Power Park Module Setting Schedule

DOCUMENT HISTORY

Issue 1: **Power Park Module Setting Schedule** March 2019

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Foreword

This **Power Park Module Setting Schedule** sets out certain technical criteria that **Generator**s must comply with in respect of their **Power Park Modules** in accordance with CC.7.2 of the **Grid Code** and this **Power Park Module Setting Schedule** is deemed to form part of the **Grid Code** and **Distribution Code**.

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

This Foreword is provided to **Generator**s and to prospective **Generator**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**.

NIE Networks Ltd

Northern Ireland Electricity Networks (NIE Networks) 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 Networks' 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 Networks 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 terms within this document are in bold.

The source of the definition is indicated. Where there is any conflict between the definition shown here and the definition in the source document (i.e. the **Grid Code**) the definition in the source document will prevail.

Term	Definition
Active Power (or MW)	As per **Grid Code** or **Distribution Code** as applicable. Also defined in EREC G99/NI
Active Power Control Set-Point Ramp Rate	As per **Grid Code** or **Distribution Code** as applicable
Available Active Power	The amount of **Active Power** that the **Controllable PPM** could produce based on current resource conditions. The **Available Active Power** shall only differ from the actual **Active Power** if the **Controllable PPM** has been curtailed, constrained or is operating in a restrictive **Frequency Response** mode.
Commissioning / Acceptance Test Panel	The panel made up of representatives from SONI and NIE Networks 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 **PPM**.
Compliance	**Compliance** with the **Grid Code** and/or the **Distribution Code** as applicable
Connection Agreement	As per **Grid Code** or **Distribution Code** as applicable. Also defined in EREC G99/NI
Connection Point	As per **Grid Code** or **Distribution Code** as applicable. Also defined in EREC G99/NI
Controllable Power Park Module	As per **Grid Code** or **Distribution Code** as applicable
Designed Minimum Operating Level (DMOL)	The **Output** below which a **Power Park Module** cannot operate without shutting down **Generating Units**.
Distribution Code	As per **Grid Code** or **Distribution Code** as applicable. Also defined in EREC G99/NI
Distribution Network Owner (DNO)	As per **Grid Code** or **Distribution Code** as applicable. Also defined in EREC G99/NI
Distribution System	As per **Grid Code** or **Distribution Code** as applicable. Also defined in EREC G99/NI
Energisation Operational Notification (EON)	A notification issued by the **DNO** to a **Generator** prior to energisation of its internal network. Also defined in EREC G99/NI
Energy Storage Generator	As per **Grid Code** or **Distribution Code** as applicable
Energy Storage Power Station (or **ESPS**)	As per **Grid Code** or **Distribution Code** as applicable
Final Operational Notification (FON)	The **Final Operational Notification** as may be issued by SONI in accordance with CC15.2.3 (for a **Transmission System** connected **Power Park Module**) or CC16.2.3 (for a distribution-**System** connected **Power Park Module**). Also defined in EREC G99/NI
Frequency	As per **Grid Code** or **Distribution Code** as applicable

Frequency Control	As per **Grid Code** or **Distribution Code** as applicable
Frequency Sensitive Mode (FSM)	As per **Grid Code** or **Distribution Code** as applicable. Also defined in EREC G99/NI
Generating Unit	As per **Grid Code** or **Distribution Code** as applicable. Also defined in EREC G99/NI
Generator	As per **Grid Code** or **Distribution Code** as applicable. Also defined in EREC G99/NI
Generator Performance Chart	As per **Grid Code** or **Distribution Code** as applicable. Also defined in EREC G99/NI
Grid Code	As per **Grid Code** or **Distribution Code** as applicable. Also defined in EREC G99/NI
Interim Operational Notification (ION)	**Interim Operational Notification** as may be issued by SONI in accordance with CC15.2.2 (for a **Transmission System** connected **PPM**) or CC16.2.2 (for a distribution-**System** connected **PPM**). Also defined in EREC G99/NI
Limited Frequency Sensitive Mode – Over frequency (LFSM-O)	As per **Grid Code** or **Distribution Code** as applicable
Limited Frequency Sensitive Mode – Under frequency (LFSM-U)	As per **Grid Code** or **Distribution Code** as applicable
Limited Operational Notification (LON)	If a non-**Compliance** arises at any point from synchronisation throughout the full operational life of the **Power Park Module**, SONI/NIE Networks may issue the **Generator** with a **Limited Operational Notification**, which will detail the level of non-**Compliance** of the **Power Park Module**, the time frame to rectify the non-**Compliance** and the MVA restriction to which the **Power Park Module** will be capped until the non-**Compliance** is resolved. Also defined in EREC G99/NI
Maximum Export Capacity	As per **Grid Code** or **Distribution Code** as applicable
Maximum Import Capacity	As per **Grid Code** or **Distribution Code** as applicable
Maximum Instantaneous Output (MIO)	The **MW** figure a **Power Park Module** is capable of generating at any instant if there is no SONI action present.
Minimum Stable Operating Level	The minimum **Active Power** output which a **PPM** can reasonably generate as registered with the **DNO or the TSO**. Also defined in EREC G99/NI
MW Availability	The amount of **Active Power** that the **Controllable PPM** could produce based on current generation resource conditions, network conditions and **System** conditions.
Operating Range	The **Active Power** range over which an **ESPS** can operate, in **MW**, taking into account **MIC**, **MEC**, **User's Plant** and **Registered Capacity**.
Operational Readiness Confirmation	Issued by SONI to the **Generator** when a **Power Park Module** passes the SONI **MW Availability** standard and successfully completes the operational readiness dispatch test.
Output	As per **Grid Code** or **Distribution Code** as applicable
Power Generating Facility (PGF)	A facility that converts primary energy into electrical energy and which consists of one or more **PPMs** connected to a **System** at one or more **Connection Points**. Also defined in EREC G99/NI. Also defined in the **Grid Code** (Power Station)
Power Park Module (PPM)	As per **Grid Code** or **Distribution Code** as applicable. Also defined in EREC G99/NI
Reactive Power (MVAr)	As per **Grid Code** or **Distribution Code** as applicable
Registered Capacity	As per **Grid Code** or **Distribution Code** as applicable. Also defined in EREC G99/NI
Resource Following Ramp Rate	The maximum rate of increase of **Active Power Output** of a

	PPM upon removal of any **TSO** actions via SCADA which limits **Active Power Output** of the **PPM**, as specified by the **TSO** from time to time in the **PPM Setting Schedule** (or such other place or by such other means as may be notified to the **Generator** from time to time.
Setting Schedule	A document that sets out certain technical criteria and **Compliance** requirements that the **Generator** must comply with.
System	As per **Grid Code** or **Distribution Code** as applicable
Transmission System	As per **Grid Code** or **Distribution Code** as applicable. Also defined in EREC G99/NI
Transmission System Operator (TSO)	As per **Grid Code** or **Distribution Code** as applicable. Also defined in EREC G99/NI.
Type C	A **PPM** with a **Connection Point** below 110 kV and a **Registered Capacity** of 5 **MW** or greater but less than 10 **MW**. Also defined in EREC G99/NI.
Type D	A **PPM** with a **Connection Point** at, or greater than, 110 kV and/or with a **Registered Capacity** of 10 **MW** or greater. Also defined in EREC G99/NI.
User Data Library (UDL)	A common directory structure for information in support of **Compliance** statements and technical data. The structure of **UDL** is given in Appendix A of this document.
Voltage Control	As per **Grid Code** or **Distribution Code** as applicable

Acronyms

AAP	**Available Active Power**
CC	Connection Conditions (**Grid Code**)
CHCC	Castlereagh House Control Centre
DCC	Distribution Control Centre
DLR	Dynamic Line Rating
DNO	**Distribution Network Operator**
DMOL	**Designed Minimum Operating Level**
DRC	Data Registration Code (**Grid Code**)
FRT	Fault Ride Through
FSM	**Frequency Sensitive Mode**
GCCA	Grid Code Compliance Agreement
HV	High Voltage
~~SEM~~	~~Single Electricity Market~~
~~SEMO~~	~~Integrated Single Electricity Market Operator~~

LV	Low Voltage
MEC	**Maximum Export Capacity**
MIC	**Maximum Import Capacity**
MIO	**Maximum Instantaneous Output**
NIE Networks	Northern Ireland Electricity Networks
NRMSD	Normalised Root Mean Square Deviation
OHL	Over Head Line
ORC	**Operational Readiness Confirmation**
PF	Power Factor
PGF	**Power Generating Facility**
PPM	**Power Park Module**
pu	per unit
SEM	Single Electricity Market
SEMO	Integrated Single Electricity Market Operator
SONI	**System** Operator of Northern Ireland
T&D	Transmission and Distribution
TDLR	Temperature Dependent Dynamic Line Rating
TUOS	Transmission Use of **System**
TUOSA	Transmission Use of **System** Agreement
UDL	**User Data Library**
VPT	Variable Price Taker

2.0 INTRODUCTION

2.1 ALL POWER PARK MODULES *EXCEPT* ENERGY STORAGE POWER STATIONS (ESPS)

This **Power Park Module Setting Schedule** comes into effect on 27 April 2019 for **Type C** and **Type D Power Park Modules** first installed on or after that date. This **Power Park Module Setting 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], the **Distribution Code** (CC1.1, CC1.2, CC1.3, CC11.1, CC11.2) and EREC G99/NI which are available on the NIE Networks website. This **Power Park Module Setting 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 **Power Generating Facilities** containing **Type C** and **Type D Power Park Modules** clarity with regard to the **Compliance** requirements of the Codes, where certain aspects of the Codes are not detailed.

This **Setting Schedule** contains specific **Compliance** requirements for **Type C** and **Type D Power Park Modules** and explains a process to manage crucial interactions and data exchange. The process involves plant testing and reporting to demonstrate **Compliance** with the SONI **Grid Code** and the NIE Networks **Distribution Code** and the Commission Regulation (EU) 2016/631, Network Code Requirements for all Generators. Where the **Connection Agreement** specifically requires additional conditions or tests, a schedule shall be agreed between the parties. The technical requirements, general compliance and commissioning requirements for **Type C** and **Type D Power Park Modules** connecting to the **Distribution System** are given in EREC G99/NI.

It is intended to inform the **Generator** of the necessary process and reference should be made to the **Grid Code**, **Distribution Code**, EREC G99/NI, the **Connection Agreement** and the **Connection Agreement** application process for a complete set of provisions relating to connection of generation.

Type C and **Type D Power Park Modules** connecting to the NIE Networks **Distribution System** are required to comply with the NIE Networks **Distribution Code**. **Power Park Modules** with a capacity greater than 5 **MW** will 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 Networks at an early stage of the project, prior to signing a contract with **Generating Unit** manufacturers. SONI and NIE Networks will provide guidance on technical issues and plant performance requirements.

SONI and NIE Networks' role will be to facilitate the compliance for the **Power Park Module**. SONI and NIE Networks' licence obligation is to ensure that the connection of **Power Park Module** does not conflict with its responsibilities mentioned in the foreword of this document.

2.2 ALL ESPS POWER PARK MODULES

[1] System Operators Northern Ireland (SONI) Website

This **Power Park Module Setting Schedule** has been updated to integrate the Battery **ESPS** Compliance Procedures and Battery **ESPS** Signal List, which were both documents previously available on the SONI **Grid Code** website. This most recent update is part of the **Grid Code** amendment to integrate the Battery Implementation Note into the **Grid Code** and came into effect on dd mmm yyyy..

It is important to note that currently all storage devices except for pump-storage are explicitly excluded from the EU Network Code Requirements for Generators (RfG) (Commission Regulation (EU) 2016 / 631), therefore the changes to the **Grid Code** from 2019 including a major part of this **Power Park Module Setting Schedule** do not apply to storage devices. To inform the **Energy Storage Generator** of the necessary compliance process and to keep a clear partition between RfG and non RfG, a separate Section 7 (**ESPS** Compliance Test procedures) and new Appendix E (**ESPS** Signal List) have been added confirming the requirements.

*The decision to update the PPM Setting Schedule with non RfG battery storage was taken as the existing non RfG WFPS Setting Schedule has not been updated since 2015 and is no longer applicable to new connections. In addition, storage devices will be included in the next update to the RfG in the near future and at that time, SONI expect to bring forward further **Grid Code** amendments to this document.*

2.3 SINGLE ELECTRICITY MARKET (SEM) ARRANGEMENTS

A **Power Park Module** 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 **Power Park Module** 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].

Upon synchronisation of a **Power Park Module**, a **Power Park Module** 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 **Power Park Module**. Upon receipt of this, a **Power Park Module** 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 **Power Park Module** 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 **Power Park Module** proposed development and the effect it may have on the NI T&D **System**.

The cost (which is included in the Connection Offer) of such studies shall be charged to the prospective **Generator**, who shall be liable to meet the costs in full whether or not

[2] www.sem-o.com

the **Generator** proceeds with any or all of the project(s) under investigation.

Initial studies may only be indicative until the **Generator** 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 **Generator** and shall be met in full by the **Generator**. The costs may reflect the **TSO**/**DNO** work or work carried out by external consultants.

Costs that are attributable to the **Power Park Module** shall be met by the **Generator** as per SONI's or NIE Networks' 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 **Power Park Module**, which may be connected to the T&D **System**. The **Connection Agreement** will show the configuration of the **Power Park Module** and NIE Networks equipment and will identify the point(s) of connection. SONI will offer **Connection Agreements** for all Transmission connected **Power Park Modules**. NIE will offer **Connection Agreements** for all Distribution connected **Power Park Module**. The entry into a **Connection Agreement** is part of the requirements on a **Power Park Module** of accepting a Connection Offer from SONI or NIE Networks.

4.2 TRANSMISSION USE OF SYSTEM AGREEMENT (TUoSA)

Under the terms of the Trading and Settlement Code, a TUoSA is required by all **Power Generating Facilities** in order to participate in the SEM. If the **Power Generating Facility** is greater than 5 **MW** it is required to pay TUoS. A **Power Generating Facility** 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 **Power Generating Facility** and SONI. Among other things it places obligations on the **Power Generating Facility** to comply with the entire **Grid Code**. The **Grid Code** Connection Conditions outline SONI's requirement for interfacing with the **Power Generating Facility** and this **Power Park Module Setting Schedule** outlines SONI's/NIE Networks' requirement for interfacing with the **Power Park Module**. This **Power Park Module Setting Schedule** details the full range of tests that are required to assess **Compliance** with the Connection Conditions; it also outlines SONI/NIE Networks' requirements on certain aspects of a **Power Park Modules** performance.

4.3 GRID CODE COMPLIANCE AGREEMENT (GCCA)

A **Power Generating Facility** with a **Registered Capacity** between 5-10 **MW** will be

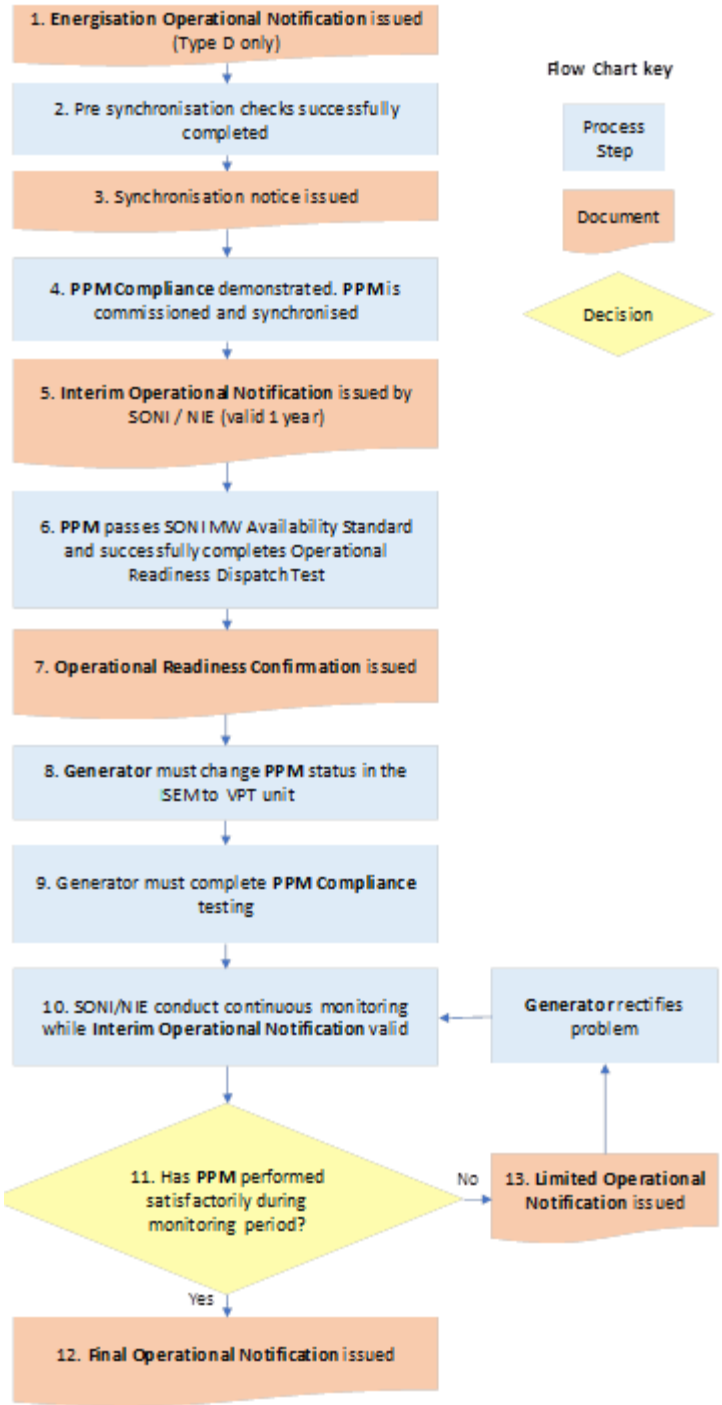
required pursuant to its **Connection Agreement** with the **DNO** to enter into a GCCA if the **Power Generating Facility** is not a SEM participant.

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

5.0 COMPLIANCE PROCEDURES

The flow chart in Figure 1 below explains the connection/**Compliance** processes that will be involved from pre-synchronisation to the issuing of a Final Operational Notification in accordance with CC15.2.3 and CC16.2.3 of the **Grid Code**. Each step in the flow chart is described in the table below Figure 1.

*Figure 1: Connection/**Compliance** Processes for Transmission & Distribution Connected **Power Park Module***



Step No.	Step	Description
1	**Energisation Operational Notification** issued (**Type D** only)	Notification is issued by NIE Networks / SONI to the **Generator** to allow energisation of the **Generator's** internal network.
2	Pre-synchronisation checks successfully completed	As per the pre-synchronisation checklist (included in Appendix B1 of this document), noting the requirement for a commissioning programme to be submitted to SONI / NIE Networks 6 weeks prior to synchronisation.
3	Synchronisation notice issued	NIE Networks will confirm to the **Generator** that the **PPM** is ready to be synchronised.
4	**PPM Compliance** is demonstrated, **PPM** is commissioned and synchronised	**Compliance** is demonstrated (via **UDL**). Commissioning tests for **PPM** are undertaken. **PPM** is synchronised (NIE Networks Circuit Breaker at the **PPM Connection Point** is closed).
5	**Interim Operational Notification** issued	An **Interim Operational Notification**[3] is issued when the **PPM** has completed step 4 to the satisfaction of SONI / NIE Networks. The **Interim Operational Notification** is valid for 1 year from when the **PPM** is due to begin exporting **Active Power**.
6	**PPM** passes SONI **MW Availability** standard and successfully completes Operational Readiness Dispatch Test	Once the **PPM** is capable of full **Active Power** export and the **PPM** is continuously passing the SONI **MW Availability** standard (Appendix C) for 2 weeks SONI will carry out an Operational Readiness Dispatch test (Section 6.2.1 of this **PPM Setting Schedule**). On the successful completion of this test, SONI will issue an **Operational Readiness Confirmation** to the **Generator**.
7	**Operational Readiness Confirmation** issued	The **Operational Readiness Confirmation** is issued by SONI to the **Generator**.
8	**Generator** must change the **PPM** status in the SEM to VPT unit	The **Operational Readiness Confirmation** issued by SONI to the **Generator** will allow the Generator to change the status of the **PPM** in the SEM from Autonomous Unit to Variable Price Taker (VPT) Unit.
9	**PPM** must complete **Compliance** testing	From the date the **PPM** is capable of full **Active Power** export, the **Generator** will have a period of 3 months to complete **Compliance** Testing (resource conditions permitting) and submit to SONI an updated **UDL** containing a satisfactory "Final Report".
10	SONI/NIE Networks conduct continuous monitoring	For the full duration of the validity of the **Interim Operational Notification** the **PPM** shall be subject to continuous monitoring by SONI/NIE Networks. SONI/NIE Networks may extend the validity of the **Interim Operational Notification** beyond 1 year if it is deemed necessary.

[3] The **Interim Operational Notification** that will be issued to the **Generator** is a joint SONI/NIE certificate that will cover the SONI requirements that are stipulated in **Grid Code** CC15.2.2 and CC16.2.2 regarding Inerim Operational Notification and also cover the Temporary **Distribution Code Compliance** Certification.

11	Assessment of satisfactory performance	SONI/NIE Networks shall confirm if the **PPM** has performed satisfactorily for the full duration of the monitoring period. If the **PPM** has performed satisfactorily, SONI shall issue the **PPM** with a **Final Operational Notification**[4]. If the **PPM** has not performed satisfactorily, SONI/NIE Networks will engage with the **PPM** to resolve the issue by use of the **Limited Operational Notification** process. This may require some retesting or an extension of the continuous monitoring period.
12	SONI issue **Final Operational Notification**	The **Final Operational Notification** is issued by NIE Networks / SONI to the **Generator**.
13	SONI/NIE Networks issue **Limited Operational Notification**	If a non-**Compliance** arises at any point from synchronisation throughout the full operational life of the **PPM**, SONI/NIE Networks may issue the **Generator** with a **Limited Operational Notification**, which will detail the level of non-**Compliance** of the **PPM**, the time frame to rectify the non-**Compliance** and the MVA restriction to which the **PPM** will be capped until the non-**Compliance** is resolved.

[4] The **Final Operational Notification** that will be issued to the **Generator** is a joint SONI/NIE certificate that will cover the SONI requirements that are stipulated in **Grid Code** CC15.2.3 and CC16.2.3 regarding Final **Operational Notificatio** and also cover the Final **Distribution Code** Compliance Certification.

5.1 PRE-SYNCHRONISATION

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

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

Synchronisation cannot take place prior to all relevant agreements (as described in section 4 of this **PPM Setting Schedule**) being signed.

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

Prior to synchronisation on to the NIE Networks T&D **System**, pre-synchronisation tests must be completed as per pre-synchronisation check list included in Appendix B1. If SONI/NIE Networks accept that all pre-synchronisation criteria have been met then a synchronisation notice will be issued.

At least 6 weeks in advance of the proposed synchronisation 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 **Generator**s connecting to the Transmission **System**) or CC11 (for **Generator**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 5.8– **User Data Library (UDL)**. SONI will make this **UDL** available to NIE Networks.

SONI/NIE Networks' objective in seeking this information is to establish from the **Generator** 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 **Generator**. The purpose of these operational studies is to determine if any of the proposed **PPM**s will have a detrimental effect on the NI T&D **System**. The costs incurred by this report will be met by the **Generator**.

5.1.1 METERING ARRANGEMENTS

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

All **Power Generating Facilities** main meters will be connected using IP (Internet Protocol) over NIE Network' 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 the **Power Park Module** will last for a minimum of 10 days before communications reliability will be confirmed and the **Power Park Module** 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 synchronisation, 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 synchronisation 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

Prior to synchronisation, 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 **Power Park Module**).

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

When all the **Power Park Module** SCADA is in place, the **Generator** must contact SONI SCADA (and NIE Networks SCADA for Distribution connected **Power Generating Facilities**) 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 **Power Park Modules** one UPS will be sufficient for both the RTU and the metering communications).

5.2 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 **Power Park Module**.

Upon synchronisation of the **Power Park Module** (i.e. closing of the NIE Networks circuit breaker), as per **Grid Code** CC15.2.2 and CC16.2.2, SONI/NIE Networks will issue the **Power Park Module** with an **Interim Operational Notification** which will be valid for a period of one year from the date that the **Power Park Module** is due to begin **Active Power** export. The **Power Park Module** must be fully remotely controllable by SONI/NIE Networks from synchronisation. SONI will perform **Active Power** control tests when the **Power Park Module** begins **Active Power** export. Until controllability has been proven, the **Generator** must restrict the Apparent Power export of the **Power Park Module** to 5 MVA. 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 **Power Park Module** ramps up

Active Power export to its **Registered Capacity**. The **Power Park Module** will be capped at each pre-agreed level until controllability has been demonstrated.

From the date when the **Power Park Module** is capable of full **Active Power** export, the **Power Park Module** will have a period of three months to complete **Compliance** testing (resource conditions 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 **Interim Operational Notification**, the **Power Park Module** will be subject to continuous monitoring by SONI/NIE Networks (the validity of the **Interim Operational Notification** can be extended if it is deemed necessary to so). Upon confirmation from SONI and NIE Networks that the **Power Park Module** has performed satisfactorily for the full duration of the monitoring period, SONI/NIE Networks will issue the **Power Park Module** with a **Final Operational Notification**. Continuous monitoring of the **Power Park Module** will be conducted by SONI/NIE Networks throughout the operational lifetime of the **Power Park Module**. Should a non-**Compliance** arise, SONI/NIE Networks may issue a **Limited Operational Notification** until the issue is resolved (**Grid Code** CC15.4 for Transmission **System** connected **PPM** and **Grid Code** CC1.4 for **Distribution System** connected **PPM**).

The **Generator** must fully complete all the applicable **Compliance** tests included in Section 6.0 of this **PPM Setting Schedule** in the timelines stipulated. Failure to complete **Compliance** testing in the stipulated timelines while conditions were suitable for testing will result in the **Interim Operational Notification** for the **Power Park Module** being revoked and the **PPM** will be disconnected from the NI **System** until the **Generator** is in a position to resume **Compliance** testing. If an updated version of the **PPM Setting 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 **Power Park Modules** 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 **PPM Setting Schedule** is for the **Power Park Module** to demonstrate **Compliance** with SONI **Grid Code**, the NIE Networks **Distribution Code** and the requirements of other Bilateral Agreements which may exist (see section 4).

All tests will need to be planned into the **Power Park Module** 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 **Power Park Module**. 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 Networks deem the **Power Park Module** to be of a **Registered Capacity** which may have an impact on NI **System** during **Compliance** testing, SONI/NIE Networks has 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 **PPM Setting Schedule**.

5.2.1 OPERATIONAL READINESS CONFIRMATION (EXCEPT FOR ESPS)

As per Step No.6 of Section 5.0 of this **PPM Setting Schedule**, when the **PPM** 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 **PPM** is submitting via SCADA. If the **PPM** passes the SONI **MW Availability** standard continuously for two weeks, then when resource conditions allow (**PPM Output** ≥ 50% **Registered Capacity**) SONI will carry out a dispatch Test to verify that the **PPM** 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 **Generator a MW** set point which equates to 10% **Registered Capacity**.
2	The **Generator** `will send SONI/NIE Networks confirmation of the **MW** set point.
3	SONI will send the **Generator** a Curtailment Time Interval set point of 1 minute.
4	The **Generator** will send SONI/NIE Networks confirmation of the Curtailment Time Interval set point.
5	SONI will turn on 'Emergency Action' mode.
6	The **PPM** will ramp at the **Active Power** Control Set-Point Ramp Rate
7	When the **PPM** has achieved the specified **MW** set point in the specified Curtailment Time Interval, the **PPM is** required to remain at that set point for 5 minutes.
8	SONI will send the **Generator** a 0 **MW** set point
9	The **Generator** will send SONI/NIE Networks confirmation of the **MW** set point.
10	SONI will send the **Generator** a Curtailment Time Interval set point of 3 minutes.
11	The **Generator** will send SONI/NIE Networks confirmation of the Curtailment Time Interval set point.
12	The **PPM** will ramp at the **Active Power** Control Set-Point Ramp Rate
13	When the **PPM** has achieved the 0 **MW** set point in the specified Curtailment Time Interval, the **PPM** is required to remain at that set point for 5 minutes.
14	SONI will send the **Generator** a **MW** set point which equates to 50% **Registered Capacity**.
15	The **Generator** will send SONI/NIE Networks confirmation of the **MW** set point.
16	SONI will send the **Generator** a Curtailment Time Interval set point of 1 minute.
17	The **Generator** will send SONI/NIE Networks confirmation of the Curtailment Time Interval set point.
18	The **PPM** will ramp at the **Active Power** Control Set-Point Ramp Rate
19	When the **PPM** has achieved the specified **MW** set point in the specified Curtailment Time Interval, the **PPM** is required to remain at that set point for 5 minutes.
20	SONI will turn off 'Emergency Action' mode.
21	The **PPM** is allowed to ramp up to **MIO** at the **Resource Following Ramp Rate**

If SONI deems the **PPM** to have performed satisfactorily in the dispatch Test an **Operational Readiness Confirmation** will be issued to the **Generator**.

5.3 CONTROLLABILITY TESTING

Some of the tests mentioned will be carried out remotely from the SONI Control Centre or the NIE Networks 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 **Generator** 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 **Power Park Modules** connected to the distribution-**System**, CC11) will be carried out, how witnessing shall be carried out (by remote monitoring, by presence at the **Power Park Module** or by recording agreed parameters) and arrange witnessing if required. The **Commissioning/Acceptance Test Panel** will inform the **Generator** 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 **Generator** 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 **Generator** 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 Networks 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 **Generator** to produce credible results for each test to the **Commissioning/Acceptance Test Panel**. Failure to do so may require the **Generator** 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 **Generator** 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~~F. The **Generator** should ensure all graphs to be submitted are annotated with at least that shown in Appendix ~~E~~F.

Test results must be submitted to SONI/NIE Networks within 20 working days after the completion of the tests. The submission must be accompanied by a statement confirming compliance with EREC G99/NI and this PPM Setting Schedule. 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 **Power Park Module** is compliant.

5.6 POST SYNCHRONISATION MONITORING

Upon satisfactory completion of **Compliance** Testing, the **Power Park Module** will be subject to a monitoring period by SONI/NIE Networks. Data sent via the Energy Management System (EMS), and retrieved from event recorders, is interrogated to determine whether or not the **Power Park Module** is performing adequately.

The data collected is used to assess the **Power Park Module's** 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 **Power Park Module Setting Schedule**.

5.6.1 DISTURBANCE RESPONSE ANALYSIS

1. **Low Voltage Ride Through Capability of the Power Park Module**
   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 **PPM**: CC.S2.1.4
   For Distribution Connected **PPM**: CC.S2.2.3

2. **High Voltage Ride Through Capability of the Power Park Module**
   The **Power Park Module** 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 **PPM**: CC.S2.1.4
   For Distribution Connected **PPM**: CC.S2.2.3

3. **Active and Reactive Power Recovery of the Power Park Module 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 **PPM**: CC.S2.1.4.6
   For Distribution Connected **PPM**: CC.S2.2.3.9

4. **Behaviour of the Power Park Module during low and high Frequency excursions**
   In the event of low/high **Frequency** excursions, the **PPM** shall comply with the criteria as

per the **Grid Code** sections below:
For Transmission Connected **PPM**: CC8.8
For Distribution Connected **PPM**: CC8.8

5. **Any significant change in rate of change of Frequency**
   During a disturbance, the **Power Park Module** 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 **PPM**: CC5.3.3.
   For Distribution Connected **PPM**: 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 **PPM**: CC.S2.1.9.

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 **PPMs**: Engineering Recommendation G5.

8. **Voltage Control and Reactive Power Capability of the Power Park Module**
   Whilst in pf mode: Historical data will be investigated to ensure that, for any given time, the power factor the **PPM** is operating at is staying consistent with the power factor set point sent to the **Generator** 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 **PPM** (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 **PPM** (if it has the reactive capability to do so).

   These capabilities are quantified in **Grid Code** section: For
   Transmission Connected **PPM**: CC.S2.1.3.2.
   For Distribution Connected **PPM** in EREC G99/NI Section 13.4 and 13.5.

5.6.2 GENERAL PERFORMANCE ANALYSIS

1. **Response of the Power Park Module during High Wind Speed Shutdown events**
   The **Power Park Module** 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 10 **MW Power Park Module** has 20, 0.5 **MW Generating Unit**s, and it loses 2 **Generating Unit**s in high speed, the **MW Availability** should show 9 **MW** and the percentage shut down should state 10%. This confirms whether or not a **PPM** is responding sufficiently to high wind speed shut down events.
   For reference in the **Grid Code** see below:
   For Transmission Connected **PPM**: CC.S2.1.5 (d).
   For Distribution Connected **PPM**: CC.S2.2.3.4 (d).

2. **Accuracy of the MW Availability signal being provided to SONI by the Power Park Module**
   The **MW Availability** is continuously monitored using a normalised root mean square deviation (NRMSD). The NRMSD for a **Power Park Module** 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 **Power Park Module**.
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 **Power Park Module** was dispatched away from its **MW Availability** by SONI. See below reference to **MW Availability** in the **Grid Code**:
For all **Power Park Modules**: SDC1.4.3.2

3. **Meeting Dispatch Instructions and Ramp Rates**
As part of a daily check, the **Power Park Modules** are monitored on their previous day's performance. Their performance is measured against the following:
    - Compliance with a dispatch instruction as required in this **Power Park Module Setting 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 **Power Park Module** that may affect **Compliance**, both SONI and NIE Networks 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 Networks 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 **Power Park Module** must still be compliant with both the **Grid Code** and the **Distribution Code**. If SONI and NIE Networks 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 Networks stipulate in order to demonstrate **Compliance**.

At all times SONI and NIE Networks must be in possession of an up-to-date full and accurate parameter listing of the **Power Park Module**. This parameter listing must cover all operational control functionality including **Frequency**, voltage and all the **Power Park Module** parameters relating the control and operation of the **Park Module.** 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 Networks. Should this parameter listing change at any stage, the **Generator** must reissue the revised parameter listing to SONI and NIE Networks.

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 **Generator** to provide **Grid Code** data; it should be noted that certain **Power Park Modules may** be required to provide further technical information as per PC.A3.4.1 and PC.B3.3.1.

Six weeks prior to synchronisation a **Generator** 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 synchronisation. 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 Networks.

Format of Data

Generators 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.

6.0 COMPLIANCE TESTS (EXCEPT FOR ESPS)

The following section details the **Compliance** tests for Transmission and Distribution connected **Power Park Modules**. 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 **Interim Operational Notification** for the **Power Park Module** being revoked and the **Power Park Module** will be disconnected from the NI **System** until the **Generator** is in a position to resume **Compliance** testing. If an updated version of the **PPM Setting 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 Networks:

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 Networks (tests will be carried out once with SONI and/or NIE Networks present as witnesses):

6.4 **Power Park Module** Control System Tests

In addition, a Distribution Connected **Generator** must do the following:

- Confirm to NIE Networks that the plant and apparatus is able of continue to operate during the frequency ranges specified in EREC G99/NI 13.2.1; and
- Provide a demonstration of the frequency control or governor/load controller/plant model and voltage control system by carrying out simulation studies in accordance with EREC G99/NI Annex C.7.8.

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 **PPM** 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 Networks:

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 **PPM** controller to achieve any **Output** at or below the **Registered Capacity** in a specified time, as instructed by SONI/NIE Networks.

This test will be carried out at a time when the actual **MW Output** of the **PPM** is greater than 50% of **Registered Capacity** and 100% of the **Generating Unit**s are in service. SONI may require the **Generator** to repeat the tests on a day where the **MW Output** of the **PPM** 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~~F) showing:

- **MW Output**
- **MW Availability**
- **MW** set point received via SONI/NIE Networks SCADA
- **PPM** Active Set Point
- Emergency Action On/Off
- Wind Speed if applicable
- Global Horizontal Irradiance (GHI) if applicable

Test Assessment:
This test is required to show **Compliance** with CC.S2.1.5 (d) for Transmission Connected **PPM** and CC.S2.2.3.4 (d) for Distribution Connected **PPM**.

Criteria of Assessment:

- The **MW Output** of the **PPM** should be within 3% (based on **Registered Capacity**) of the **MW** set point calculated by the **PPM** Controller at all times. SONI will assess wind and solar conditions for the duration of testing as applicable and take any wind gusting, wind drops or abrupt changes to resource conditions into account.
- The **PPM** should reach the '**MW** set point' within ±10 seconds of the specified 'Curtailment Time Interval'.
- Whilst 'Emergency Action' mode is on, the **PPM** 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 **PPM** response will be assessed from the time the Emergency Action Mode is engaged.
- Upon removal of the 'Emergency Action' mode by SONI, the **PPM** should ramp up at the **Resource Following Ramp Rate**; this ramp shall be a percentage of **Registered Capacity** of the **PPM** per minute which equates to 5 **MW**/min (if a different ramp rate was agreed between SONI/NIE Networks 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 **Power Park Module** shall be able to reduce or increase **Output** to a **MW** set point between 0 **MW** and the **Maximum Instantaneous Output** (**MIO**) of the **Power Park Module**. 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 **Power Park Module 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 **Power Park Module** is >80% **Registered Capacity** to fully test this functionality over the full operating ranges of the **Power Park Module**. 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 **Power Park Module** from becoming Compliant but the test must be completed within 6 months of obtaining an **Interim Operational Notification**).

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

Active Power Control Test Sequence for Test No.1-3	
Step No.	Action
1	SONI will send the **PPM** a Curtailment Time Interval set point.
2	The **PPM** will send SONI/NIE Networks confirmation of the Curtailment Time Interval set point.
3	SONI will send the **PPM** a **MW** set point.
4	The **PPM** will send SONI/NIE Networks confirmation of the **MW** set point.
5	SONI will turn on 'Emergency Action' mode.
6	The **PPM** will ramp at the **Active Power** Control Set-Point Ramp Rate
7	When the **PPM** has achieved the specified **MW** set point in the specified Curtailment Time Interval, the **PPM** is required to remain at that set point for 10 minutes.
8	SONI will turn off 'Emergency Action' mode.
9	The **PPM** is allowed to ramp up to **MIO** at the **Resource 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 **PPM** controller to restrain the **PPM** 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 **PPM** is greater than 50% of **Registered Capacity** and 100% of the **PPM 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~~F) showing:

- **MW Output**
- **MW Availability**
- **MW** set point
- Emergency Action On/Off
- 'Ramp Block' Signal On/Off
- **PPM** Active Set Point
- Wind Speed if applicable
- Global Horizontal Irradiance (GHI) if applicable

Test Assessment:

This test is required to show **Compliance** with CC.S2.1.5 (c) for Transmission Connected **PPM** and CC.S2.2.3.4 (c) for Distribution Connected **PPMs**

Criteria of Assessment:

- The **PPM** controller does not allow the **PPM MW Output** to ramp above the previous 10 minute average **MW Output** level at the time of receiving the signal.
- The **PPM** 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 **PPM** 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 Networks, **PPM** should ramp up at the **Resource Following Ramp Rate**; this ramp shall be a percentage of **Registered Capacity** of the **PPM** 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 **PPM** upon receipt of the 'Ramp Block' signal. The **PPM** shall be capable of a zero ramp rate setting when a 'SONI/NIE Networks ramp blocking signal' is present.

Ramp Block Compliance Tests

Ramp Block testing will be carried out when 100% of the **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 Networks will reduce the **PPM** from **MIO** (>50% **Registered Capacity**) to 10% **Registered**	
Step No.	Action
1	SONI will send the **PPM** a **MW** set point.
2	The **PPM** will send SONI confirmation of the **MW** set point.
3	SONI will send **PPM** a Curtailment Time Interval set point.
4	The **PPM** will send SONI confirmation of the Curtailment Time Interval set point.
5	SONI will turn on 'Emergency Action' mode.
6	When the **PPM** has achieved the specified **MW** set point in the specified Curtailment Time Interval, the **PPM** 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 **PPM** will be allowed to ramp up to **MIO** at the **Resource Following Ramp Rate**
9	SONI will send the **PPM** a 'Ramp Block' signal (When the 'Ramp Block' signal will be sent will depend on the **PPMs** size and will be at the discretion of SONI)
10	The **PPM** will remain at the 'Ramp Block' **MW** set point for 10 mins.
11	SONI will remove the 'Ramp Block' signal and the **PPM** will be allowed to ramp up to **MIO** at the **Resource 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 PPM** could produce based on current generation resource conditions, network conditions and **System** conditions. The **MW Availability** *shall only differ from the* **MW Output** *if the* **Controllable PPM** *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 the **PPM Output** due to 33kV Dynamic Line Rating schemes are NIE Networks 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 **PPM**.

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 **PPM** 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 **PPM** is greater than 50% of **Registered Capacity** and 100% of the **Generating Unit**s are in service (with the exception of Test 7 which will require the **MW Output** of the **PPM** to be greater than 90% of Rated Capacity and 100% of the **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 **PPM** 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~~F) showing:

- **MW Output**
- **MW Availability**
- **MW** set point
- **PPM** Active Set Point
- % **Generating Unit**s Available
- Simulated High Wind Speed ON/OFF if applicable
- Injected High Wind Speed signal if applicable
- Wind Speed if applicable
- Global Horizontal Irradiance (GHI) if applicable
- 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 SDC1.4.3.2

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

Pursuant to SDC1.4.3.2, each **Generator** in the case of its **Controllable Power Park Module** shall use reasonable endeavours to ensure that the **MW Availability** is declared at levels or values that the **Controllable Power Park Module**, can achieve at the relevant time. The **MW Availability** signal should reflect the amount of **Active Power** that the **Controllable PPM** could produce based on current energy resource conditions, network conditions and **System** conditions. The **MW Availability** shall only differ from the **MW Output** if the **Controllable PPM** has been curtailed, constrained or is operating in a Curtailed **Frequency** Response mode.

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

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

b) If **Generating Units** 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 **PPM** is controlling to;

f) Only actions by SONI to reduce the **PPM 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 **PPM 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 **Generator** Shutting Down **Generating Unit**s	
Step No.	Action
1	At **MIO**, the **Generator** will shut down one **Generating Unit**
2	The **MW Output** and the **MW Availability** decreases and settles to reflect the loss of one **Generating Unit**.
3	The **PPM** will remain at this the new **MW** value for 1 min after settling.
4	The **Generator** repeats steps 1-3 until the **PPM** is completely shut-down

MW Availability Test Sequence - Test 2 **Generator** Starting Up **Generating Unit**s	
Step No.	Action
1	When the **PPM** 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 **PPM** will remain at this the new **MW** value for 1 min after settling.
4	The **Generator** repeats steps 1-3 until the **PPM** is at **MIO**.

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

8	SONI will turn off 'Emergency Action' mode.
9	The **PPM** will be allowed to ramp up to **MIO** at the **Resource Following Ramp Rate**

MW Availability Test Sequence - Test 4 Applicable to wind **PPMs** 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 in the **PPM**.
2	SONI must receive a 'High Wind Speed shutdown' Alarm
3	The **PPM Output** should shut-down upon receipt of the high wind speed signal.
4	SONI should receive a 'wind **PPM** % shutdown' indication (i.e. the % of **Generating Unit**s at the wind **PPM** shutdown due to high wind speed).

MW Availability Test Sequence - Test 5 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 **PPM** will remain at this the new **MW** value for 1 min after settling.
4	The **Generator** repeats steps 1-3 until the **PPM** is completely shut-down

MW Availability Test Sequence - Test 6 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 **PPM** will remain at this the new **MW** value for 1 min after settling.
4	The **Generator** repeats steps 1-3 until the **PPM** is completely shut-down
5	The **Generator**/**Generating Unit** manufacturer must make SONI aware of all error modes that exist at the **PPM** under test so that the accuracy of the **MW Availability** checked in all error conditions.

MW Availability Test Sequence - Test 7 Temperature Dependent Dynamic Line Rating (TDLR) (If applicable at the **PPM**)	
Step No.	Action
1	The **Generator** must supply SONI with the P27 Current/Temperature Profile for the **PPM** which will show Temperature versus Current for a given conductor type. The profile should show the **PPM** controller profile and the NIE Networks 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 Networks, 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 **PPM** will simulate a step change in temperature and measure the performance of the **PPM** 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 **PPM** not been curtailed. The **MW Output** of the **PPM** should drop to 10% of **Registered Capacity** in one minute.
    2. **PPM** is within 3% of the '**MW** set point'
    3. The **PPM** should reach the '**MW** set point' within ±10 seconds of the specified 'Curtailment Time Interval'.
    4. The **PPM** 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 **PPM** response will be assessed from the time the 'Emergency Action' Mode is engaged.

    Upon removal of the 'Emergency Action' mode by SONI, the **PPM** should ramp up at the **Resource Following Ramp Rate**; this ramp shall be a percentage of

Registered Capacity of the **PPM** 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 wind **PPM** and an indication of the % of **Generating Unit**s shutdown due to high wind speed (the '**PPM** % shutdown' signal)
    2. The **Generating Unit**s will be expected to shut down 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 **PPM** (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 **PPM** 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 **Interim Operational Notification** and in accordance with CC.S2.1.12.1 and CC.S2.2.7.1, continuous monitoring of the **PPM** by SONI will take place after the signal has been tested, the **PPM** 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 **PPM** 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 **PPM** was dispatched 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 **PPM** 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 PPM CONTROL SYSTEM TESTS

Compliance Testing/monitoring	
Title of Test: **PPM** Control System Tests	Test Number: 4

Purpose of Test:
Great reliance is placed on the reliability of **PPM** 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:

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

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

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

PPM Controller Mode Compliance Tests will be carried out by the **Generator** to verify that; in the event of **PPM** 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 **PPM** is operating in this mode.

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

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

should all result in the **PPM** 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 **PPM** 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 **PPM** 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 **PPM** operates as per the SONI/NIE Networks requirement below:

i) For all failure scenarios, the **PPM** should hold its last known set point for 10mins, after which if the failure still exists the **PPM** should shut down 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 **PPM** should shut down 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 **Generating Unit**s are in service.

Results Required: Time series record and Microsoft Excel Plot (Appendix ~~E~~F) showing: • **MW Output** • **MW Availability** • **PPM** Controller Operational/ **PPM** Controller Fail • **PPM** Active Set Point • **PPM** Controller mode (Local Control/Grid Control) • Wind Speed if applicable • Global Horizontal Irradiance (GHI)
Test Assessment: • The test results should show the **PPM** will operate as per the test scenarios above

6.4.1 PPM CONTROL SYSTEM TEST PROCEDURE

PPM Control System Tests will be carried out when 100% of the **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 PPM Controller Failure Compliance Tests

PPM Controller Failure Compliance Test Sequence - Test 1	
Step No.	Action
1	The **Generator** will disable the outputs of the **PPM** controller.
2	SONI will receive a 'Grid Controller Fail' alarm.
2	The **PPM** will hold its last known set point for 10mins, after which if the failure still exists the **PPM** 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 **PPM** must shutdown to 0 **MW** in a controlled manner within 1 minute.

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

PPM Controller Failure Compliance Test Sequence - Test 3 (SONI will instruct the **PPM** to go to a **MW** set point. The **Generator** will then disable the outputs of the **PPM**)	
Step No.	Action
1	SONI will send **PPM** a **MW** set point (to be agreed with the **Commissioning/Acceptance Test Panel**)
2	The **PPM** will send SONI confirmation of the **MW** set point.
3	SONI will send the **PPM** a Curtailment Time Interval set point of 1 min.
4	The **PPM** will send SONI confirmation of the Curtailment Time Interval set point.
5	SONI will turn on 'Emergency Action' mode.
6	When the **PPM** has achieved the specified **MW** set point in the specified Curtailment Time Interval, the **PPM** will be required to remain at that set point for 1 minute.
7	The **Generator** will disable the outputs of the **PPM** controller.
8	SONI will receive a 'Grid Controller Fail' alarm.
9	The **PPM** will hold its last known set point for 10mins, after which if the failure still exists the **PPM** 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 **PPM** 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 **PPM** should hold its last known set point for 10 mins, after which if the failure still exists the **PPM** should shut down 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 **PPM** should shut down 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 **PPM** shall drop to 0 **MW** when dispatched to that **MW** value by SONI. The **PPM** 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 **PPM** 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 **PPM** should hold its last known set point for 10 mins, after which if the failure still exists the **PPM** should shut down 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 **PPM** should shut down to 0 **MW** in a controlled manner within 1 minute.
    c. SONI will receive a 'Grid Controller Fail' alarm.

6.4.1.2 PPM Controller Mode Compliance Tests

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

PPM 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 **PPM** controller has changed to 'Local Control'.
2	SONI will attempt to send the **PPM** 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 they have no controllability at the site
3	SONI will attempt to engage 'Emergency Action' mode.	

PPM 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 **PPM** controller has changed to 'Grid Control'.
2	SONI will send the **PPM** 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 they have regained controllability at the site.
3	SONI will engage 'Emergency Action' mode. SONI will confirm to the **Generator** that the **PPM** has entered 'Emergency Action' mode.	
4	The **PPM** 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 **PPM** controller is in 'Local Control'.
    b. SONI have no controllability at the site when the **PPM** is in 'Local Control' mode.
- For Test 2:
    a. SONI receive an alarm to indicate that the **PPM** controller is in 'Grid Control'.
    b. SONI have full controllability at the site when the **PPM** is in 'Grid Control' mode.

6.4.1.3 PPM Transducer Failure Compliance Tests

The **PPM** transducer acts as the main **Output** measurement for the **PPM**. Loss of inputs or output from this transducer will result in the **PPM** being incapable of carrying out any control functionality. SONI and NIE Networks 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.

PPM 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 **PPM** controller.	SONI must receive a 'Transducer Fail' alarm. The **PPM** should hold its last known set point for 10mins, after which if the failure still exists the **PPM** 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 **PPM** 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 **PPM** controller.	
3	At **MIO**, **Generator** disables the signal from the transducer to the **PPM** 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 **PPM** should hold its last known set point for 10 mins, after which if the failure still exists the **PPM** should shut down 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 **PPM** should shut down 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 **PPM**.	SONI must receive a 'Grid Controller Fail' alarm. The **PPM** should hold its last known set point for 10mins, after which if the failure still exists the **PPM** should shut down 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 **PPM** should shut down 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 **PPM** will hold its last known set point for 10 mins, after which if the failure still exists the **PPM** should shut down 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 **PPM** should shut down 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 **Power Park Module** must be capable of operating in three frequency control modes: **Frequency Sensitive Mode (FSM)**; **Limited Frequency Sensitive Mode – Over frequency (LFSM-O)**; and **Limited Frequency Sensitive Mode – Under frequency (LFSM-U)**

Under normal operating conditions the **PPM** shall operate in **LFSM-O**. With % curtailment active, the **PPM** shall operate in **FSM**. With an Emergency Action setpoint active, the **PPM** shall operate in **LFSM-O, LFSM-U,** or both, as selected by SONI via SCADA.

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

- Primary Response capability of the **Power Park Module** (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 **Power Park Module** (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 with an Emergency Action setpoint issued and Operating in LFSM-O, the **Power Park Module** should not increase its **Active Power Output** beyond the figure that has been instructed in response to low **Frequency** deviations, however the **Power Park Module** must respond to high **Frequency** deviations and reduce **Active Power Output** according to the droop and deadband specified. This mode of operation is different from % **MW** Curtailment in which the **Power Park Module** must always respond to high and low **Frequency** deviations and be operating on the required droop setting. With an Emergency Action setpoint issued and Operating in LFSM-U, the **Power Park Module** should not decrease its **Active Power Output** beyond the figure that has been instructed in response to high **Frequency** deviations, however the **Power Park Module** must respond to low **Frequency** deviations and increase **Active Power Output** according to the droop and deadband specified.

When unrestricted, the **PPM** shall operate in LFSM-O with a deadband from 50Hz to 50.2Hz. Above 50.2Hz the **PPM** shall operate on a droop characteristic of 3.6% so that the reduction in active power is equal to 100% of Registered Capacity by 52Hz.

With % curtailment active, the **PPM** shall operate in FSM with a deadband from 49.985Hz to 50.015Hz. Below 49.985Hz and above 50.015Hz the **PPM** shall operate on a droop characteristic of 4% so that the increase in active power is equal to 100% of Registered Capacity by 48Hz and the reduction in active power is equal to 100% of Registered Capacity by 52Hz.

With an Emergency Action setpoint issued and the **PPM** operating in LFSM-O, the **PPM** shall operate with a deadband from 50Hz to 50.2Hz. Above 50.2Hz the PPM shall operate on a droop characteristic of 3.6% so that the reduction in active power is equal to 100% of Registered Capacity by 52Hz.

With an Emergency Action setpoint issued and the **PPM** operating in LFSM-U, the **PPM** shall operate with a deadband from 49.5Hz to 50Hz. Below 49.5Hz the **PPM** shall operate on a droop characteristic of 3% so that the increase in active power is equal to 100% of Registered Capacity by 48Hz.

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

- Demonstrate the capability of the **Power Park Module** 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 **Power Park Module** will be demonstrated for:

1. Normal Operating Conditions (% **MW** Curtailment Controller is OFF)
2. When the **Power Park Module** is curtailed by SONI and is providing **System** reserve (% **MW** Curtailment Set Point figure between 50-100% of **MIO** is sent via SONI SCADA).
3. Emergency Action setpoint active and the PPM operating in LFSM-U

A Ramp **Frequency Control** Test (Test 5) 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 **Power Park Module** will prevent positive ramping of **MW Output**. The **MW Output** of the **Power Park Module** 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 **Power Park Module** 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~~F):

- **MW Output**
- **MW Availability**
- **Power Park Module** Active Set Point
- Ramp **Frequency** Set Point
- Simulated **System Frequency**
- Actual **System Frequency**
- Wind Speed if applicable
- Global Horizontal Irradiance (GHI) if applicable
- 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 **Power Park Module Setting Schedule** further describes and clarifies the application of CC8.8.7 for Transmission and Distribution Connected **Power Park Modules**

Criteria of Assessment:

- **Frequency Control** dead band between 50.1Hz – 50.2Hz 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** dead band between 49.5Hz – 50Hz when an emergency action setpoint is active and the PPM is operating in LFSM-U.
- **Frequency Control** device capable of operating with a nominal droop characteristic of 3.6% under normal operating conditions and a nominal droop characteristic of 4% when a % **MW** Curtailment Set Point figure is being applied to the **Power Park Module MW Output**
- Final steady state droop figure should be based on **Registered Capacity** of the **Power Park Module**
- The **TSO** deems Fast acting with regards to **Frequency Control** response as being:
    - No time delays, such as moving average frequency filters, other than those necessarily inherent in the design of the **Controllable PPM** shall be introduced.
    - **Power Park Module** shall respond to **Frequency** deviations as per **Frequency Response Ramp Rate**:
        - Primary Response capability of the **Power Park Module** (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 s they should do so)
        - Secondary Response capability of the **Power Park Module** (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 s they should do so)
- The **MW Output** of the **Power Park Module** should be within 3% (based on **Registered Capacity**) of the **MW** set point calculated by the **PPM** Controller at all times. The **Commissioning/Acceptance Test Panel** will assess wind conditions for the duration of the test and take any wind gusting or abrupt changes to resource conditions into account as applicable
- High **Frequency** trip facility enabled at a **System Frequency** of 52Hz
- Stable operation from **DMOL** to **MIO**
- Continuous **Frequency** modulation capability across full **Power Park Module** operating range
- When operating in LFSM-O or FSM, and when responding to high frequency, the PPM must not lower its MW output below DMOL.

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 **Power Park Module** to **Frequency** injections under test conditions is an accurate reflection of how the **Power Park Module** will respond to **System Frequency** variations.

Frequency *Response under Normal Operating Conditions*

Under normal operating conditions the **Power Park Module** % **MW** Curtailment Controller is OFF (signal sent via SONI SCADA). Under normal operating conditions the **Power Park Module** will cap its **Output** at 50.1Hz and will start operating on droop at 50.2 Hz. The **Frequency** Response of the **Power Park Module** will be based on **Registered Capacity** of the **Power Park Module**. Therefore whilst the **Power Park Module** is operating on a nominal droop characteristic of 3.6%, a 28% 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 **PPM** 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 **Power Park Module**

Frequency *Response under Curtailed Operating Conditions*

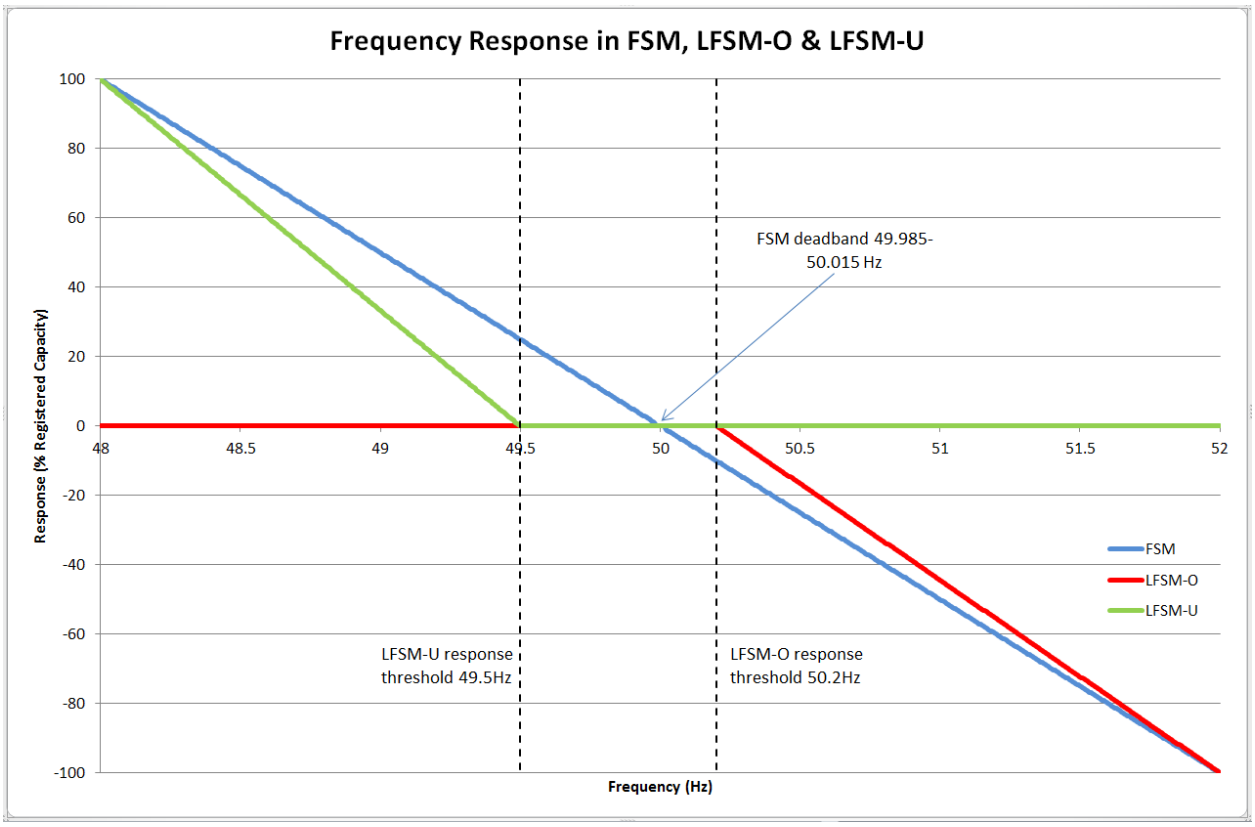
Under % curtailed conditions (i.e. in **FSM**), the **PPM** will operate on a 4% droop characteristic, e.g. a 0.5Hz **Frequency** deviation will result in a 25% change of **MW Output**. The **Frequency** response of the **Power Park Module** will be based on the **Registered Capacity** of the **Power Park Module**. A **Frequency Control** deadband exists between 49.985Hz - 50.015Hz in which the **Power Park Module** is not required to provide **Frequency Control** to the **System**. In accordance with CC.S2.1.5.2 (b) for Transmission Connected **PPM** and CC.S2.2.5.2 (b) for Distribution Connected **PPM**, the controller must be capable of being set to operate in a constrained manner within the range of at least 50% to 100% of **MIO**.

Frequency *Response When an Emergency Action Setpoint is Active*

When an emergency action setpoint is active the **PPM** will operate in **LFSM-O** or **LFSM-U** depending which is selected via SCADA. In **LFSM-O** the **PPM** will cap its **Output** at 50.1Hz and will start operating on droop at 50.2 Hz. The **Frequency** Response of the **Power Park Module** will be based on **Registered Capacity** of the **Power Park Module**. Therefore whilst the **Power Park Module** is operating on a nominal droop characteristic of 3.6%, a 28% change of **MW Output** will occur for a 0.5Hz **Frequency.** In LFSM-U the PPM will start operating on droop at 49.5 Hz and with a droop of 3%.

Figure 1 shows a graphical representation of the required **Frequency** response characteristic of a **PPM** in **FSM, LFSM-O** & **LFSM-U**.

*Figure 1 – Required Frequency Response of **PPM** in FSM, LFSM-O & LFSM-U*



***Frequency Control Compliance** Tests*
Frequency injections will be applied at four loading levels; **MIO**, 50% of **MIO, an Emergency Action MW setpoint equal to 50% of MIO, 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	**Power Park Module** 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 50.3Hz ramp **Frequency** injection over 10 seconds
6	**Frequency** injection will remain at 50.3Hz 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 50.3Hz ramp **Frequency** injection over 10 seconds
14	**Frequency** injection will remain at 50.3Hz 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 **Power Park Module** 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 50.3Hz **Frequency** injection as a step change
21	**Frequency** injection will remain at 50.3Hz 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 50.3Hz **Frequency** injection as a step change
29	**Frequency** injection will remain at 50.3Hz 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 **Power Park Module** 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 **Power Park Module** 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 **Power Park Module** 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 **Power Park Module** 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 **Power Park Module** 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 **Power Park Module** will re-stabilise at **MIO** for 1 minute

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

Step No.	Action
1	**Power Park Module** 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 **Power Park Module** 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 **Power Park Module** 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 **Power Park Module** 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 the **Power Park Module** 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 the **Power Park Module** 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 the **Power Park Module** 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 the **Power Park Module** 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 the **Power Park Module** 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 the **Power Park Module** 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 the **Power Park Module** 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 the **Power Park Module** 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 the **Power Park Module** will re-stabilise at 50% of **MIO** for 1 minute

*Test 3 – Injection Tests at **DMOL***

Step No.	Action
1	The **Power Park Module** 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 the **Power Park Module** 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 the **Power Park Module** 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 the **Power Park Module** 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 the **Power Park Module** 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 the **Power Park Module** 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 the **Power Park Module** 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 the **Power Park Module** will re-stabilise at **DMOL**

*Test 4 – Injection Tests at Emergency Action setpoint of 50% MIO & in **LFSM-U***

Step No.	Action
1	**Power Park Module** will be operating at **an** Emergency Action setpoint of 50% MIO
2	**Generator** will simulate 50Hz
3	**Generator** will apply a 49.6Hz ramp **Frequency** injection over 10 seconds
4	**Frequency** injection will remain at 49.6Hz for 1 minute
5	**Generator** will apply a 49.4Hz ramp **Frequency** injection over 10 seconds
6	**Frequency** injection will remain at 49.4Hz for 1 minute
7	**Generator** will apply a 49Hz ramp **Frequency** injection over 10 seconds
8	**Frequency** injection will remain at 49Hz for 1 minute
9	**Generator** will apply a 48.5Hz ramp **Frequency** injection over 10 seconds
10	**Frequency** injection will remain at 48.5Hz for 1 minute
11	**Generator** will apply a 49Hz ramp **Frequency** injection over 10 seconds
12	**Frequency** injection will remain at 49Hz for 1 minute
13	**Generator** will apply a 49.4Hz ramp **Frequency** injection over 10 seconds
14	**Frequency** injection will remain at 49.4Hz for 1 minute
15	**Generator** will apply a 49.6Hz ramp **Frequency** injection over 10 seconds
16	**Frequency** injection will remain at 49.6Hz for 1 minute
17	**Generator** will simulate 50Hz and **Power Park Module** will re-stabilise at setpoint for 1 minute.
18	**Generator** will apply a 49.6Hz **Frequency** injection as a step change
19	**Frequency** injection will remain at 49.6Hz for 1 minute
20	**Generator** will apply a 49.4Hz **Frequency** injection as a step change
21	**Frequency** injection will remain at 49.4Hz for 1 minute
22	**Generator** will apply a 49Hz **Frequency** injection as a step change
23	**Frequency** injection will remain at 49Hz for 1 minute
24	**Generator** will apply a 48.5Hz **Frequency** injection as a step change
25	**Frequency** injection will remain at 48.5Hz for 1 minute

26	**Generator** will apply a 49Hz **Frequency** injection as a step change
27	**Frequency** injection will remain at 49Hz for 1 minute
28	**Generator** will apply a 49.4Hz **Frequency** injection as a step change
29	**Frequency** injection will remain at 49.4Hz for 1 minute
30	**Generator** will apply a 49.6Hz **Frequency** injection as a step change
31	**Frequency** injection will remain at 49.6Hz for 1 minute
32	**Generator** will simulate 50Hz and **Power Park Module** will re-stabilise at setpoint for 1 minute
33	**Generator** will apply a 49Hz ramp **Frequency** injection over 10 seconds
34	**Frequency** injection will remain at 49Hz for 1 minute
35	**Generator** will apply a 50Hz ramp **Frequency** injection over 5 seconds and **Power Park Module** will re-stabilise at setpoint for 1 minute
36	**Generator** will apply a 48.5Hz ramp **Frequency** injection over 10 seconds
37	**Frequency** injection will remain at 48.5Hz for 1 minute
38	**Generator** will apply a 50Hz ramp **Frequency** injection over 5 seconds and **Power Park Module** will re-stabilise at setpoint for 1 minute
39	**Generator** will apply a 49Hz **Frequency** injection as a step change
40	**Frequency** injection will remain at 49Hz for 1 minute
41	**Generator** will apply a 50Hz ramp **Frequency** injection over 5 seconds and **Power Park Module** will re-stabilise at setpoint for 1 minute
42	**Generator** will apply a 48.5Hz **Frequency** injection as a step change
43	**Frequency** injection will remain at 48.5Hz for 1 minute
44	**Generator** will apply a 50Hz ramp **Frequency** injection over 5 seconds and **Power Park Module** will re-stabilise at setpoint for 1 minute
45	**Generator** will apply a 48Hz **Frequency** injection as a step change
46	**Frequency** injection will remain at 48 Hz for 1 minute
47	**Generator** will apply a 50Hz ramp **Frequency** injection over 5 seconds and **Power Park Module** will re-stabilise at setpoint for 1 minute

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

Frequency Control testing will be carried out when 100% of **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 **Power Park Module** a **MW** set point to reduce the **MW Output** to **DMOL**
2	The **Power Park Module** will send SONI confirmation of the **MW** set point
3	SONI will send **Power Park Module** a Curtailment Time Interval set point
4	The **Power Park Module** will send confirmation of the Curtailment Time Interval set point
5	SONI will turn on 'Emergency Action' mode
6	The **Power Park Module** shall ramp at the **Active Power** Control Set-Point Ramp Rate
7	When the **Power Park Module** has achieved the specified **MW** set point in the specified Curtailment Time Interval, the **Power Park Module** will be required to remain at that set point for 10 minutes
8	SONI will turn off 'Emergency Action' mode
9	The **Power Park Module** shall ramp at the **Resource Following Ramp Rate**; this ramp shall be a percentage of **Registered Capacity** of the **Power Park Module** per minute which equates to 5 **MW**/min, the ramp rate shall not exceed three times the **Resource Following Ramp Rate** in any one minute
10	Before the **MW Output** of the **Power Park Module** reaches **MIO** the **Generator** will simulate a **Frequency** of 50.1Hz (exact point at which this occurs to be determined by SONI for each **Power Park Module**). The **MW Output** of the **Power Park Module** will be capped to the **MW Output** value at the instant the **Frequency** excursion occurred, the **Power Park Module** will be required to remain at this **MW Output** for 2 minutes
11	The **Generator** will simulate a **System Frequency** of 50Hz, the **Power Park Module MW Output** shall increase to **MIO** at the **Resource 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 **PPM** 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 Networks will require the **PPM** to operate in one of the following modes of **Voltage Control** (SONI/NIE Networks will inform the **Generator** which form of **Voltage Control** is required prior to synchronisation):

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

***Voltage Control** of **PPM** in response to a Voltage set point received from SONI/NIE Networks:* The **Generator** should ensure the **PPM** 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 Networks is received by the **PPM** via SCADA, the **PPM** will achieve the set point if it has the reactive capability to do so.

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

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

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

***Voltage Control** of **PPM** in response to a Voltage set point received from SONI/NIE Networks:* The **Generator** will ensure the **PPM** 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 Networks is received by the **PPM** via SCADA, the **PPM** will achieve the set point if it has the reactive capability to do so.

***Voltage Control** of **PPM** 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 **PPM** is there to do so) the **PPM** will operate on a reactive slope characteristic to **System** Voltage perturbations.

For *Direct **Voltage Control** with Slope* the **Voltage Control** system of the **PPM** 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 Networks will advise the **Generator** as to what the slope setting should be set at). The **PPM** 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 Networks via SCADA, the **PPM** will go to its maximum lagging **Reactive Power** capability and export the maximum **Reactive Power** of the **PPM** on to the **System**. Conversely, if the **System** voltage increases by 3% above the voltage set point received from SONI/NIE Networks via SCADA, the **PPM** 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 **PPM** to demonstrate that; upon receipt of a '**Voltage Control**' signal from SONI/NIE Networks, the **PPM** enters '**Voltage Control**' mode. Depending on the form **Voltage Control** stipulated by SONI/NIE Networks, the **PPM** 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 2 of this **PPM Setting Schedule**, as an absolute minimum, the **PPM** reactive capability must at least be as per the reactive capability characteristic shown when the **PPM** is attempting to control the voltage at the **Connection Point** when the **PPM** is operating in **Voltage Control** mode. Six weeks prior to synchronisation the **Generator** must submit a **Generator Performance Chart** showing the full reactive capability of the **PPM** at the **Connection Point** (this capability must be at least of the range shown in Figure 2).

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 **PPM** is greater than 65% of **Registered Capacity** and 100% of the **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~~F) showing:

- Wind Speed if applicable
- Global Horizontal Irradiance (GHI) if applicable
- **MW Output**
- **MVAr** output
- Voltage set point
- Voltage at the **Connection Point**

Test Assessment:
The test results will be assessed against:

- CC.S2.1.7.3

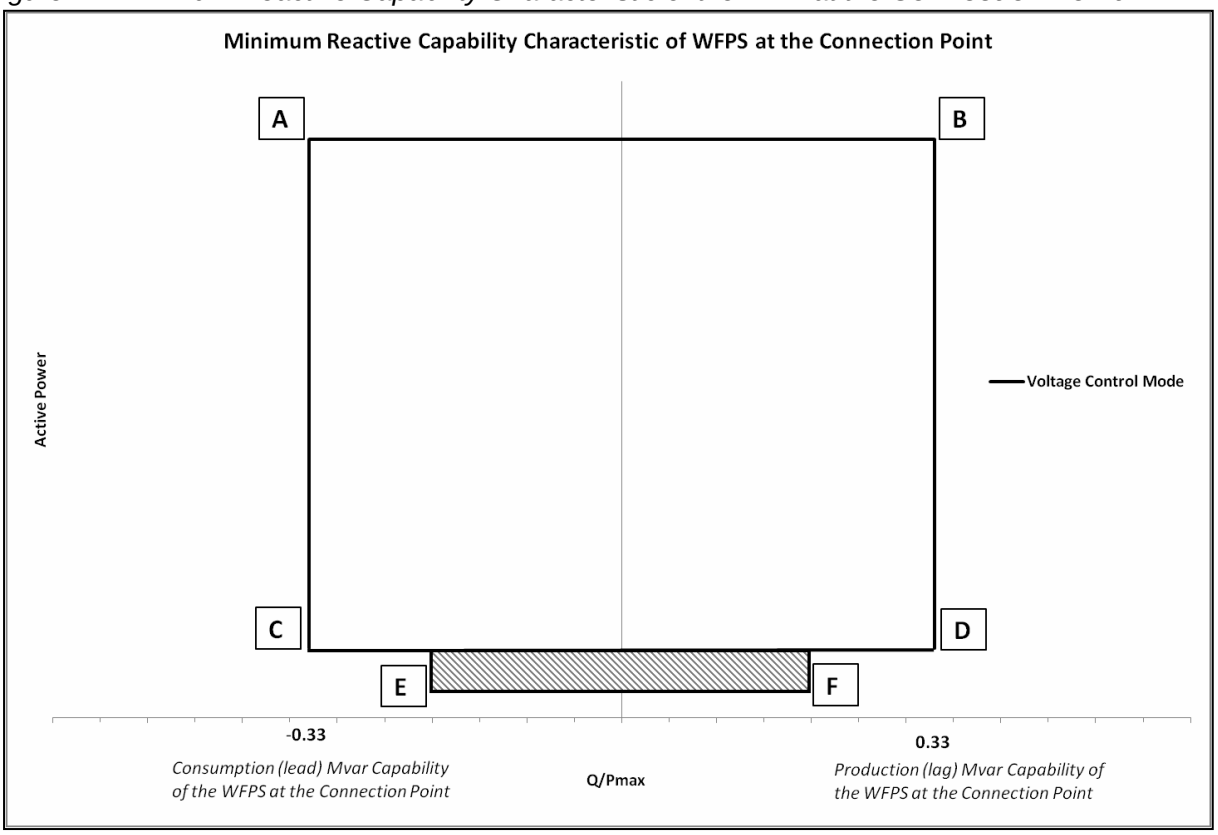
Criteria of Assessment:

- 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 Networks via SCADA, shall be such that the **PPM** 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**[5] 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.
- For *Direct Voltage Control with Slope*, if the PPM has the reactive capability to meet the voltage set point then it should switch to Slope Control after 5 seconds of the step application. The switch between Direct Voltage Control and Slope Control should be bumpless[6]
- For *Direct Voltage Control with Slope*, if the PPM does not have the reactive capability to meet the voltage set point it should remain in Direct Voltage Control until it does achieve the voltage set point at which point it should switch to Slope Control.
- The voltage set point will be adjustable over the following ranges:
  10% of nominal with a resolution of better than ±0.25% for a Transmission connected **PPM**
- 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 **PPM**
- The **PPM** will hold the required **Connection Point** voltage to within 0.25% of the Set point based on nominal voltage (as instructed via SCADA) when operating in Direct Voltage Control, otherwise the **PPM** shall respond to voltage deviations at the **Connection Point** in line with its reactive power droop setting.
- As an absolute minimum, the reactive capability of the **PPM** shown in Figure 2 (up to the **Connection Point** will be available to attempt control the voltage at the **Connection Point**.

[5] Change in steady state **Reactive Power** = steady state **Reactive Power** post set point change – steady state **Reactive Power** pre-set point change

[6] On switching between Direct Voltage Control and Slope Control the **TSO** / **DNO** expect **Reactive Power** oscillations to be no greater than 3% of the change in steady state **Reactive Power**.

*Figure 2 – Minimum Reactive Capability Characteristic of the **PPM** at the **Connection Point***



Point A	***MVAr** consumption (lead) capability of the **PPM** at **Registered Capacity** at the **Connection Point***
Point B	***MVAr** production (lag) capability of the **PPM** at **Registered Capacity** at the **Connection Point***
Point C	***MVAr** consumption (lead) capability of the **PPM** when **Output** is 12%[7] of **Registered Capacity** at the **Connection Point***
Point D	***MVAr** production (lag) capability of the **PPM** when **Output** is 12%[7] of **Registered Capacity** at the **Connection Point***
Point E	***MVAr** consumption (lead) capability at the **Minimum Stable Operating Level** of the **Generating Units** at the **Connection Point***
Point F	***MVAr** production (lag) capability at the **Minimum Stable Operating Level** of the **Generating Units** at the **Connection Point***

For the avoidance of doubt, whilst the **PPM** 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 2.

[7] 12% for connection to the **Transmission System**, 15% for connection to the **Distribution System**

6.6.1 VOLTAGE CONTROL MODE TEST PROCEDURE

Voltage Control mode testing should be carried out when 100% of **PPM 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 Networks 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 **PPM**.

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

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

12	SONI will send the **PPM** a 121kV set point. Hold until conditions stabilise. The **PPM** will remain at this set point for 1 min.	121

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

Voltage Control Mode Test Sequence 2 for both Transmission and Distribution Connected **PPMs**	
Test No.	Action
1	The **PPM** will be sent a power factor set point of 0.95 lead and upon confirmation of the signal being received, the **PPM** will be switched to Power Factor control.
2	Upon confirmation that the **PPM** is at 0.95 lead, the voltage at the **Connection Point** will be measured and called V1
3	The **PPM** will be sent a voltage set point equivalent to V1. On conformation of the signal being received the **PPM** will be switched to **Voltage Control**. The **PPM** 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 **PPM** will be required to remain at each voltage set point for 5 mins
5	The **PPM** will be sent a power factor set point of 0.98 lag (for Distribution Connected **PPM**)/ 0.95 lag (for Transmission Connected **PPM**) and upon confirmation of the signal being received the **PPM** will be switched to Power Factor control.
6	Upon confirmation that the **PPM** is at 0.98 lag the voltage at the **Connection Point** will be measured and called V2
7	The **PPM** will be sent a voltage set point equivalent to V2 On conformation of the signal being received the **PPM** will be switched to **Voltage Control**. The **PPM** 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 **PPM** 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 **PPM 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 **PPM** is in **Voltage Control** mode.
The Reactive Capability tests described below are given indicative of what SONI/NIE Networks 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 **PPM**, the **PPM** reactive capability must at least be as per the reactive capability characteristic shown in **Grid Code** CC.S2.1.3.2 and Figure 2 of this **PPM Setting Schedule**,

For Distribution connected **PPMs**, as an absolute minimum, the **PPM** reactive capability must at least be as per the reactive capability characteristic shown in Figure 2.

Six weeks prior to synchronisation the **Generator** must submit a **Generator Performance Chart** showing the full reactive capability of the **PPM** at the **Connection Point** (this capability must be at least of the range shown in Figure 2). SONI/NIE Networks will, through testing, verify if the **PPM** has the reactive capability that was submitted.

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

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

Voltage Set point (issued by SONI/NIE Networks via	**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 **PPM** 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 **PPM** can export **Reactive Power**	

The **Generator** should submit a **Generator Performance Chart** to SONI/NIE Networks 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 **PPM** 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 **PPM** is equipped with a fast-acting automatic **Voltage Control** that meets the requirements of CC.S2.1.3.2 or EREC G99/NI 13.8.1 as applicable

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

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

***Voltage Control** of **PPM** in response to a Voltage set point received from SONI/NIE Networks:* The **Generator** should ensure the **PPM** 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 Networks is received by the **PPM** via SCADA, the **PPM** will achieve the set point if it has the reactive capability to do so.

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

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

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

***Voltage Control** of **PPM** in response to a Voltage set point received from SONI/NIE Networks:* The **Generator** will ensure the **PPM** 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 Networks is received by the **PPM** via SCADA, the **PPM** will achieve the set point if it has the reactive capability to do so.

***Voltage Control** of **PPM** 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 **PPM** is there to do so) the **PPM** will operate on a reactive slope characteristic to **System** Voltage perturbations.

For *Direct **Voltage Control** with Slope* the **Voltage Control** system of the **PPM** 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 Networks will advise the **Generator** as to what the slope setting should be set at). The **PPM** 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 Networks via SCADA, the **PPM** will go to its maximum lagging **Reactive Power** capability and export the maximum **Reactive Power** of the **PPM** on to the **System**. Conversely, if the **System** voltage increases by 3% above the voltage set point received from SONI/NIE Networks via SCADA, the **PPM** 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 **PPMs**, the **PPM** 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 2 of this **PPM Setting Schedule**,

For Distribution connected **PPM**, as an absolute minimum, the **PPM** reactive capability for **Voltage Control** must at least be as per the reactive capability characteristic shown in Figure 2.

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 **PPM** is operating in power factor mode, SONI will require the **Generator** to inject a step change to the **Connection Point** voltage reference which:

a) When a Transmission Connected **PPM** is outside the statutory limits as specified in CC5.4.1 to prove that if the voltage exceeds the specified band (±10%) the **PPM** will automatically change to **Voltage Control** mode (tests 15-16).
b) When a Distribution Connected **PPM** is outside the statutory limits as specified in the **Distribution Code** to prove that if the voltage exceeds the specified band (±6%) the **PPM** 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 **PPM** is greater than 65% of **Registered Capacity** and 100% of the **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 **PPMs**, 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 Networks can provide examples of what is required in terms of **PPM** performance in **Voltage Control** if the **Generator** requires more detail on this area.

Results Required:
Time series record and Microsoft Excel Plot (Appendix ~~E~~F) 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.S2.1.3.2 and CC.5.4.1) and EREC G99/NI 10.2.1 and **Distribution Code** 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 **PPM** 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[5].
  - 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 **PPM** is operating in power factor mode (EREC G99/NI 10.2.1and **Grid Code** CC.S2.1.3.2.

6.7.1 AUTOMATIC VOLTAGE CONTROL TEST PROCEDURE

The **PPM** shall be capable of operating as per CC.S2.1.3.2 for Transmission Connected **PPMs** and EREC G99/NI 10.2.1 for Distribution Connected **PPM**s.

*Automatic **Voltage Control Compliance** Tests*

Automatic **Voltage Control** testing will be carried out when 100% of **Generating Unit**s at the **PPM** 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 **PPM** 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 **PPM** Controller			
Test No.	Action	Voltage Injection	Notes
1	Inject +1% step to the **PPM** 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 **PPM** Voltage Reference Set point. Hold for 10 sec, remove injection as a step and hold for 10 sec.	-1%	
3	Inject +2% steps to the **PPM** 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 **PPM** Voltage Reference Set point. Hold for 10 sec, remove injection as a step and hold for 10 sec.	-2%	
5	Inject +3% steps to the **PPM** 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 **PPM** 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 **PPM** 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 **PPM** 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 **PPM** 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 **PPM** 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 **PPM** 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 **PPM** 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 upstream 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 **PPM** and 10% for Transmission Connected **PPM**) 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 **PPM** is operating in power factor mode.

Voltage Injections to the **PPM** Controller			
Test No.	Action	Voltage Injection	Notes
21	Inject step to the **PPM** Voltage Reference Set point. Hold for 1 min, remove injection as a step and hold for 1 min.	+5% (Distribution Connected **PPM**) Or +11% (Transmission Connected **PPM**)	
22	Inject step to the **PPM** Voltage Reference Set point. Hold for 1 min, remove injection as a step and hold for 1 min.	-5% (Distribution Connected **PPM**) Or -11% (Transmission Connected **PPM**)	

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 **PPM** to demonstrate **Compliance** with **Grid Code** CC.S2.1.3.2 or EREC G99/NI 13.5.

- For Transmission Connected **PPM:** The **PPM** 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 **PPM:** The **PPM** must demonstrate the ability to operate at 0.95 Leading Power Factor to 0.95 Lagging Power Factor between 1% - 100% Rated **MW**. The requirement only defines the minimum capability.

The **PPM** 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 **PPM** technical connection characteristics. Power Factor Control testing will be achieved by operation of the **PPM** 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 coordinated 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 Networks Control Centre and by the **Generator**.

These tests will be carried out at a time when the **MW Output** of the **PPM** is greater than 80% of **Registered Capacity** and 100% of the **PPM 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~~F) 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 Networks via SCADA, shall be such that the **PPM** 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, steady state is deemed to have occurred when oscillations settle to within 3% of the change in steady state **Reactive Power** value.[5]
- The **Reactive Power** transfer at the **PPM** Terminals equals or exceeds the minimum requirements defined in CC.S2.1.3.2 when generating more than 0% **Active Power**.
- SONI/NIE Networks will be calculating the reactive capability of the **PPM** 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**)

6.8.1 POWER FACTOR CONTROL TEST PROCEDURE

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

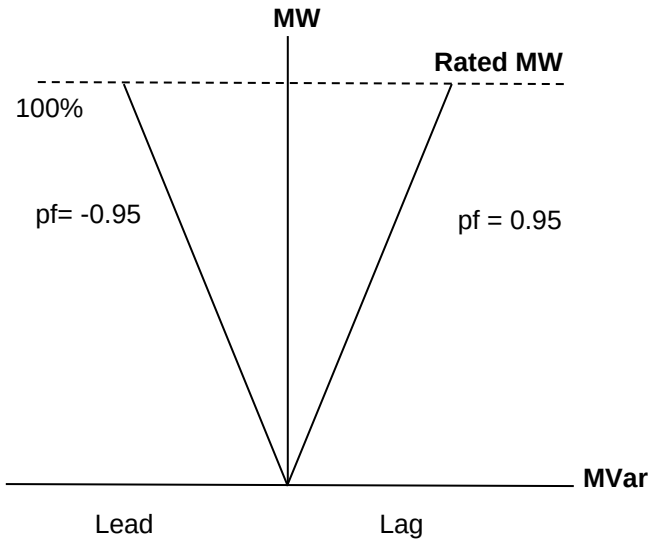


*Figure 3: Minimum Power Factor Performance Chart for Transmission and Distribution Connected **PPM***

For clarification:

The **PPM** must demonstrate the ability to operate at 0.95 Leading Power Factor to 0.95 Lagging Power between 1% - 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 **PPM** 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 **PPM** as per Figure 3 (). 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 Networks will give the **PPM** a Power Factor set point and turn on Power Factor mode in each case.

		PPM 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

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

This test will be coordinated 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 Networks Control Centre and by the **Generator**.

These tests will be carried out at a time when the **MW Output** of the **PPM** is greater than 80% of **Registered Capacity** and 100% of the **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~~F) 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 **PPM** will be within 3% (±1.5%) of the **MVAr** set point that is received via SCADA based on the **Registered Capacity** of the **PPM**
- The **TSO/DNO** 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 Networks via SCADA, shall be such that the **PPM** 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[5].
  - The final steady state reactive value is achieved within 5 seconds of the step application.
- The **Reactive Power** set point shall be adjustable over the full reactive range of the **PPM** with a resolution at least 500 kVAr

6.9.1 REACTIVE POWER DISPATCH TEST PROCEDURE

Reactive Power dispatch testing should be carried out when 100% of **PPM 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 Networks 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 **PPM 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 **PPM** at the **Connection Point** (this capability must be at least of the range shown in Figure 2) prior to the commencement of the **Reactive Power** dispatch test.

Test Step.	Action
1	**PPM** at **MIO** (≥80% **Registered Capacity**)
2	SONI/NIE Networks will send the **PPM MVAr** set point
3	The **PPM** will send SONI/NIE Networks confirmation of the **MVAr** set point.
4	SONI/NIE Networks will turn on ‘’**MVAr** dispatch’ mode
5	Hold until conditions stabilise and the **PPM** 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 **PPM** 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 Networks via SCADA will be taken from the **Generator Performance Chart** that is submitted to SONI/NIE Networks 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.S2.1.5 for Transmission Connected **PPM** and CC.S2.2.3.4 (a) for Distribution Connected **PPM**.

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 **PPM** is greater than 80% of **Registered Capacity** and 100% of the **PPM 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~~F) showing:

- **MW Output**
- **MW Availability**
- **MW** set point
- **PPM** Active Set Point
- Emergency Action ON/OFF
- Wind Speed if applicable
- Global Horizontal Irradiance (GHI) if applicable

Test Assessment:

The test results will be assessed against:

- CC.S2.1.5 for Transmission Connected **PPM** and CC.S2.2.3.4 (d) for Distribution Connected **PPM**.
- **PPM Setting Schedule**

Criteria of Assessment:

- The results of the test will demonstrate that the **MW Output** of the **PPM** reduces dynamically over the requested time interval.
- The **MW Availability** of the **PPM** will reflect the fact that SONI curtails the **Output** of the **PPM** (i.e. it should give an indication of the **MIO** of the **PPM** had the site not been curtailed by SONI).
- **PPM** 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 **PPM** response will be assessed from the time the Emergency Action Mode is engaged.

6.10.1 SHUT-DOWN REQUEST TEST PROCEDURE

The **PPM** 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.S2.1.5 (d) for Transmission Connected **PPM** and CC.S2.2.3.4 (a) for Distribution Connected **PPM**. The **PPM** 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 **PPM 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 (At **MIO**, SONI will reduce the **PPM MW Output** to zero in a 'Curtailment Time Interval' of 5 mins)	
Step No.	Action
1	SONI will send the **PPM** a 0 **MW** set point.
2	The **PPM** will send SONI confirmation of the 0 **MW** set point.
3	SONI will send the **PPM** a Curtailment Time Interval set point.
4	The **PPM** will send SONI confirmation of the Curtailment Time Interval set point.
5	SONI will turn on 'Emergency Action' mode.
6	The **PPM** will ramp down at the **Active Power** Control Set-Point Ramp Rate
7	When the **PPM** has achieved the 0 **MW** set point in the specified Curtailment Time Interval, the **PPM** will be required to remain at that set point for 5 mins.

6.11 START-UP SEQUENCE & RESOURCE FOLLOWING RAMP RATE TEST

Compliance Testing/monitoring
Title of Test: Start-up Sequence & **Resource Following Ramp Rate** Test Test Number: 11
Ramp Rates The **PPM** control system shall be capable of controlling the ramp rate of its **Active Power Output**. There shall be three ramp rate capabilities designated, **Resource Following Ramp Rate**, **Active Power** Control Set-Point Ramp Rate and **Frequency Response Ramp Rate**. The **PPM** control system shall operate the ramp rates with the following order of priority (high to low): **Frequency Response Ramp Rate**; **Active Power** Control Set-Point Ramp Rate; **Resource Following Ramp Rate**. It shall be possible to vary the **Resource Following Ramp Rate** and the **Active Power** Control Set-Point Ramp Rate each independently over a range between 1% and 100% of **Registered Capacity** per minute. *Purpose of Test:* The Start-up Sequence & **Resource Following Ramp Rate** Test will be carried out by the **Generator** to demonstrate the Start-up or **PPM** Following Ramp Rate limits are not exceeded. This test can be carried out in conjunction with the Shut-Down Request Compliance Test This test will be carried out at a time when the **MW Output** of the **PPM** is greater than 80% of **Registered Capacity** and 100% of the **PPM 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~~F) showing: • **MW Output** • **MW Availability** • **MW** set point • **PPM** Active Set Point • Ramp Rate Setting • Emergency Action ON/OFF • Wind Speed if applicable • Global Horizontal Irradiance (GHI) if applicable

Test Assessment:
The test results will be assessed against:

- CC.S2.1.5 for Transmission Connected **PPMs** and CC.S2.2.3.4 for Distribution Connected **PPM**.
- **PPM Setting Schedule**

Criteria of Assessment:

- Following Shutdown, upon removal of 'Emergency Action' mode by SONI, the **PPM** should begin to export **Active Power** within 90 seconds
- The **PPM** is able to ramp up at the required **Resource Following Ramp Rate**. For reference:

a) When the **PPM** is operating on the **Resource Following Ramp Rate** of 10% of **Registered Capacity**/min the **PPM 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.
b) When the **PPM** is operating on the **Resource Following Ramp Rate** of 100% of **Registered Capacity**/min the **PPM 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 & PPM FOLLOWING RAMP RATE TEST PROCEDURE

Start-up Sequence & ***Resource Following Ramp Rate Compliance*** *Tests*

Start-up Sequence testing should be carried out when 100% of the **PPM 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 (Test 1:The **Generator** will set the **Resource Following Ramp Rate** at 10% of **Registered Capacity**/min) (Test 2: The **Generator** will set the **Resource Following Ramp Rate** at 100% of	
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 **PPM** will be allowed to ramp up to MIO at the specified **Resource Following Ramp Rate**.

7.0 ESPS COMPLIANCE TEST PROCEDURES

The following section details the Compliance procedures and tests for **Transmission System** connected **ESPS's**.

7.1 ENERGISATION AND DISPATCH TESTING

Energisation and First Export

An **ESPS** shall complete all pre-energisation requirements and will be issued an **Energisation Operational Notification (EON)** prior to energization and an **Interim Operational Notification (ION)** prior to first export.

On energisation, the following limits / requirements apply: A limit of +/-10 **MW** (import and export) is applied by the **ESPS** independent of **Active Power** Control System used by SONI.

Frequency Response will remain OFF except as required during commissioning activities, or as instructed by SONI. Such commissioning activities will be agreed with SONI through load profiles, as noted below. The **ESPS** shall submit load profiles to SONI for approval of commissioning and internal testing activities.

*First **Active Power** Dispatch Test (+/- 10MW)*

The **ESPS** shall inform SONI when the **ESPS** is available for an **Active Power** Dispatch Test (also providing information on the available **Reactive Power**).

SONI will carry out a Dispatch Test, not exceeding the +/-10 MW limit applied within the **ESPS** controller (this may include a combination of EDIL dispatch and Emergency Action controls)

Providing there is **Reactive Power** capability available, SONI will also carry out a brief **Reactive Power** control test, which may include issuing **MVAr** set points. (Note this will only apply for transmission connected units where SONI has control over reactive power output)

SONI will review the results from the first **Active Power** Dispatch Test and will advise whether the **ESPS** has passed or failed

If the test is passed – SONI will advise that the cap can be lifted to full **MEC** and **MIC**

If the test is failed – the 10MW cap on import and export will remain in place, with the **ESPS** to resolve any issues identified and notify SONI when a repeat 10MW dispatch test can be carried out.

Completing Commissioning

The **ESPS** will continue to progress the project through the commissioning programme, submitting load profiles to SONI for approval as necessary. The **ESPS** shall also submit internal test results to demonstrate that commissioning of **Frequency** response and reactive power control and capability is completed. Following review of commissioning results, SONI may turn on frequency response and use reactive power control if required.

Operational Readiness Confirmation (ORC) *Dispatch Test*

The **ESPS** informs SONI that commissioning is complete and requests the final dispatch test for **Operational Readiness Confirmation**.

This test will consist of **Active Power** dispatch instructions across the full **Operating Range** of the **ESPS**. This may include a combination of EDIL dispatch instructions and direct Emergency Action SCADA set points.

For transmission connected units where SONI has control of **Reactive Power** output, this test will also include **Reactive Power** set points.

SONI will review the results from the **ORC** Dispatch Test and will advise whether the **ESPS** has passed or failed

If the test is passed, SONI will issue an **ORC**. On issuing the **ORC**, SONI will advise its Real-Time Operations department that the unit is now considered controllable and available for dispatch

If the test is failed – the **ESPS** must resolve any issues identified and notify SONI when a repeat **ORC** dispatch test can be carried out.

Grid Code Compliance Testing and System Services Testing

Following receipt of **Operational Readiness Confirmation**, the **ESPS** can progress to scheduling dates for **Grid Code Compliance** testing, and **System** Services testing.

Dispatch Test Procedure

The **ESPS** should, where possible, ensure the unit has sufficient state of charge in advance of commencing testing each day. Before each test section, the state of charge of the **ESPS** should be checked and adjusted if required, following approval by SONI.

Throughout the test procedure, for instances where Emergency Action is OFF it is noted that the expected **MW** output is 0MW. It is understood that there may be small **MW** imports at the connection point to account for house load, unless otherwise instructed by SONI.

It should be noted that the terms permissible import and permissible export in this procedure are defined as a maximum of 10MW in the case of the first **Active Power** Dispatch Test and or **MIC** and **MEC** in the case of the **ORC** Dispatch Test.

Step No.	Action	Comments
1	If SONI has control of the **ESPS Reactive Power**, ensure the **ESPS** is close to 0 **MVAr** at the connection point.	
2	Confirm market PNs have been submitted and notify **ESPS** EDIL operator (if required)	
3	Ensure frequency response is **OFF**	
4	In EMS, turn Emergency Action **ON**	
5	Send **Active Power** Set-point of 50% permissible export (allow the **ESPS** to achieve this Set-point and wait 1 minute).	

6	Send **Active Power** Set-point of 20% permissible export (allow the **ESPS** to achieve this Set-point and wait 1 minute).	
7	Send **Active Power** Set-point of 30% permissible import (allow the **ESPS** to achieve this Set-point and wait 1 minute).	
8	Send **Active Power** Set-point of 70% permissible import (allow the **ESPS** to achieve this Set-point and wait 1 minute).	
9	Send **Active Power** Set-point of 40% permissible import (allow the **ESPS** to achieve this Set-point and wait 1 minute).	
10	In EMS, turn Emergency Action OFF (allow **ESPS** to return to 0MW and wait 1 minute).	
11	Send **Active Power** Set-point of 20% permissible export and wait 1 minute. (**ESPS** should not respond with Emergency Action OFF)	
12	Turn Emergency Action ON (allow the **ESPS** to achieve the current Set-point and wait 1 minute).	
13	Send **Active Power** Set-point of 0 MW (allow the **ESPS** to achieve this Set-point and wait 1 minute).	
14	Send **Active Power** Set-point of 20% permissible export (allow the **ESPS** to achieve this Set-point and wait 1 minute).	
15	Turn Emergency Action OFF (allow **ESPS** to return to 0MW and wait 1 minute).	
16	Send **MVAr** Set-point no.1 (allow the **ESPS** to achieve this Set-point and wait 1 minute). *Timing and magnitude of change in **MVAr** dependent on system conditions on day of*	
17	Send **MVAr** Set-point no.2 (allow the **ESPS** to achieve this Set-point and wait 1 minute). *Timing and magnitude of change in **MVAr** dependent on system conditions on day of*	
18	Send **MVAr** Set-point no.3 (allow the **ESPS** to achieve this Set-point and wait 1 minute). *Timing and magnitude of change in **MVAr** dependent on system conditions on day of*	
19	Send **MVAr** Set-point no.4 (allow the **ESPS** to achieve this Set-point and wait 1 minute). *Timing and magnitude of change in **MVAr** dependent on system conditions on day of*	
20	Send **MVAr** Set-point of 0 **MVAr** (allow the **ESPS** to achieve this Set-point and wait 1 minute).	
21	Ensure **Frequency** Response status is returned to pre-test condition	
22	Ensure Emergency Action is OFF and **MW** set-point is 0MW	
THE FOLLOWING TEST STEPS WILL ONLY BE PERFORMED IF EDIL DISPATCH IS OPERATIONAL		
23	In EDIL, SONI/CHCC to issue DI for 40% permissible export (allow the **ESPS** to achieve this Set-point and wait 1 minute).	
24	In EDIL, SONI/CHCC to issue DI for 10% permissible export (allow the **ESPS** to achieve this Set-point and wait 1 minute).	
25	In EDIL, SONI/CHCC to issue DI for 40% permissible import (allow the **ESPS** to achieve this Set-point and wait 1 minute).	
26	In EDIL, SONI/CHCC to issue DI for 20% permissible import (allow the **ESPS** to achieve this Set-point and wait 1 minute).	
27	In EDIL, SONI/CHCC to issue DI for 0MW (allow the **ESPS** to achieve this Set-point and wait 1 minute).	

28	Ensure frequency status is returned to pre-test positon as noted in step 3	
29	In EMS, ensure EMERGENCY ACTION is OFF and **MW** set-point is 0MW	
30	Notify **ESPS** EDIL operator that the dispatch test has been completed and unit is returned to normal operation	

7.2 ACTIVE POWER CONTROL TESTS

Compliance Testing/monitoring

Title of Test: **Active Power** Control

Purpose of Tests:

To establish that the **Active Power** control capability of the **ESPS** is in compliance with the requirements of CC.s2.1.5 of the Grid Code.

The purpose of this test is to demonstrate the **Active Power** Control functions of the **ESPS**, including ramp rates applied. This test procedure also includes verification of house load and battery capacity. Availability signals are recorded during this test and should be assessed in the test report.

Results Required:

The following data must be captured by the ESPS at the time of testing and submitted to SONI in the format of a time series record and Microsoft Excel Plot (where applicable use a data sample interval of 100mHz):

- **ESPS** Available **Active Power** Export (**MW**)
- **ESPS** Available **Active Power** Import (MW**)**
- **ESPS** Useable Energy Remaining (MWhr)
- **ESPS** Total Useable Storage Capacity (MWhr)
- Actual active power to/from the **ESPS** (**MW**)
- Emergency Action ON/OFF
- Emergency Action set-point from SONI
- **Frequency** Response ON/OFF
- Number of modules online

Test Assessment:

This test is required to show **Compliance** with CC.S2.1.5 for Transmission Connected **PPMs** consisting of **ESPSs**

Criteria of Assessment:

Active Power Control

- **Active Power** export and import is limited to the **MEC** and **MIC** of the **ESPS** respectively
- **ESPS** Control System receives all online Emergency Action set-points, commences implementation of all set-points within 10 seconds of receipt and provides the correct set-point feedback
- When Emergency Action is ON, **ESPS** regulates its active power output to within the greater of (±0.5 **MW** or ±3% of **Registered Capacity**) of the **Active Power** Control Set-point
- **ESPS** does not respond to any set-points sent while Emergency Action is OFF

Ramp Rates

- Rate of change of output is equal to the **Active Power** Control set-point Ramp Rate when ramping to **Active Power** Control Set-points, with temporary deviations not exceeding ±3% of Registered Capacity
- **ESPS** output ramps to 0MW at the **Active Power Control Set-point Ramp Rate** when Emergency Action is turned OFF (unless acting under **Frequency** Response Ramp Rate or Capacity Limited Ramp Rate)
- Demonstration that the **Active Power Control Set-point Ramp Rate** can be set by SONI over a range between 1% and 100% of **Registered Capacity** per minute

Battery Signals

- Available **Active Power** export and import signals are limited to the **MEC** and **MIC** of the **ESPS** respectively

- Available **Active Power** export and import signals behave correctly when the unit is issued an Emergency Action set-point or is providing a **Frequency** response
- Useable Energy Remaining signal provides real time quantity of energy (MWhr) that the unit is capable of exporting, based on current state of charge.
- Total Useable Storage Capacity signal provides real-time quantity of energy (MWhr) that the unit is capable of importing, based on current state of charge.
- **ESPS** Charging and Discharging Signals correctly determine if the **ESPS** is charging or discharging

Capacity/Max On Time

- **ESPS** Demonstration of Capacity (Registered Characteristic / Technical Offer Data value)

7.2.1 ACTIVE POWER CONTROL TEST PROCEDURE

The **ESPS** should, where possible, ensure the unit has sufficient state of charge in advance of commencing testing each day.

Before each test section, the state of charge of the **ESPS** should be checked and adjusted if required, following approval by SONI.

Throughout the test procedure, for instances where Emergency Action is OFF it is noted that the expected **MW** output is 0MW. It is understood that there may be small **MW** imports at the connection point to account for house load, unless otherwise instructed by SONI.

Demonstration of Limiters

The ability of the **ESPS** to limit its Active Power flow (and the **AAP**) to **MEC** and **MIC** is demonstrated by sending Emergency Action set-points above **MEC** and below **MIC**.

Demonstration of Limiters Test Sequence for Test No.1	
Step No.	Action
1	**ESPS** requests permission from SONI to proceed with the Demonstration of Limiters test and confirms the following with SONI: 1. AAP of the **ESPS** 2. **Frequency** Response is OFF 3. Emergency Action is ON 4. Emergency Action set-point [0MW] 5. **MW** output of the **ESPS** 6. **ESPS** Useable Energy Remaining (MWhr)
2	**ESPS** requests SONI to issue a **MW** set-point greater than **MEC** and waits until 1 minute after export has stabilised
Note: intermediate steps may be added to avoid large MW changes during between Step 2 and 3, particularly if the difference between MEC and MIC is greater than 20MW.	
3	**ESPS** requests SONI to issue a **MW** set-point less than **MIC** and waits until 1 minute after import has stabilised
4	**ESPS** informs SONI that the Demonstration of Limiters test is complete. If further testing is not being completed, go to 5: Return to Standard Settings

Ramp Rate Settings

Active Power Control Set-point Ramp Rate is adjusted to values between 1%[8] and 100% of **Registered Capacity** per minute, with ramps carried out at each ramp rate setting.

Note: **Capacity Limited Ramp Rate** settings are changed during the **Frequency** Response Test procedure during the Ramp Rate Priority test. To avoid duplication of testing, it is suggested that data from the Ramp Rate test could be used to demonstrate the **ESPS** ability to change **Capacity Limited Ramp Rate** setting.

A selection of ramp rate settings have been proposed here, as it is not practical to test all values with the requirements. In the test report, please include a statement outlining the ranges that these parameters can be set within.

Ramp Rate Settings Test Sequence - Test No.2	
Step No.	Action
1	**ESPS** requests permission from SONI to proceed with the Ramp Rate Settings test and confirms the following with SONI: 1. Emergency Action is OFF 2. **MW** output of the ESPS 3. **Frequency** Response is OFF 4. **ESPS** Useable Energy Remaining (MWhr) 5. **ESPS** Total Useable Storage Capacity (MWhr)
2	**ESPS** requests SONI to turn Emergency Action ON and issue a **MW** set-point of 30% of **MEC** and waits until 1 minute after the set-point has been achieved
3	SONI sets the **Active Power Control Set-point Ramp Rate** to 1% of **Registered Capacity** per minute
4	**ESPS** requests SONI to issue a **MW** set-point of 35% of **Registered Capacity** and waits until 1 minute after the set-point has been achieved
5	SONI sets the **Active Power Control Set-point Ramp Rate** to 100% of **Registered Capacity** per minute
6	**ESPS** requests SONI to issue a **MW** set-point of 20% of **Registered Capacity** and waits until 1 minute after the set-point has been achieved
7	SONI sets the **Active Power Control Set-point Ramp Rate** to 50% of **Registered Capacity** per minute
8	**ESPS** requests SONI to issue a set-point of 0MW then turn Emergency Action OFF and waits until 1 minute after the **MW** output has reached zero
9	**ESPS** ends data recording
10	**ESPS** informs SONI that the Ramp Rate Settings test is complete. If further testing is not being completed, go to 5: Return to Standard Settings

[8] SONI do not anticipate setting ESUs to ramp rates as low as 1%. Ramp Rrate setting to be agreed with the **Energy Storage Generator** and SONI.

Active Power Control (Emergency Action OFF)

The following test is intended to provide data to demonstrate that the **ESPS** responds correctly when Emergency Action is turned OFF, and that the **ESPS** does not respond to any set-points sent while Emergency Action is OFF.

*Please also refer to test steps in **Frequency** Response and **Reactive Power** Test Procedures where APC set-points are issued. Data from these tests can be used to assess many of the APC pass criteria.*

Active Power Control (Emergency Action OFF) Test Sequence - Test No.3	
Step No.	Action
1	**ESPS** requests permission from SONI to proceed with the **Active Power** Control test and confirms the following with SONI: 1. **Frequency** Response is OFF 2. Emergency Action is OFF 3. AAP export of the **ESPS** 4. AAP import of the **ESPS** 5. **MW** output of the **ESPS** 6. **ESPS** Useable Energy Remaining (MWhr)
2	**ESPS** requests SONI to turn Emergency Action ON and issue a **MW** set-point of 50% of **Registered Capacity** and waits until 1 minute after the set-point has been achieved
3	**ESPS** requests SONI to turn Emergency Action **OFF** and waits until 1 minute after the **MW** output has reached 0MW
4	**ESPS** requests SONI to issue a **MW** set-point of 40% of **Registered Capacity**
5	**ESPS** requests SONI to turn Emergency Action ON and waits until 1 minute after the set-point has been achieved
6	**ESPS** requests SONI to issue a **MW** set-point of 30% of **Registered Capacity** and waits until 1 minute after the set-point has been achieved
7	**ESPS** requests SONI to issue a set-point of 0 **MW** and waits until 1 minute after the set-point has been achieved
8	**ESPS** informs SONI that the **Active Power** Control test is complete. If further testing is not being completed, go to 5: Return to Standard Settings

Demonstration of Capacity/Technical Characteristics

Please refer to the **Frequency** Response ON, Mode 2 test in the **Frequency** Response Test Procedure. This test includes a step where a **Frequency** injection is held for up to TOR2 timeframe. If this is not sufficient to demonstrate battery capacity as per registered characteristics, then the following test can be completed.

Note for Ramping services such as RRD there may also be a requirement to demonstrate EDIL response time. This should be discussed and agreed with Generator Testing if planning to apply for this service.

Demonstration of Capacity/Technical Characteristics Test Sequence –Test No.4	
Step No.	Action
1	**ESPS** requests permission from SONI to proceed with the **Active Power** Control test and confirms the following with SONI: 1. Emergency Action is OFF 2. **MW** output of **ESPS** 3. **Frequency** Response is OFF 4. AAP export of the **ESPS** 5. AAP import of the **ESPS** 6. Useable Energy MWhr remaining 7. Duration of battery at full output 8. **Capacity Limited Ramp Rate** setting applied
2	**ESPS** requests SONI to turn Emergency Action ON and issue a **MW** set-point of 100% of **Registered Capacity**
3	**ESPS** to remain at full output until **Capacity Limited Ramp Rate** reduces output to 0MW
4	**ESPS** requests SONI to issue a set-point of 0 MW and turn Emergency Action OFF
5	**ESPS** informs SONI that the **Active Power** Control test is complete. If further testing is not being completed, go to 5: Return to Standard Settings

Return to Standard Settings

The **ESPS** settings are returned to standard following completion of the **Active Power** Control Test.

Return to Standard Settings Test Sequence –Test No.5	
Step No.	Action
1	**ESPS** confirms the following with SONI: 1. **ESPS** Useable Energy Remaining (MWhr) 2. Emergency Action Set-point = 0MW 3. Emergency Action is OFF 4. **MW** output of the ESPS 5. **Frequency** Response is ON 6. **Frequency** Response is in Mode 1 (or as agreed with CHCC) 7. **ESPS** frequency reference is system frequency
5	**ESPS** informs SONI that **Active Power** Control testing is complete

7.3 FREQUENCY CONTROL TESTS

Compliance Testing/monitoring

Title of Test: **Frequency Control**

Purpose of Tests:

To establish that the **Frequency Control** capability of the **ESPS** is in compliance with the requirements in CC.S2.1.7.2 of the Grid Code.

The purpose of this test is to confirm the ability of the **ESPS** to respond to changes in **System Frequency**. The **ESPS** shall be capable of operating with a "MW/Hz" slope – e.g. able to continuously adjust its **Active Power** output in response to changes in **Frequency**. As the **System Frequency** cannot be changed at will, the test will require **Frequency** to be simulated by means of injection of a **Frequency** signal into the **ESPS** control system.

Results Required:

The following data must be captured by the ESPS at the time of testing and submitted to SONI in the format of a time series record and Microsoft Excel Plot (where applicable use a data sample interval of 100mHz):

- **ESPS** Available **Active Power** Export (MW)
- **ESPS** Available **Active Power** Import (MW)
- **ESPS** Useable Energy Remaining (MWhr)
- **ESPS** Total Useable Storage Capacity (MWhr)
- Actual active power from the **ESPS** in MW
- Emergency Action ON/OFF
- Emergency Action set-point from SONI
- **Frequency** Response ON/OFF
- **Frequency** Response Reserve Mode 1-5
- Active under **Frequency** trigger setting
- Active under **Frequency** trajectory setting
- Active Maximum underfrequency response setting
- Active over **Frequency** trigger setting
- Active over **Frequency** trajectory setting
- Active Maximum overfrequency response setting
- Simulated Test **Frequency**
- **System Frequency**
- Number of modules online

Test Assessment:
This test is required to show **Compliance** with CC.S2.1.7.2.

Criteria of Assessment:

- **Frequency** response mode settings have been implemented as per the table in 7.3.1 below.
- The selected **Frequency Response** Mode (and feedback) shall not be affected by the **Frequency Response** status (ON / OFF) i.e. the **Frequency Response** Mode does not change, nor should the feedback signal go suspect. If **Frequency Response** is OFF, the mode should not change.
- **ESPS** is capable of operating with parameters set anywhere in the following ranges:
  - Under **Frequency** Trigger F_1: 49Hz – 50Hz
  - Under **Frequency** Trajectory F_1-F_2: 1Hz – 10Hz
  - Maximum Under frequency Response: 0MW – **Operating Range**
  - Over **Frequency** Trigger F_3: 50Hz – 51Hz
  - Over **Frequency** Trajectory F_3-F_4: 1Hz – 10Hz
  - Maximum Over frequency Response: 0MW – **Operating Range**

Note: A number of settings will be demonstrated as per existing mode settings during this Frequency Response test. A statement confirming the max and min ranges that can be applied for each parameter is to be provided by the customer in the test report to further support this criteria.

- When **Frequency Response** is OFF, no response shall be provided.
- For **Frequency** ≥ F_1 and ≤ F_3, no response shall be provided
- For **Frequency** between F_1 and F_2, and F_3 and F_4 MW output is based on a MW/Hz slope, which is defined only by the Maximum Response setting and the trajectory, as defined for each Mode.
- Over **Frequency Response** (ΔP) will be limited by the lesser of availability, Maximum Over **Frequency Response** setting, maximum capacity (accounting for MIC), and application of the Capacity Limited Ramp Rate.
- Under **Frequency Response** (ΔP) will be limited by the lesser of availability, Maximum Under **Frequency Response** setting, maximum capacity (accounting for **MEC**), and application of the **Capacity Limited Ramp Rate**.
- **ESPS** provides ≥60% of its expected response within 5 seconds and 100% of its expected response within 15 seconds.
- **Frequency Response** is achieved by altering the output of all modules as opposed to switching modules on or off, insofar as possible.
- **ESPS** regulates its active power output to within the greater of:(±0.5 MW or ±3% of **Registered Capacity**) of the **Active Power Control Set-point** adjusted for Frequency Response.
- The **PPM** controller continuously recalculates its expected response during the **Frequency** excursion.

Ramp Rates

- Demonstration that the **Capacity Limited Ramp Rate** and **Active Power Control Set-point Ramp Rate** can each be set over the following ranges.

  Capacity Limited Ramp Rate range is between the following values. Minimum value shall be the lower of 10% **Registered Capacity** per minute or 5MW per minute. If 5MW is lower than 1% of **Registered Capacity,** then the minimum value shall be 1% of **Registered Capacity** per minute. Maximum value shall be 100% of **Registered Capacity** per minute.

  Active Power Control Set-point Ranp Rate range is between 1% and 100% of **Registered Capacity** per minute. Note: APC ramp rate setting is varied in the APC Test Procedure

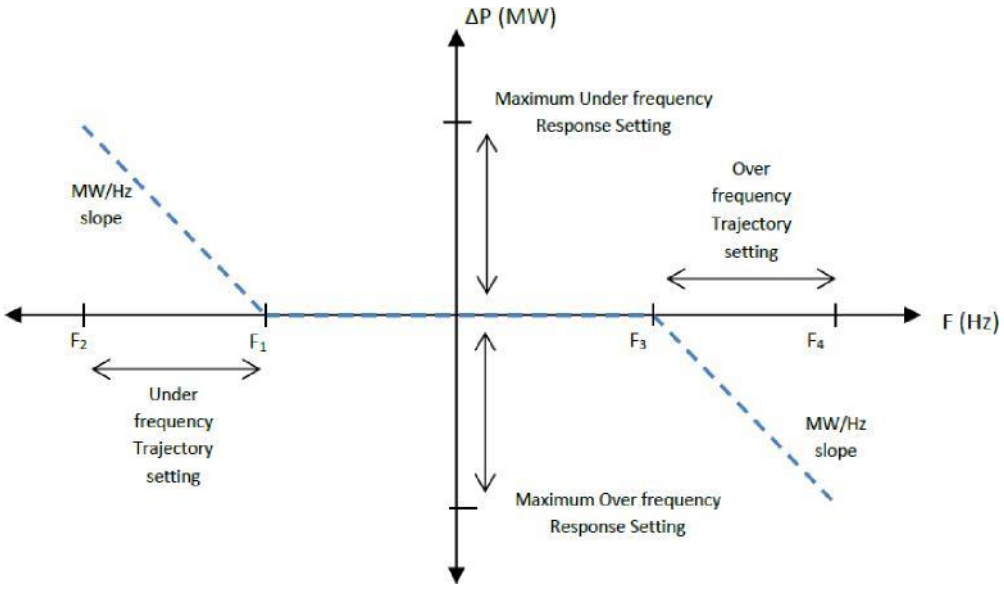
- Ramp rate priority is applied as per CC.S2.1.5.

Signals

- FFR-TOR Availability signals behave correctly under Emergency Action set-point or EDIL dispatch
- Available **Active Power** export and import signals behave correctly when the unit is issued an **APC set-point** or is providing a **Frequency Response**

7.3.1 FREQUENCY CONTROL TEST PROCEDURE

Frequency *and Ramp Rate Settings to be implemented in* ***ESPS*** *Control System*



Battery ESPS Frequency Response

Frequency Mode Settings

	Active under frequency trigger setting (Hz)	*Active under frequency trajectory setting (Hz)*	*Active Maximum underfrequency response setting (MW)*	*Active over frequency trigger setting (Hz)*	*Active over frequency trajectory setting (Hz)*	*Active Maximum overfrequency response setting (MW)*
Mode 1	49.8	0.3	**Operating Range**	50.2	0.3	**Operating Range**
Mode 2	TBC	TBC	**Operating Range**	TBC	TBC	**Operating Range**
Mode 3	49.8	0.5	**Operating Range**	50.2	0.5	**Operating Range**
Mode 4	49.9	0.3	**Operating Range**	50.1	0.3	**Operating Range**
Mode 5	49.8	0.5	50% **Operating Range**	50.2	0.5	50% **Operating Range**

Ramp Rates

Mode	Rate	Priority
Capacity Limited	Range shall be between the minimum value and maximum value. Minimum value shall be the lower of 10% **Registered Capacity** per minute or 5MW per minute. If 5MW is lower than 1% of **Registered Capacity**, then the minimum value shall be 1% of **Registered Capacity** per minute. Maximum value shall be 100% of **Registered Capacity** per minute.	1
Frequency Response	As fast as technically possible. 60% of its expected **Active Power** response within 5 seconds 100% of its expected **Active Power** response within 15	2
Active Power Dispatch	1- 100% of **Registered Capacity** per Minute (Note: Setting as selected by SONI via SCADA)	3

Note: The **ESPS** should, where possible, ensure the unit has sufficient state of charge in advance of commencing testing each day.

Before each test section, the state of charge of the **ESPS** should be checked and adjusted if required, following approval by SONI.

Throughout the test procedure, for instances where Emergency Action is OFF it is noted that the expected **MW** output is 0MW. It is understood that there may be small **MW** imports at the connection point to account for house load, unless otherwise instructed by SONI.

The **ESPS** is to specify:

- Whether **Frequency** is injected using software or external hardware
- Whether **Frequency** can be injected as a ramp or as a step
- Whether **Frequency** is injected as an offset to the **System Frequency** or the governor/control system is isolated from the **System Frequency**

Functional Test Sequence –Test No.1	
Step No.	Action
1	**ESPS** requests permission from SONI to proceed with the **Frequency Response** functional check and confirms the following with SONI: 1. **MW** output of the **ESPS** 2. EMERGENCY ACTION is OFF 3. **Frequency Response** is ON 4. **Frequency Response** Mode 1 is ON 5. Active Under **Frequency** Trajectory setting 6. Active Under **Frequency** Trigger setting 7. Active Maximum underfrequency response setting 8. Active Over **Frequency** Trajectory setting 9. Active Over frequency Trigger setting 10. Active Maximum overfrequency response setting
2	**ESPS** requests SONI to select Reserve Response Mode 2 and manually records the time between the command being issued from SONI and being implemented in the **ESPS** Control System SONI to verify trajectory and trigger settings have updated in EMS as per expected Mode 2 settings
3	**ESPS** requests SONI to select Reserve Response Mode 3 and manually records the time between the command being issued from SONI and being implemented in the **ESPS** Control System SONI to verify trajectory and trigger settings have updated in EMS as per expected Mode 3 settings
4	**ESPS** requests SONI to select Reserve Response Mode 4 and manually records the time between the command being issued from SONI and being implemented in the **ESPS** Control System SONI to verify trajectory and trigger settings have updated in EMS as per expected Mode 4 settings
5	**ESPS** requests SONI to select **Frequency Response** OFF and manually records the time between the command being issued from SONI and being implemented in the **ESPS** controller
6	**ESPS** requests SONI to select Reserve Response Mode 5 and records any change to **Frequency Response** Mode status
7	**ESPS** requests SONI to select **Frequency Response** ON and manually records the time between the command being issued from SONI and being implemented in the **ESPS** controller
8	**ESPS** requests SONI to select Reserve Response Mode 5 and manually records the time between the command being issued from SONI and being implemented in the **ESPS** control system SONI to verify trajectory and trigger settings have updated in EMS as per expected Mode 5 settings.

9	**ESPS** requests SONI to select **Frequency Response** Mode 1

Mode 1 Frequency Response ON Test Sequence – Test No.2	
Step No.	Action
1	**ESPS** requests permission from SONI to proceed with the **Frequency Response** ON, Mode 1 test and confirms the following with SONI: 1. AAP of the **ESPS** 2. **MW** set-point is 0MW 3. APC is OFF 4. **MW** output of the **ESPS** is 0MW 5. **Frequency Response** is ON 6. **Frequency Response** is in Mode 1 7. Active Under **Frequency** Trajectory setting 8. Active Under **Frequency** Trigger setting 9. Active Maximum underfrequency response setting 10. Active Over **Frequency** Trajectory setting 11. Active Over **Frequency** Trigger setting 12. Active Maximum overfrequency response setting
2	**ESPS** replaces the system frequency with a simulated **Frequency** of 50 Hz and waits 1 minute.
3	**ESPS** requests permission from SONI to inject a simulated **Frequency** step injection of 0.05Hz inside active underfrequency trigger and waits 1 minute
4	**ESPS** requests permission from SONI to inject a simulated **Frequency** step injection of 0.05Hz outside active underfrequency trigger and waits 1 minute
5	**ESPS** requests permission from SONI to inject a simulated **Frequency** step injection of 50Hz and waits 1 minute
6	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 49Hz over 10 seconds and waits 1 minute
7	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 50Hz over 10 seconds and waits 1 minute
8	**ESPS** requests permission from SONI to inject a simulated **Frequency** step injection of 0.05Hz inside active overfrequency trigger and waits 1 minute
9	**ESPS** requests permission from SONI to inject a simulated **Frequency** step injection of 0.05Hz outside active overfrequency trigger and waits 1 minute
10	**ESPS** requests permission from SONI to inject a simulated **Frequency** step injection of 50Hz and waits 1 minute
11	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 51Hz over 10 seconds and waits 1 minute
12	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 50Hz over 10 seconds and waits 1 minute
13	**ESPS** requests SONI to turn Emergency Action ON and issue an MW set-point of 50% **MEC** and waits 1 minute after set-point has been achieved
14	**ESPS** confirms simulated **Frequency** of 50Hz is in place
15	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 49Hz over 1 minute and waits 1 minute
16	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 50Hz over 1 minute and waits 1 minute
17	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 51Hz over 1 minute and waits 1 minute
18	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 50Hz over 1 minute and waits 1 minute

19	**ESPS** requests SONI to issue an Emergency Action **MW** set-point of 50% **MIC** and waits 1 minute after set-point has been achieved
20	**ESPS** confirms simulated **Frequency** of 50Hz is in place
21	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 49Hz over 1 second and waits 1 minute
22	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 50Hz over 1 second and waits 1 minute
23	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 51Hz over 1 second and waits 1 minute
24	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 50Hz over 1 second and waits 1 minute
25	**ESPS** requests SONI to issue an Emergency Action **MW** set-point of **MEC** and waits 1 minute after set-point has been achieved
26	**ESPS** confirms simulated **Frequency** of 50Hz is in place
27	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 49Hz over 10 seconds and waits 1 minute
28	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 50Hz over 10 seconds and waits 1 minute
29	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 51Hz over 10 seconds and waits 1 minute
30	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 50Hz over 10 seconds and waits 1 minute
31	**ESPS** requests SONI to issue an Emergency Action MW set-point of MIC and waits 1 minute after set-point has been achieved
32	**ESPS** confirms simulated **Frequency** of 50Hz is in place
33	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 49Hz over 1 minute and waits 1 minute
34	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 50Hz over 1 minute and waits 1 minute
35	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 51Hz over 1 minute and waits 1 minute
36	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 50Hz over 1 minute and waits 1 minute
37	**ESPS** requests SONI to issue an Emergency Action set-point of 0MW and turn Emergency Action OFF and waits 1 minute after set-point has been achieved
38	**ESPS** ends data recording
39	**ESPS** informs SONI that the **Frequency Response** ON, Mode 1 test is complete. If further testing is not being completed, go to 7 Return to Standard Settings

Mode 2 Frequency Response ON Test Sequence – Test No.3	
Step No.	Action
1	**ESPS** requests permission from SONI to proceed with the **Frequency Response** ON, Mode 2 test and confirms the following with SONI: 1. AAP of the **ESPS** 2. **MW** set-point is 0MW 3. EMERGENCY ACTION is OFF 4. **MW** output of the **ESPS** is 0MW 5. **Frequency Response** is ON 6. **Frequency Response** is in Mode 2 7. Active Under Frequency Trajectory setting 8. Active Under Frequency Trigger setting 9. Active Maximum underfrequency response setting 10. Active Over Frequency Trajectory setting 11. Active Over Frequency Trigger setting 12. Active Maximum overfrequency response setting Note: The standard trigger test is an injection of 0.05Hz above and below the Mode 2 trigger setting. In the case that this would result in large **MW** step changes, for example for units with small trajectory settings, changes to these test steps should be discussed with Generator Testing.
2	**ESPS** replaces the **System Frequency** with a simulated **Frequency** of 50 Hz and waits 1 minute.
3	**ESPS** requests permission from SONI to inject a simulated **Frequency** step injection of 0.05Hz inside active underfrequency trigger and waits 1 minute
4	**ESPS** requests permission from SONI to inject a simulated **Frequency** step injection of 0.05Hz outside active underfrequency trigger and waits 1 minute
5	**ESPS** requests permission from SONI to inject a simulated **Frequency** step injection of 50Hz and waits 1 minute
6	**ESPS** requests permission from SONI to inject a simulated **Frequency** step injection of 0.05Hz inside active overfrequency trigger and waits 1 minute
7	**ESPS** requests permission from SONI to inject a simulated **Frequency** step injection of 0.05Hz outside active overfrequency trigger and waits 1 minute
8	**ESPS** requests permission from SONI to inject a simulated **Frequency** step injection of 50Hz and waits 1 minute
9	**ESPS** requests SONI to turn EMERGENCY ACTION ON and issue an EMERGENCY ACTION MW set-point of MIC and waits 1 minute after set-point has been achieved
10	**ESPS** confirms simulated Frequency of 50Hz is in place
11	**ESPS** requests permission from SONI to inject a simulated **Frequency** step injection of underfrequency trigger-trajectory and waits 20 minutes Note 1: Unless capacity limited, the **ESPS** should remain at this output until the **Frequency** is returned towards 50Hz in step 12. Note 2: This step is intended to be used to demonstrate **System** Services **Operating Reserve** response time and volumes, and will also demonstrate the capacity of the **ESPS**. If the **ESPS** has a greater duration than 20 minutes, this timing for this step should be extended.
12	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 50Hz over 1 minute and waits 1 minute
13	**ESPS** requests SONI to issue an EMERGENCY ACTION **MW** set-point of MEC and waits 1 minute after set-point has been achieved
14	**ESPS** requests permission from SONI to inject a simulated **Frequency** step injection of overfrequency trigger + trajectory and waits 1 minute* *Note if Battery **ESPS** unit has contracted for over-frequency services as part of the Volume Capped arrangements, the timing of this step should be extended

15	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 50Hz over 1 second and waits 1 minute
16	**ESPS** requests SONI to issue an EMERGENCY ACTION set-point of 0MW and turn EMERGENCY ACTION OFF and waits 1 minute after set-point has been achieved
17	**ESPS** ends data recording
18	**ESPS** informs SONI that the **Frequency Response** ON, Mode 2 test is complete. If further testing is not being completed, go to 7 Return to Standard Settings

Mode 5 Frequency Response ON Test Sequence – Test No.4	
Step No.	Action
1	**ESPS** requests permission from SONI to proceed with the **Frequency Response** ON, Mode 5 test and confirms the following with SONI: 1. AAP of the ESPS 2. MW set-point is 0MW 3. EMERGENCY ACTION is ON 4. MW output of the ESPS is 0MW 5. **Frequency Response** is ON 6. **Frequency Response** is in Mode 5 7. Active Under **Frequency** Trajectory setting 8. Active Under **Frequency** Trigger setting 9. Active Maximum underfrequency response setting 10. Active Over **Frequency** Trajectory setting 11. Active Over **Frequency** Trigger setting 12. Active Maximum overfrequency response setting
2	**ESPS** replaces the **System Frequency** with a simulated **Frequency** of 50 Hz and waits 1 minute.
3	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 49Hz over 10 seconds and waits 1 minute
4	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 50Hz over 10 seconds and waits 1 minute
5	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 51Hz over 10 seconds and waits 1 minute
6	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 50Hz over 10 seconds and waits 1 minute
7	**ESPS** requests SONI to turn EMERGENCY ACTION OFF and waits 1 minute
8	**ESPS** ends data recording
9	**ESPS** informs SONI that the **Frequency Response** ON, Mode 5 test is complete. If further testing is not being completed, go to 7 Return to Standard Settings

Frequency Response OFF Test Sequence – Test No.5	
Step No.	Action
1	**ESPS** requests permission from SONI to proceed with the **Frequency Response** OFF test and confirms the following with SONI: 1. EMERGENCY ACTION OFF 2. **MW** output of the ESPS is 0MW 3. **Frequency Response** is OFF 4. **Frequency Response** Mode 4 is selected
2	**ESPS** replaces the **System Frequency** with a simulated **Frequency** of 50 Hz and waits 1 minute
3	**ESPS** injects a simulated **Frequency** of 49 Hz and waits 1 minute
4	**ESPS** injects a simulated **Frequency** of 51 Hz and waits 1 minute
5	**ESPS** requests SONI to issue an EMERGENCY ACTION MW set-point of 40% Registered Capacity and turn EMERGENCY ACTION ON and waits until EMERGENCY ACTION set-point has been achieved
6	**ESPS** injects a simulated **Frequency** of 49 Hz and waits 1 minute
7	**ESPS** injects a simulated **Frequency** of 51 Hz and waits 1 minute
8	**ESPS** requests SONI to issue an EMERGENCY ACTION set-point of 0MW and turn EMERGENCY ACTION OFF, and waits until output reaches 0MW
9	**ESPS** ends data recording
10	ESPS informs SONI that the **Frequency Response** OFF test is complete. If further testing is not being completed, go to 7 Return to Standard Settings

Ramp Rate Priority

This test demonstrates that the three ramp rates are prioritised in correct manner.

Ramp Rate Priority Test Sequence – Test No.6	
Step No.	Action
1	**ESPS** requests permission from SONI to proceed with the test and confirms the following with SONI: 1. EMERGENCY ACTION is OFF 2. **MW** output of the **ESPS** 3. **Frequency Response** is ON 4. Mode 1 is ON 5. **ESPS** Useable Energy Remaining (MWhr) 6. **ESPS** Total Useable Storage Capacity (MWhr)
	Under Frequency injection during EMERGENCY ACTION ramp EMERGENCY ACTION turned OFF during under frequency event
2	**ESPS** requests SONI to issue a **MW** set-point of 50% of **Registered Capacity** and turn EMERGENCY ACTION ON.
3	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 50Hz over 10 seconds and waits until output settles
4	**ESPS** requests permission from SONI to inject a simulated underfrequency step injection and waits until **ESPS** output settles. *(Note: size of under-frequency injection to be such that the required delta MW is approx. 10-20% **Operating Range**)*
5	**ESPS** requests SONI to turn EMERGENCY ACTION OFF and waits until unit output settles
6	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 50Hz over 10 seconds and waits until output reaches 0MW
Over **Frequency** injection during EMERGENCY ACTION ramp EMERGENCY ACTION turned OFF during over **Frequency** event	
7	**ESPS** requests SONI to issue a MW set-point of 15% of **Registered Capacity** and turn EMERGENCY ACTION ON. While ramping to the EMERGENCY ACTION set-point, ESPS requests permission from SONI to inject a simulated overfrequency step injection and waits until ESPS finishes ramping. *(Note: size of over-frequency injection to be such that the required delta MW is approx. 20-30% **Operating Range**)*
8	**ESPS** requests SONI to turn EMERGENCY ACTION OFF and waits until unit output settles
9	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 50Hz over 10 seconds and waits until output settles
Over **Frequency** injection during EMERGENCY ACTION ramp Returning to EMERGENCY ACTION set-point on **Frequency** recovery	
10	**ESPS** requests SONI to issue a **MW** set-point of 20% of **Registered Capacity** and turn EMERGENCY ACTION ON. While ramping to the Emergency Action set-point, ESPS requests permission from SONI to inject a simulated overfrequency step injection and waits until ESPS finishes ramping. *(Note: size of over-frequency injection to be such that the required delta MW is approx. 20-30% **Operating Range**)*
11	**ESPS** requests permission from SONI to inject a simulated **Frequency** ramp injection of 50Hz over 10 seconds and waits until output settles
Frequency injections during Capacity Limited Ramp Down	

12	**ESPS** sets the **Capacity Limited Ramp Rate** to an appropriate value to enable completion of this step. *(Note: The capacity limited ramp rate to be set to different value than the current APC ramp rate setting. This setting should be such that Steps 15 & 16 can be carried out while the unit is ramping down from a 60% registered capacity set-point (Step 13). E.g. 10% Registered Capacity/minute would give 6 minutes of a ramp down to allow Step15 & 16 to be completed.)*
13	**ESPS** requests SONI to turn Emergency Action ON and issue a **MW** set-point of 60% of **Registered Capacity**
14	**ESPS** output to be held until the unit starts ramping at **Capacity Limited Ramp Rate** *(Note: State of charge should be low enough so that this wait time is reasonable)*
15	**ESPS** requests permission from SONI to inject a simulated **Frequency** step injection of 49.5 Hz
16	**ESPS** requests permission from SONI to inject a simulated overfrequency step injection. *(Note: size of over-frequency injection to be such that the required delta MW is approx. 10-20% **Operating Range**)* If the unit is still exporting as a result of this injection, this simulated frequency injection is held until the unit output settles and/or Capacity Limited ramp is completed. If the unit has started importing as a result of this injection, this simulated **Frequency** injection should be held for 1 minute.
17	**ESPS** requests permission from SONI to inject a simulated **Frequency** step injection of 50Hz and waits 1 minute.
18	**ESPS** sets the **Capacity Limited Ramp Rate** to 20% of **Registered Capacity** per minute, as and confirms to SONI.
19	**ESPS** requests SONI to issue a set-point of 0MW then turn Emergency Action OFF and waits until 1 minute after the **MW** output has reached 0MW
20	**ESPS** ends data recording
21	**ESPS** informs SONI that the Ramp Rate Priority test is complete. If further testing is not being completed, go to 7 Return to Standard Settings

Return to Standard Settings Test Sequence – Test No.7	
Step No.	Action
1	**ESPS** removes the simulated **Frequency**, returning the **ESPS** controller reference to **system Frequency**
2	**ESPS** confirms the following with SONI: 1. EMERGENCY ACTION Set-point = 0MW 2. EMERGENCY ACTION is OFF 3. **MW** output of the **ESPS** 4. **Frequency Response** is ON 5. **Frequency Response** is in Mode 1 6. **ESPS** control **System Frequency** reference is **System Frequency**
3	**ESPS** informs SONI that **Frequency Response** testing is complete

7.4 REACTIVE POWER CAPABILITY TESTS

Compliance Testing/monitoring

Title of Test: **Reactive Capability**

Purpose of Tests:

To establish that the **Reactive Power** capability of the **ESPS** is in compliance with the requirements in CC.S2.1.3.2 of the Grid Code.

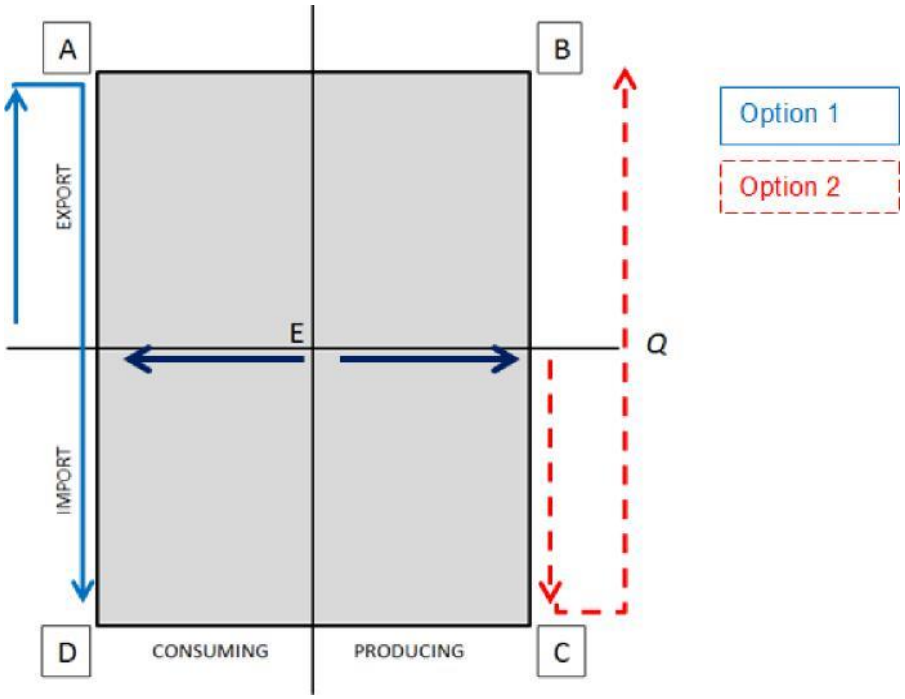
The tests should demonstrate the limits of the **ESPS Reactive Power** capability curve at the connection point. The test is undertaken at various load levels for both the export of Reactive Power from the **ESPS** and for the import of Reactive Power to the **ESPS**.

Results Required:

The following data must be captured by the **ESPS** at the time of testing and submitted to SONI in the format of a time series record and Microsoft Excel Plot (where applicable use a data sample interval of 100mHz):

- **ESPS** Available **Active Power** Export (MW)
- **ESPS** Available **Active Power** Import (MW)
- **ESPS** Useable Energy Remaining (MWhr)
- **ESPS** Total Useable Storage Capacity (MWhr)
- Actual **Active Power** from the ESPS (MW)
- **System** Voltage at Connection Point (kV)
- **Reactive Power** Flow at **Connection Point** (MVAr)
- Emergency Action ON/OFF
- Emergency Action set-point from SONI
- **Frequency Response** ON/OFF
- Number of modules online

The **ESPS** may capture any other signals as necessary to demonstrate compliance.



Test Methodology:

Depending on state of charge, the **ESPS** can follow the red or blue path to complete this test.

Each option is shown on one side of the capability curve only for illustration purposes.

ESPS to start from a 0MW **Active Power** position at **MVAr** output close to 0 **MVAr** and increase **MVAr** set-points until max lagging/leading capability as noted in Section 4 is reached. Note that this set-point shall be large enough to cover the max capability over all of the **MW** range, such that as the **MW** output is varied in subsequent test steps, the **MVAr** output is not limited by the **MVAr** set-point.

Option 1 (Blue solid line): Once at max leading/lagging capability, the **MVAr** set-point should be set to ensure the maximum capability as per the PQ chart in Section 4 is achievable. **Active power** set-points are then issued to increase from 0MW to 100% **Registered Capacity**, and then down to full import. Note depending on the capability curve, the **MVAr** output may vary as **MW** output is varied.

Option 2 (Red dashed line): Once at max leading/lagging capability, the **MVAr** set-point should be set to ensure the maximum capability as per the PQ chart in Section 4 is achievable. **Active power** set-points are then issued to decrease from 0MW to full import, and then increase to 100% **Registered Capacity**. Note depending on the capability curve, the **MVAr** output may vary as **MW** output is varied.

After each option the **MW** output is returned to 0MW and the **MVAr** output is returned to 0MVAr in steps. The size of these steps shall be confirmed with SONI.

Criteria of Assessment:

- Demonstration that the measured P-Q capability is in line with the submitted P-Q capability diagram
- Demonstration that the measured P-Q capability meets or exceeds the minimum expected **Reactive Power** capabilities of the controllable **ESPS**, as defined in the Grid Code, as measured at the **Connection Point**
- Completion of cable charging measurement
- **Reactive Power** import availability and reactive power export availability signals provide the real-time availability of **MVAr** that can be imported/consumed at point of connection, taking into account any relevant factors such as **Active Power** output (or import), module availability, faults etc.

Note: The **ESPS** should, where possible, ensure the unit has sufficient state of charge in advance of commencing testing each day.

Before each test section, the state of charge of the **ESPS** should be checked and adjusted if required, following approval by SONI.

Throughout the test procedure, for instances where Emergency Action is OFF it is noted that the expected **MW** output is 0MW. It is understood that there may be small **MW** imports at the **Connection Point** to account for house load, unless otherwise instructed by SONI.

7.4.1 REACTIVE POWER CAPABILITY TEST PROCEDURE

Reactive Power Capability: Importing Test Sequence –Test No.1	
Step No.	Action
1	**ESPS** requests permission from SONI to proceed with the **Reactive Power** Capability (Importing **Mvar**) test and confirms the following with SONI: 1. **MW** output of the **ESPS** 2. Emergency Action is OFF 3. **Frequency Response** is OFF 4. **Mvar** (Q) control mode is ON 5. The transformer tap position 6. On Load Tap Changer Mode 7. **System** Voltage 8. Maximum leading **Mvar** capability of the **ESPS** 9. **Mvar** Export at the connection point 10. **ESPS Reactive Power** Export Availability (**MVAr**) 11. **ESPS Reactive Power** Import Availability (**MVAr**) 12. **ESPS** to confirm which path it wishes to follow for testing, based on state of charge
2	**ESPS** requests SONI to decrease the MVAr set-point in steps as agreed with SONI until the **ESPS** has reached its maximum leading **MVAr** limit at the **Connection Point**
3	**ESPS** requests SONI to reduce the **MVAr** set-point by a further step (s). *Note: Ensure that the **MVAr** set-point is sufficient to cover the max capability over all of the **MW** range, such that as the MW output is varied in subsequent test steps, the **MVAr** output is not limited by the **MVAr** set-point.
4	**ESPS** requests SONI to turn EMERGENCY ACTION ON and issue a **MW** set-point of **Registered Capacity** or **MIC** *Note if **Registered Capacity/MIC** is larger than 10MW – this step may be split into multiple steps *Note depending on the **ESPS** PQ curve, the **MVAr** output may vary as **MW** output is varied for subsequent steps.
5	**ESPS** requests SONI to issue a set-point of 0 MW *Note if **Registered Capacity/MIC** is larger than 10MW – this step may be split into multiple steps *Note depending on the **ESPS** PQ curve, the **MVAr** output may vary as **MW** output is varied for subsequent steps.
6	**ESPS** requests SONI to issue a **MW** set-point of **Registered Capacity** or **MIC** *Note if **Registered Capacity/MIC** is larger than 10MW – this step may be split into multiple steps *Note depending on the **ESPS** PQ curve, the **MVAr** output may vary as **MW** output is varied for subsequent steps.
7	**ESPS** requests SONI to issue a set-point of 0MW and turn EMERGENCY ACTION OFF and waits until output reaches 0 MW. *Note if **Registered Capacity/MIC** is larger than 10MW – this step may be split into multiple steps *Note depending on the **ESPS** PQ curve, the **MVAr** output may vary as **MW** output is varied for subsequent steps.
8	**ESPS** requests SONI to increase the **MVAr** set-point in steps as agreed with SONI until the **ESPS** is exporting 0 MVAr at the **Connection Point**, or as agreed with SONI
9	**ESPS** ends data recording
10	**ESPS** informs SONI that the **Reactive Power** Capability (Importing **MVAr**) test is complete If further testing is not being completed, go to Section 4 Return to Standard Settings

Reactive Power Capability: Exporting Test Sequence –Test No.2	
Step No.	Action
1	**ESPS** requests permission from SONI to proceed with the **Reactive Power** Capability (Exporting **Mvar**) test and confirms the following with SONI: 1. **MW** output of the **ESPS** 2. Emergency Action is OFF 3. **Frequency Response** is OFF 4. **Mvar** (Q) control mode is ON 5. The transformer tap position 6. On Load Tap Changer Mode 7. **System** Voltage 8. Maximum leading **Mvar** capability of the **ESPS** 9. **Mvar** Export at the connection point 10. **ESPS Reactive Power** Export Availability (**MVAr**) 11. **ESPS Reactive Power** Import Availability (**MVAr**) 12. **ESPS** to confirm which path it wishes to follow for testing, based on state of charge
2	**ESPS** requests SONI to increase the **MVAr** set-point in steps as agreed with SONI until the **ESPS** has reached its maximum lagging **MVAr** limit at the **connection point**
3	**ESPS** requests SONI to increase the **MVAr** set-point by a further step (s). *Note: Ensure that the **MVAr** set-point is sufficient to cover the max capability over all of the **MW** range, such that as the **MW** output is varied in subsequent test steps, the **MVAr** output is not limited by the **MVAr** set-point.
4	**ESPS** requests SONI to turn EMERGENCY ACTION ON and issue a **MW** set-point of **Registered Capacity** or **MIC** *Note if **Registered Capacity/MIC** is larger than 10MW – this step may be split into multiple steps *Note depending on the **ESPS** PQ curve, the **MVAr** output may vary as **MW** output is varied for subsequent steps.
5	**ESPS** requests SONI to issue a set-point of 0 MW *Note if **Registered Capacity/MIC** is larger than 10MW – this step may be split into multiple steps *Note depending on the **ESPS** PQ curve, the **MVAr** output may vary as **MW** output is varied for subsequent steps.
6	**ESPS** requests SONI to issue a **MW** set-point of **Registered Capacity** or **MIC** *Note if **Registered Capacity/MIC** is larger than 10MW – this step may be split into multiple steps *Note depending on the **ESPS** PQ curve, the **MVAr** output may vary as **MW** output is varied for subsequent steps.
7	**ESPS** requests SONI to issue a set-point of 0MW and turn EMERGENCY ACTION OFF and waits until output reaches 0 MW. *Note if **Registered Capacity/MIC** is larger than 10MW – this step may be split into multiple steps *Note depending on the **ESPS** PQ curve, the MVAr output may vary as MW output is varied for subsequent steps.
8	**ESPS** requests SONI to decrease the **MVAr** set-point in steps as agreed with SONI until the **ESPS** is exporting 0 **MVAr** at the connection point, or as agreed with SONI
9	**ESPS** ends data recording
10	**ESPS** informs SONI that the **Reactive Power** Capability (Exporting **MVAr**) test is complete If further testing is not being completed, go to Section 4 Return to Standard Settings

Cable Network Charging Capacitance Test Sequence –Test No.3	
Step No.	Action
1	**ESPS** requests permission from SONI and shuts down all Battery Modules
2	**ESPS** records the **MVAr** at the connection point
3	**ESPS** requests permission from SONI and restarts all Battery Modules

Return To Standard Settings Test Sequence –Test No.4	
Step No.	Action
1	**ESPS** confirms the following with SONI: 1. Emergency Action setpoint is 0MW 2. **MW** output of the **ESPS** 3. Emergency Action is OFF 4. **Frequency Response** is ON 5. **Frequency Response** is in Mode1 6. AVR (kV) control mode is ON 7. The transformer tap position 8. On Load Tap Changer is in Automatic mode 9. **System** Voltage 10. kV Set-point = system voltage at connection point 11. Voltage slope setting = 3% 12. **MVAr** Export at the connection point

7.5 REACTIVE POWER CONTROL TESTS

Compliance Testing/monitoring

Title of Test: **Reactive Control**

Purpose of Tests:

To establish that the **Reactive Power** control capability of the **ESPS** is in compliance with the requirements detailed CC.S2.1.3.2 of the Grid Code.

The purpose of this test is to confirm correct operation of AVR system in kV, Q and PF control modes, and changing between modes.

It should be noted that in normal operation, and unless otherwise instructed by SONI, the reactive slope characteristic should be set to 3%. This means that a system voltage 3% lower that the active voltage setpoint will result in **MVAr** production by the **ESPS** equivalent to its minimum required capability. Conversely, a system voltage 3% higher than the active voltage setpoint will result in **MVAr** absorption by the **ESPS** equivalent to its minimum required capability.

Results Required:

The following data must be captured by the **ESPS** at the time of testing and submitted to SONI in the format of a time series record and Microsoft Excel Plot (where applicable use a data sample interval of 100mHz):

- **ESPS** Available **Active Power** Export (**MW**)
- **ESPS** Available **Active Power** Import (**MW**)
- **ESPS** Useable Energy Remaining (MWhr)
- **ESPS** Total Useable Storage Capacity (MWhr)
- Actual **Active Power** from the ESPS (MW)
- **System** Voltage at **Connection Point** (kV)
- **Reactive Power** Flow at **Connection Point** (MVAr)
- Emergency Action ON/OFF
- Emergency Action set-point from SONI
- **Frequency Response** ON/OFF
- Number of modules online

Test Assessment::

The test results will be assessed against CC.S2.1.3.2.]

Criteria of Assessment:

AVR Control

- **ESPS** receives all kV set-points, implements kV all set-points within 20 seconds of receipt of the set-point and provides the correct set-point feedback
- **ESPS** regulates its reactive power at the point of connection correctly based on the voltage slope setting, system voltage and kV set-point
- Demonstration that the voltage regulation **System** slope setting can be set between 2% and 7%
- Voltage Regulation **System** responds to a step change in voltage at the **Connection Point**, it achieves 90% of its steady-state response within 1 second

MVAr Control

- **ESPS** receives all **MVAr** set-points, implements **MVAr** all set-points within 20 seconds of receipt of the set-point and provides the correct set-point feedback
- **ESPS** maintains the **MVAr** set-point at the **Connection Point**
- The Battery **ESPS** controller will be required to maintain the effective **MVAr** setpoint during changes to **Active Power** export or import, including through zero **MW**.

Power Factor Control

- **ESPS** receives all PF set-points, implements PF all set-points within 20 seconds of receipt of the set-point and provides the correct set-point feedback
- **ESPS** maintains the PF per phase angle set-point at the **connection point**

Bumpless Transfer

- Voltage Regulation **System** implements bumpless transfer between **Reactive Power** control modes

Note: The **ESPS** should, where possible, ensure the unit has sufficient state of charge in advance of commencing testing each day.

Before each test section, the state of charge of the **ESPS** should be checked and adjusted if required, following approval by SONI.

Throughout the test procedure, for instances where Emergency Action is OFF it is noted that the expected **MW** output is 0MW. It is understood that there may be small **MW** imports at the connection point to account for house load, unless otherwise instructed by SONI.

7.5.1 REACTIVE POWER CONTROL TEST PROCEDURE

Functional Checks and Bumpless Transfer

Bumpless Transfer between **Reactive Power** control modes is tested here by changing between each of the modes and sending a positive and a negative set-point in each mode. This also demonstrates that the controls are functioning.

Functional Checks and Bumpless Transfer Test Sequence –Test No.1	
Step No.	Action
1	**ESPS** requests permission from SONI to proceed with the AVR response rate test and confirms the following with SONI: 1. **Frequency Response** is OFF 2. Emergency Action is ON 3. Emergency Action **MW** set-point is 50% of **Registered Capacity** 4. **MW** output of the **ESPS** 5. AVR (kV) control mode is ON 6. The transformer tap position 7. On Load Tap Changer is in Automatic Mode 8. **System** Voltage 9. kV set-point = system voltage at **Connection Point** 10. Voltage slope setting = 3% 11. **MVAr** Export is close to 0 **MVAr** at the **Connection Point**
2	**ESPS** requests SONI to increase the voltage set-point by 0.5 kV and waits 1 minute
3	**ESPS** requests SONI to issue a **MVAr** set-point of -1 **MVAr**
4	**ESPS** requests SONI to select **MVAr** (Q) control mode and waits 1 minute
5	**ESPS** requests SONI to issue a **MVAr** set-point of 10% of lagging **MVAr** capability and waits 1 minute
6	**ESPS** requests SONI to issue a PF set-point of 0 degrees
7	**ESPS** requests SONI to select Power Factor control mode and waits 1 minute
8	**ESPS** requests SONI to issue a PF set-point of +12 degrees noting calculated response and waits 1 minute
9	**ESPS** requests SONI to select AVR control mode and waits 1 minute
10	**ESPS** requests SONI to issue a kV set-point 1 kV lower than **system** voltage at the **connection point**
11	**ESPS** requests SONI to select Power Factor control mode and waits 1 minute
12	**ESPS** requests SONI to issue a PF set-point of -12 degrees noting calculated response and waits 1 minute
13	**ESPS** requests SONI to select **MVAr** (Q) control mode and waits 1 minute
14	**ESPS** requests SONI to issue a **MVAr** set-point of 15% of leading **MVAr** capability and waits 1 minute
15	**ESPS** requests SONI to select AVR control mode and waits 1 minute
16	**ESPS** requests SONI to issue a kV set-point equal to system voltage at the **Connection Point**
17	Ensure that the **ESPS** is producing approximately 0 **MVAr** at the **Connection Point**

18	**ESPS** requests SONI to issue an Emergency Action set-point of 0 **MW**, turn Emergency Action OFF and wait until set-point has been achieved
19	**ESPS** ends data recording
20	**ESPS** informs SONI that the bumpless transfer test is complete If further testing is not being completed, go to 6: Return to Standard Settings

Automatic Voltage Regulation Mode

SONI issues a series of kV set-points both above and below **System** voltage to demonstrate the ability of the **ESPS** to correctly calculate and maintain these set-points.

Automatic Voltage Regulation Mode Test Sequence –Test No.2	
Step No.	Action
1	**ESPS** requests permission from SONI to proceed with the AVR Mode test and confirms the following with SONI: 1. Emergency Action is OFF 2. **Frequency Response** is OFF 3. **MW** output of the **ESPS** 4. AVR (kV) control mode is ON 5. Transformer tap position 6. On Load Tap Changer is in Automatic Mode 7. **System** Voltage 8. kV set-point = system voltage at **Connection Point** 9. Voltage slope setting = 3% 10. **MVAr** export is close to 0 **MVAr** at the **Connection Point**
2	**ESPS** sets the Voltage Regulation **System** slope to 2% confirms the following to SONI: 1. Voltage Slope is now 2% 2. Calculated change in **MVAr** output caused by a 0.5 kV change in voltage set-point 3. Current **MVAr** output of **ESPS**
3	**ESPS** requests SONI to increase the voltage set-point by 0.5 kV and waits 1 minute
4	**ESPS** requests SONI to decrease the voltage set-point by 0.5 kV and waits 1 minute
5	**ESPS** confirms with SONI that **ESPS MVAr** output is approximately 0 **MVAr** at the **Connection Point**. If not, **ESPS** requests SONI to issue a voltage set-point to achieve approximately 0 **MVAr**
6	**ESPS** sets the Voltage Regulation System slope to 7% and confirms the following to SONI: 1. Voltage Slope is now 7% 2. Calculated change in **MVAr** output caused by a 2kV change in voltage set-point 3. Current **MVAr** output of **ESPS**
7	**ESPS** requests SONI to decrease the voltage set-point by 2 kV and waits 1 minute
8	**ESPS** requests SONI to increase the voltage set-point by 2 kV and waits 1 minute
9	**ESPS** confirms with SONI that **ESPS MVAr** output is approximately 0 **MVAr** at the **Connection Point**. If not, **ESPS** requests SONI to issue a voltage set-point to achieve approximately 0 **MVAr**
10	**ESPS** sets the Voltage Regulation System slope to 3% and confirms the following to SONI: 1. Voltage Slope is now 3% **2.** Calculated change in MVAr output caused by a 1kV change in voltage set-point **3.** Current **MVAr** output of **ESPS**
11	**ESPS** requests SONI to increase the voltage set-point by 1 kV and waits 1 minute
12	**ESPS** requests SONI to turn Emergency Action ON and issue an Emergency Action MW set-point of 20% of **Registered Capacity** and wait until 1 minute after Emergency Action set-point has been
13	**ESPS** requests SONI to increase the voltage set-point by 0.5 kV and waits 1 minute
14	**ESPS** requests SONI to issue an Emergency Action MW set-point of -10% of **Registered Capacity** and wait until 1 minute after Emergency Action set-point has been achieved

15	**ESPS** requests SONI to decrease the voltage set-point by 1 kV and waits 1 minute
16	**ESPS** requests SONI to issue an Emergency Action set-point of 0 **MW** and turn Emergency Action OFF and wait until 1 minute after set-point has been achieved
17	**ESPS** requests SONI to decrease the voltage set-point by 0.5 kV and waits 1 minute
18	**ESPS** requests SONI to decrease the voltage set-point by 1 kV and waits 1 minute
19	**ESPS** requests SONI to decrease the voltage set-point by 0.5 kV and waits 1 minute
20	**ESPS** requests SONI to increase the voltage set-point by 1 kV and waits 1 minute
21	**ESPS** requests SONI to increase the voltage set-point by 0.5 kV and waits 1 minute
22	ESPS confirms with SONI that **ESPS MVAr** output is approximately 0 **MVAr** at the **Connection Point**. If not, **ESPS** requests SONI to issue a voltage set-point to achieve approximately 0 **MVAr** at the **Connection Point**
23	**ESPS** ends data recording
24	**ESPS** informs SONI that the AVR Mode test is complete If further testing is not being completed, go to 6: Return to Standard Settings

Automatic Voltage Regulation Response Rate

A step change in **System** voltage is created here to allow analysis of the AVR rate of response. The step change is ideally created by SONI carrying out switching on the system. If this is not possible, the **ESPS** shall carry out a manual tap change to induce a small step change in **System** voltage.

Automatic Voltage Regulation Response Rate Test Sequence –Test No.3	
Step No.	Action
1	**ESPS** requests permission from SONI to proceed with the AVR response rate test and confirms with SONI the following with SONI: 1. **Frequency Response** is OFF 2. Emergency Action is OFF 3. **MW** output of the **ESPS** 4. AVR (kV) control mode is ON 5. The transformer tap position 6. On Load Tap Changer is in Automatic Mode 7. **System** Voltage 8. Voltage slope setting = 3% 9. **MVAr** Export at the **Connection Point**
2	**ESPS** requests SONI to induce a step change in **System** voltage by carrying out transformer tapping or carrying out switching on the **System**, if possible.
3	**ESPS** ends data recording
4	**ESPS** informs SONI that the AVR response rate test is complete
*If SONI cannot facilitate switching on the **System** to induce a step change in **System** voltage, carry out the following steps:*	
5	**ESPS** requests permission from SONI and puts the on-load tap changer into manual mode
6	**ESPS** requests permission from SONI and taps the transformer up 1 tap and waits 1 minute
7	**ESPS** requests permission from SONI, **ESPS** taps the transformer up 1 tap and waits 1 minute
8	**ESPS** requests permission from SONI, **ESPS** taps the transformer down 1 tap and waits 1 minute
9	**ESPS** requests permission from SONI, **ESPS** taps the transformer down 1 tap and waits 1 minute
10	**ESPS** requests permission from SONI, puts the on-load tap changer into automatic mode and confirms to SONI
11	**ESPS** confirms with SONI that the **ESPS** is at approximately 0 **MVAr** at the **Connection Point**
12	**ESPS** ends data recording
13	**ESPS** informs SONI that the AVR response rate test is complete If further testing is not being completed, go to 6: Return to Standard Settings

MVAr Control Mode

SONI issues a series of positive and negative **MVAr** set-points to demonstrate the ability of the **ESPS** to maintain these set-points.

MVAr Control Mode Test Sequence –Test No.4	
Step No.	Action
1	**ESPS** requests permission from SONI to proceed with the **MVAr** Control Mode test and confirms with SONI the following with SONI: 1. **Frequency Response** is OFF 2. Emergency Action is OFF 3. **MW** output of the ESPS 4. **MVAr** (Q) control mode is ON 5. The transformer tap position 6. On Load Tap Changer is in Automatic Mode 7. **Mvar** Set-point = 0 **MVAr** 8. System Voltage 9. Voltage slope setting = 3% 10. **MVAr** Export is 0 **MVAr** at the **Connection Point**
2	**ESPS** requests SONI to issue a **MVAr** set-point of 25% of lagging **MVAr** capability and waits 1 minute
3	**ESPS** requests SONI to turn Emergency Action ON and issue an Emergency Action **MW** set-point of 20% of **Registered Capacity** and wait until 1 minute after Emergency Action set-point has been achieved
4	**ESPS** requests SONI to issue a **MVAr** set-point of 60% of lagging **MVAr** capability and waits 1 minute
5	**ESPS** requests SONI to issue an Emergency Action MW set-point of -10% of **Registered Capacity** and wait until 1 minute after Emergency Action set-point has been achieved
6	**ESPS** requests SONI to issue a **MVAr** set-point of 10% of lagging **MVAr** capability and waits 1 minute
7	**ESPS** requests SONI to issue an Emergency Action set-point of 0 MW and turn Emergency Action OFF and wait until 1 minute after set-point has been achieved
8	**ESPS** requests SONI to issue a set-point of 0 **MVAr** and waits 1 minute
9	**ESPS** requests SONI to issue a **MVAr** set-point of 25% of leading **MVAr** capability and waits 1 minute
10	**ESPS** requests SONI to issue a **MVAr** set-point of 60% of leading **MVAr** capability and waits 1 minute
11	**ESPS** requests SONI to issue a **MVAr** set-point of 10% of leading **MVAr** capability and waits 1 minute
12	**ESPS** requests SONI to issue a set-point of 0 **MVAr** and waits 1 minute
13	**ESPS** confirms with SONI that the **ESPS** is at approximately 0 **MVAr** at the **Connection Point**
14	**ESPS** ends data recording
15	**ESPS** informs SONI that the **MVAr** Control Mode test is complete If further testing is not being completed, go to 6: Return to Standard Settings

Power Factor Control Mode

SONI issues a series of positive and negative PF set-points to demonstrate the ability of the **ESPS** to correctly calculate and maintain these set-points.

Power Factor Control Mode Test Sequence –Test No.5	
Step No.	Action
1	**ESPS** requests permission from SONI to proceed with the Power Factor Control Mode test and confirms the following with SONI: 1. **Frequency Response** is OFF 2. Emergency Action is ON 3. Emergency Action setpoint is 100% of **Registered Capacity** 4. **MW** output of the **ESPS** 5. Power Factor (PF) control mode is ON 6. The transformer tap position 7. On Load Tap Changer Mode 8. Voltage Set-point Control (Local/Remote) 9. **System** Voltage 10. PF set-point = 0 degrees 11. Voltage slope setting = 3% 12. **MVAr** Export
2	**ESPS** requests SONI to issue a PF set-point of +8 degrees noting calculated **MVAr** response to set-point of +8 degrees at 100% of **Registered Capacity** and waits 1 minute
3	**ESPS** requests SONI to issue a PF set-point of +12 degrees noting calculated **MVAr** response to set-point of +12 degrees at 100% of **Registered Capacity** and waits 1 minute
4	**ESPS** requests SONI to issue an Emergency Action MW set-point of 30% of **Registered Capacity** noting calculated **MVAr** response to set-point of +12 degrees at 30% of **Registered Capacity** and wait until 1 minute after Emergency Action set-point has been achieved
5	**ESPS** requests SONI to issue a PF set-point of +8 degrees noting calculated **MVAr** response to set-point of +8 degrees at 30% of **Registered Capacity** and waits 1 minute
6	**ESPS** requests SONI to issue a PF set-point of 0 degrees and waits 1 minute
7	**ESPS** requests SONI to issue a PF set-point of -8 degrees noting calculated **MVAr** response to set-point of -8 degrees at 30% of **Registered Capacity** and waits 1 minute
8	**ESPS** requests SONI to issue a PF set-point of -12 degrees noting calculated **MVAr** response to set-point of -12 degrees at 30% of **Registered Capacity** and waits 1 minute
9	**ESPS** requests SONI to issue an Emergency Action MW set-point of -10% of **Registered Capacity** noting calculated **MVAr** response to set-point of -12 degrees at -10% of **Registered Capacity** and waits until 1 minute after **Active Power** output has reached the setpoint
10	**ESPS** requests SONI to issue a PF set-point of -8 degrees noting calculated **MVAr** response to set-point of -8 degrees at -10% of **Registered Capacity** and waits 1 minute
11	**ESPS** requests SONI to issue a PF set-point of 0 degrees and waits 1 minute
12	**ESPS** requests SONI to issue an Emergency Action set-point of 0 **MW** and turn Emergency Action OFF and wait until 1 minute after set-point has been achieved
13	**ESPS** requests SONI to select AVR control mode
14	**ESPS** confirms with SONI that the **ESPS** is at approximately 0 **MVAr** at the **Connection** Point
15	**ESPS** ends data recording
16	**ESPS** informs SONI that the Power Factor Control Mode test is complete If further testing is not being completed, go to 6: Return to Standard Settings

Return to Standard Settings

The steps below return the **ESPS** to standard settings at the completion of testing.

Return To Standard Settings Test Sequence –Test No.6	
Step No.	Action
1	**ESPS** informs SONI that **Reactive Power** Control Testing is complete and confirms the following the following: 1. **MW** output of the **ESPS** 2. Emergency Action Setpoint is 0MW 3. Emergency Action is OFF 4. **Frequency Response** is ON 5. Response is in Mode Frequency 1 6. AVR (kV) control mode is ON 7. The transformer tap position 8. On Load Tap Changer is in Automatic Mode 9. **System** Voltage 10. kV set-point = **system** voltage at **Connection Point** 11. Voltage slope setting = 3% 12. **MVAr** Export at the **Connection Point**

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 **Generator** to provide **Grid Code** Data; it should be noted that certain **PPM**s may be required to provide further technical information. Six weeks prior to synchronisation a **Generator** 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 **Generator** may deem as important.

1.2 Copy of Signed legal agreements
A copy of all signed legal agreements that may exist between the **Generator** and SONI and the **Generator** and NIE Networks e.g. **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 **Generator** 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/SEM

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

1.6 Pre-Synchronisation Checklist
For details please see Appendix B1

PART 2: Safety and Operation

2.1 Site Safety Rules
A copy of the **Generator**'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 **Generator** 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 **PPM**, **Generator** to provide NIE Networks' 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 **PPM**, **Generator** to provide NIE Networks' Site Responsibility Schedule)

2.4 Site Common Drawings
CC10.1.3. A **Generator** 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 **PPM**, **Generator** to provide Site Common Drawings provided to NIE Networks)

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 **Generator** is required to provide a continually manned control facility in accordance with CC10.1.3/CC11.1.4. A **Generator** shall provide to the **TSO** a list of persons appointed by the **Generator** to undertake operational duties on the **Generator**'s **System** and to issue and receive operational messages and instructions in relation to the **Generator**'s **System**.
OC7.6.2. A **Generator** 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 **Generator**'s **System** would contribute to a three-phase short circuit at the connection to the **Distribution System**. (Applicable only to **Generator**'s seeking a new or modified connection to the **Distribution System**) CC11.1.3.

PART 3: Connection Technical Data

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

i) **Generator** 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 **Generator** for new or modified arrangements for connection to or use of the NI **System** in relation to the **Generator** s **System**.
(All Standard and Detailed Planning Data requirements for **Generator**s connected to the Transmission **System** are detailed in Appendix A of the Planning Code.
All Standard and Detailed Planning Data requirements for **Generator** s connected to the **Distribution System** are detailed in Appendix B of the Planning Code.)

3.2 NIE Networks event recorder Details

CC8.8.2. NIE Networks 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 **Generator**'s event recorder Details

It is a **Grid Code** requirement for information of a technical nature to be supplied by **Generator**s under OC8.4.2 to enable the **TSO** to undertake analysis and validation of policies in the **Grid Code**. For **Generator** s to comply with this regulation they may provide **TSO** access to the **Generator**'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 **PPMs** connected to, or applying to connect to, the NI **System** in order to assess reliably the impact of the **PPMs** proposed installation on the dynamic performance and the security and stability of the Power **System**. The **Generator** is to supply **PPM** 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 **Generator** 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 **PPM Setting Schedule**.

3.6.3 SCADA Signals and Controls between **PPM** and SONI/NIE Networks

The analogue and digital input/output signals list between the **PPM** and SONI/NIE Networks 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 **PPM**.

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 **PPM**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 **PPM**

DRC Schedule 1 lists the Standard and Detailed Planning Data required from a **Generator** 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 **Generator**s connected to the Transmission **System** are detailed in Appendix A of the Planning Code.
All Standard and Detailed Planning Data requirements for **Generator**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 SDC1 Data'
Part 1 of DRC Schedule 2 contains the **PPM** 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 PPMs** to be supplied by **Generator**s by Gate Closure pursuant to SDC1.

4.3 **Generator** Protection
CC6.4. Details of internal or integral **Generator** protection including G59/G99 test witnessed reports (Loss of Mains protection type and setting).

4.4 Final Report
OC10.A.4. **Compliance** test results as detailed in the **PPM Setting 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,** or Global Horizontal Irradiance (GHI) as applicable).

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 **Generator**s with Demand and lists Customer Demand Management Details DRC Schedule 7 Part 2 specifies that the **TSO** may require **Generator**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: **PPM** Continuous **Grid Code Compliance** monitoring

SONI to produce a report for each **PPM** to cover the **Grid Code Compliance** monitoring period.
In order for the **PPM** 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 **PPM**
6.2 Active and **Reactive Power** Recovery of the **PPM** post fault
6.3 Behaviour of the **PPM** during low and high **Frequency** excursions
6.4 Any significant rates of change of **Frequency**
6.5 **High Voltage** Ride Through Capability of the **PPM**
6.6 Harmonics Studies
6.7 Response of the **PPM** during High Wind Speed shutdown events if applicable
6.8 Accuracy of the **MW Availability** Signal being provided to SONI by the **PPM**.

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

Appendix B1 Pre-Synchronisation Checklist and Supporting Documentation

Pre-synchronisation Checklist

PPM	
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	**Generator**				
LV metering completed	Construction Project Manager				
All SCADA to **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 synchronisation		
b)	Statement to demonstrate that all relevant sections of the **Distribution Code** and G99/NI have been complied with to the best of the information, knowledge and belief of the **Generator**.	Confirmation by DCC		Min 6 weeks prior to synchronisation		
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 synchronisation		
f)	Safety co-ordinators list.			Prior to confirming synchronisation		
g)	Telephone and Facsimile Numbers.			Prior to confirming synchronisation		
h)	Nomenclature.	Switchgear numbering		Prior to confirming synchronisation		
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 Networks **System**).			6 weeks prior to synchronisation		
l)	Protection settings.	Schedule 1A of **Connection Agreement**		In **Connection Agreement**		
m)	Protection witness test (copy required).	G99/NI Tests		Prior to confirming synchronisation		
n)	**Voltage Control** statement of capability and supporting documentation.	Confirmation by DCC		Prior to confirming synchronisation date		
p)	The NIE Networks form SRG 4 Appendix C "Authorisation of Customers to operate Northern Ireland Electricity controlled HV Switchgear – Standard Form of	Required as Emergency stop located in **PPM** switchroom operates NIE Networks		Prior to confirming synchronisation date		
q)	The NIE Networks form SRG 4 Appendix G "Request for Commissioning of **High Voltage** Supplies", is to be completed by customer and submitted to NIE	Completed immediately prior to synchronisation		Day of synchronisation		
r)	The NIE Networks form SRG 4 Appendix H "Customers Guarantee and Declaration Form", is to be completed and signed by customer and submitted to NIE Networks.			Prior to confirming synchronisation 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		

Appendix C Continuous Monitoring of MW Availability

Continuous monitoring of the **PPM** by SONI will take place; the **PPM** must adhere to the following:

Background

SONI defines **MW Availability** as follows:

"The amount of **Active Power** that the **Controllable PPM** could produce based on current wind and solar conditions as applicable, and network conditions. The **MW Availability** shall only differ from the **MW Output** if the **Controllable PPM** 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 **PPM Output** due to 33kV Dynamic Line Rating schemes are NIE Networks 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 PPM**, or Aggregated **Generating Unit**, the availability or Technical Parameters at levels or values different from those that the CDGU, **Controllable PPM**, 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 or solar resource level available as applicable.

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 **PPM** is controlling to;

f) Only actions by SONI to reduce the **PPM 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 **PPM**. 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 **PPM** 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 **PPM** was dispatched 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 **PPM** 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 **PPM** fails the **MW Availability** standard, SONI will as soon as practicably possible issue a formal non-**Compliance** notice to the **PPM**. 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 **PPM** is failing the **MW Availability** standard, SONI may substitute the **PPM MW Availability** signal with the actual metered **Output** of the **PPM** 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:

$$\text{NRMSD} = \frac{RMSD}{RC_{PPM}}$$

Where:

RC is the **Registered Capacity** of the **PPM** 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 **PPM** under analysis.
n is the number of time periods in the day

Appendix D SCADA Signals and Controls between Power Park Module and SONI/NIE Networks

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

*Analogue Input Signals (to SONI/NIE Networks) from **Power Generating Facility***					
Signal Description	*Description*	*Range*	*Units*	*Scale*	*Display Units*
MW*	Indication of the **Active Power Output** at **PPM Connection Point**	4 - 20	mA	TBA	**MW**
MVAr*	Indication of the **Reactive Power** Flow at the **PPM Connection Point**	4 - 20	mA	TBA	**MVAr**
Voltage*	Indication of the Voltage at the **PPM Connection Point**	4 - 20	mA	TBA	kV
Wind Speed	For wind **PPM**s only: Indication of the highest wind speed at any instant measured by a **Generating Unit** comprised within a wind **PPM**. All measurements shall be at **Generating Unit** hub height.	4 - 20	mA	TBA	m/sec
Wind Direction	For wind **PPM**s only: Indication of wind direction at wind **PPM** at hub height	4 - 20	mA	0-359[1]	deg
Global Horizontal Irradiance (GHI)	For Solar PV PPMs only: Indication of the highest Global Horizontal Irradiance (GHI) at any instant measured by a **Generating Unit** comprised within a **PPM**. All measurements shall be at **Generating Unit** panel height.	4 - 20	mA	TBA	m/sec
Ambient Temperature	Indication of ambient temperature on **PPM** met mast	4 - 20	mA	TBA	°C
Atmospheric Pressure	Atmospheric Pressure on **PPM** met mast	4 - 20	mA	735-1060	mBar
PPM MW Availability	The amount of **Active Power** that the **Controllable PPM** could produce based on current generation resource conditions and network conditions. The **MW Availability** shall only differ from the **MW Output** if the **Controllable PPM** 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 **PPM Output** due to 33kV Dynamic Line Rating schemes are NIE Networks actions only and these should be reflected in the **MW Availability**.	4 - 20	mA	TBA	**MW**
PPM % shutdown	For wind **PPM**: 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
PPM Active Set Point[3]	Indication of the **MW** set point to which the **PPM Output** is limited	4- 20	mA	TBA	**MW**
% **Generating Unit**s Available[4]	Indication of the % Available **Generating Unit**s at the **PPM**	4 - 20	mA	TBA	%
Droop	The frequency response droop characteristic to which the PPM is currently operating, depending on frequency response mode	4 - 20	mA	2-12	%
Deadband	The frequency response deadband currently in operation, depending on frequency response mode	4 - 20	mA	0 – 0.5	Hz

TBA – Scale to be agreed with SONI/NIE Networks SCADA

*Provided by NIE Networks 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 **PPM 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 **PPM Output** is limited i.e. the **PPM** 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 **PPM** is operating in a **Frequency** response mode. The **Generator** will provide SONI/NIE Networks with the lowest of these variables as the **PPM** active set point.

[4] This set point should reflect the % of Available **Generating Unit**s at the **PPM**. 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 Networks) to **Power Park Module***					
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 Networks) from **Power Park Module** (required dc voltage to be confirmed by SONI/NIE Networks SCADA)*		
Signal Description	*Description*	*Signal*
Common	??V dc signal provided by SONI to **Generator**	
Allow Ramp	Acknowledgement signal to allow positive ramping of **PPM**	??V dc
Stop Ramp	Acknowledgement signal to stop positive ramping of **PPM**	??V dc
Emergency Action OFF	Emergency Action OFF	??V dc
Emergency Action ON	Emergency Action ON	??V dc
LFSM – O ON	Indication that LFSM-O on when Emergency Action applied	??V dc
LFSM – O OFF	Indication that LFSM-O off when Emergency Action applied	??V dc
LFSM – U ON	Indication that LFSM-U on when Emergency Action applied	??V dc
LFSM – U OFF	Indication that LFSM-U off when Emergency Action applied	??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	For wind **PPM**: Alarm that **Generating Unit**s have begun to shutdown due to high wind speed	??V dc
Island Detected Trip	Alarm that the G59/G99 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 **PPM** is under the control of SONI	??V dc
Local Control Selected	Indication that the **PPM** 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 Networks as part of the connection arrangements, included for completeness.

[3]Only applicable if connected via 200 mm^2 line and **PPM 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 **PPM**

*Digital Output signals (from SONI/NIE Networks) to **Power Park Module**(required dc voltage to be confirmed by SONI/NIE Networks SCADA)*				
Signal Description	*Description*	*Permanent Common Signal*	*5sec pulse Open Signal*	*5sec pulse Close Signal*
Stop Ramp Common Allow Ramp	Prevent **PPM Active Power Output** increase, assisting SONI to manage **System Frequency** rise Blocking signal OFF allowing **PPM** to increase **Active Power Output**	0V	??V dc	??V dc
Emergency Action ON Common Emergency Action OFF	Initiate change of **PPM Output** Remove **Output** change command	0V	??V dc	??V dc
LFSM-O ON Common LFSM-O OFF	Select LFSM-O when Emergency Action applied Deselect LFSM-O when Emergency Action applied	0V	??V dc	??V dc
LFSM – U ON Common LFSM – U OFF	Select LFSM-U when Emergency Action applied Deselect LFSM-U when Emergency Action applied	0V	??V dc	??V dc
Voltage Control SELECT [1] Common	**Voltage Control** mode selected	0V		??V dc
Power Factor Control SELECT [1] Common	Power Factor Control mode selected	0V		??V dc
Reactive Power Dispatch SELECT [1] Common	**Reactive Power** Dispatch mode select	0V		??V dc
% **MW** Curtailment Controller ON Common % **MW** Curtailment Controller OFF	Initiate % **MW** curtailment for reserve Cease % **MW** curtailment for reserve	0V	??V dc	??V dc
CB1 Close [2] Common CB1 Open [2]	Close the **DNO** Circuit Breaker at the **Connection Point** Open the **DNO** Circuit Breaker at the **Connection Point**	0V	??V dc	??V dc

The TO or DSO Trip Relay Reset ON[1] 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 **PPM** is operating in Power Factor Control and SONI/NIE Networks wish to change the **PPM** to operate in **Voltage Control**, SONI/NIE Networks will send a **Voltage Control** SELECT digital output signal to the **PPM**. The **Generator** must ensure Power Factor Control turns OFF as **Voltage Control** turns ON.

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

Appendix E SCADA SIGNALS AND CONTROLS BETWEEN ESPS AND SONI/NIE NETWORKS

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

*Analogue Input Signals (to SONI/NIE Networks) from **ESPS***					
Signal Description	*Description*	*Range*	*Units*	*Scale*	*Display Units*
ESPS (Useable) Energy Remaining	Real-time quantity of energy that can be completely extracted from the ESPS	4 - 20	mA	TBA	**MWh**
ESPS Total (Usable) Storage Capacity	Represents the total energy that can be contained in the ESPS based on the real-time plant status.	4 - 20	mA	TBA	**MWh**
ESPS Available Active Power Export	Real-time signal indicating capability to export active power onto the grid	4 - 20	mA	TBA	**MW**
ESPS Available Active Power Import	Real-time signal indicating capability to import active power from the grid.	4 - 20	mA	TBA	**MW**
ESPS Available Reactive Power Export	Real-time signal indicating capability to export Reactive power onto the grid	4 - 20	mA	TBA	**MVAr**
ESPS Available Reactive Power Import	Real-time signal indicating capability to Import Reactive power from the grid.	4 - 20	mA	TBA	**MVAr**
ESPS Active Power Export/Import	Real-time signal indicating active power flow to/from the Grid at Point of Connection.	4 - 20	mA	TBA	**MW**
ESPS Reactive Power Export/Import	Real-time signal indicating Reactive power flow to/from the Grid at Point of Connection.	4 - 20	mA	TBA	**MVAr**
ESPS HV Voltage magnitude	Real-time signal indicating Customer Voltage at Point of Connection to the Grid	4 – 20	mA	TBA	**kV**
ESPS 110 kV Power factor (decimal)	Real-time signal indicating Customer measured Power Factor at Point of Connection to the Grid.	4 - 20	mA	TBA	Decimal
Active Power Set Point feedback	Feedback to confirm received value of Active Power Dispatch Set Point Command	4 - 20	mA	TBA	**MW**
Reactive Power Set Point feedback	Feedback to confirm received value of Reactive Power Dispatch Set Point Command	4 - 20	mA	TBA	**MVAr**
Voltage Set Point Feedback	Feedback to confirm received value of Voltage Dispatch Set Point Command (kV)	4 - 20	mA	TBA	**kV**
Power Factor Set Point Feedback	Feedback to confirm received value of Power Factor Dispatch Set Point Command (decimal)	4 - 20	mA	TBA	Decimal

Ramp Rate to reach set point feedback	Feedback to confirm received value of Ramp Rate to reach Set Point Command	4 - 20	mA	0-100	% **Registered Capacity**/min
System Frequency	Real-time signal indicating System frequency as measured by ESPS	4 - 20	mA	TBA	**Hz**
Active Low Frequency Trigger Setting	Low frequency trigger which is currently active in the ESPS controller as defined by the active frequency response mode	4- 20	mA	49-50	**Hz**
Active High Frequency Trigger Setting	High frequency trigger which is currently active in the ESPS controller as defined by the active frequency response mode	4 - 20	mA	50-51	**Hz**
Active Low Frequency Trajectory Setting	Low frequency trajectory which is currently active in the ESPS controller as defined by the active frequency response mode	4 - 20	mA	0-10	**Hz**
Active High Frequency Trajectory Setting	High frequency trajectory which is currently active in the ESPS controller as defined by the active frequency response mode	4 - 20	mA	0-10	**Hz**
Active Maximum underfrequency response setting	Maximum underfrequency response which is currently active in the ESPS controller as defined by the active frequency response mode	4 - 20	mA	TBA	**MW**
Active Maximum overfrequency response setting	Maximum overfrequency response which is currently active in the ESPS controller as defined by the active frequency response mode	4 - 20	mA	TBA	**MW**
FFR Availability	Real-time signal indicating the remaining quantity of FFR which is available	4 - 20	mA	TBA	**MW**
POR Availability	Real-time signal indicating the remaining quantity of POR which is available	4 - 20	mA	TBA	**MW**
SOR Availability	Real-time signal indicating the remaining quantity of SOR which is available	4 - 20	mA	TBA	**MW**
TOR1 Availability	Real-time signal indicating the remaining quantity of TOR1 which is available	4 - 20	mA	TBA	**MW**
TOR2 Availability	Real-time signal indicating the remaining quantity of TOR2 which is available	4 - 20	mA	TBA	**MW**
FFR-o Availability	Real-time signal indicating the remaining quantity of overfrequency response which is available in the FFR timeframe	4 - 20	mA	TBA	**MW**
POR-o Availability	Real-time signal indicating the remaining quantity of overfrequency response which is available in the POR timeframe	4 - 20	mA	TBA	**MW**
SOR-o Availability	Real-time signal indicating the remaining quantity of overfrequency response which is available in the SOR timeframe	4 - 20	mA	TBA	**MW**
TOR1-o Availability	Real-time signal indicating the remaining quantity of overfrequency response which is available in the TOR1 timeframe	4 - 20	mA	TBA	**MW**
TOR2-o Availability	Real-time signal indicating the remaining quantity of overfrequency response which is available in the TOR2 timeframe	4 - 20	mA	TBA	**MW**

TBA – Scale dependent on characteristics of project and to be agreed with SONI/NIE Networks SCADA.

*Analogue Output Signals (from SONI/NIE Networks) to **ESPS***					
Signal Description	*Description*	*Range*	*Units*	*Scale*	*Display Units*
Active Power Dispatch Set Point Command	Active Power flow which the ESPS is required to maintain when Emergency Action command is active	4 - 20	mA	TBA	**MW**
Reactive Power Disp. Set Point Command	Reactive Power flow which the ESPS is required to maintain when operating in Reactive Power Dispatch	4 - 20	mA	TBA	**MVAr**
Voltage Dispatch Set Point Command	Target voltage at connection point when ESPS is operating in Voltage Control mode	4 - 20	mA	TBA	**kV**
Power Factor Dispatch Set Point Command	Power Factor which the ESPS is required to maintain when operating in Power Factor Control mode	4 - 20	mA	-0.85 to +0.85	Decimal
Ramp Rate to reach Set Point Command	Rate at which ESPS is required to ramp to meet an issued Active Power setpoint	4 - 20	mA	0 - 100	% **Registered Capacity**/minute

*Digital Input Signals (to SONI/NIE Networks) from **ESPS** (required dc voltage to be confirmed by SONI/NIE Networks SCADA)*		
Signal Description	*Description*	*Signal*
HV CB Low SF6 (Operated/reset)	Customer HV Circuit Breaker – SF6 Low alarm	??V dc
HV CB Switch Status (Open/closed)	Customer HV Circuit Breaker Position	??V dc
Earth Switch Status (Open/closed)	Customer HV Earth Switch Position	??V dc
HV CB Fail (operated /reset)	Customer HV CB Fail Indication	??V dc
HV CB Lockout (Operated/reset	Customer HV CB Lockout Indication	??V dc
Reactive Power Mode Feedback (ON/OFF)	Indication that the ESPS is in Reactive Power Dispatch mode	??V dc
Voltage Mode Feedback (ON/OFF)	Indication that the ESPS is in Voltage Control mode	??V dc
Power Factor Mode (ON/OFF)	Indication that the ESPS is in Power Factor Control mode	??V dc
Emergency Action Feedback (ON/OFF)	Indication that Emergency Action control is On or OFF	??V dc
Grid Control Selected (On/OFF)	Indication that the ESPS is under the control of SONI	??V dc
Local Control Selected (On/OFF)	Indication that the ESPS is under the control of **Generator**	??V dc
Frequency Response Command (ON/OFF)	Feedback to confirm Frequency Response is ON or OFF	??V dc
ESPS Charging Active (ON/OFF)	Indication that the ESPS is importing energy from the System	??V dc
ESPS Generating Active (ON/OFF)	Indication that the ESPS is exporting energy to the System	??V dc
ESPS Capacity Limited Ramp (ON/OFF)	Indication that ESPS is in Capacity Limited Ramp state	??V dc
Reserve Response Mode 1 (ON/OFF)	Feedback to confirm System Service Response Mode 1 On or Off	??V dc
Reserve Response Mode 2 (ON/OFF)	Feedback to confirm System Service Response Mode 2 On or Off	??V dc
Reserve Response Mode 3 (ON/OFF)	Feedback to confirm System Service Response Mode 3 On or Off	??V dc
Reserve Response Mode 4 (ON/OFF)	Feedback to confirm System Service Response Mode 4 On or Off	??V dc
Reserve Response Mode 5 (ON/OFF)	Feedback to confirm System Service Response Mode 5 On or Off	??V dc
Fire Alarm Operated (ON/OFF)	Fire Alarm Signal	??V dc

Island Detected Trip (RoCoF)	Alarm that the G59/G99 protection has operated	??V dc
Customer Emergency Push Button Trip (ON/OFF)	Indication that the Customer Emergency Push Button has operated and CB MP100 should have opened	??V dc

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**.

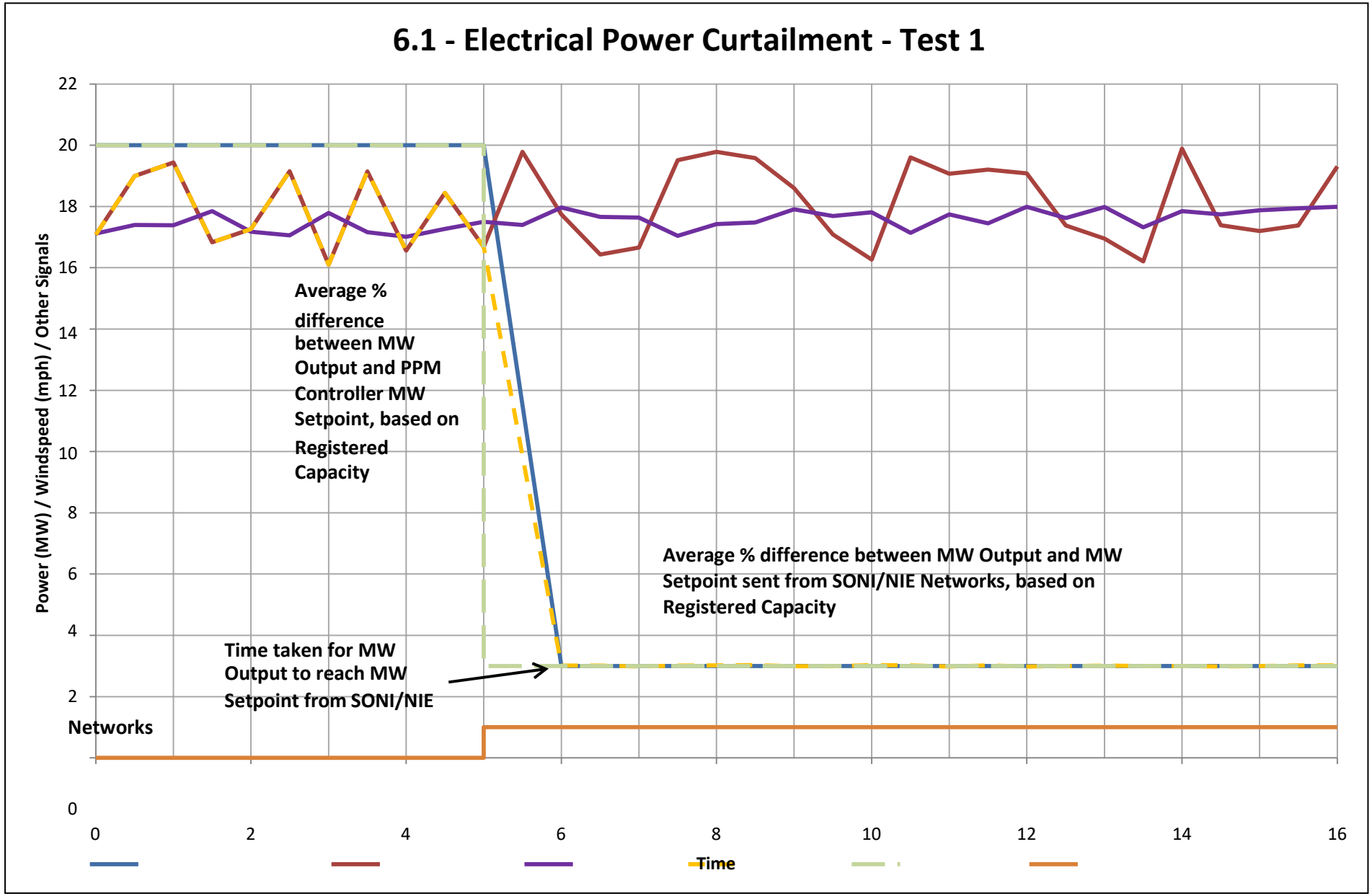
*Digital Output Signals (from SONI/NIE Networks) to **ESPS** (required dc voltage to be confirmed by SONI/NIE Networks SCADA)*		
Signal Description	*Description*	*Signal*
HV CB Open	Command from SONI/NIE Networks to open HV CB	??V dc
Reactive Power Cont. Mode select Command(ON/OFF)	Command to turn ON Reactive Power Control mode	??V dc
Voltage Control Mode Select Command (ON/OFF)	Command to turn ON Voltage Control mode	??V dc
Power Factor Cont. Mode Select Command (ON/OFF)	Command to turn ON Power Factor Control mode	??V dc
Emergency Action Command (ON/OFF)	Command to turn Emergency Action ON or OFF	??V dc
Frequency Response Command (ON/OFF)	Command to turn Frequency Response ON or OFF	??V dc
Reserve Response Mode 1 Command	Command to turn Frequency Response mode 1 ON	??V dc
Reserve Response Mode 2 Command	Command to turn Frequency Response mode 2 ON	??V dc
Reserve Response Mode 3 Command	Command to turn Frequency Response mode 3 ON	??V dc
Reserve Response Mode 4 Command	Command to turn Frequency Response mode 4 ON	??V dc
Reserve Response Mode 5 Command	Command to turn Frequency Response mode 5 ON	??V dc

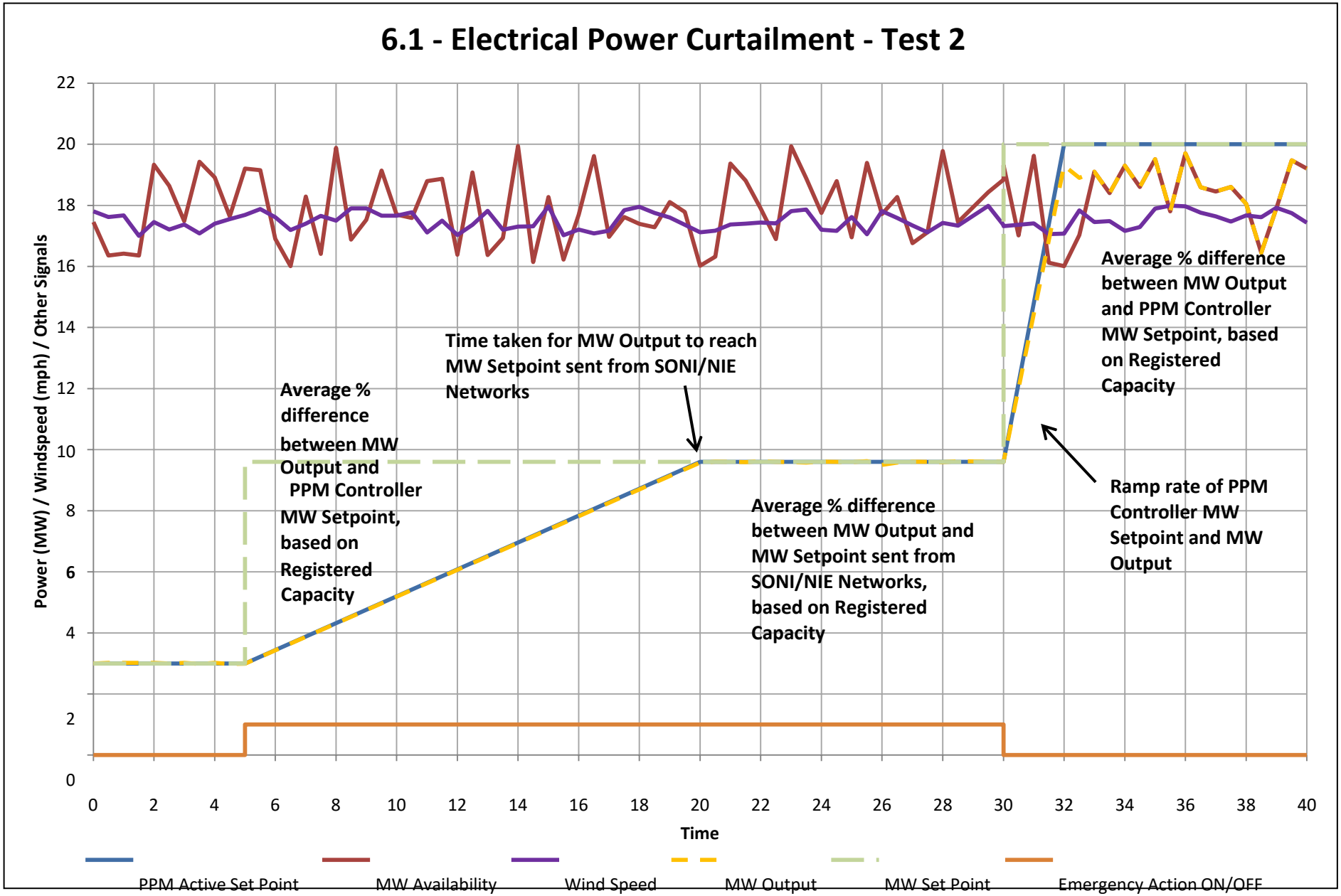
[1] It is the responsibility of the **Generator** to configure **Voltage Control**, Power Factor Control and **Reactive Power** dispatch such that one of these 3 modes is always ON and not more than one mode is ON at any one time. Thus, if the **PPM** is operating in Power Factor Control and SONI/NIE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

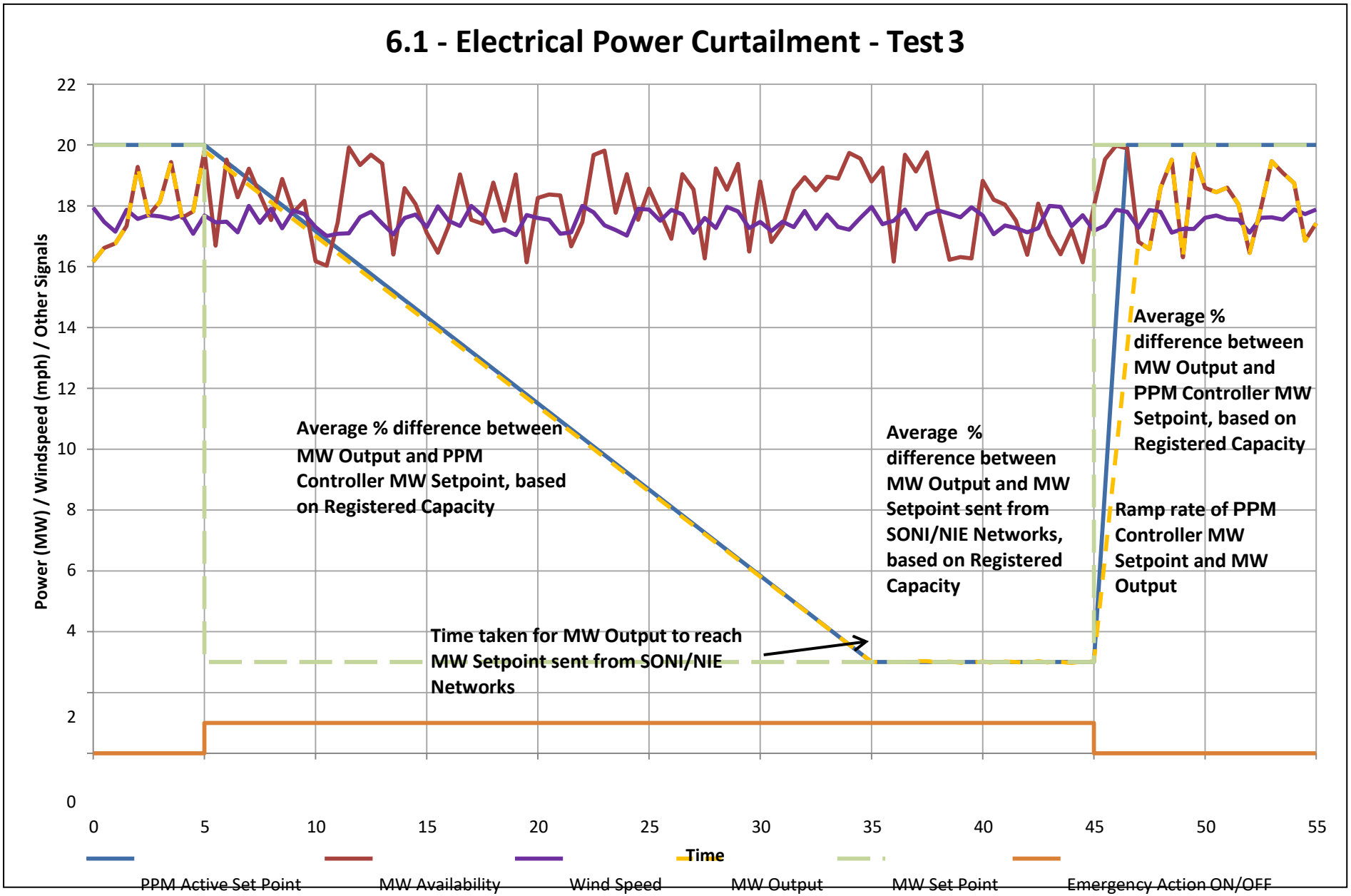
[2] Provided by NIE Networks as part of the connection arrangements included for completeness

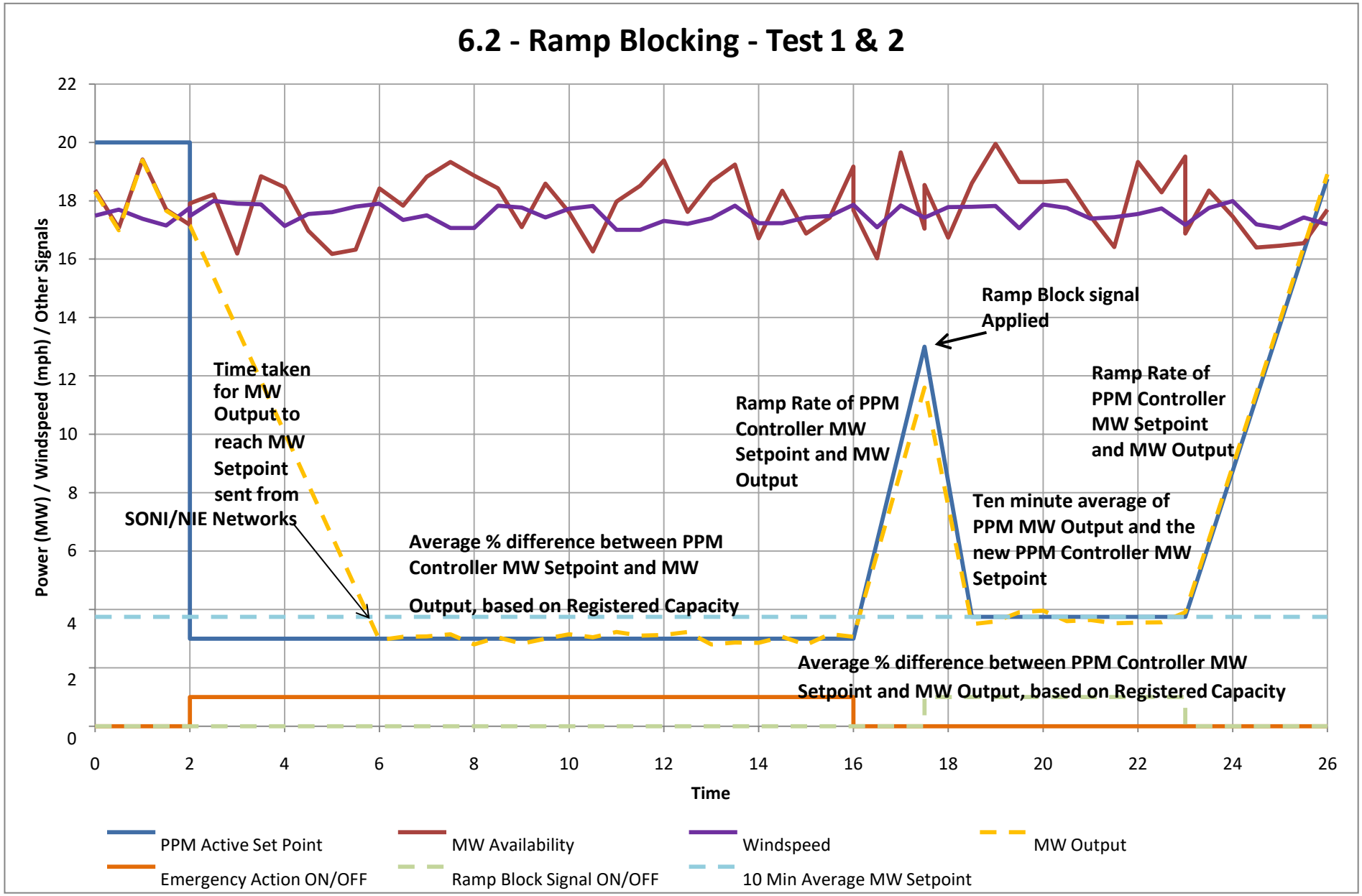
Appendix ~~E~~F Example MS Excel Plots To Be Submitted by the Generator

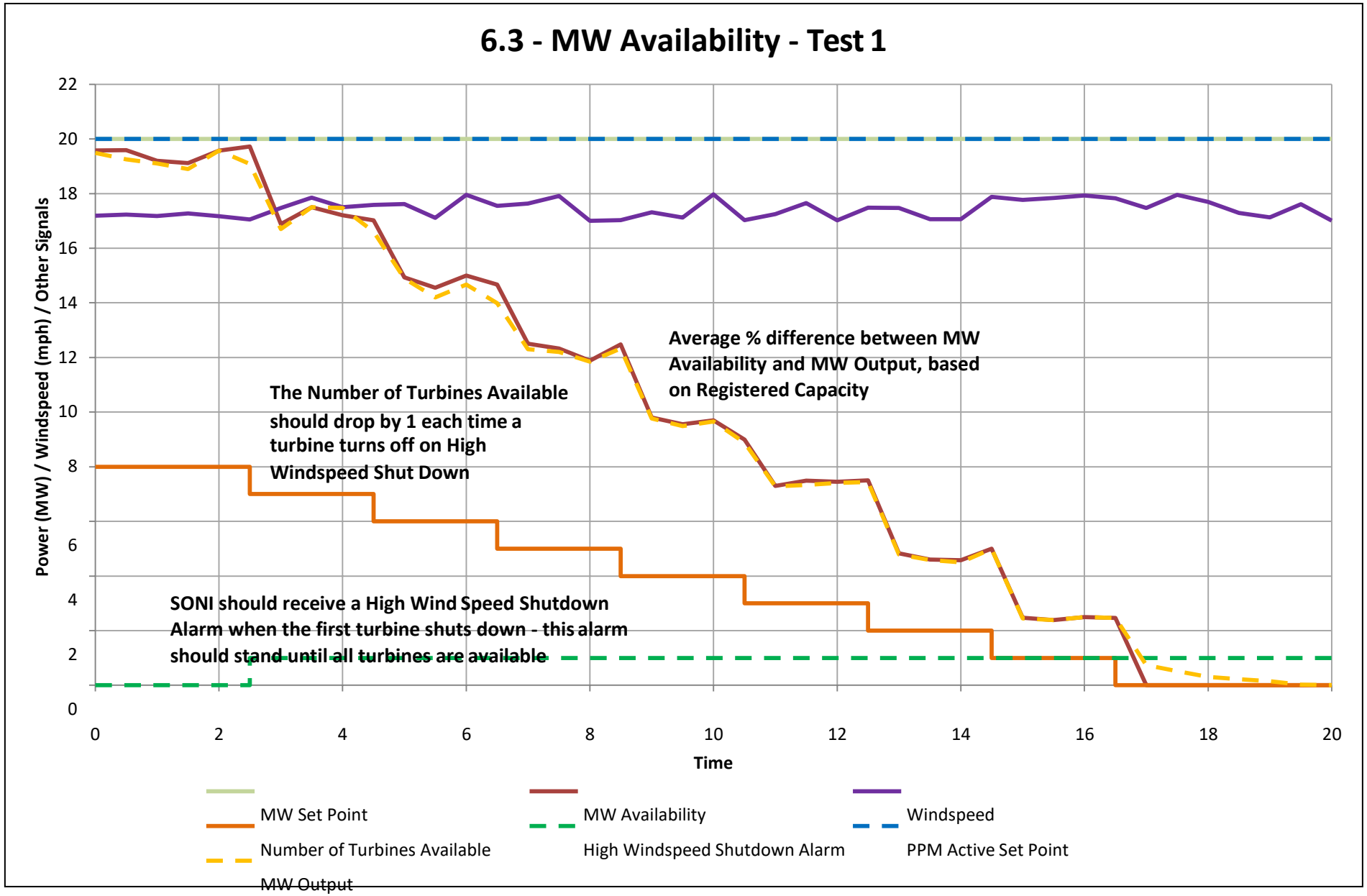
The following graphs are for illustration only, highlighting the traces to be plotted and the annotations to be included by the **Generator**. If the **Generator** feels additional information is required in order to demonstrate **Compliance** then this documentation should also be included.

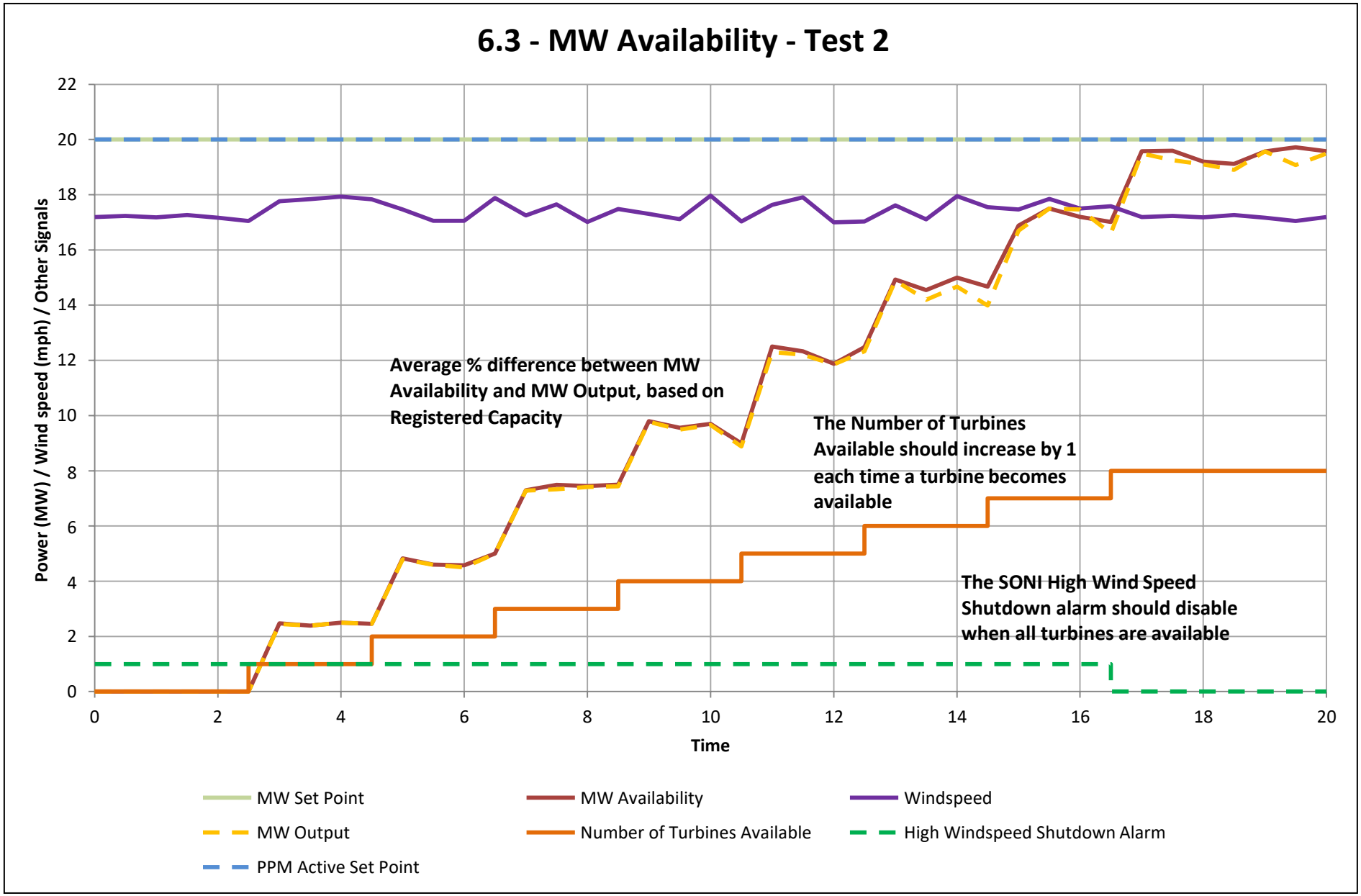

6.1 - Electrical Power Curtailment - Test 1
Power (MW) / Windspeed (mph) / Other Signals
22
20
18
16
14
12
10
8
6
4
2
0
Networks
Average % difference between MW Output and PPM Controller MW Setpoint, based on Registered Capacity
Average % difference between MW Output and MW Setpoint sent from SONI/NIE Networks, based on Registered Capacity
Time taken for MW Output to reach MW Setpoint from SONI/NIE
0
2
4
6
8
10
12
14
16
Time
PPM Active Set Point
MW Availability
Wind Speed
MW Output
MW Set Point
Emergency Action ON/OFF

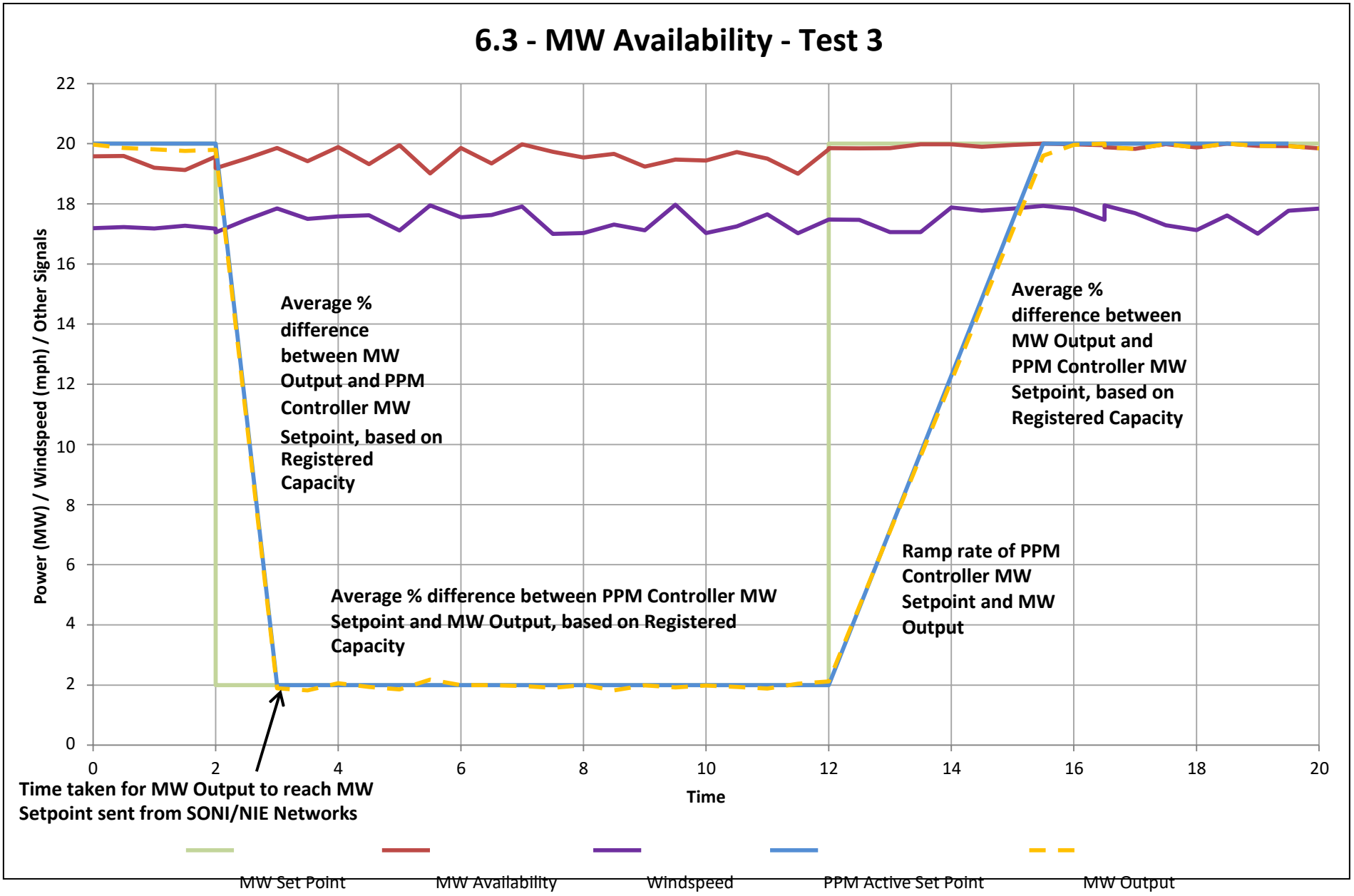

6.1 - Electrical Power Curtailment - Test 2
Power (MW) / Windspeed (mph) / Other Signals
Time
Average % difference between MW Output and PPM Controller MW Setpoint, based on Registered Capacity
Time taken for MW Output to reach MW Setpoint sent from SONI/NIE Networks
Average % difference between MW Output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

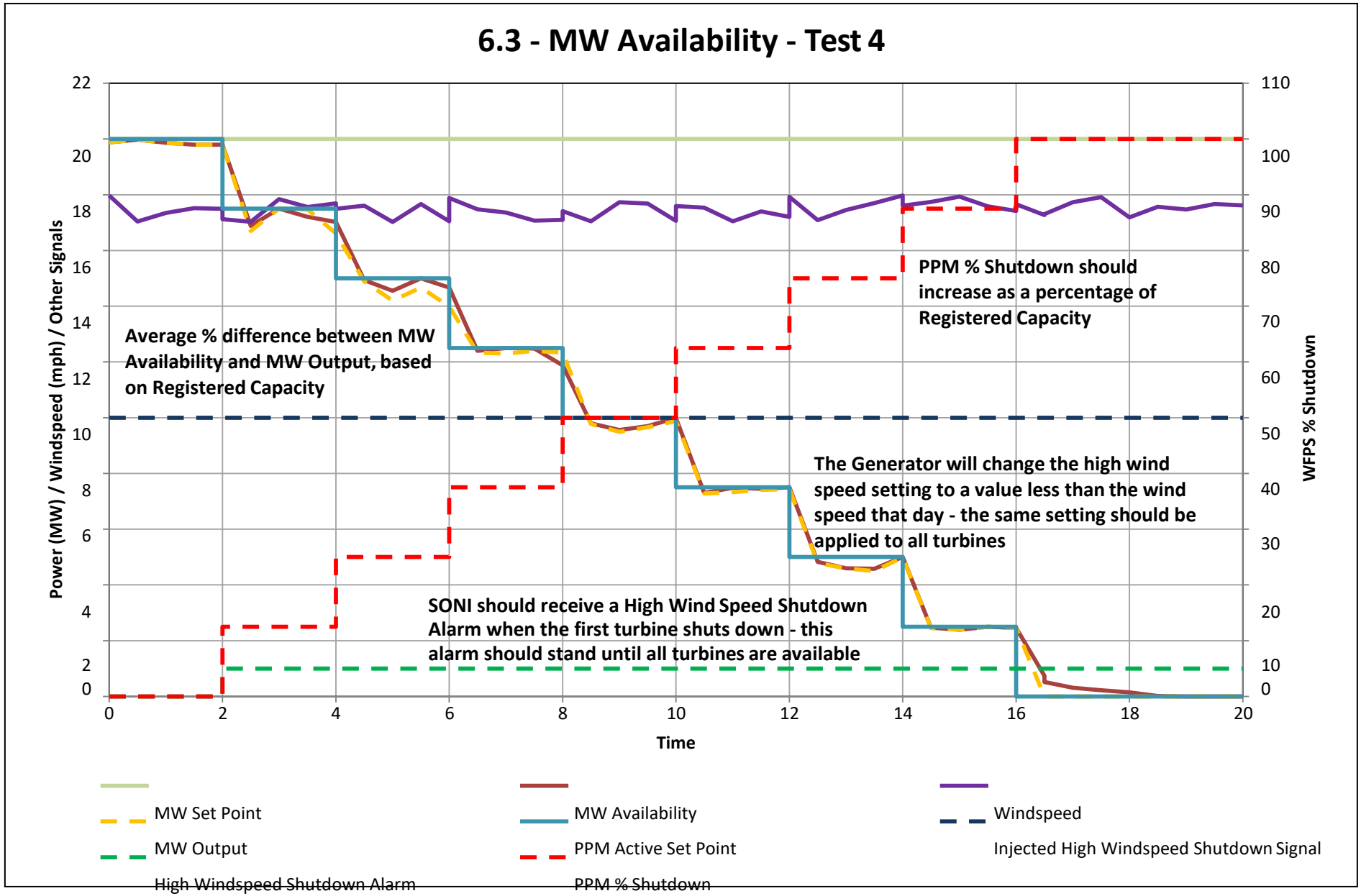

6.1 - Electrical Power Curtailment - Test 3
Power (MW) / Windspeed (mph) / Other Signals
Time
Average % difference between MW Output and PPM Controller MW Setpoint, based on Registered Capacity
Average % difference between MW Output and MW Setpoint sent from SONI/NIE Networks, based on Registered Capacity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

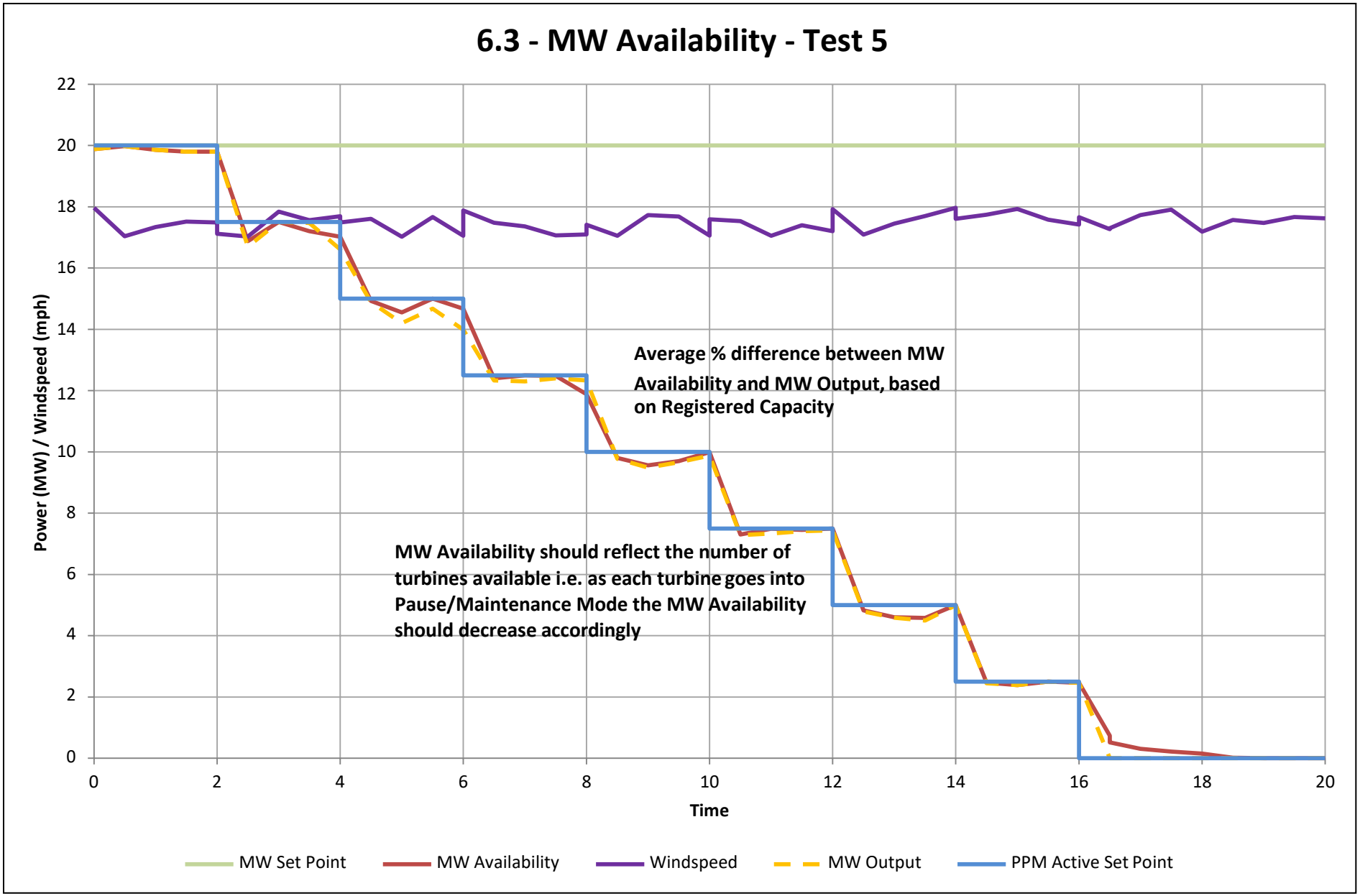

6.2 - Ramp Blocking - Test 1 & 2
Power (MW) / Windspeed (mph) / Other Signals
Time
Time taken for MW Output to reach MW Setpoint sent from SONI/NIE Networks
Average % difference between PPM Controller MW Setpoint and MW Output, based on Registered Capacity
Ramp Block signal Applied
Ramp Rate of PPM Controller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

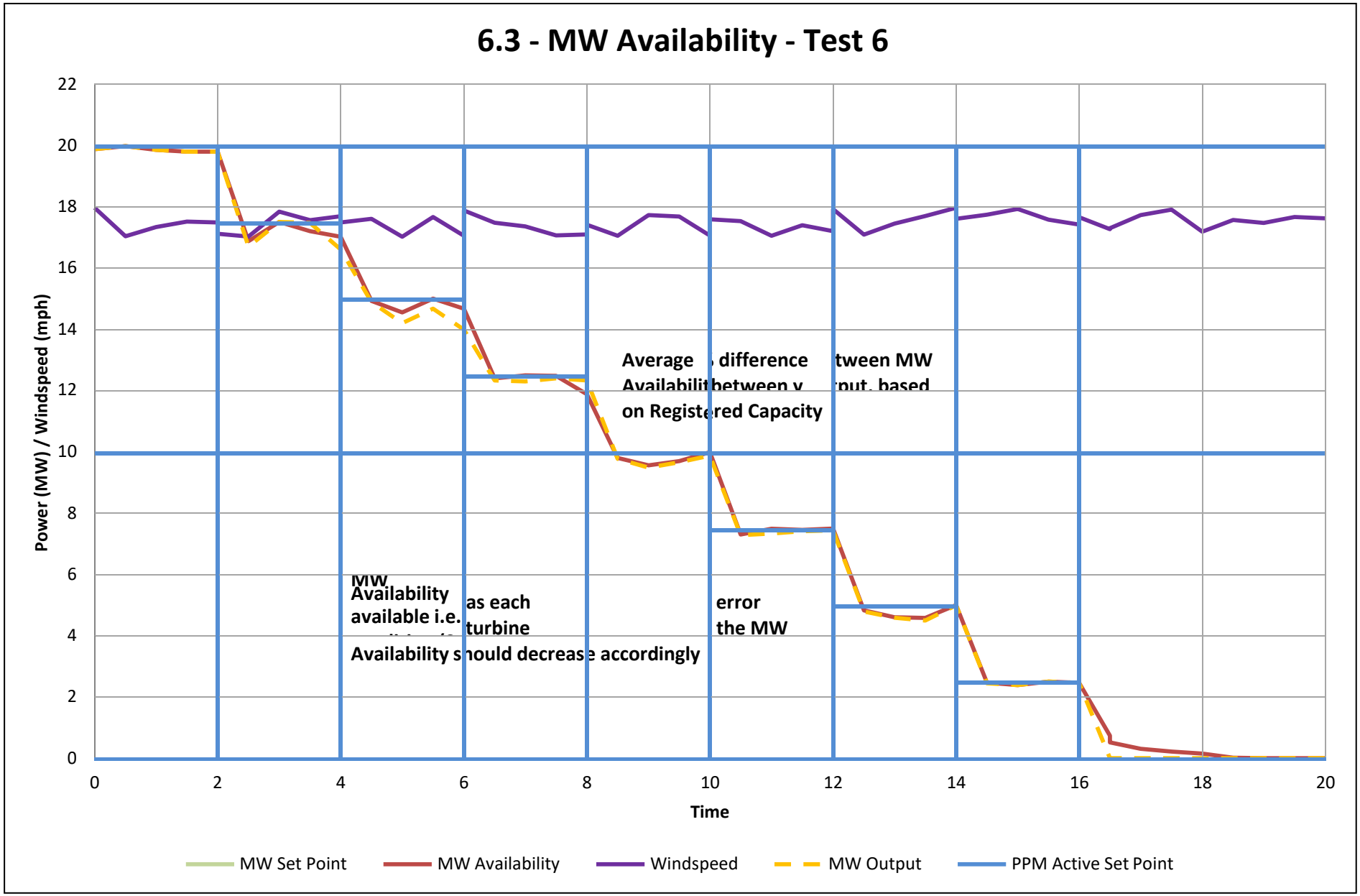

6.3 - MW Availability - Test 1
Power (MW) / Windspeed (mph) / Other Signals
Time
0
2
4
6
8
10
12
14
16
18
20
22
The Number of Turbines Available should drop by 1 each time a turbine turns off on High Windspeed Shut Down
Average % difference between MW Availability and MW Output, based on Registered Capacity
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
PPM Active Set Point
MW Output

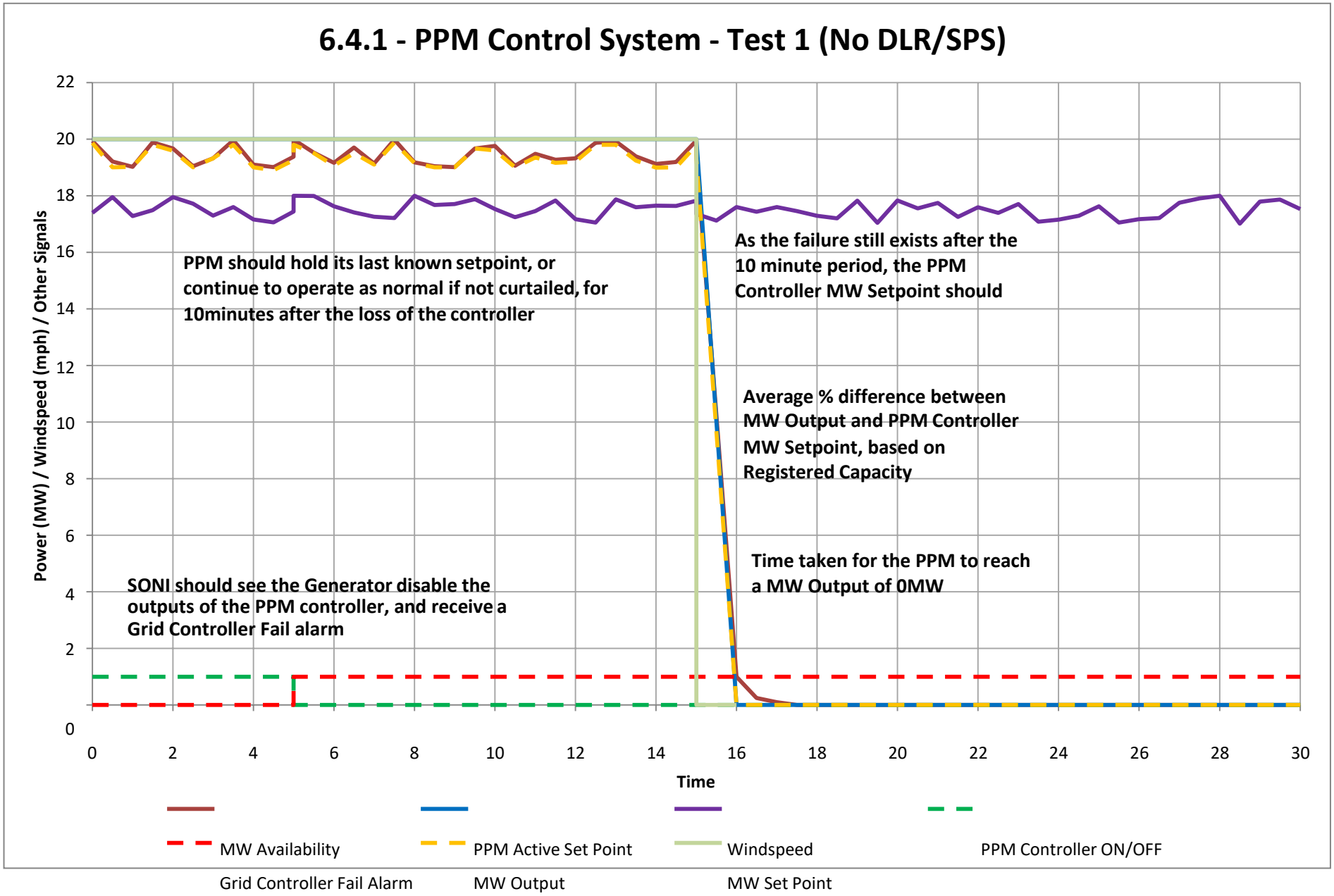

6.3 - MW Availability - Test 2
Power (MW) / Wind speed (mph) / Other Signals
Time
Average % difference between MW Availability and MW Output, based on Registered Capacity
The Number of Turbines Available should increase by 1 each time a turbine becomes available
The SONI High Wind Speed Shutdown alarm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

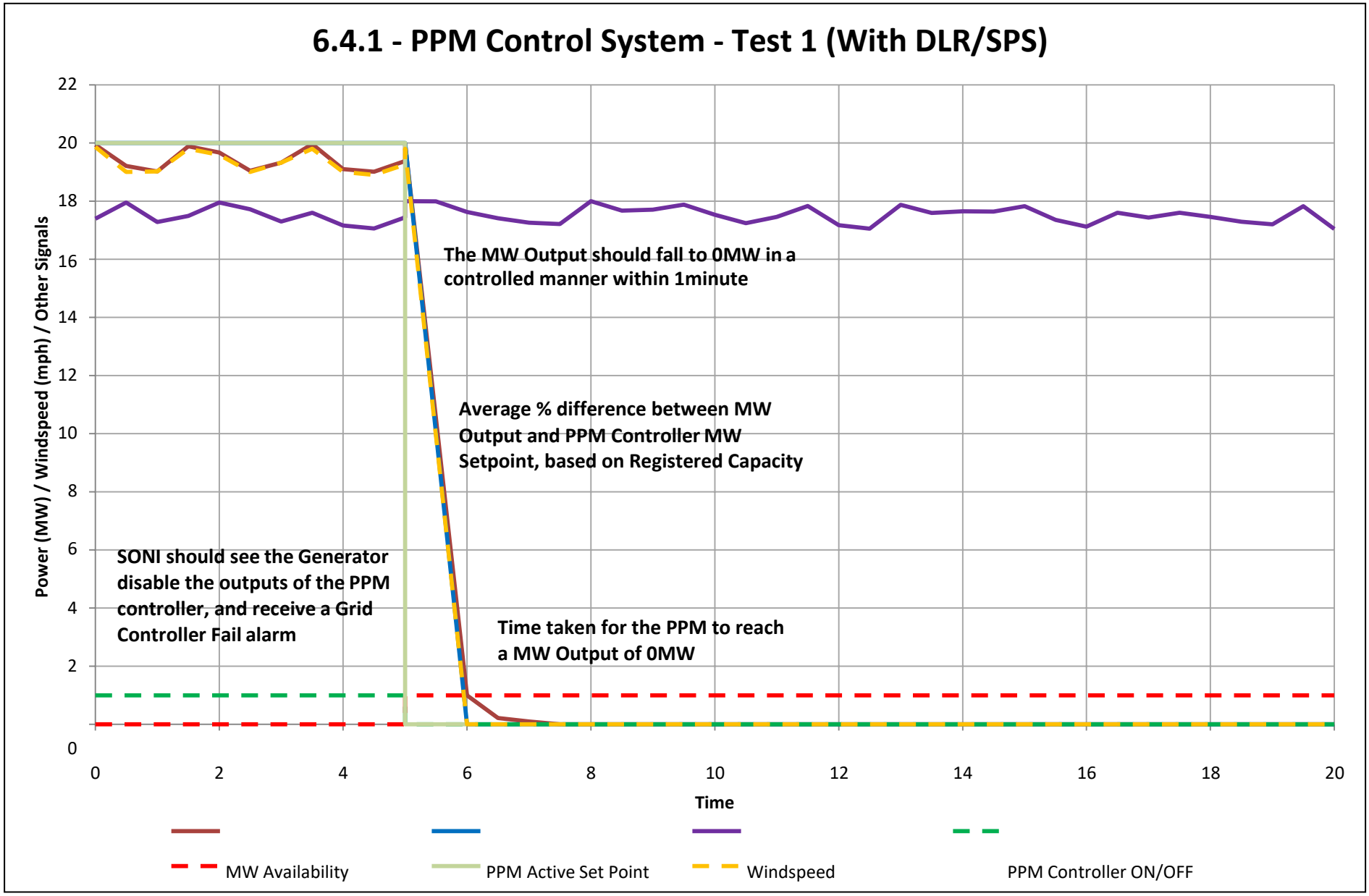

6.3 - MW Availability - Test 3
Power (MW) / Windspeed (mph) / Other Signals
Time
Average % difference between MW Output and PPM Controller MW Setpoint, based on Registered Capacity
Average % difference between PPM Controller MW Setpoint and MW Output, based on Registered Capacity
Average % difference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

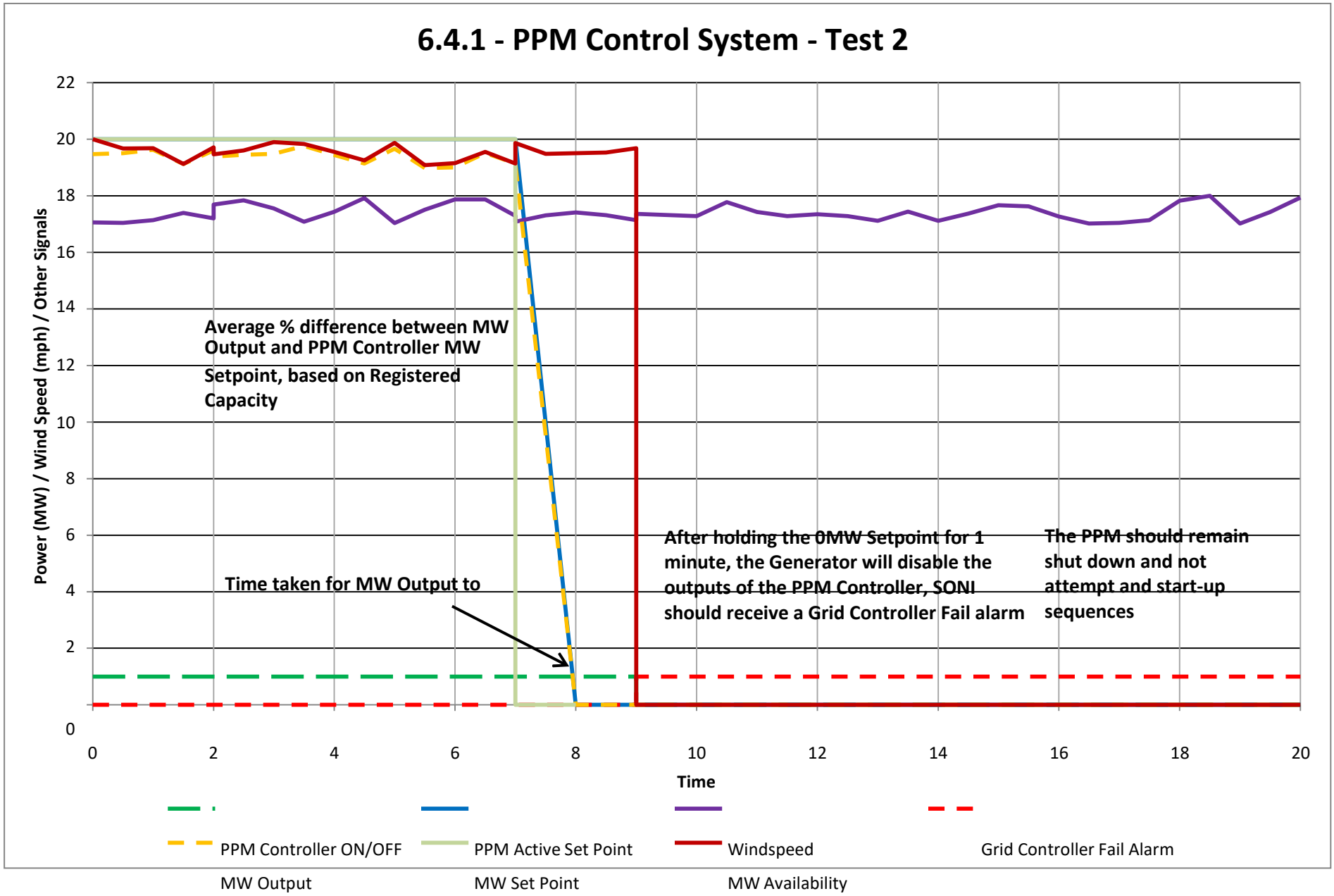

6.3 - MW Availability - Test 4
Power (MW) / Windspeed (mph) / Other Signals
WFPS % Shutdown
Time
Average % difference between MW Availability and MW Output, based on Registered Capacity
PPM % Shutdown should increase as a percentage of Registered Capacity
The Generator will change the high wind speed 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
PPM Active Set Point
Injected High Windspeed Shutdown Signal
High Windspeed Shutdown Alarm
PPM % Shutdown

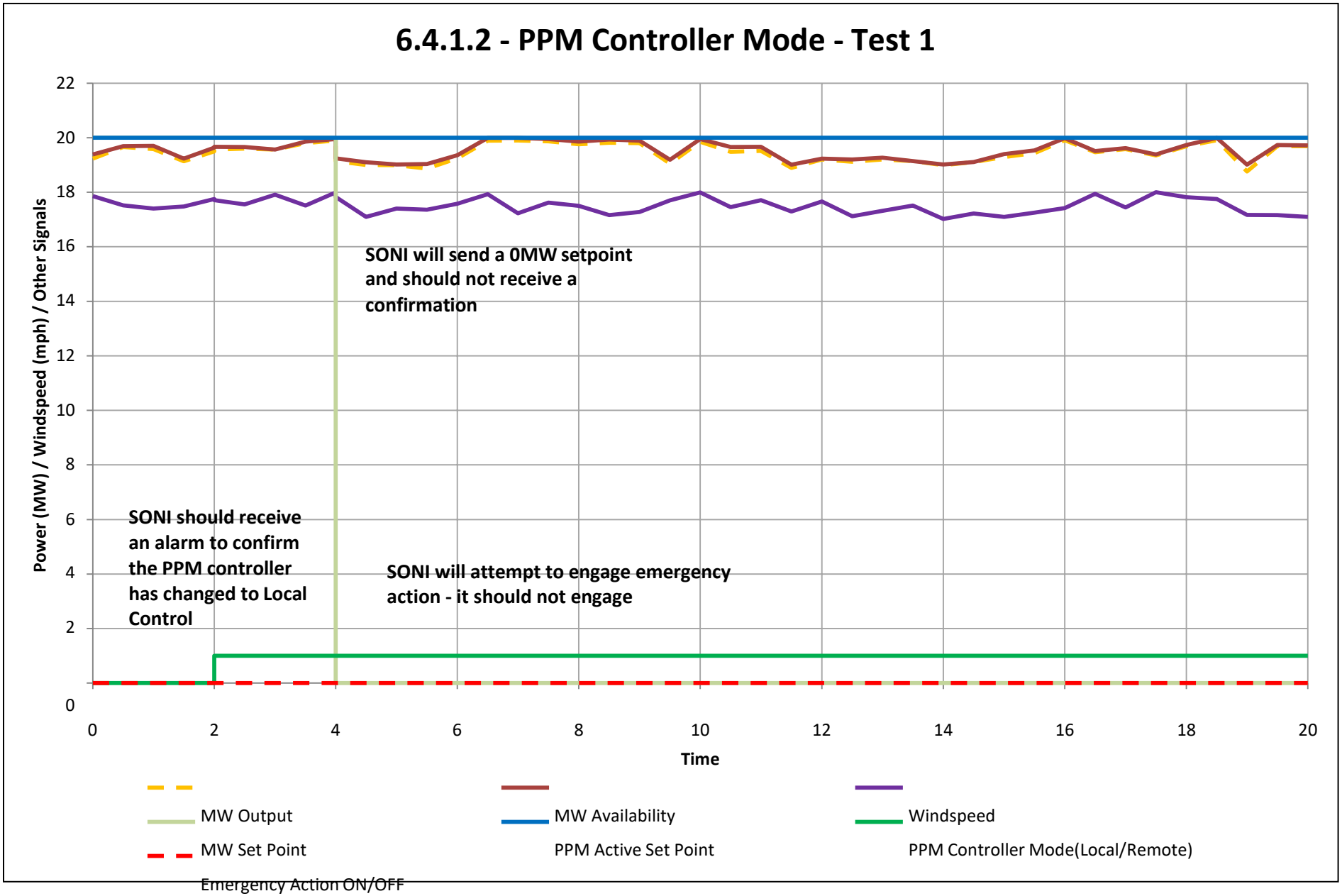

6.3 - MW Availability - Test 5
Power (MW) / Windspeed (mph)
Time
Average % difference between MW Availability and MW Output, based on Registered Capacity
MW Availability should reflect the number of turbines available i.e. as each turbine goes into Pause/Maintenance Mode the MW Availability should decrease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

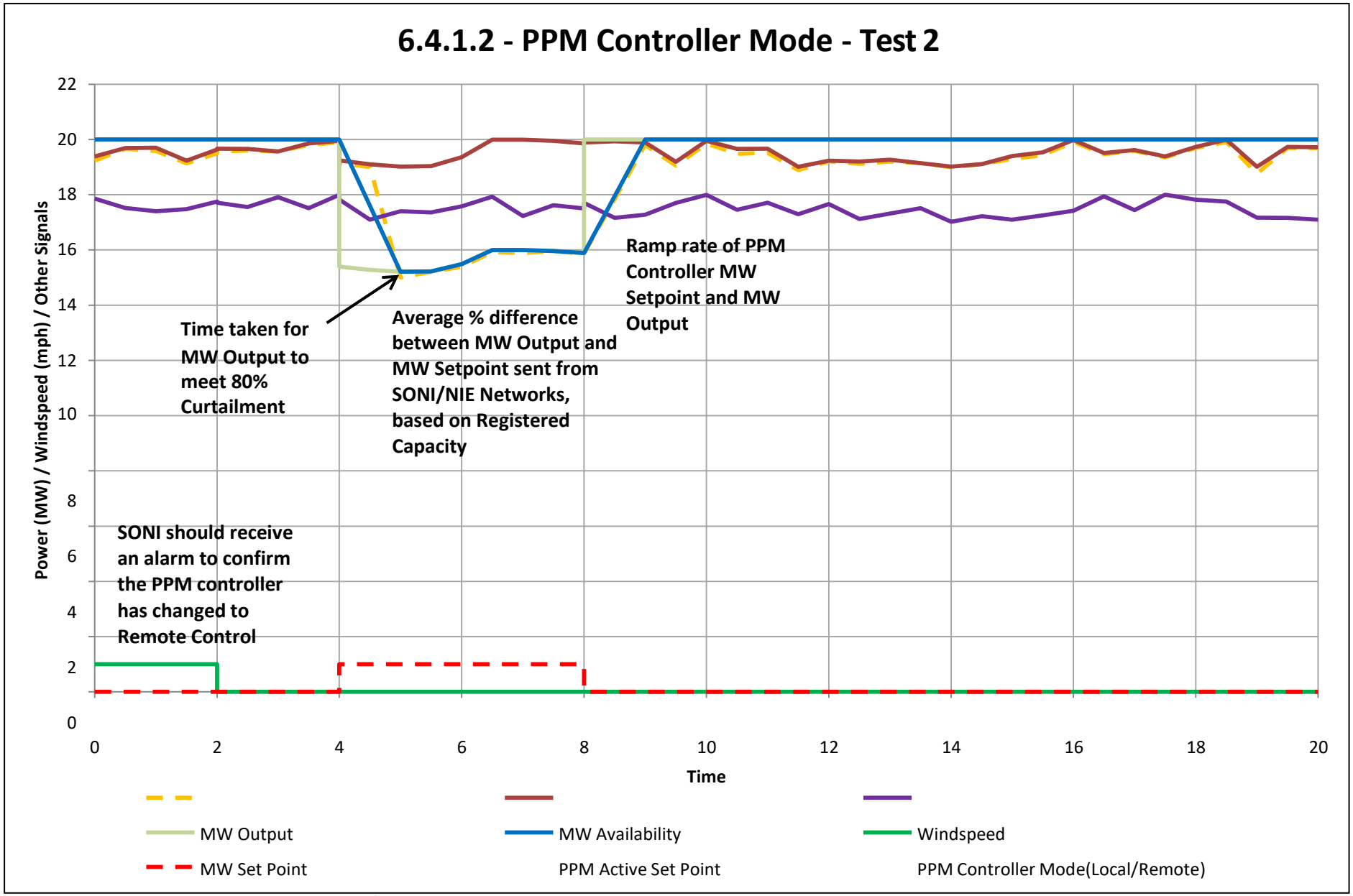

6.3 - MW Availability - Test 6
Power (MW) / Windspeed (mph)
Time
0
2
4
6
8
10
12
14
16
18
20
22
Average difference
on Registered Capacity
MW
Availability
available i.e.
as each
turbine
Availability should decrease accordingly
error
the MW
MW Set Point
MW Availability
Windspeed
MW Output
PPM Active Set Point

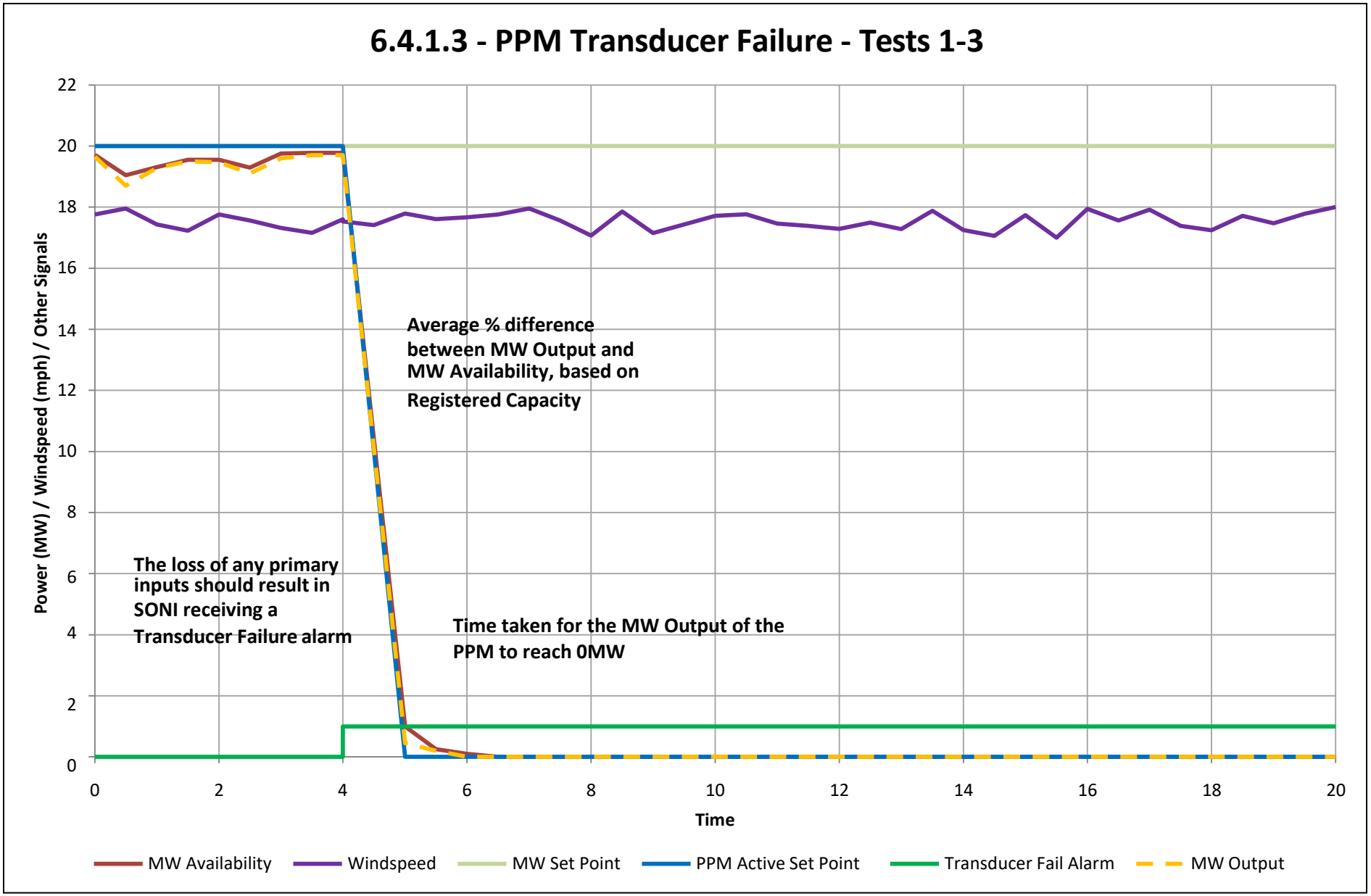

6.4.1 - PPM Control System - Test 1 (No DLR/SPS)
Power (MW) / Windspeed (mph) / Other Signals
Time
PPM should hold its last known setpoint, or continue to operate as normal if not curtailed, for 10minutes after the loss of the controller
As the failure still exists after the 10 minute period, the PPM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

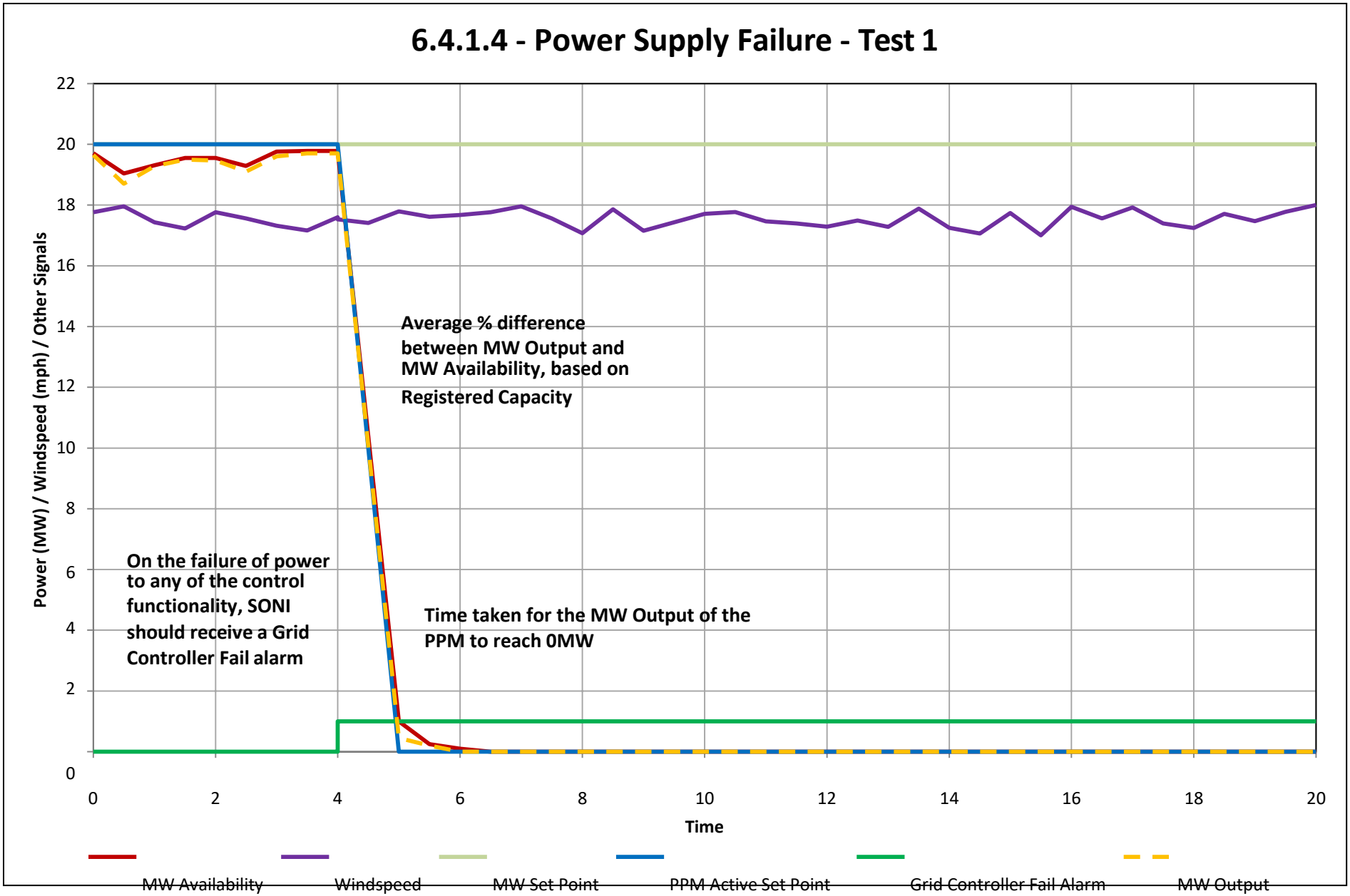

6.4.1 - PPM Control System - Test 1 (With DLR/SPS)
Power (MW) / Windspeed (mph) / Other Signals
Time
The MW Output should fall to 0MW in a controlled manner within 1minute
Average % difference between MW Output and PPM Controller MW Setpoint, based on Registered Capacity
SONI should see the Generator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

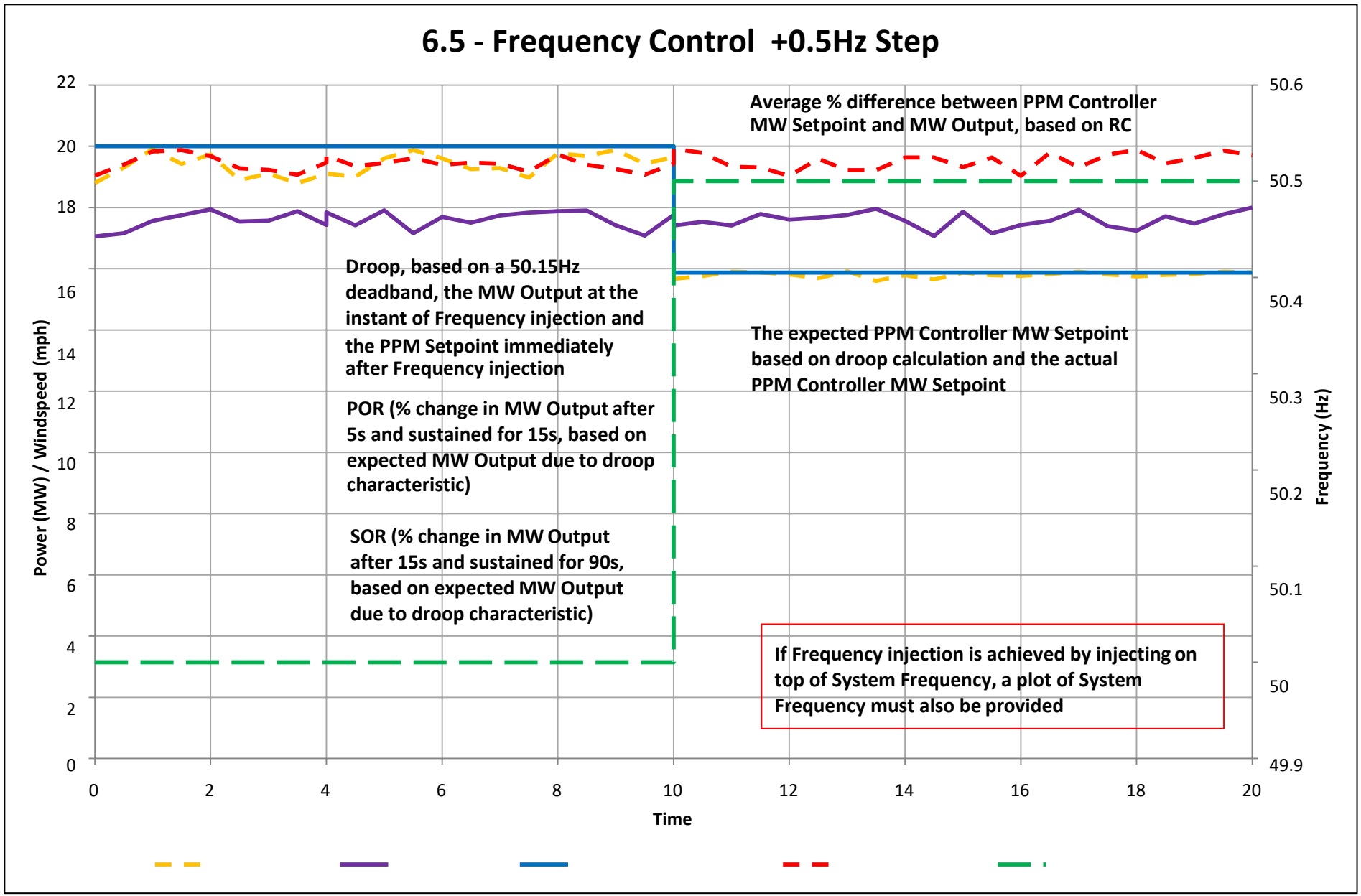

6.4.1 - PPM Control System - Test 2
Power (MW) / Wind Speed (mph) / Other Signals
Time
Average % difference between MW Output and PPM Controller MW Setpoint, based on Registered Capacity
Time taken for MW Output to
After holding the 0MW Setpoint for 1 minute, the Generator will disable the outputs of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


6.4.1.2 - PPM Controller Mode - Test 1
Power (MW) / Windspeed (mph) / Other Signals
22
20
18
16
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
16
18
20
Time
SONI will send a 0MW setpoint and should not receive a confirmation
SONI should receive an alarm to confirm the PPM 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
PPM Active Set Point
PPM Controller Mode(Local/Remote)
Emergency Action ON/OFF

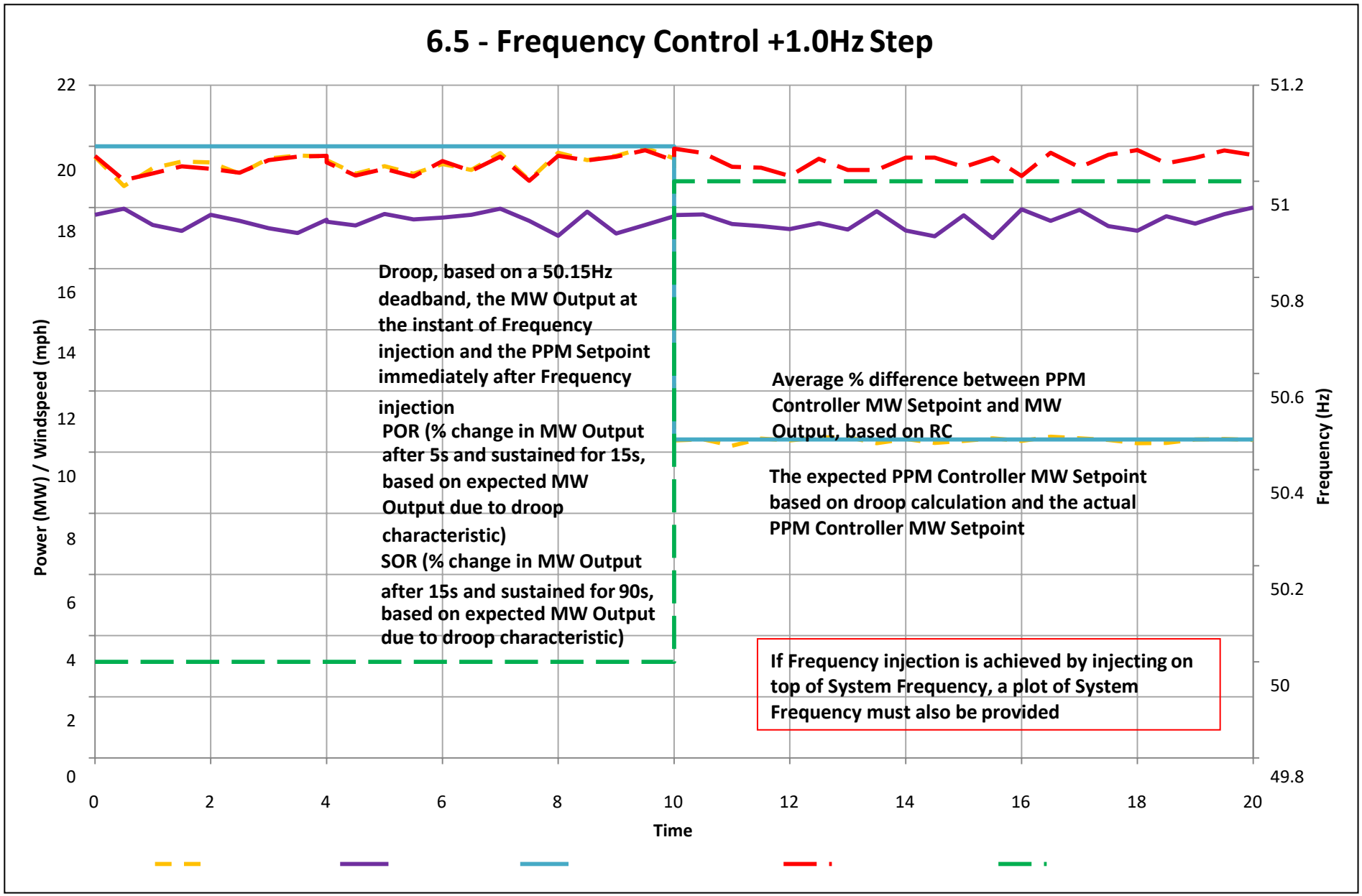

6.4.1.2 - PPM Controller Mode - Test 2
Power (MW) / Windspeed (mph) / Other Signals
Time
Time taken for MW Output to meet 80% Curtailment
Average % difference between MW Output and MW Setpoint sent from SONI/NIE Networks, based on Registered Capacity
Ramp rate of PPM Controller MW Setpoint and MW Output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


6.4.1.3 - PPM 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 PPM to reach 0MW
MW Availability
Windspeed
MW Set Point
PPM Active Set Point
Transducer Fail Alarm
MW Output

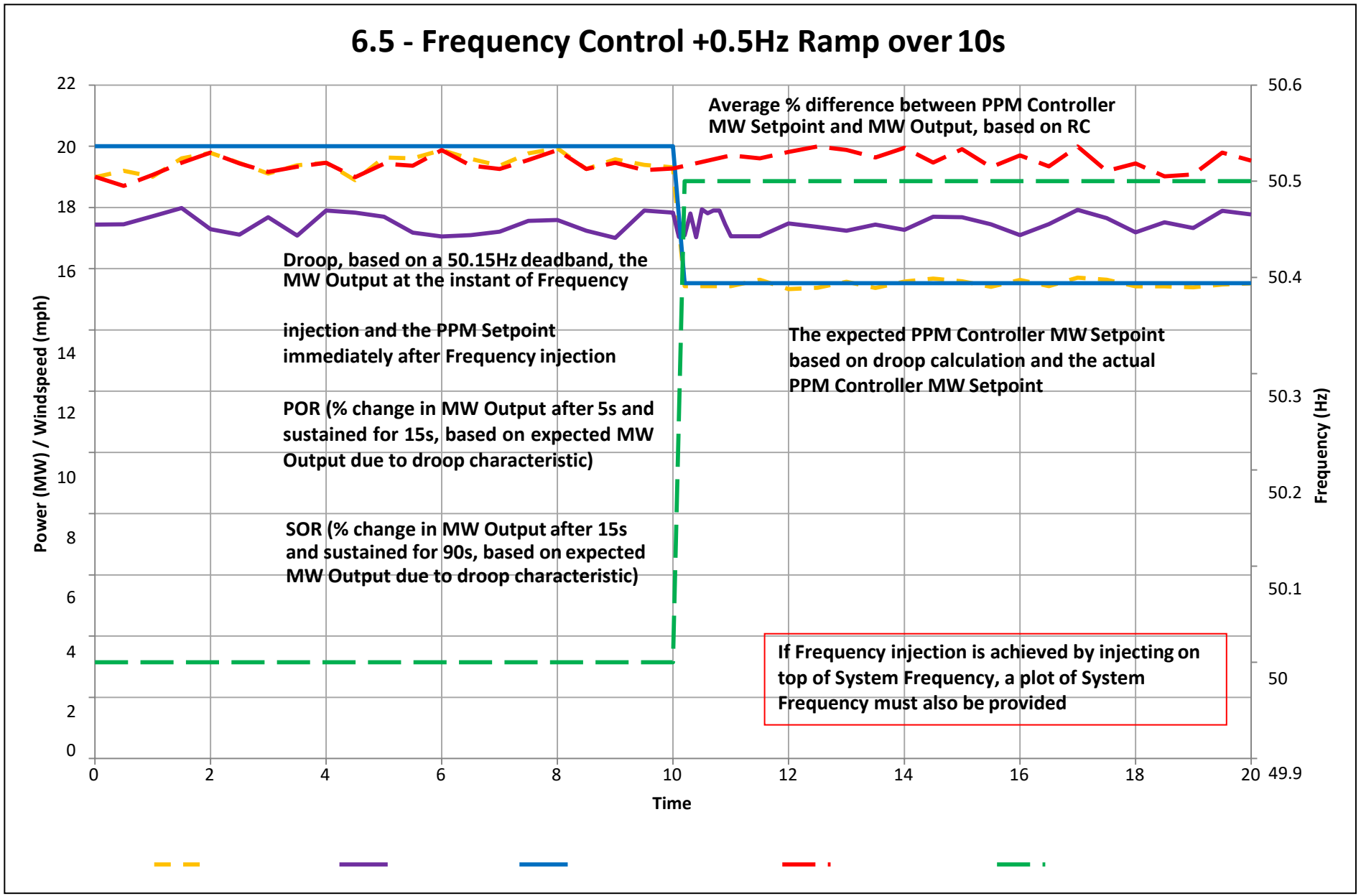

6.4.1.4 - Power Supply Failure - Test 1
Power (MW) / Windspeed (mph) / Other Signals
Time
Average % difference between MW Output and MW Availability, based on Registered Capacity
On the failure of power to any of the control functionality, SONI should receive a Grid Controller Fail alarm
Time taken for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


6.5 - Frequency Control +0.5Hz Step
Average % difference between PPM Controller MW Setpoint and MW Output, based on RC
Droop, based on a 50.15Hz deadband, the MW Output at the instant of Frequency injection and the PPM Setpoint immediately after Frequency injection
The expected PPM Controller MW Setpoint based on droop calculation and the actual PPM 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
0
2
4
6
8
10
12
14
16
18
20
22
49.9
50
50.1
50.2
50.3
50.4
50.5
50.6

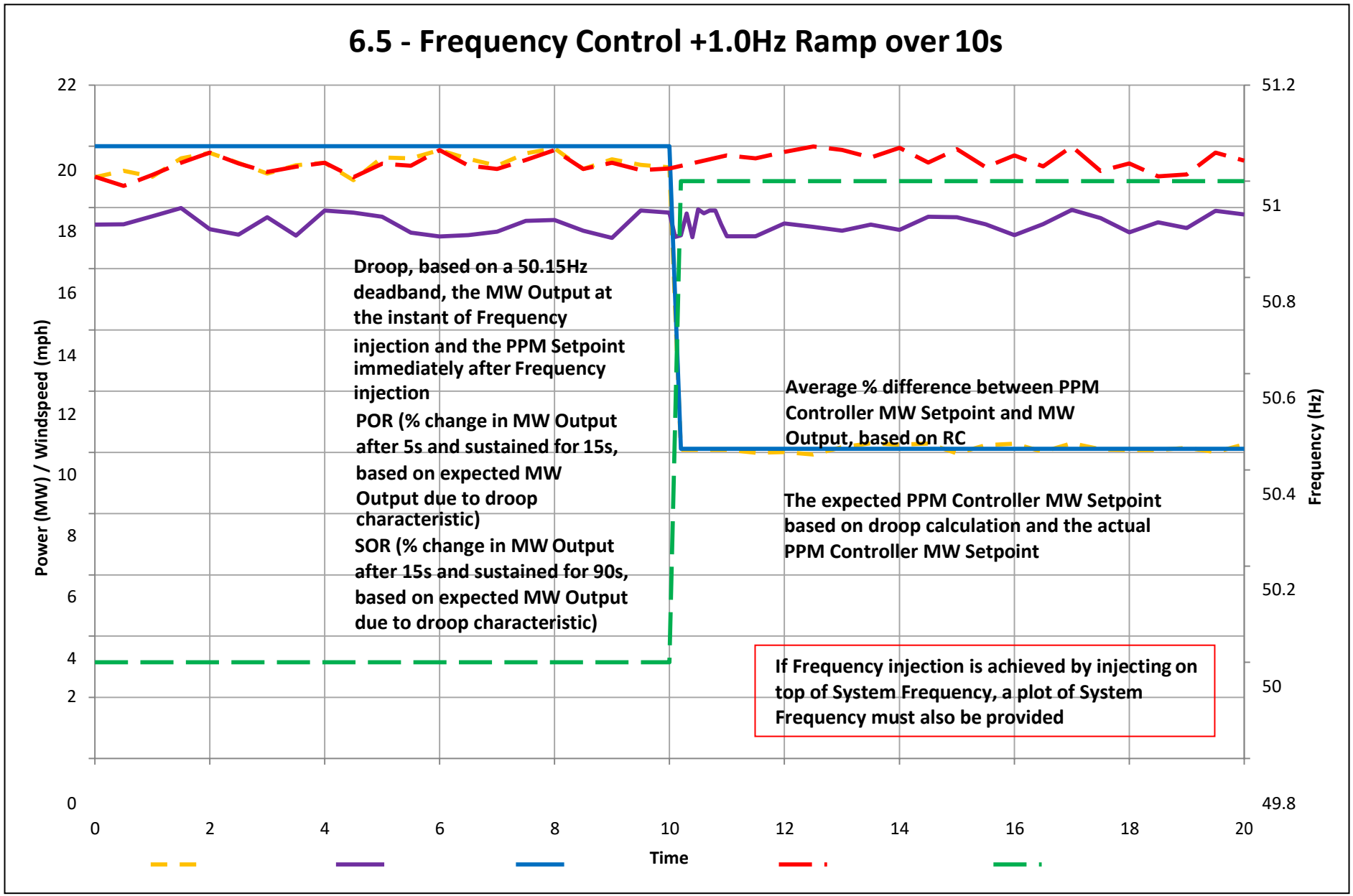
MW Output	Windspeed	PPM Active Set Point	MW Availability	Simulated Frequency


6.5 - Frequency Control +1.0Hz Step
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
0
2
4
6
8
10
12
14
16
18
20
22
49.8
50
50.2
50.4
50.6
50.8
51
51.2
Droop, based on a 50.15Hz deadband, the MW Output at the instant of Frequency injection and the PPM 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 PPM Controller MW Setpoint and MW Output, based on RC
The expected PPM Controller MW Setpoint based on droop calculation and the actual PPM Controller MW Setpoint
If Frequency injection is achieved by injecting on top of System Frequency, a plot of System Frequency must also be provided

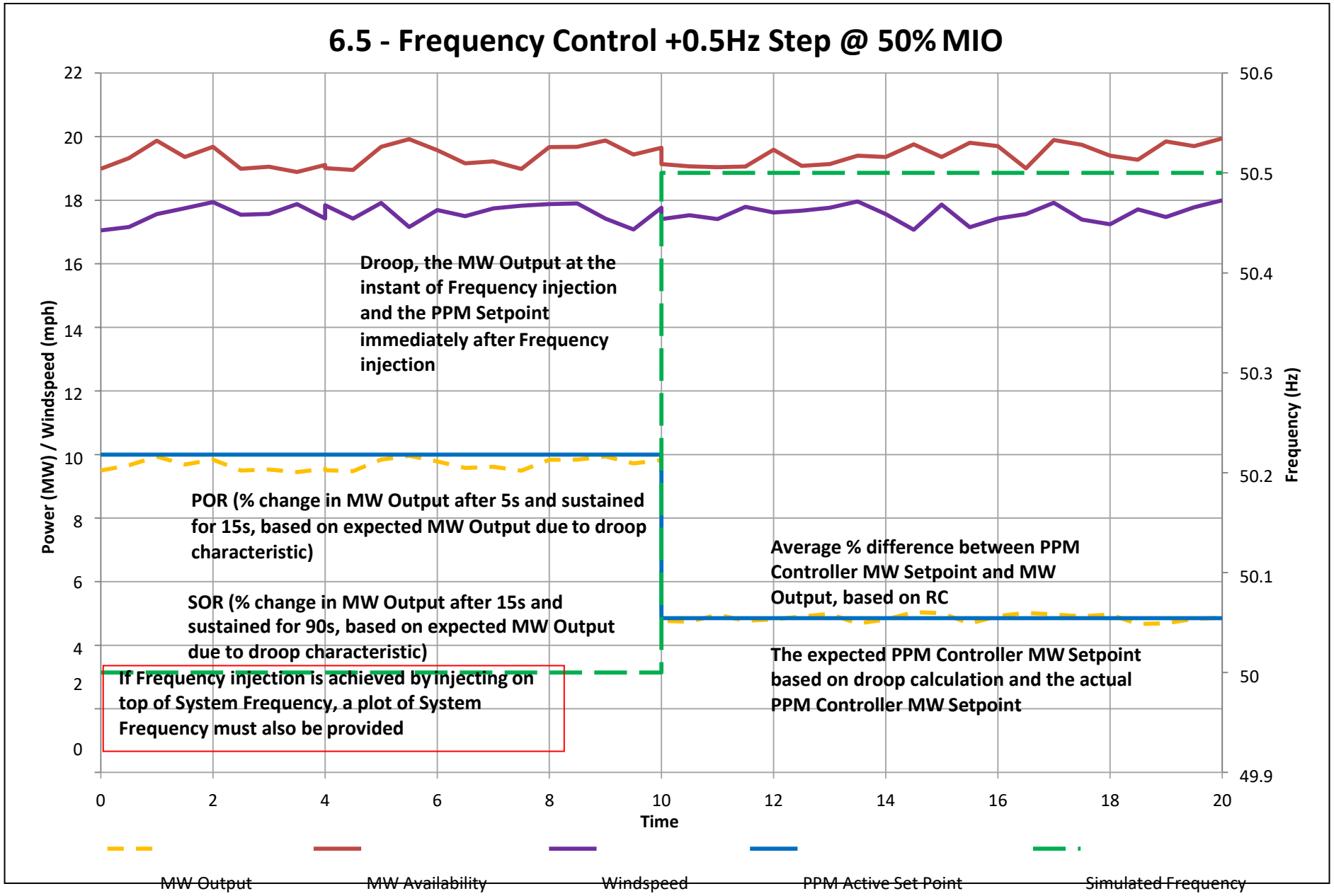
MW Output	Windspeed	PPM Active Set Point	MW Availability	Simulated Frequency

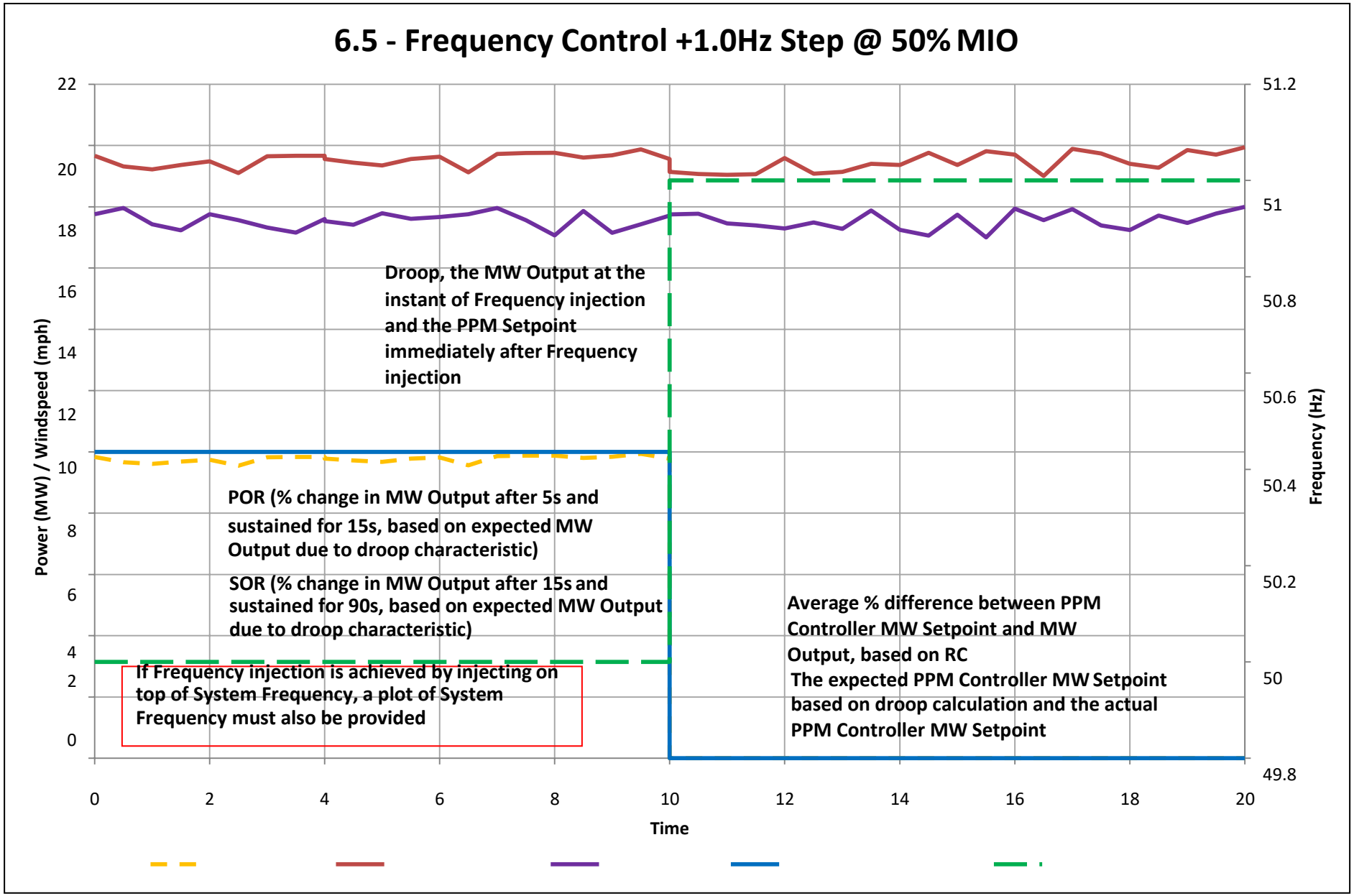

6.5 - Frequency Control +0.5Hz Ramp over 10s
Average % difference between PPM Controller MW Setpoint and MW Output, based on RC
Droop, based on a 50.15Hz deadband, the MW Output at the instant of Frequency
injection and the PPM Setpoint immediately after Frequency injection
POR (% change in MW Output 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 PPM Controller MW Setpoint based on droop calculation and the actual PPM 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
0
2
4
6
8
10
12
14
16
18
20
22
49.9
50
50.1
50.2
50.3
50.4
50.5
50.6

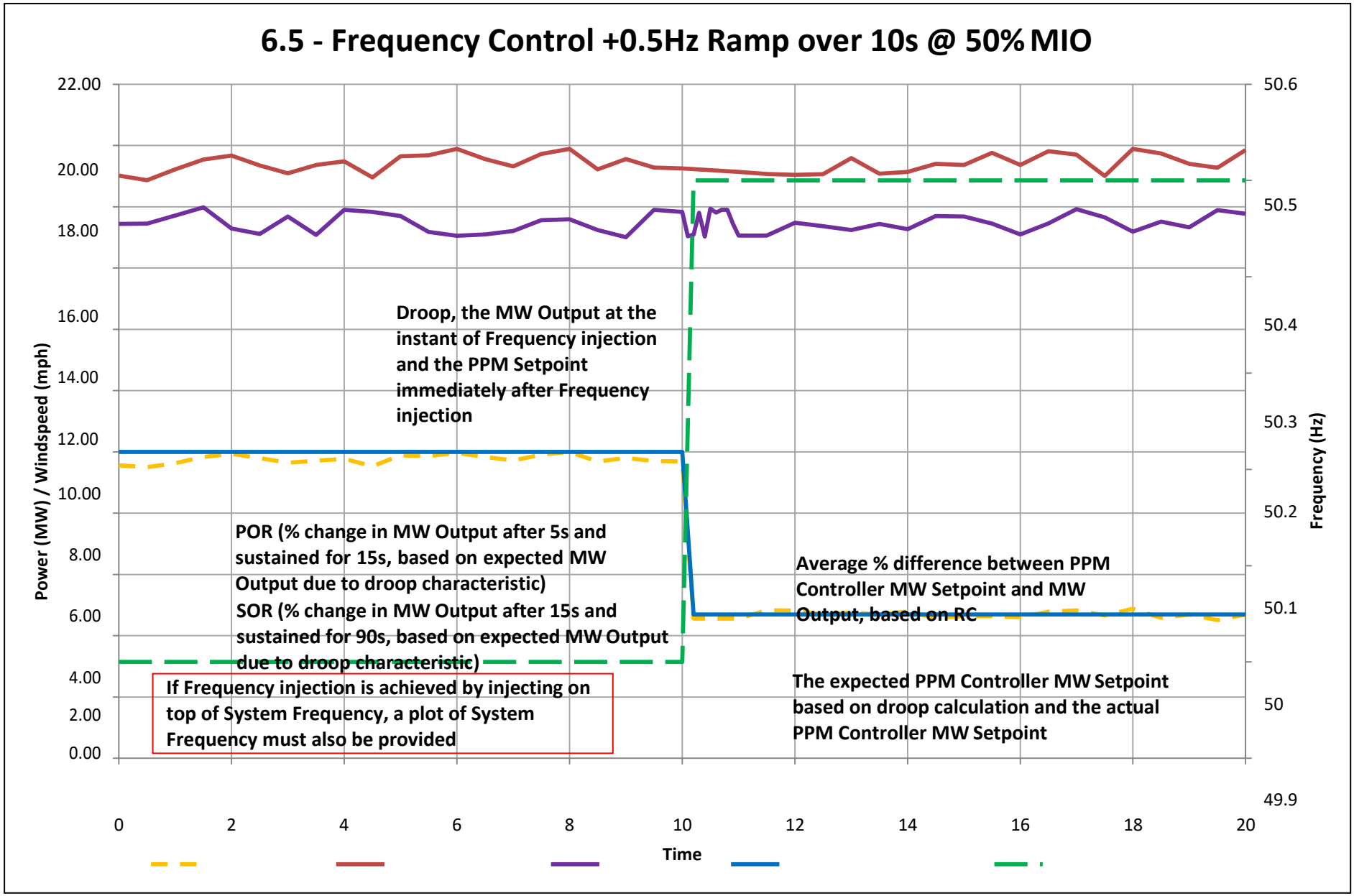
MW Output	Windspeed	PPM Active Set Point	MW Availability	Simulated Frequency


6.5 - Frequency Control +1.0Hz Ramp over 10s
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
22
20
18
16
14
12
10
8
6
4
2
0
51.2
51
50.8
50.6
50.4
50.2
50
49.8
0
2
4
6
8
10
12
14
16
18
20
Droop, based on a 50.15Hz deadband, the MW Output at the instant of Frequency injection and the PPM 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 PPM Controller MW Setpoint and MW Output, based on RC
The expected PPM Controller MW Setpoint based on droop calculation and the actual PPM Controller MW Setpoint
If Frequency injection is achieved by injecting on top of System Frequency, a plot of System Frequency must also be provided

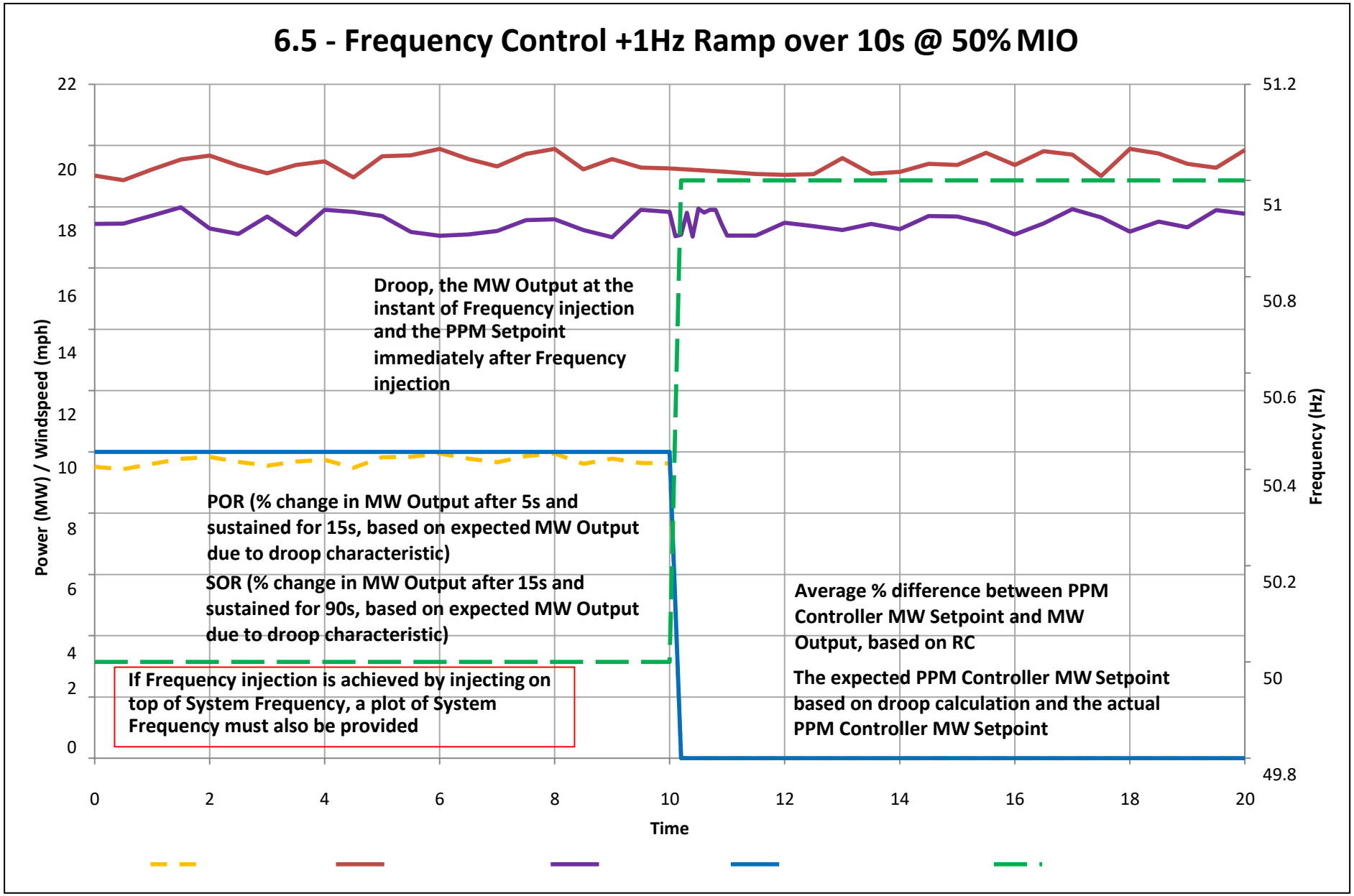
MW Output | Windspeed | PPM Active Set Point | MW Availability | Simulated Frequency

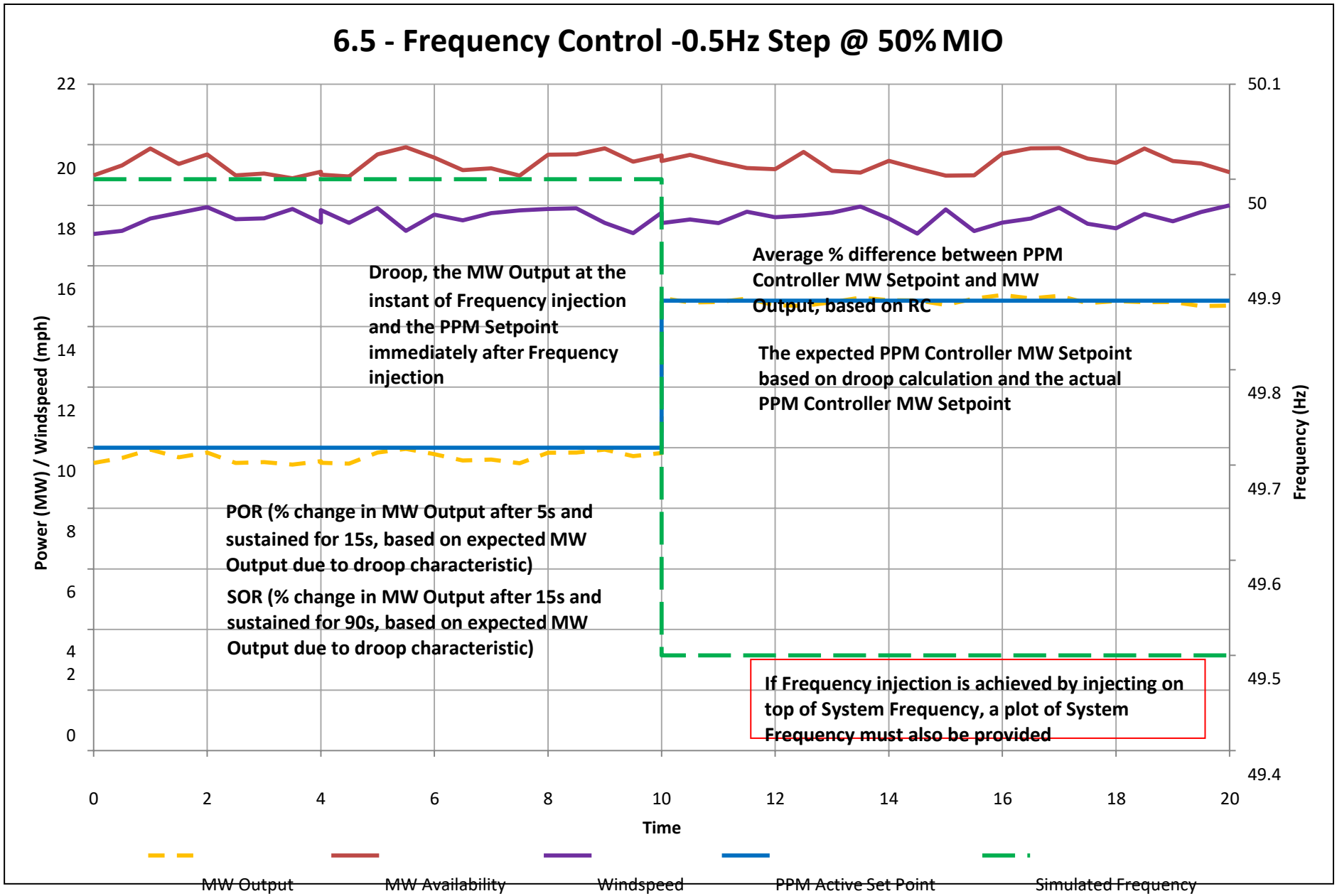

6.5 - Frequency Control +0.5Hz Step @ 50% MIO
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
Droop, the MW Output at the instant of Frequency injection and the PPM Setpoint immediately after Frequency injection
POR (% change in MW Output after 5s and sustained for 15s, based on expected MW Output due 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 PPM Controller MW Setpoint and MW Output, based on RC
The expected PPM Controller MW Setpoint based on droop calculation and the actual PPM Controller MW Setpoint
MW Output
MW Availability
Windspeed
PPM Active Set Point
Simulated Frequency

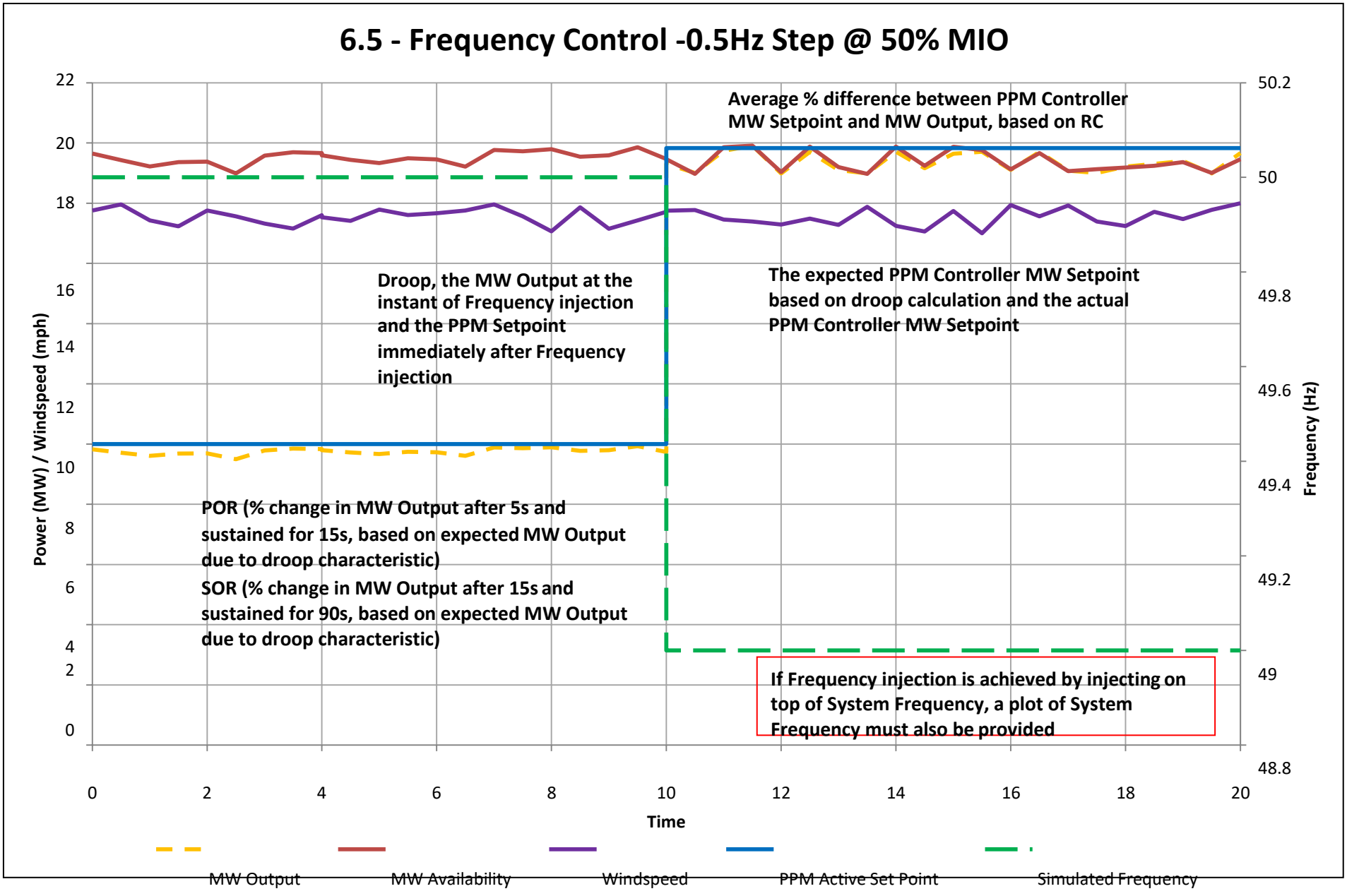

6.5 - Frequency Control +1.0Hz Step @ 50% MIO
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
22
20
18
16
14
12
10
8
6
4
2
0
51.2
51
50.8
50.6
50.4
50.2
50
49.8
0
2
4
6
8
10
12
14
16
18
20
Droop, the MW Output at the instant of Frequency injection and the PPM Setpoint immediately after Frequency injection
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 PPM Controller MW Setpoint and MW Output, based on RC
The expected PPM Controller MW Setpoint based on droop calculation and the actual PPM Controller MW Setpoint
MW Output
MW Availability
Windspeed
PPM Active Set Point
Simulated Frequency

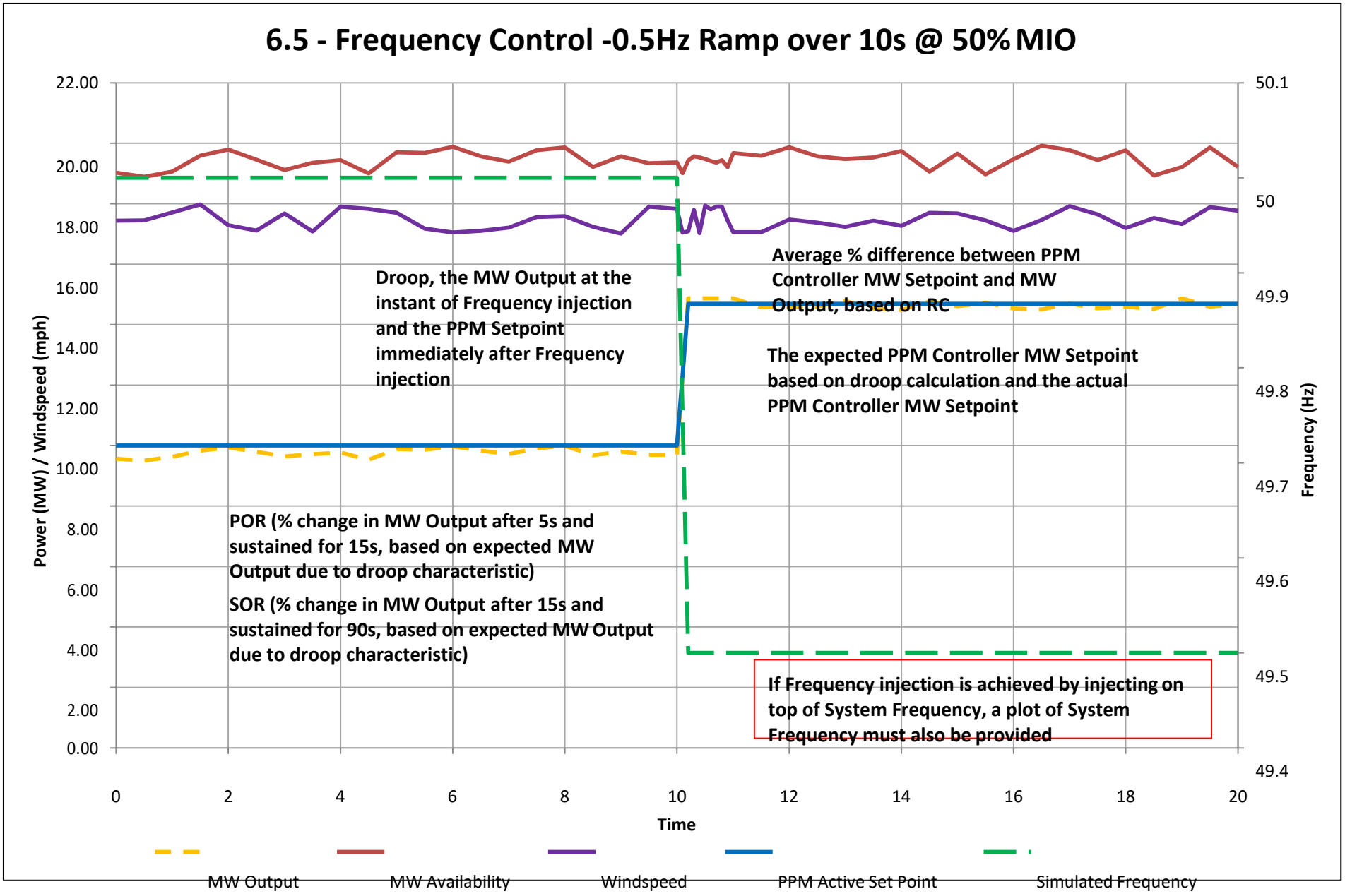

6.5 - Frequency Control +0.5Hz Ramp over 10s @ 50% MIO
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
50.6
50.5
50.4
50.3
50.2
50.1
50
49.9
0
2
4
6
8
10
12
14
16
18
20
Droop, the MW Output at the instant of Frequency injection and the PPM 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 PPM Controller MW Setpoint and MW Output, based on RC
The expected PPM Controller MW Setpoint based on droop calculation and the actual PPM Controller MW Setpoint

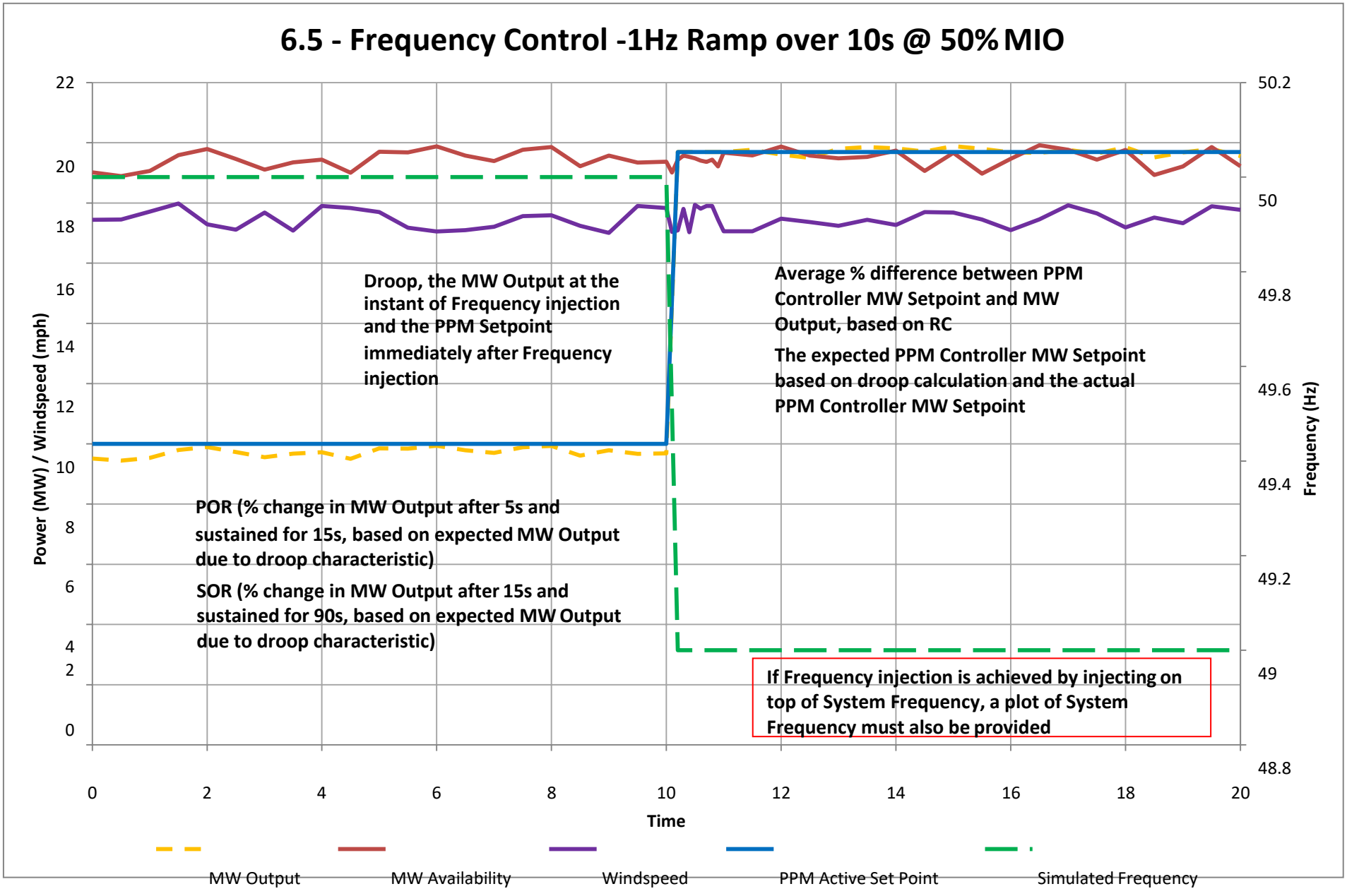
MW Output | MW Availability | Windspeed | PPM Active Set Point | Simulated Frequency

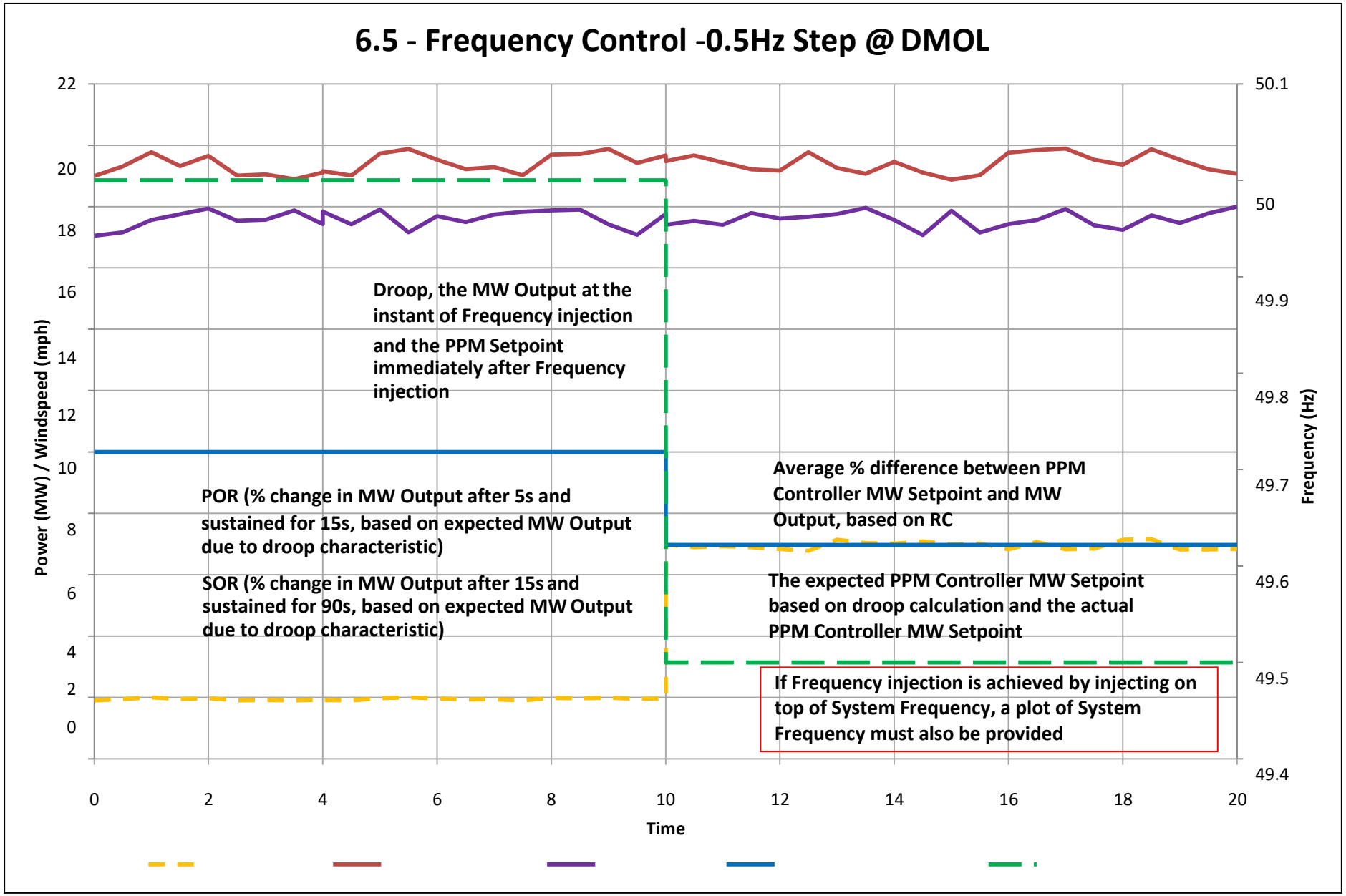

6.5 - Frequency Control +1Hz Ramp over 10s @ 50% MIO
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
Droop, the MW Output at the instant of Frequency injection and the PPM Setpoint immediately after Frequency injection
POR (% change in MW Output after 5s and sustained for 15s, based on expected MW Output 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 PPM Controller MW Setpoint and MW Output, based on RC
The expected PPM Controller MW Setpoint based on droop calculation and the actual PPM Controller MW Setpoint
MW Output
MW Availability
Windspeed
PPM 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 PPM Setpoint immediately after Frequency injection
Average % difference between PPM Controller MW Setpoint and MW Output, based on RC
The expected PPM Controller MW Setpoint based on droop calculation and the actual PPM 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
PPM Active Set Point
Simulated Frequency

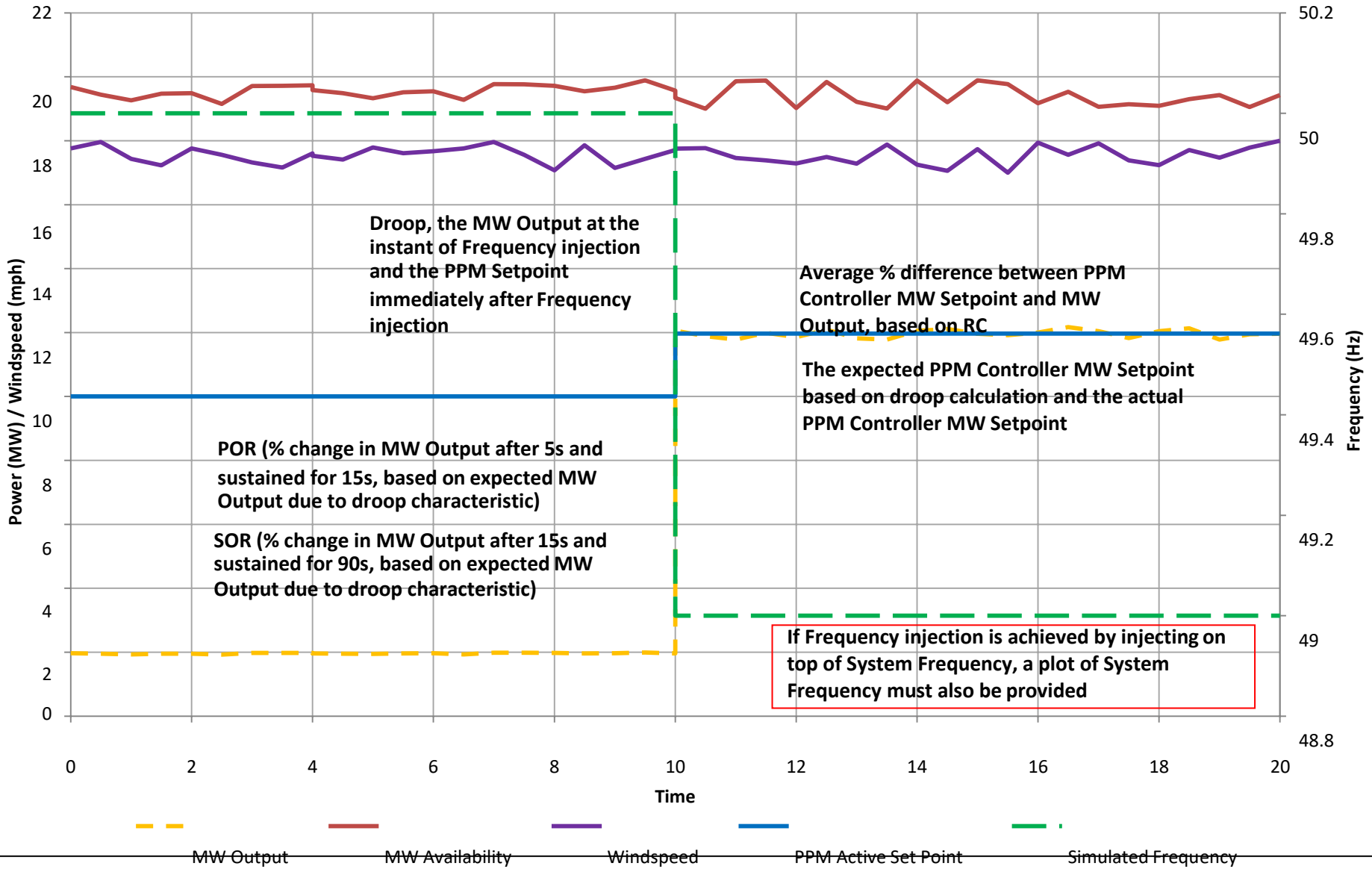

6.5 - Frequency Control -0.5Hz Step @ 50% MIO
Average % difference between PPM Controller MW Setpoint and MW Output, based on RC
Droop, the MW Output at the instant of Frequency injection and the PPM Setpoint immediately after Frequency injection
The expected PPM Controller MW Setpoint based on droop calculation and the actual PPM 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
PPM Active Set Point
Simulated Frequency

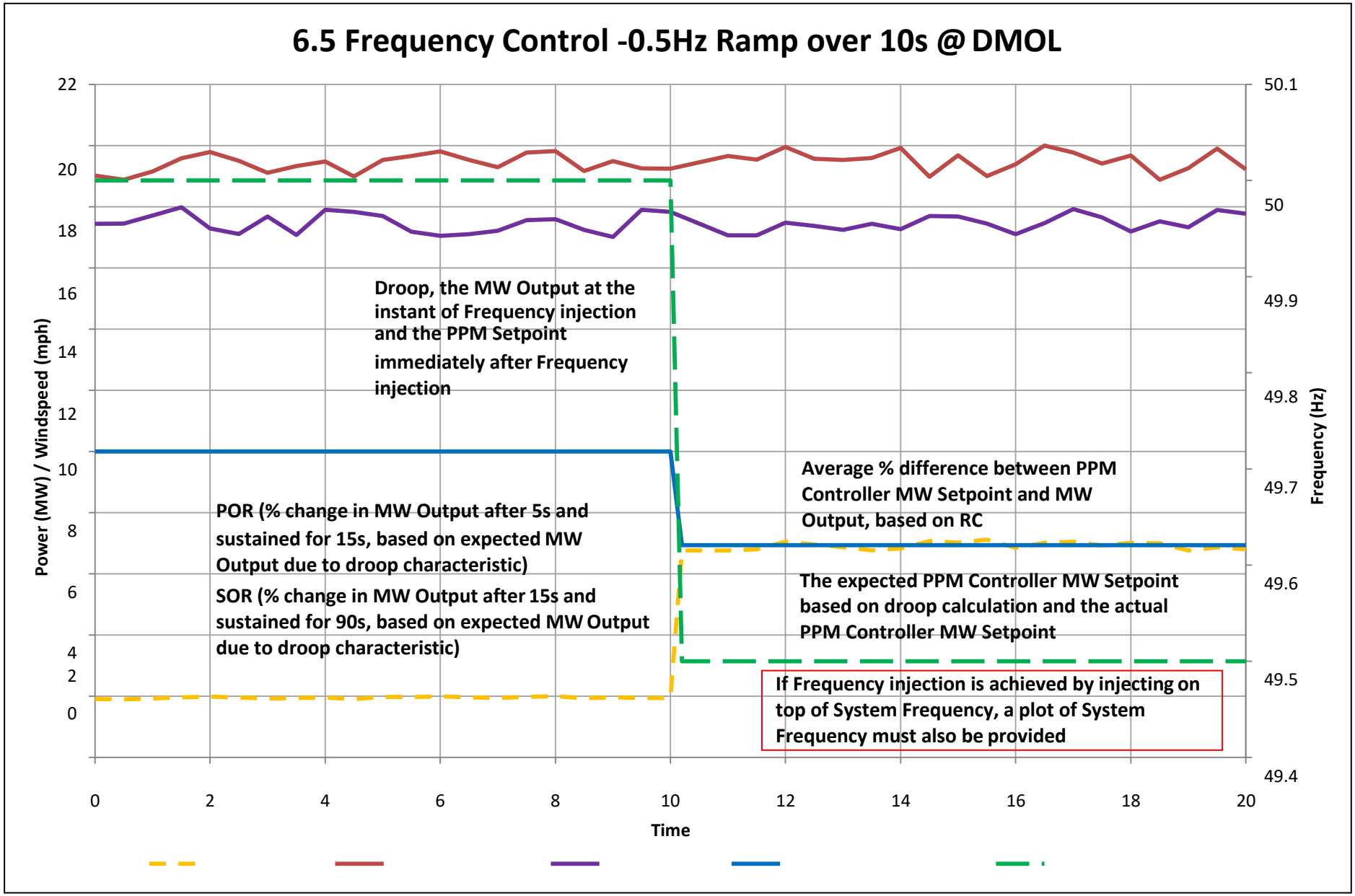

6.5 - Frequency Control -0.5Hz Ramp over 10s @ 50% MIO
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
50.1
50
49.9
49.8
49.7
49.6
49.5
49.4
0
2
4
6
8
10
12
14
16
18
20
Droop, the MW Output at the instant of Frequency injection and the PPM Setpoint immediately after Frequency injection
Average % difference between PPM Controller MW Setpoint and MW Output, based on RC
The expected PPM Controller MW Setpoint based on droop calculation and the actual PPM 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
PPM Active Set Point
Simulated Frequency

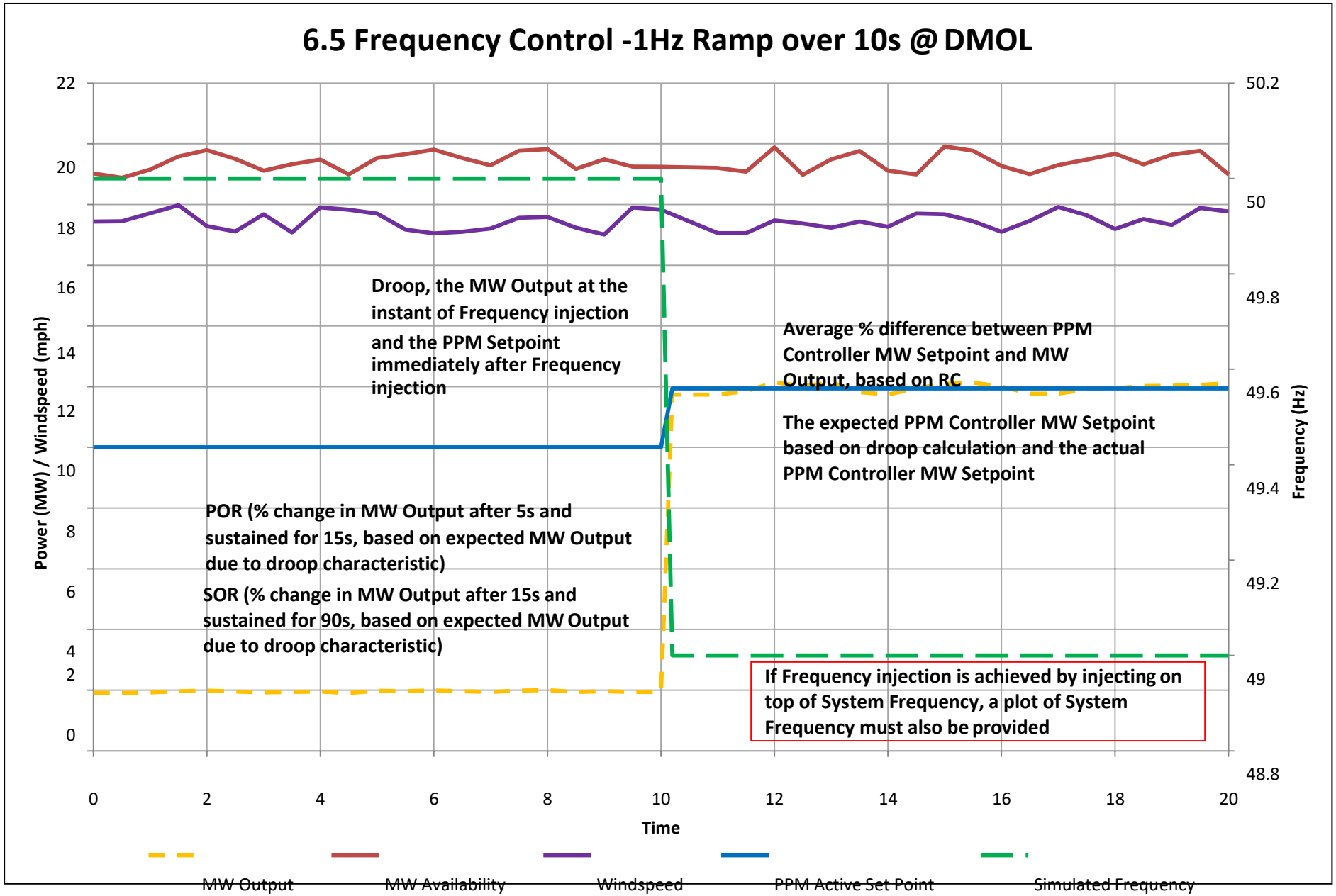

6.5 - Frequency Control -1Hz Ramp over 10s @ 50% MIO
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
Droop, the MW Output at the instant of Frequency injection and the PPM Setpoint immediately after Frequency injection
Average % difference between PPM Controller MW Setpoint and MW Output, based on RC
The expected PPM Controller MW Setpoint based on droop calculation and the actual PPM 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
PPM Active Set Point
Simulated Frequency

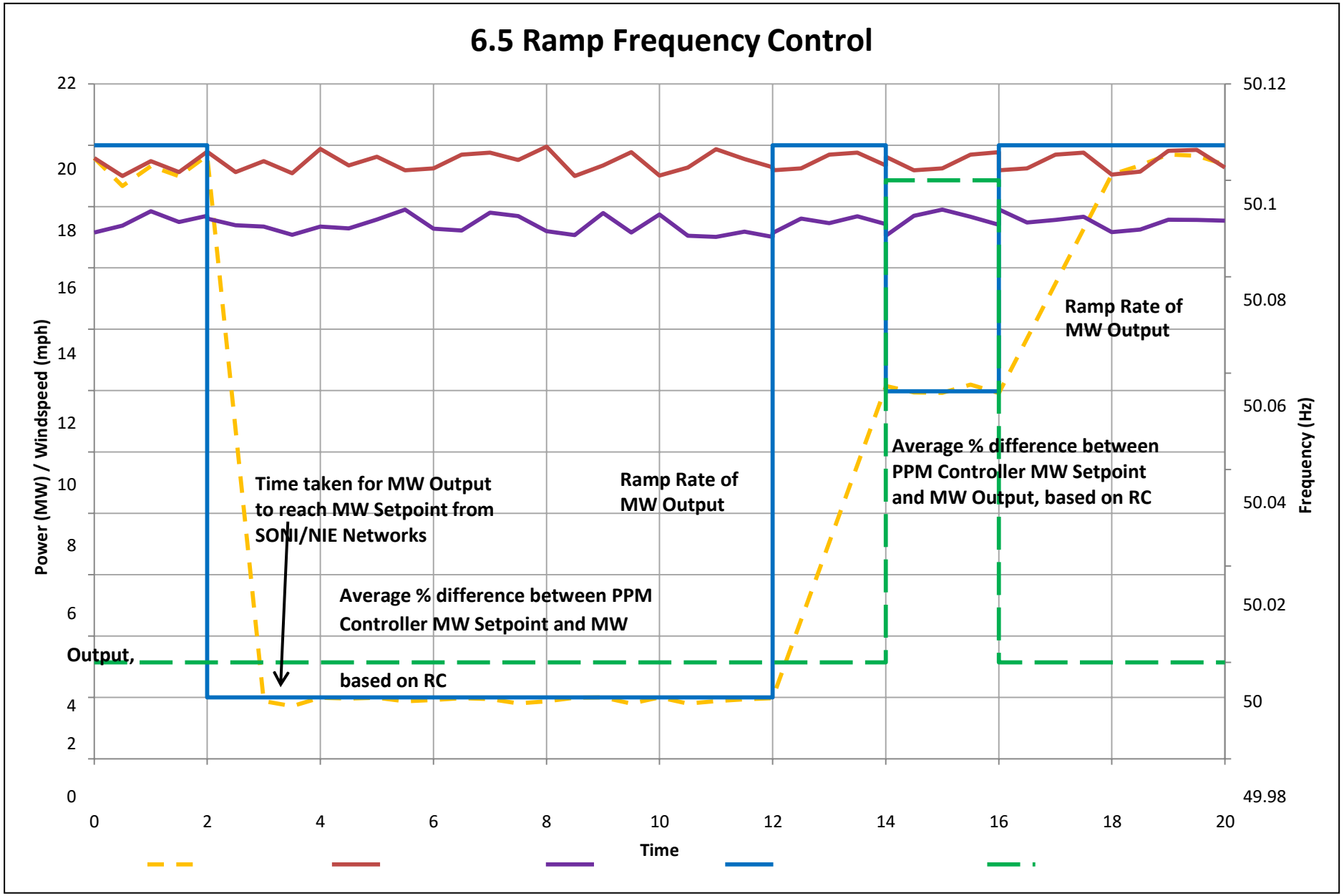

6.5 - Frequency Control -0.5Hz Step @ DMOL
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
Droop, the MW Output at the instant of Frequency injection and the PPM Setpoint immediately after Frequency injection
POR (% change in MW Output after 5s and sustained for 15s, based on expected MW Output due 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 PPM Controller MW Setpoint and MW Output, based on RC
The expected PPM Controller MW Setpoint based on droop calculation and the actual PPM 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
PPM Active Set Point
Simulated Frequency

6.5 Frequency Control -1Hz Step @ DMOL

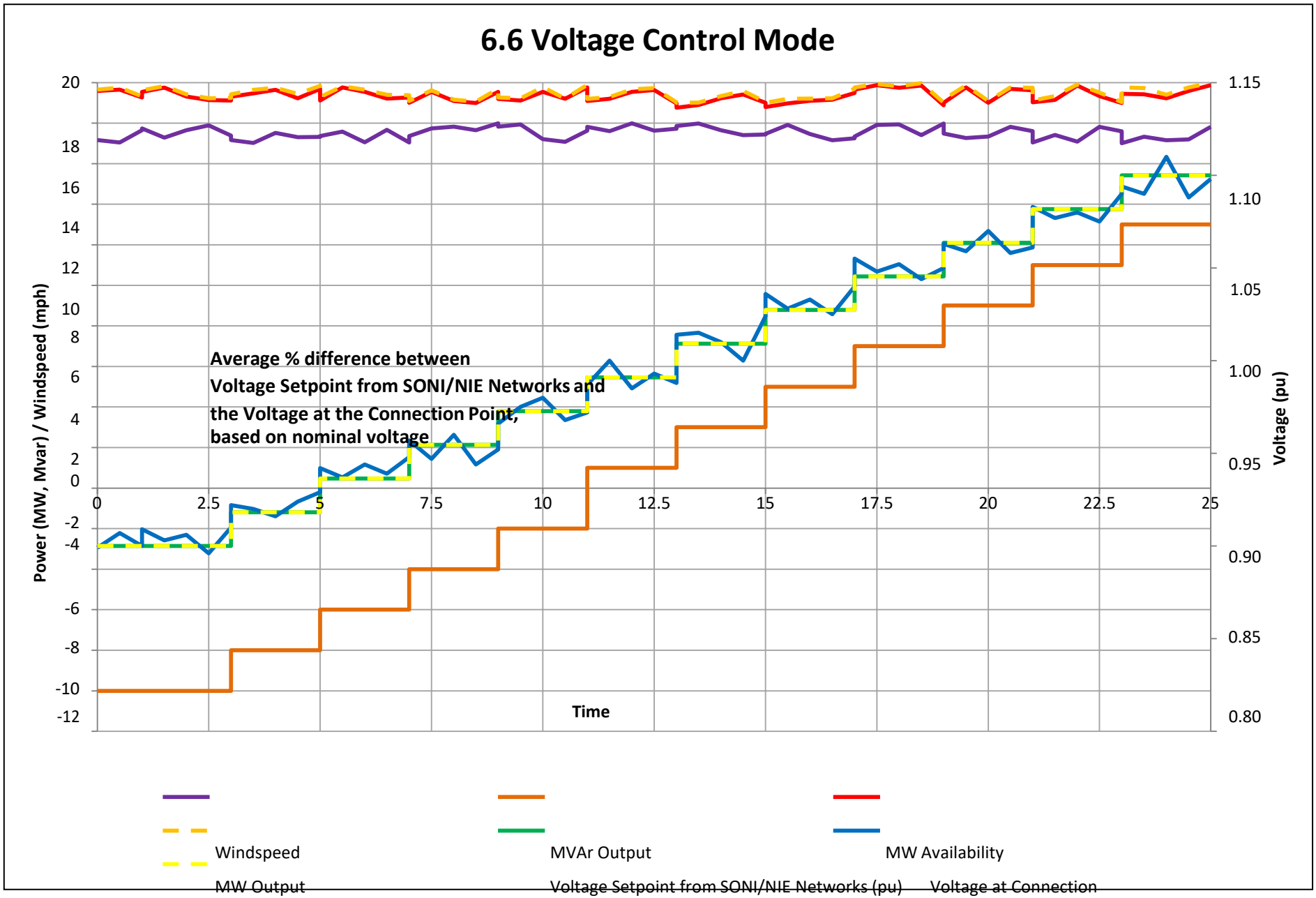



6.5 Frequency Control -0.5Hz Ramp over 10s @ DMOL
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
Droop, the MW Output at the instant of Frequency injection and the PPM Setpoint immediately after Frequency injection
POR (% change in MW Output after 5s and sustained for 15s, based on expected MW Output 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 PPM Controller MW Setpoint and MW Output, based on RC
The expected PPM Controller MW Setpoint based on droop calculation and the actual PPM 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
PPM 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 PPM Setpoint immediately after Frequency injection
Average % difference between PPM Controller MW Setpoint and MW Output, based on RC
The expected PPM Controller MW Setpoint based on droop calculation and the actual PPM 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
PPM Active Set Point
Simulated Frequency

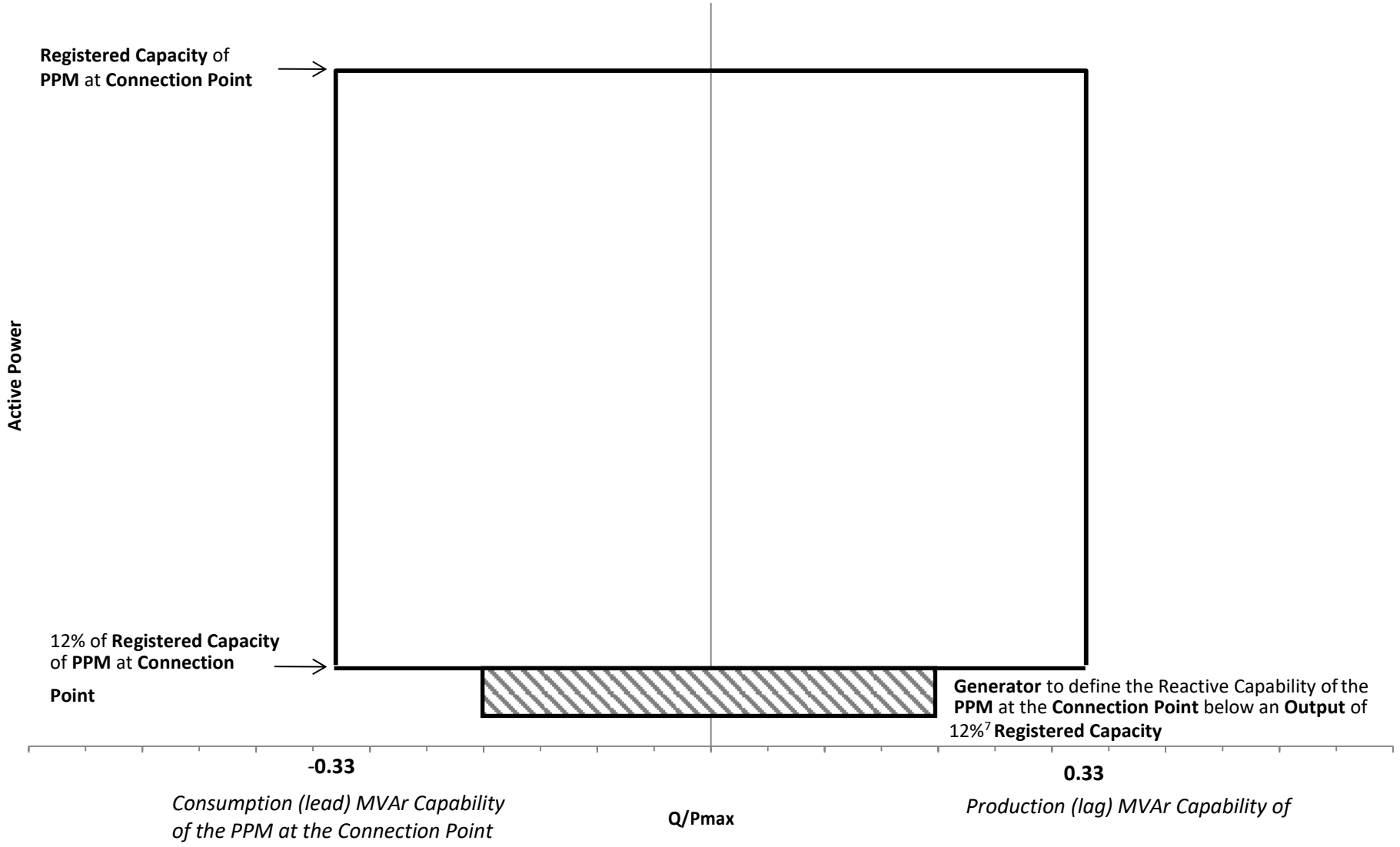

6.5 Ramp Frequency Control
Power (MW) / Windspeed (mph)
Frequency (Hz)
Time
Time taken for MW Output to reach MW Setpoint from SONI/NIE Networks
Ramp Rate of MW Output
Average % difference between PPM Controller MW Setpoint and MW Output, based on RC
Ramp Rate of MW Output
Average % difference between PPM Controller MW Setpoint and MW Output, based on RC
22
20
18
16
14
12
10
8
6
4
2
0
50.12
50.1
50.08
50.06
50.04
50.02
50
49.98
0
2
4
6
8
10
12
14
16
18
20

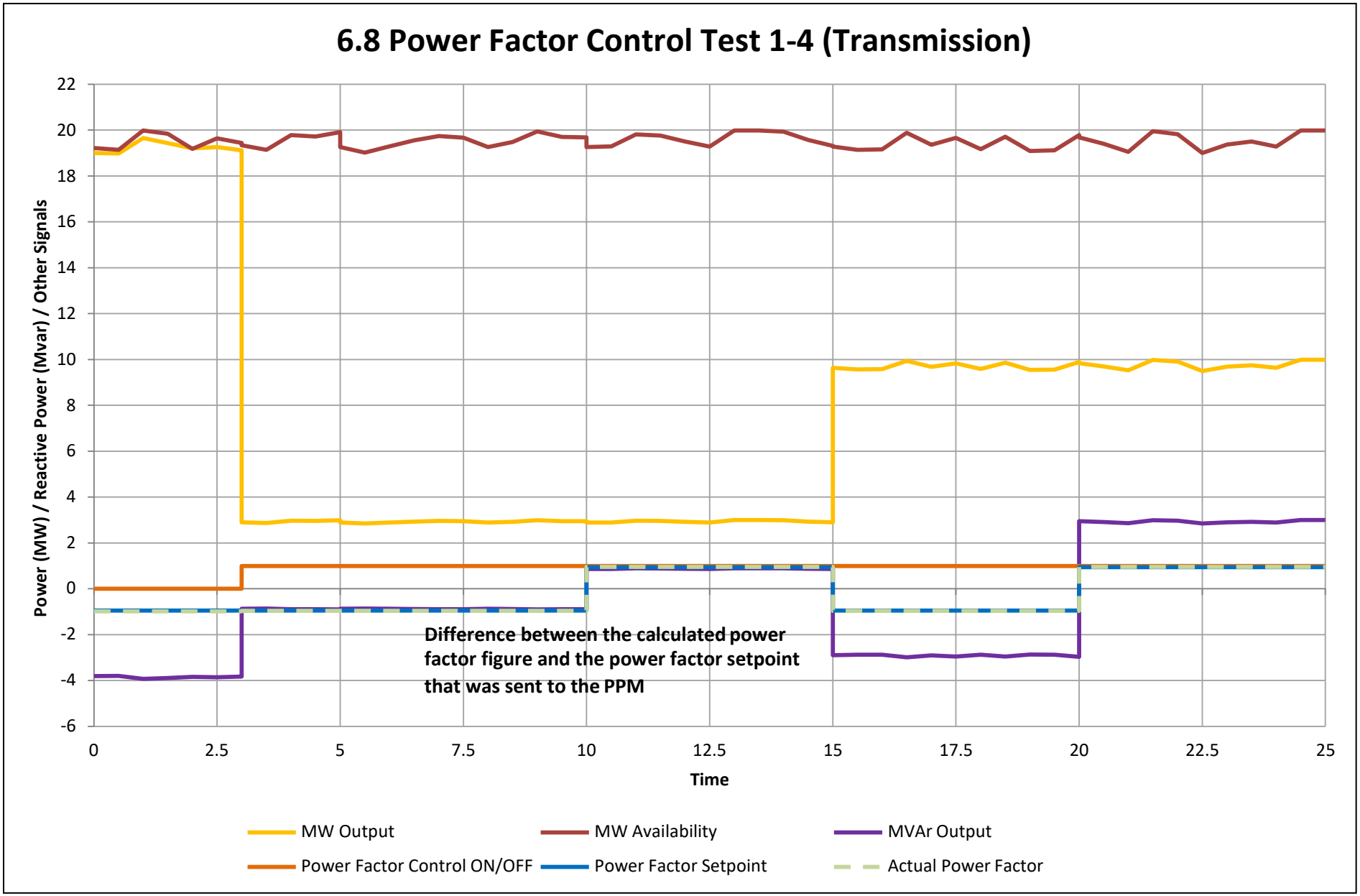
MW Output MW Availability Windspeed PPM Active Set Point Simulated Frequency


6.6 Voltage Control Mode
Power (MW, Mvar) / Windspeed (mph)
Voltage (pu)
Average % difference between
Voltage Setpoint from SONI/NIE Networks and
the Voltage at the Connection Point,
based on nominal voltage
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
MW Output
MVAr Output
Voltage Setpoint from SONI/NIE Networks (pu)
MW Availability
Voltage at Connection

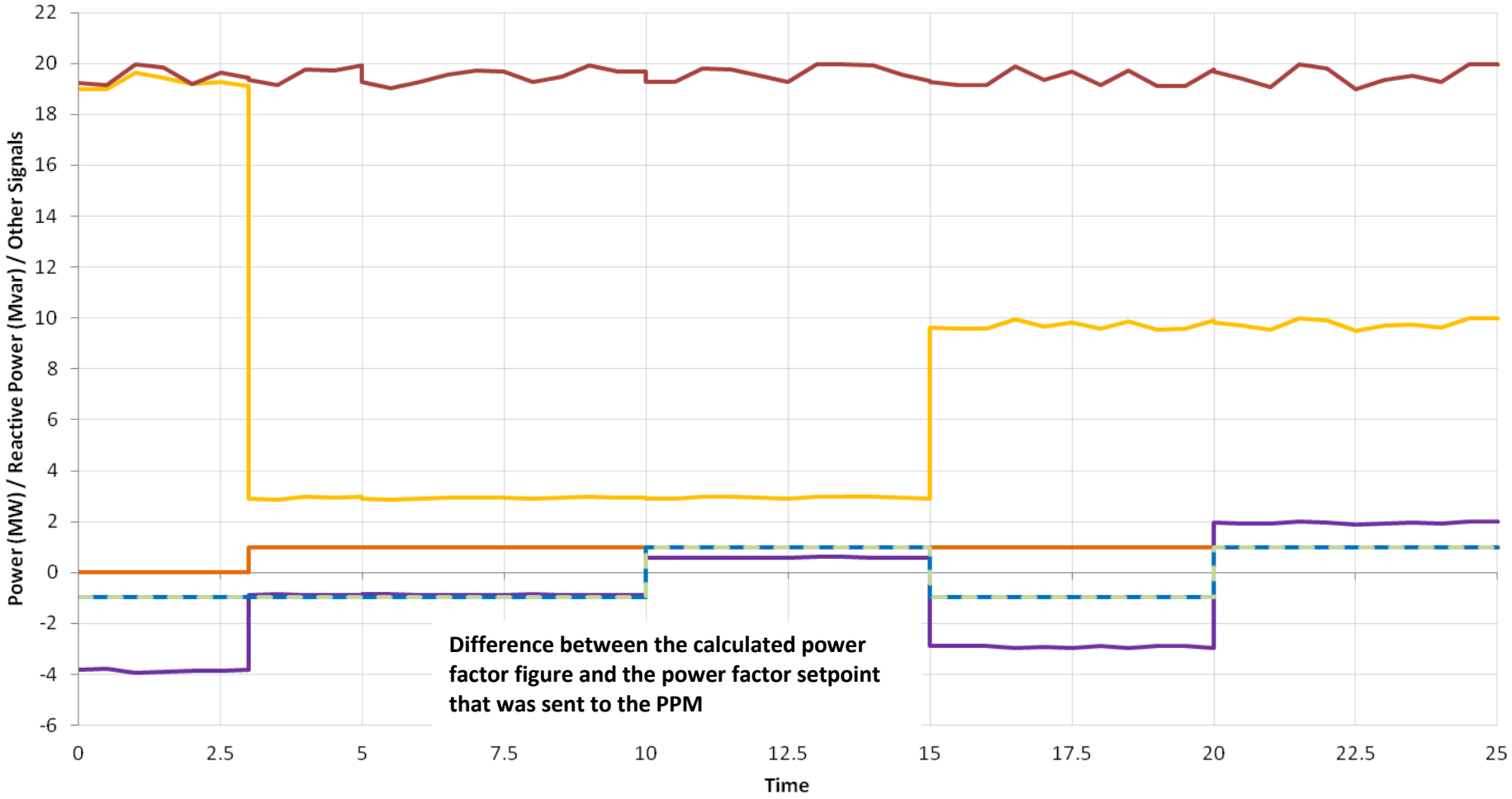
Point (pu) Predicted Voltage (pu)

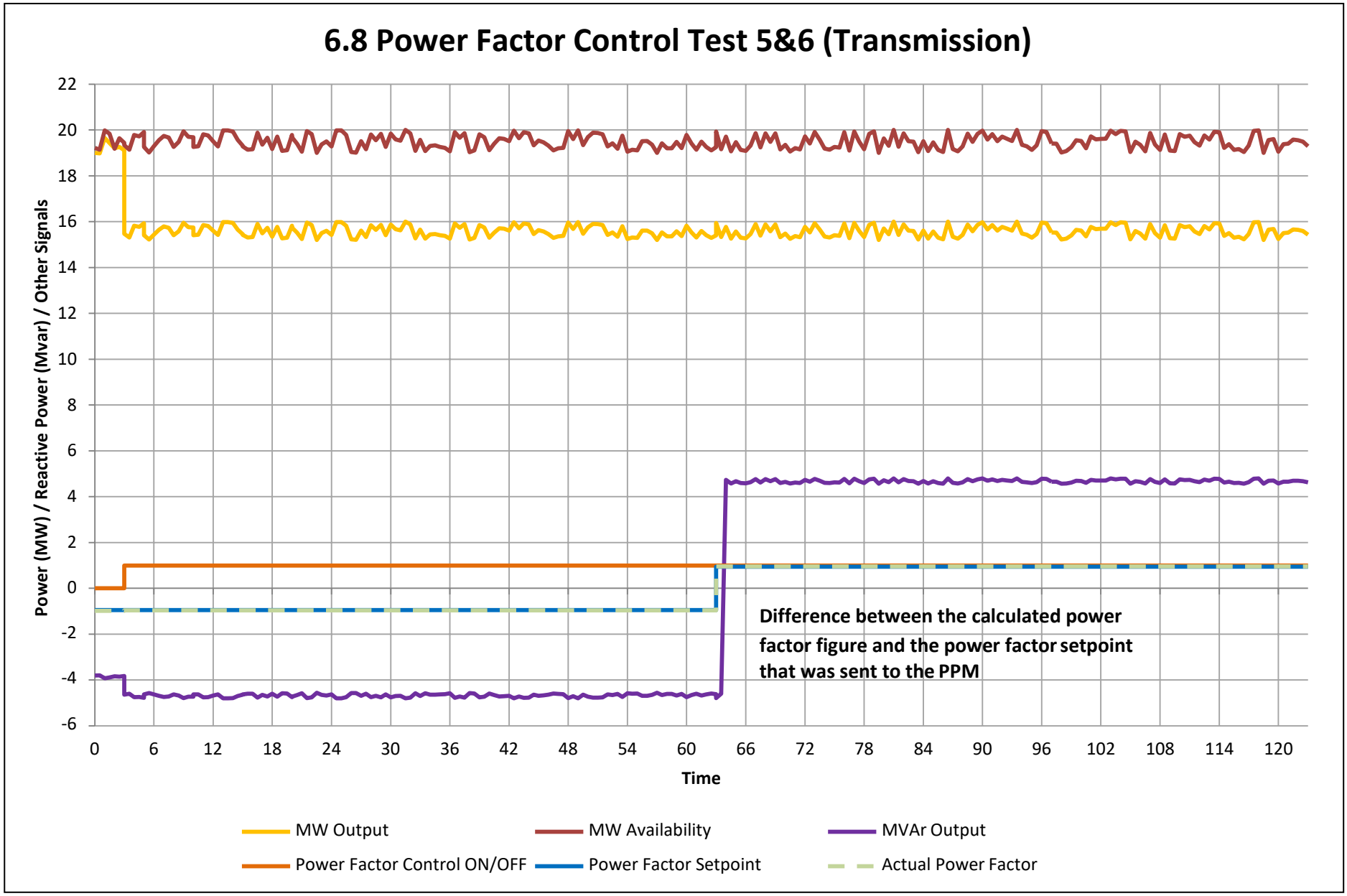
6.6 Reactive Capability

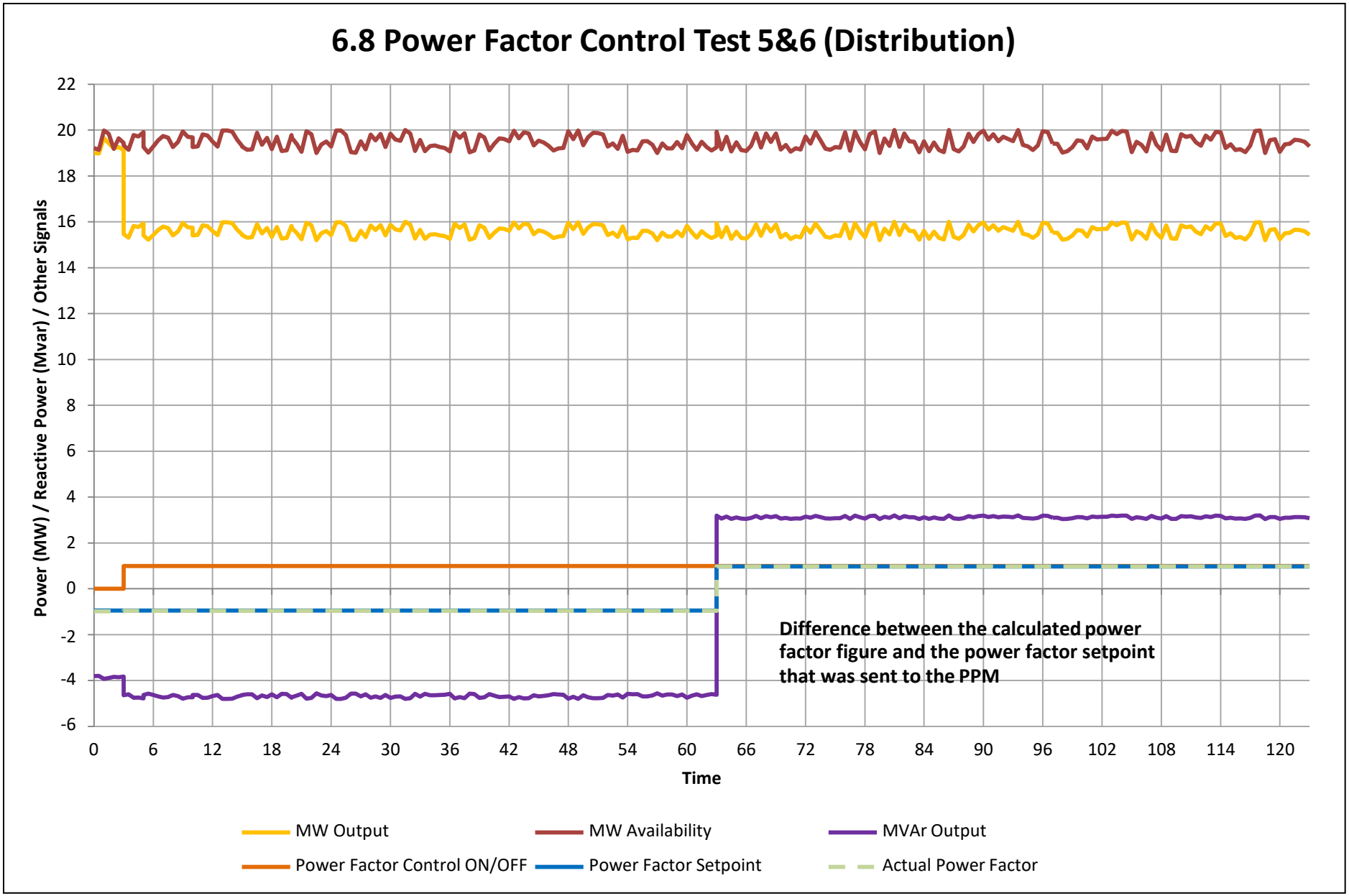



6.8 Power Factor Control Test 1-4 (Transmission)
Power (MW) / Reactive Power (Mvar) / Other Signals
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
25
Time
Difference between the calculated power factor figure and the power factor setpoint that was sent to the PPM
MW Output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

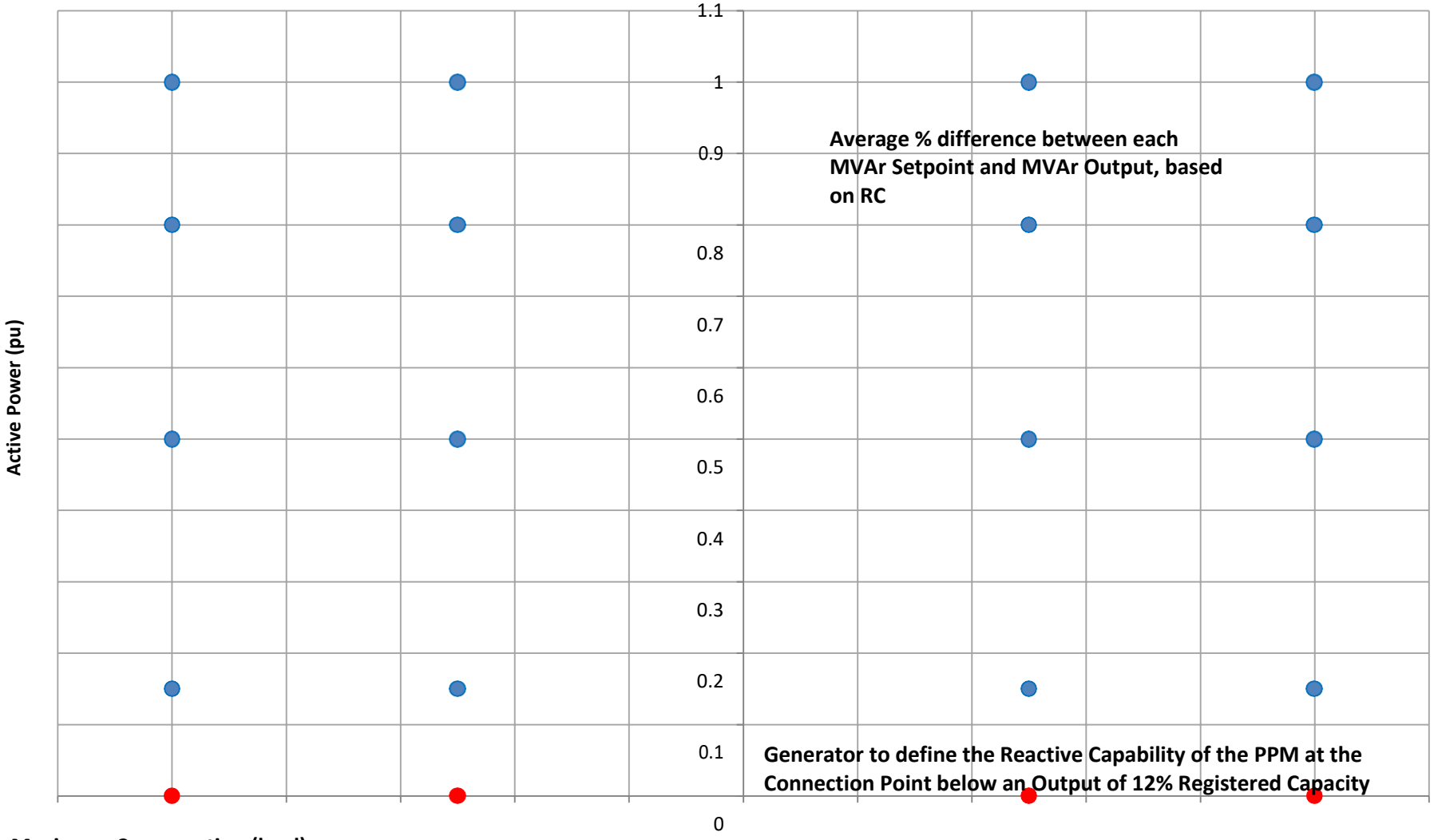
6.8 Power Factor Control Test 1-4 (Distribution)

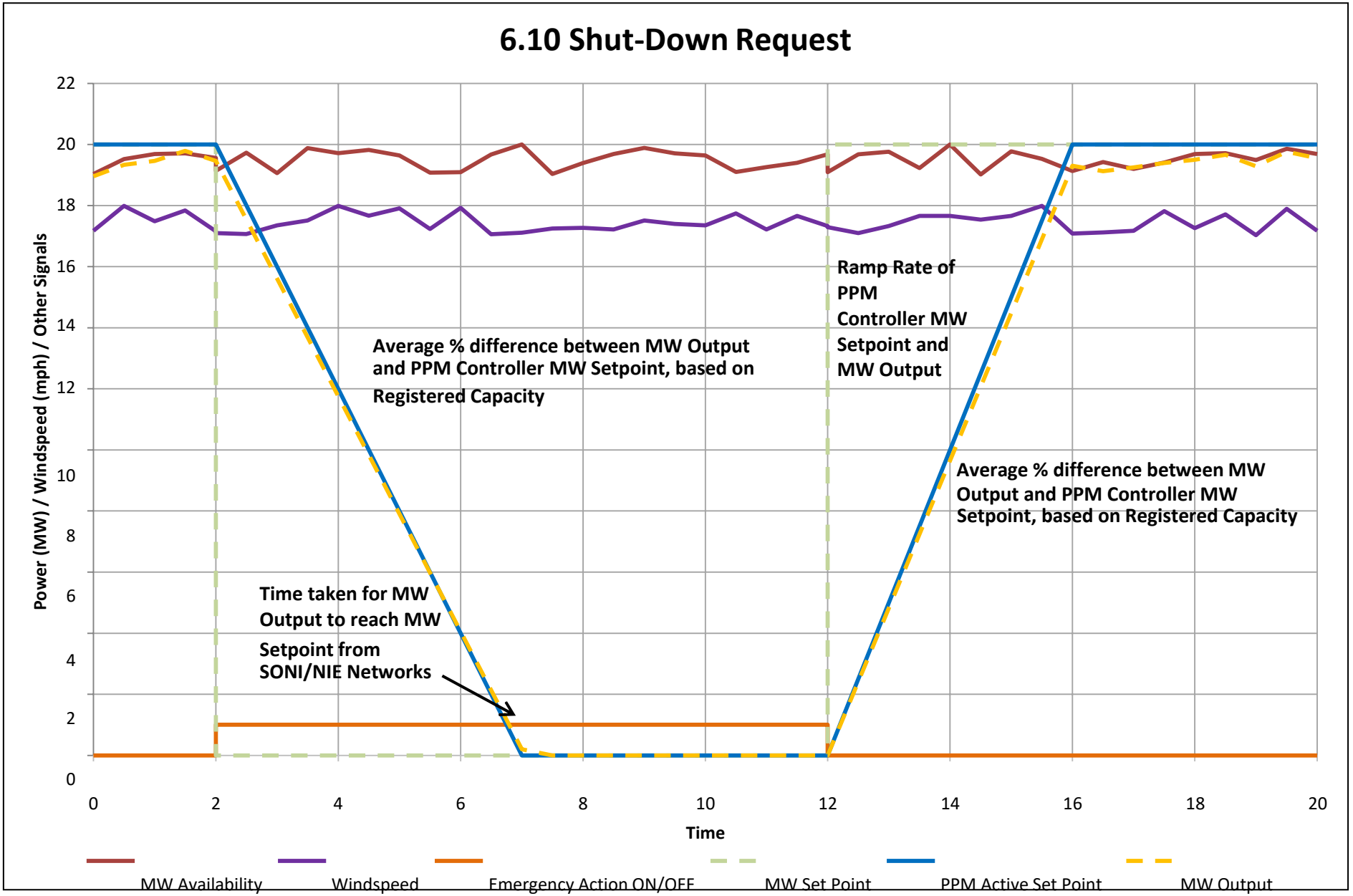


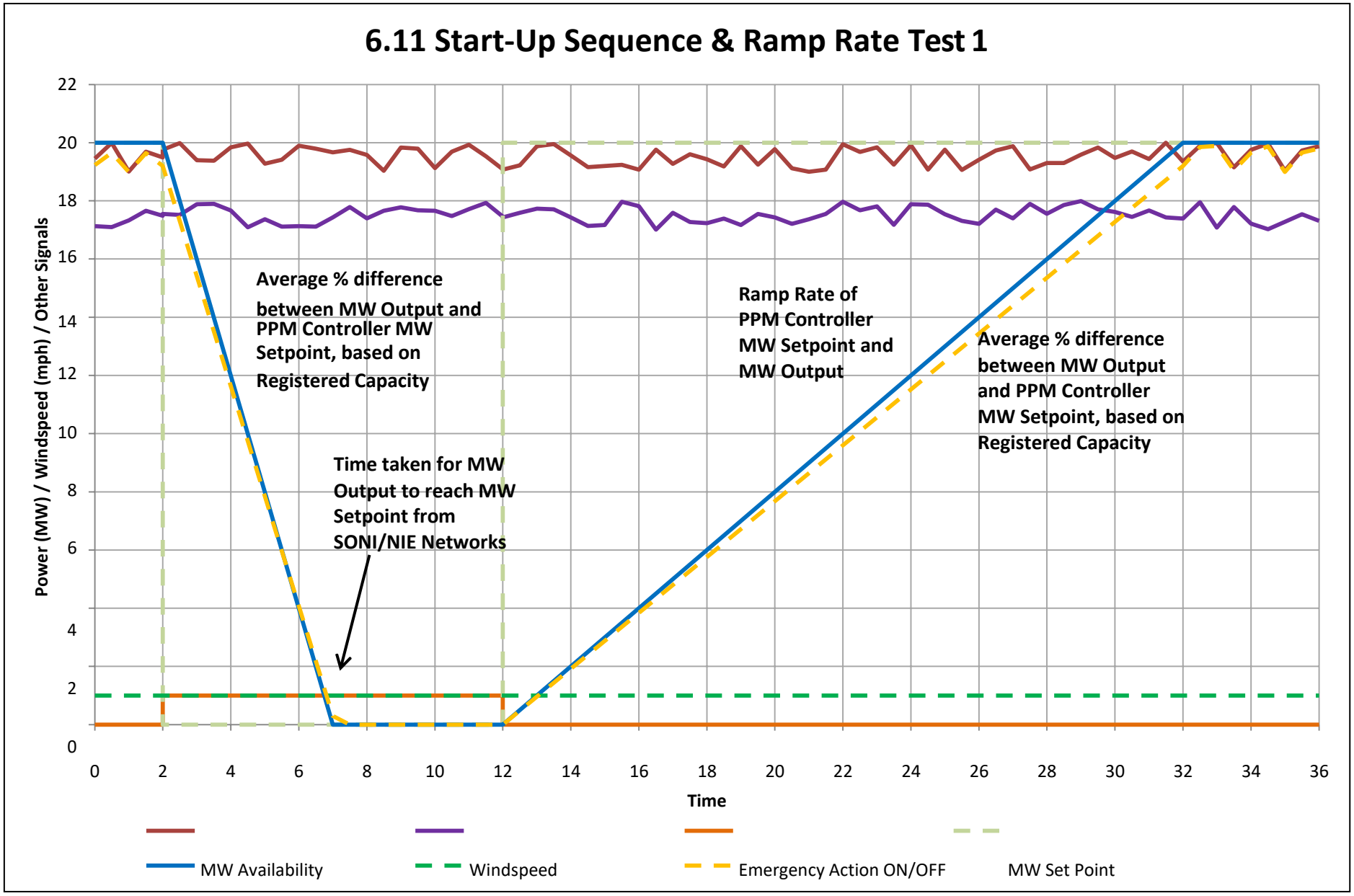

6.8 Power Factor Control Test 5&6 (Transmission)
Power (MW) / Reactive Power (Mvar) / Other Signals
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
0
6
12
18
24
30
36
42
48
54
60
66
72
78
84
90
96
102
108
114
120
Time
Difference between the calculated power factor figure and the power factor setpoint that was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

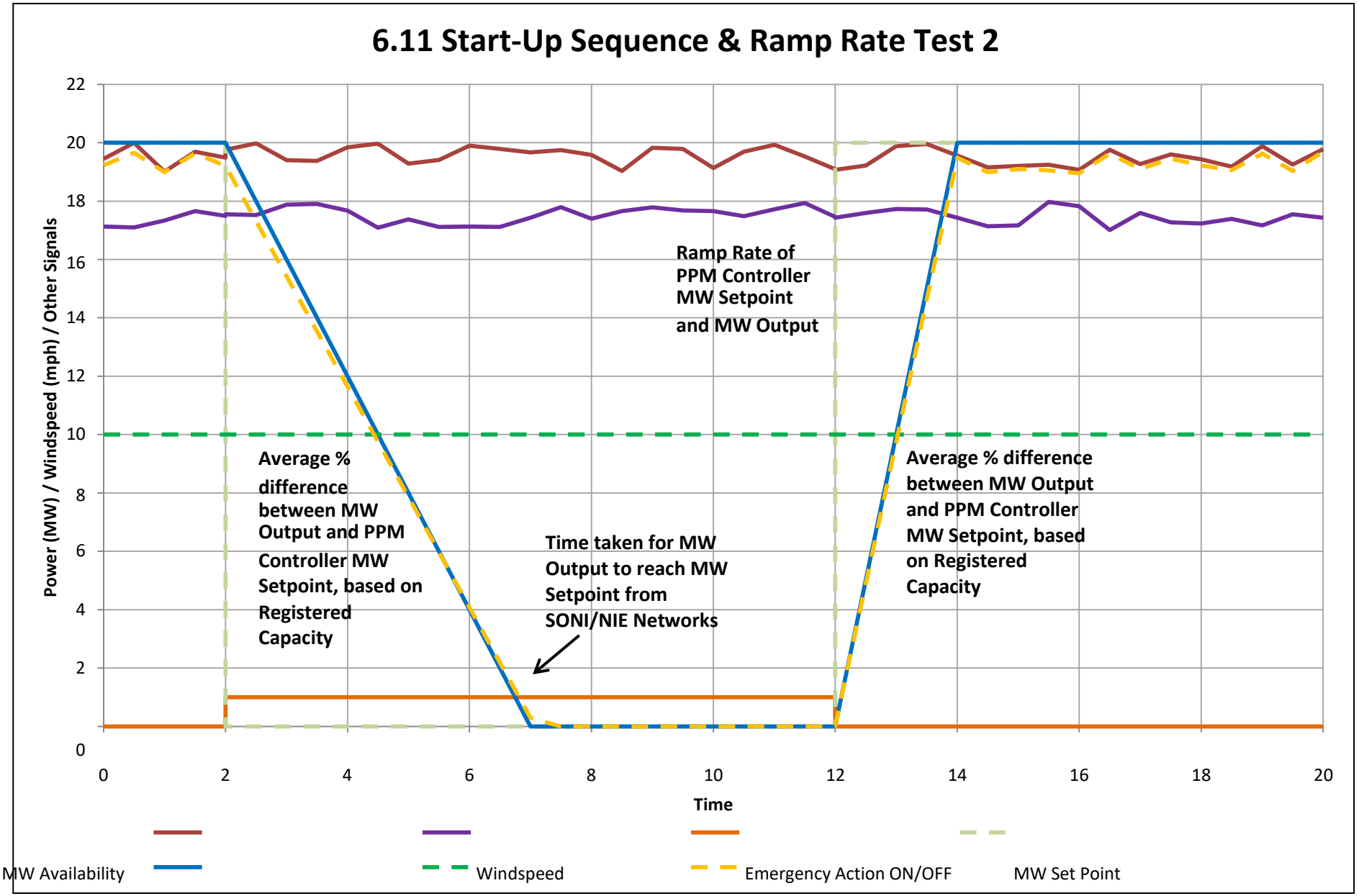

6.8 Power Factor Control Test 5&6 (Distribution)
Power (MW) / Reactive Power (Mvar) / Other Signals
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
0
6
12
18
24
30
36
42
48
54
60
66
72
78
84
90
96
102
108
114
120
Time
Difference between the calculated power factor figure and the power factor setpoint that was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

6.9 - Reactive Power Dispatch Test




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