MEMORANDUM

TO	Participants Expert Meeting	**DATE**	April 20, 2015
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		FROM	Saskia Jaarsma

SUBJECT Abstract RfG for Offshore PPM, dated 10 April 2015

REPORT	☐
INFORMATION	■

As discussed during the Expert Meeting of 16 April 2015, this document is provided by TenneT to stakeholders for the sole purpose of information.

It concerns an informal abstract of the provisions from the draft European Network Code Requirements for Generators dated 10 April 2015, which are intended to be applicable for offshore power park modules.

COMMISSION REGULATION (EU) …/…

of XXX

establishing a network code on requirements for grid connection of generators

(Text with EEA relevance)

THE EUROPEAN COMMISSION,

Having regard to Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003[1], and in particular Article 6(11) thereof,

Whereas:

(1) The swift completion of a fully functioning and interconnected internal energy market is crucial to maintaining security of energy supply, increasing competitiveness and ensuring that all consumers can purchase energy at affordable prices.

(2) Regulation (EC) No 714/2009 sets out non-discriminatory rules governing access to the network for cross-border exchanges in electricity with a view to ensuring the proper functioning of the internal market in electricity, and Article 5 of Directive 2009/73/EC of the European Parliament and of the Council[2] requires that Member States or, where Member States have so provided, regulatory authorities ensure, inter alia, that objective and non-discriminatory technical rules are developed which establish minimum technical design and operational requirements for the connection to the system. In order to provide system security within the interconnected transmission system, it is essential to establish a common understanding of the requirements applicable to power generating modules. Those requirements that contribute to maintaining, preserving and restoring system security in order to facilitate proper functioning of the internal electricity market within and between synchronous areas, and to achieve cost efficiencies, should be regarded as cross-border network issues and market integration issues.

(3) Harmonised rules on grid connection for power generating modules should be set out in order to provide a clear legal framework for grid connections, facilitate Union-wide trade in electricity, ensure system security, facilitate the integration of renewable electricity sources, allow more efficient use of the network and resources, and increase competition, for the benefit of consumers.

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1 OJ L 211, 14.8.2009, p. 15.

2 Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC (OJ L 211, 14.08.2009, p. 55).

(4) System security depends partly on the technical capabilities of power generating modules, therefore regular coordination at the level of generation and adequate performance of equipment connected to the networks with sufficient robustness to cope with disturbances and to help to prevent any major disruption or to facilitate restoration of the system after a collapse are fundamental prerequisites for system security.

(5) Secure system operation is only possible if there is close cooperation between power generating facility owners and system operators. In particular, the functioning of the system under abnormal operating conditions depends on the response of power generating modules to deviations from nominal values of voltage and frequency. In the context of system security, the networks and the power generating modules should be considered as one entity from a system engineering point of view, given that both parts of the system are interdependent. Therefore, concerning system security and as a prerequisite for grid connection relevant technical requirements should be set for power generating modules.

(6) Regulatory authorities should consider the reasonable costs effectively incurred by system operators in the implementation of this Regulation when fixing or approving transmission or distribution tariffs or their methodologies or when approving the terms and conditions for connection and access to national networks in accordance with Article 37(1) and (6) of Directive 2009/72/EC and with Article 14 of Regulation (EC) No 714/2009.

(7) Different synchronous electricity systems in the Union have different characteristics which need to be taken into account when setting the requirements for generators. It is therefore appropriate to consider regional specificities when establishing network connection rules as required by Article 8(6) of Regulation (EC) No 714/2009.

(8) In view of the need to provide regulatory certainty, the requirements of this Regulation should apply to new generating facilities but should not apply to existing generating facilities and generating facilities already at an advanced stage of planning but not yet completed unless the relevant regulatory authority or Member State decides otherwise.

(9) The significance of power generating modules should be based on their size and their effect on the overall system. Synchronous machines should be classed on the machine size and include all the components of a generating installation that normally run indivisibly, such as separate alternators driven by the separate gas and steam turbines of a single combined cycle gas turbines installation. For a facility including several such combined cycle gas turbines installations, each should be assessed on its size, and not on the whole capacity of the facility. Asynchronous machines, where they are collected together to form an economic unit should be assessed on their aggregated rating.

(10) In view of the different voltage level at which generators are connected and their maximum generating capacity, this Regulation should make a distinction between different types of generators by establishing different levels of requirements. This Regulation does not set the rules to determine the voltage level of the connection point to which the power generating module shall be connected.

(11) The requirements applicable to type A power generating modules should be of a basic level necessary to ensure capability of generation over operational ranges with limited automated response and minimal system operator control of generation. They should ensure that there

is no large-scale loss of generation over system operational ranges, thereby minimising critical events, and include requirements necessary for widespread intervention during system-critical events.

(12) The requirements applicable to type B power generating modules should provide for a wider range of automated dynamic response with greater resilience to more specific operational events in order to ensure the use of this more dynamic response and a higher level of system operator control and information to utilise those capabilities. They ensure an automated response to mitigate the impact of, and maximise dynamic generation response to, system events.

(13) The requirements applicable to type C power generating modules should provide for a refined, stable and highly controllable real-time dynamic response aiming to provide principle ancillary services to ensure security of supply. Those requirements should cover all system states with consequential detailed specification of interactions of requirements, functions, control and information to utilise those capabilities and ensure the real time system response necessary to avoid, manage and respond to system events. Those requirements should also provide sufficient generation functionality to respond to both intact and system disturbed situations, and should provide the information and control necessary to utilise generation in different situations.

(14) The requirements applicable to type D power generating modules should be specific to higher voltage connected generation with an impact on control and operation of the entire system They should ensure stable operation of the interconnected system, allowing the use of ancillary services from generation Europe-wide.

(15) The requirements should be based on the principles of non-discrimination and transparency as well as on the principle of optimisation between the highest overall efficiency and lowest total cost for all involved parties. Therefore those requirements should reflect the differences in the treatment of generation technologies with different inherent characteristics, and avoid unnecessary investments in some geographical areas in order to take into account their respective regional specificities. Transmission system operators ('TSOs') and distribution system operators ('DSOs') including closed distribution system operators ('CDSOs') can take those differences into account when defining the requirements in accordance with the provisions of this Regulation.

(16) Due to its cross-border impact, this Regulation should aim at the same frequency for all voltage levels, at least across a synchronous area. That is necessary because, within a synchronous area, a change in frequency in one Member State would immediately impact frequency and potentially damage equipment in all other Member States.

(17) To ensure system security, it should be possible for power generating modules in each synchronous area of the interconnected system to remain connected to the system for specified ranges.

(18) This Regulation should provide for ranges of parameters for national choices for fault-ride-through capability to maintain a proportionate approach reflecting varying system needs such as the level of renewable energy sources ('RES') and existing network protection schemes, both transmission and distribution. In view of the configuration of some networks,

the upper limit for fault-ride-through requirements should be 250 milliseconds. However, given that the most common fault clearing time in Europe is currently 150 milliseconds it leaves scope for regulatory authorities to verify that a longer requirement is necessary before approving it.

(19) When defining the pre-fault and post-fault conditions for the fault-ride-through capability, taking into account system characteristics such as network topology and generation mix, the relevant TSO should decide whether priority is given to pre-fault operating conditions of power generating modules or to longer fault clearance times.

(20) Ensuring appropriate reconnection after an incidental disconnection due to a network disturbance is important to the functioning of the interconnected system. Proper network protection is essential for maintaining system stability and security, particularly in case of disturbances to the system. Protection schemes can prevent aggravation of disturbances and limit their consequences.

(21) Adequate information exchange between system operators and power generating module operators is a prerequisite for enabling system operators to maintain system stability and security. System operators need to have a continuous overview of the state of the system, which includes information on the operating conditions of power generating modules, as well as the possibility to communicate with them in order to direct operational instructions.

(22) In emergency situations which could endanger system stability and security, system operators should have the possibility to instruct that the output of power generating modules be able to meet their responsibilities for system security.

(23) Voltage ranges should be coordinated between interconnected systems because voltage ranges are crucial to secure planning and operation of a power system within a synchronous area. Disconnections because of voltage disturbances have an impact on neighbouring systems. Failure to define voltage ranges could lead to widespread uncertainty in planning and operation of the system with respect to operation beyond normal operating conditions.

(24) The reactive power capability needs depend on several factors including the degree of network meshing and the ratio of in-feed and consumption, which should be taken into account when establishing reactive power requirements. When regional system characteristics vary within the area of responsibility of a system operator, more than one profile could be appropriate. Reactive power production, known as lagging, at high voltages and reactive power consumption, known as leading, at low voltages might not be necessary. Reactive power requirements could put constraints on power generation design and operation. Therefore it is important that the capabilities actually required for efficient system operation be thoroughly assessed.

(25) Synchronous power generating modules have an inherent capability to resist or slow down frequency changes, a characteristic which many RES technologies do not have. Therefore countermeasures should be adopted, to avoid a larger rate of change of frequency during high RES production. Synthetic inertia could facilitate further expansion of RES, which does not naturally contribute to inertia.

(26) Appropriate compliance testing should be required by this Regulation so that system operators can ensure operational security.

(27) A framework for derogations from the rules should be set out in this Regulation to take into account local circumstances. Those derogations could relate to exceptional instances where compliance with those rules could jeopardise the stability of the local network or where the safe operation of a power generating module might require operating conditions that are not in line with the Regulation. In the case of particular combined heat and power plants, which bring wider efficiency benefits, applying the rules set out in this Regulation could result in disproportionate costs and lead to the loss of those efficiency benefits.

(28) Subject to approval by the relevant regulatory authority, system operators should be allowed to propose derogations for certain classes of power generating modules.

(29) This Regulation has been adopted on the basis of Regulation (EC) No 714/2009 which it supplements and of which it forms an integral part. References to Regulation (EC) No 714/2009 in other legal acts should be understood as also referring to this Regulation.

(30) The measures provided for in this Regulation are in accordance with the opinion of the Committee referred to in Article 23(1) of Regulation (EC) No 714/2009

HAS ADOPTED THIS REGULATION:

TITLE I

GENERAL PROVISIONS

Article 1
Subject matter

This Regulation establishes a network code which lays down the requirements for grid connection of power generating facilities, including synchronous power generating modules, power park modules and offshore power park modules, to the interconnected system. It, therefore, helps to ensure fair conditions of competition in the internal electricity market, to ensure system security and the integration of renewable electricity sources, and to facilitate Union-wide trade in electricity.

It also lays down the obligations for ensuring that system operators make appropriate use of the power generating facilities' capabilities in a transparent and non-discriminatory manner to provide a level playing field throughout the Union.

Article 2
Definitions

For the purposes of this Regulation, the definitions in Article 2 of Regulation (EC) No 714/2009, Article 2 of Commission Regulation No [000/2014 – CACM], Article 2 of Commission Regulation (EU) No 543/2013[3] and Article 2 of Directive 2009/72/EC shall apply.

In addition, the following definitions shall apply:

1. 'synchronous area' means an area covered by interconnected TSOs with a synchronously connected and, therefore, common system frequency in a steady state, such as the synchronous areas of Continental Europe ('CE'), Great Britain ('GB'), Ireland ('IRE') and Northern Europe ('NE') and the power systems of Lithuania, Latvia and Estonia, together referred to as 'Baltic' which are part of a wider synchronous area;
2. 'voltage' means the difference in electrical potential between two points measured as the root-mean-square value of the positive sequence phase-to-phase voltages at fundamental frequency;
3. 'apparent power' means the product of voltage and current at fundamental frequency, and the square root of three in the case of three-phase systems, usually expressed in kilovolt-amperes ('kVA') or megavolt-amperes ('MVA');
4. 'power generating module' means either a synchronous power generating module or a power park module;
5. 'power generating facility' means a facility that converts primary energy into electrical energy and which consists of one or more power generating modules connected to a network at one or more connection points;

[3] Commission Regulation (EU) No 543/2013 of 14 June 2013 on submission and publication of data in electricity markets and amending Annex I to Regulation (EC) No 714/2009 of the European Parliament and of the Council (OJ L 163, 15.6.2013, p. 1).

6. ‘power generating facility owner’ means a natural or legal entity owning a power generating facility;

7. ‘synchronous power generating module’ means an indivisible set of installations which can generate electrical energy such that the frequency of the generated voltage, the generator speed and the network voltage are in a constant ratio and thus in synchronism;

8. ‘significant power generating module’ means a power generating module which is deemed significant on the basis of its impact on cross-border system performance via influence on the control area’s security of supply;

9. ‘power generating module document’ or ‘PGMD’ means a document issued by the authorised certifier and provided by the power generating facility owner to the relevant system operator for a type B or C power generating module which confirms that the power generating module’s compliance with the technical criteria set out in this Regulation has been demonstrated and provides the necessary data and statements, including a statement of compliance;

10. ‘relevant TSO’ means the TSO in whose control area a power generating module, a demand facility, a demand unit, a distribution system or a HVDC system is or will be connected to the network at any voltage level;

11. ‘network’ means a plant and apparatus connected together in order to transmit or distribute electricity;

12. 'relevant system operator’ means the transmission system operator or distribution system operator to whose system a power generating module, demand facility, distribution system or HVDC system is or will be connected.

13. ‘connection agreement’ means a contract between the relevant system operator and either the power generating facility owner, demand facility owner, distribution system operator or HVDC system owner, which includes the relevant site and specific technical requirements for the power generating facility, demand facility, distribution system, distribution system connection or HVDC system;

14. ‘connection point’ means the interface at which the power generating module, demand facility, distribution system or HVDC system is connected to a transmission system, offshore network, distribution system, including closed distribution systems, or HVDC system, as identified in the connection agreement;

15. ‘maximum capacity’ or ‘Pmax’ means the maximum continuous active power which a power generating module can produce, less any demand associated solely with facilitating the operation of that power generating module and not fed into the network as defined in the connection agreement or as agreed between the relevant system operator and the power generating facility owner;

16. ‘power park module’ or ‘PPM’ means a unit or ensemble of units generating electricity, which is either non-synchronously connected to the network or connected through power electronics, and that also has a single connection point to a transmission system, distribution system including closed distribution system or HVDC system;

17. ‘offshore power park module’ means a power park module located offshore with an offshore connection point;

18. ‘synchronous compensation operation’ means the operation of an alternator without prime mover to regulate voltage dynamically by production or absorption of reactive power;

19. ‘active power’ means the real component of the apparent power at fundamental frequency, expressed in watts or multiples thereof such as kilowatts ('kW') or megawatts ('MW');

20. ‘pump-storage’ means a hydro unit in which water can be raised by means of pumps and stored to be used for the generation of electrical energy;

21. ‘frequency’ means the electric frequency of the system expressed in hertz that can be measured in all parts of the synchronous area under the assumption of a consistent value for the system in the time frame of seconds, with only minor differences between different measurement locations. It's nominal value is 50Hz;

22. ‘droop’ means the ratio of the steady-state change of frequency, referred to as nominal frequency, to the steady-state change in active power output, referred to as maximum capacity, expressed in percentage terms;

23. ‘minimum regulating level’ means the minimum active power, as defined in the connection agreement or as agreed between the relevant system operator and the power generating facility owner, down to which the power generating module can regulate;

24. ‘setpoint’ means the target value for any parameter typically used in control schemes;

25. ‘instruction’ means any command, within its authority, given by a system operator to a power generating facility owner, demand facility owner, distribution system operator or HVDC system owner in order to perform an action;

26. ‘secured fault’ means a fault which is successfully cleared according to the system operator’s planning criteria;

27. ‘reactive power’ means the imaginary component of the apparent power at fundamental frequency, usually expressed in kilovar ('kVAr') or megavar ('MVAr');

28. 'fault-ride-through' means the capability of electrical devices to be able to remain connected to the network and operate through periods of low voltage at the connection point caused by secured faults;

29. ‘alternator’ means a device that converts mechanical energy into electrical energy by means of a rotating magnetic field;

30. ‘current’ means the rate at which electric charge flows which is measured by the root-mean-square value of the positive sequence of the phase current at fundamental frequency;

31. 'stator' means the portion of a rotating machine which includes the stationary magnetic parts with their associated windings;

32. ‘inertia’ means the property of a rotating rigid body, such as an alternator, such that it maintains its state of uniform rotational motion and angular momentum unless an external torque is applied;

33. ‘synthetic inertia’ means the facility provided by a power park module or HVDC system to replace the effect of inertia of a synchronous power generating module to a prescribed level of performance;

34. ‘frequency control’ means the capability of a power generating module or HVDC system to adjust its active power output in response to a measured deviation of system frequency from a setpoint, in order to maintain stable system frequency;

35. ‘frequency sensitive mode’ or ‘FSM’ means the operating mode of a power generating module or HVDC system in which the active power output changes in response to a change in system frequency, in such a way that it assists with the recovery to target frequency;

36. ‘limited frequency sensitive mode – overfrequency’ or ‘LFSM-O’ means a power generating module or HVDC system operating mode which will result in active power output reduction in response to a change in system frequency above a certain value;

37. ‘limited frequency sensitive mode – underfrequency’ ‘LFSM-U’ means a power generating module or HVDC system operating mode which will result in active power output increase in response to a change in system frequency below a certain value;

38. ‘frequency response deadband’ means an interval used intentionally to make the frequency control unresponsive;

39. ‘frequency response insensitivity’ means the inherent feature of the control system defined as the minimum magnitude of the frequency or input signal which results in a change of output power or output signal;

40. ‘P-Q-capability diagram’ means a diagram describing the reactive power capability of a power generating module in the context of varying active power at the connection point;

41. ‘steady-state stability’ means the state to which a network or a synchronous power generating module reverts, following a sufficiently minor disturbance;

42. ‘island operation’ means the independent operation of a whole network or part of a network that is isolated after being disconnected from the interconnected system, having at least one power generating module or HVDC system supplying power to this network and controlling the frequency and voltage;

43. ‘houseload operation’ means the operation which ensures that power generating facilities are able to continue to supply their in-house loads in the event of network failures resulting in power generating modules being disconnected from the network and tripped onto their auxiliary supplies;

44. ‘black start capability’ means the capability of recovery of a power generating module from a total shutdown through a dedicated auxiliary power source without any electrical energy supply external to the power generating facility;

45. ‘authorised certifier’ means an entity that issues equipment certificates and power generating module documents and whose accreditation is given by the national affiliate of the European cooperation for Accreditation ('EA'), established in accordance with Regulation (EC) No 765/2008;

46. ‘equipment certificate’ means a document issued by an authorised certifier for equipment used by a power generating module or a demand unit providing demand side response connected to the distribution system, transmission connected distribution system, transmission connected demand facility or HVDC system. The equipment certificate defines the scope of its validity at a national or other level at which a specific value is selected from the range allowed at a European level. The equipment certificate may include models confirmed against test results for the purpose of replacing specific parts of the compliance process.

47. ‘excitation control system’ means a feedback control system that includes the synchronous machine operating in the power system and its excitation system;

48. ‘U-Q/Pmax-profile’ means a profile representing the reactive power capability of a power generating module or HVDC converter station in the context of varying voltage at the connection point;

49. ‘minimum stable operating level’ means the minimum active power, as defined in the connection agreement or as agreed between the relevant system operator and the power generating facility owner, at which the power generating module can be operated stably for an unlimited time;

50. ‘overexcitation limiter’ means a control device within the AVR which prevents the rotor of an alternator from overloading by limiting the excitation current;

51. ‘underexcitation limiter’ means a control device within the AVR, the purpose of which is to prevent the alternator from losing synchronism due to lack of excitation;

52. ‘automatic voltage regulator’ or ‘AVR’ means the continuously acting automatic equipment controlling the terminal voltage of a synchronous power generating module by comparing the actual terminal voltage with a reference value and controlling the output of an excitation control system, depending on the deviations;

53. ‘power system stabiliser’ or ‘PSS’ means an additional functionality of the AVR of a synchronous power generating module whose purpose is to damp power oscillations;

54. ‘fast fault current’ means a current injected by a power park module or HVDC system during and after a voltage deviation caused by an electrical fault with the aim of identifying a fault by network protection systems at the initial stage of the fault, supporting system voltage retention at a later stage of the fault and system voltage restoration after fault clearance;

55. ‘power factor’ means the ratio of the absolute value of active power to apparent power under periodic conditions;

56. ‘slope’ means the ratio of the change in voltage, based on nominal voltage, to a change in reactive power in-feed from zero to maximum reactive power, based on maximum reactive power;

57. ‘offshore grid connection system’ means the complete interconnection between an offshore connection point and the onshore system at the onshore grid interconnection point;

58. ‘onshore grid interconnection point’ means the point at which the offshore grid connection system is connected to the onshore network of the relevant system operator;

59. ‘installation document’ means a simple structured document containing information about a type A power generating module or a demand unit with demand-side response below 1000V and confirming its compliance with the relevant requirements;

60. ‘statement of compliance’ means a document provided by the power generating facility owner, demand facility owner, distribution system operator or HVDC system owner to the system operator stating the current status of compliance with the relevant specifications and requirements;

61. ‘final operational notification’ or ‘FON’ means a notification issued by the relevant system operator to a power generating facility owner, demand facility owner, distribution system operator or HVDC system owner who complies with the relevant specifications and requirements, allowing them to operate respectively a power generating module, demand facility, distribution system or HVDC system by using the grid connection;

62. ‘energisation operational notification’ or ‘EON’ means a notification issued by the relevant system operator to a power generating facility owner, demand facility owner, distribution system operator or HVDC system owner prior to energisation of its internal network;

63. ‘interim operational notification’ or ‘ION’ means a notification issued by the relevant system operator to a power generating facility owner, demand facility owner, distribution system operator or HVDC system owner which allows them to operate respectively a power generating module, demand facility, distribution system or HVDC system by using the grid connection for a limited period of time and to initiate compliance tests to ensure compliance with the relevant specifications and requirements;

64. ‘limited operational notification’ or ‘LON’ means a notification issued by the relevant system operator to a power generating facility owner, demand facility owner, distribution system operator or HVDC system owner who had previously attained FON status but is temporarily subject to either a significant modification or loss of capability resulting in non-compliance with the relevant specifications and requirements.

Article 3
Scope of application

1. The connection requirements set out in this Regulation shall apply to new power generating modules which are considered significant in accordance with Article 5, unless otherwise provided.

The relevant system operator shall refuse to allow the connection of a power generating module which does not comply with the requirements set out in this Regulation and which is not covered by a derogation granted by the regulatory authority pursuant to Article 56. The relevant system operator shall communicate such refusal, by means of a reasoned statement in writing, to the power generating facility owner and to the regulatory authority.

2. This Regulation shall not apply to:

(a) power generating modules connected to the transmission system and distribution systems nor to parts of the transmission system or distribution systems, of a Member State which is not operated synchronously at the same frequency with either the Continental Europe, Great Britain, Nordic, Ireland or Baltic synchronous area;

(b) power generating modules that were installed to provide back-up power and operate in parallel with the network for less than five minutes per calendar month while the system is in normal or alert system state;

(c) storage devices except for pump-storage power generating modules in accordance with paragraph 2 of Article 6.

Article 4
Application to existing power generating modules

1. Existing power generating modules are not subject to the requirements of this Regulation, except where:

(a) a type C or type D power generating module has been modified to such an extent that its connection agreement must be substantially revised in accordance with the following procedure:

(i) power generating facility owners who intend to undertake the modernisation of a plant or replacement of equipment impacting the technical capabilities of the power generating module set out in this Regulation shall report their plans to the relevant system operator in advance;

(ii) if the relevant system operator considers that the extent of the modernisation or replacement of equipment is such that a new connection agreement is required, the system operator shall notify the relevant regulatory authority or, where applicable, the Member State; and

(iii) the relevant regulatory authority or, where applicable, the Member State shall decide if the existing connection agreement needs to be revised or a new connection agreement is required and which requirements of this Regulation shall apply; or

(b) a regulatory authority or, where applicable, the Member State decides to make an existing power generating module subject to all or some of the requirements of this Regulation, following a proposal from the relevant TSO in accordance with paragraphs 3, 4 and 5.

2. For the purposes of this Regulation, a power generating module shall be considered existing if:

(a) it is already connected to the network on the date of entry into force of this Regulation; or

(b) the power generating facility owner has concluded a final and binding contract for the purchase of the main plant by [*two years after the entry into force of the Regulation*]. The power generating facility owner must notify this to the relevant system operator and relevant TSO within [*30 months after the entry into force of the Regulation*].

The confirmation submitted by the power generating facility owner to the relevant system operator shall at least indicate the contract title, its date of signature and date of entry into force, and the specifications of the main plant to be constructed, assembled or purchased.

The Member State may provide that in specified circumstances the regulatory authority may determine whether the power generating module is to be considered an existing power generating module or a new power generating module.

3. Following a public consultation in accordance to Article 10 and in order to address significant factual changes in circumstances, such as the evolution of system requirements including penetration of renewable energy sources, smart grids, distributed generation or demand response, the relevant TSO may propose to the regulatory authority concerned, or where applicable, the Member State to extend the applicability of this Regulation to existing power generating modules.

For that purpose a sound and transparent quantitative cost-benefit analysis shall be carried out, in accordance with paragraphs 1 to 5 of Article 38, which shall indicate:

(a) the costs, in regard to existing power generating modules, of requiring compliance with this Regulation;

(b) the socio-economic benefit resulting from applying the requirements set out in this Regulation; and

(c) the potential of alternative measures to achieve the required performance.

4. Before undertaking the quantitative cost-benefit analysis referred to in paragraph 3, the relevant TSO shall:

(a) carry out a preliminary qualitative comparison of costs and benefits; and

(b) obtain approval from the regulatory authority concerned or, where applicable, the Member State.

5. The relevant regulatory authority or, where applicable, the Member State shall decide on the extension of the applicability of this Regulation to existing power generating modules within three months of receipt of the report and the recommendation of the relevant TSO or power generating facility owner in accordance with paragraph 7 of Article 38. The decision of the regulatory authority or, where applicable, the Member State shall be published.

6. The relevant TSO shall take account of the legitimate expectations of power generating facility owners as part of the assessment concerning the application of this Regulation to existing power generating modules.

7. The relevant TSO may assess the application of some or all of the provisions of this Regulation to existing power generating modules every three years in accordance with the criteria and process set out in this Article.

Article 5
Determination of significance

1. The power generating modules shall comply with the requirements on the basis of the voltage level of their connection point and their maximum capacity according to the categories set out in paragraph 3.

2. Power generating modules within the following categories shall be considered as significant:

   (a) connection point below 110 kV and maximum capacity of 0.8 kW or more (type A);

   (b) connection point below 110 kV and maximum capacity at or above a threshold proposed by each relevant TSO in accordance with the procedure laid out in paragraph 4 of Article 5 (type B). This threshold shall not be above the limits for type B power generating modules contained in Table 1;

   (c) connection point below 110 kV and maximum capacity at or above a threshold defined by each relevant TSO in accordance with paragraph 4 of Article 5 (type C). This threshold shall not be above the limits for type C power generating modules contained in Table 1; or

   (d) connection point at 110 kV or above (type D). A power generating module is also of type D if its connection point is below 110 kV and its maximum capacity is at or above a threshold defined in accordance with paragraph 4 of Article 5. This threshold shall not be above the limit for type D power generating modules contained in Table 1.

Synchronous areas	**Limit for maximum capacity threshold from which a power generating module is of type B**	**Limit for maximum capacity threshold from which a power generating module is of type C**	**Limit for maximum capacity threshold from which a power generating module is of type D**
Continental Europe	1 MW	50 MW	75 MW
Great Britain	1 MW	50 MW	75 MW
Nordic	1.5 MW	10 MW	30 MW
Ireland	0.1 MW	5 MW	10 MW
Baltic	0.5 MW	10 MW	15 MW

Table 1: Limits for thresholds for type B, C and D power generating modules

3. Proposals for maximum capacity thresholds for types B, C and D power generating modules shall be subject to approval in accordance with paragraph 1 of Article 7. In forming proposals the relevant TSO shall coordinate with adjacent TSOs and DSOs and shall conduct a public consultation in accordance with Article 10. A proposal by the relevant TSO to change the thresholds shall not be made sooner than three years after the previous proposal.

4. Power generation facility owners shall assist this process and provide data as requested by the relevant TSO.

5. If, as a result of modification of the thresholds, a power generating module qualifies under a different type, the procedure laid down in Article 4(3) concerning existing power generating modules shall apply before compliance with the requirements for the new type is required.

Article 6

Application to synchronous power generating modules, pump-storage power generating modules, combined heat and power facilities, and industrial sites

1. Offshore synchronous power generating modules connected to the interconnected system via a high voltage direct current connection or connected via a network whose frequency is not synchronously coupled to that of the main interconnected system (such as via a back to back scheme) shall meet the requirements for onshore synchronous power generating modules, unless the requirements are modified for this purpose by the relevant system operator. The categories to be taken into account for offshore power park modules for the purpose of this Regulation are defined in paragraph 3 of Article 23.

2. Pump-storage power generating modules shall fulfil all the relevant requirements in both generating and pumping operation mode. Synchronous compensation operation of pump-storage power generating modules shall not be limited in time by the technical design of power generating modules. Pump-storage variable speed power generating modules shall fulfil the requirements applicable to synchronous power generating modules as well as those set out in point (b) of Article 20(2), if they qualify as type B, C or D.

3. With respect to power generating modules embedded in the networks of industrial sites, power generating facility owners, system operators of industrial sites and relevant system operators whose network is connected to the network of an industrial site shall have the right to agree on conditions for disconnection of such power generating modules together with critical loads, which secure production processes, from the relevant system operator's network. The exercise of this right shall be coordinated with the relevant TSO.

4. Unless otherwise stated by national law, requirements of this Regulation relating to the capability to maintain constant active power output or to modulate active power output other than under paragraphs 2 and 4 of Article 13, shall not apply to power generating

modules of facilities for combined heat and power production embedded in the networks of industrial sites, where all of the following criteria are met:

(a) the primary purpose of those facilities is to produce heat for production processes of the industrial site concerned;

(b) heat and power generation is inextricably interlinked, that is to say any change of heat generation results inadvertently in a change of active power generation and vice versa;

(c) the power generating modules are of type A, B or C in accordance with points (a) to (c) of Article 5(2)

5. Combined heat and power generating facilities shall be assessed on the basis of their electrical maximum capacity.

Article 7
Regulatory aspects

1. Where a relevant system operator or TSO is required or permitted in this Regulation to specify, define, request or agree on specific terms and conditions governing connection and access to systems, at least the methodologies used to calculate or establish these terms and conditions shall be subject to approval by the responsible regulatory authorities in accordance with paragraphs (1), (6) and (10) of Article 37 of Directive 2009/72/EC and Article 14 of Regulation (EC) No 714/2009. For technical regulations pursuant to Article 1(9) of Directive 98/34/EC, the provisions under Directive 98/34/EC, especially Articles 8, 9 and 10 thereof, shall apply.

2. When applying the provisions of this Regulation, Member States, regulatory authorities and system operators shall:

(a) apply the principles of proportionality and non-discrimination;

(b) ensure transparency;

(c) apply the principle of optimisation between the highest overall efficiency and lowest total costs for all parties involved;

(d) respect the responsibility assigned to the relevant TSO to ensure system security, including as required by national legislation;

(e) consult with relevant DSOs and take account of potential impacts on their system;

(f) take into consideration agreed European standards and technical specifications.

3. Where this Regulation provides that the relevant TSO, the power generating facility owner and/or the distribution system operator shall agree, all mentioned parties shall seek agreement between them. If no agreement has been found within a reasonable timeframe, but in any case not later than [6 months] after the first proposal has been submitted by one party, each party may request the competent regulatory authority to issue a decision. The decision shall replace the required agreement.

4. Where this Regulation provides that the relevant system operator or TSO shall specify, define or agree on specific terms and conditions governing connection and access to systems or their methodologies, the initial definition shall be done within a reasonable timeframe, but in any case not later than [2 years] after the entry into force of this Regulation. Where approval of the definition requires regulatory approval pursuant to paragraph 1 of this Article, the deadline shall be deemed met if the submission for approval takes place within a reasonable timeframe, but no later than [2 years].

5. If the relevant system operator or TSO deems modifications to the initial definition under paragraphs 3 or 4 to be necessary, a new assessment has to follow the same procedural requirements described in this Article. At all stages of the procedure, due account shall be taken of legitimate expectations, if any, by power generating facility owners, equipment manufacturers and other stakeholders based on the initial definition.

Article 8
Multiple TSOs

1. In Member States where more than one transmission system operator exists, this Regulation shall apply to all transmission system operators within that Member State.

2. Member States may under the national regulatory regime provide that the responsibility of a transmission system operator to comply with one, some or all obligations under this Regulation is assigned to one or more specific transmission system operators.

Article 9
Recovery of costs

1. The costs borne by regulated system operators subject to network tariff regulation and stemming from the obligations laid down in this Regulation shall be assessed by the competent regulatory authorities. Costs assessed as reasonable, efficient and proportionate shall be recovered in accordance with Article 14 of Regulation EC (No) 714/2009.

2. If requested by the competent regulatory authorities, regulated system operators shall, within three months of the request, provide the information necessary to facilitate assessment of the costs incurred.

Article 10
Consultation

1. Relevant system operators or TSOs shall consult stakeholders, including the relevant authorities of each Member State, on draft proposals, in accordance with Articles 4(3) and 5(3) or on cost benefit analysis, in accordance Article 38(4) and (7). The consultation shall last for a period of not less than one month.

2. The relevant system operators or TSOs in paragraph 1 shall duly consider the views of stakeholders resulting from the consultations undertaken, prior to its submission for approval in accordance with Article 7. In all cases, a clear and robust justification for including or not the views resulting from the consultation shall be developed in the submission and published in a timely manner before or simultaneously with the publication of the proposal.

Article 11
Stakeholder involvement

The Agency, in close cooperation with the ENTSO for Electricity, shall organise stakeholder involvement regarding the requirements for grid connection of power generating facilities, and other aspects of the implementation of this Regulation. This shall include regular meetings with stakeholders to identify problems and propose improvements notably related to the requirements for grid connection of power generating facilities.

Article 12
Confidentiality obligations

1. Any confidential information received, exchanged or transmitted pursuant to this Regulation shall be subject to the conditions of professional secrecy laid down in paragraphs 2, 3 and 4.
2. The obligation of professional secrecy shall apply to any person subject to the provisions of this Regulation.
3. Confidential information received by the persons referred to in paragraph 2 in the course of their duties may not be divulged to any other person or authority, without prejudice to cases covered by national law, the other provisions of this Regulation or other relevant Union law.
4. Without prejudice to cases covered by national or Union law, regulatory authorities, bodies or persons who receive confidential information pursuant to this Regulation may use it only for the purpose of carrying out their duties under this Regulation.
5. This provision does not prevent the Agency, the regulatory authorities, ENTSO for electricity, or the European Commission to mutually exchange, for the purpose of applying this Regulation, any information received pursuant to this Regulation.

TITLE II

REQUIREMENTS

CHAPTER IV

REQUIREMENTS FOR OFFSHORE POWER PARK MODULES

Article 23
General provisions

1. The requirements set out in this Chapter apply to the connection to the network of AC-connected power park modules located offshore. An AC-connected power park module located offshore which does not have an offshore connection point shall be considered as an onshore power park module and thus shall comply with the requirements governing power park modules situated onshore.

2. The offshore connection point of an AC-connected offshore power park module shall be defined by the relevant system operator.

3. AC-connected offshore power park modules within the scope of this Regulation shall be categorised in accordance with the following offshore grid connection system configurations:

   (a) configuration 1: AC connection to a single onshore grid interconnection point whereby one or more offshore power park modules that are interconnected offshore to form an offshore AC system are connected to the onshore system ;

   (b) configuration 2: Meshed AC connections whereby a number of offshore power park modules are interconnected offshore to form an offshore AC system and the offshore AC system is connected to the onshore system at two or more onshore grid interconnection points.

Article 24

Frequency stability requirements applicable to AC-connected offshore power park modules

The frequency stability requirements laid down respectively in Article 13(1) to (5), Article 15(2) and Article 21(2) shall apply to any AC-connected offshore power park module.

Article 13

General requirements for type A power generating modules

1. Type A power generating modules shall fulfil the following requirements relating to frequency stability:

   (a) With regard to frequency ranges:

      (i) a power generating module shall be capable of remaining connected to the network and operate within the frequency ranges and time periods specified in Table 2;

      (ii) the relevant system operator, in coordination with the relevant TSO, and the power generating facility owner may agree on wider frequency ranges, longer minimum times for operation or specific requirements for combined frequency and voltage deviations to ensure the best use of the technical capabilities of a power generating module, if it is required to preserve or to restore system security;

      (iii) the power generating facility owner shall not unreasonably withhold consent to apply wider frequency ranges or longer minimum times for operation, taking account of their economic and technical feasibility.

   (b) With regard to the rate of change of frequency withstand capability, a power generating module shall be capable of staying connected to the network and operate at rates of change of frequency up to a value defined by the relevant TSO, unless disconnection was triggered by rate-of-change-of-frequency-type loss of mains protection. The relevant system operator, in coordination with the relevant TSO, shall define this rate-of-change-of-frequency-type loss of mains protection.

Synchronous area	Frequency range	Time period for operation
Continental Europe	47.5 Hz – 48.5 Hz	To be defined by each TSO, but not less than 30 minutes
	48.5 Hz – 49.0 Hz	To be defined by each TSO, but not less than the period for 47.5 Hz – 48.5 Hz
	49.0 Hz – 51.0 Hz	Unlimited
	51.0 Hz – 51.5 Hz	30 minutes
Nordic	47.5 Hz – 48.5 Hz	30 minutes
	48.5 Hz – 49.0 Hz	To be defined by each TSO, but not less than 30 minutes
	49.0 Hz – 51.0 Hz	Unlimited
	51.0 Hz – 51.5 Hz	30 minutes
Great Britain	47.0 Hz – 47.5 Hz	20 seconds
	47.5 Hz – 48.5 Hz	90 minutes
	48.5 Hz – 49.0 Hz	To be defined by each TSO, but not less than 90 minutes
	49.0 Hz – 51.0 Hz	Unlimited
	51.0 Hz – 51.5 Hz	90 minutes
	51.5 Hz – 52.0 Hz	15 minutes
Ireland	47.5 Hz – 48.5 Hz	90 minutes
	48.5 Hz – 49.0 Hz	To be defined by each TSO, but not less than 90 minutes
	49.0 Hz – 51.0 Hz	Unlimited
	51.0 Hz – 51.5 Hz	90 minutes
Baltic	47.5 Hz – 48.5 Hz	To be defined by each TSO, but not less than 30 minutes
	48.5 Hz – 49.0 Hz	To be defined by each TSO, but not less than the period for 47.5 Hz – 48.5 Hz
	49.0 Hz – 51.0 Hz	Unlimited
	51.0 Hz – 51.5 Hz	To be defined by each TSO, but not less than 30 minutes

Table 2: Minimum time periods for which a power generating module has to be capable of operating on different frequencies, deviating from a nominal value, without disconnecting from the network.

2. With regard to the limited frequency sensitive mode — overfrequency (LFSM-O), the following shall apply:

(a) the power generating module shall be capable of activating the provision of active power frequency response according to figure 1 at a frequency threshold and droop settings determined by the relevant TSO, in consultation with the TSOs of the same synchronous area, and taking into account the potential for compliance on an aggregate level while limiting cross-border impact and maintaining the same level of operational security in all system states. This shall be subject to notification to the

regulatory authority without the need for approval under paragraph 1 of Article 7. Where compliance is to be met on an aggregate level, those requirements should be submitted for approval by the regulatory authority concerned;

(b) the frequency threshold shall be between 50.2 Hz and 50.5 Hz inclusive;

(c) the droop settings shall be between 2 % and 12 %;

(d) the power generating module shall be capable of activating a power frequency response with an initial delay that is as short as possible. If that delay is greater than two seconds, the power generating facility owner shall justify the delay, providing technical evidence to the relevant TSO;

(e) the relevant TSO may require that upon reaching minimum regulating level, the power generating module be capable of either:

(i) continuing operation; or

(ii) further decreasing active power output;

(f) the power generating module shall be capable of operating stably during LFSM-O operation. When LFSM-O is active, the LFSM-O setpoint will prevail over any other active power setpoints.

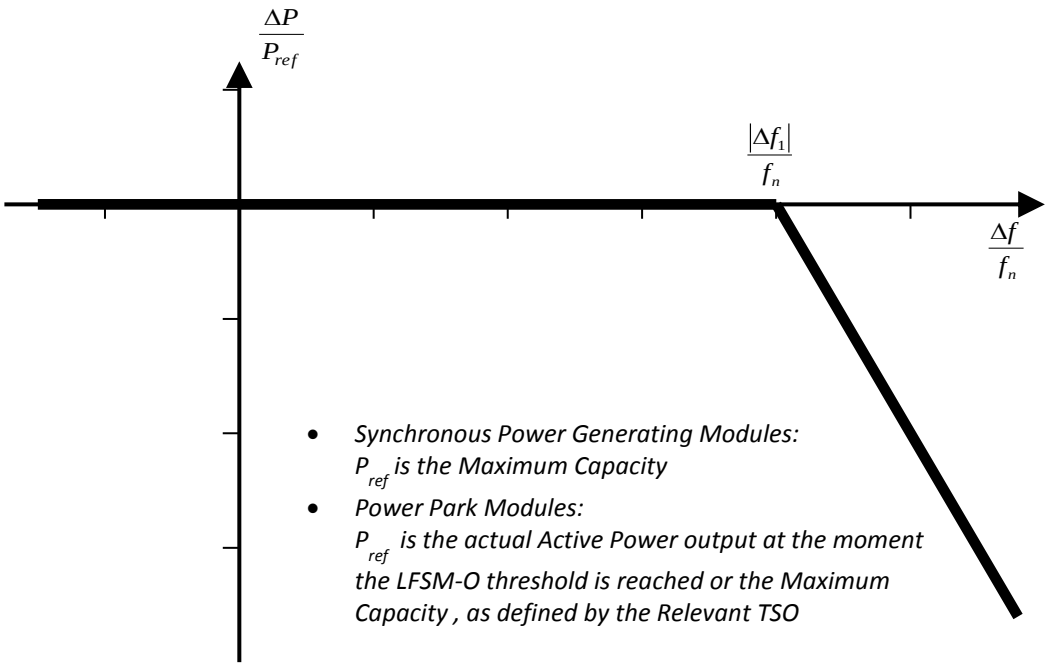

Figure 1: active power frequency response capability of power generating modules in LFSM-O. P_{ref} is the reference active power to which ΔP is related and may be defined differently for synchronous power generating modules and power park modules. ΔP is the change in active power output from the power generating module. f_n is the nominal frequency (50 Hz) in the network and Δf is the frequency change in the network. At

overfrequencies where Δf is above Δf_1, the power generating module has to provide a negative active power output change according to the droop S_2.

3. The power generating module shall be capable of maintaining constant output at its target active power value regardless of changes in frequency, except where output follows the changes defined in the context of paragraphs 2 and 4 of Article 13 or points (c) and (d) of Article 15(2) as applicable.

4. The relevant TSO shall define admissible active power reduction from maximum output with falling frequency in their control area as a rate of reduction falling within the boundaries, illustrated by the full lines in Figure 2:

   (a) below 49 Hz falling by a reduction rate of 2 % of the maximum capacity at 50 Hz per 1 Hz frequency drop;

   (b) below 49.5 Hz falling by a reduction rate of 10 % of the maximum capacity at 50 Hz per 1 Hz frequency drop.

5. The admissible active power reduction from maximum output shall:

   (a) clearly define the ambient conditions applicable;

   (b) take account of the technical capabilities of power generating modules.

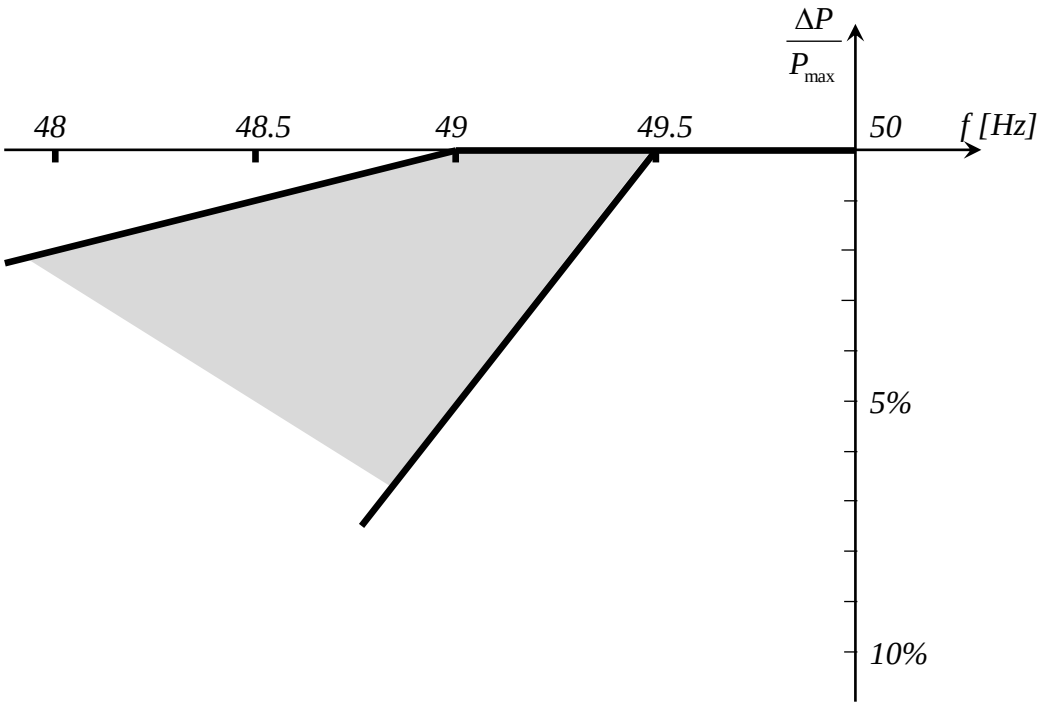

Figure 2: Maximum power capability reduction with falling frequency. The diagram represents the boundaries defined by the relevant TSO.

Article 15
General requirements for type C power generating modules

(…)

2. Type C power generating modules shall fulfil the following requirements relating to frequency stability:

(a) with regard to active power controllability and control range, the power generating module control system shall be capable of adjusting an active power setpoint in line with instructions given to the power generating facility owner by the relevant system operator or the relevant TSO.

The relevant system operator or the relevant TSO shall establish the period within which the adjusted active power setpoint must be reached. The relevant TSO shall define a tolerance (subject to the availability of the prime mover resource) applying to the new setpoint and the time within which it must be reached;

(b) manual, local measures shall be allowed in cases where the automatic remote control devices are out of service.

The relevant system operator or the relevant TSO shall notify the regulatory authority of the time required to reach the setpoint together with the tolerance for the active power;

(c) In addition to paragraph 2 of Article 13, the following requirements shall apply to type C power generating modules with regard to limited frequency sensitive mode – underfrequency (LFSM-U):

(i) the power generating module shall be capable of activating the provision of active power frequency response at a frequency threshold and with a droop determined by the relevant TSO as follows:

- the frequency threshold determined by the TSO shall be between 49.8 Hz and 49.5 Hz inclusive;
- the droop settings determined by the TSO shall be in the range 2 – 12 %.
- This is represented graphically in Figure 4;

(ii) the actual delivery of active power frequency response in LFSM-U mode should take into account:

- ambient conditions when the response is to be triggered;
- the operating conditions of the power generating module, in particular limitations on operation near maximum capacity at low frequencies and the respective impact of ambient conditions according to paragraphs 4 and 5 of Article 13; and
- the availability of the primary energy sources.

(iv) the activation of active power frequency response by the power generating module shall not be unduly delayed. In the event of any delay greater than two seconds, the power generating facility owner shall justify it to the relevant

TSO;

(v) in LFSM-U mode the power generating module shall be capable of providing a power increase up to its maximum capacity;

(vi) stable operation of the power generating module during LFSM-U operation shall be ensured;

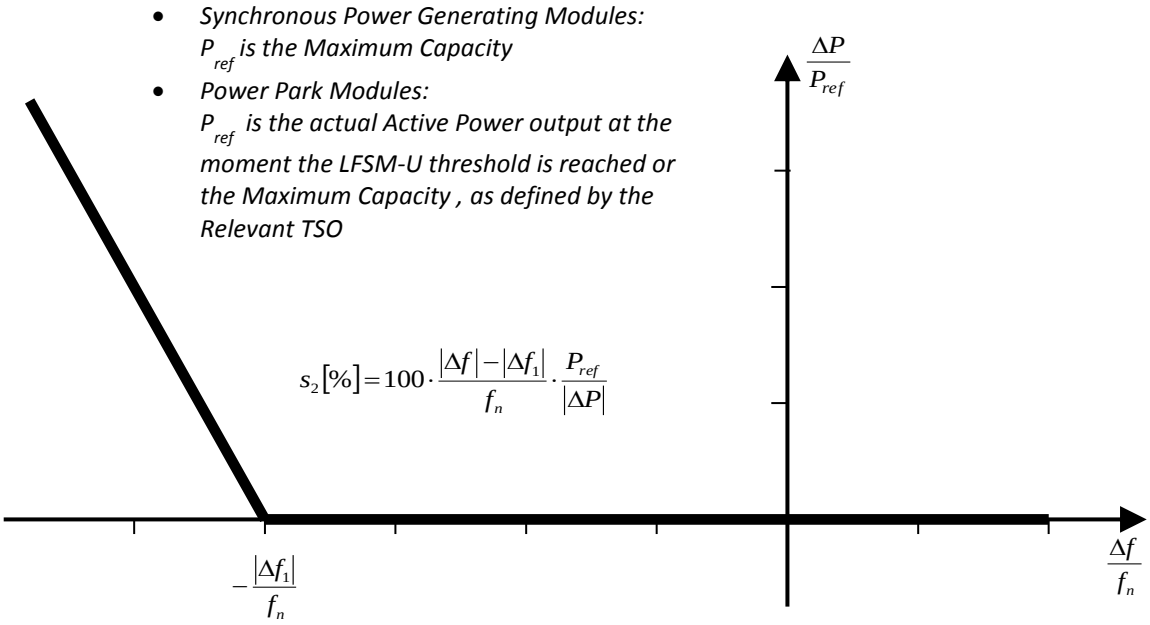

Figure 4: active power frequency response capability of power generating modules in LFSM-U. P_{ref} is the reference active power to which ΔP is related and may be defined differently for synchronous power generating modules and power park modules. ΔP is the change in active power output from the power generating module. f_n is the nominal frequency (50 Hz) in the network and Δf is the frequency change in the network. At underfrequencies where Δf is below Δf_1 the power generating module has to provide a positive active power output change according to the droop S_2.

(d) in addition to point (c) of Article 15(2), the following shall apply cumulatively when frequency sensitive mode ('FSM') is operating:

(i) the power generating module shall be capable of providing active power frequency response in accordance with the parameters specified by each TSO within the ranges shown in Table 4. In specifying those parameters, the TSO shall take account of the following facts:

- in case of overfrequency, the active power frequency response is limited by the minimum regulating level;
- in case of underfrequency, the active power frequency response is limited by maximum capacity;
- the actual delivery of active power frequency response depends on the operating and ambient conditions of the power generating module when this response is triggered, in particular limitations on operation near maximum capacity at low frequencies according to paragraphs 4 and 5 of Article 13 and available primary energy sources;

Parameters		Ranges
Active power range related to maximum capacity $\frac{\lvert\Delta P_1\rvert}{P_{\max}}$		1.5 – 10 %
Frequency response insensitivity	$\lvert\Delta f_i\rvert$	10 – 30 mHz
	$\frac{\lvert\Delta f_i\rvert}{f_n}$	0.02 – 0.06 %
Frequency response deadband		0 – 500 mHz
Droop s_1		2 – 12 %

Table 4: Parameters for active power frequency response in FSM (explanation for Figure 5)

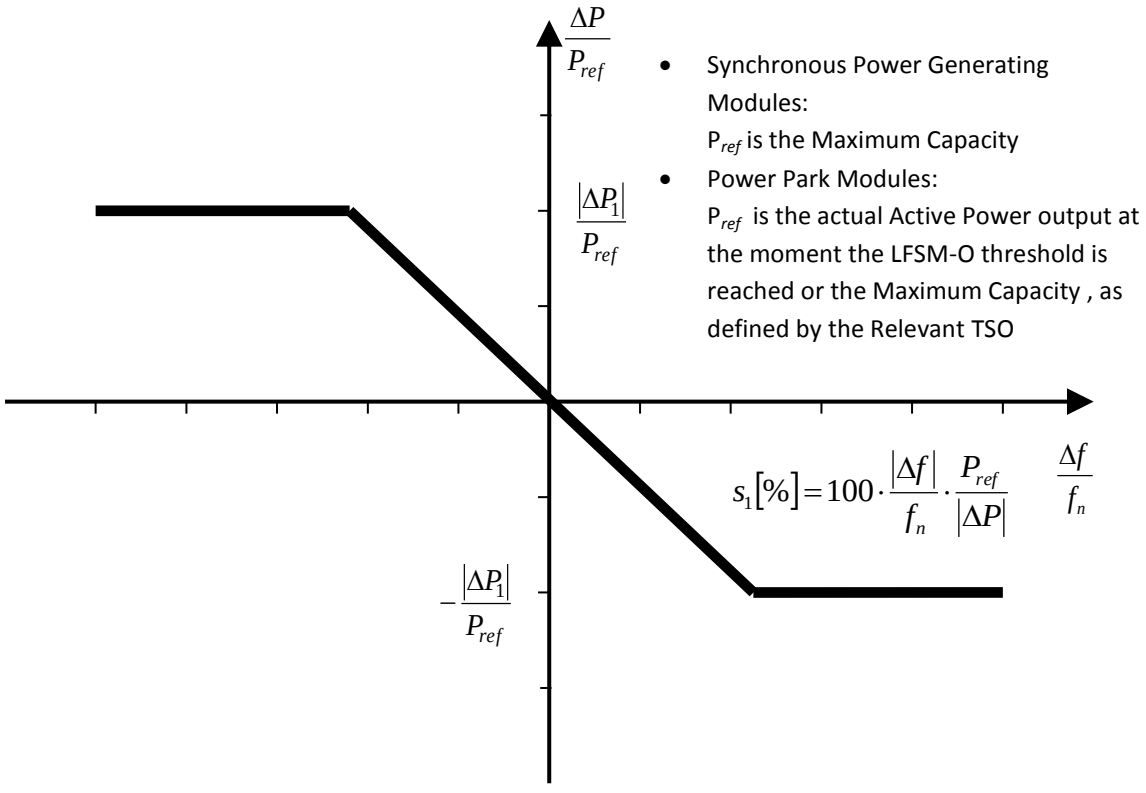

Figure 5: Active power frequency response capability of power generating modules in FSM illustrating the case of zero deadband and insensitivity. P_{ref} is the reference active power to which ΔP is related. ΔP is the change in active power output from the power generating module. f_n is the nominal frequency (50 Hz) in the network and Δf is the

frequency deviation in the network.

(ii) the frequency response deadband of frequency deviation and droop must be able to be reselected subsequently;

(iii) in the event of a frequency step change, the power generating module shall be capable of activating full active power frequency response, at or above the full line shown in Figure 6 in accordance with the parameters specified by each TSO (which shall aim at avoiding active power oscillations for the power generating module) within the ranges given in Table 5. The combination of choice of the parameters specified by the TSO shall take possible technology-dependent limitations into account;

(iv) The initial activation of active power frequency response required in accordance with this point shall not be unduly delayed.

If the delay in initial activation of active power frequency response is greater than two seconds, the power generating facility owner shall provide technical evidence demonstrating why a longer time is needed.

For power generating modules without inertia, the relevant TSO may specify a shorter time than two seconds. If the power generating facility owner cannot meet this requirement they shall provide technical evidence demonstrating why a longer time is needed for the initial activation of active power frequency response;

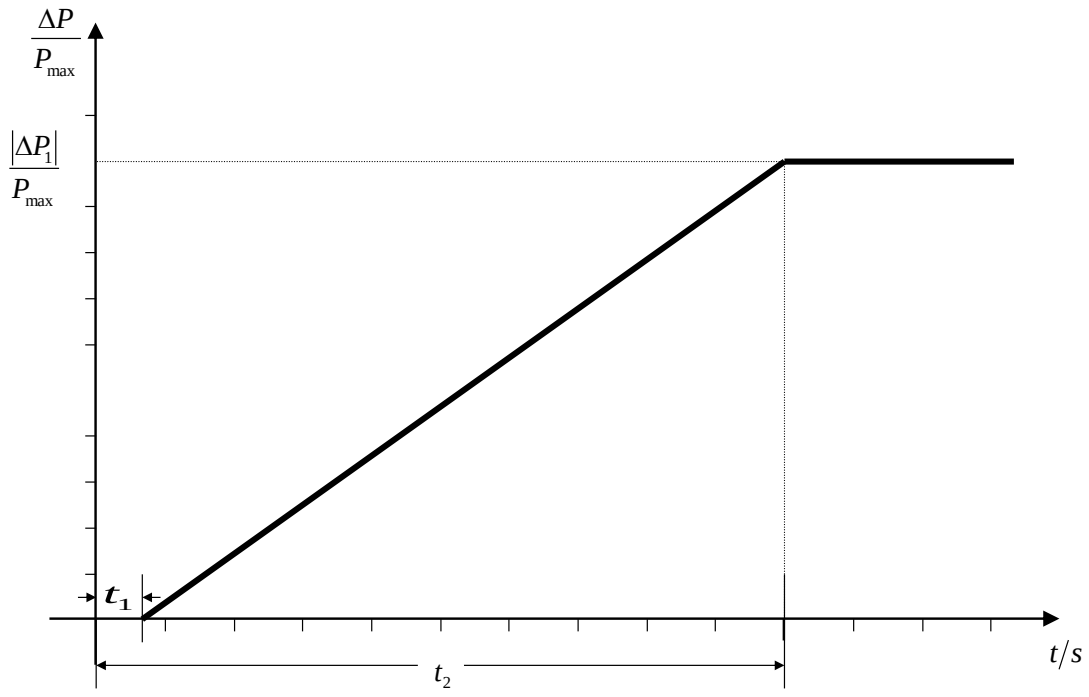

Figure 6: Active power frequency response capability. P_{max} is the maximum capacity to

which ΔP relates. ΔP is the change in active power output from the power generating module. The power generating module has to provide active power output ΔP up to the point ΔP_1 in accordance with the times t_1 and t_2 with the values of ΔP_1, $t_1$and t_2 being specified by the relevant TSO according to Table 5. t_1 is the initial delay. t_2 is the time for full activation.

(v) the power generating module shall be capable of providing full active power frequency response for a period of between 15 and 30 minutes as specified by the relevant TSO. In specifying the period, the TSO shall have regard to active power headroom and primary energy source of the power generating module;

(vi) within the time limits laid down in point (v) of Article 15(2) (d), active power control must not have any adverse impact on the frequency response of power generating modules;

(vii) the parameters specified by the relevant TSO in accordance with paragraphs 1, 2, 3 and 5 shall be notified to the relevant regulatory authority. The modalities of that notification shall be determined in accordance with the applicable national regulatory framework;

Parameters	**Ranges or values**
Active power range related to maximum capacity (frequency response range) $\frlim{\lvert\Delta P_1\rvert}{P_{max}}$	1.5 – 10 %
For power generating modules with inertia, the maximum admissible initial delay t_1 unless justified otherwise in line with Article 12 (2) (d) (iv)	2 seconds
For power generating modules without inertia, the maximum admissible initial delay t_1 unless justified otherwise in line with Article 12 (2) (d) (iv)	as specified by the relevant TSO.
Maximum admissible choice of full activation time t_2, unless longer activation times are allowed by the relevant TSO for reasons of system stability	30 seconds

Table 5: Parameters for full activation of active power frequency response resulting from frequency step change (explanation for Figure 6).

(e) with regard to frequency restoration control, the power generating module shall provide functionalities complying with specifications defined by the relevant TSO, aiming at restoring frequency to its nominal value or maintaining power exchange flows between control areas at their scheduled values;

(f) with regard to disconnection due to underfrequency, power generating facilities capable of acting as a load, including hydro pump-storage power generating facilities, shall be capable of disconnecting their load in case of underfrequency. The requirement referred to in this point does not extend to auxiliary supply;

(g) with regard to real-time monitoring of FSM:

(i) to monitor the operation of active power frequency response, the communication interface shall be equipped to transfer in real time and in a secured manner from the power generating facility to the network control centre of the relevant system operator or the relevant TSO, at the request of the relevant system operator or the relevant TSO, at least the following signals:

– status signal of FSM (on/off);
– scheduled active power output;
– actual value of the active power output;
– actual parameter settings for active power frequency response;
– droop and deadband;

(ii) the relevant system operator and the relevant TSO shall specify additional signals to be provided by the power generating facility for monitoring and recording devices in order to verify the performance of the active power frequency response provision of participating power generating modules.

Article 21
Requirements for type C power park modules

(…)

2. Type C power park modules shall fulfil the following additional requirements in relation to frequency stability:

(a) the relevant TSO shall have the right to specify that power park modules be capable of providing synthetic inertia during very fast frequency deviations;

(b) the operating principle of control systems installed to provide synthetic inertia and the associated performance parameters shall be defined by the relevant TSO.

Article 25

Voltage stability requirements applicable to AC-connected offshore power park modules

1. Without prejudice to point (a) of Article 14(3) and point (a) of Article 16(3), an AC-connected 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 (per unit), and within the time periods specified in Table 10.

2. Notwithstanding the provisions of paragraph 1, the relevant TSO in Spain may require power generating modules to remain connected to the network in the voltage range between 1.05 pu and 1.0875 pu for an unlimited period.

Synchronous area	Voltage range	Time period for operation
Continental Europe	0.85 pu – 0.90 pu	60 minutes
	0.9 pu – 1.118 pu*	Unlimited
	1.118 pu – 1.15 pu*	To be specified by each TSO
	0.90 pu – 1.05 pu**	Unlimited
	1. 05 pu – 1.10 pu**	60 minutes
Nordic	0.90 pu – 1.05 pu	Unlimited
	1.05 pu – 1.10 pu	60 minutes
Great Britain	0.90 pu – 1.10 pu*	Unlimited
	0.90 pu – 1.05 pu**	Unlimited
	1.05 pu – 1.10 pu**	15 minutes
Ireland	0.90 pu – 1.10 pu	Unlimited
Baltic	0.85 pu – 0.90 pu*	30 minutes
	0.90 pu – 1.12 pu*	Unlimited
	1.12 pu – 1.15 pu*	20 minutes
	0.88 pu – 0.90 pu**	20 minutes
	0.90 pu – 1.10 pu**	Unlimited
	1.10 pu – 1.15 pu**	20 minutes

* The voltage base for pu values is below 300 kV.

** The voltage base for pu values is from 300 kV to 400 kV.

Table 10: The table shows the minimum period during which an AC-connected offshore power park module must be capable of operating over different voltage ranges deviating from a nominal value without disconnecting.

3. The voltage stability requirements defined respectively in points (b) and (c) of Article 20(2) as well as in paragraph 3 of Article 21 shall apply to any AC-connected offshore power park module.

4. The reactive power capability at maximum capacity defined in point (b) of Article 21(3) shall apply to AC-connected offshore power park modules, except for Table 9. Instead, the requirements of Table 11 shall apply.

Synchronous area	**Maximum range of Q/P_{max}**	**Maximum range of steady-state voltage level in PU**
Continental Europe	0.75	0.225
Nordic	0.95	0.150
Great Britain	0* 0.33**	0.100
Ireland	0.66	0.218
Baltic States	0.8	0.22

*) at the offshore connection point for configuration 1

**) at the offshore connection point for configuration 2

Table 11: Parameters for Figure 8

Article 20
Requirements for type B power park modules

(…)

2. Type B power park modules shall fulfil the following additional requirements in relation to voltage stability:

(…)

(b) the relevant system operator in coordination with the relevant TSO shall have the right to specify that a power park module be capable of providing fast fault current at the connection point in case of symmetrical (3-phase) faults, under the following conditions:

(i) the power park module shall be capable of activating the supply of fast fault current either by:

– ensuring the supply of the fast fault current at the connection point; or
– 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;

(ii) the relevant system operator in coordination with the relevant TSO shall specify:

- how and when a voltage deviation is to be determined as well as the end of the voltage deviation;
- the characteristics of the fast fault current, including the time domain for measuring the voltage deviation and fast fault current, for which current and voltage may be measured differently from the method defined in Article 2;
- the timing and accuracy of the fast fault current, which may include several stages during a fault and after its clearance

(c) with regard to the supply of fast fault current in case of asymmetrical (1-phase or 2-phase) faults, the relevant system operator in coordination with the relevant TSO shall have the right to define a requirement for asymmetrical current injection.

Article 21
Requirements for type C power park modules

(…)

3. Type C power park modules shall fulfil the following additional requirements in relation to voltage stability:

(a) with regard to reactive power capability, for a power park module whose connection point is not located at the high-voltage terminals of its step-up transformer nor at the 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 relevant system operator to compensate for the reactive power demand of the high-voltage line or cable between these two points from the responsible owner of this line or cable;

(b) with regard to reactive power capability at maximum capacity:

(i) the relevant system operator in coordination with the relevant TSO shall define the reactive power provision capability requirements in the context of varying voltage. To that end, it shall define a U-Q/P_{max}-profile that may take any shape within the boundaries of which the power park module is capable of providing reactive power at its maximum capacity;

(ii) the U-Q/P_{max}-profile shall be defined by each relevant system operator in coordination with the relevant TSO in conformity with the following principles:

- the U-Q/Pmax-profile shall not exceed the U-Q/Pmax-profile envelope, represented by the inner envelope in Figure 8;

- the dimensions of the U-Q/Pmax-profile envelope (Q/Pmax range and voltage range) shall be within the values defined for each synchronous area in Table 9;
- the position of the U-Q/Pmax-profile envelope shall be within the limits of the fixed outer envelope set out in Figure 8; and
- the defined U-Q/Pmax profile may take any shape, having regard to the potential costs of delivering the capability to provide reactive power production at high voltages and reactive power consumption at low voltages;

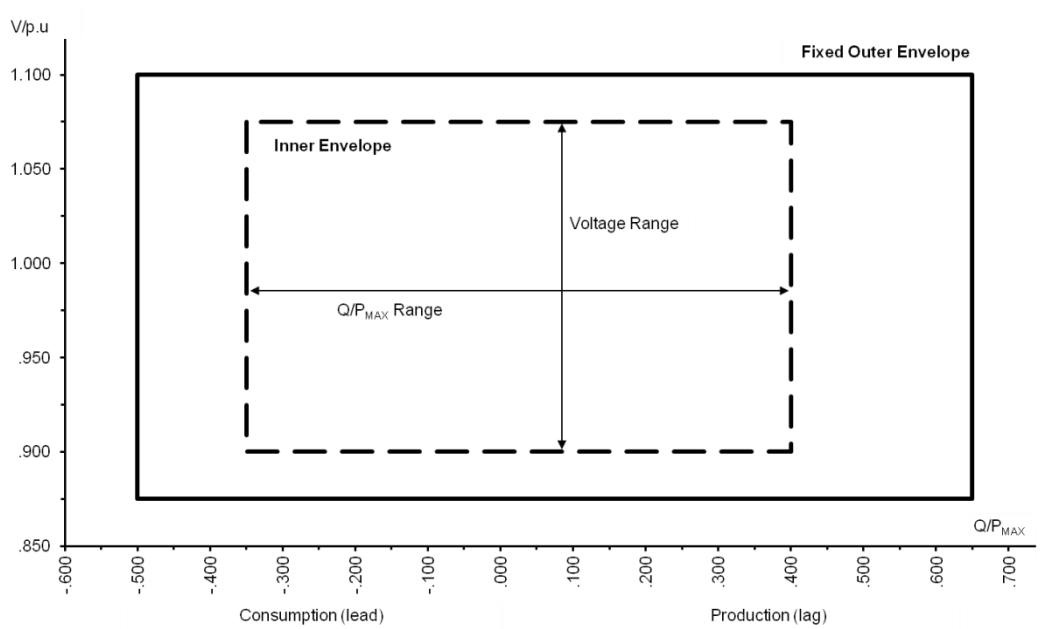

Figure 8: U-Q/P_{max}-profile of a power park module. The diagram represents boundaries of a U-Q/P_{max}-profile by the voltage at the connection point, expressed by the ratio of its actual value and its nominal value per unit, against the ratio of the reactive power (Q) and the maximum capacity (P_{max}). The position, size and shape of the inner envelope are indicative.

Synchronous area	Maximum range of Q/P_{max}	Maximum range of steady-state voltage level in PU
Continental Europe	0.75	0.225
Nordic	0.95	0.150
Great Britain	0.66	0.100
Ireland	0.66	0.218
Baltic States	0.80	0.220

Table 9: Parameters for the inner envelope in Figure 8

(iii) the reactive power provision capability requirement 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;

(c) With regard to reactive power capability below maximum capacity:

(i) the relevant system operator in coordination with the relevant TSO shall define the reactive power provision capability requirements and shall define a P-Q/P_{max}-profile that may take any shape within the boundaries of which the power park module is capable of providing reactive power below maximum capacity;

(ii) the P-Q/P_{max}-profile shall be defined by each relevant system operator in coordination with the relevant TSO, in conformity with the following principles:

- the P-Q/Pmax-profile shall not exceed the P-Q/Pmax-profile envelope, represented by the inner envelope in Figure 9;
- the Q/Pmax range of the P-Q/Pmax-profile envelope is defined for each synchronous area in Table 9;
- the active power range of the P-Q/Pmax-profile envelope at zero reactive power shall be 1 pu;
- the P-Q/Pmax-profile can be of any shape and shall include conditions for reactive power capability at zero active power; and
- the position of the P-Q/Pmax-profile envelope shall be within the limits of the fixed outer envelope set out in Figure 9;

(iii) when operating at an active power output below maximum capacity ($P<P_{max}$), the power park module shall be capable of providing reactive power at any operating point inside its P-Q/P_{max}-profile, if all units of that power park module which generate power are technically available that is to say they are not out of service due to maintenance or failure, otherwise there may be less

reactive power capability, taking into consideration the technical availabilities;

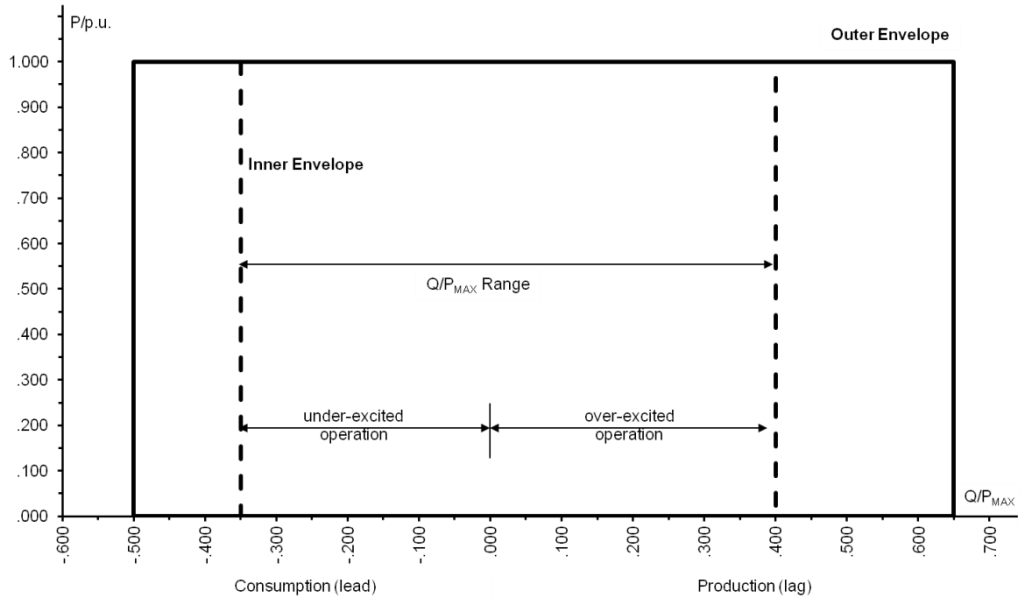

Figure 9: P-Q/P_{max}-profile of a power park module. The diagram represents boundaries of a P-Q/P_{max}-profile at the connection point by the active power, expressed by the ratio of its actual value and the maximum capacity per unit, against the ratio of the reactive power (Q) and the maximum capacity (P_{max}). The position, size and shape of the inner envelope are indicative.

(iv) the power park module shall be capable of moving to any operating point within its P-Q/P_{max} profile in appropriate timescales to target values requested by the relevant system operator;

(d) with regard to reactive power control modes:

(i) the power park module shall be capable of providing reactive power automatically by either voltage control mode, reactive power control mode or power factor control mode;

(ii) for the purposes of voltage control mode, the power park module shall be capable of contributing to voltage control at the connection point by provision of reactive power exchange with the network with a setpoint voltage covering at least 0.95 to 1.05 pu in steps no greater than 0.01 pu, with a slope having a range of at least 2 to 7 % in steps no greater than 0.5 %. The reactive power output shall be zero when the grid voltage value at the connection point equals the voltage setpoint;

(iii) the setpoint may be operated with or without a deadband selectable in a range from zero to +-5 % of nominal network voltage in steps no greater than 0.5 %;

(iv) following a step change in voltage, the power park module shall be capable of achieving 90% of the change in reactive power output within a time t_1 to be specified by the relevant system operator in the range of 1 to 5 seconds, and must settle at the value defined by the operating slope within a time t_2 to be specified by the relevant system operator in the range of 5 to 60 seconds, with a steady-state reactive tolerance no greater than 5% of the maximum reactive power. The relevant system operator shall define the time specifications;

(v) for the purpose of reactive power control mode, the power park module shall be capable of setting the reactive power setpoint anywhere in the reactive power range, defined by point (a) of Article 20(2) and by points (a) and (b) of Article 21(3), with setting steps no greater than 5 MVAr or 5% (whichever is smaller) of full reactive power, controlling the reactive power at the connection point to an accuracy within plus or minus 5 MVAr or plus or minus 5% (whichever is smaller) of the full reactive power;

(vi) for the purpose of power factor control mode, the power park module shall be capable of controlling the power factor at the connection point within the required reactive power range, defined by the relevant system operator according to point (a) of Article 20(2) or defined by points (a) and (b) of Article 18(3), with a target power factor in steps no greater than 0.01. The relevant system operator shall define the target power factor value and the tolerance expressed in Mvar or % on the reactive power value issued from conversion of power factor value, within a period of time, following a sudden change of active power output;

(vii) the relevant system operator, in coordination with the relevant TSO and with the power generating module owner, shall specify which of the above three reactive power control mode options and associated setpoints is to apply, and what further equipment is needed to make the adjustment of the relevant setpoint operable remotely;

(e) with regard to prioritising active or reactive power contribution, the relevant TSO shall specify whether active power contribution or reactive power contribution has priority during faults for which fault-ride-through capability is required. If priority is given to active power contribution, its provision shall be established no later than 150 ms from the fault inception;

(f) with regard to power oscillations damping control, if specified by the relevant TSO a power park module shall be capable of contributing to damping power oscillations. The voltage and reactive power control characteristics of power park modules must not adversely affect the damping of power oscillations.

Article 26
Robustness requirements applicable to AC-connected offshore power park modules

4. The robustness requirements of power generating modules laid down in paragraph 4 of Article 15 and paragraph 3 of Article 20 shall apply to AC-connected offshore power park modules.

5. The fault-ride-through capability requirements laid down in point (a) of Article 14(3) and point (a) of Article 16(3) shall apply to AC-connected offshore power park modules.

Article 15
General requirements for type C power generating modules

(…)

4. Type C power generating modules shall fulfil the following requirements relating to robustness:

(a) in the event of power oscillations, power generating modules shall retain steady-state stability when operating at any operating point of the P-Q-capability diagram;

(b) without prejudice to paragraph 4 and 5 of Article 13, power generating modules shall be capable of remaining connected to the network and operating without power reduction, as long as voltage and frequency remain within the specified limits pursuant to this Regulation;

(c) power generating modules shall be capable of remaining connected to the network during single-phase or three-phase auto-reclosures on meshed network lines, if applicable to the network to which they are connected. The details of that capability shall be subject to coordination and agreements on protection schemes and settings as referred to in point (b) of Article 14(5).

Article 20
Requirements for type B power park modules

(…)

3. Type B power park modules shall fulfil the following additional requirements in relation to robustness:

(a) the relevant TSO shall specify the post-fault active power recovery that the power park module is capable of providing and shall specify:

(i) when the post-fault active power recovery begins, based on a voltage criterion;

(ii) a maximum allowed time for active power recovery; and

(iii) a magnitude and accuracy for active power recovery;

(b) the specifications shall be in accordance with the following principles:

(i) interdependency between fast fault current requirements according to points (b) and (c) of paragraph (2) and active power recovery;

(ii) dependence between active power recovery times and duration of voltage deviations;

(iii) a defined limit of the maximum allowed time for active power recovery;

(iv) adequacy between the level of voltage recovery and the minimum magnitude for active power recovery; and

(v) adequate damping of active power oscillations.

Article 14
General requirements for type B power generating modules

(…)

3. Type B power generating modules shall fulfil the following requirements in relation to robustness:

(a) with regard to fault-ride-through capability of power generating modules:

(i) each TSO shall define a voltage-against-time-profile in line with Figure 3 at the connection point for fault conditions, which describes the conditions in which the power generating module is capable of staying connected to the network and continuing to operate stably after the power system has been disturbed by secured faults on the transmission system;

(ii) the voltage-against-time-profile shall express a lower limit of the actual course of the phase-to-phase voltages on the network voltage level at the connection point during a symmetrical fault, as a function of time before, during and after the fault;

(iii) the lower limit referred to in point (ii) shall be defined by the relevant TSO using the parameters set out in Figure 3, and within the ranges set out in Tables 3.1 and 3.2;

(iv) each TSO shall define and make publicly available the pre-fault and post-fault conditions for the fault-ride-through capability in terms of:

– the calculation of the pre-fault minimum short circuit capacity at the connection point;

– pre-fault active and reactive power operating point of the power generating module at the connection point and voltage at the connection point; and

– calculation of the post-fault minimum short circuit capacity at the connection point.

(v) at the request of a power generating facility owner, the relevant system operator shall provide the pre-fault and post-fault conditions to be considered for fault-ride-through capability as an outcome of the calculations at the connection point as defined in point (iv) regarding:

– pre-fault minimum short circuit capacity at each connection point expressed in MVA;

pre-fault operating point of the power generating module expressed in active power output and reactive power output at the connection point and voltage at the connection point; and

post-fault minimum short circuit capacity at each connection point expressed in MVA.

Alternatively, the relevant system operator may provide generic values derived from typical cases;

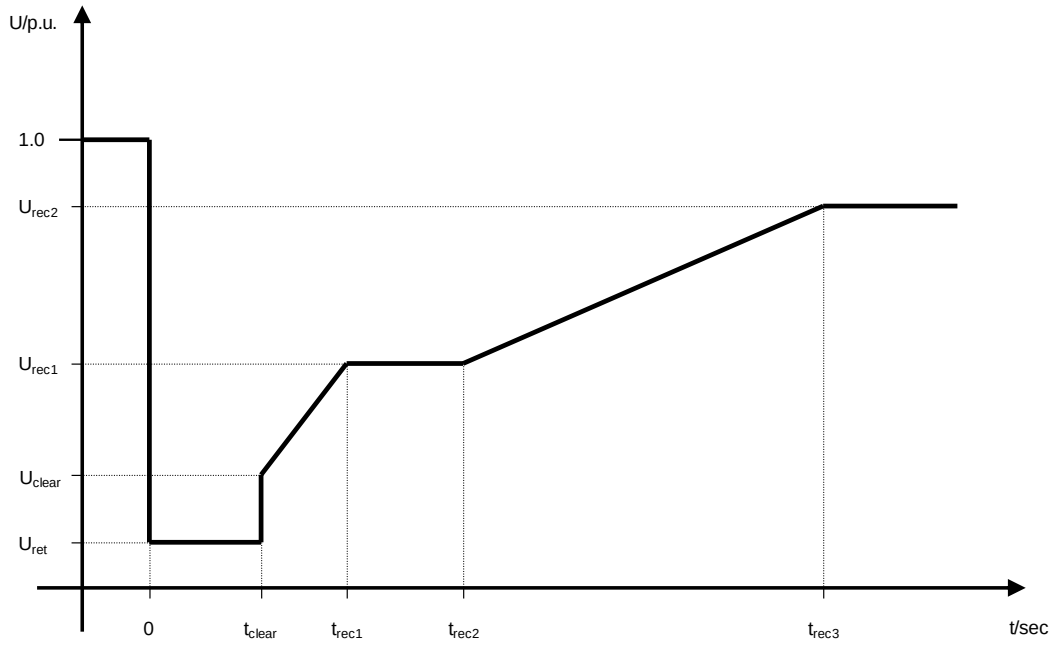

Figure 3: Fault-ride-through profile of a power generating module. The diagram represents the lower limit of a voltage-against-time profile of the voltage at the connection point, expressed as the ratio of its actual value and its nominal value per unit before, during and after a fault. U_{ret} is the retained voltage at the connection point during a fault, t_{clear} is the instant when the fault has been cleared. U_{rec1}, U_{rec2}, t_{rec1}, t_{rec2} and t_{rec3} specify

certain points of lower limits of voltage recovery after fault clearance.

Voltage parameters [pu]		**Time parameters [seconds]**	
U_{ret}:	0.05 – 0.3	t_{clear}:	0.14 – 0.15 (or 0.14 - 0.25 if system protection and secure operation so require)
U_{clear}:	0.7 – 0.9	t_{rec1}:	t_{clear}
U_{rec1}:	U_{clear}	t_{rec2}:	t_{rec1} – 0.7
U_{rec2}:	0.85 – 0.9 and ≥ U_{clear}	t_{rec3}:	t_{rec2} – 1.5

Table 3.1: Parameters for Figure 3 for fault-ride-through capability of synchronous power generating modules.

Voltage parameters [pu]		**Time parameters [seconds]**	
U_{ret}:	0.05 – 0.15	t_{clear}:	0.14 – 0.15 (or 0.14 - 0.25 if system protection and secure operation so require)
U_{clear}:	U_{ret} – 0.15	t_{rec1}:	t_{clear}
U_{rec1}:	U_{clear}	t_{rec2}:	t_{rec1}
U_{rec2}:	0.85	t_{rec3}:	1.5 – 3.0

Table 3.2: Parameters for Figure 3 for fault-ride-through capability of power park modules.

(vi) the power generating module shall be capable of remaining connected to the network and continuing to operate stably when the actual course of the phase-to-phase voltages on the network voltage level at the connection point during a symmetrical fault, given the pre-fault and post-fault conditions in points (iv) and (v) of Article 14(3)(a), remain above the lower limit defined in point (ii) of Article 14(3)(a), unless the protection scheme for internal electrical faults requires the disconnection of the power generating module from the network. The protection schemes and settings for internal electrical faults must not jeopardise fault-ride-through performance;

(vii) without prejudice to point (vi) of Article 14(3)(a), undervoltage protection (either fault-ride-through capability or minimum voltage defined at the connection point voltage) shall be set by the power generating facility owner

according to the widest possible technical capability of the power generating module, unless the relevant system operator requires narrower settings in accordance with point (b) of Article 14(5). The settings shall be justified by the power generating facility owner in accordance with this principle;

Article 16
General requirements for type D power generating modules

(…)

3. Type D power generating modules shall fulfil the following requirements in relation to robustness:

(a) with regard to fault-ride-through capability:

(i) power generating modules shall be capable of staying connected to the network and continuing to operate stably after the power system has been disturbed by secured faults. That capability shall be in accordance with a voltage-against-time profile at the connection point for fault conditions defined by the relevant TSO.

The voltage-against-time-profile shall express a lower limit of the actual course of the phase-to-phase voltages on the network voltage level at the connection point during a symmetrical fault, as a function of time before, during and after the fault.

That lower limit shall be defined by the relevant TSO, using the parameters set out in Figure 3 and within the ranges set out in Tables 7.1 and 7.2 for type D power generating modules connected at or above the 110 kV level.

That lower limit shall also be defined by the relevant TSO, using parameters set out in Figure 3 and within the ranges set out in Tables 3.1 and 3.2 for type D power generating modules connected below the 110 kV level.;

(ii) each TSO shall define the pre-fault and post-fault conditions for the fault-ride-through capability referred to in point (iv) of Article 14(3)(a). The defined pre-fault and post-fault conditions for the fault-ride-through capability shall be made publicly available;

Voltage parameters [pu]		**Time parameters [seconds]**	
U_{ret}:	0	t_{clear}:	0.14 – 0.15 (or 0.14 - 0.25 if system protection and secure operation security require)

U_{clear}:	0.25	t_{rec1}:	t_{clear} – 0.45
U_{rec1}:	0.5 – 0.7	t_{rec2}:	t_{rec1} – 0.7
U_{rec2}:	0.85 – 0.9	t_{rec3}:	t_{rec2} – 1.5

Table 7.1: Parameters for Figure 3 for fault-ride-through capability of synchronous power generating modules.

Voltage parameters [pu]		**Time parameters [seconds]**	
U_{ret}:	0	t_{clear}:	0.14 – 0.15 (or 0.14 - 0.25 if system protection and secure operation so require)
U_{clear}:	U_{ret}	t_{rec1}:	t_{clear}
U_{rec1}:	U_{clear}	t_{rec2}:	t_{rec1}
U_{rec2}:	0.85	t_{rec3}:	1.5 – 3.0

Table 7.2: Parameters for Figure 3 for fault-ride-through capability of power park modules.

Article 27

System restoration requirements applicable to AC-connected offshore power park modules

The system restoration requirements laid down respectively in paragraph 4 of Article 14 and paragraph 5 of Article 15 shall apply to AC-connected offshore power park modules.

Article 14

General requirements for type B power generating modules

(…)

4. Type B power generating modules shall fulfil the following requirements relating to system restoration:

(a) the relevant TSO shall define the conditions under which a power generating module is capable of reconnecting to the network after an incidental disconnection caused by a network disturbance; and

(b) installation of automatic reconnection systems shall be subject both to prior authorisation by the relevant system operator and to the reconnection conditions specified by the relevant TSO.

Article 15

General requirements for type C power generating modules

(…)

5. Type C power generating modules shall fulfil the following requirements relating to system restoration:

(a) with regard to black start capability:

(i) black start capability is not mandatory;

(ii) power generating facility owners shall, at the request of the relevant TSO, provide a quotation for providing black start capability. The relevant TSO may make such a request if it considers system security to be at risk due to a lack of black start capability in its control area;

(iii) a power generating module with black start capability shall be capable of starting from shutdown without any external electrical energy supply within a timeframe determined by the relevant system operator in coordination with the relevant TSO;

(iv) a power generating module with black start capability shall be able to synchronise within the frequency limits laid down in Article point (a) of

Article 13(1) and voltage limits specified by the relevant system operator or in paragraph 2 of Article 16, where applicable;

(v) a power generating module with black start capability shall be capable of automatically regulating dips in voltage caused by load connections;

(vi) a power generating module with black start capability shall:

– be capable of regulating load connections in block load;

– control frequency in case of overfrequency and underfrequency within the whole active power output range between minimum regulating level and maximum capacity as well as at houseload level;

– be capable of parallel operation of a few power generating modules within one island; and

– control voltage automatically during the system restoration phase;

(b) with regard to the capability to take part in island operation:

(i) power generating modules shall be capable of taking part in island operation if required by the relevant system operator in coordination with the relevant TSO and:

– the frequency limits for island operation shall be those established in accordance with point (a) of Article 13(1);

– the voltage limits for island operation shall be those established in accordance with paragraph 3 of Article 15 or paragraph 2 of Article 13, where applicable;

(ii) power generating modules shall be able to operate in FSM during island operation, as specified in point (d) of Article 15(2).

In the event of a power surplus, power generating modules shall be capable of reducing the active power output from a previous operating point to any new operating point within the P-Q-capability diagram. In that regard, the power generating module shall be capable of reducing active power output as much as inherently technically feasible, but to at least 55 % of its maximum capacity;

(iii) the method for detecting a change from interconnected system operation to island operation shall be agreed between the power generating facility owner and the relevant system operator in coordination with the relevant TSO. The agreed method of detection must not rely solely on the system operator's switchgear position signals;

(c) with regard to quick re-synchronisation capability:

(i) in case of disconnection of the power generating module from the network, the power generating module shall be capable of quick re-synchronisation in line with the protection strategy agreed between the relevant system operator in coordination with the relevant TSO and the power generation facility owner in

the event of disturbances to the system;

(ii) a power generating module with a minimum re-synchronisation time greater than 15 minutes after its disconnection from any external power supply must be designed to trip to houseload from any operating point in its P-Q-capability diagram. In this case, the identification of houseload operation must not be based solely on the system operator's switchgear position signals;

(iii) power generating modules shall be capable of continuing operation following tripping to houseload, irrespective of any auxiliary connection to the external network. The minimum operation time shall be specified by the relevant system operator in coordination with the relevant TSO, taking into consideration the specific characteristics of the prime mover technology.

Article 28
General system management requirements applicable to AC-connected offshore power park modules

The general system management requirements laid down in paragraph 5 of Article 14, paragraph 6 of Article 15 and paragraph 4 of Article 16 shall apply to AC-connected offshore power park modules.

Article 14
General requirements for type B power generating modules

(…)

5. Type B power generating modules shall fulfil the following general system management requirements:

(a) with regard to control schemes and settings:

(i) the schemes and settings of the different control devices of the power generating module that are necessary for transmission system stability and for taking emergency action shall be coordinated and agreed between the relevant TSO, the relevant system operator and the power generating facility owner;

(ii) any changes to the schemes and settings, mentioned in point (i), of the different control devices of the power generating module shall be coordinated and agreed between the relevant TSO, the relevant system operator and the power generating facility owner, in particular if they apply in the circumstances referred to in point (i) of Article 14(5) (a);

(b) with regard to electrical protection schemes and settings:

(i) the relevant system operator shall define the schemes and settings necessary to protect the network, taking into account the characteristics of the power generating module. The protection schemes needed for the power generating module and the network as well as the settings relevant to the power generating module shall be coordinated and agreed between the relevant system operator and the power generating facility owner,. The protection schemes and settings for internal electrical faults must not jeopardise the performance of a power generating module, in line with the requirements set out in this Regulation;

(ii) electrical protection of the power generating module shall take precedence over operational controls, taking into account the security of the system and the health and safety of staff and of the public, as well as mitigating any damage to the power generating module;

(iii) protection schemes may cover the following aspects:

– external and internal short circuit;

- asymmetric load (negative phase sequence);
- stator and rotor overload;
- over-/underexcitation;
- over-/undervoltage at the connection point;
- over-/undervoltage at the alternator terminals;
- inter-area oscillations;
- inrush current;
- asynchronous operation (pole slip);
- protection against inadmissible shaft torsions (for example, subsynchronous resonance);
- power generating module line protection;
- unit transformer protection;
- backup against protection and switchgear malfunction;
- overfluxing (U/f);
- inverse power;
- rate of change of frequency; and
- neutral voltage displacement.

(iv) changes to the protection schemes needed for the power generating module and the network and to the settings relevant to the power generating module shall be agreed between the system operator and the power generating facility owner, and be concluded before any changes are made;

(c) the power generating facility owner shall organise its protection and control devices in accordance with the following priority ranking (from highest to lowest):

(i) network and power generating module protection;

(ii) synthetic inertia, if applicable;

(iii) frequency control (active power adjustment);

(iv) power restriction; and

(v) power gradient constraint.

(d) with regard to information exchange:

(i) power generating facilities shall be capable of exchanging information between the power generating facility and the relevant system operator or the relevant TSO in real time or periodically with time stamping, as defined by the relevant system operator or the relevant TSO;

(ii) the relevant system operator, in coordination with the relevant TSO, shall

define the content of information exchanges and the precise list and time of data to be facilitated.

Article 15
General requirements for type C power generating modules

(…)

6. Type C power generating modules shall fulfil the following general system management requirements**:**

(a) with regard to loss of angular stability or loss of control, a power generating module shall be capable of disconnecting automatically from the network in order to help preserve system security or to prevent damage from the power generating module. The power generating facility owner and the relevant system operator in coordination with the relevant TSO shall agree on the criteria for detecting loss of angular stability or loss of control;

(b) with regard to instrumentation:

(i) Power generating facilities shall be equipped with a facility to provide fault recording and dynamic system behaviour monitoring of the following parameters:

– voltage;

– active power;

– reactive power; and

– frequency.

The relevant system operator shall have the right to define quality of supply parameters to be complied with on condition that reasonable prior notice is given;

(ii) the settings of the fault recording equipment, including triggering criteria and the sampling rates shall be agreed between the power generating facility owner and the relevant system operator in coordination with the relevant TSO;

(iii) the dynamic system behaviour monitoring shall include an oscillation trigger detecting poorly damped power oscillations, specified by the relevant system operator in coordination with the relevant TSO;

(iv) the facilities for quality of supply and dynamic system behaviour monitoring shall include arrangements for the power generating facility owner, and the relevant system operator and the relevant TSO to access the information. The communications protocols for recorded data shall be agreed between the power generating facility owner, the relevant system operator and the relevant TSO;

(c) with regard to the simulation models:

(i) at the request of the relevant system operator or the relevant TSO, the power generating facility owner shall provide simulation models which properly reflect the behaviour of the power generating module in both steady-state and dynamic simulations (50 Hz component) or in electromagnetic transient simulations.

The power generating facility owner shall ensure that the models provided have been verified against the results of compliance tests referred to in Chapters 2, 3 and 4 of Title 4, and shall notify the results of the verification to the relevant system operator or relevant TSO. Member States may require that such verification be carried out by an authorised certifier;

(ii) the models provided by the power generating facility owner shall contain the following sub-models, depending on the existence of the individual components:

– alternator and prime mover;

– speed and power control;

– voltage control, including, if applicable, power system stabiliser ('PSS') function and excitation control system;

– power generating module protection models, as agreed between the relevant system operator and the power generating facility owner; and

– converter models for power park modules;

(iii) the request by the relevant system operator referred to in point (i) shall be coordinated with the relevant TSO. It shall include:

– the format in which models are to be provided;

– the provision of documentation on a model's structure and block diagrams; and

– an estimate of the minimum and maximum short circuit capacity at the connection point, expressed in MVA, as an equivalent of the network;

(iv) the power generating facility owner shall provide power generating module recordings to the relevant system operator or relevant TSO if requested. The relevant system operator or relevant TSO may make such a request, in order to compare the response of the models with those recordings;

(d) with regard to the installation of devices for system operation and devices for system security, if the relevant system operator or the relevant TSO considers that it is necessary to install additional devices in a power generating facility in order to preserve or restore system operation or security, the relevant system operator or relevant TSO and the power generating facility owner shall investigate that matter and agree on an appropriate solution;

(e) the relevant system operator shall define, in coordination with the relevant TSO, minimum and maximum limits on rates of change of active power output (ramping limits) in both an up and down direction for a power generating module, taking into consideration the specific characteristics of the prime mover technology;

(f) earthing arrangement of the neutral-point at the network side of step-up transformers shall comply with the specifications of the relevant system operator.

Article 16
General requirements for type D power generating modules

(…)

4. Type D power generating modules shall fulfil the following general system management requirements:

(a) with regard to synchronisation, when starting a power generating module, synchronisation shall be performed by the power generating facility owner only after authorisation by the relevant system operator;

(b) the power generating module shall be equipped with the necessary synchronisation facilities;

(c) synchronisation of power generating modules shall be possible at frequencies within the ranges set out in Table 2;

(d) the relevant system operator and the power generating facility owner shall agree on the settings of synchronisation devices to be concluded prior to operation of the power generating module. This agreement shall cover:

(i) voltage;

(ii) frequency;

(iii) phase angle range;

(iv) phase sequence;

(v) deviation of voltage and frequency.

TITLE IV

COMPLIANCE

CHAPTER IV

COMPLIANCE TESTING FOR OFFSHORE POWER PARK MODULES

Article 49
Compliance tests for offshore power park modules

The compliance tests established in paragraph 2 of Article 43, as well as in paragraphs (2), (3), (4), (5), (7), (8) and (9) of Article 47 shall apply to offshore power park modules.

Article 43
Compliance tests for type B synchronous power generating modules

(…)

2. The following requirements with regard to the LFSM-O response test shall apply:

(a) the power generating module's technical capability to continuously modulate active power to contribute to frequency control in case of any large increase of frequency in the system shall be demonstrated. The steady-state parameters of regulations, such as droop and deadband and dynamic parameters, including frequency step change response shall be verified;

(b) the test shall be carried out by simulating frequency steps and ramps big enough to trigger at least 10 % of maximum capacity change in active power, taking into account the droop settings and the deadband. If required, simulated frequency deviation signals shall be injected simultaneously at both the speed and power control loops of the control systems, taking into account the scheme of those control systems;

(c) The test shall be deemed successful if the following conditions are fulfilled:

(i) the test results, for both dynamic and static parameters, meet the requirements set out in paragraph 2 of Article 13; and

(ii) undamped oscillations do not occur after the step change response.

Article 47
Compliance tests for type C power park modules

(…)

2. With regard to the active power controllability and control range test the following requirements shall apply:

(a) the power park module's technical capability to operate at a load level below the setpoint set by the relevant system operator or the relevant TSO shall be demonstrated.

(b) the test shall be deemed successful if the following conditions are fulfilled:

(i) the load level of the power park module is kept below the setpoint;

(ii) the setpoint is implemented according to the requirements laid down in Article 15(2) (a); and

(iii) the accuracy of the regulation complies with the value specified in point (a) of Article 15(2).

3. With regard to the LFSM-U response test the following requirements shall apply:

(a) the power park module's technical capability to continuously modulate active power to contribute to frequency control in case of a large frequency drop in the system shall be demonstrated;

(b) the test shall be carried out by simulating the frequency steps and ramps big enough to trigger at least 10 % of maximum capacity active power change with a starting point of no more than 80 % of maximum capacity, taking into account the droop settings and the deadband. If applicable, simulated frequency deviation signals shall be injected into the power park module controller scheme, taking into account both speed governor and load controller scheme.

(c) the test shall be deemed successful if the following conditions are fulfilled:

(i) the test results, for both dynamic and static parameters, comply with the requirements laid down in Article 15(2) (c); and

(ii) undamped oscillations do not occur after the step change response.

4. With regard to the FSM response test the following requirements shall apply:

(a) the power park module's technical capability to continuously modulate active power over the full operating range between maximum capacity and minimum regulating level to contribute to frequency control shall be demonstrated. The steady-state parameters of regulations, such as insensitivity, droop, deadband and range of regulation, as well as dynamic parameters, including frequency step change response shall be verified;

(b) the test shall be carried out by simulating frequency steps and ramps big enough to trigger the whole active power frequency response range, taking into account the droop settings and the deadband. Simulated frequency deviation signals shall be injected to perform the test.

(c) The test shall be deemed successful if the following conditions are fulfilled:

(i) the activation time of the full active power frequency response range as a result of a step in frequency change is no longer than that required by point (d) of Article 15(2);

(ii) undamped oscillations do not occur after the step change response;

(iii) the initial delay is in line with point (d) of Article 15(2);

(iv) the droop settings are available within the ranges defined in point (d) of Article 15(2) and the deadband (threshold) is not higher than the value chosen by the relevant TSO; and

(v) the insensitivity of active power frequency response does not exceed the requirement set out in point (d) of Article 15(2).

5. With regard to the frequency restoration control test the following requirements shall apply:

(a) the power park module's technical capability to participate in frequency restoration control shall be demonstrated. The cooperation of both FSM and frequency restoration control shall be checked;

(b) the test shall be deemed successful if the results for both dynamic and static parameters comply with the requirements of point (e) of Article 15(2).

6. (…)

7. With regard to the voltage control mode test the following requirements shall apply:

(a) the power park module's capability to operate in voltage control mode referred to in the conditions set out in points (ii) to (iv) of Article 21(3) (d) shall be demonstrated;

(b) The voltage control mode test shall verify the following parameters:

(i) the implemented slope and deadband of the static characteristic;

(ii) the accuracy of the regulation;

(iii) the insensitivity of the regulation; and

(iv) the time of reactive power activation;

(c) The test shall be deemed successful if the following conditions are fulfilled:

(i) the implemented slope and deadband of the static characteristic;

(ii) the range of regulation and adjustable droop and deadband complies with the agreed or decided characteristic parameters set out in point (d) of Article 21(3);

(iii) the insensitivity of voltage control is not higher than 0.01 pu, in accordance with point (d) of Article 21(3); and

(iv) following a step change in voltage, 90 % of the change in reactive power output has been achieved within the times and tolerances specified in point (d) of Article 21(3).

8. With regard to the reactive power control mode test the following requirements shall apply:

(a) the power park module's capability to operate in reactive power control mode, in accordance with point (v) of Article 21(3) (d), shall be demonstrated;

(b) the reactive power control mode test shall be complementary to the reactive power capability test;

(c) the reactive power control mode test shall verify the following parameters:

(i) the reactive power setpoint range and step;

(ii) the accuracy of the regulation; and

(iii) the time of reactive power activation.

(d) the test shall be deemed successful if the following conditions are fulfilled:

(i) the reactive power setpoint range and step are ensured in accordance with point (d) of Article 21(3); and

(ii) the accuracy of the regulation complies with the conditions set out in point (d) of Article 21(3).

9. With regard to the power factor control mode test the following requirements shall apply:

(a) the power park module's capability to operate in power factor control mode in accordance with point (vi) of Article 21(3) (d) shall be demonstrated;

(b) the power factor control mode test shall verify the following parameters:

(i) the power factor setpoint range;

(ii) the accuracy of the regulation; and

(iii) the response of reactive power due to step change of active power;

(c) the test shall be deemed successful if the following conditions are cumulatively fulfilled:

(i) the power factor setpoint range and step are ensured in accordance with point (d) of Article 21(3);

(ii) the time of reactive power activation as a result of step active power change does not exceed the requirement laid down in point (d) of Article 21(3); and

(iii) the accuracy of the regulation complies with the value specified in point (d) of Article 21(3).

CHAPTER VII

COMPLIANCE SIMULATIONS FOR OFFSHORE POWER PARK MODULES

Article 56
Compliance simulations applicable to offshore power park modules

The compliance simulations defined in paragraphs 3 and 5 of Article 53 as well as in paragraphs 4, 5 and 7 of Article 54 shall apply to any offshore power park module.

Article 53
Compliance simulations for type B power park modules

(…)

3. With regard to the fast acting additional reactive current injection simulation the following requirements shall apply:

   (a) the power generating module's capability to simulate fast acting additional reactive current injection in accordance with the conditions set out in point (b) of Article 20(2) shall be demonstrated;

   (b) the simulation shall be deemed successful if compliance with the requirement laid down in point (b) of Article 20(2) is demonstrated.

4. (…)

5. The following requirements with regard to the post fault power active recovery simulation shall apply:

   (a) the power generating module's capability to simulate post fault active power recovery in accordance with the conditions set out in paragraph 3 of Article 20 shall be demonstrated;

   (b) The simulation shall be deemed successful if compliance with the requirement laid down in paragraph 3 of Article 20 is demonstrated.

Article 54
Compliance simulations for type C power park modules

(…)

4. With regard to the island operation simulation, the following requirements shall apply:

   (a) the power generating module's performance during island operation in accordance with the conditions set out in point (b) of Article 15(5) shall be demonstrated;

(b) the simulation shall be deemed successful in the event that the power generating module reduces or increases the active power output from its previous operating point to any new operating point, within the P-Q-capability diagram and within the limits set out in point (b) of Article 15(5), without disconnection of the power generating module from the island due to over-/underfrequency.

5. With regard to the simulation of the capability of providing synthetic inertia, the following requirements shall apply:

(c) the model of the power generating module shall demonstrate that it can simulate the capability of providing synthetic inertia to a low frequency event as set out in point (a) of Article 21(2);

(d) the simulation shall be deemed successful if the model demonstrates that it complies with the conditions set out in paragraph 2 of Article 21.

6. (…)

7. With regard to the power oscillations damping control simulation, the following requirements shall apply:

(a) the model of the power generating module shall demonstrate that it can simulate power oscillations damping capability accordance with point (f) of Article 21(3);

(b) the simulation shall be deemed successful in the event that the model demonstrates compliance with the conditions described in point (f) of Article 21(3).