INITIAL RFG NATIONAL PARAMETER SELECTION

BASED ON DRAFT RFG VERSION DATED 14 JANUARY 2014

DECEMBER 2014

Notes:- Red Text – Areas of further work

Highlighted text:- Areas of further clarification required

Article	Requirement	Range		Suggested GB Value		Comments
8.1(a)	Frequency Ranges	47 – 47.5Hz 47.5 – 48.5Hz 48.5 – 49.0Hz 49.0 – 51.0Hz 51.0 – 51.5Hz 51.5 – 52Hz	20 seconds 90 minutes TSO defined (not less than 90mins) Unlimited 90 minutes 15 minutes	47 – 47.5Hz 47.5 – 49.0Hz 49.0 – 51Hz 51.0 – 51.5Hz 51.5 – 52Hz	20 seconds 90 minutes Continuous 90 minutes 15 minutes	Already consistent – no change required (CC.6.1.3)
8.2	Rate of change of frequency	Specified by TSO		2Hz/s?		Not currently specified in GB Grid Code
8.3	LFSM-O	Frequency threshold	50.2 – 50.5Hz	Frequency threshold	50.4Hz	Already consistent with BC.3.7.2 except Activation Time
		Droop	2 – 12%	Droop	10%	
		Activation time	2 seconds	Activation time	2 seconds	
		Operation at Minimum Regulating Level	TSO defined	Operation at Minimum Regulating Level	Operation required to Minimum Generation (BC3.7.3)	
8.4	Maintenance of Constant Active Power regardless of	49.5 – 50.5 Hz? – By interpretation		49.5 – 50.4Hz		Already consistent with CC.6.3.3

Article	Requirement	Range		Suggested GB Value		Comments
	changes in System Frequency					
8.5	Power Output with Falling Frequency	Below 49Hz falling by a reduction rate of 2% of the Maximum Capacity at 50Hz per 1Hz Frequency drop Below 49.5Hz by a reduction rate of 10% of the maximum Capacity at 50Hz per 1Hz Frequency drop		Power Output should not drop by more than prorata with frequency (ie maximum permitted requirement is 100% power at 49.5Hz falling linearly to 95% at 47.0Hz)		Already consistent with CC.6.3.3
Type B						
9.3	Fault Ride Through (Synch)	U_{ret}:- 0.05 – 0.3 U_{clear}:- 0.7 – 0.9 U_{rec1}:- U_{clear} U_{rec2}:- 0.85 – 0.9 and $\geq U_{clear}$	t_{clear}:- 0.14 – 0.15 t_{rec1}:- t_{clear} trec2:- t_{rec1} – 0.7 trec3:- t_{rec2} – 1.5	U_{ret}:- 0.25 U_{clear}:- 0.7 U_{rec1}:- 0.7 U_{rec2}:- 0.85	t_{clear}:- 0.14 t_{rec1}:- 0.14 trec2:- 0.45? trec3:- 1.5	Substantial study work and DNO input required
9.3	Fault Ride Through (Asynch)	U_{ret}:- 0.05 – 0.15 U_{clear}:- U_{ret} – 0.15 U_{rec1}:- U_{clear} U_{rec2}:- 0.85	t_{clear}:- 0.14 – 0.15 t_{rec1}:- t_{clear} t_{rec2}:- t_{rec1} t_{rec3}:- 1.5 – 3.0	U_{ret}:- 0.15 U_{clear}:- 0.15 U_{rec1}:- 0.15 U_{rec2}:- 0.85	t_{clear}:- 0.14 t_{rec1}:- 0.14 t_{rec2}:- 0.14 t_{rec3}:- 3.0?	Substantial study work and DNO input required (would suggest the same values as current GB Offshore requirements)
Type C						
10.2(b)	LFSM-U	Frequency Threshold Droop Activation Time	49.8–49.5Hz 2 – 12% 2 s	Frequency Threshold Droop Activation Time	49.5Hz 10%? 2 s	This is a new requirement and new to the GB Grid Code. Initial values based on FSM Mode of Operation.
10.2(c)	FSM	Active Power range $\lvert\Delta P_1\rvert/P_{max}$ Frequency Insensitivity $\lvert\Delta f_i\rvert$ Frequency Insensitivity $\lvert\Delta f_i\rvert / f_n$ Deadband Droop Maximum admissible delay t_1 for Generation with Inertia	1.5 – 10% 10 – 30mHz 0.02–0.06% 0-500mHz 2 – 12% 2 s	Active Power range $\lvert\Delta P_1\rvert/P_{max}$ Frequency Insensitivity $\lvert\Delta f_i\rvert$ Frequency Insensitivity $\lvert\Delta f_i\rvert / f_n$ Deadband Droop Maximum admissible delay t_1 for Generation with Inertia	10% ±15mHz ±0.03% ±15mHz 3 – 5% 2 s	Frequency Response Insensitivity is not currently used in GB. There is an issue as to how Primary and Secondary Response is defined. There only appears to be one

Article	Requirement	Range		Suggested GB Value		Comments
		Maximum admissible delay t_1 for Generation without Inertia Activation time t2	TSO defined 30 s	Maximum admissible delay t_1 for Generation without Inertia Activation time t2	TBC? 10s	option of low frequency response in GB.
10.2(f)	ASBMON	Status Signal (on/off) Scheduled Active Power output Actual value of Active Power output Actual parameter settings for Active Power Frequency Response Droop and deadband		Status Signal (on/off) Scheduled Active Power output Actual value of Active Power output Actual parameter settings for Active Power Frequency Response Droop and deadband		Changes required to NGTS3.24.95 /RES
10.6(b)	DSM / Fault Recording	Voltage Active Power Reactive Power Frequency		Voltage Active Power Reactive Power Frequency		Changes required to NGTS3.24.70 /RES. No reference to Breaker Status
Type D						
11.2(a)(1) Table 6.1	Voltage Range 110kV – 300kV	0.9 – 1.10 p.u	Unlimited	0.9 – 1.10p.u 0.94–1.06p.u	Unlimited (275 and 132kV) Below 132kV	Narrower bands do not appear to be permitted
11.2(a)(1) Table 6.2	Voltage Range 300kV – 400kV	0.9 – 1.05 p.u 1.05 – 1.10 p.u	Unlimited 15 minutes	0.9 – 1.05p.u 1.05 - 1.1p.u	Unlimited at 400kV 15 minutes at 400kV	
11.3	Fault Ride Through (Synchronous) (Table 7.1)	U_{ret}:- 0 U_{clear}:- 0.25 U_{rec1}:- 0.5 – 0.7 U_{rec2}:- 0.85 – 0.9	t_{clear}:- 0.14 – 0.15 t_{rec1}:- t_{clear} – 0.45 trec2:- t_{rec1} – 0.7 trec3:- t_{rec2} – 1.5	U_{ret}:- 0 U_{clear}:- 0.25 U_{rec1}:- 0.5 U_{rec2}:- 0.85	t_{clear}:- 0.14 t_{rec1}:- 0.14 trec2:- 0.45 trec3:- 0.884	Further assessment required. RfG only requires resilience against secured faults whilst GB requires resilience against both secured and unsecured faults. This issue is being addressed through the fault ride through working group.
11.3	Fault Ride	U_{ret}:- 0	t_{clear}:- 0.14 – 0.15	U_{ret}:- 0	t_{clear}:- 0.14	Substantial study work and

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	Through (Asynchronous) (Table 7.2)	U_{clear}:- U_{ret} U_{rec1}:- U_{clear} U_{rec2}:- 0.85	t_{rec1}:- t_{clear} t_{rec2}:- t_{rec1} t_{rec3}:- 1.5 – 3.0	U_{clear}:- 0 U_{rec1}:- 0 U_{rec2}:- 0.85	t_{rec1}:- 0.14 t_{rec2}:- 0.14 t_{rec3}:- 1.5	DNO input required
Type B Synch						
12.3	Fault Ride Through Active Power Recovery	TSO specified		0.5 seconds		
Type C Synch						
13.2(b)	Reactive Power Capability at Maximum Capacity	In accordance with U-Q/P_{max} profile of Figure 7 and Table 8 Maximum range of Q/P_{max} – 0.95 Max range of steady state voltage 0.1p.u		Maximum range of Q/P_{max} – 0.95 Max range of steady state voltage 0.1p.u		RfG requirements are very different to GB. GB requires 0.85pf lag to 0.95 pf lead at the Generator unit terminals. RfG requires Q/Pmax range of 0.95 at the Connection Point. This equates to 0.9 pf lead to 0.9 pf lag at the connection point and a full reactive delivery over a system voltage range of 0.95 – 1.05 p.u.
13.2(c)	Reactive Power Capability below Maximum Capacity	Operation required in every possible point in the P-Q Capability Diagram of the alternator down to the Minimum Stable Operating Level		Operation expected to be within the Operating Chart as defined under OC2 of the Grid Code		
Type D						

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Synch				
14.2(b)	Specifications and performance of AVR and Excitation System	Specified by RNO and TSO – No ranges given Bandwidth Limitation Underexcitation Limiter requirements Overexcitation limiter requirements Stator Current Limiter Power System Stabiliser requirements	As per CC.A.6 of the Grid Code Stator Current Limits may be an issue	Check Overexcitation limiter and Stator Current Limiter requirements
Type B PPM's				
15.2(b)	Fast Fault Current Injection	Specified by RNO and TSO Requirements for fast fault current either at the Connection Point or Turbine Terminals Criteria for determination of voltage deviation The characteristics of Fast Fault Current The timing and accuracy of the fast fault current which may include several stages Fast Fault current injection for asymmetrical faults	To be determined Current GB requirement states each Power Park Module should generate maximum reactive current without exceeding the transient rating of the generating unit during the period of the fault	This requirement is much more detailed than currently specified in CC.6.3.15 of the Grid Code. Requires extensive analysis and modelling work.
15.3	Post Fault Active Power Recovery	Specified by TSO When the post fault active power recovery begins based on a voltage criterion Maximum allowed time for active power recovery Magnitude and accuracy for Active Power Recovery Priority between Fast Fault Current requirements and Active Power Recovery Dependence between Active Power Recovery times and duration of voltage deviations A defined limit of the maximum allowed time for Active Power Recovery Adequacy between level of voltage recovery	Specifications and requirements are new to GB Grid Code. Current requirement requires 90% of the Active Power to be fully restored within 0.5 seconds of restoration of the voltage to the values specified in CC.6.1.4 of the Grid Code.	This requirement is much more detailed than currently specified in CC.6.3.15 of the Grid Code. Requires extensive analysis and modelling work.

Article	Requirement	Range	Suggested GB Value	Comments
		and minimum magnitude for active power recovery Adequate damping of active power oscillations		
Type C PPM's				
16.3(b)	Reactive Capability at Maximum Capacity	In accordance with U-Q/P_{max} profile of Figure 8 and Table 9 Maximum range of Q/P_{max} – 0.66 Max range of steady state voltage 0.1p.u	Maximum range of Q/P_{max} – 0.66 Max range of steady state voltage 0.1p.u	RfG requirements are specified in a different way to GB. GB requires 0.95pf lag to 0.95 pf lead at the Connection Point. RfG requires Q/P max range of 0.66 at the Connection Point. This equates to the same requirement of 0.95 pf lead to 0.9 pf lag at the connection point and a full reactive delivery over a system voltage range of 0.95 – 1.05 p.u. In other words the RfG requirements when translated are the same as the GB requirements. Checks however need to be made as to how the Voltage / Reactive Power curve under CC.A.7 fit into the prescribed format of Figure 8 as there could be a reduction in required performance
16.3(c)	Reactive Capability	In accordance with U-Q/P_{max} profile of Figure 9 The P-Q/Pmax profile shall not exceed the P-	Requires further analysis but it is believed the current Reactive Capability requirements	Further analysis required

Article	Requirement	Range	Suggested GB Value	Comments
	below Maximum Capacity	Q/Pmax profile envelope, represented by the inner envelope of Figure 9 TheQ/Pmax range of the P-Q/Pmax profile envelope is defined for each Synchronous Area Maximum range of Q/P_{max} – 0.66 Max range of steady state voltage 0.1p.u The Active Power range of the P-Q/Pmax profile envelope at zero reactive power shall be 1p.u The P-Q/Pmax profile can be any shape and shall include conditions for Reactive Capability at zero Active Power and The position of the Q/Pmax profile envelope within the limits of the fixed outer envelope in figure 9.	defined under CC.6.3.2(c) of the Grid Code would fit into the dimensions specified in the RfG code.	
16.3(d)	Reactive Power Control Modes	Power Park Module to be capable of providing Reactive Power automatically by either Voltage Control, Reactive Power Control or Power Factor Control	Voltage Control for plant caught by requirements of Grid Code. There could be an issue with Offshore Power Park Modules.	For DNO connected plant power factor control, reactive power control or voltage control may be used but discussion required.
16.3(d) (2) – (4)	Voltage Control	Setpoint Voltage:- 0.95 – 1.05p.u Step Size (no greater than):- 0.01p.u Slope Setting:- 2 – 7% Slope step:- 0.5% Reactive Power to equal zero MVAr when Grid Voltage value at the Connection Point = Voltage Sepoint Deadband range:- 0 to ±5% Deadband tolerance:- 0.5% t1 range:- 1 – 5 seconds* t2 range:- 5 – 60 seconds*	Setpoint Voltage:- 1.0p.u Step Size:- 0.0025p.u (0.25%) Slope Setting:- 4% (Initial) Slope step:- 0.5% Reactive Power to equal zero MVAr when Grid Voltage value at the Connection Point = Voltage Sepoint Deadband range:- 0.25% Deadband tolerance:- 0.25% t1 range:- 1 second* t2 range:- 15 seconds to achieve 5% of new	*t1 and t2 define the time requirements for voltage control performance. t1 defines the time to achieve 90% of the change in reactive power following a step change in voltage. t2 defines the time that the steady state tolerance in reactive power should be controlled within ±5%.

Article	Requirement	Range	Suggested GB Value	Comments
		Steady state tolerance of reactive power to be no greater than 5% of the maximum reactive power	steady state reactive power value*	Further DNO input will be required
16.3(5)	Reactive Power Control	Reactive Power Range as per Article 16.3(b) Target MVArs:- no greater than 5MVAr or 5% (whichever is Smaller) Accuracy:- ±5MVAr or ±5%	For Onshore Power Park Modules to be disabled	For onshore PPM's the Grid Code requires Constant Reactive Power Control to be disabled (BC.2.11.2) Issue for DNO's. Potential issue for Offshore Power Park Modules
16.3(6)	Power Factor Control	Reactive Power Range as per Article 16.3(b) Target MVArs:- no greater than 0.01 Relevant Network Operator to define target Power Factor value and tolerance expressed in MVAr or % on the Reactive Power value issued from conversion of Power Factor within a period of time following a sudden change of Active Power Output	For Onshore Power Park Modules to be disabled	For onshore PPM's the Grid Code requires Constant Power Factor Control to be disabled (BC.2.11.2) Issue for DNO's. Potential issue for Offshore Power Park Modules
16.3(7)	Selection of Power Factor Control, Reactive Power Control or Voltage Control	Relevant Network Operator in coordination with the Relevant TSO to define which of the three reactive control modes (ie Reactive Power Control, Power Factor Control or Voltage Control) and associated set points should be used and equipment to make adjustment of the relevant setpoint remotely operable	Voltage Control	Remote operation is normally via ENCC instructions to the User's Control Point. It is assumed RfG permits this option for remote control. There may be an issue for DNO's and a potential issue for Offshore Generation which can choose between Reactive Power Control or

Article	Requirement	Range	Suggested GB Value	Comments
				Voltage control.
16.3(e)	Fault Ride Through – Priority of Active or Reactive Power Contribution	The Relevant TSO to define the priority of Active and Reactive Power during faults for which fault ride through is required. If priority is given to Active Power Contribution its provision shall be established no later than 150ms from fault inception	For secured faults of zero voltage on the Transmission System priority to be given to Reactive Power. Consideration to be given to Embedded Generation	Issues to be picked up as part of fault ride through work
Offshore PPM's				
20.1	Voltage Range	0.9 – 1.1 p.u* 0.9 – 1.05 p.u ** 1.05 – 1.10 p.u**	0.9 – 1.1 p.u* 0.9 – 1.05 p.u ** 1.05 – 1.10 p.u**	* Voltage range permitted below 300kV (Check SQSS) **Voltage range between 300kV – 400kV
20.2	Voltage Stability requirements	The voltage Stability requirements defined in Article 16(3)(a)(c)(d)(e) and (f) shall apply to any Offshore Power Park Module	Under Article 16(3)(d) the Offshore requirements are different to the Onshore requirements. This will necessitate graded requirements between Onshore and Offshore performance. The current GB Grid Code gives more flexibility than RfG so further work will be required in this area.	Further clarification required between Onshore and Offshore.
20.3	Reactive Capability at Maximum Capacity	Q/Pmax: – 0* Q/Pmax:- 0.33** Max range of steady state voltage 0.1p.u	Q/Pmax: – 0* Q/Pmax:- 0.33** Max range of steady state voltage 0.1p.u	*Refers to Configuration 1 which assumes a single AC Onshore Connection Point which equates to zero transfer of reactive power at the Connection Point or Unity Power Factor ** Refers to Configuration 2 which assumes a number of AC interconnected Offshore Power Park Modules with

Article	Requirement	Range	Suggested GB Value	Comments
				two or more Onshore connection points. This equates to 0.986 pf lead to 0.986 pf lag at the Offshore connection point and a full reactive delivery over a system voltage range of 0.95 – 1.05 p.u. This is a new requirement to GB