Hand out for RFG workshop: Examples of categories of obligation

Please note this document contains the RFG examples identified to support discussion on categories of obligation and GB application. It includes extracts of the relevant articles from the code. It has been prepared to aid discussion during the RFG workshop and identifies potential areas of the Grid Code which could be impacted – for discussion purposes only.

	Mandatory Requirement (Directly applicable)	**Non Mandatory - Principles defined**	**Non Mandatory – Parameters defined**
New Requirement	**1.** Article 10 (2) (b) – Limited Frequency Sensitive Mode – Under Frequency applies to all Type C Power Generating Modules	**2**. Article 16 (2)(a) – Provision of a Synthetic Inertia Facility	**3.** Article 10 (2) (b) – Limited Frequency Sensitive Mode – Underfrequency: TSO can define the frequency threshold and Droop.
Existing Requirement – currently met	**4**. Article 11 (2)(a) - Voltage Range	**5**. Article 10 (6)(f) - Earthing Arrangements of the Neutral Point at the Network Side of a Step Up Transformer	**6**. Article 8 (1)(e) - Output Power with falling frequency – TSO to define requirements within range (currently met for Medium and Large in GB)
Existing Requirement - amendment required	**7**. Article 9 (3) – Fault Ride Through – Voltage **duration profile and shape** fully specified and different from GB Grid Code	**8.** Article 10 (6) (c) – Simulation Models – TSO can request electromagnetic transient simulations where justified.	**9**. Article 9 (3) – Fault Ride Through – Parameters to be used are to be defined by TSO (**voltage duration length and range** different to GB Grid Code)
New for Category of User* **Not covered by GB Grid Code*	**10.** Article 8 (1) (c) - Type A Units are required to satisfy the Limited Frequency Sensitive Mode - Overfrequency of operation requirements for over frequencies (currently does not apply to all categories of generator)	**11**. Article 9 (5)(d)(2) – The Relevant Network Operator in co-ordination with the Relevant TSO shall define the contents of information exchange and the precise list and time of the data to be facilitated (RFG also applicable to Small and embedded)	**12**. Article 8 (1) (e) – Type A units are required to satisfy power output with falling frequency with the parameters being defined by the TSO (not currently met for Small in GB)

1. Mandatory, new: Article 10 (2) (b)
Limited Frequency Sensitive Mode – Under frequency applies to all Type C Power Generating Modules

Article 10
GENERAL REQUIREMENTS FOR TYPE C POWER GENERATING MODULES

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2. Type C Power Generating Modules shall fulfil the following requirements referring to Frequency stability

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b) In addition to Article 8(1) (c) the following shall apply accumulatively with regard to Limited Frequency Sensitive Mode – Underfrequency (LFSM-U):

1) The Power Generating Module shall be capable of activating the provision of Active Power Frequency Response according to figure 4 at a Frequency threshold between and including 49.8 Hz and 49.5 Hz with a Droop in a range of 2 – 12 %. In the LFSM-U mode the Power Generating Module shall be capable of providing a power increase up to its Maximum Capacity. The actual delivery of Active Power Frequency Response in LFSM-U mode depends on the operating and ambient conditions of the Power Generating Module when this response is triggered, in particular limitations on operation near Maximum Capacity at low frequencies according to Article 8(1) (e) and available primary energy sources. The actual Frequency threshold and Droop settings shall be determined by the Relevant TSO. The Active Power Frequency Response shall be activated as fast as technically feasible with an initial delay that shall be as short as possible and reasonably justified by the Power Generating Facility Owner to the Relevant TSOif greater than 2 seconds.

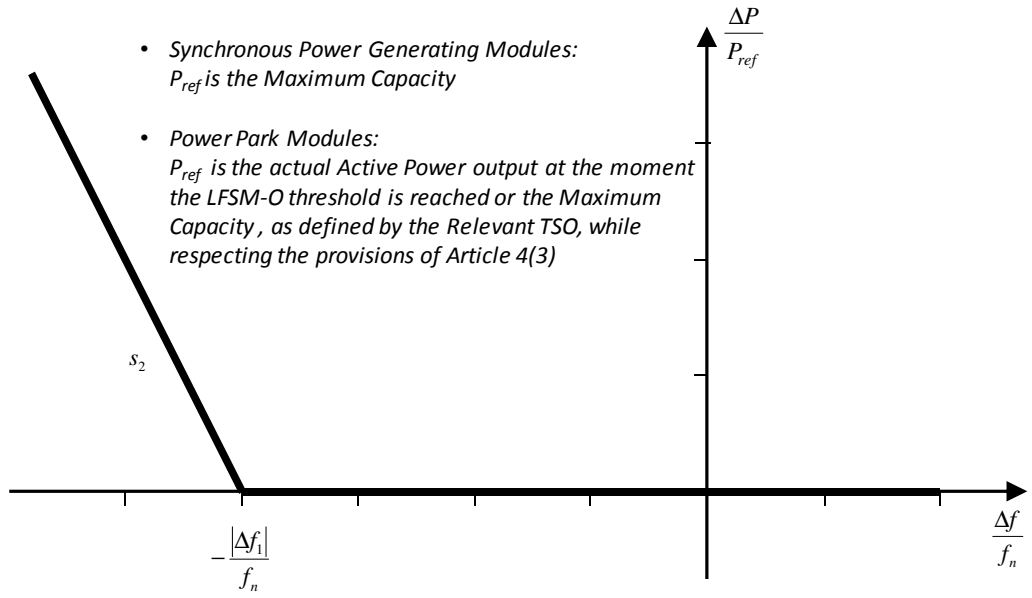

Figure 4: Active Power Frequency Response capability of Power Generating Modules in LFSM-U. P_{ref} is the reference Active Power to which ΔP is related and may be defined differently for Synchronous Power Generating Modules and Power Park Modules. ΔP is the change in Active Power output from the Power Generating Module. f_n is the nominal Frequency (50 Hz) in the Network and Δf is the Frequency change in the Network. At underfrequencies where Δf is below Δf_1 the Power

Generating Module has to provide a positive Active Power output change according to the Droop S_2.

2) Stable operation of the Power Generating Module during LFSM-U operation shall be ensured. The LFSM-U reference Active Power shall be the Active Power output at the moment of activation of LFSM-U and shall not be changed unless triggered by frequency restoration action.

Not currently specified in Grid Code
Could sit with BC3.7

2. Non-Mandatory, principles defined, new: Article 16 (2) (a)
Provision of Synthetic Inertia Facility

Article 16
REQUIREMENTS FOR TYPE C POWER PARK MODULES

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2. Type C Power Park Modules shall fulfil the following requirements referring to Frequency stability:
   a) With regard to the capability of providing Synthetic Inertia to a low Frequency event:

      1) The Relevant TSO shall have the right to require while respecting the provisions of Article 4(3), in co-operation with other TSOs in the relevant Synchronous Area, a Power Park Module, which is not inherently capable of supplying additional Active Power to the Network by its Inertia and which is greater than a MW size to be specified by the Relevant TSO, to install a feature in the control system which operates the Power Park Module so as to supply additional Active Power to the Network in order to limit the rate of change of Frequency following a sudden loss of infeed.

      2) The operating principle of this control system and the associated performance parameters shall be defined by the Relevant TSO while respecting the provisions of Article 4(3).

Not currently specified in Grid Code
Could sit with CC6.3.7 or a new section in CC6.3

3. Non-Mandatory, parameters defined, new: Article 10 (2) (b)
Limited Frequency Sensitive Mode – Underfrequency: TSO can define the frequency threshold and droop

Article 10
GENERAL REQUIREMENTS FOR TYPE C POWER GENERATING MODULES

2. Type C Power Generating Modules shall fulfil the following requirements referring to Frequency stability

……

b) In addition to Article 8(1) (c) the following shall apply accumulatively with regard to Limited Frequency Sensitive Mode – Underfrequency (LFSM-U):

1) The Power Generating Module shall be capable of activating the provision of Active Power Frequency Response according to figure 4 at a Frequency threshold between and including 49.8 Hz and 49.5 Hz with a Droop in a range of 2 – 12 %. In the LFSM-U mode the Power Generating Module shall be capable of providing a power increase up to its Maximum Capacity. The actual delivery of Active Power Frequency Response in LFSM-U mode depends on the operating and ambient conditions of the Power Generating Module when this response is triggered, in particular limitations on operation near Maximum Capacity at low frequencies according to Article 8(1) (e) and available primary energy sources. The actual Frequency threshold and Droop settings shall be determined by the Relevant TSO. The Active Power Frequency Response shall be activated as fast as technically feasible with an initial delay that shall be as short as possible and reasonably justified by the Power Generating Facility Owner to the Relevant TSO if greater than 2 seconds.

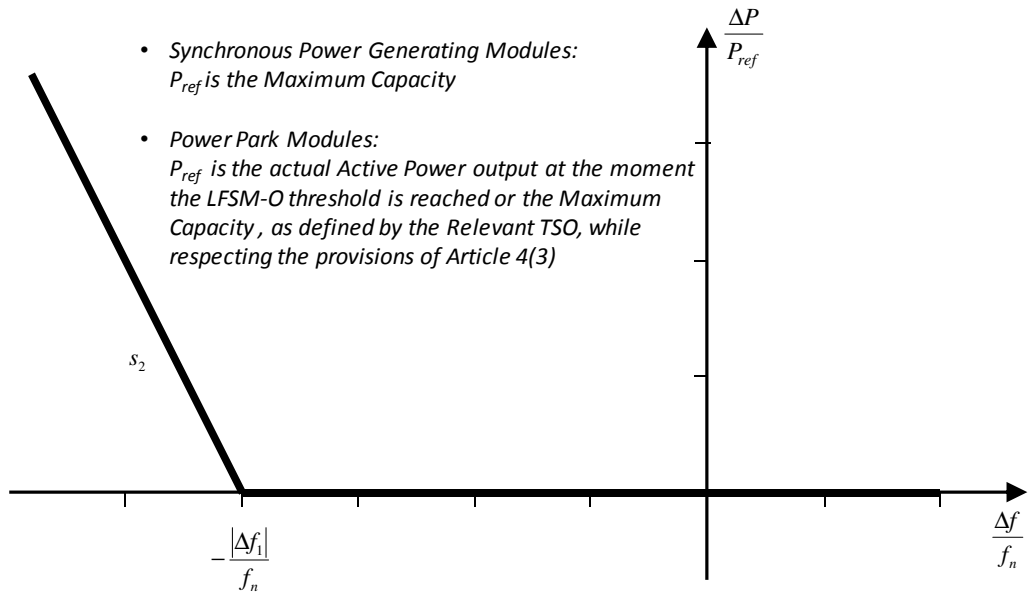

Figure 4: Active Power Frequency Response capability of Power Generating Modules in LFSM-U. P_{ref} is the reference Active Power to which ΔP is related and may bedefined differently for Synchronous Power Generating Modules and Power Park Modules. ΔP is the change in Active Power output from the Power Generating Module. f_n is the nominal Frequency (50 Hz) in the Network and Δf is the Frequency change in the Network. At underfrequencies where Δf is below Δf_1 the Power Generating Module has to provide a positive Active Power output change according to the Droop S_2.

2) Stable operation of the Power Generating Module during LFSM-U operation shall be ensured. The LFSM-U reference Active Power shall be the Active Power output at the moment of activation of LFSM-U and shall not be changed unless triggered by frequency restoration action.

Not currently specified in Grid Code
Could sit with BC3.7.2 (instruction) or CC6.3.7 (capability)

4. Mandatory, existing, currently met: Article 11 (2) (a)
Voltage Range

Article 11
GENERAL REQUIREMENTS FOR TYPE D POWER GENERATING MODULES

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2. Type D Power Generating Modules shall fulfil the following requirements referring to Voltage stability:
   a) With regard to Voltage ranges:

      1) While still respecting the provisions according to Articles 9(3) (a) and 11(3) (a), a Power Generating Module shall be capable of staying connected to the Network and operating within the ranges of the Network Voltage at the Connection Point, expressed by the Voltage at the Connection Point related to nominal Voltage (per unit), and the time periods specified by tables 6.1 and 6.2.

Synchronous Area	**Voltage Range**	**Time period for operation**
Continental Europe	0.85 pu – 0.90 pu	60 minutes
	0.90 pu – 1.118 pu	Unlimited
	1.118 pu – 1.15 pu	To be decided by each TSO while respecting the provisions ofArticle 4(3), but not less than 20 minutes
Nordic	0.90 pu – 1.05 pu	Unlimited
	1.05 pu – 1.10 pu	60 minutes
Great Britain	0.90 pu–1.10 pu	Unlimited
Ireland	0.90 pu – 1.118 pu	Unlimited
Baltic	0.85 pu – 0.90 pu	30 minutes
	0.90 pu – 1.12 pu	Unlimited
	1.12 pu – 1.15 pu	20 minutes

Table 6.1: This table shows the minimum time periods a Power Generating Module shall be capable of operating for Voltages deviating from the nominal value at the Connection Point without disconnecting from the Network. (The Voltage base for pu values is from 110 kV to 300 kV (excluding).)

Synchronous Area	Voltage Range	Time period for operation
Continental Europe	0.85 pu – 0.90 pu	60 minutes
	0.90 pu – 1.05 pu	Unlimited
	1.05 pu – 1.0875 pu	To be decided by each TSO while respecting the provisions ofArticle 4(3), but not less than 60 minutes
	1.0875 pu – 1.10 pu	60 minutes
Nordic	0.90 pu – 1.05 pu	Unlimited
	1.05 pu – 1.10 pu	60 minutes
Great Britain	0.90 pu – 1.05 pu	Unlimited
	1.05 pu – 1.10 pu	15 minutes
Ireland	0.90 pu – 1.05 pu	Unlimited
Baltic	0.88 pu – 0.90 pu	20 minutes
	0.90 pu – 1.10 pu	Unlimited
	1.10 pu – 1.15 pu	20 minutes

Table 6.2: This table shows the minimum time periods a Power Generating Module shall be capable of operating for Voltages deviating from the nominal value at the Connection Point without disconnecting from the Network. (The Voltage base for pu values is from 300 kV to 400 kV.)

2) While respecting the provisions of Article 4(3), wider Voltage ranges or longer minimum times for operation can be agreed between the Relevant Network Operator in coordination with the Relevant TSO and the Power Generating Facility Owner to ensure the best use of the technical capabilities of a Power Generating Module if needed to preserve or to restore system security. If wider Voltage ranges or longer minimum times for operation are economically and technically feasible, the consent of the Power Generating Facility Owner shall not be unreasonably withheld.

3) While still respecting the provisions of Article 11(2) (a) point 1),the Relevant Network Operator in coordination with the Relevant TSO shall have the right to specify while respecting the provisions of Article 4(3) Voltages at the Connection Point at which a Power Generating Module shall be capable of automatic disconnection. The terms and settings for automatic disconnection

shall be agreed between the Relevant Network Operator and the Power Generating Facility Owner, while respecting the provisions of Article 4(3).

Grid Code CC6.1.4; CC6.3.15.3 (iv)

5. Non-Mandatory, principles defined, existing, currently met: Article 10 (6) (f) Earthing Arrangements of the Neutral Point at the Network Side of the Step Up Transformer

Article 10
GENERAL REQUIREMENTS FOR TYPE C POWER GENERATING MODULES

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6. Type C Power Generating Modules shall fulfil the following general system management requirements**:**

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f) With regard to earthing arrangement of the neutral-point at the Network side of step-up transformers, it shall be in accordance with the specifications of the Relevant Network Operator.

Grid Code CC6.3.11

6. Non-Mandatory, parameters defined, existing, currently met: Article 8 (1) (e) Output Power with falling frequency – TSO to define requirements within range

Article 8
GENERAL REQUIREMENTS FOR TYPE A POWER GENERATING MODULES

1. Type A Power Generating Modules shall fulfil the following requirements referring to Frequency stability**:**

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…

e) The Relevant TSO shall define admissible Active Power reduction from maximum output with falling Frequency within the boundaries, given by the full lines in Figure 2:

- Below 49 Hz falling by a reduction rate of 2 % of the Maximum Capacity at 50 Hz per 1 Hz Frequency drop;
- Below 49.5 Hzby a reduction rate of 10 % of the Maximum Capacity at 50 Hz per 1 Hz Frequency drop.

Applicability of this reduction is limited to a selection of affected generation technologies and may be subject to further conditions defined by the Relevant TSOwhile respecting the provisions of Article 4(3).

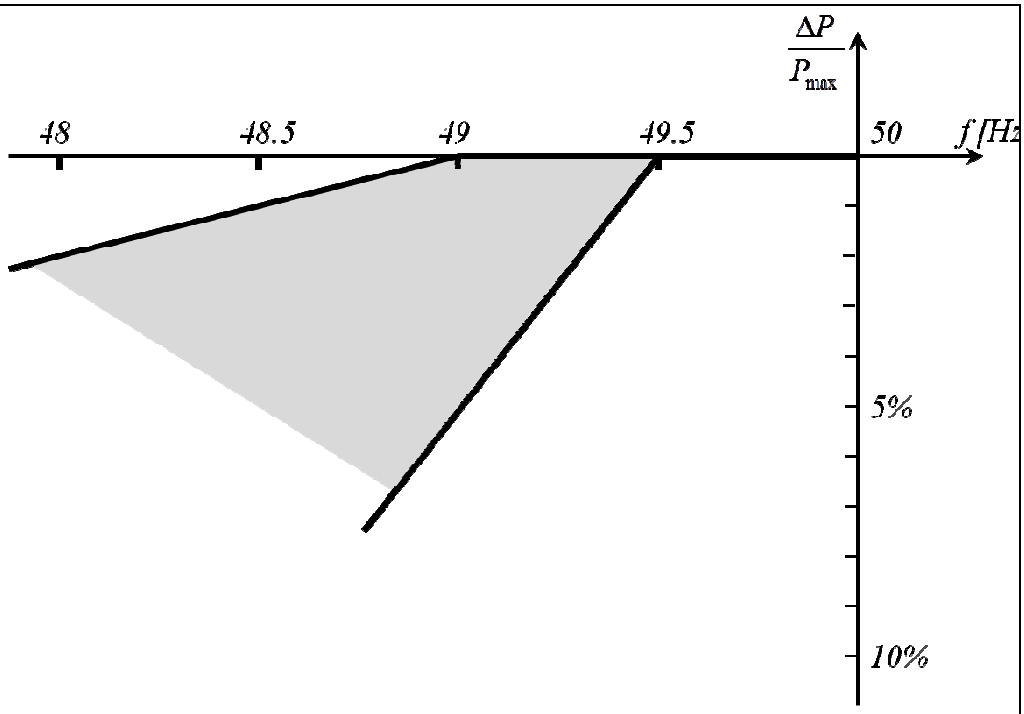

Figure 2 – Maximum power capability reduction with falling Frequency. The diagram represents the boundaries defined by the Relevant TSO while respecting the provisions ofArticle 4(3).

Grid Code CC6.3.3

7. Mandatory, existing, amendment needed: Article 9 (3)
Fault Ride Through – Voltage duration profile and shape

Article 9
GENERAL REQUIREMENTS FOR TYPE B POWER GENERATING MODULES

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3. Type B Power Generating Modules shall fulfil the following requirements referring to robustness of Power Generating Modules:
   a) With regard to fault-ride-through capability of Power Generating Modules:

   1) Each TSO shall definewhile respecting the provisions of Article 4(3) a voltage-against-time-profile according to figure 3 at the Connection Point for fault conditions which describes the conditions in which the Power Generating Module shall be capable of staying connected to the Network and continuing stable operation after the power system has been disturbed by Secured Faults on the Network.

   2) This voltage-against-time-profile shall be expressed by a lower limit of the course of the phase-to-phase Voltages on the NetworkVoltage level at the Connection Point during a symmetrical fault, as a function of time before, during and after the fault. This lower limit is defined by the TSO using parameters in figure 3 according to tables 3.1 and 3.2.

   3) Each TSO shall define and make publicly available while respecting the provisions of Article 4(3) defining the pre-fault and post-fault conditions for the fault-ride-

through capability in terms of:

- conditions for the calculation of the pre-fault minimum short circuit capacity at the Connection Point;
- conditions for pre-fault active and Reactive Power operating point of the Power Generating Module at the Connection Point and Voltage at the Connection Point; and
- conditions for the calculation of the post-fault minimum short circuit capacity at the Connection Point.

4) Each Relevant Network Operator shall provide on request by the Power Generating Facility Owner the pre-fault and post-fault conditions to be considered for fault-ride-through capability as an outcome of the calculations at the Connection Point as defined in Article 9 (3) (a) point 3) regarding:

- pre-fault minimum short circuit capacity at each Connection Point expressed in MVA;
- pre-fault operating point of the Power Generating Module expressed in Active Power output and Reactive Power output at the Connection Point and Voltage at the Connection Point; and
- post-fault minimum short circuit capacity at each Connection Point expressed in MVA.

Alternatively generic values for the above conditions derived from typical cases may be provided by the Relevant Network Operator.

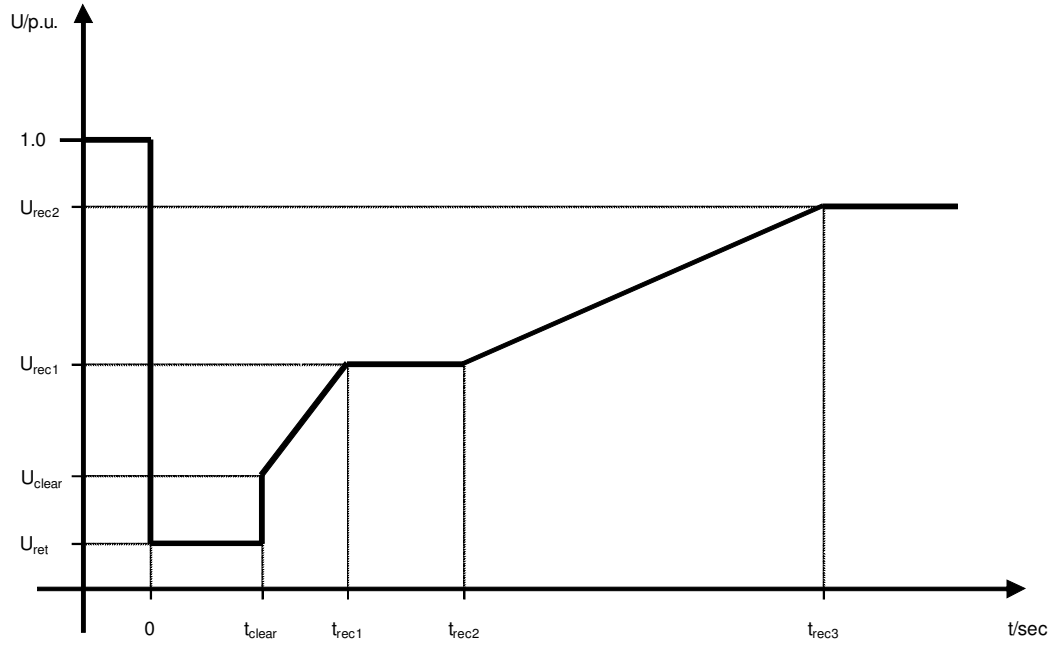

Figure 3 – Fault-ride-through profile of a Power Generating Module. The diagram represents the lower limit of a voltage-against-time profile by the Voltage at the Connection Point, expressed by the ratio of its actual value and its nominal value in per unit before, during and after a fault.U_{ret} is the retained Voltage at the Connection Point During a fault, t_{clear} is the instant when the fault has been cleared. U_{rec1}, U_{rec2}, t_{rec1}, t_{rec2} and t_{rec3} specify certain points of lower limits of Voltage recovery after fault clearance.

Voltage parameters [pu]		Time parameters [seconds]	
U_{ret}:	0.05 – 0.3	t_{clear}:	0.14 – 0.25
U_{clear}:	0.7 – 0.9	t_{rec1}:	t_{clear}
U_{rec1}:	U_{clear}	t_{rec2}:	t_{rec1} – 0.7
U_{rec2}:	0.85 – 0.9 and ≥ U_{clear}	t_{rec3}:	t_{rec2} – 1.5

Table 3.1 – Parameters for figure 3 for fault-ride-through capability of Synchronous Power Generating Modules.

Voltage parameters [pu]		Time parameters [seconds]	
U_{ret}:	0.05 – 0.15	t_{clear}:	0.14 – 0.25
U_{clear}:	U_{ret} – 0.15	t_{rec1}:	t_{clear}
U_{rec1}:	U_{clear}	t_{rec2}:	t_{rec1}
U_{rec2}:	0.85	t_{rec3}:	1.5 – 3.0

Table 3.2 – Parameters for figure 3 for fault-ride-through capability of Power Park Modules.

5) The Power Generating Module shall be capable of staying connected to the Network and continue stable operation when the actual course of the phase-to-phase Voltages on the Network Voltage level at the Connection Point during a symmetrical fault, given the pre-fault and post-fault conditions according to Article 9(3) (a) points 3) and 4), remains above the lower limit defined in Article 9(3) (a) point 2), unless the protection scheme for internal electrical faults requires the disconnection of the Power Generating Module from the Network. The protection schemes and settings for internal electrical faults shall be designed not to jeopardize fault-ride-through performance.

6) While still respecting Article 9(3) (a) point 5), undervoltage protection (either fault-ride-through capability or minimum Voltage defined at the connection point Voltage) shall be set by the Power Generating Facility Owner to the widest possible technical capability of the Power Generating Module unless the Relevant Network Operator requires less wide settings according to Article 9(5) (b). The settings shall be justified by the Power Generating Facility Owner in accordance with this principle.

7) Fault-ride-through capabilities in case of asymmetrical faults shall be defined by each TSO while respecting the provisions of Article 4(3).

Grid Code CC6.3.15

8. Non-mandatory, principles defined, amendment needed: Article 10 (6) (c) Simulation Models

Article 10
GENERAL REQUIREMENTS FOR TYPE C POWER GENERATING MODULES

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6. Type C Power Generating Modules shall fulfil the following general system management requirements**:**

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c) With regard to the simulation models:

1) The Relevant Network Operator in coordination with the Relevant TSO shall have the right to require while respecting the provisions of Article 4(3) the Power Generating Facility Owner to provide simulation models, that shall properly reflect the behaviour of the Power Generating Module in both steady-state and dynamic simulations (50 Hz component) and, where appropriate and justified, in electromagnetic transient simulations.

   The decision shall include:
   - the format in which models shall be provided
   - the provision of documentation of models structure and block diagrams

   The models shall be verified against the results of compliance tests as of Title 4 Chapters 2, 3 and 4. They shall then be used for the purpose of verifying the requirements of this Network Code including but not limited to Compliance Simulations as of Title 4 Chapters 5, 6 and 7 and for use in studies for continuous evaluation in system planning and operation.

2) For the purpose of dynamic simulations, the models provided shall contain the following sub-models, depending on the existence of the mentioned components:

   - Alternator and prime mover;
   - Speed and power control;
   - Voltage control, including, if applicable, Power System Stabilizer (PSS) function and excitation system;
   - Power Generating Module protection models as agreed between the Relevant Network Operator and the Power Generating Facility Owner, while respecting the provisions of Article 4(3); and
   - Converter models for Power Park Modules.

3) The Relevant Network Operator shall deliver to the Power Generating Facility Owner an estimate of the minimum and maximum short circuit capacity at the connection point, expressed in MVA, as an equivalent of the Network.

4) The Relevant Network Operator or Relevant TSO shall have the right to require while respecting the provisions of Article 4(3) Power Generating Module recordings in order to compare the response of the models with these

recordings.

Grid Code PCA5.3 and PCA5.4

9. Non-mandatory, existing, amendment needed: Article 9 (3)
Fault Ride Through – Voltage duration length and range (parameters to be defined)

Article 9
GENERAL REQUIREMENTS FOR TYPE B POWER GENERATING MODULES

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3. Type B Power Generating Modules shall fulfil the following requirements referring to robustness of Power Generating Modules:
   a) With regard to fault-ride-through capability of Power Generating Modules:

      1) Each TSO shall define while respecting the provisions of Article 4(3) a voltage-against-time-profile according to figure 3 at the Connection Point for fault conditions which describes the conditions in which the Power Generating Module shall be capable of staying connected to the Network and continuing stable operation after the power system has been disturbed by Secured Faults on the Network.

      2) This voltage-against-time-profile shall be expressed by a lower limit of the course of the phase-to-phase Voltages on the NetworkVoltage level at the Connection Point during a symmetrical fault, as a function of time before, during and after the fault. This lower limit is defined by the TSO using parameters in figure 3 according to tables 3.1 and 3.2.

      3) Each TSO shall define and make publicly available while respecting the provisions of Article 4(3) defining the pre-fault and post-fault conditions for the fault-ride-through capability in terms of:

         - conditions for the calculation of the pre-fault minimum short circuit capacity at the Connection Point;
         - conditions for pre-fault active and Reactive Power operating point of the Power Generating Module at the Connection Point and Voltage at the Connection Point; and
         - conditions for the calculation of the post-fault minimum short circuit capacity at the Connection Point.

      4) Each Relevant Network Operator shall provide on request by the Power Generating Facility Owner the pre-fault and post-fault conditions to be considered for fault-ride-through capability as an outcome of the calculations at the Connection Point as defined in Article 9 (3) (a) point 3) regarding:

         - pre-fault minimum short circuit capacity at each Connection Point expressed in MVA;
         - pre-fault operating point of the Power Generating Module expressed in Active Power output and Reactive Power output at the Connection Point and Voltage at the Connection Point; and
         - post-fault minimum short circuit capacity at each Connection Point expressed in MVA.

Alternatively generic values for the above conditions derived from typical cases may be provided by the Relevant Network Operator.

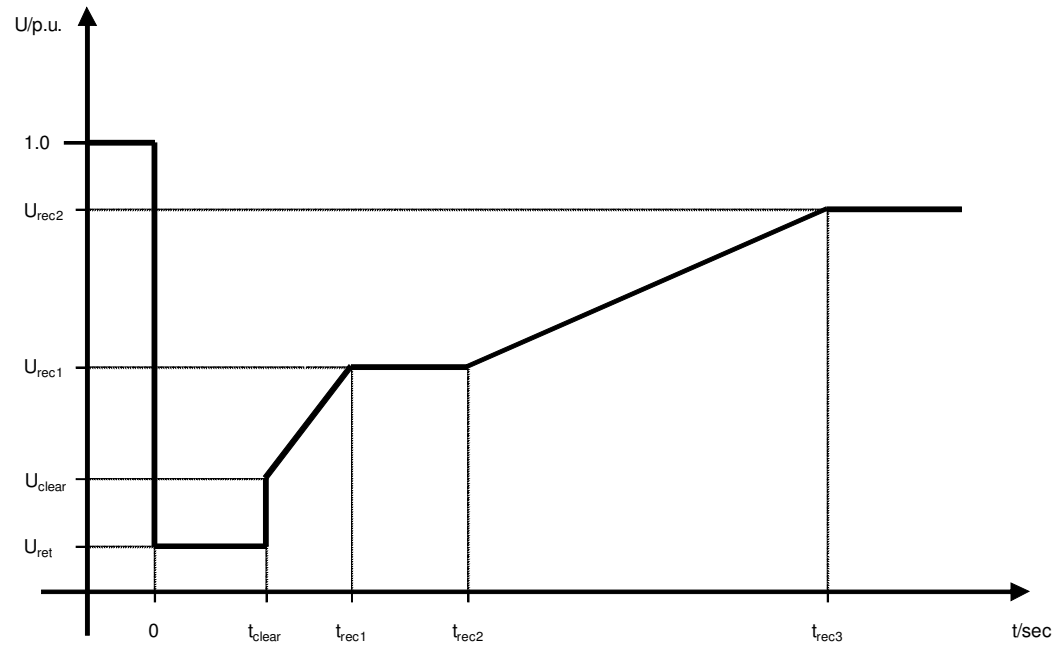

Figure 3 – Fault-ride-through profile of a Power Generating Module. The diagram represents the lower limit of a voltage-against-time profile by the Voltage at the Connection Point, expressed by the ratio of its actual value and its nominal value in per unit before, during and after a fault.U_{ret} is the retained Voltage at the Connection Point During a fault, t_{clear} is the instant when the fault has been cleared. U_{rec1}, U_{rec2}, t_{rec1}, t_{rec2} and t_{rec3} specify certain points of lower limits of Voltage recovery after fault clearance.

Voltage parameters [pu]		**Time parameters [seconds]**	
U_{ret}:	0.05 – 0.3	t_{clear}:	0.14 – 0.25
U_{clear}:	0.7 – 0.9	t_{rec1}:	t_{clear}
U_{rec1}:	U_{clear}	t_{rec2}:	t_{rec1} – 0.7
U_{rec2}:	0.85 – 0.9 and ≥ U_{clear}	t_{rec3}:	t_{rec2} – 1.5

Table 3.1 – Parameters for figure 3 for fault-ride-through capability of Synchronous Power Generating Modules.

Voltage parameters [pu]		**Time parameters [seconds]**	
U_{ret}:	0.05 – 0.15	t_{clear}:	0.14 – 0.25
U_{clear}:	U_{ret} – 0.15	t_{rec1}:	t_{clear}
U_{rec1}:	U_{clear}	t_{rec2}:	t_{rec1}
U_{rec2}:	0.85	t_{rec3}:	1.5 – 3.0

Table 3.2 – Parameters for figure 3 for fault-ride-through capability of Power Park Modules.

5) The Power Generating Module shall be capable of staying connected to the Network and continue stable operation when the actual course of the phase-to-phase Voltages on the Network Voltage level at the Connection Point during a symmetrical fault, given the pre-fault and post-fault conditions according to Article 9(3) (a) points 3) and 4), remains above the lower limit defined in Article 9(3) (a) point 2), unless the protection scheme for internal electrical faults requires the disconnection of the Power Generating Module from the Network. The protection schemes and settings for internal electrical faults shall be designed not to jeopardize fault-ride-through performance.

6) While still respecting Article 9(3) (a) point 5), undervoltage protection (either fault-ride-through capability or minimum Voltage defined at the connection point Voltage) shall be set by the Power Generating Facility Owner to the widest possible technical capability of the Power Generating Module unless the Relevant Network Operator requires less wide settings according to Article 9(5) (b). The settings shall be justified by the Power Generating Facility Owner in accordance with this principle.

7) Fault-ride-through capabilities in case of asymmetrical faults shall be defined by each TSO while respecting the provisions of Article 4(3).

Grid Code CC6.3.15

10. Mandatory, new to category of user: Article 8 (1) (c)
Limited Frequency sensitive Mode – Overfrequency: for Type A

Article 8
GENERAL REQUIREMENTS FOR TYPE A POWER GENERATING MODULES

1. Type A Power Generating Modules shall fulfil the following requirements referring to Frequency stability**:**

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c) with regard to the Limited Frequency Sensitive Mode - Overfrequency (LFSM-O) the following shall apply:

1) The Power Generating Module shall be capable of activating the provision of Active Power Frequency Response according to figure 1 at a Frequency threshold between and including 50.2 Hz and 50.5 Hz with a Droop in a range of 2 – 12 %. The actual Frequency threshold and Droop settings shall be determined by the Relevant TSO. The Power Generating Module shall be capable of activating Active Power Frequency Response as fast as technically feasible with an initial delay that shall be as short as possible and reasonably justified by the Power Generating Facility Owner to the Relevant TSO if greater than 2 seconds. The Power Generating Module shall be capable of either continuing operation at Minimum Regulating Level when reaching itorfurther decreasing Active Power output in this case, as defined by the Relevant TSO

while respecting the provisions of Article 4(3).

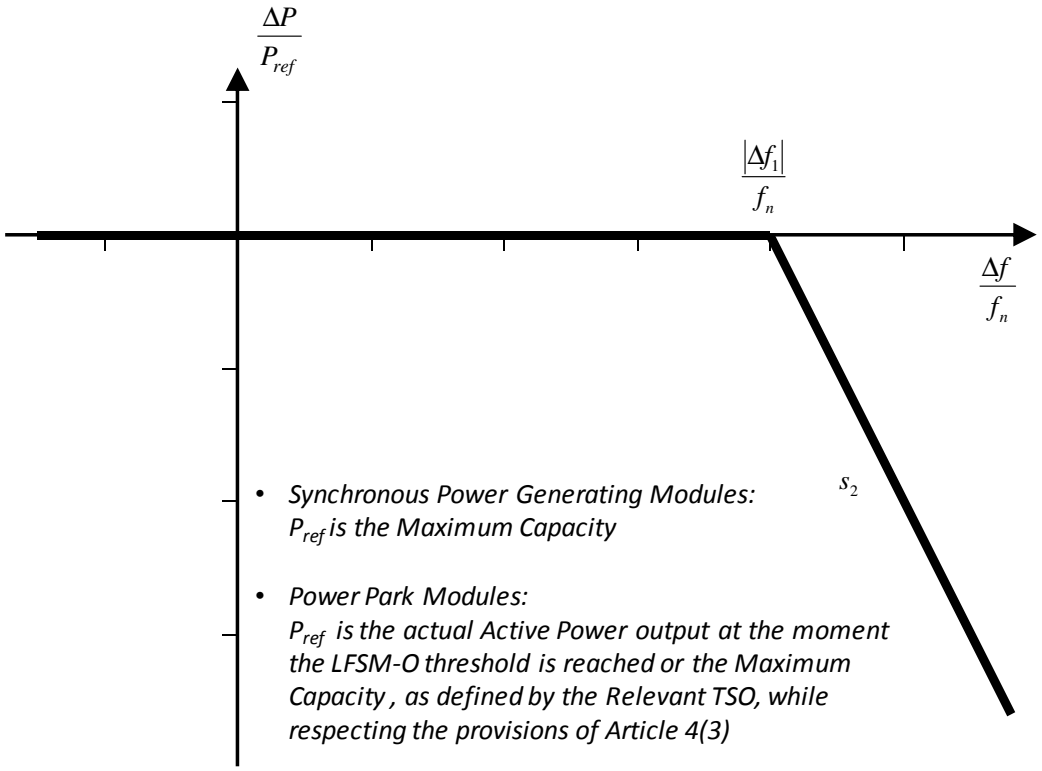

Figure 1: Active Power Frequency Response capability of Power Generating Modules in LFSM-O. P_{ref} is the reference Active Power to which ΔP is related and may be defined differently for Synchronous Power Generating Modules and Power Park Modules.ΔP is the change in Active Power output from the Power Generating Module. f_n is the nominal Frequency (50 Hz) in the Network and Δf is the Frequency change in the Network. At over frequencies where Δf is above Δf_1 the Power Generating Module has to provide a negative Active Power output change according to the Droop S_2.

2) The Power Generating Module shall be capable of stable operation during LFSM-O operation. When LFSM-O is active, the LFSM-O Setpoint will prevail over any other Active Power Setpoints.

NA – new category of user
Grid Code BC3.7.2 applicable for BM Units and Large

11. Non-mandatory, principles defined, new category of user : Article 9 (5) (d) (2) Definition of information exchange

Article 9
GENERAL REQUIREMENTS FOR TYPE B POWER GENERATING MODULES

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5. Type B Power Generating Modules shall fulfil the following general system management requirements:

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d) With regard to information exchange:

…

2) The Relevant Network Operator in coordination with the Relevant TSO shall define while respecting the provisions of Article 4(3) the contents of information exchanges and the precise list and time of data to be facilitated.

NA – new category of user
PCA5.4.1, PCA5.4.2, PCA6, CC6.5 applicable for Large and Medium

12. Non-mandatory, parameters defined, new category of user : Article 8 (1) (e) Output power with falling frequency (applies to Type A)

Article 8
GENERAL REQUIREMENTS FOR TYPE A POWER GENERATING MODULES

1. Type A Power Generating Modules shall fulfil the following requirements referring to Frequency stability**:**

…

…

e) The Relevant TSO shall define admissible Active Power reduction from maximum output with falling Frequency within the boundaries, given by the full lines in Figure 2:

- Below 49 Hz falling by a reduction rate of 2 % of the Maximum Capacity at 50 Hz per 1 Hz Frequency drop;
- Below 49.5 Hz by a reduction rate of 10 % of the Maximum Capacity at 50 Hz per 1 Hz Frequency drop.

Applicability of this reduction is limited to a selection of affected generation technologies and may be subject to further conditions defined by the Relevant TSO while respecting the provisions of Article 4(3).

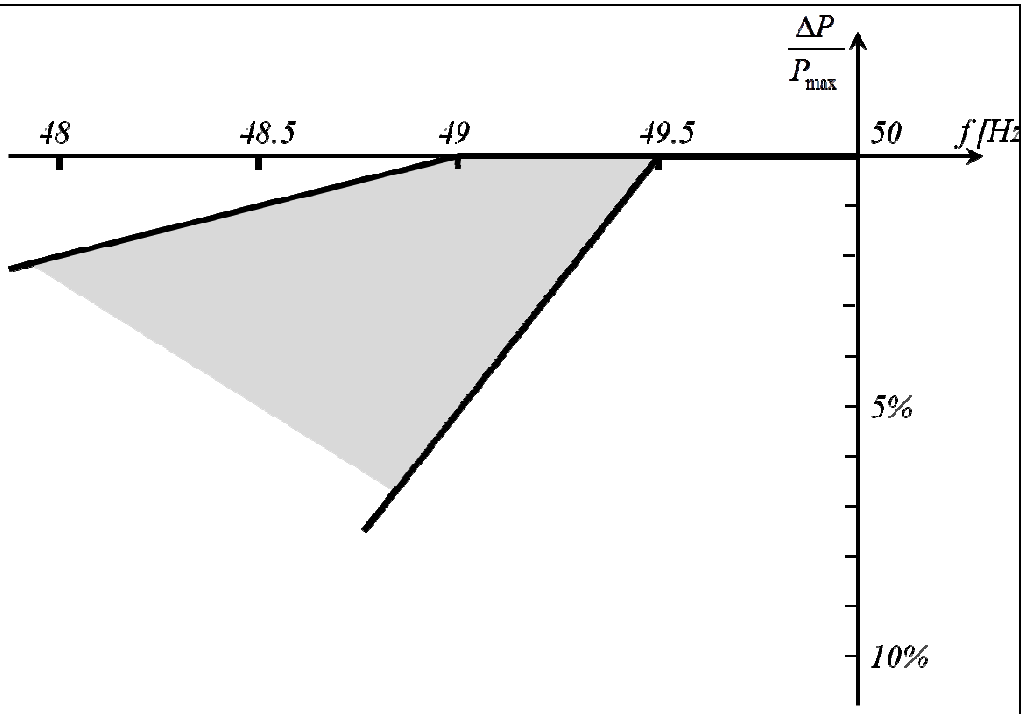

Figure 2 – Maximum power capability reduction with falling Frequency. The diagram represents the boundaries defined by the Relevant TSO while respecting the provisions of Article 4(3).

NA – new category of user
Grid Code CC6.3.3 applicable for Large and Medium

Article 4(3)

Article 4
REGULATORY ASPECTS

3) Where reference is made to this paragraph, the determination of the terms and conditions for connection and access to networks or the methodologies to establish them shall be set in accordance with the rules of national law implementing Article 37 (6) (a), (7) and (10) of Directive 2009/72/EC, and with the principles of transparency, proportionality and non-discrimination.

The establishment of these terms and conditions or their methodologies shall be performed by entities and based on the legal framework indicated in this Network Code where reference is made to this paragraph, unless the rules of national law at the date of the entry into force of this Network Code assign this establishment to a different entity and according to a different legal framework.