MODIFICATION RECOMMENDATION FORM
MPID 250 – WFPS Signal Lists

RECOMMENDATION TO CER BY EIRGRID OF MODIFICATION TO GRID CODE.

ABSTRACT / TITLE OF MODIFICATION	WFPS Signal Lists
MODIFICATION NUMBER	MPID 250
RECOMMENDED AT GCRP MEETING NUMBER	39
LIST OF GRID CODE SECTION(S) AFFECTED BY PROPOSED MODIFICATION:	WFPS 1.7
CURRENT GRID CODE VERSION :	V5.0
MODIFICATION DESCRIPTION Overview **THE REASON FOR THE RECOMMENDED MODIFICATION**	Following the DS3 modifications on Windfarm standards a number of changes to the signal requirements have arisen. This modification aims to outline the new signalling requirements to cater for the voltage control, reactive power and power factor control modes. Some existing signal names have been tidied up for consistency.

History of Progression through GCRPs, Working Group and/or Consultation	MPID 250 was submitted to the GCRP in June 2014 for consideration by the panel. This modification specified that the wind farm shall transition between voltage, reactive power and power factor control modes in a smooth fashion by calculating the specific set-point that is consistent with the current operating point before changing control mode. This method of transition had been specified in the TSO Technical Query documents that were issued to each wind farm in April 2013 and was subsequently brought forward as a modification to the Grid Code for clarification purposes. Following discussions with the members there were a number of actions required. The first action was to revise the modification so that the text for the smooth voltage transition was in clause WFPS1.6.2.2 instead of WFPS1.7.1.1. This is now reflected in the attached modification. The other main action was to conduct a pilot test to demonstrate the functionality of the smooth voltage transition. Testing was successfully completed on Athea windfarm by EirGrid and SSE to demonstrate this functionality last week. Following this testing, we can confirm that all actions relating to this modification have been complete and we would now wish to submit the modification for consideration by CER.
Summary Note of any Objections to the Recommended change from GCRP Members or Consultation Responses	No further objections were raised.
Outcome of any GCRP Meeting Actions Relating to the Recommended Modification	No further actions required.
Implication of not implementing the Modification	The new signals are required to allow for the full capabilities of the windfarms to be operated by the TSO. Without these signals the TSO will be unable t fully utilise the new control methods for voltage regulation in windfarms.

RED-LINE VERSION

WFPS1.6.2   AUTOMATIC VOLTAGE REGULATION

WFPS1.6.2.1 **Controllable WFPSs** shall have a continuously-variable and continuously-acting **Voltage Regulation System** with similar response characteristics to a conventional **Automatic Voltage Regulator** and shall perform generally as described in BS4999 part 140, or equivalent European Standards.

WFPS1.6.2.2 Under steady state conditions, the **Voltage Regulation System** shall be capable of implementing the following **Reactive Power** control modes which shall be available to the **TSO:**

  a) The **Controllable WFPS** shall be capable of receiving a **Power Factor** control (PF) set-point to maintain the **Power Factor** set-point at the **Connection Point;**

  b) The **Controllable WFPS** shall be capable of receiving a **Reactive Power** control (Q) set-point to maintain the **Reactive Power** set-point at the **Connection Point**;

  c) The **Controllable WFPS** shall be capable of receiving a **Voltage Regulation** (kV) **Set-point** for the **Voltage** at the **Connection Point.** The **Voltage Regulation System** shall act to regulate the **Voltage** at this point by continuous modulation of the **Controllable WFPS's Reactive Power** output, without violating the **Voltage Step Emissions** limits as set out in the IEC standard 61000-3-7:1996 *Assessment of Emission limits for fluctuating loads in MV and HV power systems.*

A change to the **Power Factor** control (PF) set-point, **Reactive Power** control (Q) set-point or **Voltage Regulation** (kV) **Set-Point** shall be implemented by the **Controllable WFPS** within 20 seconds of receipt of the appropriate signal from the **TSO,** within its reactive power capability range as specified in WFPS1.6.3.

One **Reactive Power Control** mode shall be operational at all times with the facility to toggle between each of the **Reactive Power** control modes from NCC. Toggling between **Reactive Power** controllers shall be smooth in transfer *i.e.* the **Controllable WFPS** shall calculate and implement an appropriate set-point when transferring to the new control mode. The set-point calculated for the new control mode shall be consistent with the Mvar output at that time.

WFPS1.7   SIGNALS, COMMUNICATIONS & CONTROL

WFPS1.7.1   SIGNALS FROM THE CONTROLLABLE WFPS TO THE TSO

Signals from **Controllable WFPSs** to the **TSO** shall be broken up into a number of logical groups. There shall be different requirements for **Controllable WFPSs** depending on the **Controllable WFPS's MEC**. The following groups shall apply:

- ▪ *Signals List #1* - applies to **all Controllable WFPSs**;

In addition, **Controllable WFPSs** shall be required to provide signals from *Signals Lists 2, 3, 4 and/or 5*. These lists relate to:

- ▪ *Signals List #2* - Meteorological Data;

- ▪ *Signals List #3 -* **Availability** Data;

- ▪ *Signals List #4* - **Active Power Control** Data;

- ▪ *Signals List #5* - **Frequency Response System** Data.

WFPS1.7.1.1   *Signals List #1*

The **Controllable WFPS** shall make the following signals available at the designated **TSO Telecommunication Interface Cabinet** for that **Controllable WFPS**:

a) **Active Power** output (MW) at the lower voltage side of the **Grid Connected Transformer**;

b) **Reactive Power** output/demand (+/-Mvar) at the lower voltage side of the **Grid Connected Transformer**;

c) Voltage (in kV) at the lower voltage side of the **Grid Connected Transformer**;

d) **Available Active Power** (MW) at the lower voltage side of the **Grid Connected Transformer**;

e) **Grid Connected Transformer** tap positions;

f) i) **Power Factor** control mode status feedback (ON/OFF);

    ii) **Power Factor** set-point feedback (degrees);

    iii) **Reactive Power** control mode status feedback (ON/OFF);

    iv) **Reactive Power** set-point feedback (Mvar);

    v) **Voltage Regulation** control mode status feedback (ON/OFF);

    vi) **Voltage Regulation Set-point** feedback (in kV);

g) On/off status indications for all **Reactive Power** devices exceeding 5 Mvar[1];

h) Circuit-breaker and disconnect position indication shall be required. These may include indications from MV circuit-breakers on individual **WTG** circuits. Signals from individual **WTG** circuit-breakers shall not be required. The actual circuit-breaker and disconnect signals required shall be specified by the **TSO** at least 120 **Business Days** prior to the **Controllable WFPS's** scheduled **Operational Date**;

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[1] Typically the position indication from capacitor/ SVC circuit breakers

i)   A minimum of four sets of normally open potential free auxiliary contacts in each **Grid Connected Transformer** lower voltage bay for fault indications; and

j)   On/off status of **TSO** remote control enable switch, which disables the ability of the **TSO** to send commands to the **Controllable WFPS**.

For the **Controllable WFPS's** where the **Connection Point** is at the HV side of the **Grid Connected Transformer**, signals a), b) and c) above will also be required from the HV side of the **Grid Connected Transformer**.

WFPS1.7.1.2   *Signals List #2*

WFPS1.7.1.2.1 **Controllable WFPSs** with a **MEC** in excess of 10 MW shall make the following meteorological data signals available at the designated **TSO Telecommunication Interface Cabinet** for that **Controllable WFPS**:

		[Units, Range]
a)	Wind speed (at hub height) - measurand signal;	[m/s, 0-70]
b)	Wind direction (at hub height) - measurand signal;	[deg, 0-360]
c)	Air temperature- measurand signal;	[deg C, -40-70]
d)	Air pressure- measurand signal.	[mBar, 735-1060]

WFPS1.7.1.2.2 The meteorological data signals shall be provided by a dedicated **Meteorological Mast** located at the **Controllable WFPS** site or, where possible and preferable to do so, data from a means of the same or better accuracy.   For **Controllable WFPSs** where the **WTG** are widely dispersed over a large geographical area and rather different weather patterns are expected for different sections of the **Controllable WFPS**, the meteorological data shall be provided from a number of individual **Meteorological Masts**, or where possible and preferable to do so, data from a source of the same or better reliability for groups of **WTG** (e.g. 1 set of meteorological data for each group of XX **WTG** within the **Controllable WFPS**). It is expected that **WTG** within an individual group shall demonstrate a high degree of correlation in **Active Power** output at any given time.   The actual signals required shall be specified by the **TSO** at least 120 **Business Days** prior to the **Controllable WFPS's** scheduled **Operational Date.**

WFPS1.7.1.3   *Signals List #3*

WFPS1.7.1.3.1 **Controllable WFPSs** with a **MEC** in excess of 10 MW shall make the following signals available at the designated **TSO Telecommunication Interface Cabinet** for that **Controllable WFPS**:

a)   **Controllable WFPS Availability** (0-100 % signal);

b)   Percentage of **WTG** shutdown due to high wind-speed conditions (0-100 %);

c)   Percentage of **WTG** not generating due low wind-speed shutdown (0-100 %).

WFPS1.7.1.3.2 For **Controllable WFPSs** with a **MEC** in excess of 10 MW, where the **WTG** are widely dispersed over a large geographical area and rather different weather patterns are expected for different sections of the **Controllable WFPS**, the above data set (ref. WFPS1.7.1.3.1) shall be provided for a number of groups of **WTG** (e.g. 1 signal for each group of XX **WTG** within the **Controllable WFPS**). It is expected that **WTG** within an individual group shall demonstrate a high degree of correlation in **Active Power** output at any given time. The actual signals required shall be specified by the **TSO** at least 120 **Business Days** prior to the **Controllable WFPS's** scheduled **Operational Date.**

WFPS1.7.1.4   *Signals List #4*

The **Controllable WFPS** shall make the following signals available at the designated **TSO Telecommunication Interface Cabinet** for that **Controllable WFPS**:

a) ~~Controllable WFPS~~ **Active Power Control Set-point** ~~value~~ feedback (MW);

b) ~~Controllable WFPS~~ **Active Power Control** status ~~indication~~ feedback (ON/OFF).

WFPS1.7.1.5   *Signals List #5*

The **Controllable WFPS** shall make the following signals available at the designated **TSO Telecommunication Interface Cabinet** for that **Controllable WFPS**:

a) Frequency Response Curve ~~System mode signal~~ (i.e. *Power-Frequency Response Curve 1 or 2*);

b) **Frequency Response System** status ~~indication~~ feedback (ON/OFF);~~.~~

c) **Frequency Response System Governor Droop** ~~value~~ feedback (%).

WFPS1.7.1.6   **Time Delays and Data Quality**

WFPS1.7.1.6.1 Digital signal changes from the **Controllable WFPS** shall be relayed to the **TSO Telecommunication Interface Cabinet** within 1 second of the associated change of state event. Analogue signal changes shall be relayed within 5 seconds and with an error of 0.5% or less, with the exception of the Meteorological Data required as per **WFPS1.7.1.2.1**, which shall be updated within 5 seconds and with an error of 2.5% or less.

WFPS1.7.2   **CONTROL SIGNALS FROM THE TSO TO CONTROLLABLE WFPS**

WFPS1.7.2.1   The control signals described in WFPS1.7.2 shall be sent from the **TSO** to the **Controllable WFPS**. The **Controllable WFPS** shall be capable of receiving these signals and acting accordingly.

WFPS1.7.2.2   **Active Power Control**

An **Active Power Control Set-point** signal shall be sent by the **TSO** to the **Wind Farm Control System**. This set-point shall define the maximum **Active Power** output permitted from the **Controllable WFPS**. The **Wind Farm Control System** shall be capable of receiving this signal and acting accordingly to achieve the desired change in

Active Power output. This signal shall be in the form of a single analogue value and a strobe pulse to enable.

The **Controllable WFPS** is required to make it possible for the **TSO** toremotely enable/disable the **Active Power Control** function in the **Wind Farm Control System**. The associated status indication is described in WFPS1.7.1.4.

WFPS1.7.2.3   **Frequency Response**

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

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

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

WFPS1.7.2.4   **Voltage Regulation**

The following signals shall allow the **TSO** to select **Reactive Power** control mode and send **Reactive Power** control set-points to the **Voltage Regulation System**. Set-point signals shall be in the form of a single analogue value and a strobe pulse to enable.

- **Power Factor** control mode with **Power Factor** set-point (PF set-point),
- **Reactive Power** control mode with **Reactive Power** set-point (Q set-point).
- **Automatic Voltage Regulation** control mode with **Voltage Regulation Set-point** (kV set-point),

WFPS1.7.2.5   **Black Start Shutdown**

Means shall be provided by the **Controllable WFPS** to facilitate the disconnection of the **Controllable WFPS** by the **TSO** and to also prevent re-connection in the event of **Black Start**. The **TSO** shall send a **Black Start Shutdown** signal and upon receipt, the **Controllable WFPS** shall be required to trip the circuit-breaker(s) at the **Controllable WFPS's Connection Point** and shutdown the **Controllable WFPS** in a controlled manner. The precise circuit-breakers for which this facility shall be provided shall be specified by the **TSO** at least 120 **Business Days** prior to the **Controllable WFPS's** scheduled **Operational Date. Controllable WFPSs** may only be reconnected (i.e. made live) when the **Network** is fully restored following instruction from the **TSO**[2] and only earlier if the **TSO** deems it acceptable to do so.

WFPS1.7.2.6   **Time Delays and Data Quality**

WFPS1.7.2.6.1 Digital output commands from the **TSO Telecommunication Interface Cabinet** shall be relayed to the **Controllable WFPS** equipment within 1 second. Set-point output signals shall be relayed within 5 seconds and with an error of 0.5% or less.

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[2] Typically this instruction will be in the form of a Blackstart Shutdown OFF command

WFPS1.7.3   RESPONSIBLE OPERATOR

A designated **Responsible Operator** shall be contactable by the **TSO** at all times to discuss operational matters without undue delay and in any case within 15 minutes. Following a request from the **TSO**, the **Responsible Operator** shall be present at the **Controllable WFPS's Connection Point** without undue delay and in any case within one hour and shall be capable of taking any required appropriate actions. The **Responsible Operator** shall be contactable 24 hours a day, 365 days a year.

WFPS1.7.4   DATA AND COMMUNICATIONS SPECIFICATIONS

WFPS1.7.4.1   The location of the **TSO Telecommunication Interface Cabinet** shall be agreed between the **TSO** and the **Controllable WFPS** at least 120 **Business Days** prior to the **Controllable WFPS's** scheduled **Operational Date**. A standard interface for signals will be made available to the **Controllable WFPS** by the **TSO**.

WFPS1.7.4.2   The necessary communications links, communications protocol and an individual **Controllable WFPS** signal list shall be specified by the **TSO** at least 120 **Business Days** prior to the **Controllable WFPS's** scheduled **Operational Date.** Current applicable standards shall apply and the accuracy class for signals shall comply with the prevailing European Standard at that time.

WFPS1.7.4.3   For loss of communications links, persistence (i.e. continuing to operate with the most recent data set) shall be used in terms of set-points until the designated **Responsible Operator** has been contacted by the **TSO**.

WFPS1.7.4.4   If **Active Power Control**, **Frequency Response** or **Voltage Regulation** facilities for the **Controllable WFPS** become unavailable, the **Controllable WFPS** shall contact the **TSO** without undue delay.

WFPS1.7.4.5   Where signals or indications required to be provided by the **Controllable WFPS** under WFPS1.7.1 and WFPS 1.7.2 become unavailable or do not comply with applicable standards due to failure of the **Controllable WFPS's** technical equipment or any other reason under the control of the **Controllable WFPS**, the **Controllable WFPS** shall, acting in accordance with **Good Industry Practice**, restore or correct the signals and/or indications as soon as possible.

WFPS1.7.5   WIND POWER FORECASTS

WFPS1.7.5.1   Should the **TSO** determine that wind power forecasts as produced by the **Controllable WFPS** are required, the **TSO** shall inform the **Controllable WFPS** and the wind power forecasts shall be provided by the **Controllable WFPSs**. These forecasts, if required, shall be provided in a format and timescale as specified by the **TSO**, and by means of an **Electronic Interface** in accordance with the reasonable requirements of the **TSO's** data system.

WFPS1.7.5.2 **Controllable WFPSs** shall engage fully with the **TSO** to ensure that the necessary information is available to the **TSO** for the production of wind generation forecasts with the appropriate level of accuracy by the **TSO**. Where this engagement involves the provision of data by the **Controllable WFPS** to the **TSO**, this data must be provided as soon as reasonably practicable, or in any event, within 60 business days of the date of the request.

WFPS1.7.6   CONTROLLABLE WFPS MW AVAILABILITY DECLARATIONS

Controllable WFPSs shall submit **Controllable WFPS MW Availability Declarations** whenever changes in **Controllable WFPS Availability** occur or are predicted to occur. These declarations shall be submitted by means of an **Electronic Interface** in accordance with the reasonable requirements of the **TSO**'s data system.

GREEN-LINE VERSION

WFPS1.6.2   AUTOMATIC VOLTAGE REGULATION

WFPS1.6.2.1 **Controllable WFPSs** shall have a continuously-variable and continuously-acting **Voltage Regulation System** with similar response characteristics to a conventional **Automatic Voltage Regulator** and shall perform generally as described in BS4999 part 140, or equivalent European Standards.

WFPS1.6.2.2 Under steady state conditions, the **Voltage Regulation System** shall be capable of implementing the following **Reactive Power** control modes which shall be available to the **TSO:**

d) The **Controllable WFPS** shall be capable of receiving a **Power Factor** control (PF) set-point to maintain the **Power Factor** set-point at the **Connection Point;**

e) The **Controllable WFPS** shall be capable of receiving a **Reactive Power** control (Q) set-point to maintain the **Reactive Power** set-point at the **Connection Point**;

f) The **Controllable WFPS** shall be capable of receiving a **Voltage Regulation** (kV) **Set-point** for the **Voltage** at the **Connection Point.** The **Voltage Regulation System** shall act to regulate the **Voltage** at this point by continuous modulation of the **Controllable WFPS's Reactive Power** output, without violating the **Voltage Step Emissions** limits as set out in the IEC standard 61000-3-7:1996 *Assessment of Emission limits for fluctuating loads in MV and HV power systems.*

A change to the **Power Factor** control (PF) set-point, **Reactive Power** control (Q) set-point or **Voltage Regulation** (kV) **Set-Point** shall be implemented by the **Controllable WFPS** within 20 seconds of receipt of the appropriate signal from the **TSO,** within its reactive power capability range as specified in WFPS1.6.3.

One **Reactive Power Control** mode shall be operational at all times with the facility to toggle between each of the **Reactive Power** control modes from NCC. Toggling between **Reactive Power** controllers shall be smooth in transfer *i.e.* the **Controllable WFPS** shall calculate and implement an appropriate set-point when transferring to the new control mode. The set-point calculated for the new control mode shall be consistent with the Mvar output at that time.

WFPS1.7   SIGNALS, COMMUNICATIONS & CONTROL

WFPS1.7.1   SIGNALS FROM THE CONTROLLABLE WFPS TO THE TSO

Signals from **Controllable WFPSs** to the **TSO** shall be broken up into a number of logical groups. There shall be different requirements for **Controllable WFPSs** depending on the **Controllable WFPS's MEC**. The following groups shall apply:

- *Signals List #1* - applies to **all Controllable WFPSs**;

In addition, **Controllable WFPSs** shall be required to provide signals from *Signals Lists 2, 3, 4 and/or 5*. These lists relate to:

- *Signals List #2* - Meteorological Data;

- *Signals List #3* - **Availability** Data;

- *Signals List #4* - **Active Power Control** Data;

- *Signals List #5* - **Frequency Response System** Data.

WFPS1.7.1.1   *Signals List #1*

The **Controllable WFPS** shall make the following signals available at the designated **TSO Telecommunication Interface Cabinet** for that **Controllable WFPS**:

a)   **Active Power** output (MW) at the lower voltage side of the **Grid Connected Transformer**;

b)   **Reactive Power** output/demand (+/-Mvar) at the lower voltage side of the **Grid Connected Transformer**;

c)   Voltage (in kV) at the lower voltage side of the **Grid Connected Transformer**;

d)   **Available Active Power** (MW) at the lower voltage side of the **Grid Connected Transformer**;

e)   **Grid Connected Transformer** tap positions;

f)   i) **Power Factor** control mode status feedback (ON/OFF);

   ii) **Power Factor** set-point feedback (degrees);

   iii) **Reactive Power** control mode status feedback (ON/OFF);

   iv) **Reactive Power** set-point feedback (Mvar);

   v) **Voltage Regulation** control mode status feedback (ON/OFF);

   vi) **Voltage Regulation Set-point** feedback (kV);

g)   On/off status indications for all **Reactive Power** devices exceeding 5 Mvar[3];

h)   Circuit-breaker and disconnect position indication shall be required. These may include indications from MV circuit-breakers on individual **WTG** circuits. Signals from individual **WTG** circuit-breakers shall not be required. The actual circuit-breaker and disconnect signals required shall be specified by the **TSO** at least 120 **Business Days** prior to the **Controllable WFPS's** scheduled **Operational Date**;

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[3] Typically the position indication from capacitor/ SVC circuit breakers

i) A minimum of four sets of normally open potential free auxiliary contacts in each **Grid Connected Transformer** lower voltage bay for fault indications; and

j) On/off status of **TSO** remote control enable switch, which disables the ability of the **TSO** to send commands to the **Controllable WFPS**.

For the **Controllable WFPS's** where the **Connection Point** is at the HV side of the **Grid Connected Transformer**, signals a), b) and c) above will also be required from the HV side of the **Grid Connected Transformer**.

WFPS1.7.1.2 *Signals List #2*

WFPS1.7.1.2.1 **Controllable WFPSs** with a **MEC** in excess of 10 MW shall make the following meteorological data signals available at the designated **TSO Telecommunication Interface Cabinet** for that **Controllable WFPS**:

		[Units, Range]
e)	Wind speed (at hub height) - measurand signal;	[m/s, 0-70]
f)	Wind direction (at hub height) - measurand signal;	[deg, 0-360]
g)	Air temperature- measurand signal;	[deg C, -40-70]
h)	Air pressure- measurand signal.	[mBar, 735-1060]

WFPS1.7.1.2.2 The meteorological data signals shall be provided by a dedicated **Meteorological Mast** located at the **Controllable WFPS** site or, where possible and preferable to do so, data from a means of the same or better accuracy. For **Controllable WFPSs** where the **WTG** are widely dispersed over a large geographical area and rather different weather patterns are expected for different sections of the **Controllable WFPS**, the meteorological data shall be provided from a number of individual **Meteorological Masts**, or where possible and preferable to do so, data from a source of the same or better reliability for groups of **WTG** (e.g. 1 set of meteorological data for each group of XX **WTG** within the **Controllable WFPS**). It is expected that **WTG** within an individual group shall demonstrate a high degree of correlation in **Active Power** output at any given time. The actual signals required shall be specified by the **TSO** at least 120 **Business Days** prior to the **Controllable WFPS's** scheduled **Operational Date.**

WFPS1.7.1.3 *Signals List #3*

WFPS1.7.1.3.1 **Controllable WFPSs** with a **MEC** in excess of 10 MW shall make the following signals available at the designated **TSO Telecommunication Interface Cabinet** for that **Controllable WFPS**:

d) **Controllable WFPS Availability** (0-100 % signal);

e) Percentage of **WTG** shutdown due to high wind-speed conditions (0-100 %);

f) Percentage of **WTG** not generating due low wind-speed shutdown (0-100 %).

WFPS1.7.1.3.2 For **Controllable WFPSs** with a **MEC** in excess of 10 MW, where the **WTG** are widely dispersed over a large geographical area and rather different weather patterns are expected for different sections of the **Controllable WFPS**, the above data set (ref. WFPS1.7.1.3.1) shall be provided for a number of groups of **WTG** (e.g. 1 signal for each group of XX **WTG** within the **Controllable WFPS**). It is expected that **WTG** within an individual group shall demonstrate a high degree of correlation in **Active Power** output at any given time. The actual signals required shall be specified by the **TSO** at least 120 **Business Days** prior to the **Controllable WFPS's** scheduled **Operational Date.**

WFPS1.7.1.4   *Signals List #4*

The **Controllable WFPS** shall make the following signals available at the designated **TSO Telecommunication Interface Cabinet** for that **Controllable WFPS**:

c)   **Active Power Control Set-point** feedback (MW);

d)   **Active Power Control** status feedback (ON/OFF).

WFPS1.7.1.5   *Signals List #5*

The **Controllable WFPS** shall make the following signals available at the designated **TSO Telecommunication Interface Cabinet** for that **Controllable WFPS**:

d)   Frequency Response Curve (i.e. *Power-Frequency Response Curve 1 or 2*);

e)   **Frequency Response System** status feedback (ON/OFF);

f)   **Frequency Response System Governor Droop** feedback (%).

WFPS1.7.1.6   **Time Delays and Data Quality**

WFPS1.7.1.6.1 Digital signal changes from the **Controllable WFPS** shall be relayed to the **TSO Telecommunication Interface Cabinet** within 1 second of the associated change of state event. Analogue signal changes shall be relayed within 5 seconds and with an error of 0.5% or less, with the exception of the Meteorological Data required as per **WFPS1.7.1.2.1**, which shall be updated within 5 seconds and with an error of 2.5% or less.

WFPS1.7.2   **CONTROL SIGNALS FROM THE TSO TO CONTROLLABLE WFPS**

WFPS1.7.2.1   The control signals described in WFPS1.7.2 shall be sent from the **TSO** to the **Controllable WFPS**. The **Controllable WFPS** shall be capable of receiving these signals and acting accordingly.

WFPS1.7.2.2   **Active Power Control**

An **Active Power Control Set-point** signal shall be sent by the **TSO** to the **Wind Farm Control System**. This set-point shall define the maximum **Active Power** output permitted from the **Controllable WFPS**. The **Wind Farm Control System** shall be capable of receiving this signal and acting accordingly to achieve the desired change in **Active Power** output. This signal shall be in the form of a single analogue value and a strobe pulse to enable.

The **Controllable WFPS** is required to make it possible for the **TSO** to remotely enable/disable the **Active Power Control** function in the **Wind Farm Control System**. The associated status indication is described in WFPS1.7.1.4.

WFPS1.7.2.3 **Frequency Response**

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

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

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

WFPS1.7.2.4 **Voltage Regulation**

The following signals shall allow the **TSO** to select **Reactive Power** control mode and send **Reactive Power** control set-points to the **Voltage Regulation System**. Set-point signals shall be in the form of a single analogue value and a strobe pulse to enable.

- **Power Factor** control mode with **Power Factor** set-point (PF set-point),
- **Reactive Power** control mode with **Reactive Power** set-point (Q set-point).
- **Automatic Voltage Regulation** control mode with **Voltage Regulation Set-point** (kV set-point),

WFPS1.7.2.5 **Black Start Shutdown**

Means shall be provided by the **Controllable WFPS** to facilitate the disconnection of the **Controllable WFPS** by the **TSO** and to also prevent re-connection in the event of **Black Start**. The **TSO** shall send a **Black Start Shutdown** signal and upon receipt, the **Controllable WFPS** shall be required to trip the circuit-breaker(s) at the **Controllable WFPS's Connection Point** and shutdown the **Controllable WFPS** in a controlled manner. The precise circuit-breakers for which this facility shall be provided shall be specified by the **TSO** at least 120 **Business Days** prior to the **Controllable WFPS's** scheduled **Operational Date. Controllable WFPSs** may only be reconnected (i.e. made live) when the **Network** is fully restored following instruction from the **TSO**[4] and only earlier if the **TSO** deems it acceptable to do so.

WFPS1.7.2.6 **Time Delays and Data Quality**

WFPS1.7.2.6.1 Digital output commands from the **TSO Telecommunication Interface Cabinet** shall be relayed to the **Controllable WFPS** equipment within 1 second. Set-point output signals shall be relayed within 5 seconds and with an error of 0.5% or less.

WFPS1.7.3   **RESPONSIBLE OPERATOR**

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[4] Typically this instruction will be in the form of a Blackstart Shutdown OFF command

A designated **Responsible Operator** shall be contactable by the **TSO** at all times to discuss operational matters without undue delay and in any case within 15 minutes. Following a request from the **TSO**, the **Responsible Operator** shall be present at the **Controllable WFPS's Connection Point** without undue delay and in any case within one hour and shall be capable of taking any required appropriate actions. The **Responsible Operator** shall be contactable 24 hours a day, 365 days a year.

WFPS1.7.4   **DATA AND COMMUNICATIONS SPECIFICATIONS**

WFPS1.7.4.1   The location of the **TSO Telecommunication Interface Cabinet** shall be agreed between the **TSO** and the **Controllable WFPS** at least 120 **Business Days** prior to the **Controllable WFPS's** scheduled **Operational Date**. A standard interface for signals will be made available to the **Controllable WFPS** by the **TSO**.

WFPS1.7.4.2   The necessary communications links, communications protocol and an individual **Controllable WFPS** signal list shall be specified by the **TSO** at least 120 **Business Days** prior to the **Controllable WFPS's** scheduled **Operational Date.** Current applicable standards shall apply and the accuracy class for signals shall comply with the prevailing European Standard at that time.

WFPS1.7.4.3   For loss of communications links, persistence (i.e. continuing to operate with the most recent data set) shall be used in terms of set-points until the designated **Responsible Operator** has been contacted by the **TSO**.

WFPS1.7.4.4   If **Active Power Control**, **Frequency Response** or **Voltage Regulation** facilities for the **Controllable WFPS** become unavailable, the **Controllable WFPS** shall contact the **TSO** without undue delay.

WFPS1.7.4.5   Where signals or indications required to be provided by the **Controllable WFPS** under WFPS1.7.1 and WFPS 1.7.2 become unavailable or do not comply with applicable standards due to failure of the **Controllable WFPS's** technical equipment or any other reason under the control of the **Controllable WFPS**, the **Controllable WFPS** shall, acting in accordance with **Good Industry Practice**, restore or correct the signals and/or indications as soon as possible.

WFPS1.7.5   **WIND POWER FORECASTS**

WFPS1.7.5.1   Should the **TSO** determine that wind power forecasts as produced by the **Controllable WFPS** are required, the **TSO** shall inform the **Controllable WFPS** and the wind power forecasts shall be provided by the **Controllable WFPSs**. These forecasts, if required, shall be provided in a format and timescale as specified by the **TSO**, and by means of an **Electronic Interface** in accordance with the reasonable requirements of the **TSO's** data system.

WFPS1.7.5.2   **Controllable WFPSs** shall engage fully with the **TSO** to ensure that the necessary information is available to the **TSO** for the production of wind generation forecasts with

the appropriate level of accuracy by the **TSO**. Where this engagement involves the provision of data by the **Controllable WFPS** to the **TSO**, this data must be provided as soon as reasonably practicable, or in any event, within 60 business days of the date of the request.

WFPS1.7.6   **CONTROLLABLE WFPS MW AVAILABILITY DECLARATIONS**

Controllable WFPSs shall submit **Controllable WFPS MW Availability Declarations** whenever changes in **Controllable WFPS Availability** occur or are predicted to occur. These declarations shall be submitted by means of an **Electronic Interface** in accordance with the reasonable requirements of the **TSO**'s data system.