COMPARISION OF OFFSHORE REQUIREMENTS

(Comparison based on GB Grid Code Issue 4 Revision 13 only and ENSTO - E RFG Internal Version dated 26 June 2012)

(Note – Does not include other Industry Codes such as the STC)

Key to Table

Table 3 compares the Offshore GB Grid Code requirements with the Offshore ENTSO-E RfG. This is a detailed Table comparing the exact Offshore requirements of the GB Grid Code with the exact Offshore requirements of the ENTSO-E RfG. The reader should however be aware that in adopting this comparison there may be elements in the ENTSO-E RfG that have not been identified as and this is where Table 1 is considered to be helpful. The text in highlighted yellow indicates areas which are unclear with the ENTSO-E Code or areas which are worthy of comment.

TABLE 3 – OFFSHORE ENTSO-E RfG to GB GRID CODE

Symbol	***Definition***
N/A	Not specified in GB Grid Code but other requirements may apply in other industry Codes such as the System Operator Transmission Owner Code (STC) Distribution Code or Engineering Recommendations such as G59, ETR 113 and G83.
N/S	Not specified in ENTSO-E RfG Code often because not deemed to be a cross border issue but other National requirements may apply.
Article 4(3)	Where reference in the Table is given to Article 4(3) this means that any decision made by a Relevant Network Operator, or Relevant TSO and a Relevant Network Operator or Power Generator may require agreement with the National Regulating Authority.
Offshore Power Park Modules	NOTE:- The same grading thresholds applies to Offshore Power Park Modules as Onshore Generating Units and Onshore Power Park Modules. To simplify the Offshore Table and reduce complexity the Type has been explicitly defined. Offshore Power Park Modules are required to meet those requirements applicable to Offshore Power Park Modules but the following should be noted:- Type A Offshore Power Park Module:- 800W – 1MW and connected below 110kV Type B Offshore Power Park Module:- 1MW – 10MW and connected below 110KV Type C Offshore Power Park Module:- 10MW – 30MW and connected below 110kV Type D Offshore Power Park Module:- 30 MW or Greater or Connected at 110kV or more Type D units are required to meet the full requirements of Type A, B and C Units, Type C units are required to meet the requirements of Type A and B and Type B units are required to meet the requirements of Type A except where the following Exclusions noted below apply. Exclusions Type C Offshore Power Park Modules are required to meet the requirements applicable to Type A and B Units defined in Articles 7 and 8 except for Article 7(1)(d)(facilitation of a logic interface signal to permit disconnection from the network or additional facilities pursuant to Article 4(3)), Article 8(2)(a) (Capability to reduce Active Power in steps not bigger than 20% of Maximum Capacity through an interface and the requirements applicable to Type A Onshore Power Park Modules). For Type C Units, more stringent requirements are specified. Type D Units are required to meet the requirements of types A, B and C Units defined in Articles 7, 8 and 9 except Article 7(1)(d) (facilitation of a logic interface signal to permit disconnection from the network or additional facilities pursuant to Article 4(3)), Article 8(2)(a) (Capability to reduce Active Power in steps not bigger than 20% of Maximum Capacity through an interface), Article 9(3)(a) (Generating Units to be capable of automatic disconnection at specified voltages if required by the Network Operator with the settings pursuant to Article 4(3)) and the requirements applicable to Type A Onshore Power Park Modules.
1	Directly Applicable (no scope for Member State specificity)
2	Member State specificity can be applied
3	A Member state CBA or consultation is required to determine applicability
4	Further detail is required to implement ENC obligations – need to confirm that governance processes would constitute the necessary NRA consultation
5	No change is needed to the GB framework (we already meet the requirements)
6	Completely new to the GB framework
7	Where different obligations are introduced at interconnection points to deeper in the system – with dual references required to the 2 co-existing obligations
8	Where different obligations are introduced for new as opposed to existing parties
9	GB arrangements go beyond those stipulated in the ENC

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TABLE 3 – OFFSHORE ENTSO-E RfG to GB GRID CODE				
Requirement	**Key**	**GB Power Station Type**		**ENTSO-E – RfG -Generating Unit Type**
		Large > 10 MW	**Small** < 10MW	**Offshore Power Park Modules**
Definitions and Scope	N/A	Any Generating Plant which is connected to an Offshore Transmission System at an Offshore Grid Entry Point is required to satisfy the Offshore Grid Code requirements. In general the Offshore Grid Code requirements are the same as the Onshore Grid Code requirements unless otherwise stated in this table below. An Offshore Transmission System is one which is owned under Licence by an appointed Offshore Transmission Licensee and comprises high voltage electric lines or cables of 132 kV or above between an Offshore Platform and the Shore. The Offshore Transmission System is classified as part of the National Electricity Transmission System being Controlled by National Grid as System Operator but the actual Offshore Transmission Network is owned and maintained by an appointed Offshore Transmission Licensee. The Offshore Generator will be required to satisfy technical connection requirements under the Grid Code where as the Offshore Transmission Licensee will be required to satisfy connection requirements under the System Operator Transmission Owner Code (STC). The point of connection between an Offshore Generator and Offshore	As per Large except, the connection requirements as detailed under CC.6.3 of the GB Grid Code connection conditions such as reactive capability(CC.6.3.2), output power with falling frequency (CC.6.3.3), active power output and voltage range(CC.6.3.4), black start (CC.6.3.5), frequency control (CC.6.3.6, CC.6.3.7), voltage control (CC.6.3.6, CC.6.3.8), steady state load inaccuracies (CC.6.3.9), negative phase sequence loadings (CC.3.10), neutral earthing (CC.6.3.11), frequency sensitive relays (CC.6.3.12 – CC.6.3.13), fast start (CC.6.3.14) and fault ride through (CC.6.3.15) are not required.	The ENTSO-E RfG applies only to Offshore Power Park Modules only. A Power Park Module located Offshore which does not have an Offshore Connection Point shall be considered as an Onshore Power Park Module and shall thus be compliant with the requirements defined above for Onshore Power Park Modules. Whilst respecting the provisions of Article 4(3) the Offshore Connection Point of an Offshore Power Park Module shall be defined by the Relevant Network Operator. Offshore Power Park Modules within the scope of the RfG Network Code are categorised in accordance to the following Offshore Grid Connection System Configurations. 1) Configuration 1 – AC connection to single onshore point - One or more Offshore Power Park Modules are interconnected offshore to form an Offshore AC System. The Offshore AC System is connected to the Onshore System with one or more AC connection(s) to the same Onshore Grid Interconnection Point. 2) Configuration 2 - Meshed AC connection - A number of Offshore Power Park Modules are interconnected offshore to form an Offshore AC System. The Offshore AC System is connected to the Onshore System at two or more Onshore Grid Interconnection Point locations.

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Deleted: may comprise of one or more Generating Units. All associated auxiliary system and secondary equipments shall be considered as parts of the Offshore Power Park Module.¶ ¶ Under the ENTSO-E RfG the Offshore Power Park Modules

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Deleted: 3) . Configuration 3 - DC connection to single onshore point with AC collection - One or more Offshore Power Park Modules are interconnected offshore to form an Offshore AC System. The Offshore AC System is connected to the Onshore System with one or more DC connections at one Onshore Grid Interconnection Point location. ¶ ¶ 4) . Configuration 4 - Meshed Hybrid AC and DC connections with AC collection - A number of Offshore Power Park Modules are interconnected offshore to form an Offshore AC System. The Offshore AC System is connected to the Onshore System with AC and DC connections at two or more Onshore Grid Interconnection Point locations. ¶ ¶ 5) . Configuration 5 - Meshed Multiterminal DC connection with AC Collection - A number of Offshore Power Park Modules are interconnec ... [1]

TABLE 3 – OFFSHORE ENTSO-E RfG to GB GRID CODE				
Requirement	**Key**	**GB Power Station Type**		**ENTSO-E – RfG -Generating Unit Type**
		Large > 10 MW	**Small** < 10MW	**Offshore Power Park Modules**
		Transmission Licensee is defined as the Offshore Grid Entry Point whereas the point of Connection between an Offshore Transmission Licensee and Onshore Transmission Licensee is defined as the Interface Point. When the Offshore Transmission Grid Code was prepared in 2008/2009, it generally assumed the Offshore Transmission System to comprise of radial HVAC or HVDC connections of 132kV or above. There have been some applications in the last few years where there has been interconnection between Offshore Platforms and Offshore Transmission Interface Points. However, as Offshore Transmission Systems start to evolve and become increasingly integrated, there will be an increasing requirement to update and amend the Offshore Grid Code and STC requirements The Offshore Grid Code requirements will apply to all types of plant which connect to an Offshore Grid Entry Point irrespective of whether they are Synchronous or Asynchronous. The requirements applicable to asynchronous plant not only apply to wind generation but other technologies such as wave and tidal generation. The connection process under the Offshore Transmission regime can progress in two ways. 1) The Enduring process in which an Offshore Generator will apply to the System Operator (National Grid) for a connection. National Grid will then prepare an indicative offer to the generator based on a number of		

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		assumptions including the Interface Point and Onshore Network reinforcements. A Tender process will then take place which seeks to encourage a number of potential Offshore Transmission Licensee's (OFTO) to design an Offshore Transmission System. The Regulator (Ofgem), will then select the preferred OFTO based on their ability to design, build and construct an Offshore Transmission Network to appropriate standards and provide value for money. The OFTO is then appointed, agreements between the OFTO and National Grid are prepared and the initial connection offer to the Offshore Generator is revised based on the requirements of the OFTO and the design of the Offshore Transmission network. Construction can then commence but it should be noted that a draw back of this option is the potential delays to the Offshore Generator whilst the Offshore Transmission Tender process is proceeding. 2) An alternative to this process is the Generator Build option. Under this arrangement the Offshore Generator will design and build the Offshore Transmission System as well as the Offshore Generation. Once the Offshore Transmission System has been constructed the Offshore Transmission element will be sold to an appointed Offshore Transmission License. The advantage to the Offshore Generator over the above		

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		Large > 10 MW	**Small** < 10MW	**Offshore Power Park Modules**
		option is that there is no delay to the Offshore Generator whilst Tender process is taking place. Where a Generator is not connected to an Offshore Transmission Network (ie the Offshore Transmission Network contains undersea cables or overhead lines of no greater than 132 kV) then the Offshore network is considered to comprise solely of Generator assets and the Generator is treated in the same way as an Onshore Power Park Module.		
Frequency Stability GB CC.6.1.3, CC.6.3.6(a), CC.6.3.7, CC.6.3.9, CC.6.3.12, CC.6.3.13, BC.3.7.1 and BC.3.7.2 (ENTSO-E – Article 19)	2, 5,6, 9	The requirements for Offshore Power Park Modules are the same as Onshore Power Park Modules in respect of frequency range (CC.6.1.3), Frequency Control (both in Frequency Sensitive and Limited Frequency Sensitive Mode) (CC.6.3.6(a)/CC.6.3.7, Steady State load inaccuracies (CC.6.3.9) frequency sensitive relays (CC.6.3.12 and CC.6.3.13) and frequency performance under high frequencies when operating above 50.5Hz (Frequency Sensitive Mode BC.3.7.1) and when operating above 50.4Hz (Limited Frequency Sensitive Mode BC.3.7.2)	Not applicable	**Frequency Stability** (Article 19) The frequency stability requirements defined respectively in Article 8(1) (a) (Frequency Range), (b) (Rate of Change of Frequency Withstand), (c) (Limited Frequency Sensitive Mode – Overfrequency (LFSM – O), (d) (maintenance of constant output Active Power irrespective of frequency changes), (e) (Power Output with falling frequency) Article 10(2) (Limited Frequency Mode – Under Frequency (LFSM-U) and Frequency Sensitive Mode (FSM) and Article 16(2) (provisions relating to Synthetic Inertia) shall apply to any Offshore Power Park Module
Voltage Stability Requirements Voltage Range GB CC.6.1.4, CC.6.3.15, CC.6.3.2(e) CC.6.3.8 (b) (ENTSO-E – Article 20)	2, 5	Voltage Range (CC.6.1.4) - Large Offshore Generators are required to satisfy the same voltage range requirements as Large Onshore Generators as defined in CC.6.1.4 (ie at 400kV ± 5% with operation unless abnormal conditions prevail. The minimum voltage is -10% and the maximum is +10% but voltages of +5 to +10% will not last longer than 15 minutes. For voltages of 275kV and 132kV the system voltage variation shall be ± 10%. Reactive Power Injection (CC.6.3.15) – The requirements for	Not applicable	**Voltage Stability Requirements** (Article 20) **Voltage Range** (Article 20(1)) While respecting the provisions according to Articles 9(3)(a) (Fault Ride Through – Type B Power Generating Modules)) and 11(3) (a) (Fault Ride Through – Type D Power Generating Modules) an Offshore Power Park 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 (p.u) and within the time periods specified by Table 10 of Article 20 – (1). In GB the voltage ranges specified in Table 10 are 0.9 – 1.1 p.u continuously where the voltage base is less than 300kV and 0.9 – 1.05 p.u continuously and 1.05 – 1.1 p.u for 15 minutes where the voltage base is between 300 and 400kV. **Voltage Stability Requirements** (Article 20(2)) The Voltage stability requirements defined respectively in Article 15(2) (b) (Fault Ride Through –current injection) and (c) (Fault Ride Through additional reactive

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The frequency stability requirements defined in Article 8(2)(a) (Reduction of Active Power in steps not greater than 20%) shall apply to any Offshore Power Park Module irrespective of its configuration.¶
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Type C and D Offshore Power Park Modules¶
In addition to the requirements of Type B Offshore Power Park Modules, Type C and D Offshore Power Park Modules are also required to satisfy the Frequency stability requirements defined in Article 9(2) (a) (Active Power Set Point control / Steady State Load inaccuracies) Article 9(2)(b), (Synthetic Inertia), Article 9(2)(e) (frequency restoration), Article 9(2)(g) (real time frequency monitoring) irrespective of the Offshore Power Park Module configuration.¶

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Type A, B, C and D Offshore Power Park Modules ¶
The Frequency ranges as defined in Article 7(1) (a) (as per onshore) shall apply to Offshore Power Park Mo... [2]

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The Voltage ranges defined in Table 8 apply to all Offshore Power Park Modules of ... [3]

TABLE 3 – OFFSHORE ENTSO-E RfG to GB GRID CODE				
Requirement	**Key**	**GB Power Station Type**		**ENTSO-E – RfG -Generating Unit Type**
		Large > 10 MW	**Small** < 10MW	**Offshore Power Park Modules**
		reactive Power injection for an Offshore Power Park Module are defined in the Fault Ride Through requirements defined under CC.6.3.15.1 or CC.6.3.15.2. In summary the Offshore Power Park Module is required to generate maximum reactive current without exceeding the transient rating of the Offshore Generating Unit or Offshore Power Park Module. Reactive Capability (CC.6.3.2(e)) – Offshore Generators have the option of one of the following requirements. i) Maintenance of zero transfer of Reactive Power at all Active Power output levels (ie unity power factor) at the Offshore Grid Entry Point where the Offshore Grid Entry Point is at the LV side of the Offshore Platform. The steady state tolerance on Reactive Power Transfer to and from an Offshore Transmission System expressed in MVAr shall be no greater than 5% of the Rated MW (CC.6.2.3(e)(i)) ii) Maintain a transfer of Reactive Power at the Offshore Grid Entry Point at a value specified in the Bilateral Agreement that is equivalent to zero transfer (ie unity Power Factor) at the LV Side of the Offshore Platform. The steady state tolerance on Reactive Power to and from an Offshore Transmission System expressed in MVAr shall be no greater than 5% of the rated MW. In other words this requirement is the same as i) above except allowing for the fact that the Offshore Grid Entry Point may not be at the LV Side		current injection) as well as in Article 16(3) (a) (Reactive Capability), (c) (Reactive Capability below maximum capacity), (d) (Reactive Power Control Modes), (e) (Priority of Active / Reactive Power Injection) and (f) (Power Oscillation damping Control) shall apply to any Offshore Power Park Module. **Reactive Capability** (Article 20(3)) The Reactive Power capability at Maximum Capacity as defined in Article 16 - (3) (b) (Reactive Power Capability at Maximum Capacity) shall apply to any Offshore Power Park Module, except for Table 9 which shall be replaced by Table 11. In GB the maximum Q/PMax range is specified as 0 at the Offshore Connection Point for Configuration 1 (ie Unity Power Factor) and 0.33 for Configuration 2 (ie 0.987 PF lead to 0.987 PF lag).

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The voltage stability requirements defined in Article 15(2) (a) and (b) (Reactive Current Injection) shall apply to Offshore Power Park Modules of configurations 1, 2, 3, 4 and 5¶
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Type C and D Offshore Power Park Modules¶
In addition to the requirements of Type B Offshore Power Park Modules, Type C and D Offshore Power Park Modules are required to meet Article 16 (3) (c) (Reactive Power below maximum capacity) and Article 16(3)(d) (the priority of Active Power over Reactive Power)

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The Reactive Power Capability at maximum Active Power as defined in Article 16(3) (b) (Reactive Power Capability (P/Q Profile at maximum capacity) shall apply to Offshore Power Park Modules of configurations 1, 2, 3, 4 and 5 except for Table 7 of Article 16(3)(b) which shall be replaced by Table 9 of Article 20(3). Under the ENTSO-E RfG within Great Britain the Q/P_{Max} range for Configurations 1 and 6 shall be 0 (equivalent to Unity Power Factor at 1.0 p.u ... [4]

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Type C and D Offshore Power Park Modules¶
The Reactive Power Control Modes as defined in Article 16(3) (e) (ie Power Factor Control, Reactive Power Control or Voltage Control) shall apply to Offshore P ... [5]

TABLE 3 – OFFSHORE ENTSO-E RfG to GB GRID CODE				
Requirement	**Key**	**GB Power Station Type**		**ENTSO-E – RfG -Generating Unit Type**
		Large > 10 MW	**Small** < 10MW	**Offshore Power Park Modules**
		of the Offshore Platform (CC.6.3.2(e)(ii)) iii) The Reactive Power Capability (including any tolerance) will be specified in the Bilateral Agreement providing agreement has been reached between the Generator, Offshore Transmission Licensee and NGET (CC.6.3.2(e)(iii)). iv) For Offshore Synchronous Generators, the Short Circuit Ration should be not less than 0.5. Voltage Control (CC.6.3.8(b)) – A continuously acting control system is required to provide control of reactive power (as detailed in CC.6.3.2(e)(i)(ii)) at the Offshore Grid Entry Point without instability over the entire operating range. The performance requirements of this automatic control system will be specified in the Bilateral Agreement. Where an alternative reactive capability has been specified in the Bilateral Agreement in accordance with CC.6.3.2(e)(iii) the Offshore Generator will be required to control voltage and / or reactive power without instability over the entire operating range. The performance requirements of the control system will be specified in the Bilateral Agreement. In addition the requirements for excitation control facilities including Power System Stabilisers where in NGET's view these are necessary for system reasons they will be specified in the Bilateral Agreement.		
Robustness of Generating Units applicable to	2, 5	In Great Britain the same requirements for Onshore	Not applicable	**Steady State Stability** (Article 21(1) The robustness of Power Generating Modules requirements as defined in Article

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Requirement	**Key**	**GB Power Station Type**		**ENTSO-E – RfG -Generating Unit Type**
		Large > 10 MW	**Small** < 10MW	**Offshore Power Park Modules**
Offshore Power Park Modules (GB CC.6.3.7(b), CC.6.3.8(b), CC.6.3.15 and ENTSO-E Article 21		Generators applies to Offshore Generator unless otherwise specified. Steady State Stability – captured under Governor / Frequency Control Stability covered under CC.6.3.7(b), Voltage / Reactive Power Controllers covered under CC.6.3.8(b) and Stability during faults is covered under the fault ride through requirements defined under CC.6.3.15. Torsional Stress – Not explicitly defined. The requirements for subsynchronous resonance are however applicable to HVDC Converters. Power Oscillation Damping Control – Captured under Voltage / Reactive Power Control under CC.6.3.8(b) with the specific requirement for power oscillation damping being specified in the Bilateral Agreement. Fault Ride Through – Offshore Power Park Modules are required to have a fault ride through capability and have the option of satisfying one of two options. Option 1 – is the same requirement as required from Onshore Power Park Modules with compliance being measured at the Interface Point as defined under CC.6.3.15.1 as outlined above. Option 2 - Fault Ride Through requirements are defined at the LV side if the Offshore Platform. Faults up to 140ms in duration:- For faults up to 140ms in duration each offshore Generating Unit or Power Park Module is required to		10(4) (a) (Power Generating Module Stability when operating at any point within the P/Q diagram) and (c) (and Article 15 (3) (Post Fault Active Power Recovery following Fault Ride Through) shall apply to any Power Park Module. **Fault Ride Through Capability** (Article 21(2)) The fault ride through capability requirements as defined in Articles 9 (3) (a) (fault Ride Through for Type B Power Generating Modules) and 11(3)(a) (Fault Ride Through for Type D Power Generating Modules) shall apply to any Offshore Power Park Module

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The requirements defined in Article 9(4)(a) (maintenance of steady state stability for any point within the PQ diagram in the case of power oscillations and prohibition of tripping or power reduction) shall apply to Offshore Power Park Modules of configurations 1, 2, 4 and 6. ¶
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Torsional Stress

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The requirements defined in Article 9(4)(b) (ability of Generating units to be designed in a way that shaft torsional stress which may be excited by transient Active Power steps up to 50% of its maximum capacity are considered a routine part of normal operation and shall be taken into account when specifying the shaft characteristics) withstand torsional stress and the ability of generating units to withstand auto re-closure (including fast single phase auto re-closure) shall apply to Offshore Power Park Modules of configurations 1, 2 and 4.¶
¶
Power Oscillation Damping Control (Article 21(3))¶
Type C and D Offshore Power Park Modules¶ ... [6]

Deleted: **Fault Ride Through Capability** (Article 21(4))¶
Type D Offshore Power Park Modules¶
The fault ride through requirements of Power Park Modules as defined as in Article 17(1)(a) (Fault Ride Thro ... [7]

TABLE 3 – OFFSHORE ENTSO-E RfG to GB GRID CODE				
Requirement	**Key**	**GB Power Station Type**		**ENTSO-E – RfG -Generating Unit Type**
		Large > 10 MW	**Small** < 10MW	**Offshore Power Park Modules**
		remain transiently stable and connected to the System without tripping for any balanced or unbalanced voltage dips on the LV Side of the Offshore Platform whose voltage profile is anywhere on or above the heavy black line shown in Figure 6. Under worst case conditions this requires the Offshore Generator or Offshore Power Park Module to remain connected to the system for voltage dips of 15% retained voltage or above. During the period of the fault each Offshore Generating Unit or Offshore Power Park Module is required to provide Active Power at least in proportion to the retained voltage at the LV Side of the Offshore Platform except in the case of an Offshore Power Park Module where there has been a reduction in the intermittent power source in the time range in Figure 6 that restricts the Active Power below this level. In addition, each Offshore Generating Unit or Offshore Power Park Module shall generate maximum reactive current without exceeding the transient rating limits of the Offshore Generating Unit or Offshore Power Park Modules. Faults greater than 140ms in duration: In addition to the requirements for faults lasting up to 140ms, each Offshore Power Park Module and Offshore Generating Unit is required to remain transiently stable and connected to the System without tripping for any balanced voltage dip on the LV Side of the Offshore Platform and associated durations anywhere on or above the heavy black line shown in Figure 7. In addition each Offshore Generating Unit or Offshore Power Park Module shall provide Active Power output		

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Requirement	**Key**	**GB Power Station Type**		**ENTSO-E – RfG -Generating Unit Type**
		Large > 10 MW	**Small** < 10MW	**Offshore Power Park Modules**
		during voltage dips on the LV Side of the Offshore Platform as described in Figure 7 at least in proportion to the retained balanced or unbalanced or unbalanced voltage at the LV Side of the Offshore Platform except in the case of an Offshore Power Park Module where there has been a reduction in the intermittent Power Source that restricts the active power below this level and in addition shall generate maximum reactive current (where the voltage at the Offshore Grid Entry Point is outside the limits specified in CC.6.1.4) without exceeding the transient rating limits of the Offshore Generating Unit or Offshore Power Park Module. In addition within 1 second of the restoration of the voltage at the LV Side of the Offshore Platform (to the minimum levels specified in CC.6.1.4) restore Active Power to at least 90% of the Offshore Generating Units or Offshore Power Park Modules immediate pre-disturbed value unless there has been a reduction in the intermittent Power Source in the time range in Figure 7 that restricts the Active Power below this level. In addition, Offshore Generators (which includes Offshore Generating Units and Offshore Power Park Modules) are required to also meet the requirements of CC.6.3.15.3 which are the same as the Onshore requirements.		
System Restoration Requirements applicable to Offshore Power Park Modules (GB CC.6.3.5, CC.6.3.7(c) ENTSO-E – Article 22)	2, 5, 6	Blank Start (CC.6.3.5) – Specified by NGET in the Bilateral Agreement. Island Operation (CC.6.3.7(c) – As per onshore requirement in CC.6.3.7(c). Resynchronisation – Specified in the Bilateral Agreement between NGET	Black Start and Island Operation – Not applicable Resynchronisation – Specified in Bilateral Agreement between NGET and the User.	**System Restoration** (Article 22) The System Restoration requirements defined respectively in Article 9(4)(reconnection after a disconnection) and 10 (5) (Black Start) shall apply to any Offshore Power Park Module.

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TABLE 3 – OFFSHORE ENTSO-E RfG to GB GRID CODE				
Requirement	**Key**	**GB Power Station Type**		**ENTSO-E – RfG -Generating Unit Type**
		Large > 10 MW	**Small** < 10MW	**Offshore Power Park Modules**
		and the User.		
General System Management Requirements Applicable to Offshore Power Park Modules (GB CC.6.2.2.2, CC.6.5.6, PC, CC.6.6, BC.1.A.1.1, CC.6.3.11, CC.6.1.5, C.6.1.6 and CC.6.1.8 ENTSO-E Article 23	2.5	General Type B Requirements (Controllability of Active Power, Reconnection requirements, Control Schemes and Settings and information exchange) are captured above in the Onshore Table. Protection Schemes and Settings (CC.6.2.2.2) The applicable protection requirements for Offshore Generators are the same as for Onshore Generators in accordance with CC.6.2.2.2. These are covered in detail in the above Onshore Table. Instrumentation and Monitoring (CC.6.5.6 and CC.6.6). The requirements for Operational Metering (CC.6.5.6) and Dynamic System Monitoring (CC.6.6) are the same as the Onshore requirements although the Offshore Transmission Licensee will have responsibility for transfer of this data to the Onshore Transmission Licensee. Submission of Models and Data (PC) The full data requirements including models are captured under the Grid Code Planning Code. There is no significant difference between the Offshore Data requirements and Offshore Data requirements. The European Grid Code requires electromagnetic transient simulations which the GB Grid Code does not. Installation of additional devices to install additional devices to preserve and restore system operation or security Defined in the Bilateral Agreement pursuant to the requirements of the Grid Code	As per Large except for:- Neutral Earthing (CC.6.3.11)	**General System Management Requirements** (Article 23) The general system management requirements defined respectively in Articles (9)(5) (Control Schemes and Settings) 10(6) (System Management Requirements) and 11(4) (synchronisation) shall apply to any Offshore Power Park Module irrespective of its configuration.

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In addition to the requirements applicable to Type B Offshore Power Park Modules, Type C and D Offshore Power Park Modules shall also be required to satisfy the requirements of Article 9(6)(b) (Protection schemes and Settings), Article 9(6)(c) Priority ranking of Protection and Control), Article 9(6)(d) (disconnection/tripping in the event of loss of stability), Article 9(6)(e) (Instrumentation, Dynamic System Monitoring, fault recording, Article 9(6)(f) (submission of simulation models including electromagnetic transient simulations), Article 9(6)(g) (requirements to install additional devices to preserve and restore system operation or security pursuant to the requirements of Article 4(3)), Article 9(6)(h) (maximum and minimum limits on rates of change of Active Power), Article 9(6)(i) (Earthing requirements for the neutral point of a step up transformer), Article 9(6)(j)(Power Quality requirements), Article 9(6)(k)(Requirements for modernised or replaced plant and equipment)¶
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TABLE 3 – OFFSHORE ENTSO-E RfG to GB GRID CODE				
Requirement	**Key**	**GB Power Station Type**		**ENTSO-E – RfG -Generating Unit Type**
		Large > 10 MW	**Small** < 10MW	**Offshore Power Park Modules**
		Limits on Maximum Rates of Change of Active Power (BC.1.A.1.1) Defined in Grid Code BC.1.A.1.1 for each BM Participant at the Grid Entry Point For a change up to 300MW - No Limit For a change greater than 300MW and less than 1000MW – 50MW/min For a change of 1000MW or more 40MW /min This requirement equally applies to Onshore and Offshore Connections. Earthing Points for the Neutral Point of a Step up transformer (CC.6.3.11) As per an Onshore Generator – At nominal system voltages of 132kV or above the higher voltage windings of a transformer of a Generating Unit, DC Converter or Power Park Module must be star connected with the star point suitable for connection to earth. Power Quality (CC.6.1.5, CC.6.1.6 and CC.6.1.8) The same power quality requirements onshore apply offshore other than in respect of Phase unbalance and Voltage fluctuations where such requirements are specified in the Bilateral Agreement. Requirements for modernisation of plant (Classified as a Modification under the Grid Code Glossary and Definitions) Where plant is modernised or replaced, the requirements applicable to the new plant will fall under a "Modification" which is defined under the Grid Code Glossary and Definitions. A Modification is defined as any proposed replacement, renovation,		

TABLE 3 – OFFSHORE ENTSO-E RfG to GB GRID CODE				
Requirement	**Key**	**GB Power Station Type**		**ENTSO-E – RfG -Generating Unit Type**
		Large > 10 MW	**Small** < 10MW	**Offshore Power Park Modules**
		modification alteration or construction which may have a material effect on NGET or a User. In general the Bilateral Agreement would be updated and the new item of plant or equipment would be required to meet the latest Grid Code requirements where applicable. The requirement is equally applicable to both Onshore Generators. <u>Synchronisation Requirements</u> Specified under the Bilateral Agreement and as detailed in the Relevant Electrical Standards		

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3) Configuration 3 - DC connection to single onshore point with AC collection - One or more Offshore Power Park Modules are interconnected offshore to form an Offshore AC System. The Offshore AC System is connected to the Onshore System with one or more DC connections at one Onshore Grid Interconnection Point location.

4) Configuration 4 - Meshed Hybrid AC and DC connections with AC collection - A number of Offshore Power Park Modules are interconnected offshore to form an Offshore AC System. The Offshore AC System is connected to the Onshore System with AC and DC connections at two or more Onshore Grid Interconnection Point locations.

5) Configuration 5 - Meshed Multiterminal DC connection with AC Collection - A number of Offshore Power Park Modules are interconnected offshore to form an Offshore AC System. The Offshore AC System is connected to the Onshore System with multiple DC connections at two or more Onshore Grid Interconnection Point locations. The DC connections may be combined in a multi-terminal system and may also have a connection to an offshore system of another country.

Configuration 6 - Meshed DC connection with DC Collection - An Offshore Power Park Module consisting of DC Generating Units and DC collection network. The Offshore Power Park Module connected by DC to an Offshore DC System. The Offshore DC connection is connected to the Onshore system with one or more DC link(s).

NOTE:- A further Connection Procedures Code (ie detailing the Connection Process) is planned at a later stage. The Florence forum has decided that the Connection Procedures Code is of lower priority and will be implemented post 2015.

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Frequency Ranges

Type A, B, C and D Offshore Power Park Modules

The Frequency ranges as defined in Article 7(1) (a) (as per onshore) shall apply to Offshore Power Park Modules of Configurations 1, 2 and 4. For Configuration 3 and 5 in anticipation to temporarily extreme system disturbances, such as transient oscillations or HVDC Controller failures, wider frequency ranges may apply in the range 46.5Hz to 53Hz for at most 10 seconds. The precise frequency ranges are to be decided by the TSO pursuant to Article 4(3).

Rate of Change of Frequency

Type A, B, C and D Offshore Power Park Modules

The rate of change of frequency withstand capability requirement as defined in Article 7(1) (b) (of 2Hz/s) shall apply to Offshore Power Park Modules of configurations 1,2,3,4 and 5.

Frequency Stability

Type A and B Offshore Power Park Modules

The Frequency stability requirements as defined in Article 7(1)(c) (operation to high frequencies in Limited Frequency Sensitive Mode) shall apply to any Offshore Power Park Module irrespective of its configuration. Nevertheless, for configurations 3, 5, and 6 offshore frequency or alternatively onshore frequency signals shall be used as reference.

Type C and D Offshore Power Park Modules

In addition to the requirements of Type B Offshore Power Park Modules, Type C and D Offshore Power Park Modules are also required to satisfy the Frequency stability requirements as defined in Article 9(2)(c) (operation to low frequencies in Limited Frequency Sensitive Mode), Article 9(2)(d) (Response to frequency changes in Frequency Sensitive Mode) and Article 16(2)(a) (synthetic inertia). These requirements shall apply to any Offshore Power Park Module irrespective of its configuration. Nevertheless, for configurations 3, 5, and 6 offshore frequency or alternatively onshore frequency signals shall be used as reference.

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All Offshore Power Park Modules – Irrespective of Type

The Voltage ranges defined in Table 8 apply to all Offshore Power Park Modules of configurations 1, 2, 3, 4 and 5 within the time periods specified by Table 8 of Article 20(1). For configuration 6, the voltage range shall be defined individually. In GB (for voltages of 110kV and upwards) the ranges defined are 0.9 – 1.05 p.u continuous operation required and 1.05 – 1.10 operation is required for 15 minutes. *(NOTE – Reference to Table 5.2 (which is applicable to voltages in the range of 110kV to 300KV) appears to be missing).*

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Type C and D Offshore Power Park Modules

The Reactive Power Capability at maximum Active Power as defined in Article 16(3) (b) (Reactive Power Capability (P/Q Profile at maximum capacity) shall apply to Offshore Power Park Modules of configurations 1, 2, 3, 4 and 5 except for Table 7 of Article 16(3)(b) which shall be replaced by Table 9 of Article 20(3). Under the ENTSO-E RfG within Great Britain the Q/P_{Max} range for Configurations 1 and 6 shall be 0 (equivalent to Unity Power Factor at 1.0 p.u voltage) and for Configurations 2,3,4 within Great Britain the Q/P_{Max} range shall be 0.33 (equivalent to a Power Factor Range of 0.95 or 0.975 lead to 0.975 lag) at 1.0 p.u voltage. *(NOTE:- Figure 11 should be read in the context of Table 9 instead of Table 7)).*

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Reactive Power Control Modes (Article 20 (4))

Type C and D Offshore Power Park Modules

The Reactive Power Control Modes as defined in Article 16(3) (e) (ie Power Factor Control, Reactive Power Control or Voltage Control) shall apply to Offshore Power Park Modules of Configurations 1, 2, 3, 4 and 5. For Configuration 6 only the Voltage Control option shall apply.

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Type C and D Offshore Power Park Modules

The requirements defined in Article 9(4)(b) (ability of Generating units to be designed in a way that shaft torsional stress which may be excited by transient Active Power steps up to 50% of its maximum capacity are considered a routine part of normal operation and shall be taken into account when specifying the shaft characteristics) withstand torsional stress and the ability of generating units to withstand auto re-closure (including fast single phase auto re-closure) shall apply to Offshore Power Park Modules of configurations 1, 2 and 4.

Power Oscillation Damping Control (Article 21(3))

Type C and D Offshore Power Park Modules

The requirements as defined in Article 16(3)(f) (requirements for power oscillations damping control as specified by the TSO pursuant to Article 4(3)) shall apply to Offshore Power Park Modules of configurations 1, 2, 4 and 5.

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Fault Ride Through Capability (Article 21(4))

Type D Offshore Power Park Modules

The fault ride through requirements of Power Park Modules as defined as in Article 17(1)(a) (Fault Ride Through for Type D Power Park Modules) shall apply to any Offshore Power Park Module, irrespective of its configuration. (Note – This reference (Article 17(1)(a)) may require review as it only applies to Type D Offshore Power Park Modules)

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Type C and D Offshore Power Park Modules

In addition to the requirements applicable to Type B Offshore Power Park Modules, Type C and D Offshore Power Park Modules shall also be required to satisfy the requirements of Article 9(6)(b) (Protection schemes and Settings), Article 9(6)(c) Priority ranking of Protection and Control), Article 9(6)(d) (disconnection/tripping in the event of loss of stability), Article 9(6)(e) (Instrumentation, Dynamic System Monitoring, fault recording, Article 9(6)(f) (submission of simulation models including electromagnetic transient simulations), Article 9(6)(g) (requirements to install additional devices to preserve and restore system operation or security pursuant to the requirements of Article 4(3)), Article 9(6)(h) (maximum and minimum limits on rates of change of Active Power), Article 9(6)(i) (Earthing requirements for the neutral point of a step up transformer), Article 9(6)(j)(Power Quality requirements), Article 9(6)(k)(Requirements for modernised or replaced plant and equipment)

Synchronisation Requirements (Article 23(2))

Type C and D Offshore Power Park Modules

The synchronisation requirement as defined in Article 9(6)(a) (Synchronisation requirements) shall apply to Offshore Power Park Modules of Configurations 1,2,3, 4 and 5.