ENTSO-E Network Code for

Requirements for Grid Connection Applicable to all Generators

26 June 2012

Notice
This document reflects the work done by ENTSO-E in line with the ACER Framework Guidelines on Electricity Grid Connections published on 20 July 2011 after the EC mandate letter was received by ENTSO-E on 29 July 2011. This document takes into account the comments received by ENTSO-E during the public consultation of the "Draft Network Code for requirements for grid connection applicable to all generators" it has organised between 24 January and 20 March 2012 in an open and transparent manner in compliance with Article 10 of Regulation (EC) 714/2009. It furthermore includes the outcomes of numerous bilateral and common user group meetings and working sessions with stakeholders, the DSOs Technical Expert Group, as well as bilateral/trilateral meetings with ACER and with the EC. **In addition, this document is based on the input of an extensive informal dialogue with stakeholders and of several public workshops that took place during the pilot period between the Summer of 2009 and 3 March 2011, the date on which Regulation (EC) 714/2009 entered into force.** **This document is now called "Network code for requirements for grid connection applicable to all generators" and is submitted to ACER for ACER's reasoned opinion pursuant to Article 6 of Regulation (EC) 714/2009.**

PURPOSE AND OBJECTIVES

Having regard to 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;

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 and especially Article 6;

Having regard to the priority list issued by the European Commission on 22 December 2010;

Having regard to the Framework Guidelines on Electricity Grid Connection issued by the Agency for the Cooperation of Energy Regulators (ACER) on 20 July 2011;

Whereas :

(1) 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/CE and Regulation 714/2009 of the European Parliament and of the Council of 13 July 2009 (whereas section 6) underline the need for an increased cooperation and coordination among transmission system operators within a European network of transmission system operators for electricity (ENTSO-E) to create Network Codes for providing and managing effective and transparent access to the transmission networks across borders, and to ensure coordinated and sufficiently forward-looking planning and sound technical evolution of the transmission system in the Community, including the creation of interconnection capacities, with due regard to the environment ;

(2) Transmission system operators (TSOs) are according to Articles 2 and 12 of Directive 2009/72/EC responsible for providing and operating high and extra-high voltage networks for long-distance transmission of electricity as well as for supply of lower-level regional distribution systems and directly connected customers. Apart from this transmission and supply task it is also the TSOs' responsibility to ensure the system security with a high level of reliability and quality;

(3) Distribution system operators (DSOs) are according to Articles 2 and 25 of Directive 2009/72/EC responsible for providing and operating low, medium and high voltage networks for regional distribution of electricity as well as for supply of lower-level distribution systems and directly connected customers. Besides the regional distribution and supply task it is also the DSOs' responsibility to ensure the security of their networks with a high level of reliability and quality.

(4) Secure system operation is only possible by close cooperation between Power Generating Facility Owners and Network Operators. In particular, the system behaviour in disturbed operating conditions depends upon 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 need to be considered as one entity from a systems engineering approach, respecting that the security of both parts of the system (network or generation) are interdependent

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

of the other part. It is therefore of crucial importance that Power Generating Modules are obliged to meet the relevant technical requirements set out in the Network Code concerning system security as a prerequisite for grid connection. Appropriate dynamic behaviour of Power Generating Modules and their protection and control facilities are necessary in normal operating conditions and in a range of disturbed operating conditions in order to preserve or to re-establish system security. The close cooperation between Power Generating Facility Owners and Network Operators shall take place in due compliance with the principle of confidentiality, such as further detailed in Article 16(1) of Directive 2009/72/EC.

(5) ENTSO-E has drafted this Network Code for grid connection requirements aiming at setting out clear and objective requirements for Power Generating Modules for grid connection in order to contribute to non-discrimination, effective competition and the efficient functioning of the internal electricity market and to ensure system security.

(6) Regulation (EC) 714/2009 in its Article 9(7) defines that "the network codes shall be developed for cross-border network issues and market integration issues and shall be without prejudice to the Member States' right to establish national network codes which do not affect cross-border trade".

For the purposes of this Network Code the definition of cross-border network issues and market integration issues is derived with due consideration to the targets of the EC 3rd legislative package for the internal electricity market, namely:

- supporting the completion and functioning of the internal market in electricity and cross-border trade
- facilitating the targets for penetration of renewable generation
- maintaining security of supply

The interconnected transmission system establishes the wholesale platform for the internal electricity market. TSOs are responsible for maintaining, preserving and restoring security of the interconnected system with a high level of reliability and quality, which in this context is the essence in facilitating cross-border trading.

As indicated in (4) above, system security cannot be ensured independently from the technical capabilities of Power Generating Modules. Regular coordination at the level of generation and adequate performance of equipment connected to the networks with robustness to face disturbances and to help to prevent any large disturbance or to facilitate restoration of the system after a collapse are fundamental prerequisites.

Also as stated in (4) above, secure system operation is only possible by close cooperation of Power Generating Facility Owners with Network Operators in an appropriate way. Consequently, the transmission system and the Power Generating Modules need to be considered as one entity from a systems engineering perspective. It is therefore of crucial importance that Power Generating Modules are obliged to meet the requirements and to provide the technical capabilities with relevance to system security.

To ensure system security within the interconnected transmission system and to provide adequate security level a common understanding on these requirements for Power Generating Modules is essential. All 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 achieving cost efficiencies through harmonization of requirements shall be regarded as "cross-border network issues and market integration issues".

Pursuant to Article 6 of Regulation (EC) 714/2009, ENTSO-E shall submit this Network Code to ACER.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Title 1

GENERAL PROVISIONS

Article 1

SUBJECT MATTER

This Network Code defines a common framework of grid connection requirements for Power Generating Facilities, including Synchronous Power Generating Modules, Power Park Modules and Offshore Generation Facilities. It also defines a common framework of obligations for Network Operators to appropriately make use of the Power Generating Facilities' capabilities in a transparent and non-discriminatory manner ensuring a level-playing field throughout the European Union.

Article 2

DEFINITIONS (glossary)

For the purpose of this Network Code, the following definitions shall apply:

Active Power - is the real component of the Apparent Power at fundamental Frequency, expressed in watts or multiples thereof (e.g. kilowatts (kW) or megawatts (MW)).

Active Power Frequency Response - is an automatic response of Active Power output from a Power Generating Module, in response to a change in system Frequency from the nominal system Frequency.

Agency – The Agency for the Cooperation of Energy Regulators (ACER) as established by Regulation (EC) No 713/2009

Alternator – is a device that converts mechanical energy into electrical energy by means of a rotating magnetic field.

Apparent Power - is the product of Voltage and Current at fundamental Frequency. It is usually expressed in kilovolt-amperes (kVA) or megavolt-amperes (MVA) and consists of a real component (Active Power) and an imaginary component (Reactive Power).

Authorised Certifier - is an entity to issue Equipment Certificates. The accreditation of the Authorised Certifier shall be given from the national affiliation of the European co-operation for Accreditation (EA), established according to Regulation (EC) 765/2008.

Automatic Voltage Regulator (AVR) - is 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 by appropriate means the output of an Excitation System, depending on the deviations.

Black Start Capability - is the capability of recovery of a Power Generating Module from a total shutdown through a dedicated auxiliary power source without any energy supply which is external to the Power Generating Facility.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Closed Distribution System Operator (CDSO) - is a natural or legal person operating, ensuring the maintenance of and, if necessary, developing a closed distribution Network according to Article 28 of Directive 2009/72/CE.

Compliance Monitoring - is the process to verify that the (technical) capabilities of Power Generating Modules are maintained compliant by the Power Generating Facility Owner with the specifications and requirements of this Network Code.

Compliance Simulation - is the process to verify that Power Generating Modules are compliant with the specifications and requirements of this Network Code, for example before starting their operation. The verification should include, inter alia, the revision of documentation, the verification of the requested capabilities of the Power Generating Module by simulation studies and the revision against actual measurements.

Compliance Testing - is the process to verify that Power Generating Modules are compliant with the specifications and requirements of this Network Code, for example before starting their operation. The verification includes, inter alia, the revision of documentation, the verification of the requested capabilities of the Power Generating Module by practical tests.

Connection Agreement - is a contract between the Relevant Network Operator and the Power Generating Facility Owner which includes the relevant site and technical specific requirements for the Power Generating Facility.

Connection Point - is the interface at which the Power Generating Module is connected to a transmission, distribution or closed distribution Network according to Article 28 of Directive 2009/72/CE as identified in the Connection Agreement.

Control Area - is a part of the interconnected electricity transmission system controlled by a single TSO.

Cost-Benefit Analysis – is a process by which the Relevant Network Operator weighs the expected costs of alternative actions aiming at the same objective against the expected benefits in order to determine the alternative with the highest net socio-economic benefit. If applicable, the alternatives include network-based and market-based actions.

Current - unless stated otherwise, Current refers to the root-mean-square value of the positive sequence of the phase Current at fundamental Frequency.

Derogation - is a time limited or indefinite (as specified) acceptance in writing of a non-compliance of a Power Generating Module with regard to identified requirements of this Network Code.

Droop - is the ratio of the steady-state change of Frequency (referred to nominal Frequency) to the steady-state change in power output (referred to Maximum Capacity).

Distribution System Operator (DSO) - is a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution Network in a given area and, where applicable, its interconnections with other Networks and for ensuring the long-term ability of the Network to meet reasonable demands for the distribution of electricity.

Energisation Operational Notification (EON) - is a notification issued by the Relevant Network Operator to a Power Generating Facility Owner prior to energisation of its internal Network. An EON entitles the Power Generating Facility Owner to energise its internal Network by using the grid connection.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Equipment Certificate - is a document issued by an Authorised Certifier for equipment used in Power Generating Modules confirming performance in respect of the requirements of this Network Code. In relation to those parameters, for which this Network Code defines ranges rather than definite values, the Equipment Certificate shall define the extent of its validity. This will identify 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 can additionally include models confirmed against test results for the purpose of replacing specific parts of the compliance process for Type B, C and D Power Generating Modules. The Equipment Certificate will have a unique number allowing simple reference to it in the Installation Document or the Power Generating Module Document.

Excitation System - is the equipment providing the field Current of a synchronous electrical machine, including all regulating and control elements, as well as field discharge or suppression equipment and protective devices.

Existing Power Generating Module - is a Power Generating Module which is not a New Power Generating Module.

Final Operational Notification (FON) - is a notification issued by the Relevant Network Operator to a Power Generating Facility Owner confirming that the Power Generating Facility Owner is entitled to operate the Power Generating Module by using the grid connection because compliance with the technical design and operational criteria has been demonstrated as referred to in this Network Code.

Frequency - is the Frequency of the electrical power system that can be measured in all Network areas of the synchronous system under the assumption of a coherent value for the system in the time frame of seconds (with minor differences between different measurement locations only); its nominal value is 50 Hz.

Frequency Control - is the capability of a Power Generating Module to control speed by adjusting the Active Power Output in order to maintain stable system Frequency (also acceptable as speed control for Synchronous Power Generating Modules).

Frequency Response Deadband - is used intentionally to make the Frequency Control not responsive. In contrast to (in)sensitivity, deadband has an artificial nature and basically is adjustable.

Frequency Response Insensitivity - is the inherent feature of the control system defined as the minimum magnitude of the Frequency (input signal) which results in a change of output power (output signal).

Frequency Sensitive Mode (FSM) - is a Power Generating Module operating mode which will result in Active Power output changing, in response to a change in System Frequency, in a direction which assists in the recovery to Target Frequency, by operating so as to provide Frequency Response.

Houseload Operation - in case of Network failures resulting in disconnection of Power Generating Modules from the Network and being tripped onto their auxiliary supplies, house-load operation ensures that Power Generating Facilities are able to continue to supply their in-house loads.

Inertia - is the fact that a rotating rigid body such as an Alternator maintains its state of uniform rotational motion. Its angular momentum is unchanged, unless an external torque is applied. In the context of this code, this definition refers to the technologies for which Alternator speed and system Frequency are coupled.

Installation Document - is a simple structured document (data/tick sheet) containing information about a Type A Power Generating Module and confirming compliance with the relevant

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

requirements of this Network Code. The blank Installation Document shall be available from the Relevant Network Operator for the Type A Power Generating Facility Owner or alternatively the site installer on the owner's behalf to fill in and submit to the Relevant Network Operator.

Instruction - is a command given orally, manually or by automatic remote control facilities, e. g. a Setpoint, from a Network Operator to a Power Generating Facility Owner in order to perform an action.

Interim Operational Notification (ION) - is a notification issued by the Relevant Network Operator to a Power Generating Facility Owner confirming that the Power Generating Facility Owner is entitled to operate the Power Generating Module by using the grid connection for a limited period of time and to undertake compliance tests to meet the technical design and operational criteria of this Network Code.

Island Operation - is the independent operation of a whole or a part of the Network that is isolated after its disconnection from the interconnected system, having at least one Power Generating Module supplying power to this Network and controlling the Frequency and Voltage.

Limited Frequency Sensitive Mode – Overfrequency (LFSM-O) - is a Power Generating Module operating mode which will result in Active Power output reduction in response to a change in System Frequency above a certain value.

Limited Frequency Sensitive Mode – Underfrequency (LFSM-U) - is a Power Generating Module operating mode which will result in Active Power output increase in response to a change in System Frequency below a certain value.

Limited Operational Notification (LON) - is a notification issued by the Relevant Network Operator to a Power Generating Facility Owner which has previously reached FON status, but is temporarily subject to either a significant modification or loss of capability which has resulted in non-compliance to the Network Code.

Maximum Capacity - is the maximum continuous Active Power which a Power Generating Module can feed into the Network as defined in the Connection Agreement or as agreed between the Relevant Network Operator and the Power Generating Facility Owner. It is also referred to in this Network Code as P_{max}.

Minimum Regulating Level - is the minimum Active Power as defined in the Connection Agreement or as agreed between the Relevant Network Operator and the Power Generating Facility Owner, that the Power Generating Module can regulate down to and can provide Active Power control.

Minimum Stable Operating Level - is the minimum Active Power as defined in the Connection Agreement or as agreed between the Relevant Network Operator and the Power Generating Facility Owner, at which the Power Generating Module can be operated stably for unlimited time.

Network - is plant and apparatus connected together in order to transmit or distribute electrical power.

Network Operator - is an entity that operates a Network. These can be either a TSO, a DSO or CDSO.

New Power Generating Module - is a Power Generating Module for which

- with regard to the provisions of the initial version of this Network code, a final and binding contract of purchase of the main plant has been signed after the day, which is two years after the day of the entry into force of this Network Code, or,

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

- with regard to the provisions of the initial version of this Network code, no confirmation is provided by the Power Generating Facility Owner, with a delay not exceeding thirty months as from the day of entry into force of this Network Code, that a final and binding contract of purchase of the main plant exists prior to the day, which is two years after the day of the entry into force of this Network Code, or,
- with regard to the provisions of any subsequent amendment to this Network Code and/or after any change of thresholds pursuant to the re-assessment procedure of Article 3(6), a final and binding contract of purchase of the main plant has been signed after the day, which is two years after the entry into force of any subsequent amendment to this Network Code and/or after the entry into force of any change of thresholds pursuant to the re-assessment procedure of Article 3(6).

Offshore Connection Point - is a Connection Point located offshore.

Offshore Grid Connection System - is the complete interconnection between the Offshore Connection Point and the connection to the interconnected onshore system at the Onshore Grid Interconnection Point.

Offshore Power Park Module - is a Power Park Module located offshore with an Offshore Connection Point.

Onshore Grid Interconnection Point - is the point at which the Offshore Grid Connection System is connected to the onshore Network of the Relevant Network Operator.

Overexcitation Limiter - is a control device within the AVR which prevents the rotor of an Alternator from overload by limiting the excitation Current.

Power Factor - is the ratio of Active Power to Apparent Power.

Power Generating Facility - is a facility to convert primary energy to electrical energy which consists of one or more Power Generating Modules connected to a Network at one or more Connection Points.

Power Generating Facility Owner - is a natural or legal entity owning a Power Generating Facility.

Power Generating Module - is either a

- Synchronous Power Generating Module, or
- a Power Park Module.

Power Generating Module Document (PGMD) - is a document issued by the Power Generating Facility Owner to the Relevant Network Operator for a Type B or C Power Generating Module. The PGMD is intended to contain information confirming that the Power Generating Module has demonstrated compliance with the technical criteria as referred to in this Network Code and provided the necessary data and statements including a Statement of Compliance.

Power Park Module (PPM) - is a unit or ensemble of units generating electricity, which

- is connected to the Network non-synchronously or through power electronics, and
- has a single Connection Point to a transmission, distribution or closed distribution Network.

Power System Stabilizer (PSS) - is an additional functionality of the AVR of a Synchronous Power Generating Module with the purpose of damping power oscillations.

Pump-Storage - is a hydro unit in which water can be raised by means of pumps and stored to be used later for the generation of electrical energy.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

P-Q-Capability Diagram - describes the Reactive Power capability of a Power Generating Module in context of varying Active Power at the Connection Point.

Reactive Power - is the imaginary component of the Apparent Power at fundamental Frequency, usually expressed in kilovar (kvar) or megavar (Mvar).

Relevant National Regulatory Authority - is the regulatory authority as referred to in Article 35(1) of Directive 2009/72/EC.

Relevant CDSO - is the CDSO to whose Network a Power Generating Module is or will be connected.

Relevant DSO - is the DSO to whose Network a Power Generating Module is or will be connected.

Relevant Network Operator - is the operator of the Network to which a Power Generating Module is or will be connected.

Relevant TSO - is the TSO in whose Control Area a Power Generating Module is or will be connected to the Network at any Voltage level.

Secured Fault - is defined as a fault, which is successfully cleared by Network protection according to the Network Operator's planning criteria.

Setpoint - is a target value for any parameter typically used in control schemes.

Significant Power Generating Module - is a Power Generating Module which is deemed significant on the basis of its impact on the cross-border system performance via influence on the control area's security of supply, which is identified according to the criteria set forth in this Network Code and falls within one of the categories provided in Article 3(6).

Slope - is the ratio of the change in Voltage, based on nominal Voltage, to a change in Reactive Power infeed from zero to maximum Reactive Power, based on maximum Reactive Power.

Statement of Compliance - is a document provided by the Power Generating Facility Owner to the Network Operator stating the current status with respect to compliance itemised for each relevant element of this Network Code.

Steady-State Stability - if the Network or a Synchronous Power Generating Module previously in the steady-state reverts to this state again following a sufficiently minor disturbance, it has Steady-State Stability.

Synchronous Compensation Operation - is the operation of an Alternator without prime mover to regulate Voltage dynamically by production or absorption of Reactive Power

Synchronous Power Generating Module - is an indivisible set of installations which can generate electrical energy. It is either a

- a single synchronous unit generating power within a Power Generating Facility directly connected to a transmission, distribution or closed distribution Network, or
- an ensemble of synchronous units generating power within a Power Generating Facility directly connected to a transmission, distribution or closed distribution Network with a common Connection Point, or
- an ensemble of synchronous units generating power within a Power Generating Facility directly connected to a transmission, distribution or closed distribution Network that cannot be operated independently from each other (e. g. units generating in a combined-cycle gas turbine facility), or

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

- a single synchronous storage device operating in electricity generation mode directly connected to a transmission, distribution or closed distribution Network, or
- an ensemble of synchronous storage devices operating in electricity generation mode directly connected to a transmission, distribution or closed distribution Network with a common Connection Point.

Synthetic Inertia - is a facility provided by a Power Park Module to replicate the effect of Inertia of a Synchronous Power Generating Module to a prescribed level of performance.

Transmission System Operator (TSO) - is a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity.

U-Q/P_{max}-profile - is a profile representing the Reactive Power capability of a Power Generating Module in context of varying Voltage at the Connection Point.

Underexcitation Limiter - is a control device within the AVR, the purpose of which is to prevent the Alternator from losing synchronism due to lack of excitation.

Voltage - unless stated otherwise, Voltage refers to the root-mean-square value of the positive sequence of the phase-to-phase Voltages at fundamental Frequency.

1 pu grid Voltage - for the 400 kV grid Voltage level (or alternatively commonly referred to as 380 kV level) the reference 1 pu value is 400 kV, for other grid Voltage levels the reference 1 pu Voltage may differ for each TSO in the same synchronous area i.e. the Voltage range in kV for all TSOs within a synchronous area may not be the same.

Article 3

SCOPE

1. The requirements set forth by this Network Code shall apply to New Power Generating Modules in a Member State which are significant according to the provisions of this Network Code unless otherwise provided in this Network Code.

2. The requirements set forth by this Network Code shall apply to Existing Power Generating Modules in a Member State which are significant according to the provisions of this Network Code, to the extent their applicability has been decided by the National Regulatory Authority of the Member State, and if this has been proposed by the Relevant TSO, following a public consultation. The proposal by the Relevant TSO shall be made in particular on the basis of a sound and transparent quantitative Cost-Benefit Analysis, including the costs of requiring compliance that shall demonstrate the socio-economic benefit of application of the requirements set forth by this Network Code to Existing Power Generating Modules. The Relevant TSO shall have the right to re-assess, in case of factual change such as the evolution of system requirements (e.g. penetration of renewable energy sources, smart grids, distributed generation, demand response, etc.), the applicability of the requirements set forth by this Network Code to Existing Power Generating Modules regularly, but not more often than every three years and respecting the provisions of Article 4(3). The relevant TSO shall notify the launch of the procedure for re-assessment on its website. The date of notification on the website shall

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

constitute the first day of the launch of the procedure for re-assessment. A public consultation shall be conducted in the frame of the procedure for re-assessment. Prior to the Relevant TSO carrying out the quantitative Cost-Benefit Analysis an initial qualitative comparison of costs and benefits shall be undertaken in order to determine the cases of sizes of Power Generating Modules or types of Power Generating Modules or locations of Power Generating Modules or clauses of this Network Code for which there may be a viable case for application to Existing Power Generating Modules. Where this preparatory stage demonstrates that a subsequent analytical Cost-Benefit Analysis has a reasonable prospect of demonstrating positive cost-benefit, the Relevant TSO may proceed with the full transparent quantitative Cost-Benefit Analysis. Where the preparatory stage or later stage demonstrate that applicability of the Network Code to Existing Power Generating Modules is not required no further action is to be undertaken.

3. Existing Power Generating Modules not covered by Article 3(2) shall continue to be bound by such technical requirements that apply to them pursuant to legislation in force in the respective Member States or contractual arrangements in force. Should national legislation be repealed or cease to be in force, the Existing Power Generation Module not covered by Article 3(2) shall continue to be bound by such technical requirements that applied to it pursuant to the respective national legislation such as it was the day prior to it ceasing to be in force.

4. With regard to Power Generating Modules not yet connected to the Network:

   a) Within a delay not exceeding thirty months as from the day of entry into force of this Network Code, the Power Generating Facility Owner shall provide the Relevant Network Operator with a confirmation of final and binding contracts it has concluded for the construction, assembly or purchase of the main plant of a Power Generating Module with relevance to the provisions of this Network Code and which exists prior to the day, which is two years after the day of entry into force of this Network Code.

   b) The confirmation shall at least indicate the contract title, its date of signature and of entry into force, and the specifications of the main plant to be constructed, assembled or purchased.

   c) The Relevant Network Operator may demand that the National Regulatory Authority confirms the existence, relevance and finality of such a contract, i.e. that its material terms can no longer be changed by one of the parties to the contract unilaterally and that no party to the contract has the right to terminate it at will. The Power Generating Facility Owner shall supply the National Regulatory Authority with all documents the National Regulatory Authority requests in order to ascertain that a binding and final contract exists.

   d) The Power Generating Module shall be considered as an Existing Power Generating Module, provided that:

      1) In accordance with Article 3(4) (a) and (b) above, the Relevant Network Operator is provided with sufficient evidence of the existence of binding and final contracts for the construction, assembly or purchase of the main plant of a Power Generating Module exists prior to the day, which is two years after the day of entry into force of this Network Code; or

      2) Following the verification performed by the National Regulatory Authority in accordance with Article 3(4) (c), it is ascertained that binding and final contracts for the construction, assembly or purchase of the main plant of a Power Generating Module exist prior to the day, which is two years after the day of entry into force of this Network Code.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

e) In case the Power Generating Facility Owner does not provide the Relevant Network Operator with the confirmation within the delay set forth in Article 3(4) (a), the Power Generating Module shall be considered as a New Power Generating Module.

5. The applicability and extent of the requirements a Power Generating Modules has to comply with depends on the Voltage level of their Connection Point and their Maximum Capacity according to the categories defined in Article 3 (6).

6. Power Generating Modules which are considered to be Significant Power Generating Modules within the scope of this Network Code are categorized as follows:

a) A Power Generating Module is of Type A if its Connection Point is below 110 kV and its Maximum Capacity is 0.8 kW or more. Requirements applicable to Type A Power Generating Modules are the basic level requirements, necessary to ensure capability of generation over operational ranges with limited automated response and minimal system operator control of generation. They ensure there is no wide scale loss of generation over system operational ranges, thereby minimizing critical events, and include requirements necessary for wide spread intervention during system critical events.

b) A Power Generating Module is of Type B if its Connection Point is below 110 kV and its Maximum Capacity is at or above a threshold defined by each Relevant TSO while respecting the provisions of Article 4(3). This threshold shall not be above the threshold for Type B Power Generating Modules according to table 1. The definition of the threshold shall be coordinated with adjacent TSOs and DSOs and shall be reviewed by the National Regulatory Authority. Power Generating Facility Owners shall assist and contribute to this determination of the threshold and provide the relevant data as requested by the Relevant TSO. The Relevant TSO shall have the right to re-assess the determination of the threshold regularly, if relevant circumstances have changed materially, but not more often than every three years and respecting the provisions of Article 4(3). A public consultation shall be conducted in the frame of the procedure for re-assessment. Following any change to thresholds any Power Generating Module that has been moved to a new type will not automatically have to comply retroactively with the additional requirements but will be subject to the same procedure as applied to Existing Power Generating Modules in line with Article 33. Requirements applicable to Type B Power Generating Modules provide a wider level of automated dynamic response with higher resilience to more specific operational events to ensure use of this higher dynamic response and a higher level system operator control and information to utilize these capabilities. They ensure automated response to alleviate and maximize dynamic generation response to system events, greater Power Generating Module resilience of these events to ensure this dynamic response and better communication and control to leverage these capabilities.

c) A Power Generating Module is of Type C if its Connection Point is below 110 kV and its Maximum Capacity is at or above a threshold defined by each Relevant TSO while respecting the provisions of Article 4(3). This threshold shall not be above the threshold for Type C Power Generating Modules according to table 1. The definition of the threshold shall be coordinated with adjacent TSOs and DSOs and shall be reviewed by the National Regulatory Authority. Power Generating Facility Owners shall assist and contribute to this determination of the threshold and provide the relevant data as requested by the Relevant TSO. The Relevant TSO shall have the right to re-assess the determination of the threshold regularly, if relevant circumstances have changed materially, but not more often than every three years and respecting the provisions of Article 4(3). A public consultation shall be conducted in the frame of the procedure for re-assessment. Following any change to

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

thresholds any Power Generating Module that has been moved to a new type will not automatically have to comply retroactively with the additional requirements but will be subject to the same procedure as applied to Existing Power Generating Modules in line with Article 33. Requirements applicable to Type C Power Generating Modules provide refined, stable and highly controllable (real time) dynamic response to provide principle ancillary services to ensure security of supply. These requirements cover all operational Network states with consequential detailed specification of interactions of requirements, functions, control and information to utilize these capabilities. They ensure real time system response necessary to avoid, manage and respond to system events. These requirements provide sufficient generation functionality to respond to both intact and system disturbed situations, and the need for information and control necessary to utilise this generation over this diversity of situations.

Synchronous Area	**maximum capacity threshold from which on a Power Generating Module is of Type B**	**maximum capacity threshold from which on a Power Generating Module is of Type C**	**maximum capacity threshold from which on a Power Generating Module is of Type D**
Continental Europe	1 MW	50 MW	75 MW
Nordic	1.5 MW	10 MW	30 MW
Great Britain	1 MW	10 MW	30 MW
Ireland	0.1 MW	5 MW	10 MW
Baltic	0.5 MW	10 MW	15 MW

Table 1: Thresholds for Type B, C and D Power Generating Modules

d) A Power Generating Module is of Type D if its Connection Point is at 110 kV or above. A Synchronous Power Generating Module or Power Park Module is of Type D as well if its Connection Point is below 110 kV and its Maximum Capacity is at or above a threshold defined by each Relevant TSO while respecting the provisions of Article 4(3). This threshold shall not be above the threshold for Type D Power Generating Modules according to table 1. The definition of the threshold shall be coordinated with adjacent TSOs and DSOs and shall be reviewed by the National Regulatory Authority. Power Generating Facility Owners shall assist and contribute to this determination of the threshold and provide the relevant data as requested by the Relevant TSO. The Relevant TSO shall have the right to re-assess the determination of the threshold regularly, if relevant circumstances have changed materially, but not more often than every three years and respecting the provisions of Article 4(3). A public consultation shall be conducted in the frame of the procedure for re-assessment. Following any change to thresholds any Power Generating Module that has been moved to a new type will not automatically have to comply retroactively with the additional requirements but will be subject to the same procedure as applied to Existing Power Generating Modules in line with Article 33. Requirements applicable to Type D Power Generating Modules are in particular specific for higher Voltage connected generation with impact on entire system control and operation. They ensure stable operation of the interconnected Network, allowing the use of ancillary services from generation Europe wide.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

e) For offshore connected Synchronous Power Generating Modules the requirements for onshore synchronous Power Generating Modules shall apply unless modified by the Relevant Network Operator while respecting the provisions of Article 4(3). The categories to be taken into account for Offshore Power Park Modules for the purpose of this Network Code are defined in Article 18(3).

f) Pump-storage Power Generating Modules shall fulfil all requirements in both generating and pumping operation mode. Synchronous Compensation Operation of Pump-Storage Power Generating Modules shall not be limited in time by technical design of the Power Generating Modules. Pump-Storage variable speed Power Generating Modules shall fulfil all requirements applicable to synchronous Power Generating Modules and in addition those set forth in Article 15(2) (b), if they are of Type B, C or D.

g) Without prejudice to the general applicability of the requirements set forth in this Network Code, a Power Generating Facility Owner, the Network Operator of an industrial site and the Relevant Network Operator to whose Network the Network of the industrial site is connected to, shall have the right in coordination with the Relevant TSO, with respect to Power Generation Modules which are embedded in the Networks of industrial sites, to agree while respecting the provisions of Article 4 (3) on conditions for disconnection of such Power Generating Modules together with critical loads, which secure production processes, from the Relevant Network Operator's Network. The only objective of such an agreement shall be to secure production processes of such a site in case of disturbed conditions in the Relevant Network Operator's Network. The requirements of this Network Code, notwithstanding such an agreement, shall apply to Power Generating Modules embedded in the Networks of such industrial sites.

h) Without prejudice to the general applicability of the requirements set forth in this Network Code, a requirement of this Network Code shall not apply to Power Generating Modules of facilities for combined heat and power production (CHP) embedded in the Networks of industrial sites in the following cumulative circumstances:

- the primary purpose of these facilities is to produce steam for production processes of this industrial site;
- the generation of steam and power are rigidly coupled to each other, i. e. any change of steam generation results inadvertently in a change of Active Power generation and vice versa;
- the Power Generating Modules are of Type A, B or C according to Article 3(6) (a) to (c); and
- the requirement is related to the capability maintain constant Active Power output or to modulate Active Power output other than Article 8(1) (c) and (e).

i) For the avoidance of doubt, combined heat and power generating facilities will be regarded on their electrical Maximum Capacity.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Article 4

REGULATORY ASPECTS

1. The requirements established in this Network Code and their applications are based on the principle of non-discrimination and transparency as well as the principle of optimisation between the highest overall efficiency and lowest total cost for all involved parties.

2. Notwithstanding the above, the application of the principles of non-discrimination and the principle of optimisation between the highest overall efficiency and lowest total costs for all involved parties shall be balanced with the aim of achieving the maximum transparency and the assignment to the real originator of the costs. This shall be reflected in objective differences in treatment of different generation technologies with different inherent characteristics as well as by avoiding unnecessary investments in some geographical areas so that their respective regional specifics are appropriately taken into account. TSOs, DSOs and CDSOs shall have the right to take into account these differences when defining requirements, in compliance with the provisions of this Network Code and their national law.

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

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

4. Any decision by a Network Operator other than the Relevant TSO and any agreement between a Network Operator other than the Relevant TSO and a Power Generating Facility Owner shall be exercised in compliance with and respecting the Relevant TSO's responsibility to ensure system security according to national legislation. Further details to ensure this principle may be specified either by national legislation or by agreements between the Relevant TSO and the Network Operators in its Control Area, as the case may be.

Article 5

Recovery of Costs

1. The costs related to the obligations referred to in this network code which have to be borne by regulated Network Operators shall be assessed by National Regulatory Authorities.

2. Costs assessed as reasonable and proportionate shall be recovered in a timely manner via network tariffs or appropriate mechanisms as determined by National Regulatory Authorities.

3. If requested to do so by National Regulatory Authorities, regulated Network Operators shall, within three months of such a request, use best endeavours to provide such additional

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

information as reasonably requested by National Regulatory Authorities to facilitate the assessment of the costs incurred.

Article 6

CONFIDENTIALITY OBLIGATIONS

1. Each Relevant Network Operator, Relevant TSO, Relevant DSO or Relevant CDSO shall preserve the confidentiality of the information and data submitted to them in fulfilment of the obligations under this Network Code and shall use them exclusively for the purpose they have been submitted in compliance with this Network Code, notably to verify the compliance of requirements set forth in this Network Code.

2. Notwithstanding the above, disclosure of such information and data may occur in case a Relevant Network Operator, a Relevant TSO, Relevant DSO or a Relevant CDSO is compelled under EU or national law to disclose it, under the conditions set forth in the relevant legislation. The disclosure shall be reported to the owner of such information and data.

3. In case of disclosure for other purposes than those described in Article 6(1) and/or (2), a Relevant Network Operator, a Relevant TSO, Relevant DSO or a Relevant CDSO shall seek the consent of the owner of such information and data. This consent cannot be unreasonably withheld.

Article 7

RELATIONSHIP WITH NATIONAL LAW PROVISIONS

This Network Code shall be without prejudice to the rights of Member States to maintain or introduce measures that contain more detailed or more stringent provisions than those set out herein, provided that these measures are compatible with the principles set forth in this Network Code.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Title 2

REQUIREMENTS

Chapter 1

GENERAL REQUIREMENTS

Article 8

GENERAL REQUIREMENTS FOR TYPE A POWER GENERATING MODULES

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

   a) With regard to Frequency ranges:

      1) A Power Generating Module shall be capable of staying connected to the Network and operating within the Frequency ranges and time periods specified by table 2.

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

      3) While respecting the provisions of Article 8(1) (a) point 1) a Power Generating Module shall be capable of automatic disconnection at specified frequencies, if required by the Relevant Network Operator. While respecting the provisions of Article 4(3), Terms and settings for automatic disconnection shall be agreed between the Relevant Network Operator and the Power Generating Facility Owner.

   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 operating at rates of change of Frequency up to a value defined by the Relevant TSO while respecting the provisions of Article 4(3) other than triggered by rate-of-change-of-Frequency-type of loss of mains protection. This rate-of-change-of-Frequency-type of loss of mains protection will be defined by the Relevant Network Operator in coordination with the Relevant TSO.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Synchronous Area	Frequency Range	Time period for operation
Continental Europe	47.5 Hz – 48.5 Hz	To be defined by each TSO while respecting the provisions of Article 4(3), but not less than 30 minutes
	48.5 Hz – 49.0 Hz	To be defined by each TSO while respecting the provisions of Article 4(3), 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 while respecting the provisions of Article 4(3), 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 while respecting the provisions of Article 4(3), 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 while respecting the provisions of Article 4(3), 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 while respecting the provisions of Article 4(3), but not less than 30 minutes
	48.5 Hz – 49.0 Hz	To be defined by each TSO while respecting the provisions of Article 4(3), 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 while respecting the provisions of Article 4(3), but not less than 30 minutes

Table 2: Minimum time periods for which a Power Generating Module shall be capable of operating for different frequencies deviating from a nominal value without disconnecting from the Network.

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

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

1) The Power Generating Module shall be capable of activating the provision of Active Power Frequency Response according to figure 1 at a Frequency threshold between and including 50.2 Hz and 50.5 Hz with a Droop in a range of 2 – 12 %. The actual Frequency threshold and Droop settings shall be determined by the Relevant TSO. The Power Generating Module shall be capable of activating Active Power Frequency Response as fast as technically feasible with an initial delay that shall be as short as possible and reasonably justified by the Power Generating Facility Owner to the Relevant TSO if greater than 2 seconds. The Power Generating Module shall be capable of either continuing operation at Minimum Regulating Level when reaching it or further decreasing Active Power output in this case, as defined by the Relevant TSO while respecting the provisions of Article 4(3).

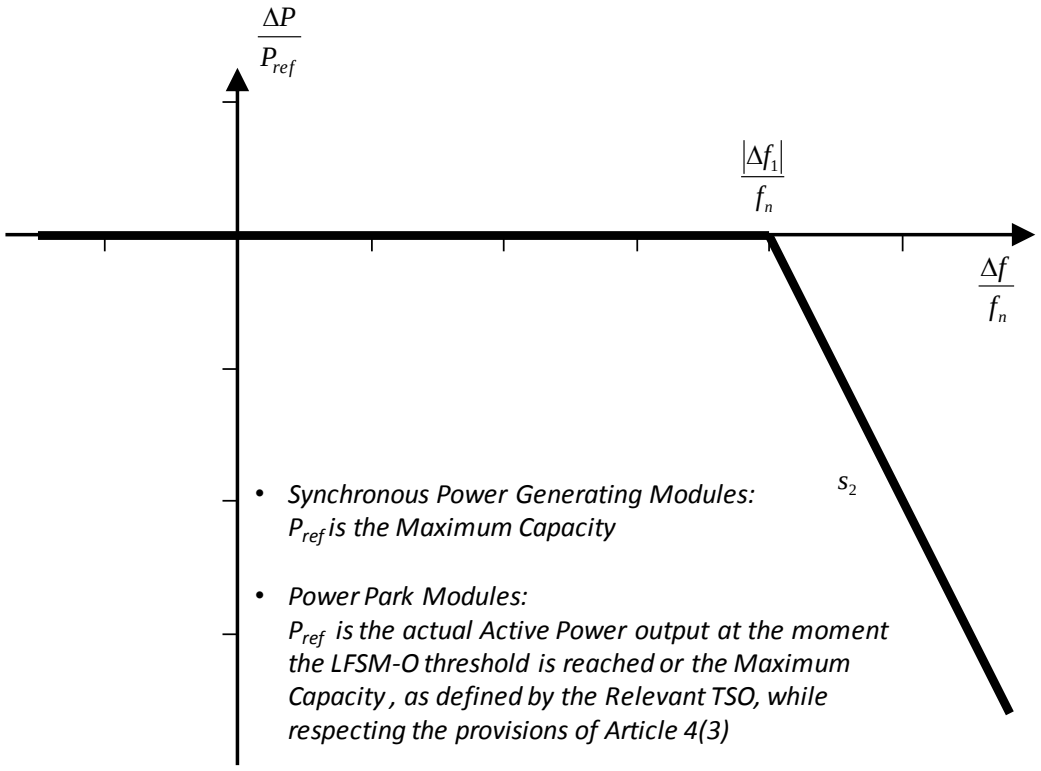

Figure 1: Active Power Frequency Response capability of Power Generating Modules in LFSM-O. P_{ref} is the reference Active Power to which ΔP is related and may be defined differently for Synchronous Power Generating Modules and Power Park Modules. ΔP is the change in Active Power output from the Power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

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

d) The Power Generating Module shall be capable of maintaining constant output at its target Active Power value regardless of changes in Frequency, unless output shall follow the defined changes in output in the context of Article 8(1) (c), (e) or Article 10(2) (b), and Article 10(2) (c) where applicable.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

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

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

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

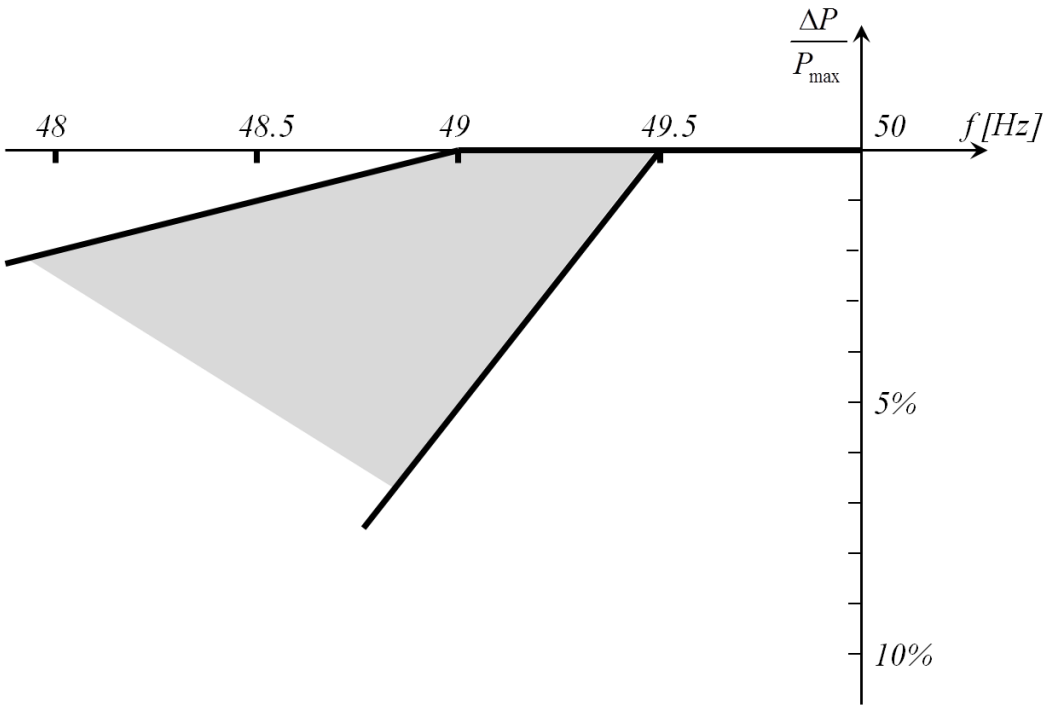

Figure 2 – Maximum power capability reduction with falling Frequency. The diagram represents the boundaries defined by the Relevant TSO while respecting the provisions of Article 4(3).

f) The Power Generating Module shall be equipped with a logic interface (input port) in order to cease Active Power output within less than 5 seconds following an Instruction from the Relevant Network Operator. The Relevant Network Operator shall have the right to define while respecting the provisions of Article 4(3) the requirements for further equipment to make this facility operable remotely.

g) The Relevant TSO shall define while respecting the provisions of Article 4(3) the conditions under which a Power Generating Module shall be capable of connecting automatically to the Network. These conditions shall include:

- Frequency ranges, within which an automatic connection is admissible, and a corresponding delay time
- maximum admissible gradient of increase of Active Power output

Automatic connection is allowed unless determined otherwise by the Relevant Network Operator in coordination with the Relevant TSO.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Article 9

GENERAL REQUIREMENTS FOR TYPE B POWER GENERATING MODULES

1. In addition to fulfilling the requirements listed in Article 8, Type B Power Generating Modules shall fulfil the requirements in this Article.

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

   a) In order to be able to control Active Power output, the Power Generating Module shall be equipped with a interface (input port) in order to be able to reduce Active Power output as instructed by the Relevant Network Operator and/or the Relevant TSO. The Relevant Network Operator shall have the right to define while respecting the provisions of Article 4(3) the requirements for further equipment to make this facility operable remotely.

3. Type B Power Generating Modules shall fulfil the following requirements referring to robustness of Power Generating Modules:

   a) With regard to fault-ride-through capability of Power Generating Modules:

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

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

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

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

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

         - pre-fault minimum short circuit capacity at each Connection Point expressed in MVA;

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

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

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

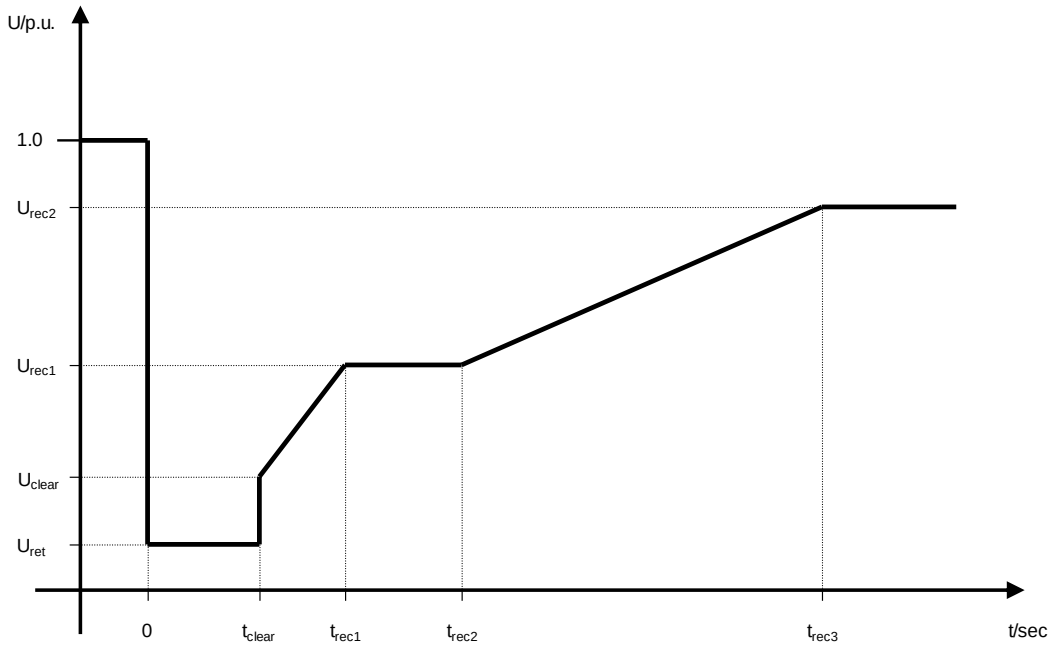

Figure 3 – Fault-ride-through profile of a Power Generating Module. The diagram represents the lower limit of a voltage-against-time profile by the Voltage at the Connection Point, expressed by the ratio of its actual value and its nominal value in per unit before, during and after a fault. U_{ret} is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

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

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

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

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

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

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

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

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

4. Type B Power Generating Modules shall fulfil the following requirement referring to system restoration:

a) With regard to capability of reconnection after an incidental disconnection due to a Network disturbance, the Relevant TSO shall adopt a decision while respecting the provisions of Article 4(3) defining the conditions under which a Power Generating Module shall be capable of reconnecting to the Network after an incidental disconnection has taken place due to a Network disturbance. Installation of automatic reconnection systems shall be subject to prior authorization by the Relevant Network Operator subject to reconnection conditions specified by the Relevant TSO.

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

a) With regard to control schemes and settings

1) While respecting the provisions of Article 4(3), schemes and settings of the different control devices of the Power Generating Module relevant for transmission system

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

stability and to enable emergency actions shall be coordinated and agreed between the Relevant TSO, the Relevant Network Operator and the Power Generating Facility Owner.

2) While respecting the provisions of Article 4(3), any changes to the schemes and settings of the different control devices of the Power Generating Module, relevant for transmission system stability and to enable emergency actions, shall be coordinated and agreed between the Relevant TSO, the Relevant Network Operator and the Power Generating Facility Owner, especially if they concern the circumstances referred to under Article 9(5) (a) point 1).

b) With regard to electrical protection schemes and settings:

1) The Relevant Network Operator shall define the schemes and settings necessary to protect the Network taking into account the characteristics of the Power Generating Module. While respecting the provisions of Article 4(3), protection schemes relevant for the Power Generating Module and the Network and settings relevant for the Power Generating Module shall be coordinated and agreed between the Relevant Network Operator and the Power Generating Facility Owner. The protection schemes and settings for internal electrical faults shall be designed not to jeopardize the performance of a Power Generating Module according to this Network Code requirements otherwise.

2) Electrical protection of the Power Generating Module shall take precedence over operational controls taking into account system security, health and safety of staff and the public and mitigation of the damage to the Power Generating Module.

3) Protection schemes can protect against 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 schemes against protection and switchgear malfunction;
- overfluxing (U/f);
- inverse power;
- rate of change of Frequency; and
- neutral Voltage displacement.

4) While respecting the provisions of Article 4(3), any changes to the protection schemes relevant for the Power Generating Module and the Network and to the setting relevant for the Power Generating Module shall be agreed between the Network Operator and the Power Generating Facility Owner and be concluded prior to the introduction of changes.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

c) With regard to priority ranking of protection and control, the Power Generating Facility Owner shall organize its protections and control devices in compliance with the following priority ranking, organized in decreasing order of importance:

- Network system and Power Generating Module protection;
- Synthetic Inertia, if applicable;
- Frequency control (Active Power adjustment);
- Power Restriction; and
- Power gradient constraint.

d) With regard to information exchange:

1) Power Generating Facilities shall be capable of exchanging information between the Power Generating Facility Owner and the Relevant Network Operator and/or the Relevant TSO in real time or periodically with time stamping as defined by the Relevant Network Operator and/or the Relevant TSO while respecting the provisions of Article 4(3).

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

Article 10

GENERAL REQUIREMENTS FOR TYPE C POWER GENERATING MODULES

1. In addition to fulfilling the requirements listed in Articles 8 and 9, except for Article 8(1) (f) and Article 9(2) (a), Type C Power Generating Modules shall fulfil the requirements in this Article.

2. Type C Power Generating Modules shall fulfil the following requirements referring 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 as instructed by the Relevant Network Operator or the Relevant TSO to the Power Generating Facility Owner. It shall be capable of implementing the Setpoint within a period specified in the above Instruction and within a tolerance defined by the Relevant Network Operator or the Relevant TSO (subject to the availability of the prime mover resource). Manual, local measures shall be possible in the case that any automatic remote control devices are out of service.

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

1) The Power Generating Module shall be capable of activating the provision of Active Power Frequency Response according to figure 4 at a Frequency threshold between and including 49.8 Hz and 49.5 Hz with a Droop in a range of 2 – 12 %. In the LFSM-U mode the Power Generating Module shall be capable of providing a power increase up to its Maximum Capacity. The actual delivery of Active Power Frequency Response in LFSM-U mode depends on the operating and ambient conditions of the Power Generating

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Module when this response is triggered, in particular limitations on operation near Maximum Capacity at low frequencies according to Article 8(1) (e) and available primary energy sources. The actual Frequency threshold and Droop settings shall be determined by the Relevant TSO. The Active Power Frequency Response shall be activated as fast as technically feasible with an initial delay that shall be as short as possible and reasonably justified by the Power Generating Facility Owner to the Relevant TSO if greater than 2 seconds.

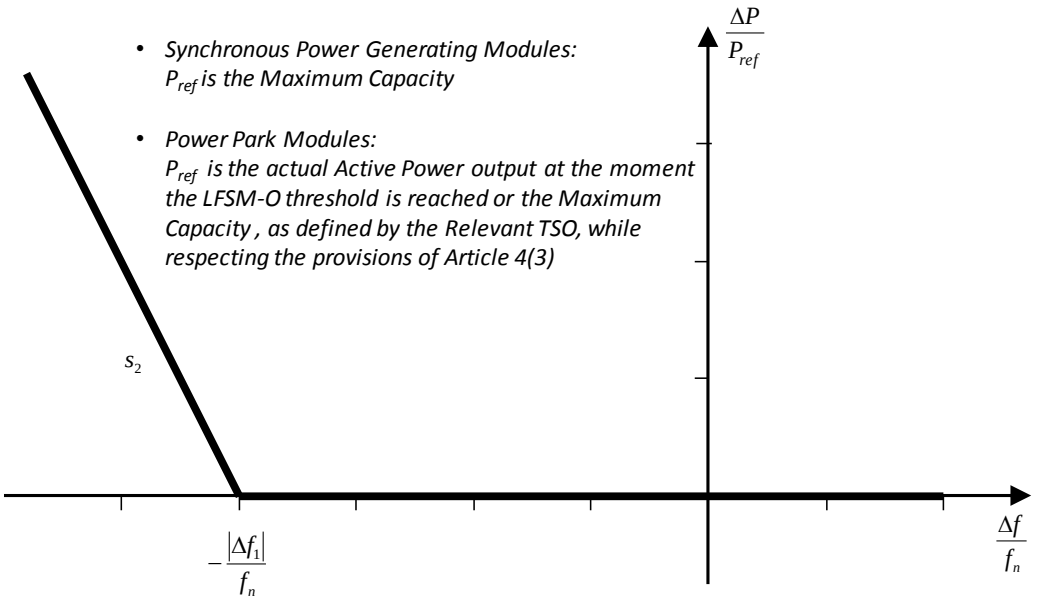

Figure 4: Active Power Frequency Response capability of Power Generating Modules in LFSM-U. P_{ref} is the reference Active Power to which ΔP is related and may be defined differently for Synchronous Power Generating Modules and Power Park Modules. ΔP is the change in Active Power output from the Power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

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

c) In addition to Article 10(2) (b) the following shall apply accumulatively, when operating in Frequency Sensitive Mode (FSM):

1) The Power Generating Module shall be capable of providing Active Power Frequency Response with respect to figure 5 and in accordance with the parameters specified by each TSO within the ranges shown in table 4.

2) In case of overfrequency the Active Power Frequency Response is limited by the Minimum Regulating Level.

3) 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

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

is triggered, in particular limitations on operation near Maximum Capacity at low frequencies according to Article 8(1) (e) and available primary energy sources.

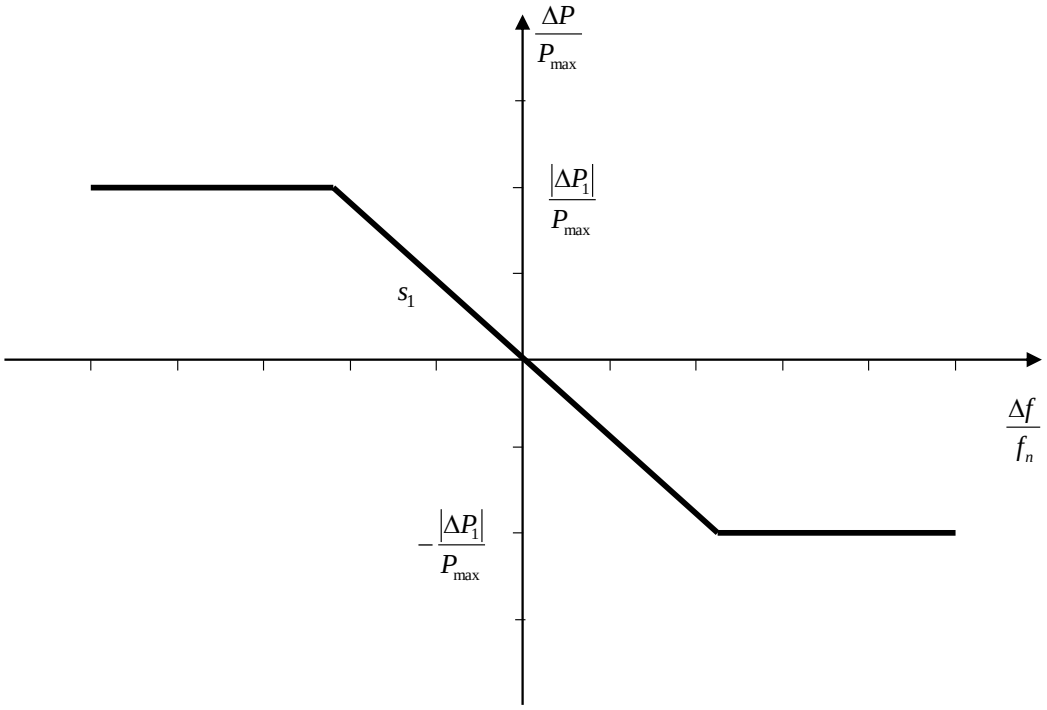

Figure 5: Active Power Frequency Response capability of Power Generating Modules in FSM illustrating the case of zero deadband and insensitivity. P_{max} is the Maximum Capacity to which ΔP is related. ΔP is the change in Active Power output from the Power Generating Module. f_n is the nominal Frequency (50 Hz) in the Network and Δf is the Frequency deviation in the Network.

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)

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

4) The Frequency Response Deadband of Frequency deviation and Droop are selected by the TSO and must be able to be reselected subsequently (without requiring to be online or remote) within the given frames in the table 4.

5) As a result 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 according to figure 6 in accordance with the parameters specified by each TSO (aiming at avoiding Active Power oscillations for the Power Generating Module) within the ranges according to table 5. The combination of choice of the parameters according to table 5 shall take into account possible technology dependent limitations. The initial delay of activation shall be as short as possible and reasonably justified by the Power Generating Facility Owner to the Relevant TSO, by providing technical evidence for why a longer time is needed, if greater than 2 seconds or a shorter time if specified by the Relevant TSO while respecting the provisions of Article 4(3) for generation technologies without Inertia.

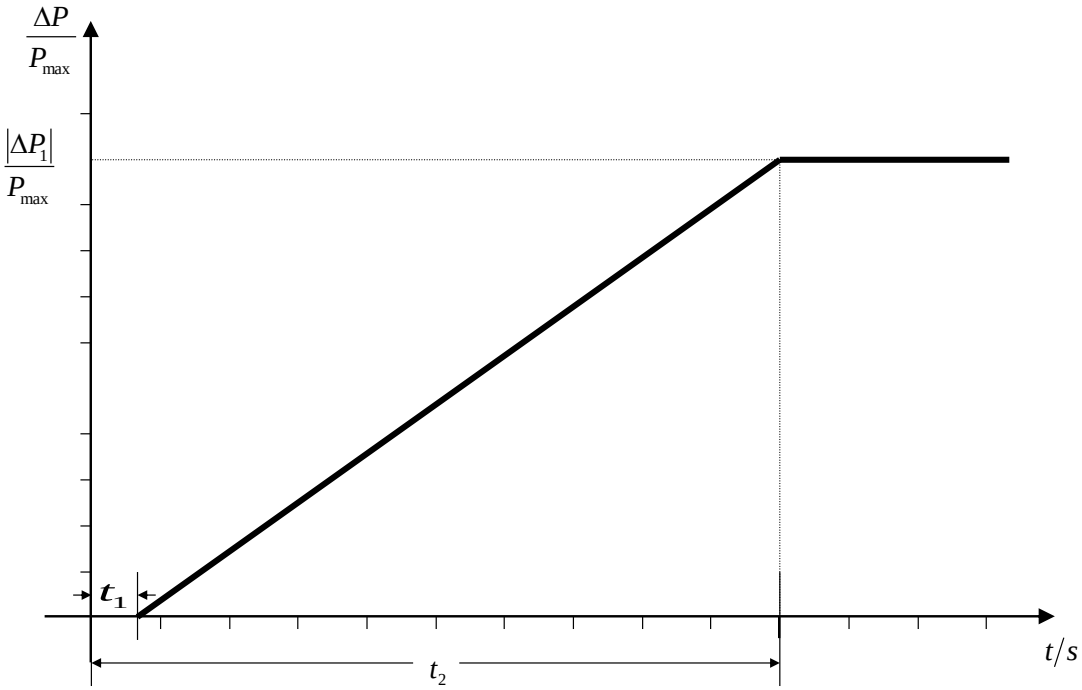

Figure 6: Active Power Frequency Response capability. P_{max} is the Maximum Capacity to which ΔP is related. ΔP is the change in Active Power output from the Power Generating Module. The Power Generating Modules have to provide Active Power Output ΔP up to the point ΔP_1 in accordance with the times 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.

6) The Power Generating Module shall be capable of providing full Active Power Frequency Response for a period specified by the TSOs, considering the technical feasibility, for each Synchronous Area between 15 min and 30 min, considering the Active Power headroom and primary energy source of the Power Generating Module.

7) As long as a Frequency deviation continues Active Power control shall not have any adverse impact on the Frequency response within the time limits of Article 10(2) (c) point 6).

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Parameters	Ranges or values
Active Power range related to Maximum Capacity (Frequency response range) $\frac{\lvert\Delta P_1\rvert}{P_{\max}}$	1.5 – 10 %
Maximum admissible initial delay t_1 unless justified otherwise for generation technologies with Inertia	2 seconds
Maximum admissible initial delay t_1 unless justified otherwise for generation technologies without Inertia	as specified by the Relevant TSO while respecting the provisions of Article 4(3)
Maximum admissible choice of full activation time t_2, unless longer activation times are admitted by the Relevant TSO due to system stability reasons	30 seconds

Table 5: Parameters for full activation of Active Power Frequency Response resulted from Frequency step change (explanation for figure 6).

d) With regard to Frequency restoration control, the Power Generating Module shall provide functionalities compliant to specifications defined by the Relevant TSO while respecting the provisions of Article 4(3), aiming at restoring Frequency to its nominal value and/ or maintain power exchange flows between control areas at their scheduled values.

e) With regard to disconnection due to underfrequency, any Power Generating Facility being capable of acting as a load except for auxiliary supply, including hydro Pump-Storage Power Generating Facilities, shall be capable of disconnecting its load in case of underfrequency.

f) With regard to real-time monitoring of FSM:

1) To monitor the operation of Active Power Frequency Response the communication interface shall be equipped to transfer on-line from the Power Generating Facility to the Network control centre of the Relevant Network Operator and/or the Relevant TSO on request by the Relevant Network Operator and/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; and
- Droop and dead band.

2) The Relevant Network Operator and the Relevant TSO shall define while respecting the provisions of Article 4(3) additional signals to be provided by the Power Generating Facility for monitoring and/or recording devices in order to verify the performance of

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

the Active Power Frequency Response provision of participating Power Generating Modules.

3. Type C Power Generating Modules shall fulfil the following requirements referring to Voltage stability:

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

4. Type C Power Generating Modules shall fulfil the following requirements referring to robustness of Power Generating Modules

   a) In case of power oscillations, Steady-state Stability of a Power Generating Module is required when operating at any operating point of the P-Q-Capability Diagram. A Power Generating Module shall be capable of staying connected to the Network and operating without power reduction notwithstanding the provisions of Article 8(1) (e), as long as Voltage and Frequency remain within the admissible limits pursuant to this Network Code.

   b) Single-phase or three-phase auto-reclosures on meshed Network lines, if applicable to this Network, shall be withstood by Power Generating Modules without tripping. Details of this capability shall be subject to coordination and agreements on protection schemes and settings according to Article 9(5) (b).

5. Type C Power Generating Modules shall fulfil the following requirements referring to system restoration:

   a) With regard to Black Start Capability:

      1) Black Start Capability is not mandatory. If the Relevant TSO deems system security to be at risk due to a lack of Black Start Capability in a Control Area, the Relevant TSO shall have the right to obtain a quote for Black Start Capability from Power Generating Facility Owners.

      2) A Power Generating Module with a Black Start Capability shall be able to start from shut down within a timeframe decided by the Relevant Network Operator in coordination with the Relevant TSO while respecting the provisions of Article 4(3), without any external energy supply. The Power Generating Module shall be able to synchronise within the Frequency limits defined in Article 8(1) and Voltage limits defined by the Relevant Network Operator or defined by Article 11(2) where applicable.

      3) The Power Generating Module Voltage regulation shall be capable of regulating load connections causing dips of Voltage automatically.

         The Power Generating Module 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;

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

- 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 capability to take part in Island Operation:

1) The capability to take part in Island Operation, if required by the Relevant Network Operator in coordination with the Relevant TSO while respecting the provisions of Article 4(3), shall be possible within the Frequency limits defined in Article 8(1) and Voltage limits according to Article 10(3) or Article 11(2) where applicable.

2) If required, the Power Generating Module shall be able to operate in FSM during Island Operation, as defined in Article 10(2) (b). In the case of a power surplus, it shall be possible to reduce the Active Power Output of the Power Generating Module from its previous operating point to any new operating point within the P-Q-Capability Diagram as much as inherently technically feasible, but at least a Active Power output reduction to 55 % of its Maximum Capacity shall be possible.

3) Detection of change from interconnected system operation to Island Operation shall not rely solely on the Network Operator's switchgear position signals. The detection method shall be agreed between the Power Generating Facility Owner and the Relevant Network Operator in coordination with the Relevant TSO while respecting the provisions of Article 4(3).

c) With regard to quick re-synchronization capability:

1) Quick re-synchronization capability is required in case of disconnection of the Power Generating Module from the Network in line with the protection strategy agreed between the Relevant Network Operator in coordination with the Relevant TSO and the Power Generation Facility Owner in the event of disturbances to the system.

2) The Power Generating Module whose minimum re-synchronization time after its disconnection from any external power supply exceeds 15 minutes shall be designed for tripping to houseload from any operating point in its P-Q-Capability Diagram. For identifying houseload operation any Network Operator's switchgear position signals may be used only as additional information which cannot be solely relied on.

3) 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 defined by the Relevant Network Operator in coordination with the Relevant TSO taking into consideration the specific characteristics of the prime mover technology .

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 support preservation of system security and/or to prevent damage from the Power Generating Module. The Power Generating Facility Owner and the Relevant Network Operator in coordination with the Relevant TSO shall agree on the criteria to detect loss of angular stability or loss of control.

b) With regard to instrumentation:

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

1) 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 Network Operator shall have the right to define while respecting the provisions of Article 4(3) quality of supply parameters to be complied with provided a reasonable prior notice is given.

2) While respecting the provisions of Article 4 (3), 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 Network Operator in coordination with the Relevant TSO.

3) The dynamic system behaviour monitoring shall include an oscillation trigger, specified by the Relevant Network Operator in coordination with the Relevant TSO, detecting poorly damped power oscillations.

4) The facilities for quality of supply and dynamic system behaviour monitoring shall include arrangements for the Power Generating Facility Owner, the Relevant Network Operator and/or the Relevant TSO to access the information. While respecting the provisions of Article 4 (3) the communications protocols for recorded data shall be agreed between the Power Generating Facility Owner and the Relevant Network Operator and Relevant TSO.

c) With regard to the simulation models:

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

   The decision shall include:

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

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

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

   - Alternator and prime mover;
   - Speed and power control;

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

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

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

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

d) With regard to the installation of devices for system operation and/or security, if the Relevant Network Operator or the Relevant TSO considers additional devices necessary to be installed in a Power Generating Facility in order to preserve or restore system operation or security, the Relevant Network Operator or Relevant TSO and the Power Generating Facility Owner shall investigate this request and, while respecting the provisions of Article 4(3), agree on an appropriate solution .

e) The Relevant Network Operator in coordination with the Relevant TSO shall define while respecting the provisions of Article 4(3) minimum and maximum limits on rates of change of Active Power output (ramping limits) in both up and down direction for a Power Generating Module taking into consideration the specific characteristics of the prime mover technology.

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

g) With regard to changes to, modernization of or replacement of equipment of Power Generating Modules, any Power Generating Facility Owner intending to change plant and equipment of the Power Generating Module that may have an impact on the grid connection and on the interaction, such as turbines, Alternators, converters, high-voltage equipment, protection and control systems (hardware and software), shall notify in advance (in accordance with agreed or decided national timescales) the Relevant Network Operator in case it is reasonable to foresee that these intended changes may be affected by the requirements of this Network Code and shall, while respecting the provisions of Article 4(3), agree on these requirements before the proposals are implemented with the Relevant Network Operator in coordination with the Relevant TSO. In case of modernisation or replacement of equipment in existing Power Generating Modules the new equipment shall comply with the respective requirements which are relevant to the planned work. While respecting the provisions of Article 4 (3), the use of existing spare components that do not comply with the requirements has to be agreed with the Relevant Network Operator in coordination with the Relevant TSO in each case.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Article 11

GENERAL REQUIREMENTS FOR TYPE D POWER GENERATING MODULES

1. In addition to fulfilling the requirements listed in Articles 8, 9 and 10 unless referred to otherwise in this Article, except for Article 8(1) (f), (g), Article 9(2) (a) and Article 10(3) (a), Type D Power Generating Modules shall fulfil the requirements in this Article.

2. Type D Power Generating Modules shall fulfil the following requirements referring to Voltage stability:

   a) With regard to Voltage ranges:

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

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

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

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

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

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

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

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

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

3. Type D Power Generating Modules shall fulfil the following requirements referring to robustness of Power Generating Modules:

   a) With regard to fault-ride-through capability of Power Generating Modules:

      1) The voltage-against-time-profile shall be defined by the TSO using parameters in figure 3 according to tables 7.1 and 7.2.

      2) Each TSO shall define and make publicly available while respecting the provisions of Article 4(3) the pre-fault and post-fault conditions for the fault-ride-through capability according to Article 9(3) (a) point 3).

Voltage parameters [pu]		**Time parameters [seconds]**	
U_{ret}:	0	t_{clear}:	0.14 – 0.25
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 – 0.25
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.

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

         - pre-fault minimum short circuit capacity at each Connection Point expressed in MVA;

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

- 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.

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

4. Type D Power Generating Modules shall fulfil the following general system management requirements:

a) With regard to synchronization, when starting a Power Generating Module, synchronization shall be performed by the Power Generating Facility Owner after authorization by the Relevant Network Operator. The Power Generating Module shall be equipped with the necessary synchronization facilities. Synchronization of Power Generating Modules shall be possible for frequencies within the ranges set out in table 2. While respecting the provisions of Article 4(3), the Relevant Network Operator and the Power Generating Facility Owner shall agree on the settings of synchronization devices to be concluded prior to operation of the Power Generating Module. An agreement shall cover the following matters: Voltage, Frequency, phase angle range, phase sequence, deviation of Voltage and Frequency.

Chapter 2

REQUIREMENTS FOR SYNCHRONOUS POWER GENERATING MODULES

Article 12

REQUIREMENTS FOR TYPE B SYNCHRONOUS POWER GENERATING MODULES

1. In addition to fulfilling the requirements listed in Articles 8 and 9, Type B Synchronous Power Generating Modules shall fulfil the requirements in this Article.

2. Type B Synchronous Power Generating Modules shall fulfil the following requirements referring to Voltage stability:

a) With regard to Reactive Power capability the Relevant Network Operator shall have the right to define while respecting the provisions of Article 4(3) the capability of a Synchronous Power Generating Module to provide Reactive Power.

b) With regard to the Voltage control system, a Synchronous Power Generating Module shall be equipped with a permanent automatic excitation control system in order to provide constant Alternator terminal Voltage at a selectable Setpoint without instability over the entire operating range of the Synchronous Power Generating Module.

3. Type B Synchronous Power Generating Modules shall fulfil the following requirements referring to robustness of Power Generating Modules:

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

a) With regard to post fault Active Power recovery after fault-ride-through, the Relevant TSO shall define while respecting the provisions of Article 4(3) magnitude and time for Active Power recovery the Power Generating Module shall be capable of providing.

Article 13

REQUIREMENTS FOR TYPE C SYNCHRONOUS POWER GENERATING MODULES

1. In addition to fulfilling the requirements listed in Articles 8, 9, 10 and 12, except for Article 8(1) (f), Article 9(2) (a) and Article 12(2) (a), Type C Synchronous Power Generating Modules shall fulfil the requirements in this Article.

2. Type C Synchronous Power Generating Modules shall fulfil the following requirements referring to Voltage stability:

   a) With regard to Reactive Power Capability, for Synchronous Power Generating Modules where the Connection Point is not at the location of the high-voltage terminals of the step-up transformer to the Voltage level of the Connection Point nor at the Alternator terminals, if no step-up transformer exists, supplementary Reactive Power may be defined by the Relevant Network Operator, while respecting the provisions of Article 4(3), 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:

      1) The Relevant Network Operator in coordination with the Relevant TSO shall define while respecting the provisions of Article 4(3) the Reactive Power provision capability requirements in the context of varying Voltage. For doing so, it shall define a U-Q/P_{max}-profile that shall take any shape within the boundaries of which the Synchronous Power Generating Module shall be capable of providing Reactive Power at its Maximum Capacity.

      2) The U-Q/P_{max}-profile is defined by the Relevant Network Operator in coordination with the Relevant TSO while respecting the provisions of Article 4(3) in conformity with the following principles:

         - the U-Q/P_{max}-profile shall not exceed the U-Q/P_{max}-profile envelope, represented by the inner envelope in figure 7;
         - the dimensions of the U-Q/P_{max}-profile envelope (Q/P_{max} range and Voltage range) are defined for each Synchronous Area in table 8; and
         - the position of the U-Q/P_{max}-profile envelope within the limits of the fixed outer envelope in figure 7.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

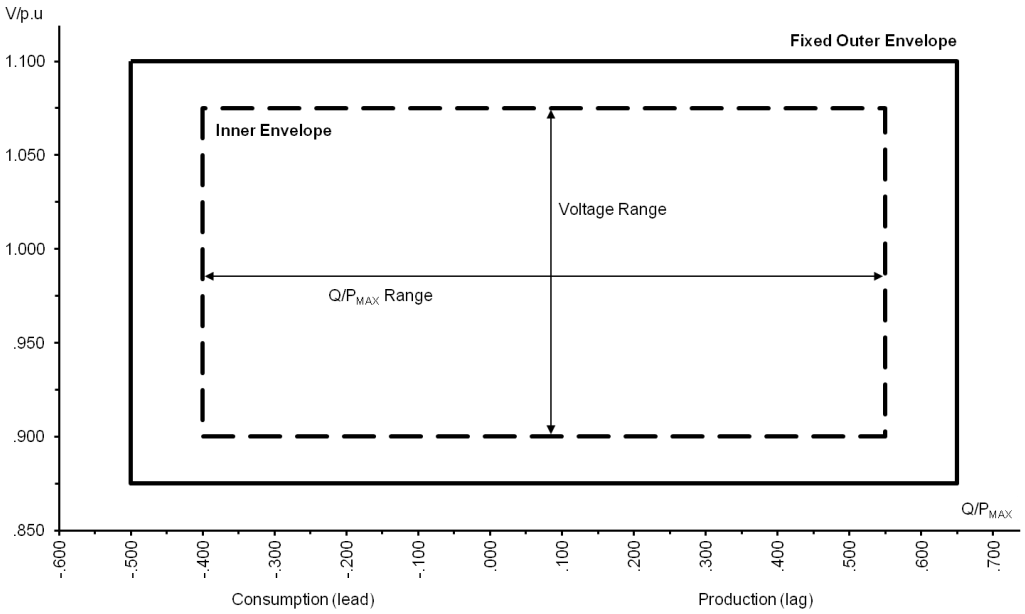

Figure 7 – U-Q/P_{max}-profile of a Synchronous Power Generating Module. The diagram represents boundaries of a U-Q/P_{max}-profile by the Voltage at the Connection Point, expressed by the ratio of its actual value and its nominal value in per unit, against the ratio of the Reactive Power (Q) and the 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	0.95	0.225
Nordic	0.95	0.150
Great Britain	0.95	0.100
Ireland	1.08	0.218
Baltic States	1.0	0.220

Table 8: Parameters for the inner envelope in figure 7

3) 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.

4) The Synchronous Power Generating Module shall be capable of moving to any operating point within its U-Q/P_{max} profile in appropriate timescales to target values requested by the Relevant Network Operator.

c) With regard to Reactive Power capability below Maximum Capacity, when operating at an Active Power output below the Maximum Capacity ($P<P_{max}$), the Synchronous Power

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Generating Modules shall be capable of operating in every possible operating point in the P-Q Capability Diagram of the Alternator of this Synchronous Power Generating Module at least down to Minimum Stable Operating Level. Even at reduced Active Power output, Reactive Power supply at the Connection Point shall fully correspond to the P-Q-Capability Diagram of the Alternator of this Synchronous Power Generating Module, taking the auxiliary supply power and the Active and Reactive Power losses of the step-up transformer, if applicable, into account.

Article 14

REQUIREMENTS FOR TYPE D SYNCHRONOUS POWER GENERATING MODULES

1. In addition to fulfilling the requirements listed in Articles 8, 9, 10, 11, 12 and 13, except for Article 8(1) (f), Article 9(2) (a), Article 10(3) (a), and Article 12(2), Type D Synchronous Power Generating Modules shall fulfil the requirements in this Article.

2. Type D Synchronous Power Generating Modules shall fulfil the following requirements referring to Voltage stability:

   a) While respecting the provisions of Article 4(3), the parameters and settings of the components of the Voltage control system shall be agreed between the Power Generating Facility Owner and the Relevant Network Operator in coordination with the Relevant TSO Such agreement shall include:

      - specifications and performance of an Automatic Voltage Regulator (AVR) with regards to steady-state Voltage and transient Voltage control; and
      - specifications and performance of the Excitation System:
        - bandwidth limitation of the output signal to ensure that the highest Frequency of response cannot excite torsional oscillations on other Power Generating Modules connected to the Network;
        - an Underexcitation Limiter to prevent the Automatic Voltage Regulator from reducing the Alternator excitation to a level which would endanger synchronous stability;
        - an Overexcitation Limiter to ensure that the Alternator excitation is not limited to less than the maximum value that can be achieved whilst ensuring the Synchronous Power Generating Module is operating within its design limits;
        - a stator Current limiter; and
        - a PSS function to attenuate power oscillations, if the Synchronous Power Generating Module size is above a value of Maximum Capacity defined by the Relevant TSO while respecting the provisions of Article 4(3).

3. Type D Synchronous Power Generating Modules shall fulfil the following requirements referring to robustness of Power Generating Modules:

   a) Technical capabilities in order to aid angular stability under fault conditions (e. g. fast valving or braking resistor) shall be implemented if allowed or requested by the Relevant TSO. While respecting the provisions of Article 4 (3), the specifications shall be agreed between the TSO and the Power Generating Facility Owner.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Chapter 3

REQUIREMENTS FOR POWER PARK MODULES

Article 15

REQUIREMENTS FOR TYPE B POWER PARK MODULES

1. In addition to fulfilling the general requirements listed in Articles 8 and 9, Type B Power Park Modules shall fulfil the requirements in this Article.

2. Type B Power Park Modules shall fulfil the following requirement referring to Voltage stability:

   a) With regard to Reactive Power capability the Relevant Network Operator shall have the right to define while respecting the provisions of Article 4(3) the capability of a Power Park Module to provide Reactive Power.

   b) The Relevant Network Operator in coordination with the Relevant TSO shall have the right to require while respecting the provisions of Article 4(3) fast acting additional reactive Current injection at the Connection Point to the pre-fault reactive Current injection in case of symmetrical (3-phase) faults:

      1) The Power Park Module shall be capable of activating this additional reactive Current injection during the period of faults. The Power Park Module shall be capable of either:

         a. ensuring the supply of the additional reactive Current at the Connection Point according to further specifications by the Relevant Network Operator in coordination with the Relevant TSO of the magnitude of this Current, depending on the deviation of the Voltage at the Connection point from its nominal value; or

         b. alternatively, measuring Voltage deviations at the terminals of the individual units of the Power Park Module and providing an additional reactive Current at the terminals of these units according to further specifications by the Relevant Network Operator in coordination with the Relevant TSO of the magnitude of this Current, depending on the deviation of the Voltage at units' terminals from its nominal value.

      2) The Power Park Module (Article 15(2) (b) point 1) option a.) or the individual units of the Power Park Module (Article 15(2) (b) point 1) option b.) shall be capable of providing at least 2/3 of the additional reactive Current within a time period specified by the Relevant TSO, which shall not be less than 10 milliseconds. The target value of this additional reactive Current defined by Article 15(2) (b) point 1) shall be reached with an accuracy of 10% within 60 milliseconds from the moment the Voltage deviation has occurred as further specified according to Article 15(2) (b) point 1).

      3) The total reactive Current contribution shall be not more than 1 pu of the short term dynamic Current rating (covering up to 0.4 seconds) of the Power Park Module (Article

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

15(2) (b) point 1) option a.) or of the individual units of the Power Park Module (Article 15(2) (b) point 1) option b.) taking into account the pre-fault reactive Current. If additional real Current injection is given priority over additional reactive Current injection, the total Current contribution can be further limited by the real Current based on limiting the apparent Current (vector addition of real and reactive Current) to 1 pu of the short term dynamic Current rating of the Power Park Module (Article 15(2) (b) point 1) option a.) or the individual units of the Power Park Module (Article 15(2) (b) point 1) option b.).

c) With regard to fast acting additional reactive Current injection in case of asymmetrical (1-phase or 2-phase) faults the Relevant Network Operator in coordination the Relevant TSO shall have the right to introduce while respecting the provisions of Article 4(3) a requirement for asymmetrical Current injection.

3. Type B Power Park Modules shall fulfil the following requirements referring to robustness of Power Generating Modules:

a) With regard to post fault Active Power recovery after fault-ride-through**,** the Relevant TSO shall specify while respecting the provisions of Article 4(3) magnitude and time for Active Power recovery the Power Park Module shall be capable of providing.

Article 16

REQUIREMENTS FOR TYPE C POWER PARK MODULES

1. In addition to fulfilling the requirements listed in Articles 8, 9, 10 and 15, except for Article 8(1) (f), Article 9(2) (a), and Article 15(2) (a) unless referred to otherwise in Article 16(3) (d) points 3) and 4), Type C Power Park Modules shall fulfil the requirements in this Article.

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

a) With regard to the capability of providing Synthetic Inertia to a low Frequency event:

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

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

3. Type C Power Park Modules shall fulfil the following requirements referring to Voltage stability:

a) With regard to Reactive Power Capability, for Power Park Modules where the Connection Point is not at the location of 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

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Module, if no step-up transformer exists, supplementary Reactive Power may be required by the Relevant Network Operator while respecting the provisions of Article 4(3) 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**:**

1) The Relevant Network Operator in coordination with the Relevant TSO shall define while respecting the provisions of Article 4(3) the Reactive Power provision capability requirements in the context of varying Voltage. For doing so, it shall define a U-Q/P_{max}-profile that shall take any shape within the boundaries of which the Power Park Module shall be capable of providing Reactive Power at its Maximum Capacity.

2) The U-Q/P_{max}-profile is defined by each Relevant Network Operator in coordination with the Relevant TSO while respecting the provisions of Article 4(3) in conformity with the following principles:

- the U-Q/P_{max}-profile shall not exceed the U-Q/P_{max}-profile envelope, represented by the inner envelope in figure 8, its shape does not need to be rectangular;
- the dimensions of the U-Q/P_{max}-profile envelope (Q/P_{max} range and Voltage range) are defined for each Synchronous Area in table 9; and
- the position of the U-Q/P_{max}-profile envelope within the limits of the fixed outer envelope in figure 8.

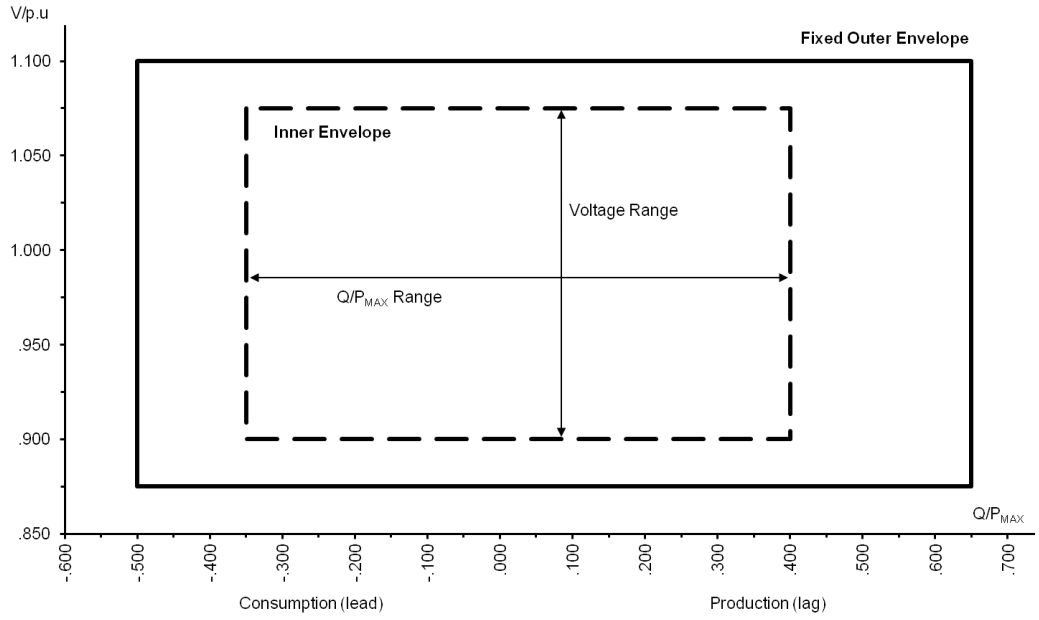

Figure 8 – U-Q/P_{max}-profile of a Power Park Module. The diagram represents boundaries of a U-Q/P_{max}-profile by the Voltage at the Connection Point, expressed by the ratio of its actual value and its nominal value in per unit, against the ratio of the Reactive Power (Q) and the Maximum Capacity (P_{max}). The position, size and shape of the inner envelope are indicative.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

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

3) 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:

1) The Relevant Network Operator in coordination with the Relevant TSO shall define while respecting the provisions of Article 4(3) the Reactive Power provision capability requirements. For doing so, it shall define a P-Q/P_{max}-profile that shall take any shape within the boundaries of which the Power Park Module shall be capable of providing Reactive Power below Maximum Capacity.

2) The P-Q/P_{max}-profile is defined by each Relevant Network Operator in coordination with the Relevant TSO while respecting the provisions of Article 4(3), in conformity with the following principles:

- the P-Q/P_{max}-profile shall not exceed the P-Q/P_{max}-profile envelope, represented by the inner envelope in figure 9;
- the Q/P_{max} range of the P-Q/P_{max}-profile envelope is defined for each Synchronous Area in table 9;
- the Active Power range of the P-Q/P_{max}-profile envelope at zero Reactive Power shall be 1 pu;
- the P-Q/P_{max}-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/P_{max}-profile envelope within the limits of the fixed outer envelope in figure 9.

3) When operating at an Active Power output below the 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 this Power Park Module, which generate power, are technically available (i. e. not out-of-service due to maintenance or failure). Otherwise the Reactive Power capability may be less taking into consideration the technical availabilities.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

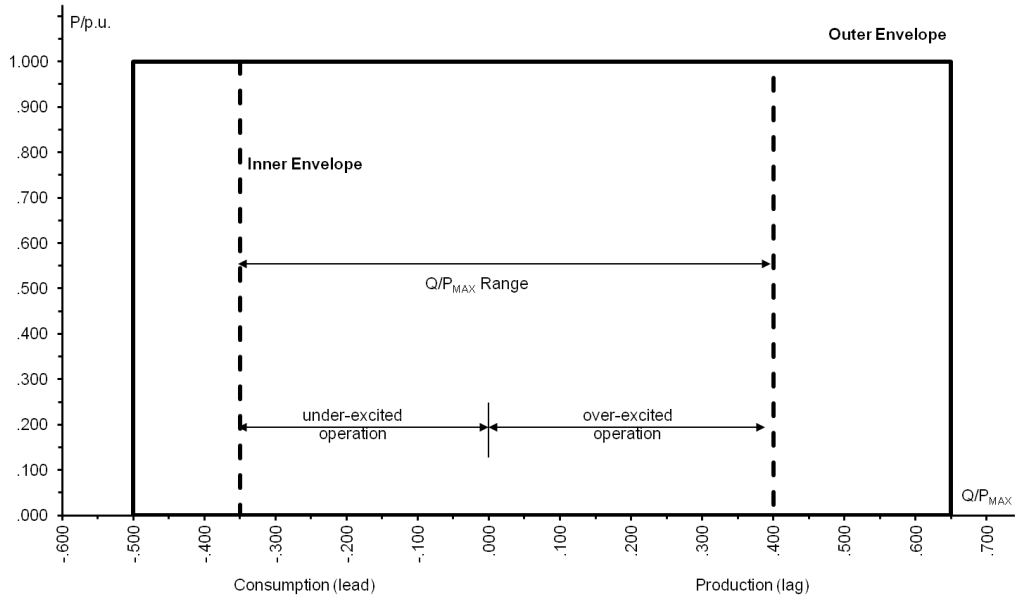

Figure 9 - P-Q/P_{max}-profile of a Power Park Module. The diagram represents boundaries of a P-Q/P_{max}-profile at the Connection Point by the Active Power, expressed by the ratio of its actual value and the Maximum Capacity in per unit, against the ratio of the Reactive Power (Q) and the Maximum Capacity (P_{max}). The position, size and shape of the inner envelope are indicative.

4) 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 Network Operator.

d) With regard to Reactive Power control modes:

1) 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.

2) 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 with 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.

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 %.

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 Relevant Network operator while respecting the provisions of Article 4(3) in the range of 1 - 5 seconds and settle at the value defined by the operating Slope within a time t_2 to be specified by Relevant Network Operator while respecting the provisions of Article 4(3) in the range of 5 - 60 seconds, with a steady-state reactive tolerance no greater than 5 % of the maximum Reactive Power.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

3) For the purposes 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 Article 15(2) (a) and by Article 16(3) (a) and (b), 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 +-5 Mvar or +-5 % (whichever is smaller) of the full Reactive Power.

4) For the purposes 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 Network Operator according to Article 15(2) (a) or defined by Article 16(3) (a) and (b), with a target Power Factor in steps no greater than 0.01. The Relevant Network Operator shall define while respecting the provisions of Article 4(3) 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.

5) The Relevant Network Operator in coordination with the Relevant TSO shall define while respecting the provisions of Article 4(3) which of the above three reactive power control mode options and associated Setpoints shall apply and further equipment to make the adjustment of the relevant Setpoint operable remotely.

e) With regard to priority to Active or Reactive Power contribution, the Relevant TSO shall define while respecting the provisions of Article 4(3), 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 required by the Relevant TSO, while respecting the provisions of Article 4(3), a Power Park Module shall be capable of contributing to damping power oscillations. The voltage and reactive power control characteristics of Power Park Modules shall not adversely affect the damping of power oscillations.

Article 17

REQUIREMENTS FOR TYPE D POWER PARK MODULES

Type D Power Park Modules shall fulfil the requirements listed in Articles 8, 9, 10, 11, 15 and 16, except for Article 8(1) (f), Article 9(2) (a), Article 10(3) (a), and Article 15(2) (a).

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Chapter 4

REQUIREMENTS FOR OFFSHORE POWER PARK MODULES

Article 18

GENERAL PROVISIONS

1. The requirements in this Chapter apply to the connection to the Network of Power Park Modules located offshore. A 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 be compliant with the requirements set forth for the Power Park Modules situated onshore.

2. While respecting the provisions of Article 4(3), the Offshore Connection Point of an Offshore Power Park Module shall be defined by the Relevant Network Operator.

3. Offshore Power Park Modules within the scope of this Network Code are categorized in accordance to the following Offshore Grid Connection System configurations:

   a) Configuration 1: AC connection to single onshore point

      One or more Offshore Power Park Modules are interconnected offshore to form an Offshore AC System. The Offshore AC System is connected to the Onshore System with one or more AC connection(s) to the same Onshore Grid Interconnection Point.

   b) Configuration 2: Meshed AC connection

      A number of Offshore Power Park Modules are interconnected offshore to form an Offshore AC System. The Offshore AC System is connected to the Onshore System at two or more Onshore Grid Interconnection Point locations.

Article 19

FREQUENCY STABILITY REQUIREMENTS APPLICABLE TO OFFSHORE POWER PARK MODULES

The Frequency stability requirements defined respectively in Article 8(1) (a), (b), (c), (d) and (e), Article 10(2) and Article 16(2) (a) shall apply to any Offshore Power Park Module.

Article 20

VOLTAGE STABILITY REQUIREMENTS APPLICABLE TO OFFSHORE POWER PARK MODULES

1. While still respecting the provisions according to Articles 9(3) (a) and 11(3) (a), a 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

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Connection Point related to nominal Voltage (per unit), and within the time periods specified by table 10.

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 decided by each TSO while respecting the provisions of Article 4(3), but not less than 20 minutes
	0.90 pu – 1.05 pu**	Unlimited
	1.05 pu – 1.0875 pu**	To be defined by each TSO while respecting the provisions of Article 4(3), but not less than 60 minutes
	1.0875 pu – 1.10 pu**	60 minutes
Nordic	0.90 pu – 1.05 pu	Unlimited
	1.05 pu – 1.10 pu	60 minutes
Great Britain	0.90 pu – 1.10 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.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Table 10: This table shows the minimum period an Offshore Power Park Module shall be capable of operating for different Voltage ranges deviating from a nominal value without disconnecting.

2. The Voltage stability requirements defined respectively in Article 15(2) (b) and (c) as well as in Article 16(3) (a), (c), (d), (e) and (f) shall apply to any Offshore Power Park Module.

3. The Reactive Power capability at Maximum Capacity as defined in Article 16(3) (b) shall apply to any Offshore Power Park Module, except for table 9, which shall be replaced by table 11.

Synchronous Area	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 21

ROBUSTNESS OF POWER GENERATING MODULES REQUIREMENTS APPLICABLE TO OFFSHORE POWER PARK MODULES

1. The robustness of Power Generating Modules requirements as defined in Article 10(4) (a) and (c), and Article 15 (3) shall apply to any Offshore Power Park Module.

2. The fault-ride-through capability requirements as defined in Articles 9(3) (a) and 11(3) (a) shall apply to any Offshore Power Park Module.

Article 22

SYSTEM RESTORATION REQUIREMENTS APPLICABLE TO OFFSHORE POWER PARK MODULES

The system restoration requirements defined respectively in Articles 9(4) and 10(5) shall apply to any Offshore Power Park Module.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Article 23

GENERAL SYSTEM MANAGEMENT REQUIREMENTS APPLICABLE TO OFFSHORE POWER PARK MODULES

The general system management requirements defined respectively in Articles 9(5), 10(6) and 11(4) shall apply to any Offshore Power Park Module.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Title 3

OPERATIONAL NOTIFICATION PROCEDURE FOR CONNECTION

Chapter 1

OPERATIONAL NOTIFICATION PROCEDURE FOR CONNECTION OF NEW POWER GENERATING MODULES

Article 24

GENERAL PROVISIONS

1. The provisions of Title 3 chapter 1 shall apply to New Power Generating Modules only.

2. The Power Generating Facility Owner shall demonstrate to the Relevant Network Operator its compliance with the requirements referred to in Title 2 of this Network Code by completing successfully the operational notification procedure for connection of each Power Generating Module as defined in Articles 25 to 32.

3. Further details of the operational notification procedure shall be defined and made publicly available by the Relevant Network Operator while respecting the provisions of Article 4(3).

Article 25

PROVISIONS FOR TYPE A POWER GENERATING MODULES

1. The operational notification procedure for connection of each new Type A Power Generating Module shall consist of an Installation Document. Based on an Installation Document obtained from the Relevant Network Operator, the Power Generating Facility Owner shall fill in the required information and submit it to the Relevant Network Operator. For subsequent Power Generating Modules separate independent Installation Documents shall be provided.

2. The content of the Installation Document shall be defined by the Relevant Network Operator while respecting the provisions of Article 4(3), at least containing the following:

   - the location at which the connection is made;
   - the date of the connection;
   - the Maximum Capacity of the installation in kW;
   - the type of primary energy source;
   - reference to Equipment Certificates used in the site installation;
   - for equipment used, which has not received an Equipment Certificate, information shall be provided as directed by the Relevant Network Operator; and
   - the contact details of the Power Generating Facility Owner and the installer and their signatures.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

3. On permanent decommissioning of a Power Generating Module the Power Generating Facility Owner shall notify the Relevant Network Operator in writing.

Article 26

PROVISIONS FOR TYPE B, C AND D POWER GENERATING MODULES

1. The operational notification procedure for connection of each new Type B, C and D Power Generating Module allows for the use of a Equipment Certificate.

2. The Equipment Certificate is intended to collate verified data and performance for a specific make and type of Power Generating Module. The purpose of this process is to repeatedly use this data, where relevant, to verify specific parts of data and performance in place of part of the Operational Notification Procedure.

3. The Equipment Certificate cannot indicate total compliance, but can be used as validated information about components of the Power Generating Module. The Power Generating Facility Owner is advised to check with the Relevant Network Operator at an early stage of a project what parts, if any, are acceptable instead of the full compliance process and how to proceed to make use of this facility.

Article 27

PROVISIONS FOR TYPE B AND C POWER GENERATING MODULES

1. The operational notification procedure for connection of each new Type B and C Power Generating Module shall comprise a Power Generating Module Document (PGMD). The PGMD provided by the Power Generating Facility Owner shall contain information as defined by the Relevant Network Operator, including a Statement of Compliance. The selection of the required content of the PGMD shall be defined by the Relevant Network Operator while respecting the provisions of Article 4 (3). Its content shall comprise the information defined in Articles 28 to 32 for Type D Power Generating Modules, but can be simplified through delivery in a single stage of operational notification as well as reduced requirements of details. The Power Generating Facility Owner shall provide the required information and submit it to the Relevant Network Operator. For subsequent Power Generating Modules separate independent PGMDs shall be provided.

2. The Relevant Network Operator on acceptance of a complete and adequate PGMD shall issue a Final Operational Notification to the Power Generating Facility Owner.

3. On permanent decommissioning of a Power Generating Module the Power Generating Facility Owner shall notify the Relevant Network Operator in writing.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Article 28

PROVISIONS FOR TYPE D POWER GENERATING MODULES

The operational notification procedure for connection for each new Type D Power Generating Module shall comprise:

- Energisation Operational Notification (EON);
- Interim Operational Notification (ION);and
- Final Operational Notification (FON).

Article 29

ENERGISATION OPERATIONAL NOTIFICATION (EON) FOR TYPE D POWER GENERATING MODULES

1. An Energisation Operational Notification (EON) shall entitle the Power Generating Facility Owner to energise its internal Network and auxiliaries for the Power Generating Modules by using the grid connection that is defined by the Connection Point.

2. An Energisation Operational Notification (EON) shall be issued by the Relevant Network Operator, subject to completion of preparation including agreement on the protection and control settings relevant to the Connection Point between the Relevant Network Operator and the Power Generating Facility Owner.

Article 30

INTERIM OPERATIONAL NOTIFICATION (ION) FOR TYPE D POWER GENERATING MODULES

1. An Interim Operational Notification (ION) shall entitle the Power Generating Facility Owner to operate the Power Generating Module and generate power by using the grid connection for a limited period of time.

2. An Interim Operational Notification (ION) shall be issued by the Relevant Network Operator, subject to the completion of data and study review process as required by this Network Code.

3. With respect to data and study review the Relevant Network Operator shall have the right to request the following from the Power Generating Facility Owner:

    - itemized Statement of Compliance;
    - detailed technical data of the Power Generating Module with relevance to the grid connection as specified by the Relevant Network Operator;
    - Equipment Certificates of Power Generating Module, where these are relied upon as part of the evidence of compliance;
    - simulation models as specified by Article 10(6) (c) and as required by the Relevant Network Operator while respecting the provisions of Article 4(3);
    - studies demonstrating expected steady-state and dynamic performance as required by Title 4 Chapters 5, 6 or 7 of this Network Code; and
    - details of intended compliance tests according to Title 4 Chapters 2, 3 and 4.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

4. The maximum period for the Power Generating Facility Owner to remain in the Interim Operational Notification (ION) status shall not exceed twenty-four months. The Relevant Network Operator is entitled to specify a shorter ION validity period while respecting the provisions of Article 4(2) with ION extensions granted only if the Power Generating Facility Owner has made substantial progress towards full compliance. At the time of ION extension, the outstanding issues should be explicitly identified.

5. A prolongation of the maximum period for the Power Generating Facility Owner to remain in the Interim Operational Notification (ION) status (beyond a total of twenty-four months) may be granted upon request for derogation made to the Relevant Network Operator before the expiry of that period in accordance with the derogation procedure defined in the Code.

Article 31

FINAL OPERATIONAL NOTIFICATION (FON) FOR TYPE D POWER GENERATING MODULES

1. A Final Operational Notification (FON) shall entitle the Power Generating Facility Owner to operate the Power Generating Module by using the grid connection.

2. A Final Operational Notification (FON) shall be issued by the Relevant Network Operator, upon prior removal of all incompatibilities identified for the purpose of the Interim Operational Notification (ION) status and subject to the completion of data and study review process as required by this Network Code.

3. With respect to data and study review the following must be submitted to the Relevant Network Operator by the Power Generating Facility Owner:

   - itemized Statement of Compliance; and
   - update of applicable technical data, simulation models and studies as referred to in Article 30(3) (b), (c), (d) and (e), including use of actual measured values during testing.

4. In case of incompatibility identified for the purpose of the granting of the Final Operational Notification (FON), a derogation may be granted upon request made to the Relevant Network Operator, in accordance with the derogation procedure according to Title 5. A Final Operational Notification (FON) shall be issued by the Relevant Network Operator, if the Power Generating Module is compliant with the provisions of the derogation. The Relevant Network Operator shall have the right to refuse the operation of the Power Generating Module, whose owner's request for derogation was rejected, until the Power Generating Facility Owner and the Relevant Network Operator have established a resolution of the incompatibility and the Power Generating Module is considered to be compliant by the Relevant Network Operator.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Article 32

LIMITED OPERATIONAL NOTIFICATION (LON) FOR TYPE D POWER GENERATING MODULES

1. Power Generating Facility Owners to whom a Final Operational Notification (FON) has been granted shall inform the Relevant Network Operator immediately in the following circumstances:

   - it is temporarily subject to either a significant modification or loss of capability, due to implementation of one or more modifications of significance to its performance; or
   - in case of equipment failures leading to non compliance with some relevant requirements.

2. The Power Generating Facility Owner shall apply to the Relevant Network Operator for a Limited Operational Notification (LON), if the Power Generating Facility Owner reasonably expects the circumstances according to Article 32(1) to persist for more than three months.

3. A Limited Operational Notification (LON) shall be issued by the Relevant Network Operator with a clear identification of:

   - the unresolved issues justifying the granting of the Limited Operational Notification (LON);
   - the responsibilities and timescales for expected solution; and

   a) a maximum period of validity which shall not exceed twelve months. The initial period granted may be shorter, with possibility for extension, if evidence to the satisfaction of the Relevant Network Operator has been made, which demonstrates that substantial progress has been made in terms of achieving full compliance.

4. The Final Operational Notification (FON) shall be suspended during the period of validity of the Limited Operational Notification (LON) with regard to the subjects for which the Limited Operational Notification (LON) has been issued.

5. A further prolongation of the period of validity of the Limited Operational Notification (LON) may be granted upon request for derogation made to the Relevant Network Operator, before the expiry of that period, in accordance with the derogation procedure according to Title 5.

6. The Relevant Network Operator shall have the right to refuse the operation of the Power Generating Module, if the Limited Operational Notification (LON) terminates without removal of the circumstances which caused its issuing. In such a case the Final Operational Notification (FON) shall automatically be invalid.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Chapter 2

OPERATIONAL NOTIFICATION PROCEDURE FOR EXISTING POWER GENERATING MODULES

Article 33

GENERAL PROVISIONS

1. In order to assess the advantages of the applicability of any requirement set forth in this Network Code to Existing Power Generating Modules, the Relevant TSO shall initiate the process referred to in Article 3(2) by a preparatory stage aimed at identifying cases of merit with the phases defined in Article 33(2) to (8) below. This preparatory stage shall consist of a qualitative comparison of costs and benefits related to the requirement under consideration for application to Existing Power Generating Modules taking into account network-based or market-based alternatives, where applicable. If the Relevant TSO deems the cost of applying the requirement to be low and the benefit to be high then the case can proceed as defined below. If however, the cost is deemed high and or the benefit is deemed low then the Relevant TSO may not proceed further.

2. The TSO shall carry out a quantitative Cost-Benefit Analysis of a requirement under consideration for application to Existing Power Generating Modules that has demonstrated potential benefits as a result of the preparatory stage according to Article 33(1) above. This Cost-Benefit Analysis shall be followed by a public consultation. The public consultation shall include, amongst others, a proposal for a transition period for applying a requirement to Existing Power Generating Modules. Such a transition period should not exceed two years from the decision of the National Regulatory Authority on the applicability.

3. Power Generating Facility Owners, DSOs and CDSOs shall assist and contribute to this Cost-Benefit Analysis and provide the relevant data as requested by the Relevant TSO within three months after reception of the request, unless agreed otherwise.

4. The Cost-Benefit Analysis shall be undertaken using one or more of the following calculating principles:

   - net present value;
   - return on investment;
   - rate of return; and
   - time to break-even.

   The quantified benefits shall include any marginal socio-economic benefits in terms of improvement of security of supply including, but not limited to:

   - associated reduction in probability of loss of supply over the lifetime of the modification;
   - the probable extent and duration of such loss of supply;
   - the societal cost per hour of such loss of supply;

   as well as benefits to the internal market in electricity, cross-border trade and integration of renewable energies including, but not limited to:

   - Frequency response;
   - reserve holding;
   - Reactive Power provision;

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

- congestion management; and
- defence measures.

The quantified costs shall include as appropriate, but are not limited to:

- costs for implementing the requirement;
- any attributable loss of opportunity; and/or
- change in maintenance and operating costs.

5. If the socio-economic benefits outweigh the costs of applying the requirement under consideration to Existing Power Generating Modules, the Relevant TSO shall summarise the analysis within three months in a report which shall include a recommendation on how to proceed. This report shall be subject to public consultation. If, taking due account of the outcome of the public consultation, the Relevant TSO decides to proceed with the issue, the report including such consultation outcome and a proposal on the applicability of the requirement under consideration to Existing Power Generating Modules, shall be forwarded to the Relevant National Regulatory Authority within six months for decision.

6. The proposal by the Relevant TSO to the National Regulatory Authority on applicability of any requirement of this Network Code according to Article 3(2) to Existing Power Generating Modules according to Title 1 Article 3(2) shall include the following:

   a) an operational notification procedure in order to demonstrate the implementation of the requirements by the Power Generating Facility Owner;
   b) an appropriate transition period for implementing the requirements. The determination of the transition period shall take into account the category of the Power Generating Module according to Article 3(6) (a) to (e) and any underlying obstacles for efficient undertaking of the equipment modification/refitting.

   The Relevant National Regulatory Authority shall decide on the case within three months after receipt of the report and the recommendation of the Relevant TSO. The decision of the Relevant TSO on how to proceed with the issue and the decision of the National Regulatory Authority, if any, shall be published.

7. All relevant clauses in contracts and/or relevant clauses in general terms and conditions relating to the grid connection of Existing Power Generating Modules shall be amended to achieve compliance with the requirements of this Network Code, that shall apply to them according to Article 33(6). The relevant clauses shall be amended within three years after the decision of the National Regulatory Authority on the applicability according to Article 3(2). This requirement for amendment shall apply regardless of whether the relevant contracts or general terms and conditions provide for such an amendment.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Title 4

COMPLIANCE

Chapter 1

COMPLIANCE MONITORING

Article 34

RESPONSIBILITY OF THE POWER GENERATING FACILITY OWNER

1. The Power Generating Facility Owner shall ensure that a Power Generating Module is compliant with the requirements under this Network Code. This compliance shall be maintained throughout the lifetime of the facility.

2. Planned modifications of the technical capabilities of the Power Generating Module with possible impact on its compliance to the requirements under this Network Code shall be notified to the Relevant Network Operator by the Power Generating Facility Owner before initiating such modification.

3. Any operational incidents or failures of a Power Generating Module that have impact on its compliance to the requirements of this Network Code shall be notified to the Relevant Network Operator by the Power Generating Facility Owner as soon as possible without any delay after the occurrence of such an incident.

4. Any foreseen test schedules and procedures to verify compliance of a Power Generating Module with the requirements of this Network Code shall be notified to the Relevant Network Operator by the Power Generating Facility Owner in due time and prior to their launch and shall be approved by the Relevant Network Operator.

5. The Relevant Network Operator shall be facilitated to participate in such tests and may record the performance of the Power Generating Modules.

Article 35

TASKS OF THE NETWORK OPERATOR

1. The Relevant Network Operator shall regularly assess the compliance of a Power Generating Module with the requirements under this Network Code throughout the lifetime of the Power Generating Facility. The Power Generating Facility Owner shall be informed of the outcome of this assessment.

2. The Relevant Network Operator shall have the right to request that the Power Generating Facility Owner carries out compliance tests and simulations not only during the operational notification procedures according to Title 3, but repeatedly throughout the lifetime of the Power Generating Facility according to a plan or general scheme for repeated tests and simulations

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

defined while respecting the provisions of Article 4(3) or after any failure, modification or replacement of any equipment that may have impact on the Power Generating Module's compliance with the requirements under this Network Code. The Power Generating Facility Owner shall be informed of the outcome of these compliance tests and simulations.

3. The Relevant Network Operator shall make publicly available the list of information and documents to be provided as well as the requirements to be fulfilled by the Power Generating Facility Owner in the frame of the compliance process. Such list shall, notably, cover the following information, documents and requirements:

   - all documentation and certificates to be provided by the Power Generating Facility Owner;
   - details of the technical data of the Power Generating Module with relevance to the grid connection;
   - requirements for models for steady-state and dynamic system studies;
   - timely provision of system data required to perform the studies;
   - studies by the Power Generating Facility Owner for demonstrating expected steady-state and dynamic performance referring to the requirements set forth in Title 4 Chapter 4 and 5 of this Network Code; and
   - conditions and procedures including the scope for registering Equipment Certificates.
   - conditions and procedures for use of relevant Equipment Certificates by the Power Generating Facility Owner instead of part of the activity for compliance as described in this Network Code.

4. The Relevant Network Operator shall make publicly available the allocation of responsibilities to the Power Generating Facility Owner and to the Network Operator for compliance testing, simulation and monitoring.

5. The Relevant Network Operator may partially or totally assign the performance of its compliance monitoring to third parties. In this case, the Relevant Network Operator shall ensure compliance of Article 6 of this Network Code by appropriate confidentiality commitments with the assignee.

6. The Relevant Network Operator shall not withhold unreasonably any operational notification as per Title 3, if compliance tests or simulations cannot be performed as agreed between the Relevant Network Operator and the Power Generating Facility Owner due to reasons which are in the sole control of the Relevant Network Operator.

Article 36

COMMON PROVISIONS ON COMPLIANCE TESTING

1. The testing of the performance of the individual Power Generating Modules within the Power Generating Facility shall aim at demonstrating the fulfilment of the requirements of this Network Code.

2. Notwithstanding the minimum requirements relating to the compliance testing laid down by the provisions of this Network Code, the Relevant Network Operator is, while respecting the provisions of Article 4 (3), entitled to:

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

- allow the Power Generating Facility Owner to carry out an alternative set of tests, provided that those tests are efficient and sufficient to demonstrate compliance of a Power Generating Module to the requirements under this Network Code;
- require the Power Generating Facility Owner to carry out an additional or alternative set of tests in case information supplied to the Relevant Network Operator by the Power Generating Facility Owner in relation to compliance testing under the provisions of Title 4 Chapter 2, 3 or 4 of this Network Code are not sufficient to demonstrate compliance to the requirements under this Network Code; and
- require the Power Generating Facility Owner to carry out appropriate tests in order to demonstrate a Power Generating Module's performance when operating on alternative fuels or fuel mixes. The Relevant Network Operator and the Power Generating Facility Owner shall agree on which types of fuel are tested.

3. The Power Generating Facility Owner is responsible for carrying out the tests in accordance with the conditions laid down in Title 4 Chapters 2, 3 and 4 of this Network Code. The Relevant Network Operator shall make its reasonable efforts to cooperate and not unduly delay the performance of the tests.

4. The Power Generating Facility Owner is responsible for the safety of the personnel and the plant during the tests.

5. The Relevant Network Operator shall be facilitated to participate to the test either on site or remotely from the Network Operator's control centre. For that purpose, the Power Generating Facility Owner shall provide suitable monitoring equipment to record all relevant test signals and measurements as well as ensure that the relevant representatives from the Power Generating Facility Owner are available on site for the entire testing period. Signals specified by the Relevant Network Operator shall be provided, if the Relevant Network Operator wishes for selected tests to use own equipment to record the performance during tests. The decision as regards the participation of the Relevant Network Operator to the test and the form of this participation remains at the sole and exclusive discretion of the Relevant Network Operator.

Article 37

COMMON PROVISIONS ON COMPLIANCE SIMULATIONS

1. The simulation of the performance of the individual Power Generating Modules within the Power Generating Facility shall aim at demonstrating the fulfilment of the requirements of this Network Code.

2. Notwithstanding the minimum requirements relating to the Compliance Simulations laid down by the provisions of this Network Code, the Relevant Network Operator is, while respecting the provisions of Article 4(3), entitled to:

   a) allow the Power Generating Facility Owner to carry out an alternative set of simulations, provided that those simulations are efficient and sufficient to demonstrate compliance of a Power Generating Module to the requirements under this Network Code or national legislation including national codes; and
   b) require the Power Generating Facility Owner to carry out an additional or alternative set of simulations in case information supplied to the Relevant Network Operator by the Power

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Generating Facility Owner in relation to Compliance Simulation under the provisions of Title 4 Chapter 5, 6 or 7 of this Network Code are not sufficient to demonstrate compliance to the requirements under this Network Code.

3. The Power Generating Facility Owner shall provide simulation results relevant to each and any individual Power Generating Module within the Power Generating Facility in a report form in order to demonstrate the fulfilment of the requirements of this Network Code. The Power Generating Facility Owner shall produce and provide a validated simulation model for a Power Generating Module. The coverage of the simulation models are described in Article 10(6) (c).

4. The Relevant Network Operator shall have the right to check the compliance of a Power Generating Module with the requirements of this Network Code by carrying out its own Compliance Simulations based on the provided simulation reports, simulation models and compliance test measurements.

5. The Relevant Network Operator shall provide to the Power Generating Facility Owner the technical data and the simulation model of the Network, in the extent necessary for carrying out the requested simulations according to Title 4 Chapter 5, 6 or 7 of this Network Code.

Chapter 2

COMPLIANCE TESTING FOR SYNCHRONOUS POWER GENERATING MODULES

Article 38

COMPLIANCE TESTS FOR TYPE B SYNCHRONOUS POWER GENERATING MODULES

1. Type B Synchronous Power Generating Modules are subject to the following compliance tests. The Equipment Certificate may be used instead of part or all of the tests below, provided that they are provided to the Relevant Network Operator.

2. With regard to the LFSM-O response test:

   a) The Power Generating Module shall demonstrate its technical capability to continuously modulate Active Power to contribute to Frequency Control in case of large increase of Frequency in the system and shall verify the steady-state parameters of regulations, such as Droop and deadband, and dynamic parameters, including Frequency step change response.

   b) The test shall be carried out by simulating Frequency steps and ramps big enough to activate at least 10 % of Maximum Capacity change in Active Power, taking into account the Droop settings and the deadband. Simulated Frequency deviation signals shall be injected simultaneously at both the speed and power control loops of the control systems if required, taking in account the scheme of these control system.

   c) The test is deemed passed, provided that the following conditions are both fulfilled:

      1) the test results, for both dynamic and static parameters, are in line with the requirements as referred to in Article 8(1) (c); and

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

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

Article 39

COMPLIANCE TESTS FOR TYPE C SYNCHRONOUS POWER GENERATING MODULES

1. In addition to the compliance tests for Type B Synchronous Power Generating Modules in the conditions as referred to in Article 38, Type C Synchronous Power Generating Modules are subject to the following compliance tests. The Equipment Certificate may be used instead of part or all of the tests below, provided that they are provided to the Relevant Network Operator.

2. With regard to the LFSM-U response test:

   a) The Power Generating Module shall demonstrate its technical capability to continuously modulate Active Power at operating points below Maximum Capacity to contribute to Frequency Control in case of large drop of Frequency in the system.

   b) The test shall be carried out by simulating at appropriate Active Power load points (e.g. 80 %) with low Frequency steps and ramps big enough to activate at least 10 % of Maximum Capacity Active Power change, taking into account the Droop settings and the deadband. Simulated Frequency deviation signals shall be injected simultaneously into both the speed governor and the load controller references if required, taking into account the speed governor and the load controller scheme.

   c) The test is deemed passed, provided that the following conditions are both fulfilled:

      1) the test results, for both dynamic and static parameters, are in line with the requirements as referred to in Article 10(2) (b); and

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

3. With regard to the FSM response test:

   a) The Power Generating Module shall demonstrate its technical capability to continuously modulate Active Power over the full operating range between Maximum Capacity and Minimum Regulating Level to contribute to Frequency Control and shall verify the steady-state parameters of regulations, such as Droop and deadband and dynamic parameters, including robustness through Frequency step change response and large, fast Frequency changes.

   b) The test shall be carried out by simulating Frequency steps and ramps big enough to activate the whole Active Power Frequency response range, taking into account the Droop settings, the deadband and the Real Power headroom or deload (margin to Maximum Capacity in operational timescale). Simulated Frequency deviation signals shall be injected simultaneously into the references of both the speed governor and the load controller of the unit or plant control system if required, taking into account the speed governor and load controller scheme.

   c) The test is deemed to be passed, provided that the following conditions are all fulfilled:

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

1) activation time of full Active Power Frequency response range as result of a step Frequency change has been no longer than required by Article 10(2) (c);

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

3) the initial delay time has been according to Article 10(2) (c);

4) the Droop settings are available within the range defined in Article 10(2) (c) and deadband (thresholds) is not more than the value in Article 10(2) (c); and

5) insensitivity of Active Power Frequency response at any relevant operating point does not exceed the requirements set forth in Article 10(2) (c).

4. With regard to the frequency restoration control test:

   a) The Power Generating Module shall demonstrate its technical capability to participate in Frequency restoration control. The cooperation of FSM and Frequency restoration control shall be checked.

   b) The test is deemed passed, provided that the test results, for both dynamic and static parameters, are in line with the requirements as referred to in Article 10(2) (d).

5. With regard to the Black Start Capability test:

   a) Power Generating Modules with Black Start Capability in accordance with Article 10(5) (a), shall demonstrate this technical capability to start from shut down without any external energy supply.

   b) The test is deemed passed, provided that the start-up time has been not longer than the timeframe according to Article 10(5) (a) point 2).

6. With regard to the tripping to houseload test:

   a) Power Generating Modules shall demonstrate their technical capability to trip to and stably operate on house load.

   b) The test shall be carried out at the Maximum Capacity and nominal Reactive Power of the Power Generating Module before load shedding.

   c) Further conditions for this test shall be defined by the Relevant Network Operator while respecting the provisions of Article 4(3) taking into account Article 10(5) (c).

   d) The test is deemed passed, provided that tripping to houseload has been successful and stable Houseload Operation has been demonstrated for time period according to Article 10(5) (c) and re-synchronisation to the Network has been performed successfully.

7. With regard to the Reactive Power Capability test:

   a) The Power Generating Module shall demonstrate its technical capability to provide leading and lagging Reactive Power capability according to Article 13(2) (b) and (c).

   b) The test is deemed passed, provided that the following conditions are cumulatively fulfilled:

      1) the Power Generating Module has been operating no shorter than 1 hour at maximum Reactive Power, both leading and lagging, for each of:

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

- Minimum Stable Operating Level;
- Maximum Capacity; and
- an Active Power operating point between those maximum and minimum ranges;

2) the Power Generating Module demonstrates its capability to change to any Reactive Power target value within the agreed or decided Reactive Power range within the specified performance targets of the relevant Reactive Power control scheme.

Article 40

COMPLIANCE TESTS FOR TYPE D SYNCHRONOUS POWER GENERATING MODULES

Type D Synchronous Power Generating Modules are subject to the compliance tests for Type B and C Synchronous Power Generating Modules in the conditions as referred to in Articles 38 and 39. The Equipment Certificate may be used instead of part or all of the tests below, provided that they are provided to the Relevant Network Operator.

Chapter 3

COMPLIANCE TESTING FOR POWER PARK MODULES

Article 41

COMPLIANCE TESTS FOR TYPE B POWER PARK MODULES

1. The Equipment Certificate may be used instead of part or all of the tests below, provided that they are provided to the Relevant Network Operator.

2. With regard to Type B Power Park Modules the LFSM-O response tests shall be carried out reflecting the choice of control scheme selected by the Relevant Network Operator.

   a) The Power Park Module shall demonstrate its technical capability to continuously modulate Active Power to contribute to Frequency Control in case of increase of Frequency in the system and shall verify the steady-state parameters of regulations, such as Droop and deadband, and dynamic parameters, including Frequency step change response.

   b) The test shall be carried out by simulating Frequency steps and ramps big enough to activate at least 10 % of Maximum Capacity change in Active Power, taking into account the Droop settings and the deadband. Simulated Frequency deviation signals shall be injected to perform this test.

   c) The test is deemed passed, provided that the test results, for both dynamic and static parameters, are in line with the requirements as referred to in Article 8(1) (c).

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Article 42

COMPLIANCE TESTS FOR TYPE C POWER PARK MODULES

1. In addition to the compliance tests for Type B Power Park Modules in the conditions as referred to in Article 41, Type C Power Park Modules are subject to the following compliance tests. The Equipment Certificate may be used instead of part or all of the tests below, provided that they are provided to the Relevant Network Operator.

2. With regard to the Active Power controllability and control range test:

   a) The Power Park Module shall demonstrate its technical capability to operate at a load level no higher than the Setpoint set by the Relevant Network Operator or the Relevant TSO.

   b) The test is deemed passed, provided that the following conditions are cumulatively fulfilled:

      1) the load level of the Power Park Module is kept below the Setpoint;

      2) the Setpoint is implemented according to the requirements as referred to in Article 10(2) (a); and

      3) the accuracy of the regulation is compliant with specified value according to Article 10(2) (a).

3. With regard to the LFSM-U response test:

   a) The Power Park Module shall demonstrate its technical capability to continuously modulate Active Power to contribute to Frequency Control in case of large drop of Frequency in the system.

   b) The test shall be carried out by simulating the Frequency steps and ramps big enough to activate 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. Simulated Frequency deviation signals shall be injected in the Power Park Module controller scheme, taking into account both speed governor and load controller scheme, if applicable.

   c) The test is deemed passed, provided that the following conditions are cumulatively fulfilled:

      1) the test results, for both dynamic and static parameters, are in line with the requirements as referred to in Article 10(2) (b); and

      2) undamped oscillations after the step change response does not occur.

4. With regard to the FSM response test:

   a) The Power Park Module shall demonstrate its technical capability to continuously modulate Active Power over the full operating range between Maximum Capacity and Minimum Regulating Level to contribute to Frequency Control and shall verify 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.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

b) The test shall be carried out by simulating Frequency steps and ramps big enough to activate whole Active Power Frequency response range, taking into account the Droop settings and the deadband. Simulated Frequency deviation signals shall be injected to perform this test.

c) The test is deemed passed, provided that the following conditions are cumulatively fulfilled:

1) the activation time of full Active Power Frequency response range as result of a step Frequency change has been no longer than that required by Article 10(2) (c);

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

3) the initial delay has been according to Article 10(2) (c);

4) the Droop settings are available within the ranges defined in Article 10(2) (c) and deadband (thresholds) is not more than the value chosen by the TSO; and

5) the insensitivity of Active Power Frequency response does not exceed the requirement according to Article 10(2) (c).

5. With regard to the frequency restoration control test:

a) The Power Park Module shall demonstrate its technical capability to participate in Frequency restoration control. The cooperation of both FSM and Frequency restoration control shall be checked.

b) The test is deemed passed, provided that the test results for both dynamic and static parameters are in line with the requirements as referred to in Article 10(2) (d).

6. With regard to the Reactive Power capability test:

a) The Power Park Module shall demonstrate its technical capability to provide leading and lagging Reactive Power capability according to Article 16(3) (b) and (c).

b) The Reactive Power Capability test shall be carried out at maximum Reactive Power, both leading and lagging, and concerning the verification of the following parameters:

1) operation in excess of 60 % of Maximum Capacity for 30 min;

2) operation within the range of 30 – 50 % of Maximum Capacity for 30 min; and

3) operation within the range of 10 – 20 % of Maximum Capacity for 60 min.

c) The test is deemed passed, provided that the following criteria are cumulatively fulfilled:

1) the Power Park Module has been operating no shorter than requested duration at maximum Reactive Power, both leading and lagging, in each parameter as referred to in Article 42(6) (b);

2) the Power Park Module has demonstrated its capability to change to any Reactive Power target value within the agreed or decided Reactive Power range within the specified performance targets of the relevant Reactive Power control scheme; and

3) no action of any protection within the operation limits defined by Reactive Power capacity diagram occurs.

7. With regard to the Voltage Control Mode test:

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

a) The Power Park Module shall demonstrate its capability to operate in Voltage control mode in the conditions set forth in Article 16(3) (d) point 2).

b) The Voltage Control Mode test shall apply concerning the verification of the following parameters:

1) the implemented Slope and deadband of the static characteristic;

2) the accuracy of the regulation;

3) the insensitivity of the regulation; and

4) the time of Reactive Power activation.

c) The test is deemed passed, provided that the following conditions are cumulatively fulfilled:

1) the implemented Slope and deadband of the static characteristic;

2) the range of regulation and adjustable the Droop and deadband is compliant with agreed or decided characteristic parameters, according to Article 16(3) (d);

3) the insensitivity of Voltage Control is not higher than 0.01 pu, according to Article 16(3) (d); and

4) following a step change in Voltage, 90 % of the change in Reactive Power output has been achieved within the times and tolerances according to Article 16(3) (d).

8. With regard to the Reactive Power Control Mode test:

a) The Power Park Module shall demonstrate its capability to operate in Reactive Power control mode, according to the conditions referred to in Article 16(3) (d) point 3).

b) The Reactive Power Control Mode test shall be complementary to the Reactive Power Capability test.

c) The Reactive Power Control Mode test shall apply concerning the verification of the following parameters:

1) the Reactive Power Setpoint range and step;

2) the accuracy of the regulation; and

3) the time of Reactive Power activation.

d) The test is deemed passed, provided that the following conditions are cumulatively fulfilled:

1) the Reactive Power Setpoint range and step is ensured according to Article 16(3) (d); and

2) the accuracy of the regulation is compliant with the conditions as referred to in Article 16(3) (d).

9. With regard to the Power Factor Control Mode test:

a) The Power Park Module shall demonstrate its capability to operate in Power Factor control mode according to the conditions referred to in Article 16(3) (d) point 4).

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

b) The Power Factor Control Mode test shall apply concerning the verification of the following parameters:

1) the Power Factor Setpoint range;

2) the accuracy of the regulation; and

3) the response of Reactive Power due to step change of Active Power.

c) The test is deemed passed, provided that the following conditions are cumulatively fulfilled:

1) the Power Factor Setpoint range and step is ensured according to Article 16(3) (d);

2) the time of Reactive Power activation as result of step Active Power change does not exceed the requirement according to Article 16(3) (d); and

3) the accuracy of the regulation is compliant with the value, as referred to in Article 16(3) (d).

10. With regard to the tests identified in Article 42(7), (8) and (9) the Relevant Network Operator may select only one of the three control options for testing.

Article 43

COMPLIANCE TESTS FOR TYPE D POWER PARK MODULES

Type D Power Park Modules are subject to the compliance tests for Type B and C Power Park Modules in the conditions as referred to in Articles 41 and 42. The Equipment Certificate may be used instead of part or all of the tests below, provided that they are provided to the Relevant Network Operator.

Chapter 4

COMPLIANCE TESTING FOR OFFSHORE POWER PARK MODULES

Article 44

COMPLIANCE TESTING APPLICABLE TO OFFSHORE POWER PARK MODULES

The compliance tests as defined in Article 41(2), as well as in Article 42(2), (3), (4), (5) and (7), (8) and (9) shall apply to any Offshore Power Park Module.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Chapter 5

COMPLIANCE SIMULATIONS FOR SYNCHRONOUS POWER GENERATING MODULES

Article 45

COMPLIANCE SIMULATIONS FOR TYPE B SYNCHRONOUS POWER GENERATING MODULES

1. The Equipment Certificate may be used instead of part or all of the simulations below, provided that they are provided to the Relevant Network Operator.

2. Type B Synchronous Power Generating Modules are subject to the following compliance simulations.

3. With regard to the LFSM-O response simulation:

   a) The Power Generating Module shall demonstrate its capability to simulate Active Power modulation at high Frequency according to Article 8(1) b.

   b) The simulation shall be carried out by simulating high Frequency steps and ramps reaching Minimum Regulating Level, taking into account the Droop settings and the deadband.

   c) The simulation is deemed passed, provided that:

      1) the simulation model of the Power Generating Module is validated against the compliance test for LFSM-O response as referred to in Article 38(2); and

      2) compliance with the requirement according to Article 8(1) (c) is demonstrated.

4. With regard to the Type B fault-ride-through capability of Synchronous Power Generating Modules simulation:

   d) The Power Generating Module shall demonstrate its capability to simulate fault-ride-through capability in the conditions set forth in Article 9(3) (a).

   e) The simulation is deemed passed, provided that compliance with the requirement according to Article 9(3) (a) is demonstrated.

5. With regard to the Post Fault Power Active Recovery simulation:

   f) The Power Generating Module shall demonstrate its capability to simulate post fault Active Power recovery in the conditions set forth in Article 12(3) (a).

   g) The simulation is deemed passed, provided that compliance with the requirement according to Article 12(3) (a) is demonstrated.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Article 46

COMPLIANCE SIMULATIONS FOR TYPE C SYNCHRONOUS POWER GENERATING MODULES

1. In addition to the Compliance Simulations for Type B Synchronous Power Generating Modules in the conditions as referred to in Article 45, Type C Synchronous Power Generating Modules are subject to the following Compliance Simulations. The Equipment Certificate may be used instead of part or all of the simulations below, provided that they are provided to the Relevant Network Operator.

2. With regard to the LFSM-U response simulation:

   a) The Power Generating Module shall demonstrate its capability to simulate Active Power modulation at low Frequencies according to Article 10(2) b.

   b) The simulation shall be carried out by simulating low Frequency steps and ramps reaching Maximum Capacity, taking into account the Droop settings and the deadband.

   c) The simulation is deemed passed, provided that:

      1) the simulation model of the Power Generating Module is validated against the compliance test for LFSM-U response as referred to in Article 39(2); and

      2) compliance with the requirement according to Article 10(2) (b) is demonstrated.

3. With regard to the FSM response simulation:

   a) The Power Generating Module shall demonstrate its capability to modulate Active Power over the full Frequency range according to Article 10(2) (c).

   b) The simulation shall be carried out by simulating Frequency steps and ramps big enough to activate whole Active Power Frequency response range, taking into account the Droop settings and the deadband.

   c) The simulation is deemed passed, provided that:

      1) the simulation model of the Power Generating Module is validated against the compliance test for LFSM-U response as referred to in Article 39(3); and

      2) compliance with the requirement according to Article 10(2) (c) is demonstrated.

4. With regard to the Island Operation simulation:

   a) The Power Generating Module shall demonstrate its performance during Island Operation in the conditions as referred to in Article 10(5) (b).

   b) The simulation is deemed passed, provided 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 within the limits of Article 10(5) (b) without disconnection of the Power Generating Module from the island due to over-/underfrequency; and

5. With regard to the Reactive Power Capability simulation:

   a) The Power Generating Module shall demonstrate its capability to simulate leading and lagging Reactive Power capability in the conditions referred to in Article 13(2) (b) and (c).

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

b) The simulation is deemed passed, provided that the following conditions are cumulatively fulfilled:

1) the simulation model of the Power Generating Module is validated against the compliance tests for Reactive Power Capability at the as referred to in Article 39(7); and

2) compliance with the requirements as referred to in Article 13(2) (b) and (c) is demonstrated.

Article 47

COMPLIANCE SIMULATIONS FOR TYPE D SYNCHRONOUS POWER GENERATING MODULES

1. In addition to the Compliance Simulations for Type B and C Synchronous Power Generating Modules in the conditions as referred to in Articles 46 and 47, except for the Type B fault-ride-through capability of Synchronous Power Generating Modules as referred to in Article 45(4), Type D Synchronous Power Generating Modules are subject to the following Compliance Simulations. The Equipment Certificate may be used instead of part or all of the simulations below, provided that they are provided to the Relevant Network Operator.

2. With regard to the Power Oscillations Damping Control simulation:

a) The Power Generating Module shall demonstrate the performance of its control system (PSS function) to damp power oscillations in the conditions set forth in Article 14(2) (g).

b) The tuning shall result in improved damping of corresponding Active Power response of the AVR in combination with the PSS function compared to the Active Power response of the AVR alone.

c) The simulation is deemed passed, provided that the following conditions are cumulatively fulfilled:

1) the PSS function damps the existing power oscillations of the Power Generating Module within a Frequency range specified by the Relevant TSO. This Frequency range shall include the local mode frequency of the Power Generating Module and the expected Network oscillations; and

2) a sudden load reduction of the Power Generating Module from 1p.u. to 0.6p.u. of the Maximum Capacity has not lead to undamped oscillations in Active or Reactive Power of the Power Generating Module.

3. With regard to the Type D fault-ride-through capability of Synchronous Power Generating Modules simulation:

a) The Power Generating Module shall demonstrate its capability to simulate fault-ride-through capability in the conditions set forth in Article 11(3) (a).

b) The simulation is deemed passed, provided that compliance with the requirement according to Article 11(3) (a) is demonstrated.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Chapter 6

COMPLIANCE SIMULATIONS FOR POWER PARK MODULES

Article 48

COMPLIANCE SIMULATIONS FOR TYPE B POWER PARK MODULES

1. Type B Power Park Modules are subject to the following compliance simulations. The Equipment Certificate may be used instead of part or all of the simulations below, provided that they are provided to the Relevant Network Operator.

1. With regard to the LFSM-O response simulation:

   a) The Power Park Module shall demonstrate its capability to simulate Active Power modulation at high Frequency according to Article 8(1) b.

   b) The simulation shall be carried out by simulating high Frequency steps and ramps reaching Minimum Regulating Level, taking into account the Droop settings and the deadband.

   c) The simulation is deemed passed, provided that:

      1) the simulation model of the Power Park Module is validated against the compliance test for LFSM-O response as referred to in Article 41(2); and

      2) compliance with the requirement according to Article 8(1) (c) is demonstrated.

2. With regard to the fast acting additional reactive Current injection simulation:

   d) The Power Generating Module shall demonstrate its capability to simulate fast acting additional reactive Current injection in the conditions set forth in Article 15(2) (b).

   e) The simulation is deemed passed, provided that compliance with the requirement according to Article 15(2) (b) is demonstrated.

3. With regard to the Type B fault-ride-through capability of Power Park Modules simulation:

   a) The Power Generating Module shall demonstrate its capability to simulate fault-ride-through capability in the conditions set forth in Article 9(3) (a).

   b) The simulation is deemed passed, provided that compliance with the requirement according to Article 9(3) (a) is demonstrated.

4. With regard to the Post Fault Power Active Recovery simulation:

   a) The Power Generating Module shall demonstrate its capability to simulate post fault Active Power recovery in the conditions set forth in Article 15(3) (a).

   b) The simulation is deemed passed, provided that compliance with the requirement according to Article 15(3) (a) is demonstrated.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Article 49

COMPLIANCE SIMULATIONS FOR TYPE C POWER PARK MODULES

1. In addition to the Compliance Simulations for Type B Power Park Modules in the conditions as referred to in Article 48, Type C Power Park Modules are subject to the following Compliance Simulations. The Equipment Certificate may be used instead of part or all of the simulations below, provided that they are provided to the Relevant Network Operator.

2. With regard to the LFSM-U response simulation:

   a) The Power Park Module shall demonstrate its capability to simulate Active Power modulation at low Frequencies according to Article 10(2) b.

   b) The simulation shall be carried out by simulating low Frequency steps and ramps reaching Maximum Capacity, taking into account the Droop settings and the deadband.

   c) The simulation is deemed passed, provided that:

      1) the simulation model of the Power Park Module is validated against the compliance test for LFSM-U response as referred to in Article 42(3); and

      2) compliance with the requirement according to Article 10(2) (b) is demonstrated.

3. With regard to the FSM response simulation:

   a) The Power Park Module shall demonstrate its capability to modulate Active Power over the full Frequency range according to Article 10(2) (c).

   b) The simulation shall be carried out by simulating Frequency steps and ramps big enough to activate whole Active Power Frequency response range, taking into account the Droop settings and the deadband.

   c) The simulation is deemed passed, provided that:

      1) the simulation model of the Power Park Module is validated against the compliance test for LFSM-U response as referred to in Article 42(4); and

      2) compliance with the requirement according to Article 10(2) (c) is demonstrated.

4. With regard to the Island Operation simulation:

   a) The Power Generating Module shall demonstrate its performance during Island Operation in the conditions as referred to in Article 10(5) (b).

   b) The simulation is deemed passed, provided 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 within the limits of Article 10(5) (b) without disconnection of the Power Generating Module from the island due to over-/underfrequency; and

5. With regard to the simulation of the capability of providing Synthetic Inertia:

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

a) The model of the Power Generating Module shall demonstrate its capability to simulate the capability of providing Synthetic Inertia to a low Frequency event in the conditions as referred to in Article 16(2) (a).

b) The simulation is deemed passed, provided that the model demonstrates compliance with the conditions of Article 16(2) (a).

6. With regard to the Reactive Power capability simulation:

a) The Power Park Module shall demonstrate its capability to simulate leading and lagging Reactive Power capability in the conditions referred to in Article 16(3) (b) and (c).

b) The simulation is deemed passed, provided that the following conditions are cumulatively fulfilled:

1) the simulation model of the Power Park Module is validated against the compliance tests for Reactive Power Capability at the as referred to in Article 42(6); and

2) compliance with the requirements as referred to in Article 16(3) (b) and (c) is demonstrated.

7. With regard to the power oscillations damping control simulation:

a) The model of the Power Generating Module shall demonstrate its capability to simulate power oscillations damping capability in the conditions as referred to in Article 16(3) (f).

b) The simulation is deemed passed, provided that the model demonstrates compliance with the conditions of Article 16(3) (f).

Article 50

COMPLIANCE SIMULATIONS FOR TYPE D POWER PARK MODULES

1. In addition to the Compliance Simulations for Type B and C Power Park Modules in the conditions as referred to in Articles 49 and 50, except for the Type B fault-ride-through capability of Power Park Modules as referred to in Article 48(4), Type D Power Park Modules are subject to the Type D fault-ride-through capability of Power Park Modules Compliance Simulation. The Equipment Certificate may be used instead of part or all of the simulations below, provided that they are provided to the Relevant Network Operator.

2. The model of the Power Generating Module shall demonstrate its capability to simulate fault-ride-through capability in the conditions as referred to in Article 11(3) (a).

3. The simulation is deemed passed, provided that the model demonstrates compliance with the conditions of Article 11(3) (a) respectively.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Chapter 7

COMPLIANCE SIMULATIONS FOR OFFSHORE POWER PARK MODULES

Article 51

COMPLIANCE SIMULATIONS APPLICABLE TO OFFSHORE POWER PARK MODULES

The Compliance Simulations as defined in Article 48 (3) and (5) as well as in Article 49(4), (5) and (7) shall apply to any Offshore Power Park Module.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Title 5

DEROGATIONS

Article 52

GENERAL PROVISIONS

1. The procedure for derogation defined in this Title applies to all Power Generating Facility Owners, both of Existing and New Power Generating Modules, to which the provisions of this Network Code are applicable pursuant to Article 3. Only the Power Generating Facility Owner shall have the right to apply for derogations for Power Generating Modules within its facility.

2. It shall apply as well to Network Operators when applying for derogations for classes of both existing and new Power Generating Modules connected to their Network.

3. The derogation process shall be transparent, non-discriminatory, non-biased, well documented and based in particular on the Cost-Benefit Analysis performed, in the conditions set forth by Article 33(4) and (5), by the Relevant Network Operator in coordination with the Relevant TSO. Cost-Benefit Analysis does not need to be performed by the Relevant Network Operator if, on its reasoned request, an individual exemption is granted to the Relevant Network Operator by the National Regulatory Authority.

4. Criteria for assessing the request for derogation shall be set by the relevant National Regulatory Authority taking into account recommendation of the Relevant Network Operator in coordination with the Relevant TSO. The criteria set by the Relevant National Regulatory Authority shall be non-discriminatory, objective and shall be published by the National Regulatory Authority.

Article 53

REQUEST FOR DEROGATION

1. Power Generating Facility Owners may apply for derogation in respect of one or more requirements of this Network Code by submitting a request to the Relevant Network Operator.

2. The request for derogation, submitted by the Power Generating Facility Owner shall include all the information and documents which are required by the Relevant Network Operator in coordination with the Relevant TSO, including, inter alia, but not limited to:

   a) identifying data of the Power Generating Facility Owner, with reference contact person for any communications;

   b) the specific Power Generating Module to which the request is referred to;

   c) the provision of the Network Code for which a derogation is requested, with the detailed description of the requested derogation;

   d) detailed reasoning accompanied with all relevant documents supporting the request.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

3. A DSO or CDSO may apply for derogation in respect of one or more requirements of this Network Code by submitting a request to the Relevant TSO.

4. The request for derogation, submitted by the DSO or CDSO shall include all the information and documents which are required by the Relevant TSO, including, inter alia, but not limited to:

    a) identifying data of the DSO or CDSO, with reference contact person for any communications;

    b) the number of Power Generating Modules affected and the total installed capacity to which the request is referred to;

    c) the provision of the Network Code for which a derogation is requested, with the detailed description of the requested derogation;

    d) detailed reasoning accompanied with all relevant documents supporting the request.

5. A TSO may apply for derogation in respect of one or more requirements of this Network Code by submitting a request to the National Regulatory Authority.

6. The request for derogation, submitted by the TSO shall include the following information:

    a) identifying data of the TSO, with reference contact person for any communications;

    b) the number of Power Generating Modules affected and the total installed capacity to which the request is referred to;

    c) the provision of the Network Code for which a derogation is requested, with the detailed description of the requested derogation;

    d) detailed reasoning accompanied with all relevant documents supporting the request.

Article 54

DECISION ON DEROGATION

1. Further to the request for derogation submitted by the Power Generating Facility Owner, the Relevant Network Operator shall assess the request and related documentation. If the request or the related documentation is considered to be incomplete the Power Generating Facility Owner shall submit the missing information as requested by the Relevant Network Operator. As from the day of the receipt of the complete request by the Relevant Network Operator until the issuance of the decision granting or refusing the derogation by the National Regulatory Authority according to Article 54(7), the Power Generating Module to which the request is referred to is deemed as compliant.

2. No later than six months after the receipt of the complete request according to Article 54(1) the Relevant Network Operator shall submit its assessment of the request, including a reasoned opinion, together with a related documentation and, where applicable, a Cost-Benefit Analysis to the National Regulatory Authority.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

The above deadline shall be shortened to three months in case a reasoned request for exemption from Cost-Benefit Analysis is submitted by the Relevant Network Operator to the National Regulatory Authority.

In case the request by the Power Generating Facility Owner is for a Type C or D Power Generating Module connected to a distribution Network or closed distribution Network the Relevant Network Operator shall obtain the assessment of the Relevant TSO within two months after notification to the Relevant TSO by the Relevant Network Operator and include it in its submission to the National Regulatory Authority.

If the Relevant Network Operator has requested an exemption from Cost-Benefit Analysis the National Regulatory Authority shall decide on granting or refusing the exemption within one month after the receipt of this request. When the request is rejected, the Relevant Network Operator shall provide a Cost-Benefit Analysis within three months following the decision of the National Regulatory Authority.

3. Further to the request for derogation submitted by a DSO or CDSO, the Relevant TSO shall assess the request and related documentation. If the request or the related documentation is considered to be incomplete the DSO or CDSO shall submit the missing information as requested by the Relevant TSO. As from the day of the receipt of the complete request by the DSO or CDSO until the issuance of the decision granting or refusing the derogation by the National Regulatory Authority according to Article 54(7), the Power Generating Facilities to which the request is referred to are deemed as compliant.

4. No later than six months after the receipt of the complete request according to Article 54(3) the TSO shall submit its assessment of the request, including a reasoned opinion, together with a related documentation and, where applicable, a Cost-Benefit Analysis performed by the DSO or CDSO.

   The above deadline shall be shortened to three months in case a reasoned request for exemption from Cost-Benefit Analysis is submitted by the DSO or CDSO to the National Regulatory Authority.

   If the DSO or CDSO has requested an exemption from Cost-Benefit Analysis the National Regulatory Authority shall decide on granting or refusing the exemption within one month after the receipt of this request. If the request is rejected, the DSO or CDSO shall provide a Cost-Benefit Analysis within three months following the decision of the National Regulatory Authority.

5. Further to the request for derogation submitted by the TSO, the National Regulatory Authority shall assess the request and related documentation. If the request or the related documentation is considered to be incomplete the TSO shall submit the missing information as requested by the National Regulatory Authority. As from the day of the receipt of the complete request by the TSO until the issuance of the decision granting or refusing the derogation by the National Regulatory Authority according to Article 54(7), the Power Generating Facilities to which the request is referred to are deemed as compliant.

6. Together with request according to Article 54(5) the TSO shall submit either a Cost-Benefit Analysis or a reasoned request for exemption from Cost-Benefit Analysis to the National Regulatory Authority. If the TSO has requested an exemption from Cost-Benefit Analysis the National Regulatory Authority shall decide on granting or rejecting this request within one month after the receipt of this request. When the request is rejected, the TSO shall provide a

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Cost-Benefit Analysis within three months following the decision of the National Regulatory Authority.

7. The National Regulatory Authority shall issue a motivated decision granting or refusing the derogation and specifying the duration of the derogation, including a reasoned opinion, within a further three months after receipt of the complete documentation.

8. The National Regulatory Authority shall communicate to the applicant, the Relevant Network Operator and the Agency the decision granting or rejecting the derogation. In case the applicant is a DSO or CDSO, the Relevant TSO shall be informed as well.

9. The Agency shall monitor the procedures of derogation and the National Regulatory Authority shall cooperate with the Agency in this task and shall provide the Agency with all information necessary for this purpose.

10. The Agency may issue a reasoned recommendation to the National Regulatory Authority to revoke any derogation, which has been granted without due justification.

11. The National Regulatory Authority shall have the right to issue a motivated decision revoking the granted derogation under the conditions and pursuant to the provisions of national law reserving the vested interests of the concerned grid users, in the cases where the prerequisites for granting the derogation no longer exist for reasons attributable to the concerned grid users.

Article 55

COMPLIANCE OF EXISTING POWER GENERATING MODULES

1. An Existing Power Generating Module which is not compliant with a requirement of the Network Code, that applies to it according to Article 3, shall apply for derogation from this requirement according to Article 53 within twelve months from the day the requirement, of which it is not compliant with, becomes applicable.

2. The Relevant Network Operator shall have the right to refuse the operation of the Power Generating Module, if the twelve months period terminates without an application for derogation.

Article 56

REGISTER OF DEROGATIONS TO THE NETWORK CODE

1. Each National Regulatory Authority shall maintain a register of all derogations it has granted or refused and shall provide to the Agency an updated and consolidated register at least every six months with a copy to ENTSO-E.

2. These registers shall contain in particular:

   - the requirement(s) for which the derogation is granted or refused
   - content of the derogation

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

- consequences of the granting of the derogation
- reasons for granting or refusing the derogation
- whether the exemption from the performance of the cost-benefit analysis was granted.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu

Title 6

FINAL PROVISIONS

Article 57

AMENDMENT OF CONTRACTS AND GENERAL TERMS AND CONDITIONS

All relevant clauses in contracts and/or relevant clauses in general terms and conditions relating to the grid connection of New Power Generating Modules shall be amended to achieve compliance with the requirements of this Network Code. The relevant clauses shall be amended within three years after the entry into force of this Network Code. This requirement for amendment shall apply regardless of whether the relevant contracts or general terms and conditions provide for such an amendment.

Article 58

ENTRY INTO FORCE

This Network Code shall enter into force on the twentieth day following that of its publication in the *Official Journal of the European Union*.

With the exception of Article 3 (4), which shall apply thirty months after the entry into force, all provisions of this Network Code shall apply as from the day of expiration of a three year period following its publication.

This Network Code shall be binding in its entirety and directly applicable in all member states.

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 info@entsoe.eu • www.entsoe.eu