TABLE 1 – GB Grid Code Comparison to ENTSO-E RfG

(Comparison based on GB Grid Code Issue 5 Revision 11 only and ENSTO - E RFG Version dated 14 January 2014)

(Note – Does not include other Industry Codes)

Table 1 compares the ENTSO-E Network Code – Requirements for Generators (RfG) with the GB Grid Code. In other words each clause of the ENTSO-E RfG has been compared against the GB Grid Code. This table is deliberately light on detail to identify where the ENTSO-E RfG is possibly more onerous (grey highlighted text) or less onerous (blue highlighted text) than the GB Grid Code. All track change marks from the previous comparison table (Table 1) are in Red. Text in highlighted yellow indicates areas which are unclear with the ENTSO-E Code.

TABLE 1 – COMPARISION OF ENTSO-E RfG TO GB GRID CODE	
ENTSO-E – RfG	**GB Grid Code**
Requirements applicable to Type A Units - 800W – 1MW but equally applicable to Type A, B, C and D Units	
Article 8 – General Requirements - Type A Power Generating Modules	
Article 8 (1) (a - d) - Frequency range	Broadly c~~C~~onsistent with GB Grid Code – CC.6.1.3, CC.6.3.12 and CC.6.3.13 (CC.6.3.12 and CC.6.3.13 apply only to Large and Medium Power Stations.
Article 8 (~~2~~1) ~~(b)~~ – Rate of Change of Frequency	Rate of change of Frequency limits not specially covered in GB Grid Code although reference can be made in the Bilateral Agreement as specified in CC.6.3.12 - applies only to Large and Medium Generators). Text changes and parameters will need to be included in Grid Code and Distribution Code
Article 8 (~~3~~1) ~~(c)~~ – Limited Frequency Sensitive Mode – Over- frequency	Consistent with GB Code but only for BM Units (ie Generation operating in the wholesale Electricity Market) – BC.3.7.2. Text changes required in Grid Code and Distribution Code. Requirements and parameters to be included in Connection Conditions but would be expected to mirror those in BC3.7.2
Article 8 (~~4~~1) ~~(d)~~ – Maintenance of Active Power regardless of changes in System Frequency	Consistent with CC.6.3.9 and (CC.6.3.3 for frequencies between 49.5 Hz and 50.4 Hz. (Note CC.6.3.9 and CC.6.3.3 applies only to Large and Medium Power Stations).
Article 8 (~~5~~1) ~~(d)~~ – Active Power output not to fall more than prorata with frequency	Consistent with CC.6.3.3 for frequencies between 49.5Hz and 47 Hz (CC.6.3.3 applies only to Large and Medium Power Stations)- RFG parameters consistent with BC.3.7.2 of Code.
Article 8 (~~6~~1) ~~(d)~~ – Fitting of logic interface in order to cease Active Power output within less than 5 seconds	For Embedded Small Power Stations which are not BMU's – N/A. The BC's will apply to BMU's. –Distribution Code issues.
Article 8 (1) (g) – Conditions for automatic connection to the network including frequency range, Active Power gradient. Permitted only if determined by TSO. Erro r in text – the word "not" should be included between "is" and "allowed"in the first line of the last paragraph.	Not specified in GB Grid Code but subject to National Choice.
Article 9 – General Requirements - Type B Power Generating Modules	
Article 9 (1) – All Type B Power Generating Modules must meet the same requirements as Type A units in addition to the requirements below	
Article 9 (2) ~~(a)~~ – Generators to be fitting with an Interface port to be able to reduce Active Power upon instruction and for remote operation~~.~~	For Small Power Stations – N/A. For Large and Medium Power Stations more stringent requirements apply in GB Grid Code.
Article 9 (3) ~~(a)~~ – Fault Ride Through Additional Notes:- Tables 3.1 and 3.2 (Uret – time) – Is not clear and requires clarification	GB Grid Code requirements (CC.6.3.15) are slightly different ~~(see Table 2)~~. In summary, the differences from the GB Code as against the ENTSO-E RfG are:- i) Voltage profile is defined at the Connection Point whereas in GB, requirement applies only to Transmission System faults which occur at 200kV or above. ii) The ENTSO-E RfG stipulates a voltage range for both short duration and long duration faults. The TSO needs~~will be able~~ to define the parameters for the voltage profile requirements within a range of between 140ms and 250ms. ~~.~~ The minimum voltage at the Connection voltage will be in the

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TABLE 1 – COMPARISION OF ENTSO-E RfG TO GB GRID CODE	
ENTSO-E – RfG	**GB Grid Code**
	range of between 0.05 p,u and 0.3 p.u for Synchronous Plant and 0.05 – 0.15 for Power Park Modules. These requirements / parameters are defined in Table 3.1 (for Synchronous Power Generating Modules) and Table 3.2 (for Power Park Modules), thus the voltage against timeduration curve requirements between a Synchronous Generator will be different to that of an Asynchronous Generator. The voltage duration curve (ie the time for which a Generator must withstand low voltages (due to symmetrical faults) in GB is different to the voltage against time curveat stipulated in ENTSO-RfG but the revised ENTSO-E Code does provide for greater National choice than previous iterations of the ENTSO-E Code. . For longer duration faults, the voltage duration curve in GB is more onerous than the RfG Voltage against time curveEurope. Compliance issues have been experienced in GB which it is believed the ENTSO-E RfG will resolve. The ENTSO-E RfG implementation will give an opportunity to resolve GB Grid Code anomalies which has been fast tracked for Large Synchronous Plant through the GB Grid Code Fault Ride Through Working Group . An issue however still remains for the Fault Ride Through Requirements for Embedded Synchronous Plant. iii) The TSO (whilst respecting the provisions of article 4(3)) is required to define pre and post fault operating conditions (the details are covered in Table 2 on the Power Generating Module). iv) The Generator is required to design its protection settings not to jeopardise the fault ride through performance. v) Fault Ride Through Performance for Asymmetrical faults shall be defined by the TSO (whilst respecting the provisions of Article 4(3)). In GB CC.6.3.15.1 applies for short duration faults up to 140ms and includes both Symmetrical and Asymmetrical faults. CC.6.3.15.2 applies to longer duration faults and applies only to balanced faults. In general there are slight differences but the ENTSO-E RfG are considered to be slightly easier than the GB requirements.
Article 9 (4) (a) – Reconnection requirements following a Network Disturbance Additional Note:- Article 9 (4(a) – Poorly worded.	Applicable only to Power Stations for which NGET have a direct relationship – specified under the Grid Code Balancing Codes.
Article 9 (5) (a) – General System Management requirements – Control schemes and settings as agreed with the TSO, Network Operator and Power Generating Facility Owner if they concern the elements referred under Article 9 (5) (a) Point 1 – Schemes and Settings for different Control Devices for Transmission System Stability and to enable Emergency Conditions.–	Not believed to conflict with the GB Grid Code.
Article 9 (5) (b) (1) – Protection Schemes and Settings – Relevant Network Operator to define the Schemes and Settings to protect the Network taking into account the Characteristics of the Power Generating Module considering the characteristics of the Power Generating Module.	Consistent with GB Grid Code (CC.6.2.2) and Bilateral Agreement
Article 9 (5) (b) (2) – Electrical Protection of the Power Generating Module to take precedence over operational controls taking into account system security, health and safety and damage to the Power Generating Module	Not currently specified in GB Grid Code other than loose references in CC.6.3.13 relating to frequency excursions.
Article 9 (5) (b) (3) Protection Schemes available eg External and internal short circuits, asymmetric load (Negative Phase Sequence) stator and rotor overload, under / over excitation etc.	Consistent with GB Grid Code (CC.6.2.2) and Bilateral Agreement
Article 9 (5) (b) (4) – Changes to protection schemes and settings to be agreed with the TSO and Relevant Network Operator whilst respecting the provisions of Article 4(3)	Consistent with GB Grid Code and Bilateral Agreement. For Embedded and Small Power Stations the DNO would have an increasing responsibility.
Article 9(6)(c) – Priority ranking of protection and control	Not currently specified in GB Grid Code but not believed to be an issue
Article 9 (5) (d) Information Exchange – Power Generating facilities shall be capable of exchanging information between the Relevant Network Operator and / or the Relevant TSO in real time or periodically with time stamping whilst respecting the provisions of Article 4(3)..	Not believed to conflict with the GB Grid Code. Requirements for information exchange are covered in CC.6.5 Control Telephony, CC.6.5.6 Operational Metering, CC.6.5.78 – Instructor Facilities, CC.6.5.8 – Electronic Communications facilities, and CC.6.5.9 – Fax machines and the Bilateral Agreement. Note these requirements apply only to Large Power Power Stations. Some work will be required in relation to DNO connected Generation.

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TABLE 1 – COMPARISION OF ENTSO-E RfG TO GB GRID CODE	
ENTSO-E – RfG	**GB Grid Code**
Article 10 – General Requirements - Type C Power Generating Modules	
Article 10 (1) – All Type C Power Generating Modules must meet the same requirements as Type A and B units except Articles 8(1)(f) and Article 9(2)(a) in addition to the requirements below.	
Article 10(2) (a) – Active Power controllability and Control range	Consistent with GB Grid Code – CC.6.3.6(a), CC.6.3.7 and BC3.
Article 10(2)(a) (b) – Limited Frequency Sensitive Mode – Under Frequency	Not specified in GB Grid Code – ENTSO-E RfG requirement is over and above the requirement in the GB Grid Code. Requirements and Parameter settings to be defined.
Article 10(2)(c) – Frequency Sensitive Mode	Consistent with GB Grid Code – CC.6.3.7 and CC.A.3. Note:- The ENTSO-E RfG specifies a frequency response capacity (as a percentage of Registered Capacity of between 1.5 and 10%). The GB Grid Code specifies a minimum frequency response capability of 10% of Registered Capacity. ENTSO –E Code places obligations on maximum admissible delay time before an increase in Active Power output. This is defined as 2 seconds unless justified by the Power Generating facility ownerotherwise agreed by the TSO. For generation technologies without inertia the Relevant TSO may specify a shorter time than 2 seconds for which the Power Generating Facility Owner is required to provide technical evidence setting out why a longer time is needed for the initial activation of full Active Power Frequency Response. – Parameter settings required but considered to broadly fit into current GB Grid Code requirements. Some additional parameters required – eg Frequency Response Insensitivity and initial delay time.
Article 10(2)(d) – Frequency Restoration Control	Consistent with GB Grid Code CC.6.3.7.
Article 10 (2) (e) – Disconnection due to under frequency – any Power Generating Facilitiesy being capable of acting as a load except for auxiliary supply (including pumped storage hydro plant) shall be capable of disconnecting its load in case of underfrequency This requirement does not extend to auxiliary supply.	This is not currently specified in the GB Grid Code. There is no mandatory requirement for Demand Disconnection from Pumped Storage Demand to control system frequency. Currently only applicable to HVDC Converters and Pumped Storage or Demand Customers for whom NGET have a Commercial Contract OC.6.6 of the Grid Code places obligations on Non Embedded Customers (including Pumped Storage Plant) to provide automatic low frequency demand disconnection which will be split into discrete blocks. Specific under-frequency commercial contracts are also available with National Grid via separate negotiation.
Article 10(2)(f) – Real Time Monitoring of Frequency Sensitive Mode operation	Broadly consistent with GB Code – OC5.4.1(c) – Ancillary Services Monitoring. The GB Grid requirements for Ancillary Services Monitoring are generally vague and less specific on this issue with the detail being captured in the Bilateral Agreement and associated Technical Specifications. Some of the frequency response monitoring signals which are provided back to NGET are not currently provided (eg droop and deadband as specified in the ENTSO-E Code. There will be a need to update NGET's internal specifications and the RES. The TSO can specify additional signals if required..
Article10 (3) (a) – Voltage Stability – automatic disconnection at specified voltages if required by the Relevant Network Operator in co-ordination with the Relevant TSO. RfG is very poorly worded on this issue.	Does not contravene GB Grid Code.
Article 10 (4) (a3) - In the case of power oscillations Power Generating Modules shall retain steady state stability of a Power Generating Module is required when operating at any point of the P-Q Capability diagram. A Power Generating Module shall capable of staying connected to the Network and operating without power reduction as long as voltage and frequency remain within admissible limits.	Broadly consistent with GB Grid Code – fault ride through requirements CC.6.3.15.1 and CC.6.3.15.2
Article 10(4)(b) A Power Generating Module shall capable of staying connected to the Network and operating without power reduction as long as voltage and frequency remain within admissible limits.	Broadly consistent with GB Grid Code – CC.6.1.3, CC.6.1.4, CC.6.3.12, CC.6.3.13 CC.6.3.15.1 and CC.6.3.15.2
Article 10(4)(cb) – Single Phase or Three Phase Auto Re-closure on meshed lines to be withstood by Power Generating Modules without tripping.	Broadly consistent with GB Grid Code requirements CC.6.3.15 and CC.6.3.10
Article 10 (5) (a) – Black Start	Consistent with GB Grid Code – CC.6.3.5 and specified by National Grid under the Bilateral Agreement. Note RfG is mouch more specific on the Black Start requirements than GB but the same requitrements are broadly covered in a Black Start Contract. There is an issue as to whether such requirements should be included within the Grid Code as well as the Black Start Contract.
Article 10 (5) (b) – Island Operation	Consistent with GB Grid Code – CC.6.3.7(c)(i). The ENTSO-E Code states "Detection of the change from interconnected system operation shall not rely solely on the Network Operators switchgear position signals. The detection method shall be agreed between the Power Generating Facility Owner, Relevant Network

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ENTSO-E – RfG	**GB Grid Code**
	Operator and TSO whilst respecting the provisions of Article 4(3) .
Article 10(5) (c) (1) – Quick Re-synchronisation capability – as agreed with TSO, Relevant Network Operator and Power Generating Facility Owner.	Consistent with GB Grid Code but would also be linked to the Black Start Contract.
Article 10(5) (c) (2) and (3) – The Power Generating Module with awhose minimum re-synchronisation time after its disconnection from an external power supply exceedsgreater than 15 minutes shall be designed tofor trippping to house load from any operating point in the P Q Capability Diagram. In this case the identification of houseload operation shall not be based solely on the Network Operators switchgear position signals.	Not currently specified in GB Grid Code. For island operation the requirements are covered in CC.6.3.7(c)(i) but this dose not explicitly include house load operation.
Article 10 (5)(c)(3) – Power Generating Modules shall be capable of continuing operation following tripping to house load, irrespective of any auxiliary connection to the external network. The minimum operation time shall be decided by the Relevant Network Operator in coordination with the Relevant TSO taking into consideration the specific characteristics of the prime mover technology	Trip to house load is not currently specified in the GB Grid Code although reference is made to Islanding under CC.6.3.7(c) (i).
Article 10(6)(a) – Loss of Angular Stability or loss of control of a Power Generating Module.	Consistent with Grid Code (CC.6.2.2.3.4 – Pole Slipping Protection) and Bilateral Agreement
Article 10(6)(b) – Instrumentation and monitoring – Fault Recording, Dynamic System Monitoring, Quality of Supply	Consistent with GB Grid Code (CC.6.1.5 - Quality of Supply and CC.6.6 – System Monitoring) and Bilateral Agreement, although there may be a need to re-check policies / procedures and the requirements of the Relevant Electrical Standards.
Article 10(6)(c) – Simulation Models including verification against compliance tests. The Power Generating Facility Owner shall provide Power Generating Module Recordings to the Relevant Network Operator or TSO if requested subject to the provisions of Article 4(3)	Consistent with GB Grid Code (Planning Code -)Compliance Processes and OC5). Note the GB Grid Code does not at present require Generating Units to provide electromagnetic transient simulations but note these are at the request of the TSO and whilst respecting the provisions of Article 4(3). The Relevant Network Operator is required to provide to the Power Generating Facility Owner an estimate of the minimum and maximum short circuit capacity at the Connection Point. In GB such information would be provided to Generators upon request.
Article 10(6)(d) – Installation of devices for system operation and/or security as specified by the Relevant Network Operator or Relevant TSO whilst respecting the provisions of Article 4(3).	Consistent with GB Grid Code
Article 10(6)(e) – Minimum and maximum limits on rates of change of Active Power	Consistent with GB Grid Code BC1.A.1.1 but only for BMU's – does not extedn to Smaller Units.
Article 10(6)(f) – Neutral earthing arrangements at the Network side of step up transformers	Consistent with GB Grid Code – CC.6.3.11
Article 10(6)(gk)(h) – Modernisation / replacement of Generating Plant and Equipment	Covered under CUSC and Grid Code Modification process
Article 11 – General Requirements - Type D Power Generating Modules	
Article 11 (1) – All Type D Power Generating Modules must meet the same requirements as Type A, B and C units except Articles 8(1)(f) (g), Article 9(2)(a) and Article 10(3)(a).	
Article 11(2)(a)(1) – Voltage ranges from 110kV to 300kV and 300kV to 400kV	Consistent with GB Grid Code (CC.6.1.4) except CC.6.1.4 requires a voltage range of ±10% at 132kV and ±6% at voltages below 132kV. RfG requires ±10% between 132kV and 110kV.
Article 11 (2)(b)a)(2) – Wider Voltage ranges of longer minimum operating times can be agreed with the Relevant TSO, Relevant Network Operator and Power Generating Facility Owner whilst respecting the provisions of Article 4(3).	Consistent with GB Grid Code (CC.6.1.4)
Article 11 (2)(ca)(3) – Relevant Network Operator, Relevant TSO and Power Generating Facility can agree voltages at the Connection Point at which a Power Generating Module shall be capable of automatic disconnection whilst respecting the provisions of Article 4(3).	Consistent with GB Grid Code (CC.6.1.4 and CC.6.3.15.3(iv))
Article 11 (3) – Fault Ride Through – NOTE – Revised wording is not clear particularly Article 11 (3) (a). There is no reference to Transmission Network or Distribution Network. Confusion between Article 9 (3) and Article 11(3). Tables 7.1 and 7.2 t_{clear} is also unclear.	The fault ride through requirements for Type D Power Generating Modules are the same as the fault ride through requirements for Type B Power Generating Modules with the following differences. i) The voltage profile withstand capability curve is the same as that for Type B Power Generating Modules except the parameters are defined in Tables 7.1 (Synchronous Power Generating Modules) and 7.2 (Power Park Modules). ii) For all Power Generating Modules (Synchronous and Asynchronous) the retained voltage for which the Generator must remain connected is 0 Volts for a period of between 140ms – 150ms (or 250ms if system protection and operational security require).

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ENTSO-E – RfG	**GB Grid Code**
	iii) There is greater National choice for selecting the fault ride through parameters of the voltage duration curve and if anything these are believed to be more flexible than previous versions of the ENTSO-E Code. If anything the requirements for Synchronous Plant are less onerous than the current GB Grid Code requirements. – Parameter selection and interpretation being addressed through GB Grid Code Fault Ride Through Working Group in respect of large directly connected Synchronous Generators.
Article 11 (4) – General System Management requirements – Synchronisation requirements	Consistent with Grid Code – Bilateral Agreement and Relevant Electrical Standards but consisntency checking required.
Article 12 – Requirements for Type B Synchronous Power Generating Modules	
Article 12 (1) – All Type B Power Synchronous Power Generating Modules must meet the same requirements as Type A and Type B Power Generating Modules as defined in Articles 8 and 9 in addition to the requirements below.	
Article 12(2) Voltage stability – Reactive Power Capability (Article 12 (2) (a) and Excitation System requirements (Article 12 (2) (b).	Consistent with GB Grid Code (CC.6.3.2 and CC.6.3.8). For Small Power Stations N/A.
Article 12 (3) – Active power recovery (magnitude and time) following fault ride through defined by Relevant TSO while respecting the provisions of Article 4(3)).	RfG Code requires TSO to specify Active Power Recovery characteristics. Current GB Grid Code ~~is more onerous for Active Power Recovery than ENTSOE- Code~~ (CC.6.3.15) requires active power recovery within 0.5 seconds for faults up to 140ms and 1 second for faults in excess of 140ms.
Article 13 – Requirements for Type C Synchronous Power Generating Modules	
Article 13(1) – All Type C Synchronous Power Generating Modules must meet the requirements of Type A, B and C Power Generating Modules listed in Articles , 8, 9, 10 and 12 as well as the specific type C Synchronous Power Generating Module requirements listed in Article 13, except Article 8 (1) (f), Article 9 (2) (a) and Article 12 (2) (a).	
Article 13 (2) (a) – Where the Connection Point is not at the location of the high voltage terminals of the step up transformer to the voltage level at the connection point or at the Alternator terminals (if no step-up transformer exists) supplementary Reactive Power may be defined by the Relevant Network Operator to compensate for the Reactive Power Demand of the high voltage line or cable while respecting the provisions of Article 4(3).	Not currently specified in the GB Code but noted that the requirement is subject to National choice. ~~As a general point CC.8 of the Grid Code states "Reactive Power supplied (in accordance with CC.6.3.2) otherwise than by means of synchronous or static compensators (except in the case of a Power Park Module where synchronous or static compensators within the Power Park Module may be used to provide Reactive Power).~~
Article 13 (3) – Reactive Power Capability	ENTSO-E RfG is broadly consistent with GB Grid Code but is specified in a ~~slightly~~ different way ~~as detailed in table 2 below~~. The principle differences are as follows:- i) TSO to define a U/Q profile (Voltage / Reactive Power profile), Figure 7 - which is not replicated in the GB Code. ii) Under the ENTSO-E RfG the maximum Q/Pmax range specified for GB is 0.95 at the HV terminals of the Generator Transformer. This equates to a Power Factor range of approximately 0.9 Power Factor Lead to 0.9 Power Factor lag at the HV terminals of the Generator Transformer. The ENTSO-E RfG does not provide any distinction between lead and lag – ie the mid point. Under the GB Grid Code the requirement is for a Power Factor of 0.85 Power Lag to 0.95 Power Factor Lead at the Generating Unit terminals. iii) These requirements apply at a steady state voltage of 0.1p.u. (ie 10%) as specified in Table 7~~8~~. iv) The Reactive Power provision capability applies at the Connection Point. For profile shapes other than rectangular, the voltage range represents the highest and lowest values. The full Reactive Power Range is therefore not expected to be available across the range of steady state Voltages.
Article 14 – Requirements for Type D Synchronous Power Generating Modules – Error in title Type C should be Type D.	

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TABLE 1 – COMPARISION OF ENTSO-E RfG TO GB GRID CODE	
ENTSO-E – RfG	**GB Grid Code**
Article 14(1) – All Type D Synchronous Power Generating Modules must meet the general requirements listed in Articles , 8, 9, 10, 11, 12 and 13 except for Article 8(1) (f), Article 9 (2)(a), Article 10 (3) (a) and Article 12 (2) in addition to the requirements listed below.	
Article 14(2) ~~(a)~~ – AVR and Excitation System Performance requirements including Power System Stabilisers, limiting functions, settings, bandwidth and performance to be agreed by the Relevant TSO whilst respecting the provisions of Article 4(3).	Consistent with GB Grid Code (CC.6.3.8 and CC.A.6)
Article 14 (3) – Technical capabilities to aid angular stability under fault conditions ~~(eg fast valving or breaking resistors) shall be allowed or requested by the R~~to be agreed by the Relevant TSO~~, whilst respecting the provisions of Article 4(3)~~.	Consistent with GB Grid Code (CC.6.3.8(a)(v).
Article 15 – Requirements for Type B Power Park Modules	
Article 15 (1) – All Type B Power Park Modules must meet the general requirements listed in Articles 8 and 9 as well as the specific requirements listed in Article 15 below.	
Article 15 (2) (a) The Relevant Network Operator shall have the right to require the capability of a Power Park Module to provide Reactive Power whilst respecting the provisions of Article 4(3).	Consistent with GB Grid Code for Large and Medium Power Stations. For Small Power Stations N/A.
Article 15(2) (b) – The Relevant Network Operator in coordination with the Relevant TSO shall have the right whilst respecting the provisions of Article 4(3) ~~can specify the requirements for additional~~the capability of a Power Park Module to provide F~~f~~ast Fault ~~Reactive~~ current ~~injection~~ at the Connection Point ~~to the pre-fault reactive current injection for balanced faults whilst respecting the provisions of Article 4(3)~~in the case of symmetrical (3-phase) faults.	The GB Grid Code is not detailed on this issue other than under CC.6.3.15 (fault ride through). The GB Grid Code states (within clause CC.6.3.15) that a Generating Unit or Power Park Module should inject maximum reactive current without exceeding the Transient Rating of the Generating Unit or Power Park Module. The ENTSO-E RfG is very differe~~nt on these requirements and much more specific In summary the ENTSO-E codes states~~ ~~i) Power Park Modules~~ Fast Fault Current at the Connection Point in case of symmetrical (3-phase) faults~~ should be capable of achieving the additional reactive current injection by either~~ (1) Ensuring the supply of the Fast Fault Current at the Connection Point or:- (2) By measuring Voltage deviations at the terminals of the individual units of the Power Park Module and providing a Fast Fault Current at the terminals of these units. ~~a) Ensuring the magnitude of the supply of additional reactive current at the Connection Point is dependant upon the voltage at the Connection Point as specified by the Relevant Network Operator in co-ordination with the Relevant TSO whilst respecting the provisions of Article 4(3).~~ ~~b) Alternatively by measuring the voltage deviations at the terminals of the individual units of the Power Park Module and providing additional reactive current at the terminals of these units depending on the deviation of the voltage that the Power Park Modules terminals as specified by the Relevant Network Operator and Relevant TSO.~~ The Relevant Networl Operator in coordination with the Relevant TSO shall while respecting the provisions of Article 4(3) specify How and when a Voltage deviation is to be determined as well as the end of the voltage deviation The characteristics of Fast Fault Current which may include several stages. ~~ii) The Power Park Module or the individual units of the Power Park Module (depending which option is selected above) shall be capable of providing at least 2/3 of the additional reactive current within a time period specified by the Relevant TSO which shall be less than 10ms. The target value of the additional reactive current shall be reached with an accuracy of 10% within 60ms from the moment the voltage deviation has~~

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ENTSO-E – RfG	**GB Grid Code**
	occurred. iii) The total reactive current contribution shall be not more than 1 p.u of the short term dynamic current rating (covering up to 0.4 seconds) of the Power Park Module (option (a) above) or the individual units within the Power Park Module (option (b) above) taking into account the pre fault reactive current. If additional real current is given priority over additional reactive current injection, the total current contribution can be further limited by the real current based on limiting the apparent current (vector addition of real and reactive current) to 1 p.u of the of the short term dynamic current rating of the Power Park Module (option (a) above) or individual Power Park Units (option (b) above). iv) With regard to the supply of Fast Fault Current in the case of asymmetrical faults, the relevant Network Operator in co-ordination with the and TSO shall have the right to introduce while respecting the provisions of Article 4(3) a requirement for asymmetrical current injection. specify the additional reactive current injection required whilst respecting the provisions of Article 4(3)).
Article 15(3) – Active Power recovery following Fault Ride Through specified by the Relevant TSO whilst respecting the provisions of Article 4(3)	Consistent with CC.6.3.15 of the Grid Code but note only applies to Large and Medium Power Stations. For Small Power Stations N/A. Note RfG is much more prescriptive than GB Code. In summary the additional requirements include:- (a) The Relevant TSO shall specifiy the post fault Active Power recovery the Power Park Module shall be capable of providing while respecting the provisions of Article 4(3). In this regard the Relevant TSO shall specify (1) When the post –fault Active Power recovery begins based on a Voltage criterion. (2) A maximum allowed time for Active Power recovery and (3) A magnitude and accuracy for Active Power recovery (b) The specifications shall be in accordance to the following principles:- (1) Priority between Fast Fault Current requirements according to Article 15 (2)(b) and)(c) and Active Power Recovery (2) Dependance between Active Power recovery tiems and duration of voltage deviations (3) A defined limit of the maximum allowed time for Active Power recovery (4) Adequacy between the level of voltage recovery and the minimum magnitude for Active Power recovery (5) Adequate damping of Active Power oscillations. Significant work and assessment is required in this area.
Article 16 – Requirements for Type C Power Park Modules	
Article 16 (1) – All Type C Power Park Modules must meet the general requirements listed in Articles 8, 9, 10 and 15 except for Article 8 (1)(f), Article 9 (2) (a) and Article 15 (2) (a) unless otherwise referred to otherwise in Article 16(3) (d) points (3) And (4) as well as the specific requirements for Type C Power Park Modules listed below.	
Article 16 (2) – Synthetic Inertia – specified by TSO whilst respecting the provisions of Article 4(3)	Not currently specified in GB Grid Code but the Frequency Response Working Group are investigating these issues. The ENTSO-E Code is not prescriptive on the method in which additional active power is supplied to the network following a frequency fall but the method, principle and settings shall be defined by the TSO.
Article 16 (3) – Reactive Power Capability where the Connection Point is not at the high voltage terminals of the high voltage line, or cable to the Connection Point at the Power Park Module if no step up transformer exists. Supplementary reactive power may be required by the TSO whilst	Not currently specified in the GB Code but noted that the requirement is subject to National choice

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TABLE 1 – COMPARISION OF ENTSO-E RfG TO GB GRID CODE	
ENTSO-E – RfG	**GB Grid Code**
respecting the provisions of Article 4(3) to compensate for the Reactive Power Demand of the high voltage line or cable between these points.	
Article 16(3) (b) – Reactive Power capability at maximum capacity	ENTSO-E RfG is ~~fully~~ consistent with the GB Grid Code (CC.6.3.2(c)) but is specified in a slightly different way as detailed in table 2. The principle differences are as follows:- i) TSO to define a U-/Q/Pmax profile (Voltage / Reactive Power profile), Figure 8 - which is not replicated ~~—~~ in the GB Code. ii) Under the ENTSO-E RfG the ~~maximum~~maximum U- Q/Pmax range specified for GB is 0.66 at the Connection ~~—~~ Point. This equates to a Power Factor range of 0.95 Power Factor Lead to 0.95 Power Factor ~~———~~ lag)(ie the same as the GB Code). The ENTSO-E RfG does not provide any distinction between lead and lag but simply provides a range. These requirements apply at a steady state voltage range of 0.1 p.u (ie 10%) The requirements specified by the TSO shall respect the provisions of Article 4(3).
Article 16(3) (c) – Reactive Power capability below maximum capacity specified by the TSO in coordination with the Relevant Network Operator whilst respecting the provisions of Article 4(3).	Consistent with GB Grid Code (CC.6.3.2(c)). In the GB the requirement of Figure 1 of CC.6.3.2(c)) does have a reduction in reactive capability when operating in the leading mode of operation (below 50%) MW output and the reactive capability requirement is further reduced when the plant is operating below 20% of Registered Capacity. The ENTSO-E RfG does not capture this current GB requirement. i) The ENTSO-E codes states that P – Q/Pmax profile shall not exceed the P-Q/Pmax profile represented by the inner envelope of Figure 9 (between 0.92 PF to 0.83 PF Lag) and (0.94 PF to 0.89 PF lead). In Great Britain the Q/Pmax Range is defined as 0.66 which equates to 0.95 PF lead to 0.95 PF lag but it is not clear how this fits within the defined envelope. ii) The Active Power range of the PQ-Q/Pmax profile at zero reactive power shall be 1 p.u. iii) The P – Q/Pmax profile can be of any shape and shall include conditions for Reactive Power Capability at zero Active Power iv) The TSO shall specify the position of the P-Q/P profile envelope within the limits of the fixed outer envelope in Figure 9. v) The Power Park Module shall be capable of moving to any operating point within its P-Q/Pmax profile in appropriate timescales to target values requested by the Relevant Network Operator.
Article 16(3)(d) – Reactive Power Control Modes – ie Voltage Control, Reactive Power Control or Power Factor Control	Consistent with GB Grid Code (CC.6.3.8, CC.A.7 and CC.6.3.2). Note the GB requirements for transient voltage control are beyond those stipulated in the ENTSO-E code, in particular the settling time which in GB is defined as 2 seconds where as ENTSO-E defines a range of between 5 – 60 seconds. The Relevant Network Operator will specify the requirements for Power Factor Control in steps no greater than 0.01 which is not covered in the GB Code but it should be noted that the TSO and Relevant Network Operator will specify which control mode is required be it voltage control, reactive Power Control or Power Factor Control whilst respecting the provisions of Article 4(3).
Article 16(3)(e) – Priority of Reactive Power or Active Power specified by TSO whilst respecting the provisions of Article 4(3)	Consistent with GB Grid Code (CC.6.3.15) but not explicitly specified. – Further analysis and parameter setting will be required in is area.
Article 16 (3) (f) – Power Oscillation Damping Control specified by TSO if required whilst respecting the provisions of Article 4(3). The voltage and reactive power control characteristics of Power Park Modules shall not adversely affect the damping of Power Oscillations.	Consistent with GB Grid Code (CC.A.7.2.4) the specific requirements for Power Oscillation Damping being specified in the Bilateral Agreement.
Article 17 – Requirements for Type D Power Park Modules	
Article 17 – All Type D Power Park Modules must meet the general requirements listed in Articles 8, 9, 10, 11, 15 and 16 except Article 8(1)(f), Article 9(2) (a), Article 10(3)(a) and Article 15(2)(a).	
Requirements for Offshore Power Park Modules – ~~Articles 18 – 23~~	~~Table 3 details the GB and ENTSO-E RfG differences between Offshore Power Park Modules. This comparison has been completed on the basis of comparing the ENTSO-E RfG with the GB Code such that no elements of the ENTSO-E RfG have been omitted. The reader is therefore referred to Table 3 to compare the differences between the Offshore GB Code and Offshore ENTSO-E RfG.~~

TABLE 1 – COMPARISION OF ENTSO-E RfG TO GB GRID CODE	
ENTSO-E – RfG	**GB Grid Code**
Article 18 – General Provisions RfG Only applies to Offshore AC Connected Power Park Modules. Two configurations are defined – Configuration 1 (AC radial connections) and Configuration 2 (Meshed AC Connections). For HVDC Connected Power Park Modules the requirements are defined in the HVDC Network Code.	In GB the Offshore requirements are defined within the overall Generator Connection Conditions. It should be noted that there are significant differences in structure between the RfG and GB Grid Code.
Article 19 – Frequency Stability requirements applicable to Offshore Power Park Modules	As per RfG Onshore Requirements. See above but believed to be consistent with GB Grid Code.
Article 20 – Voltage stability requirements applicable to Offshore Power Park Modules	
Article 20 (1) – Voltage Range	Consistent with GB Grid Code for voltages of 132kV and above. Is not consistent with GB Grid Code for voltages below 132kV where a tolerance of ±6% is required.
Article 20 (2) – Voltage Stability	As per RfG Onshore requirements. See above for differences with GB Code
Article 20 (3) – Reactive Power Capability at Maximum Capacity	For Configuraiton 1 – as per GB Grid Code. For Configuration 2 this is a new requirement. Note the GB Grid Code requirement do not cater for fully meshed interconnected Offshore Networks.
Article 21 – Robustness of Power Generating Modules	
Article 21(1) - as per Article 10(4) (a) and (b) (power oscillations, power reduction under normal frequency and voltage limits and auto-reclosures). Article 15(3) – Active Power Recovery and Fast Fault Current Injection . Should Article 15(2) not be included?	As per Onshore requirements.
Article 21(2) – Fault Ride Requirements for Offshore Power Park Modules – Articles 9(3) (a) and Articles 11(3)(a) apply to Offshore Power Park Modules	As per Onshore requirements
Article 22 – System restoration requirements applicable to Offshore Power Park Modules – Articles 9(4) and 10(5) apply to Offshore Power Park Modules	As per Onshore requirements
Article 23 – General System Management requirements applicable to Offshore Power Park Modules – Articles 9(5), 10(6) and 11(4) apply to Offshore Power Park Modules	As per Onshore requirements
Operational Notification Procedure – Article 24 - 51	Consistent with GB Grid Code, (CP's, OC5 and CC.6.6). ~~The GB Grid Code does not currently specify a compliance requirement. At the present time the compliance requirements are currently specified in two guidance notes (Guidance Notes for Synchronous Generators, Issue 11, September 2008 and Guidance Notes for Power Park Developers, Issue 2, September 2008). A Consultation has been held on the proposed Compliance Requirements for inclusion in the Grid Code which is currently with Ofgem (the Regulator) for final approval.~~

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