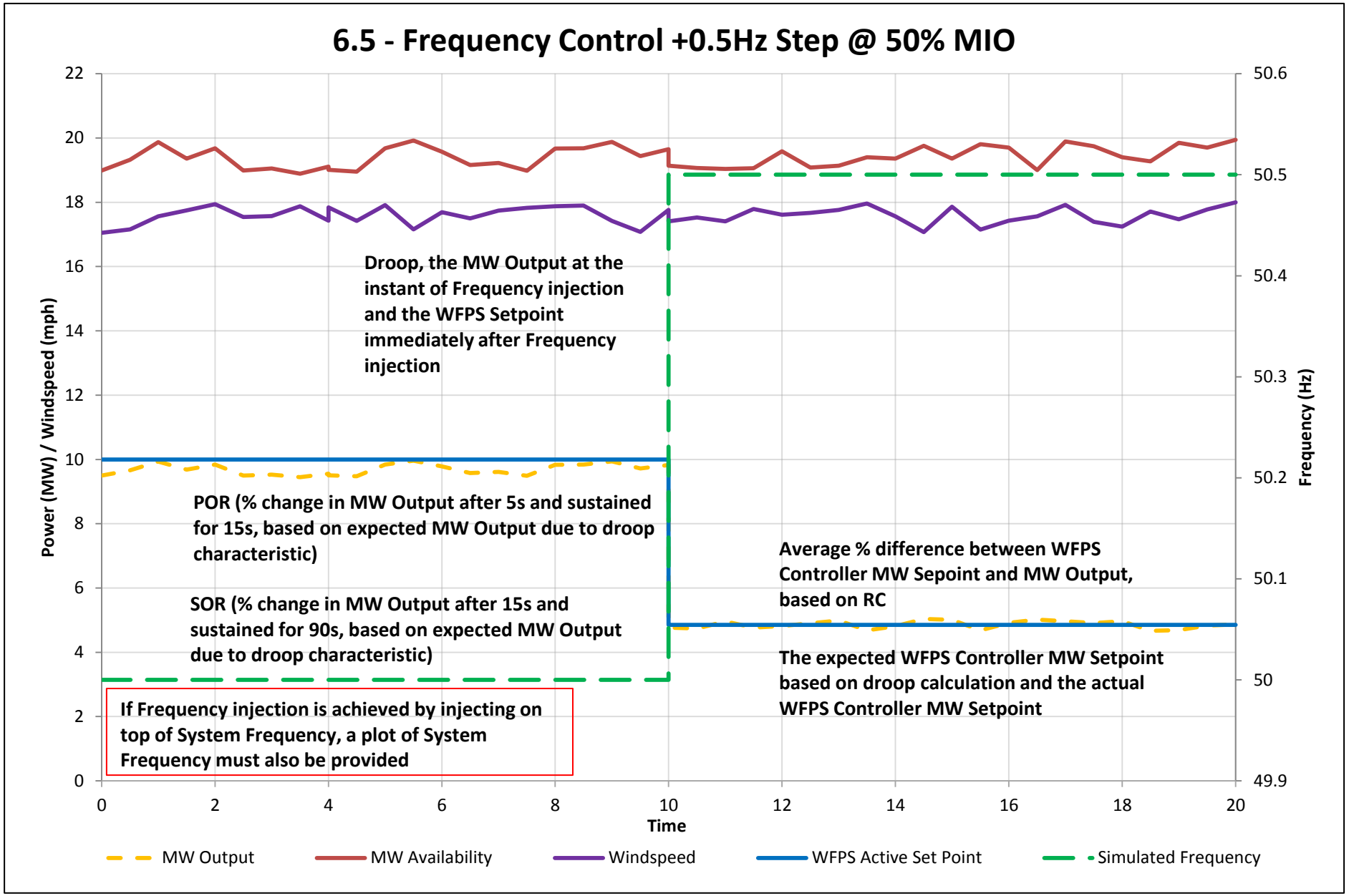

6.4.1.4 - Power Supply Failure - Test 1
Power (MW) / Windspeed (mph) / Other Signals
Time
Average % difference between MW Output and MW Availability, based on Registered Capacity
On the failure of power to any of the control functionality, SONI should receive a Grid Controller Fail alarm
Time taken for the MW Output of the WFPS to reach 0MW
MW Availability
Windspeed
MW Set Point
WFPS Active Set Point
Grid Controller Fail Alarm
MW Output

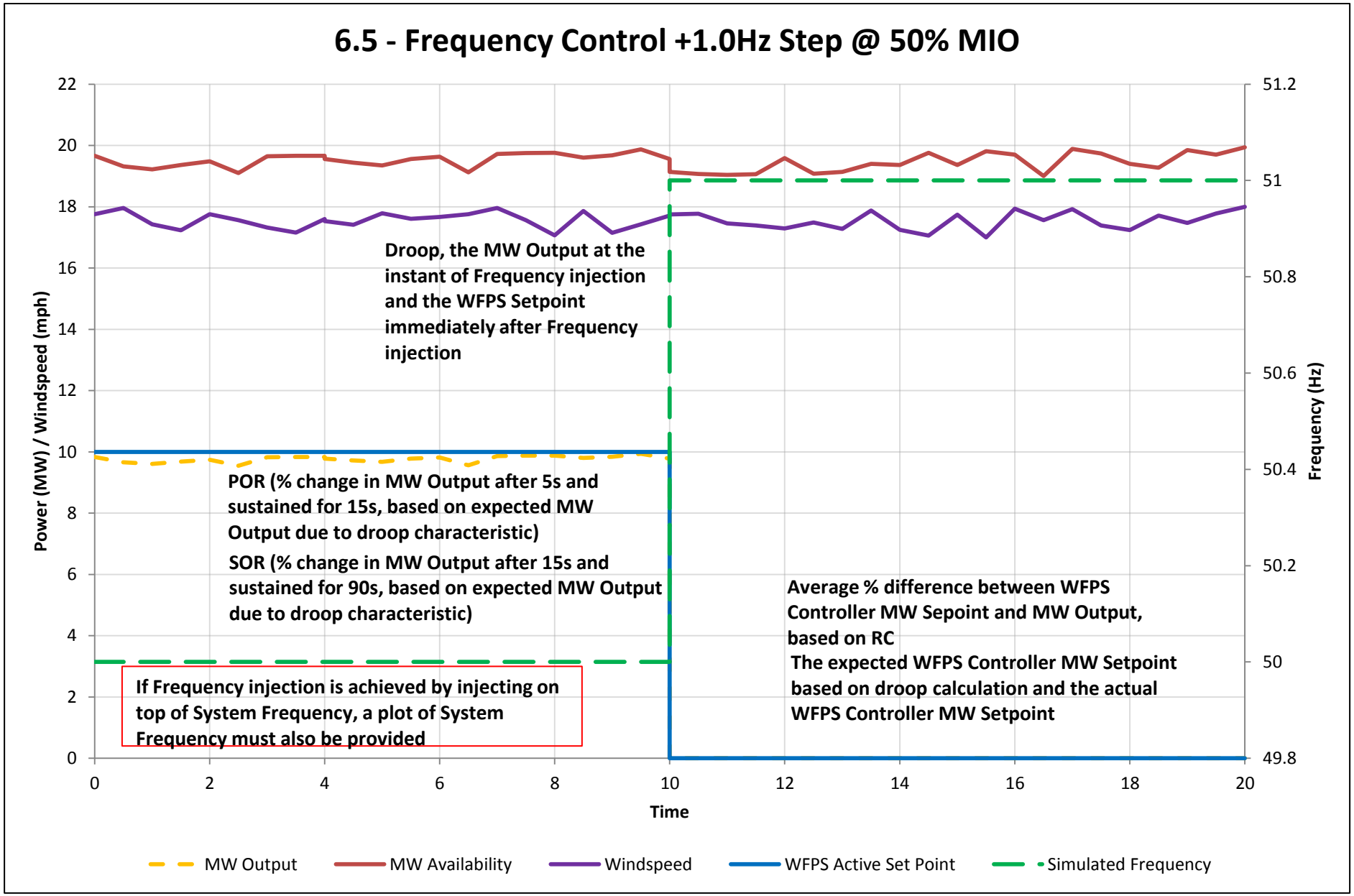

6.5 - Frequency Control +0.5Hz Step
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
Average % difference between WFPS Controller MW Sepoint and MW Output, based on RC
Droop, based on a 50.15Hz deadband, the MW Output at the instant of Frequency injection and the WFPS Setpoint immediately after Frequency injection
POR (% change in MW Output after 5s and sustained for 15s, based on expected MW Output due to droop characteristic)
SOR (% change in MW Output after 15s and sustained for 90s, based on expected MW Output due to droop characteristic)
The expected WFPS Controller MW Setpoint based on droop calculation and the actual WFPS Controller MW Setpoint
If Frequency injection is achieved by injecting on top of System Frequency, a plot of System Frequency must also be provided
MW Output
Windspeed
WFPS Active Set Point
MW Availability
Simulated Frequency

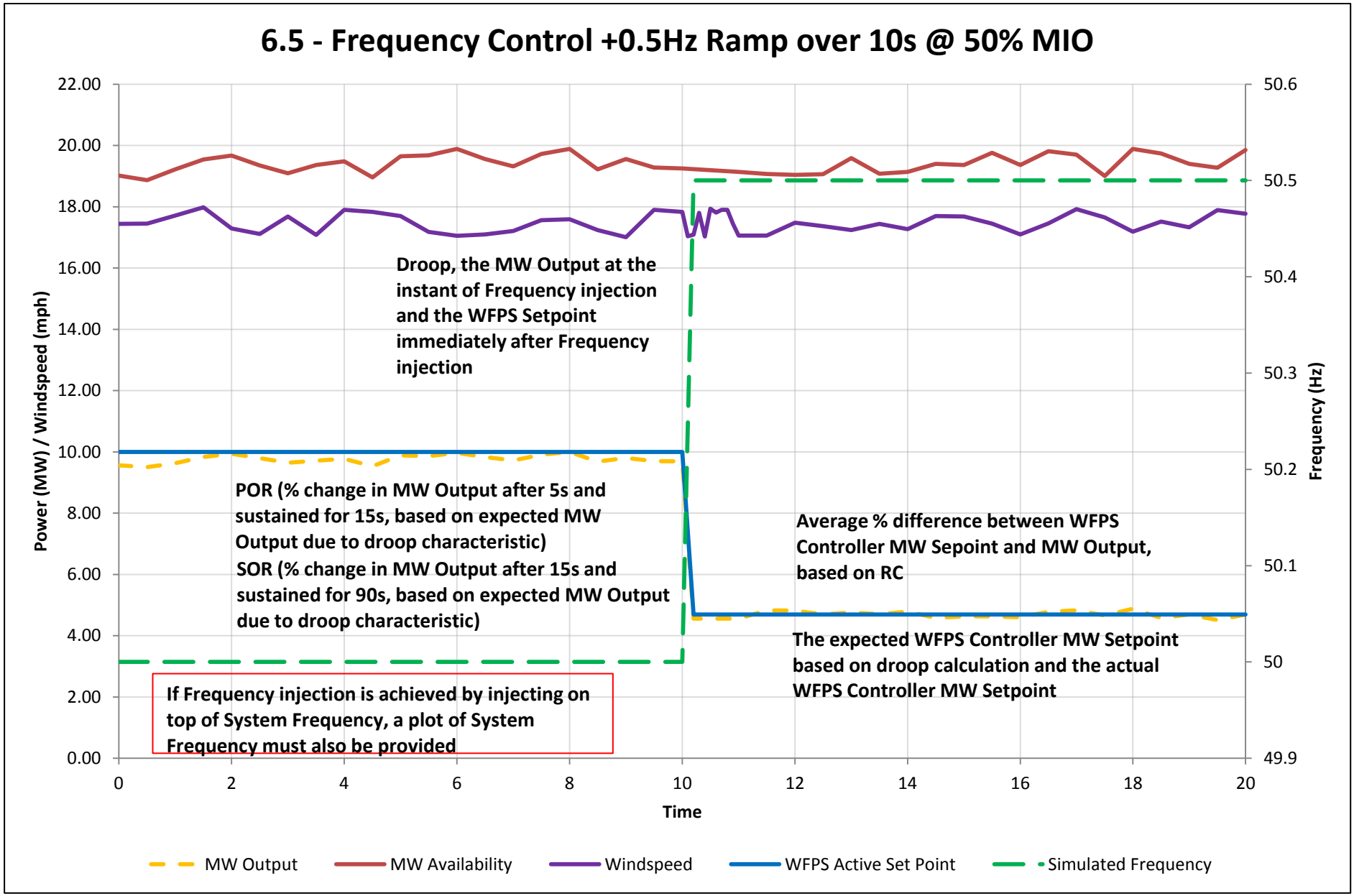

6.5 - Frequency Control +1.0Hz Step
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
Droop, based on a 50.15Hz deadband, the MW Output at the instant of Frequency injection and the WFPS Setpoint immediately after Frequency injection
POR (% change in MW Output after 5s and sustained for 15s, based on expected MW Output due to droop characteristic)
SOR (% change in MW Output after 15s and sustained for 90s, based on expected MW Output due to droop characteristic)
Average % difference between WFPS Controller MW Sepoint and MW Output, based on RC
The expected WFPS Controller MW Setpoint based on droop calculation and the actual WFPS Controller MW Setpoint
If Frequency injection is achieved by injecting on top of System Frequency, a plot of System Frequency must also be provided
MW Output
Windspeed
WFPS Active Set Point
MW Availability
Simulated Frequency

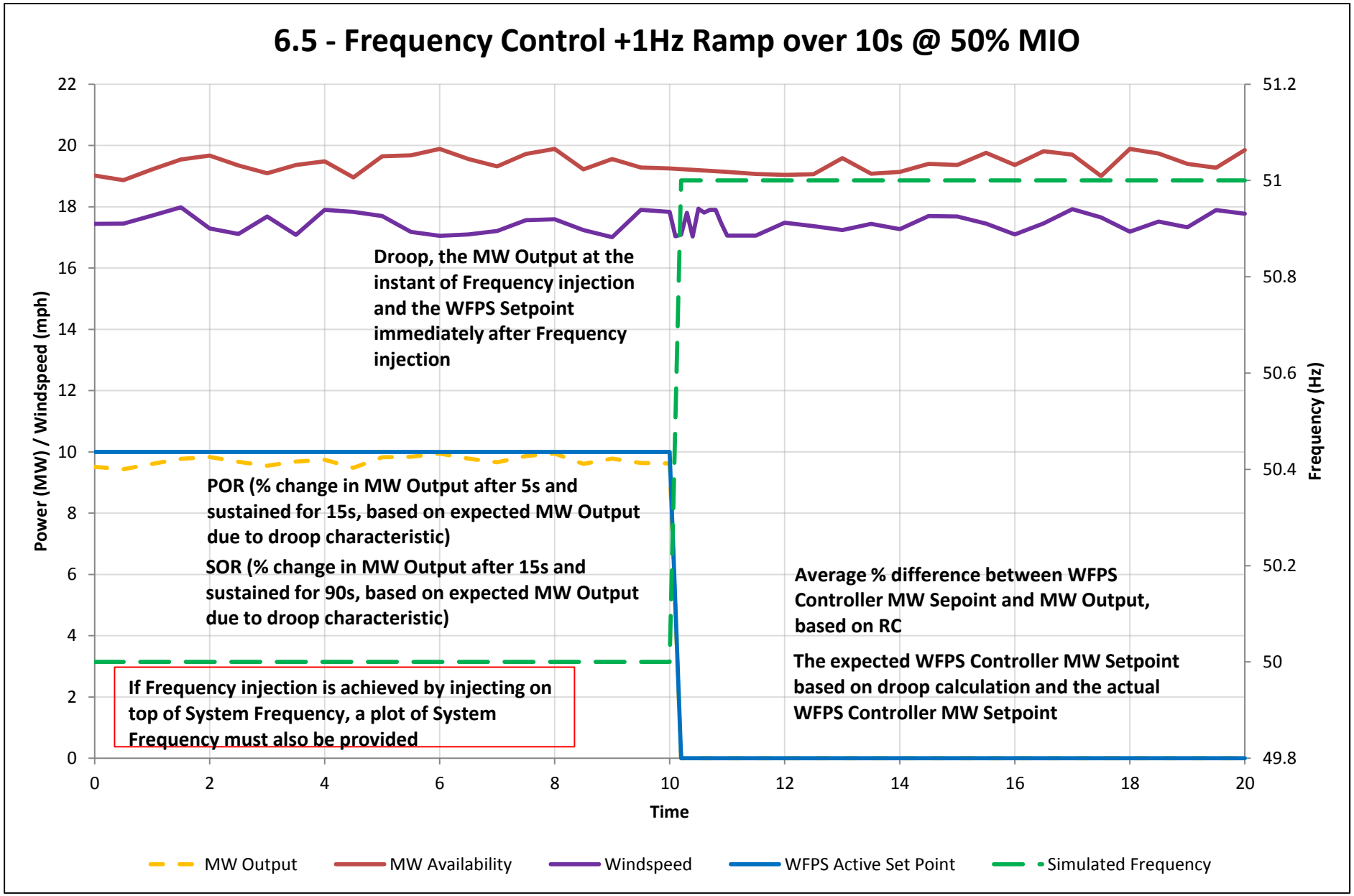

6.5 - Frequency Control +0.5Hz Ramp over 10s
Average % difference between WFPS Controller MW Sepoint and MW Output, based on RC
Droop, based on a 50.15Hz deadband, the MW Output at the instant of Frequency injection and the WFPS Setpoint immediately after Frequency injection
POR (% change in MW Output after 5s and sustained for 15s, based on expected MW Output due to droop characteristic)
SOR (% change in MW Output after 15s and sustained for 90s, based on expected MW Output due to droop characteristic)
The expected WFPS Controller MW Setpoint based on droop calculation and the actual WFPS Controller MW Setpoint
If Frequency injection is achieved by injecting on top of System Frequency, a plot of System Frequency must also be provided
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
MW Output
Windspeed
WFPS Active Set Point
MW Availability
Simulated Frequency

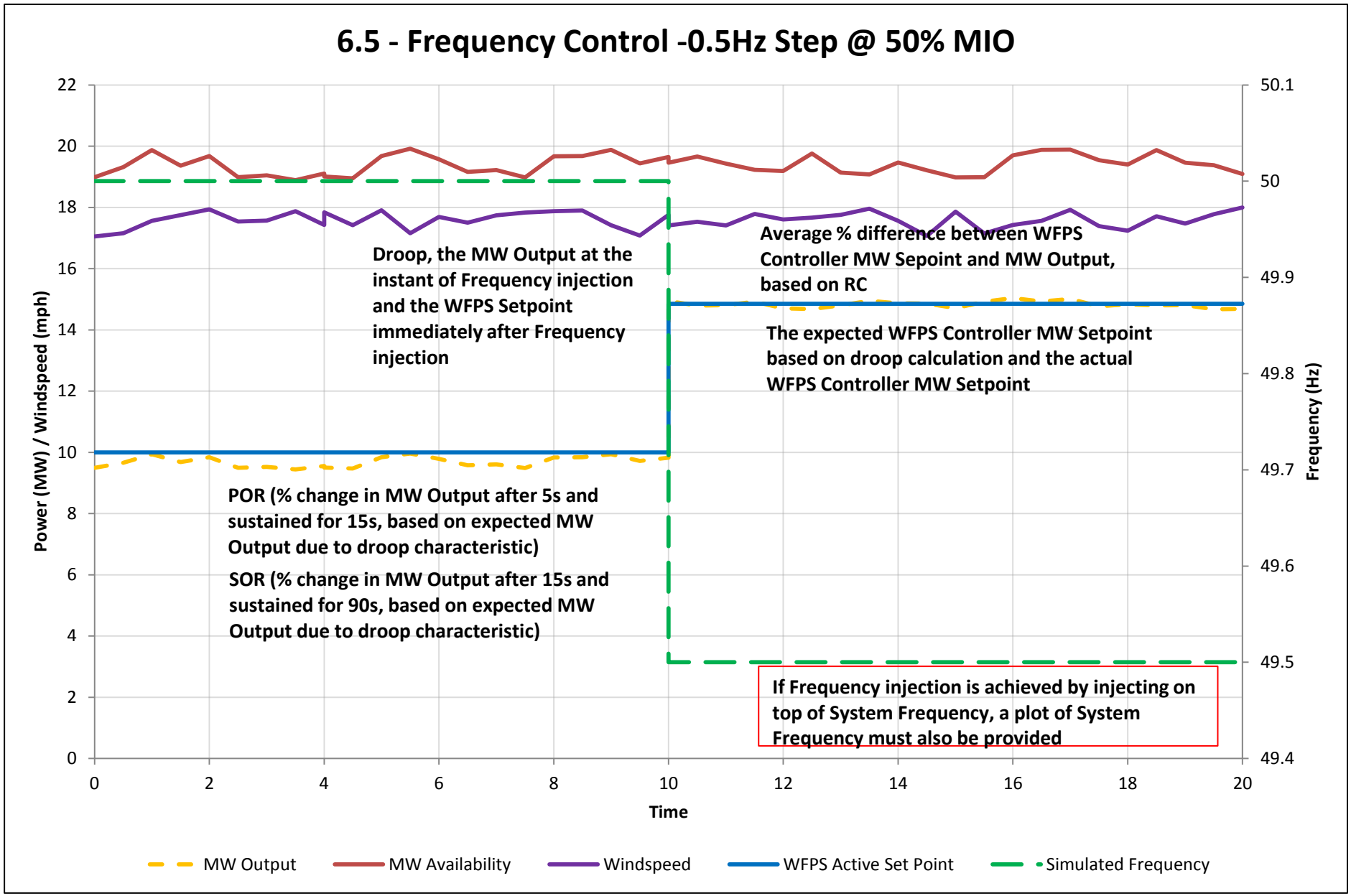

6.5 - Frequency Control +1.0Hz Ramp over 10s
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
Droop, based on a 50.15Hz deadband, the MW Output at the instant of Frequency injection and the WFPS Setpoint immediately after Frequency injection
POR (% change in MW Output after 5s and sustained for 15s, based on expected MW Output due to droop characteristic)
SOR (% change in MW Output after 15s and sustained for 90s, based on expected MW Output due to droop characteristic)
Average % difference between WFPS Controller MW Sepoint and MW Output, based on RC
The expected WFPS Controller MW Setpoint based on droop calculation and the actual WFPS Controller MW Setpoint
If Frequency injection is achieved by injecting on top of System Frequency, a plot of System Frequency must also be provided
MW Output
Windspeed
WFPS Active Set Point
MW Availability
Simulated Frequency

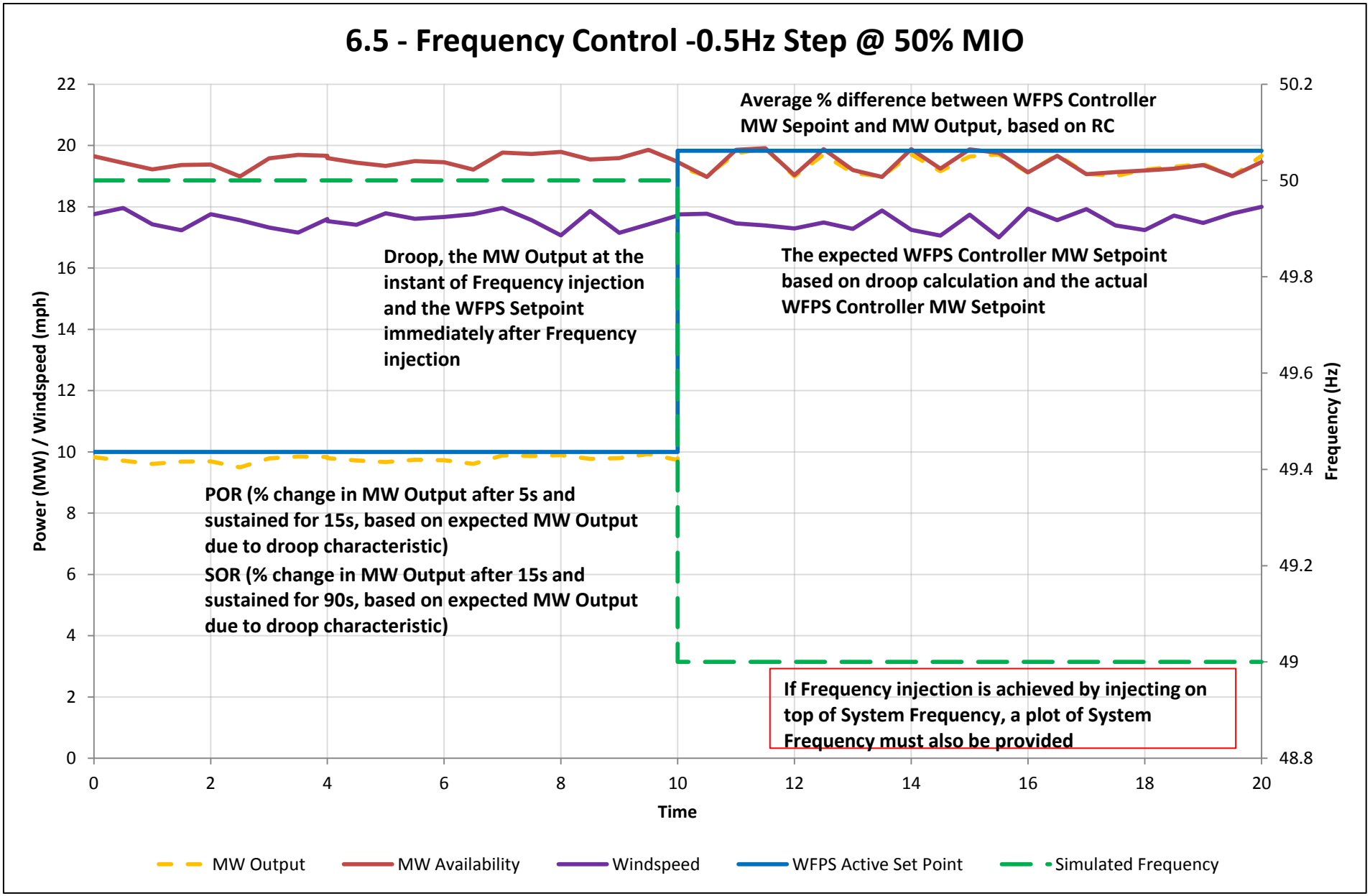

6.5 - Frequency Control +0.5Hz Step @ 50% MIO
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
Droop, the MW Output at the instant of Frequency injection and the WFPS Setpoint immediately after Frequency injection
POR (% change in MW Output after 5s and sustained for 15s, based on expected MW Output due to droop characteristic)
SOR (% change in MW Output after 15s and sustained for 90s, based on expected MW Output due to droop characteristic)
If Frequency injection is achieved by injecting on top of System Frequency, a plot of System Frequency must also be provided
Average % difference between WFPS Controller MW Sepoint and MW Output, based on RC
The expected WFPS Controller MW Setpoint based on droop calculation and the actual WFPS Controller MW Setpoint
MW Output
MW Availability
Windspeed
WFPS Active Set Point
Simulated Frequency

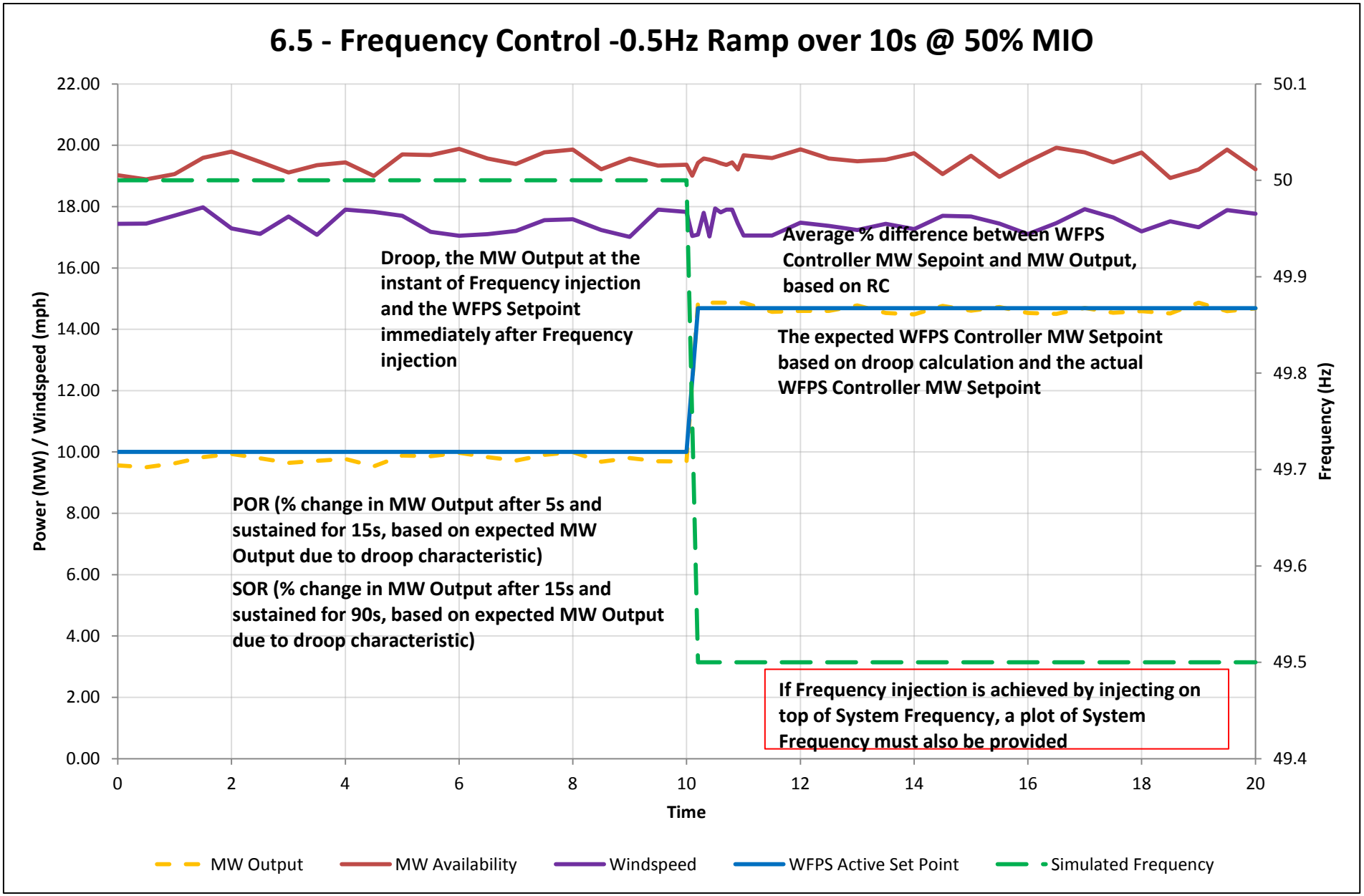

6.5 - Frequency Control +1.0Hz Step @ 50% MIO
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
Droop, the MW Output at the instant of Frequency injection and the WFPS Setpoint immediately after Frequency injection
POR (% change in MW Output after 5s and sustained for 15s, based on expected MW Output due to droop characteristic)
SOR (% change in MW Output after 15s and sustained for 90s, based on expected MW Output due to droop characteristic)
If Frequency injection is achieved by injecting on top of System Frequency, a plot of System Frequency must also be provided
Average % difference between WFPS Controller MW Sepoint and MW Output, based on RC
The expected WFPS Controller MW Setpoint based on droop calculation and the actual WFPS Controller MW Setpoint
MW Output
MW Availability
Windspeed
WFPS Active Set Point
Simulated Frequency

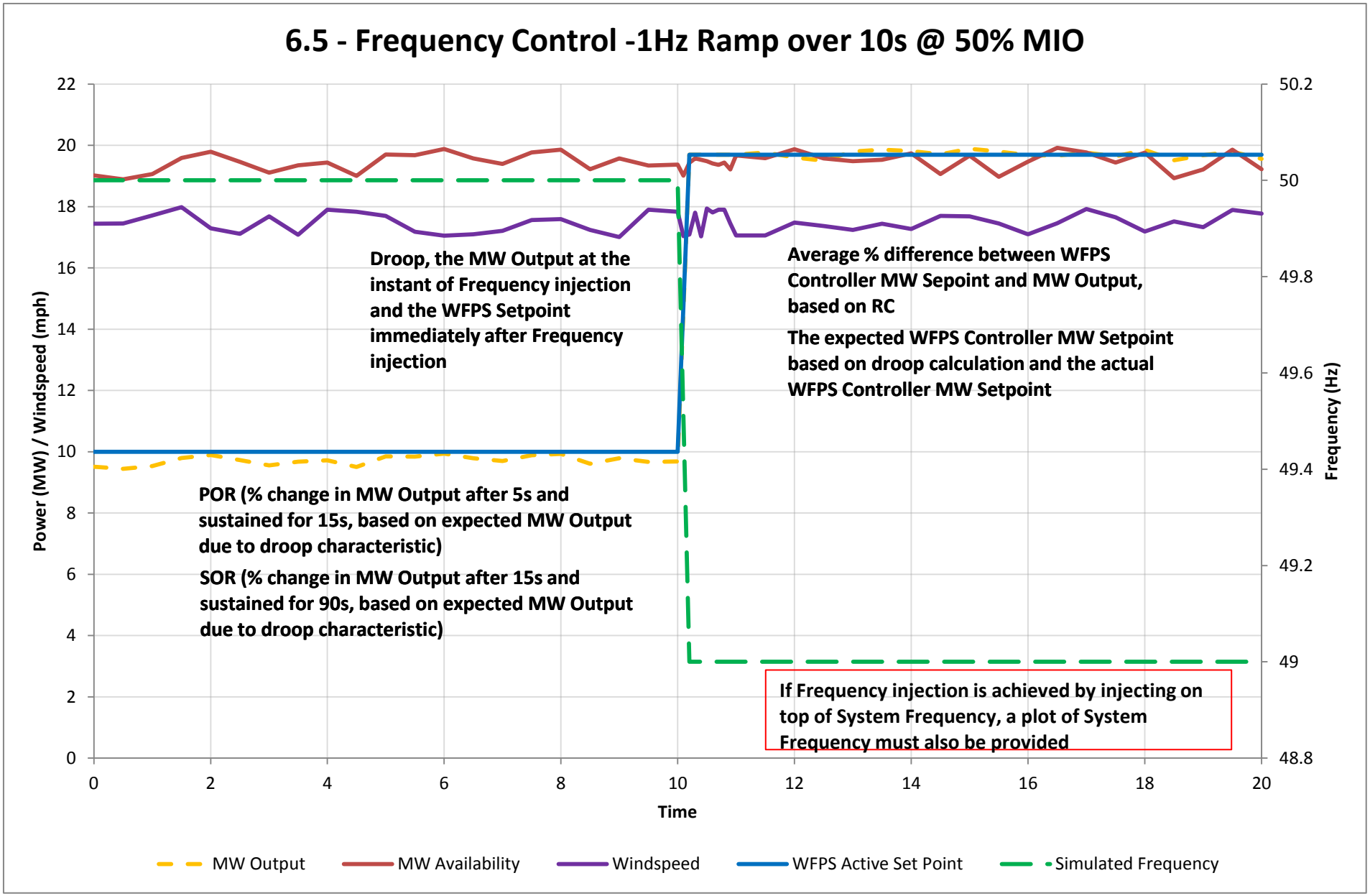

6.5 - Frequency Control +0.5Hz Ramp over 10s @ 50% MIO
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
50.6
50.5
50.4
50.3
50.2
50.1
50
49.9
0
2
4
6
8
10
12
14
16
18
20
Droop, the MW Output at the instant of Frequency injection and the WFPS Setpoint immediately after Frequency injection
POR (% change in MW Output after 5s and sustained for 15s, based on expected MW Output due to droop characteristic)
SOR (% change in MW Output after 15s and sustained for 90s, based on expected MW Output due to droop characteristic)
Average % difference between WFPS Controller MW Sepoint and MW Output, based on RC
The expected WFPS Controller MW Setpoint based on droop calculation and the actual WFPS Controller MW Setpoint
If Frequency injection is achieved by injecting on top of System Frequency, a plot of System Frequency must also be provided
MW Output
MW Availability
Windspeed
WFPS Active Set Point
Simulated Frequency

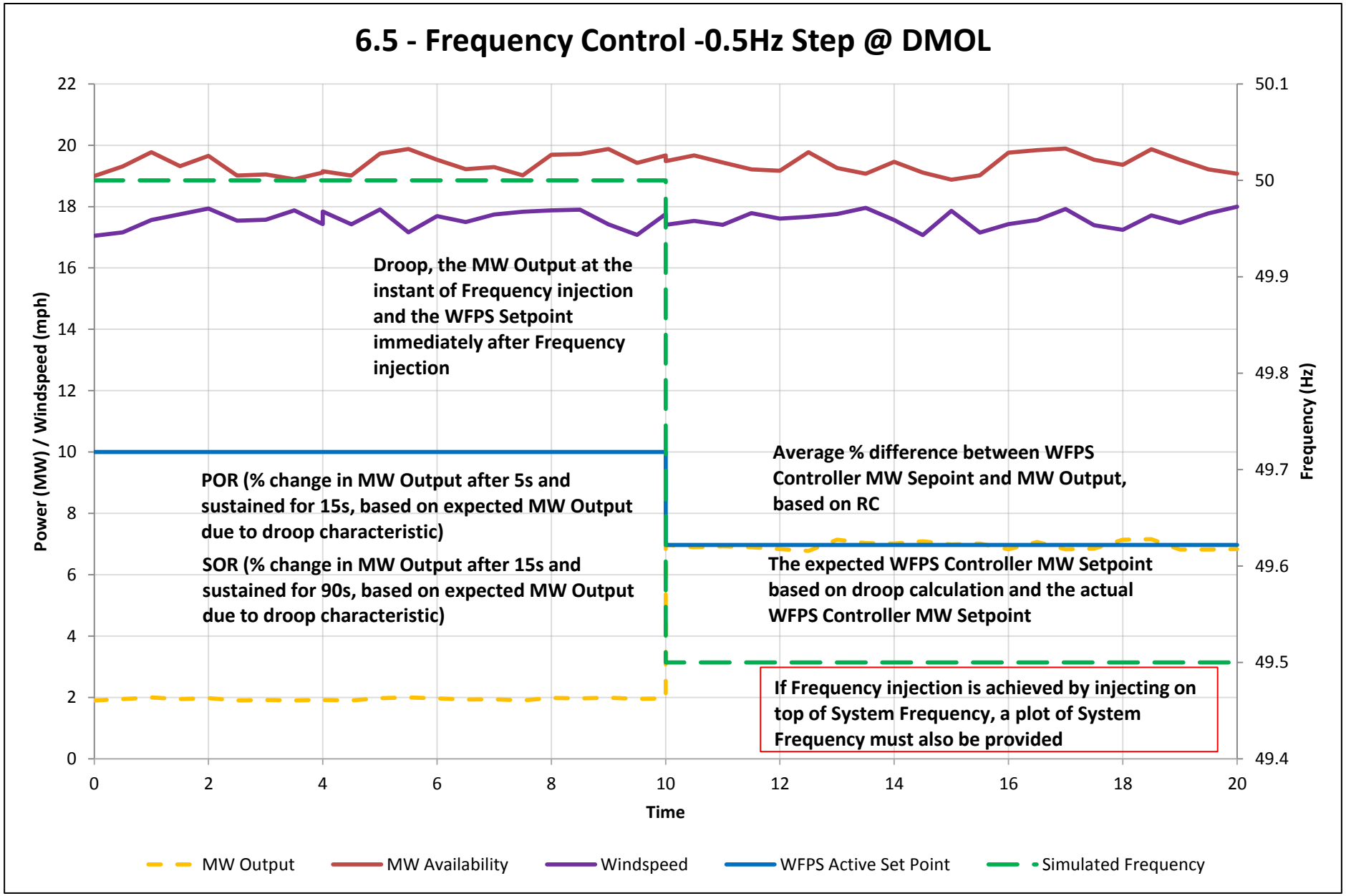

6.5 - Frequency Control +1Hz Ramp over 10s @ 50% MIO
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
Droop, the MW Output at the instant of Frequency injection and the WFPS Setpoint immediately after Frequency injection
POR (% change in MW Output after 5s and sustained for 15s, based on expected MW Output due to droop characteristic)
SOR (% change in MW Output after 15s and sustained for 90s, based on expected MW Output due to droop characteristic)
If Frequency injection is achieved by injecting on top of System Frequency, a plot of System Frequency must also be provided
Average % difference between WFPS Controller MW Sepoint and MW Output, based on RC
The expected WFPS Controller MW Setpoint based on droop calculation and the actual WFPS Controller MW Setpoint
MW Output
MW Availability
Windspeed
WFPS Active Set Point
Simulated Frequency

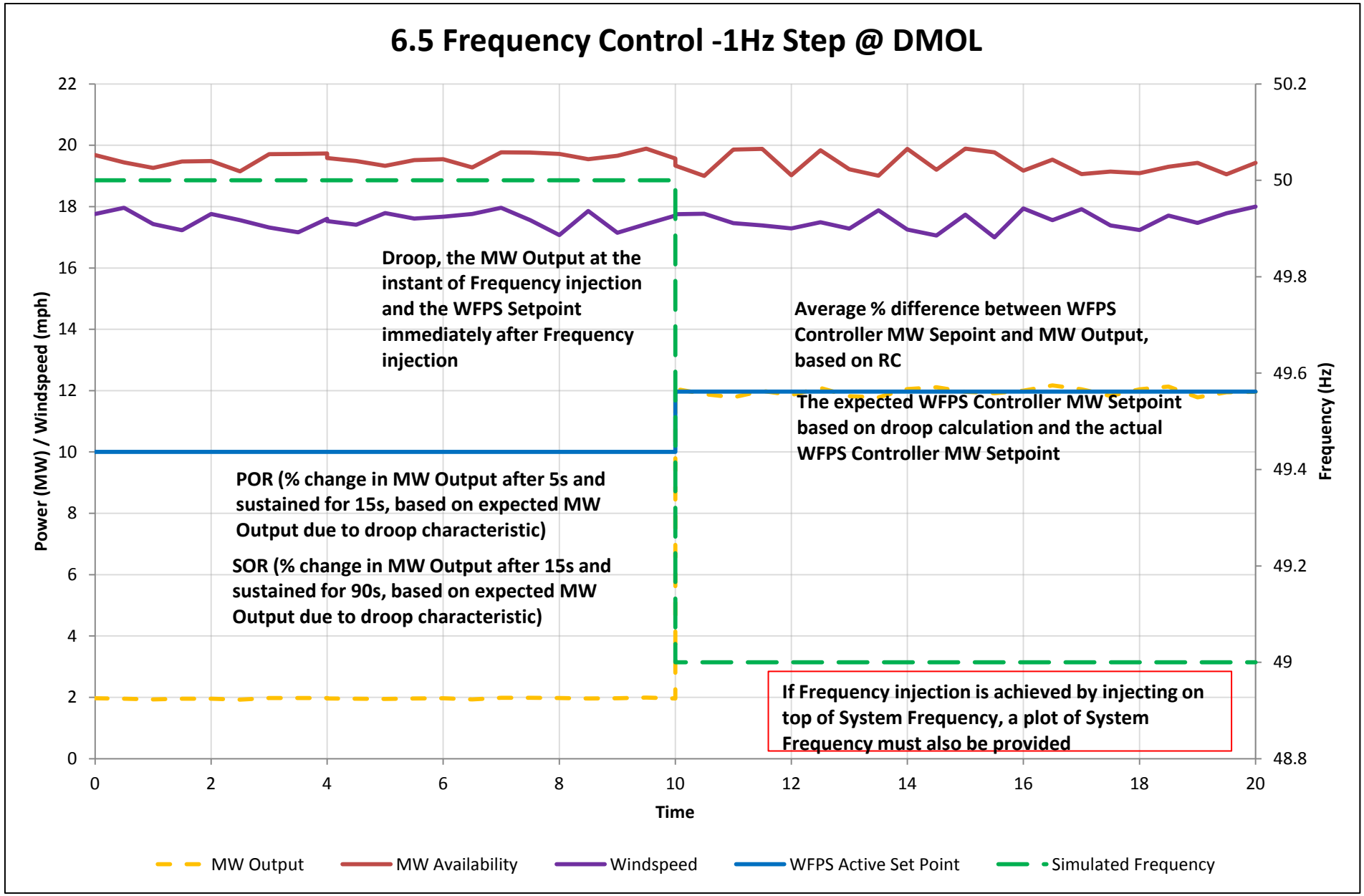

6.5 - Frequency Control -0.5Hz Step @ 50% MIO
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
Droop, the MW Output at the instant of Frequency injection and the WFPS Setpoint immediately after Frequency injection
Average % difference between WFPS Controller MW Sepoint and MW Output, based on RC
The expected WFPS Controller MW Setpoint based on droop calculation and the actual WFPS Controller MW Setpoint
POR (% change in MW Output after 5s and sustained for 15s, based on expected MW Output due to droop characteristic)
SOR (% change in MW Output after 15s and sustained for 90s, based on expected MW Output due to droop characteristic)
If Frequency injection is achieved by injecting on top of System Frequency, a plot of System Frequency must also be provided
MW Output
MW Availability
Windspeed
WFPS Active Set Point
Simulated Frequency

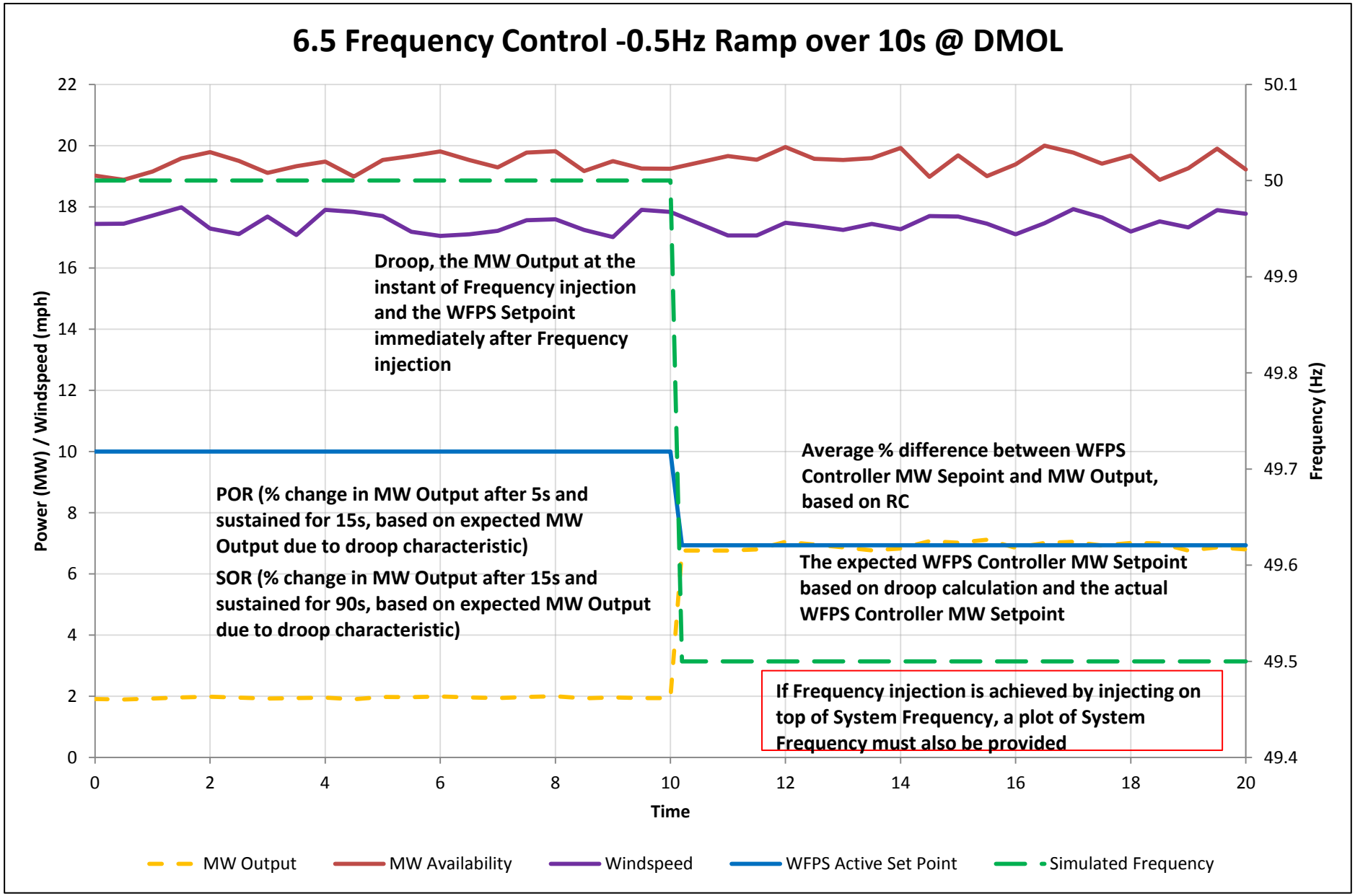

6.5 - Frequency Control -0.5Hz Step @ 50% MIO
Average % difference between WFPS Controller MW Sepoint and MW Output, based on RC
Droop, the MW Output at the instant of Frequency injection and the WFPS Setpoint immediately after Frequency injection
The expected WFPS Controller MW Setpoint based on droop calculation and the actual WFPS Controller MW Setpoint
POR (% change in MW Output after 5s and sustained for 15s, based on expected MW Output due to droop characteristic)
SOR (% change in MW Output after 15s and sustained for 90s, based on expected MW Output due to droop characteristic)
If Frequency injection is achieved by injecting on top of System Frequency, a plot of System Frequency must also be provided
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
MW Output
MW Availability
Windspeed
WFPS Active Set Point
Simulated Frequency

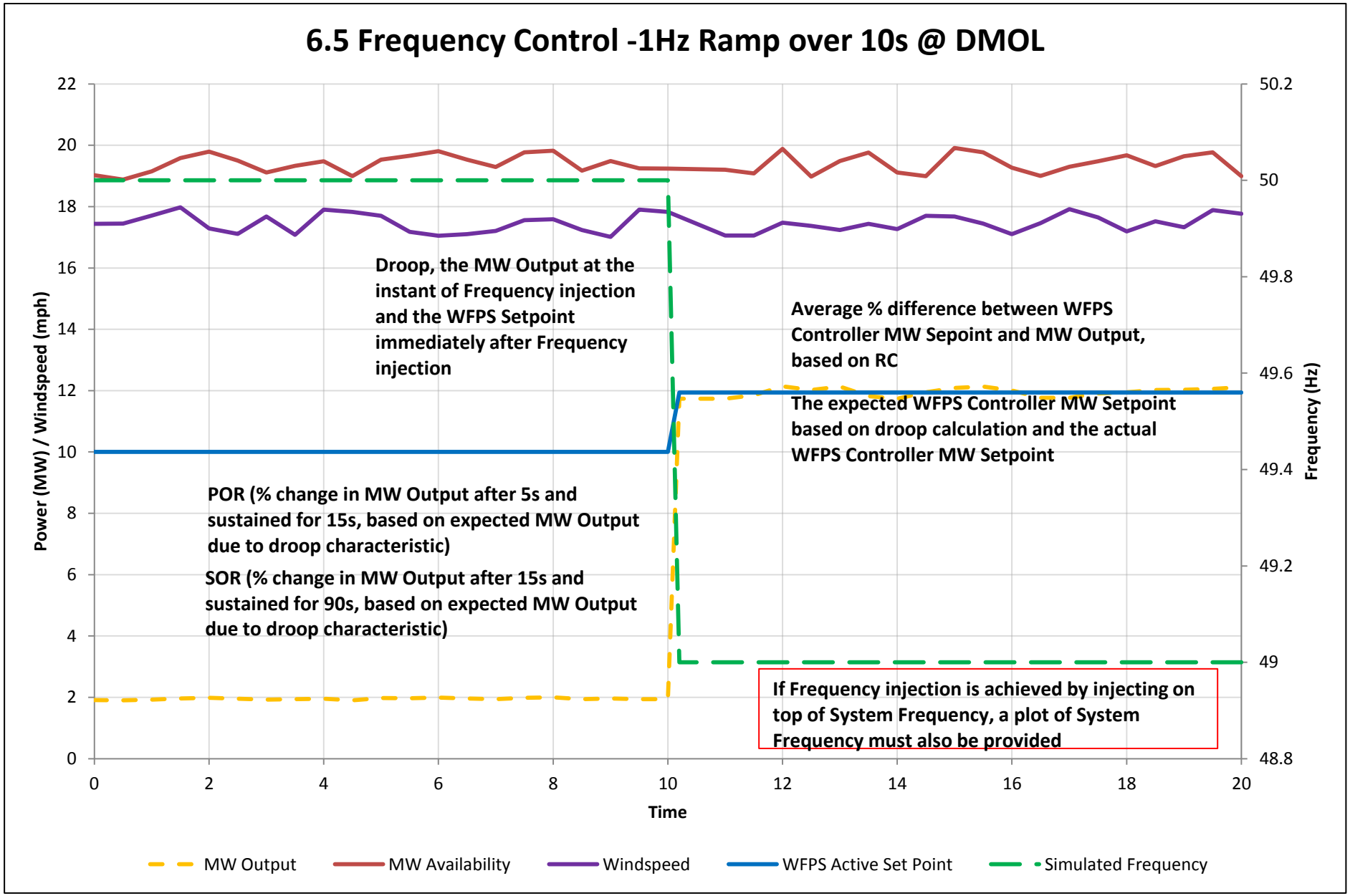

6.5 - Frequency Control -0.5Hz Ramp over 10s @ 50% MIO
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
50.1
50
49.9
49.8
49.7
49.6
49.5
49.4
0
2
4
6
8
10
12
14
16
18
20
Droop, the MW Output at the instant of Frequency injection and the WFPS Setpoint immediately after Frequency injection
Average % difference between WFPS Controller MW Sepoint and MW Output, based on RC
The expected WFPS Controller MW Setpoint based on droop calculation and the actual WFPS Controller MW Setpoint
POR (% change in MW Output after 5s and sustained for 15s, based on expected MW Output due to droop characteristic)
SOR (% change in MW Output after 15s and sustained for 90s, based on expected MW Output due to droop characteristic)
If Frequency injection is achieved by injecting on top of System Frequency, a plot of System Frequency must also be provided
MW Output
MW Availability
Windspeed
WFPS Active Set Point
Simulated Frequency

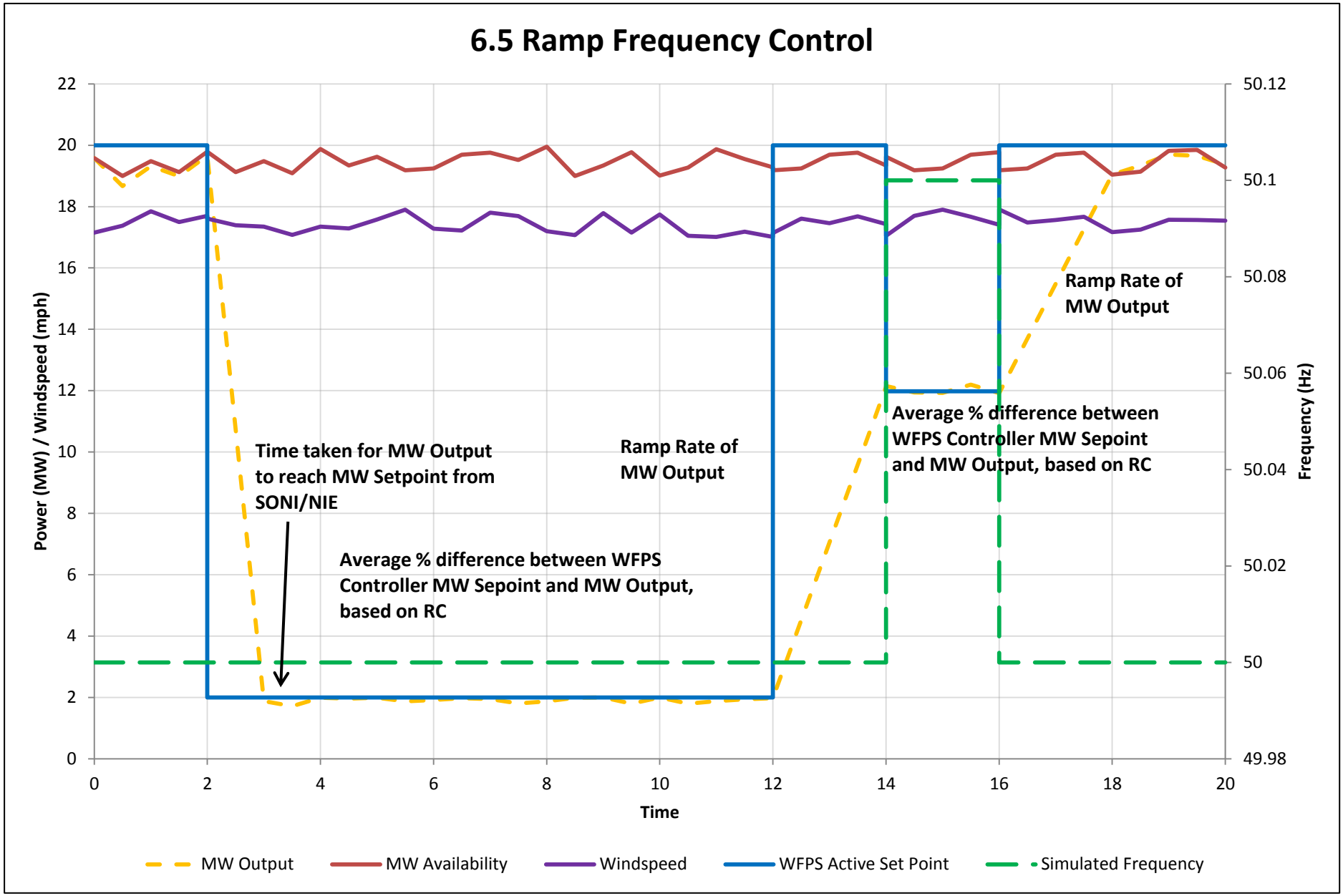

6.5 - Frequency Control -1Hz Ramp over 10s @ 50% MIO
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
Droop, the MW Output at the instant of Frequency injection and the WFPS Setpoint immediately after Frequency injection
Average % difference between WFPS Controller MW Sepoint and MW Output, based on RC
The expected WFPS Controller MW Setpoint based on droop calculation and the actual WFPS Controller MW Setpoint
POR (% change in MW Output after 5s and sustained for 15s, based on expected MW Output due to droop characteristic)
SOR (% change in MW Output after 15s and sustained for 90s, based on expected MW Output due to droop characteristic)
If Frequency injection is achieved by injecting on top of System Frequency, a plot of System Frequency must also be provided
MW Output
MW Availability
Windspeed
WFPS Active Set Point
Simulated Frequency

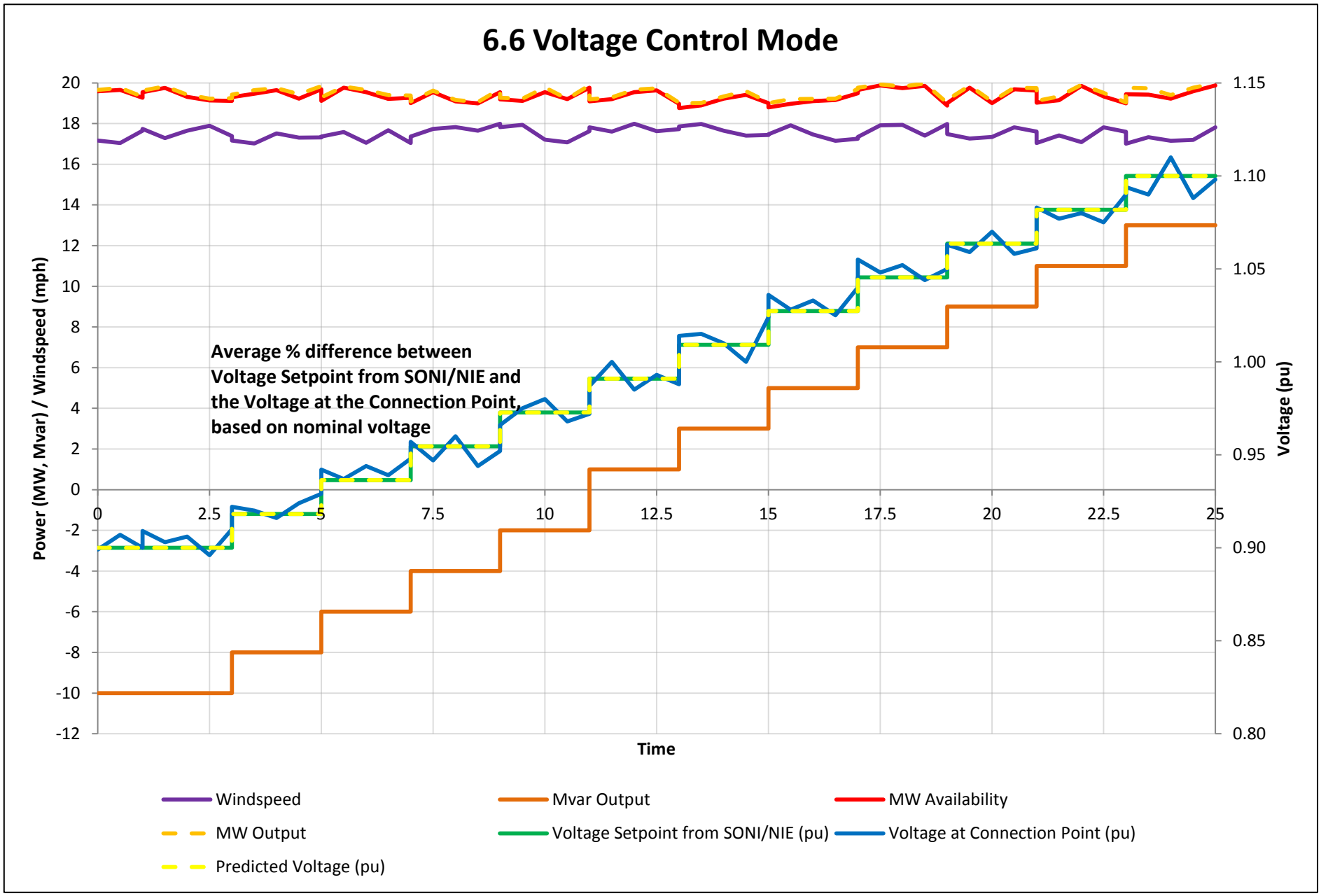

6.5 - Frequency Control -0.5Hz Step @ DMOL
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
Droop, the MW Output at the instant of Frequency injection and the WFPS Setpoint immediately after Frequency injection
POR (% change in MW Output after 5s and sustained for 15s, based on expected MW Output due to droop characteristic)
SOR (% change in MW Output after 15s and sustained for 90s, based on expected MW Output due to droop characteristic)
Average % difference between WFPS Controller MW Sepoint and MW Output, based on RC
The expected WFPS Controller MW Setpoint based on droop calculation and the actual WFPS Controller MW Setpoint
If Frequency injection is achieved by injecting on top of System Frequency, a plot of System Frequency must also be provided
MW Output
MW Availability
Windspeed
WFPS Active Set Point
Simulated Frequency


6.5 Frequency Control -1Hz Step @ DMOL
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
Droop, the MW Output at the instant of Frequency injection and the WFPS Setpoint immediately after Frequency injection
Average % difference between WFPS Controller MW Sepoint and MW Output, based on RC
The expected WFPS Controller MW Setpoint based on droop calculation and the actual WFPS Controller MW Setpoint
POR (% change in MW Output after 5s and sustained for 15s, based on expected MW Output due to droop characteristic)
SOR (% change in MW Output after 15s and sustained for 90s, based on expected MW Output due to droop characteristic)
If Frequency injection is achieved by injecting on top of System Frequency, a plot of System Frequency must also be provided
MW Output
MW Availability
Windspeed
WFPS Active Set Point
Simulated Frequency

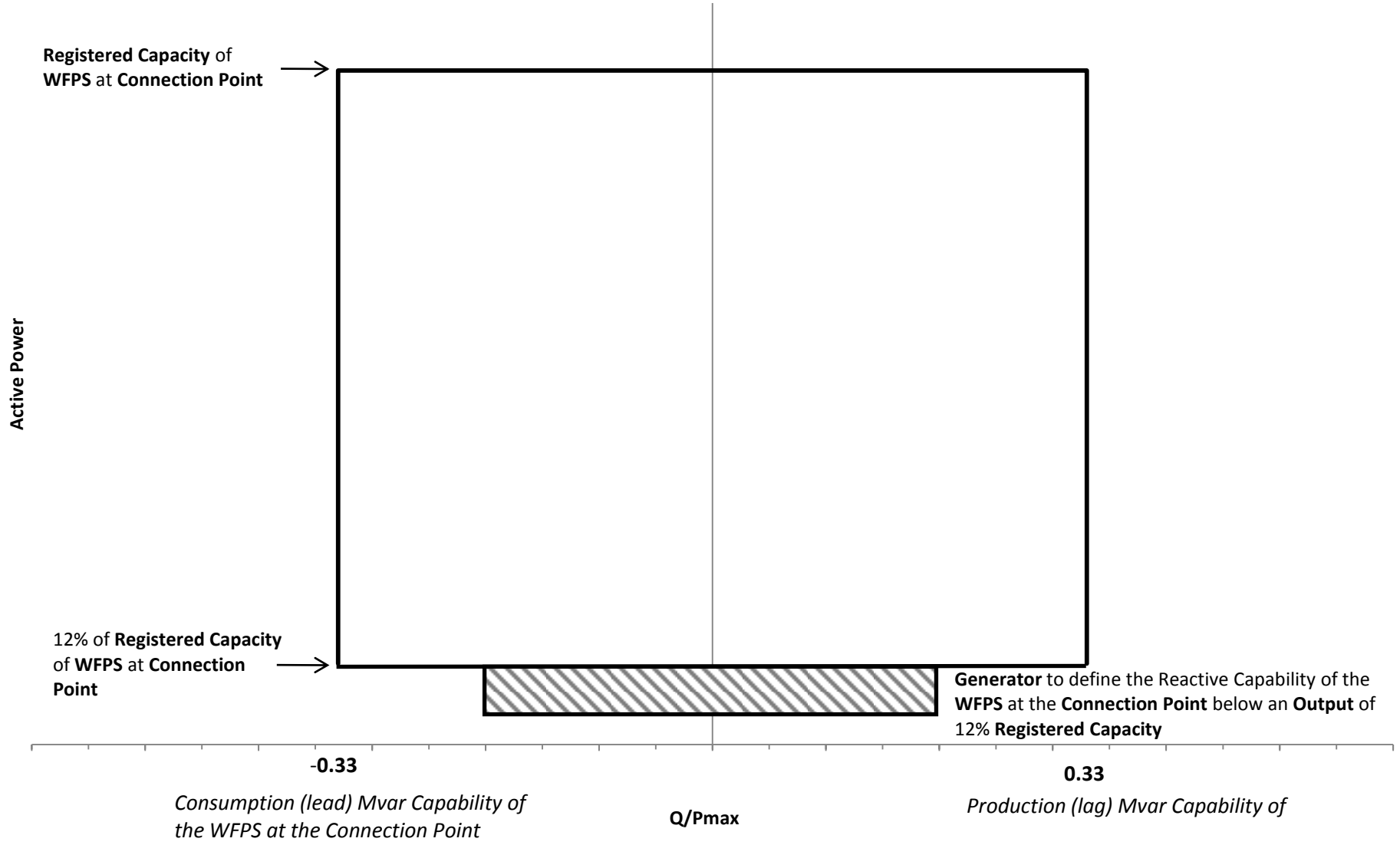

6.5 Frequency Control -0.5Hz Ramp over 10s @ DMOL
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
Droop, the MW Output at the instant of Frequency injection and the WFPS Setpoint immediately after Frequency injection
POR (% change in MW Output after 5s and sustained for 15s, based on expected MW Output due to droop characteristic)
SOR (% change in MW Output after 15s and sustained for 90s, based on expected MW Output due to droop characteristic)
Average % difference between WFPS Controller MW Sepoint and MW Output, based on RC
The expected WFPS Controller MW Setpoint based on droop calculation and the actual WFPS Controller MW Setpoint
If Frequency injection is achieved by injecting on top of System Frequency, a plot of System Frequency must also be provided
MW Output
MW Availability
Windspeed
WFPS Active Set Point
Simulated Frequency

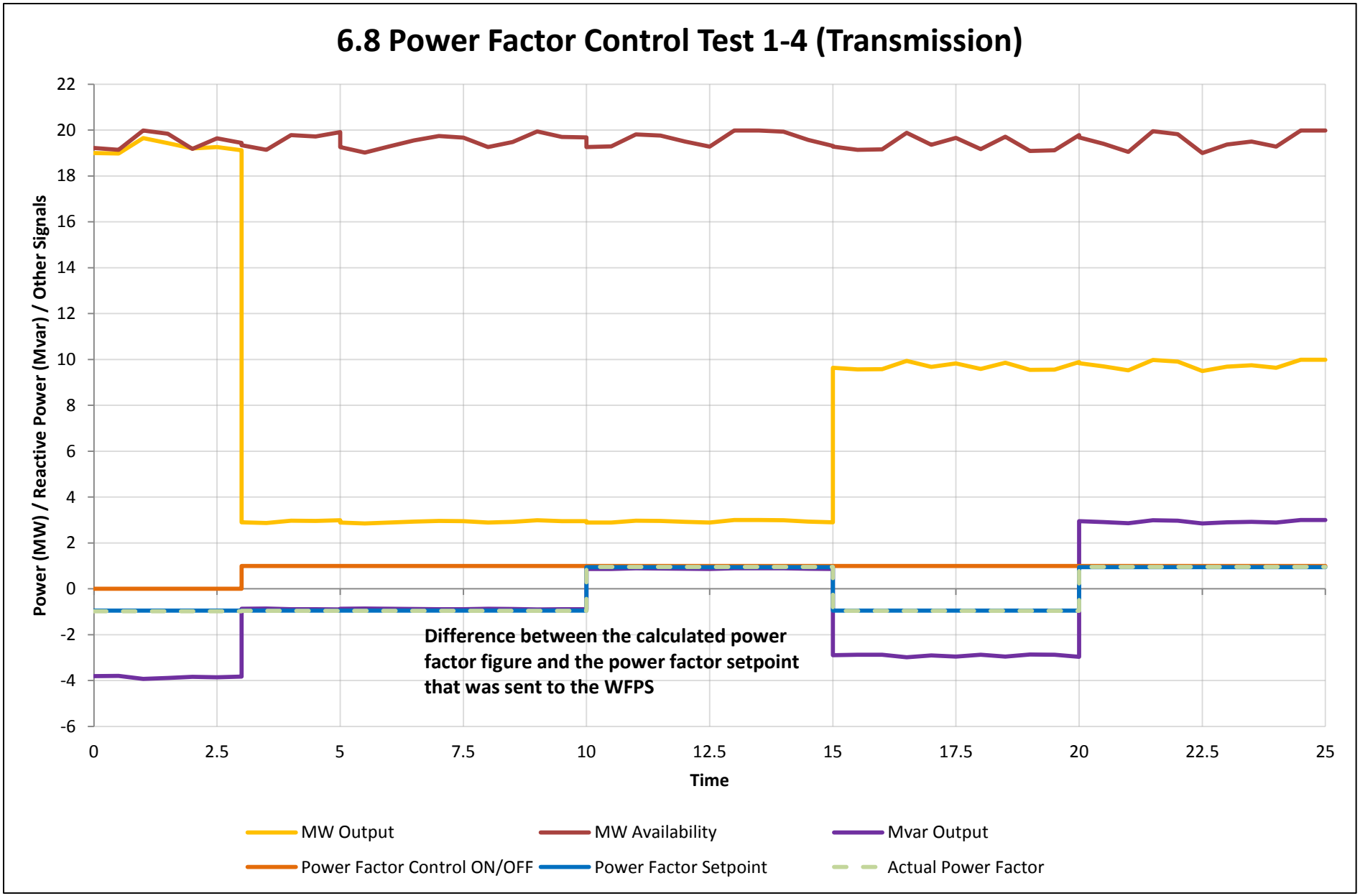

6.5 Frequency Control -1Hz Ramp over 10s @ DMOL
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
Droop, the MW Output at the instant of Frequency injection and the WFPS Setpoint immediately after Frequency injection
Average % difference between WFPS Controller MW Sepoint and MW Output, based on RC
The expected WFPS Controller MW Setpoint based on droop calculation and the actual WFPS Controller MW Setpoint
POR (% change in MW Output after 5s and sustained for 15s, based on expected MW Output due to droop characteristic)
SOR (% change in MW Output after 15s and sustained for 90s, based on expected MW Output due to droop characteristic)
If Frequency injection is achieved by injecting on top of System Frequency, a plot of System Frequency must also be provided
MW Output
MW Availability
Windspeed
WFPS Active Set Point
Simulated Frequency

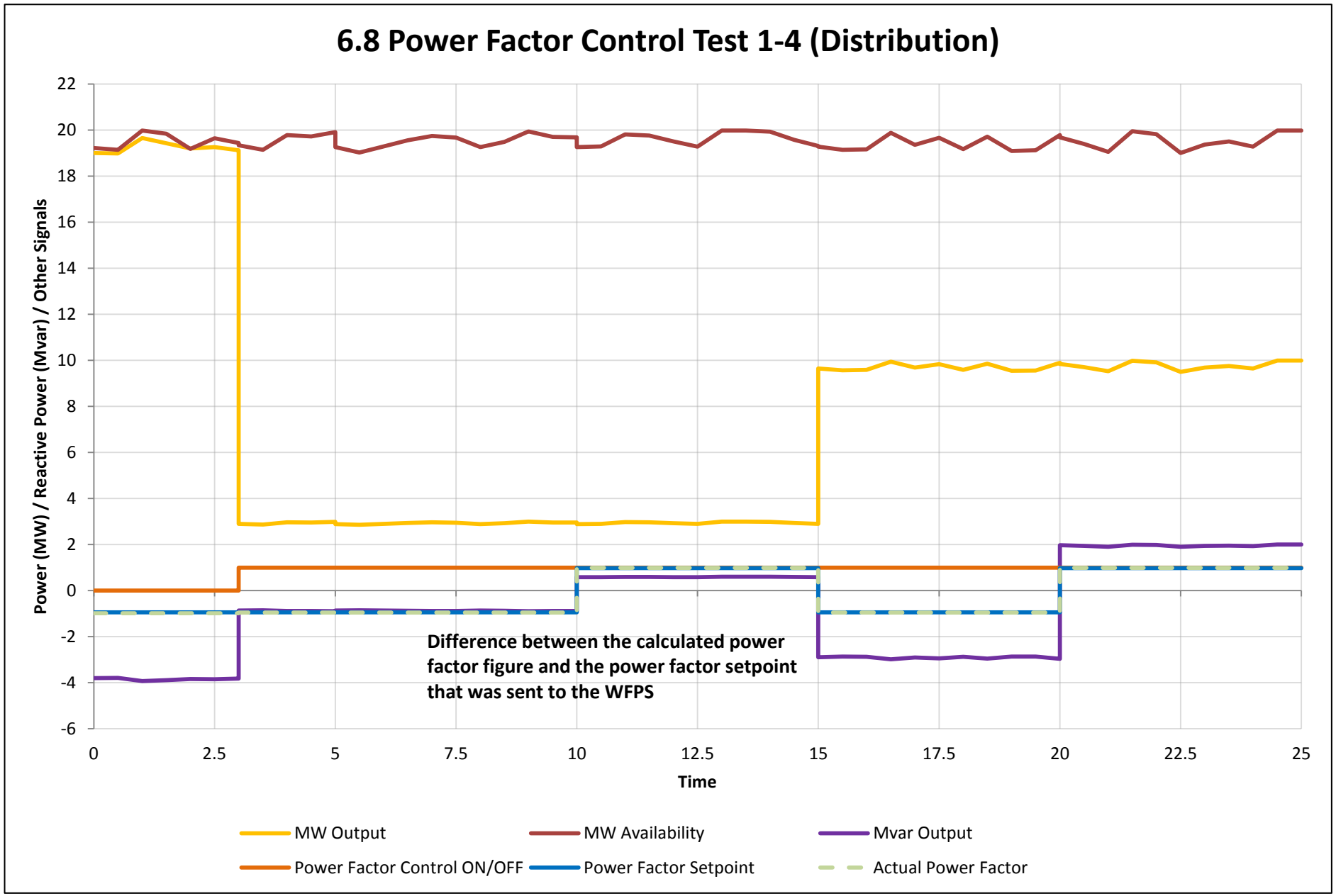

6.5 Ramp Frequency Control
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
Time taken for MW Output to reach MW Setpoint from SONI/NIE
Ramp Rate of MW Output
Average % difference between WFPS Controller MW Sepoint and MW Output, based on RC
Ramp Rate of MW Output
Average % difference between WFPS Controller MW Sepoint and MW Output, based on RC
MW Output
MW Availability
Windspeed
WFPS Active Set Point
Simulated Frequency

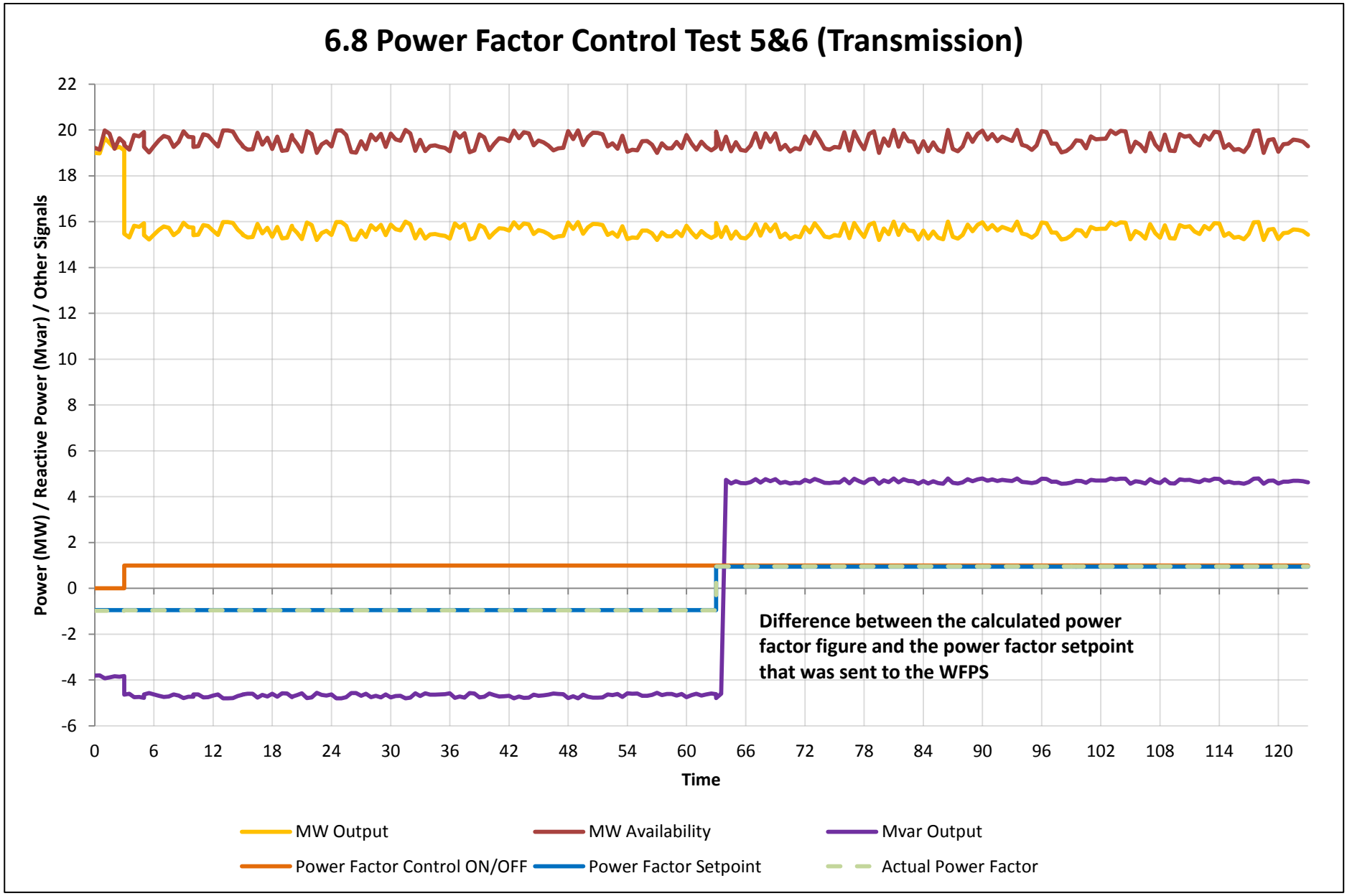

6.6 Voltage Control Mode
Average % difference between Voltage Setpoint from SONI/NIE and the Voltage at the Connection Point, based on nominal voltage
Power (MW, Mvar) / Windspeed (mph)
Voltage (pu)
Time
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
25
Windspeed
Mvar Output
MW Availability
MW Output
Voltage Setpoint from SONI/NIE (pu)
Voltage at Connection Point (pu)
Predicted Voltage (pu)

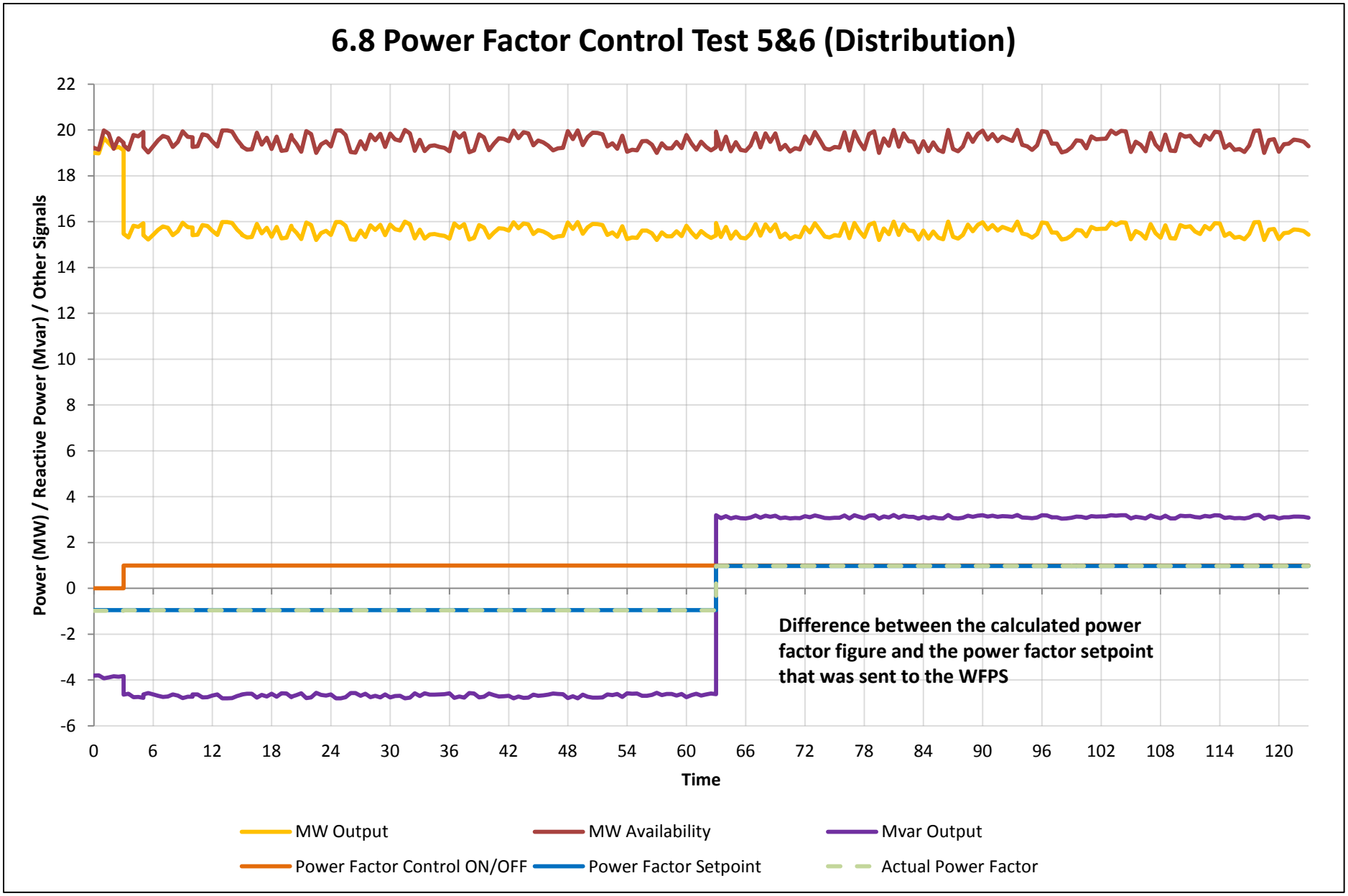
# 6.6 Reactive Capability

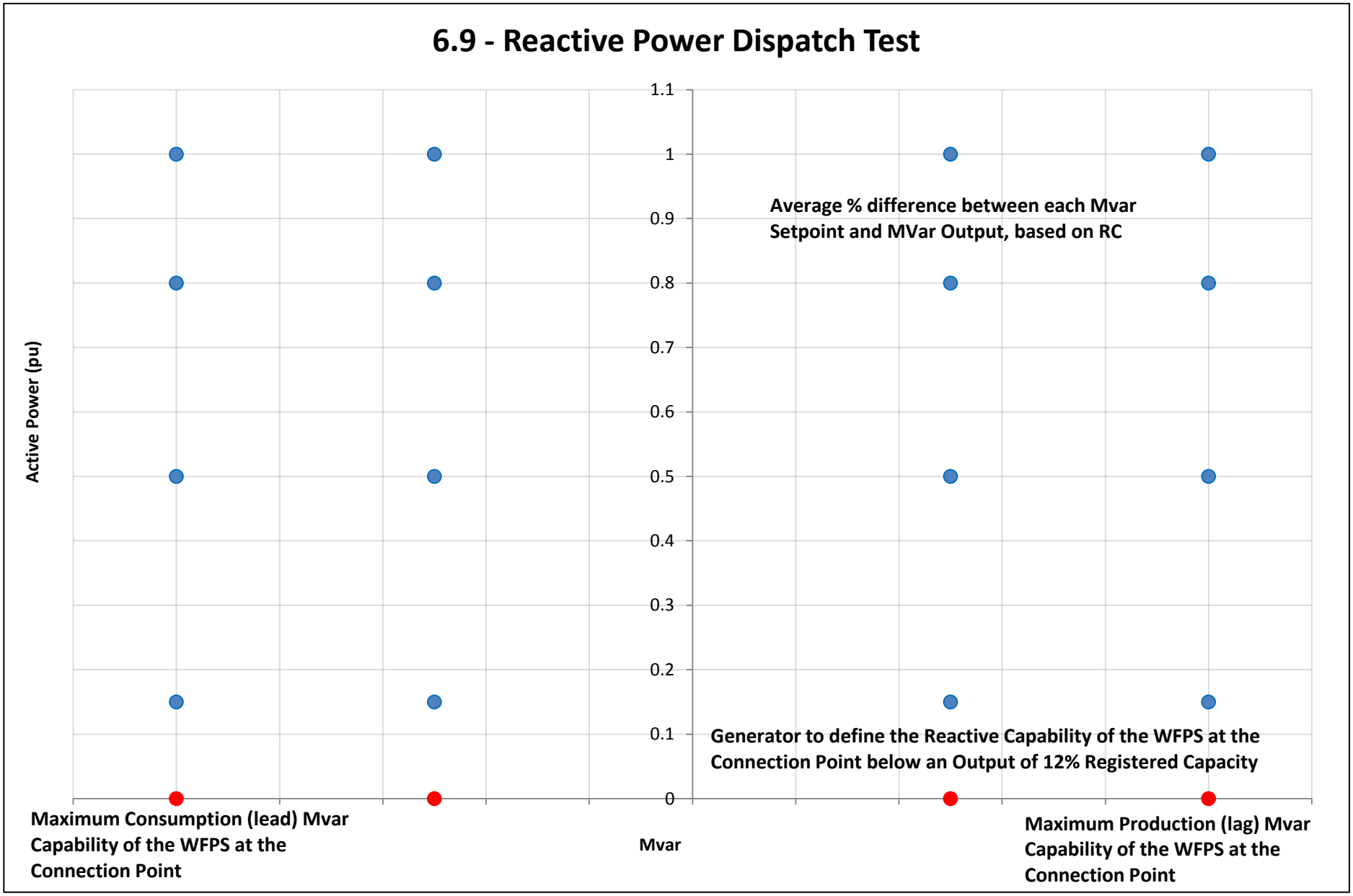


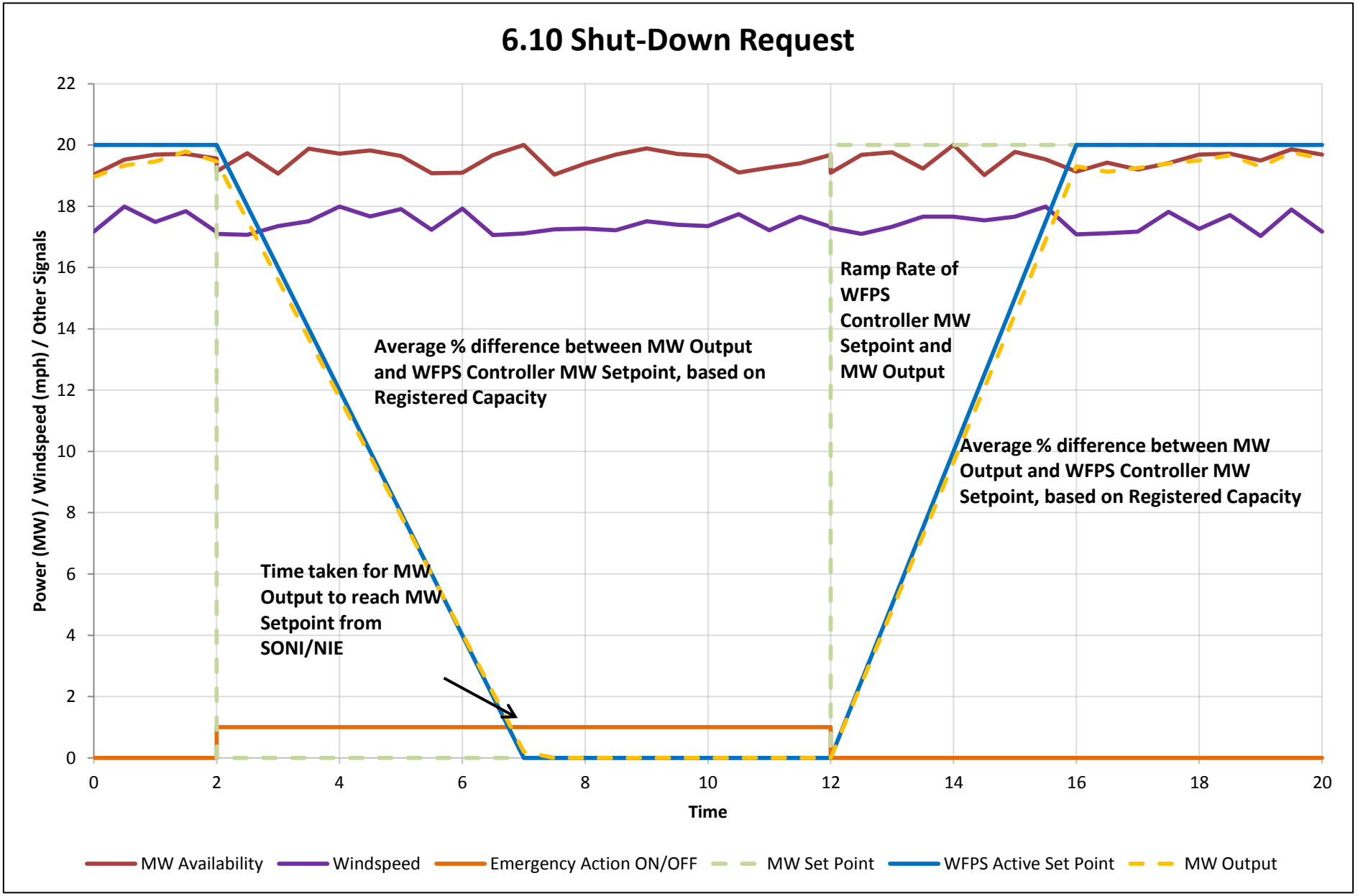

6.8 Power Factor Control Test 1-4 (Transmission)
Power (MW) / Reactive Power (Mvar) / Other Signals
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
25
Time
Difference between the calculated power factor figure and the power factor setpoint that was sent to the WFPS
MW Output
MW Availability
Mvar Output
Power Factor Control ON/OFF
Power Factor Setpoint
Actual Power Factor

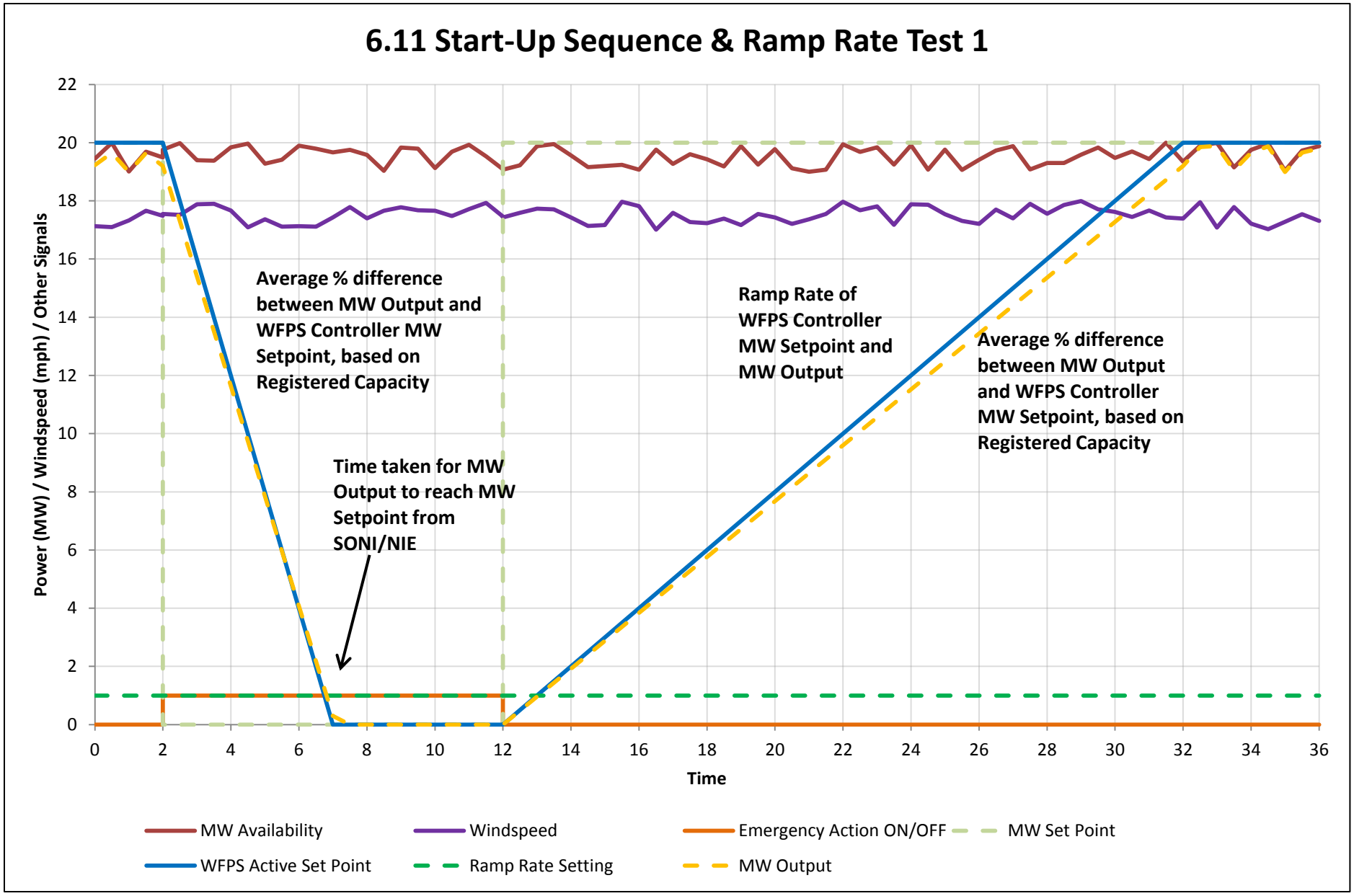

6.8 Power Factor Control Test 1-4 (Distribution)
Power (MW) / Reactive Power (Mvar) / Other Signals
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
25
Time
Difference between the calculated power factor figure and the power factor setpoint that was sent to the WFPS
MW Output
MW Availability
Mvar Output
Power Factor Control ON/OFF
Power Factor Setpoint
Actual Power Factor

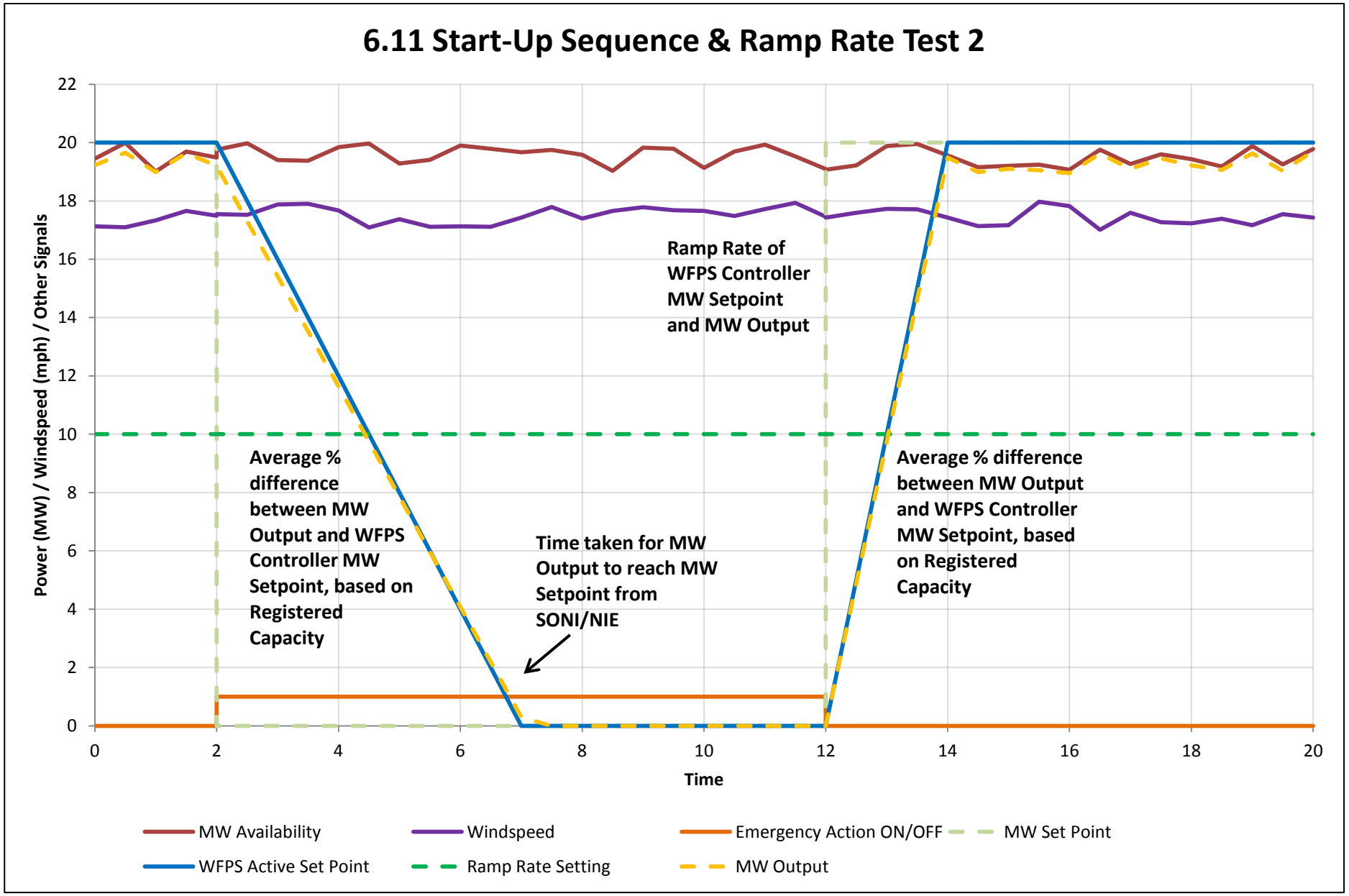

6.8 Power Factor Control Test 5&6 (Transmission)
Power (MW) / Reactive Power (Mvar) / Other Signals
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
0
6
12
18
24
30
36
42
48
54
60
66
72
78
84
90
96
102
108
114
120
Time
Difference between the calculated power factor figure and the power factor setpoint that was sent to the WFPS
MW Output
MW Availability
Mvar Output
Power Factor Control ON/OFF
Power Factor Setpoint
Actual Power Factor


6.8 Power Factor Control Test 5&6 (Distribution)
Power (MW) / Reactive Power (Mvar) / Other Signals
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
0
6
12
18
24
30
36
42
48
54
60
66
72
78
84
90
96
102
108
114
120
Time
Difference between the calculated power factor figure and the power factor setpoint that was sent to the WFPS
MW Output
MW Availability
Mvar Output
Power Factor Control ON/OFF
Power Factor Setpoint
Actual Power Factor


6.9 - Reactive Power Dispatch Test
Active Power (pu)
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Average % difference between each Mvar Setpoint and MVar Output, based on RC
Generator to define the Reactive Capability of the WFPS at the Connection Point below an Output of 12% Registered Capacity
Maximum Consumption (lead) Mvar Capability of the WFPS at the Connection Point
Mvar
Maximum Production (lag) Mvar Capability of the WFPS at the Connection Point


6.10 Shut-Down Request
Power (MW) / Windspeed (mph) / Other Signals
Time
Average % difference between MW Output and WFPS Controller MW Setpoint, based on Registered Capacity
Ramp Rate of WFPS Controller MW Setpoint and MW Output
Average % difference between MW Output and WFPS Controller MW Setpoint, based on Registered Capacity
Time taken for MW Output to reach MW Setpoint from SONI/NIE
MW Availability
Windspeed
Emergency Action ON/OFF
MW Set Point
WFPS Active Set Point
MW Output


6.11 Start-Up Sequence & Ramp Rate Test 1
Power (MW) / Windspeed (mph) / Other Signals
Time
Average % difference between MW Output and WFPS Controller MW Setpoint, based on Registered Capacity
Time taken for MW Output to reach MW Setpoint from SONI/NIE
Ramp Rate of WFPS Controller MW Setpoint and MW Output
Average % difference between MW Output and WFPS Controller MW Setpoint, based on Registered Capacity
MW Availability
Windspeed
Emergency Action ON/OFF
MW Set Point
WFPS Active Set Point
Ramp Rate Setting
MW Output


6.11 Start-Up Sequence & Ramp Rate Test 2
Power (MW) / Windspeed (mph) / Other Signals
Time
Ramp Rate of WFPS Controller MW Setpoint and MW Output
Average % difference between MW Output and WFPS Controller MW Setpoint, based on Registered Capacity
Time taken for MW Output to reach MW Setpoint from SONI/NIE
Average % difference between MW Output and WFPS Controller MW Setpoint, based on Registered Capacity
MW Availability
Windspeed
Emergency Action ON/OFF
MW Set Point
WFPS Active Set Point
Ramp Rate Setting
MW Output

## Appendix F Contact Names & Addresses

For contact details relating to this document please contact:

Conor O'Doherty – Grid Operations Planning Engineer.
Tel: 02890707513
Email: conor.o'doherty@soni.ltd.uk

Sam Alexander – NIE Operations
Tel: 028 38368727
Email: Sam.Alexander@nie.co.uk