

MPID 163 - Change to WFPS1- Wind Farm Power Station Provisions

Change to the Grid Code WFPS1 to more accurately reflect the signals, communications and control requirements for wind farms, given our experience of dealing with wind farm communications facilities thus far.

- 1) Remove references to 'providing the signals at the **TSO's RTU**'.
Instead the code should refer to the **TSO Telecommunication Interface Cabinet**
New definition for **TSO Telecommunication Interface Cabinet** must be provided:
The physical interface point between the **TSO's** telecommunications equipment and the **Wind Farm Power Station's** control equipment.
- 2) kV setpoint will now be referred to as **Voltage Regulation Set-point**:
New definition for **Voltage Regulation Set-point**:
The voltage in kV that the **Voltage Regulation System** will act to regulate by continuous modulation of the **Wind Farm Power Station's Reactive Power**.
- 3) MW Curtailment will now be called **Active Power Control**. This is because the wind farm output could be restricted for a number of reasons; curtailment or constraint. Delete references to MW Curtailment and Curtailed Active Power

New definition of **Active Power Control**:

The automatic change in **Active Power** output from a **Wind Farm Power Station** in a response to an **Active Power Control Set-point** received from the **TSO**.

New definition of **Controlled Active Power**:

The amount of **Active Power** that a **Wind Farm Power Station** is permitted to export based on the **Active Power Control Set-point** signal sent by the **TSO**.

New definition for **Active Power Control Set-point**:

The maximum amount of **Active Power** in **MW**, set by the **TSO**, that the **Wind Farm Power Station** is permitted to export.

New definition for **Wind Farm Control System**:

The control system at the **Wind Farm Power Station** which provides for **Active Power Control**, **Frequency Response**, ramp rate control and other **WTG** control features.

- 4) New definition for Black Start Shutdown
In the event of a **Partial** or **Total Shutdown** of the **Transmission System**, the **Wind Farm Power Station** shall be sent a **Black Start Shutdown** signal by the **TSO** and upon receipt of the signal, the **Wind Farm Power Station** shall trip the circuit breaker(s) at the **Connection Point** and shutdown the **Wind Farm Power Station** in a controlled manner.
- 5) Change reference to LV to lower voltage
- 6) Information relating to signal lists, interface cabinets, ramp rate setting, power-frequency curves, slope setting for voltage regulation system etc will be supplied no less than 120 BD's before the scheduled Operational Date.
- 7) Addition of the TSO remote control enable switch as part of the standard list
- 8) Refining the sections about data & communications, time delays and data quality

WFPS1 WIND FARM POWER STATION GRID CODE PROVISIONS

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WFPS 1 WIND FARM POWER STATION GRID CODE PROVISIONS

WFPS1.1 INTRODUCTION

All **Generators** connecting to the **Transmission System** are required to comply with the **Grid Code**. The **Grid Code** was originally developed with synchronous generators in mind. Since **Wind Turbine Generators (WTG)** do not have the same characteristics as synchronous generators, it was considered appropriate to develop a new set of **Grid Code** provisions specifically for **Wind Farm Power Stations**. This section of the **Grid Code** gives the specific requirements for **Wind Farm Power Stations**.

WFPS1.2 OBJECTIVE

The primary objective of WFPS1 is to establish the technical rules which **Wind Farm Power Stations** must comply with in relation to their connection to and operation on the **Transmission System**.

WFPS1.3 SCOPE

WFPS1.3.1 WFPS1 applies to the following **Users**:

- (a) The **TSO**; and
- (b) **Grid Connected Wind Farm Power Stations**.

WFPS1.3.2 In addition to WFPS1, **Wind Farm Power Stations** are required to comply with the following sections of the **Grid Code**:

- GC - General Conditions
- PC - Planning Code
- PCA – Planning Code Appendix
- CC- Connection Conditions excluding:
 - *CC 7.2.5.1*
 - *CC 7.2.5.2*
 - *CC7.3.1.1(a) to (h) and (j) to (u)*
 - *CC7.3.1.2*
 - *CC7.3.5*
 - *CC7.3.6*
 - *CC7.3.7*
 - *CC7.3.8*
 - *CC.12.2*
 - *CC.12.3*

- OC1
- OC2
- OC4 excluding:
 - OC4.3.4
 - OC4.4.5.3
 - OC4.4.5.4
 - OC4.4.5.5
- OC6
- OC7 excluding
 - OC7.2.4.2
- OC8
- OC9
- OC10 excluding
 - OC10.5.7
 - OC10.7.1
 - OC10.7.2
 - OC10.7.3
 - OC10.7.4
 - OC10.7.6
- OC11

In the **Grid Code**, where applicable, for the purposes of **Wind Farm Power Stations** references to **Generation Unit** or **Generator** should be interpreted to mean **Wind Farm Power Station**.

WFPS1.4 FAULT RIDE THROUGH REQUIREMENTS

WFPS1.4.1 A **Wind Farm Power Station** shall remain connected to the **Transmission System** for **Transmission System Voltage** dips on any or all phases, where the **Transmission System Phase Voltage** measured at the HV terminals of the **Grid Connected Transformer** remains above the heavy black line in *Figure WFPS1.1*.

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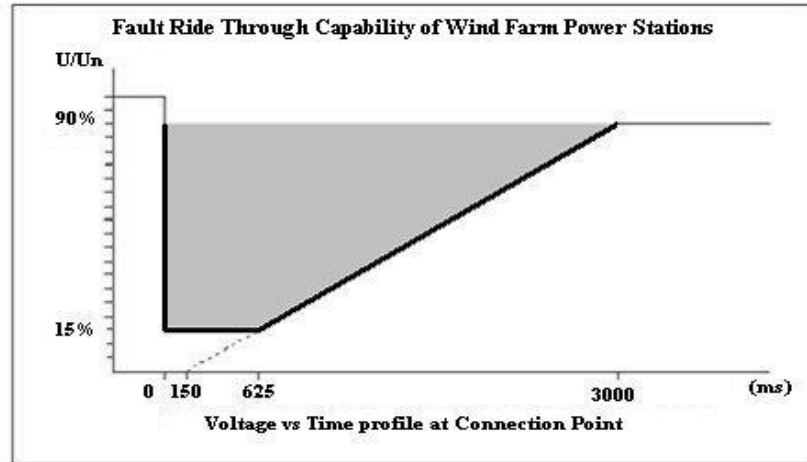


Figure WFPS1.1 - Fault Ride-Through Capability of *Wind Farm Power Stations*

WFPS1.4.2 In addition to remaining connected to the **Transmission System**, the **Wind Farm Power Station** shall have the technical capability to provide the following functions:

- a) During the **Transmission System Voltage** dip the **Wind Farm Power Station** shall provide **Active Power** in proportion to retained **Voltage** and maximise reactive current to the **Transmission System** without exceeding **WTG** limits. The maximisation of reactive current shall continue for at least 600 ms or until the **Transmission System Voltage** recovers to within the normal operational range of the **Transmission System** (ref. WFPS1.6.1), whichever is the sooner;
- b) The **Wind Farm Power Station** shall provide at least 90 % of its maximum **Available Active Power** as quickly as the technology allows and in any event within 1 second of the **Transmission System Voltage** recovering to the normal operating range (ref. WFPS1.6.1).

WFPS1.5.1 TRANSMISSION SYSTEM FREQUENCY RANGES

Wind Farm Power Stations shall have the capability to:

- a) operate continuously at normal rated output at **Transmission System Frequencies** in the range 49.5 Hz to 50.5 Hz;
- b) remain connected to the **Transmission System** at **Transmission System Frequencies** within the range 47.5 Hz to 52.0 Hz for a duration of 60 minutes;
- c) remain connected to the **Transmission System** at **Transmission System Frequencies** within the range 47.0 Hz to 47.5 Hz for a duration of 20 seconds required each time the **Transmission System Frequency** is below 47.5 Hz;
- d) remain connected to the **Transmission System** during rate of change of **Transmission System Frequency** of values up to and including 0.5 Hz per second.

No additional **WTG** shall be started while the **Transmission System Frequency** is above 50.2 Hz.

WFPS1.5.2 ACTIVE POWER MANAGEMENT

A Wind Farm Control System shall be installed by the **Wind Farm Power Station** to allow for the provision of **Active Power Control** and **Frequency Response** from the **Wind Farm Power Station**. The Wind Farm Control System and Frequency Response System shall provide the functionality as specified in this section WFPS1.5.2.

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WFPS1.5.2.1 Active Power Control

The **Wind Farm Control System** shall be capable of operating each **WTG** at a reduced level if the **Wind Farm Power Station's Active Power** output has been restricted by the **TSO**. The **Wind Farm Control System** shall be capable of receiving an on-line Active Power Control Set-point sent by the **TSO** and shall commence implementation of the set-point within 10 seconds of receipt of the signal from the TSO. The rate of change of output to achieve the **Active Power**

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Control Set-point should be no less than the maximum ramp rate settings of the **Wind Farm Control System**, as advised by the TSO, as per WFPS1.5.3.

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WFPS1.5.2.2 Frequency Response

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WFPS1.5.2.2.1 The **Frequency Response System** shall have the capabilities as displayed in the **Power-Frequency Response Curve** in *Figure WFPS1.2*, where the power and frequency ranges required for points A, B, C, D, E are defined below in *Table WFPS1.1* and *Table WFPS1.2*.

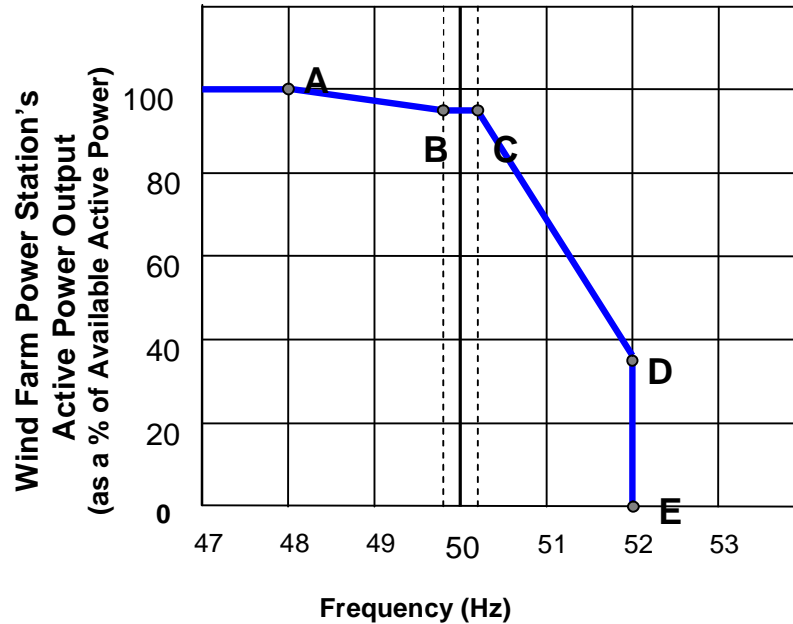


Figure WFPS1.2 – Example of Power-Frequency Response Curve.

WFPS1.5.2.2.2 Under normal **Transmission System Frequency** ranges, the **Wind Farm Power Station** shall operate with an **Active Power** output as set by the line 'B' - 'C'. If the **Transmission System Frequency** falls below point 'B', then the **Frequency Response System** shall act to ramp up the **Wind Farm Power Station's Active Power** output, in accordance with the **Frequency/Active Power** characteristic defined by the line 'B'-'A'.

WFPS1.5.2.2.3 Where the **Transmission System Frequency** is below the normal range and is recovering back towards the normal range, the **Frequency Response System** shall act to ramp down the **Wind Farm Power Station's Active Power** output in

accordance with the **Frequency/Active Power** characteristic defined by the line 'A'-'B'.

WFPS1.5.2.2.4 A **Frequency** dead-band shall be applied between the **Transmission System Frequencies** corresponding to points 'B' and 'C', where no change in the **Wind Farm Power Station's Active Power** output shall be required.

WFPS1.5.2.2.5 Once the **Transmission System Frequency** rises to a level above point 'C', the **Frequency Response System** shall act to ramp down the **Wind Farm Power Station's Active Power** output in accordance with the **Frequency/Active Power** characteristic defined by the line 'C'-'D'-'E'. At **Transmission System Frequencies** greater than or equal to 'D'-'E', there shall be no **Active Power** output from the **Wind Farm Power Station**.

WFPS1.5.2.2.6 Points 'A', 'B', 'C', 'D' and 'E' shall depend on a combination of the **Transmission System Frequency, Active Power** and **Active Power Control Set-point** settings. These settings may be different for each **Wind Farm Power Station** depending on system conditions and **Wind Farm Power Station** location. These settings are defined in *Table WFPS1.1* below.

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Point	Transmission System Frequency (Hz)	Wind Farm Power Station Active Power Output (% of Available Active Power)
A	F_A	P_A
B	F_B	Minimum of: P_B or Active Power, Control Set-point (converted to a % of Available Active Power)
C	F_C	Minimum of: P_C or Active Power, Control Set-point (converted to a % of Available Active Power)
D	F_D	Minimum of: P_D or Active Power, Control Set-point (converted to a % of Available Active Power)
E	F_E	$P_E = 0\%$

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Table WFPS1.1: Transmission System Frequency and % Available Active Power Settings for the Points 'A', 'B', 'C', 'D' and 'E' illustrated in Figure WFPS1.2

Two settings for each of F_A , F_B , F_C , F_D , F_E , P_A , P_B , P_C , P_D and P_E shall be specified by the TSO at least 120 Business Days prior to the **Wind Farm Power Station's** scheduled **Operational Date** (refer to 1.5.2.3 below). The **Wind Farm Power Station** shall be responsible for implementing the appropriate settings during **Commissioning**.

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Alterations to the Active Power Control Set-point may be requested in real-time by the TSO and the implementation of the set-point shall commence within 10 seconds of receipt of the signal from the TSO. The rate of change of output to achieve the Active Power Control Set-point should be no less than the maximum ramp rate settings of the **Wind Farm Control System**, as advised by the TSO, as per WFPS1.5.3.

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WFPS1.5.2.2.7 The table below, *Table WFPS1.2*, shows the **Transmission System Frequency** and **Active Power** ranges for F_A , F_B , F_C , F_D , F_E , P_A , P_B , P_C , P_D and P_E .

	Transmission System Frequency (Hz)		Available Active Power (%)	
			MEC > 10 MW	5 MW < MEC ≤ 10 MW
F_A	47.0-51.0	P_A	50-100	100
F_B	49.5-51.0	P_B	50-100	100
F_C	49.5-51.0	P_C		
F_D	50.5-52.0	P_D	20-100	20-100
F_E		P_E	0	0

Table WFPS1.2: Transmission System Frequency & Active Power ranges appropriate to Figure WFPS1.2.

For the **Transmission System Frequency** values in *Table WFPS1.2* above, $F_A \leq F_B \leq F_C \leq F_D = F_E$.

WFPS1.5.2.2.8 Alterations to the **Wind Farm Power Station's Active Power** output, triggered by **Transmission System Frequency** changes, shall be achieved by proportionately altering the **Active Power** output of all available **WTGs** as opposed to switching individual **WTGs** on or off, insofar as possible.

WFPS1.5.2.2.9 No time delay other than those necessarily inherent in the design of the **Frequency Response System** shall be introduced. The response rate of each

available online **WTG** shall be a minimum of 1 % of **WTG** rated capacity per second (MW/second). The **Frequency Response System** shall continuously monitor the **Transmission System Frequency** in order to continuously determine the **Wind Farm Power Station's** appropriate **Active Power** output by taking account of the **Wind Farm Power Station's Available Active Power** or **Controlled Active Power**.

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WFPS1.5.2.2.10 If the **Transmission System Frequency** rises to a level above 'D'-'E', as defined by the *Power-Frequency Response Curve in Figure WFPS1.2*, the **TSO** accepts that **WTGs** may disconnect. Any **WTG** which has disconnected shall be brought back on load as fast as technically feasible (provided the **Transmission System Frequency** has fallen below 50.2 Hz).

WFPS1.5.2.3 Procedure for Setting and Changing the *Power-Frequency Response Curves*

Two *Power-Frequency Response Curves* (Curve 1 and Curve 2) shall be specified by the **TSO** at least 120 Business Days prior to the **Wind Farm Power Station's** scheduled **Operational Date**. The **Wind Farm Power Station** shall be responsible for implementing the appropriate settings during **Commissioning**. The **Frequency Response System** shall be required to change between the two curves within one minute from receipt of the appropriate signal from the **TSO**. The **TSO** shall give the **Wind Farm Power Station** a minimum of 2 weeks notice if changes to either of the curve's parameters (*i.e. $F_A, F_B, F_C, F_D, F_E, P_A, P_B, P_C, P_D$ or P_E*), are required. The **Wind Farm Power Station** shall formally confirm that any requested changes have been implemented within two weeks of receiving the **TSO's** formal request.

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WFPS1.5.3 RAMP RATES

WFPS1.5.3.1 The **Wind Farm Control System** shall be capable of controlling the ramp rate of its **Active Power** output with a maximum MW per minute ramp rate set by the **TSO**. There shall be two maximum ramp rate settings. The first ramp rate setting shall apply to the MW ramp rate average over one (1) minute. The second ramp rate setting shall apply to the MW per minute ramp rate average over ten (10) minutes. These ramp rate settings shall be applicable for all ranges of operation including start up, normal operation and shut down. The **TSO** acknowledges that falling wind speed or **Frequency Response** may cause either of the maximum ramp rate settings to be exceeded.

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WFPS1.5.3.2 It shall be possible to vary each of these two maximum ramp rate settings independently over a range between 1 and 30 MW per minute. The **Wind Farm Control System** shall have the capability to set the ramp rate in MW per minute averaged over both one and ten minutes.

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WFPS1.5.3.3 Procedure for Setting and Changing the Ramp Rate Control
The ramp rate settings shall be specified by the **TSO** at least **120 Business Days** prior to the **Wind Farm Power Station's** scheduled **Operational Date**. The **Wind Farm Power Station** shall be responsible for implementing the appropriate settings during **Commissioning**. The ramp rate settings may need to be changed from time to time depending on system needs. The **TSO** shall give the **Wind Farm Power Station** a minimum of two weeks notice if a change is required. The **Wind Farm Power Station** shall formally confirm that any requested changes have been implemented within two weeks of receiving the **TSO's** formal request.

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WFPS1.6 TRANSMISSION SYSTEM VOLTAGE REQUIREMENTS

WFPS1.6.1 TRANSMISSION SYSTEM VOLTAGE RANGE

Wind Farm Power Stations shall remain continuously connected to the **Transmission System** at maximum **Available Active Power** or **Controlled Active Power** output for normal and disturbed system conditions and for step changes in **Transmission System Voltage** of up to 10 %. The following are the ranges which may arise during **Transmission System** disturbances or following transmission faults:

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- (a) 400 kV system: 350 kV to 420 kV;
- (b) 220 kV system: 200 kV to 245 kV;
- (c) 110 kV system: 99 kV to 123 kV.

WFPS1.6.2 AUTOMATIC VOLTAGE REGULATION

WFPS1.6.2.1 **Wind Farm Power Stations** 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 The **Voltage Regulation System** shall be capable of receiving a **Voltage Regulation 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 **Wind Farm Power Station's Reactive Power** output, within its **Reactive Power** range and 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 **Voltage Regulation Set-point** shall be implemented by the **Wind Farm Power Station** within **20 seconds** of receipt of the appropriate signal from the **TSO**.

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WFPS1.6.2.3 The slope setting of the **Voltage Regulation System** shall be capable of being set to any value between **1%** and 10 %. The setting shall be specified by the **TSO** at least **120 Business Days** prior to the **Wind Farm Power Station's** scheduled **Operational Date**. The **Wind Farm Power Station** shall be responsible for implementing the appropriate settings during **Commissioning**. The slope setting may be varied from time to time depending on **Transmission System** needs. The **TSO** shall give the **Wind Farm Power Station** a minimum

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of two weeks notice if a change is required. The **Wind Farm Power Station** shall formally confirm that any requested changes have been implemented within two weeks of receiving the **TSO's** formal request.

WFPS1.6.2.4 The speed of response of the **Voltage Regulation System** shall be such that, following a step change in **Voltage** at the **Connection Point** the **Wind Farm Power Station** shall achieve 90 % of its steady-state **Reactive Power** response within 1 second.

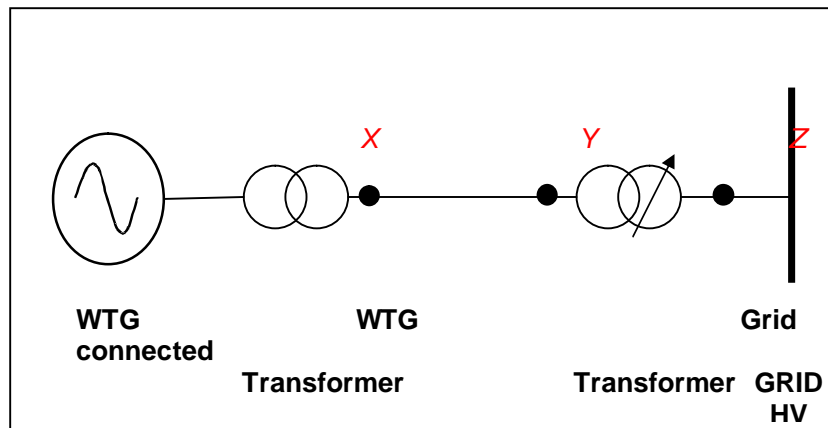
WFPS1.6.2.5 *Figure WFPS1.3* shows the relevant points appropriate to the **Voltage Regulation System** for a **Wind Farm Power Station**. X is the **HV** side of the **WTG** transformer, Y is the **lower voltage** side of the **Grid Connected Transformer** and Z is the **Connection Point**.

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*Figure WFPS1.3 - Locations for **Voltage Regulation** set-point (Z) and the **Power Factor** range (Y). The **HV** side of the **WTG** transformer is (X).*

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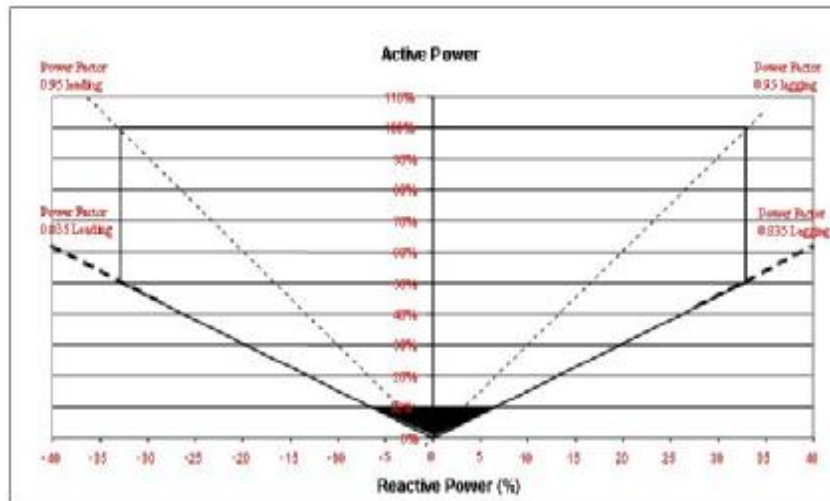
WFPS1.6.3 REACTIVE POWER CAPABILITY

WFPS1.6.3.1 **Wind Farm Power Stations** shall be capable of operating at any point within the **Power Factor** ranges illustrated in *Figure WFPS1.4*, as measured at the **lower voltage** side of the **Grid Connected Transformer** (point Y in *Figure WFPS1.3*).

The design reference voltage for the **Reactive Power** capability shall be the nominal voltage at point Y.

The **Grid Connected Transformer** tap changing range must be capable of ensuring nominal voltage at point Y for any **Voltage** at the **Connection Point** (Point Z) within the ranges specified in WFPS1.6.1.]

WFPS1.6.3.2 For **Wind Farm Power Stations** where the **Connection Point** is remote from the **Grid Connected Transformer**, any supplementary **Reactive Power** compensation required to offset the **Reactive Power** demand of the HV line, or cable, between the **Connection Point** and the **Wind Farm Power Station** shall be identified during the **TSO's Connection Offer** process.



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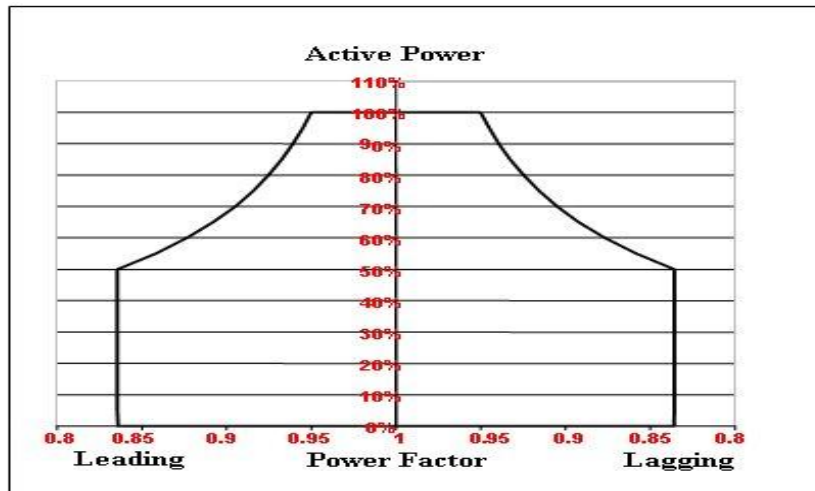


Figure WFPS1.4 - Reactive Power Capability of Wind Farm Power Station

WFPS1.6.3.3 For operation below 10 % of the **Wind Farm Power Station's MEC**, the **Wind Farm Power Station** shall operate within the shaded triangle in *Figure WFPS1.4*. However, if this cannot be achieved, then the total charging of the **Wind Farm Power Station** network during low load operation (below 10 %) shall be examined during the **TSO's Connection Offer** process. If during this examination it is identified that this charging may cause the voltage on the **Transmission System** to be outside the **Transmission System Voltage** ranges, as specified in WFPS1.6.1, then the **Reactive Power** requirements will need to be altered.

WFPS1.6.4 VOLTAGE STEP EMISSIONS

IEC 61000-3-7:1996 *Assessment of Emission limits for fluctuating loads in MV and HV power systems*, gives a table of the emission limits for **Voltage** changes as a function of the number of changes, R, per hour. This standard shall also apply to **Wind Farm Power Stations**.

WFPS1.6.5 WIND FARM POWER STATION'S GRID CONNECTED TRANSFORMER

WFPS1.6.5.1 All relevant references in the **Grid Code** to **Generator Transformers** shall be interpreted to mean the **Wind Farm Power Station's Grid Connected Transformer** rather than the individual **WTG** transformers. For **Wind Farm Power Stations** where the **Connection Point** is remote from the **Wind Farm**

Power Station, Grid Connected Transformer shall be interpreted to mean the HV transformer located at the **Wind Farm Power Station**.

WFPS1.6.5.2 **Wind Farm Power Stations** shall provide on-load tap-changing (OLTC) facilities for all **Grid Connected Transformers**. All **Wind Farm Power Stations** shall liaise with the **TSO** on the design specification for the performance of the tap-changing facility of the **Grid Connected Transformer**.

WFPS1.6.5.3 The **Wind Farm Power Station's Grid Connected Transformers** may be connected either:

- (a) in delta on the lower ~~voltage~~ side and in star (with the star point or neutral brought out) on the ~~HV~~ side; or
- (b) in star on both ~~HV~~ and lower ~~voltage~~ sides with a delta tertiary winding provided.

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WFPS1.7 SIGNALS, COMMUNICATIONS & CONTROL

WFPS1.7.1 SIGNALS FROM THE WIND FARM POWER STATION TO THE TSO

Signals from **Wind Farm Power Stations** to the **TSO** shall be broken up into a number of logical groups. There shall be different requirements for **Wind Farm Power Stations** depending on the **Wind Farm Power Station's MEC**. The following groups shall apply:

§ **Signals List #1** - applies to all **Wind Farm Power Stations**;

In addition, **Wind Farm Power Stations** 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;

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

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WFPS1.7.1.1 **Signals List #1**

The **Wind Farm Power Station** shall make the following signals available at the designated TSO Telecommunication Interface Cabinet for that **Wind Farm Power Station**:

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- 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) **Voltage Regulation Set-point** (in kV);
- g) On/off status indications for all **Reactive Power** devices exceeding 5 Mvar¹;

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¹ Typically the position indication from capacitor/ SVC circuit breakers

- 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 **Wind Farm Power Station's** scheduled **Operational Date**;
- i) A minimum of four sets of normally open potential free auxiliary contacts in each **Grid Connected Transformer** lower voltage bay for fault indications.
- j) On/off status of TSO remote control enable switch, which disables the ability of the TSO to send commands to the Wind Farm Power Station.

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For the Wind Farm Power Station'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 **Wind Farm Power Stations** 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 **Wind Farm Power Station**:

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- _____ [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 **Wind Farm Power Station** site or, where possible and preferable to do so, data from a means of the same or better accuracy. For **Wind Farm Power Stations** where the **WTG** are widely dispersed over a large geographical area and rather different weather patterns are expected for different sections of the **Wind Farm Power Station**, 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 **Wind Farm Power Station**). 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 **Wind Farm Power Station's** **scheduled Operational Date**,

Deleted: no more than 60 business days after a **Connection Agreement** has been signed between the **Wind Farm Power Station** and the **TSO**

WFPS1.7.1.3 Signals List #3

WFPS1.7.1.3.1 **Wind Farm Power Stations** with a **MEC** in excess of 10 MW shall make the following signals available at the designated **TSO Telecommunication Interface Cabinet** for that **Wind Farm Power Station**:

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- a) **Wind Farm Power Station 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 **Wind Farm Power Stations** 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 **Wind Farm Power Station**, 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 **Wind Farm Power Station**). 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 **Wind Farm Power Station's** scheduled **Operational Date**.

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WFPS1.7.1.4 Signals List #4

The **Wind Farm Power Station** shall make the following signals available at the designated **TSO Telecommunication Interface Cabinet** for that **Wind Farm Power Station**:

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- a) **Wind Farm Power Station Active Power Control Set-point** value (MW);
- b) **Wind Farm Power Station Active Power Control** status indication (ON/OFF).

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WFPS1.7.1.5 Signals List #5

The **Wind Farm Power Station** shall make the following signals available at the designated **TSO Telecommunication Interface Cabinet** for that **Wind Farm Power Station**:

- a) **Frequency Response System** mode signal (i.e. *Power-Frequency Response Curve 1 or 2*);
- b) **Frequency Response System** status indication (ON/OFF).

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WFPS1.7.1.6 Time Delays and Data Quality

WFPS1.7.1.6.1 Digital signal changes from the **Wind Farm Power Station** 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.

Comment: Time Delays and Data Quality from wind farms to the TSO are still being discussed and this clause may change

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WFPS1.7.2 CONTROL SIGNALS FROM THE TSO TO WIND FARM POWER STATIONS

WFPS1.7.2.1 The control signals described in WFPS1.7.2 shall be sent from the **TSO** to the **Wind Farm Power Station**. The **Wind Farm Power Station** 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 **Wind Farm Power Station**. 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 **Wind Farm Power Station** 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.

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WFPS1.7.2.3 Frequency Response

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

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The **Wind Farm Power Station** 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.

WFPS1.7.2.4 Voltage Regulation

This signal shall allow the **TSO** to send a **Voltage Regulation Set-point** for **Voltage Regulation** purposes. This signal shall be in the form of a single analogue value and a strobe pulse to enable.

Deleted: kV set-point

WFPS1.7.2.5 Black Start Shutdown,

Means shall be provided by the **Wind Farm Power Station** to facilitate the disconnection of the **Wind Farm Power Station** 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 Wind Farm Power Station shall be required to trip the circuit-breaker(s) at the Wind Farm Power Station's Connection Point and shutdown the Wind Farm Power Station 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 Wind Farm Power Station's scheduled Operational Date. **Wind Farm Power Stations** 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.

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Deleted: trip and inhibit signal to the circuit-breaker(s) at the **Wind Farm Power Station's Connection Point**.

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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 Wind Farm Power Station 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

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 **Wind Farm Power Station's Connection Point** without undue

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

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 Wind Farm Power Station at least 120 Business Days prior to the Wind Farm Power Station's scheduled Operational Date, ~~A standard interface for signals will be made available to the Wind Farm Power Station by the TSO.~~

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WFPS1.7.4.2 The necessary communications links, communications protocol and an individual Wind Farm Power Station signal list shall be specified by the TSO at least 120 Business Days prior to the Wind Farm Power Station'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.

Deleted: the requirement for analogue or digital signals

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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 Wind Farm Power Station become unavailable, the Wind Farm Power Station shall contact the TSO without undue delay.

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WFPS1.7.4.5 Where signals or indications required to be provided by the Wind Farm Power Station under WFPS1.7.1 and WFPS 1.7.2 become unavailable or do not comply with applicable standards due to failure of the Wind Farm Power Stations' technical equipment or any other reason under the control of the Wind Farm Power Station, the Wind Farm Power Station 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

Wind power forecasts shall be provided by Wind Farm Power Stations with a MEC in excess of 30 MW. These forecasts shall be provided at 10:00 a.m. on a daily basis for the following 48 hours for each 30 minute time-period by means of

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an electronic interface in accordance with the reasonable requirements of the **TSO's** data system.

WFPS1.7.6 WIND FARM POWER STATION MW AVAILABILITY DECLARATIONS

Wind Farm Power Stations with a **MEC** in excess of 30 MW shall submit **Wind Farm Power Station MW Availability Declarations** whenever changes in **Wind Farm Power Station 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.

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Approved: 06/09/2005