

**NC RfG DC Recommendation:**

**Annex 1 – Amended RfG Regulation**

(text rectified by corrigendum of 19 December 2023)

**COMMISSION REGULATION (EU) .../...**

**of ...**

**establishing a network code on requirements for grid connection of generators**

**(Text with EEA relevance)**

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity (recast) <sup>(1)</sup>, and in particular Articles 59(2)(a) and 60(1) thereof,

Whereas:

- (1) The swift completion of a fully functioning and interconnected internal energy market is crucial to maintaining security of energy supply, increasing competitiveness and ensuring that all consumers can purchase energy at affordable prices.
- (2) Regulation (EU) 2019/943 sets out non-discriminatory rules governing access to the network for cross-border exchanges in electricity with a view to ensuring the proper functioning of the internal market in electricity. In addition Article 3 of Directive (EU) 2019/944 of the European Parliament and of the Council <sup>(2)</sup> requires that Member States shall ensure, inter alia, a level playing field where electricity undertakings are subject to transparent, proportionate and non-discriminatory rules, fees and treatment. Where requirements constitute terms and conditions for connection to national networks, Article 59(7) of the same Directive requires regulatory authorities to be responsible for fixing or approving at least the national methodologies used to calculate or establish them. In order to provide system security within the interconnected transmission system, it is essential to establish a common understanding, from the system perspective, of the requirements applicable to power-generating modules. Those requirements that contribute to maintaining, preserving and restoring system security in order to facilitate proper functioning of the internal electricity market within and between synchronous areas, and to achieve cost efficiencies, should be regarded as cross-border network issues and market integration issues.
- (3) Harmonised rules for grid connection for power-generating modules should be set out in order to provide a clear legal framework for grid connections, facilitate Union-wide trade in electricity, ensure system security, facilitate the integration of renewable electricity sources, increase competition and allow more efficient use of the network and resources, for the benefit of consumers.
- (s1) Equally, electricity storage plays a key role in the system as different energy storage technologies have a dual behaviour of being able to consume electricity from or inject electricity into the network at different times and scales. For this reason, and due to the specific characteristics of storage and impact on the system, it is necessary to introduce requirements for the grid connection of electricity storage modules. The requirements on electricity storage are considered to be the same as those on power

generation modules unless explicitly stated otherwise in this Regulation. In the case of electrical equipment such as synchronous compensators, flywheels and regenerative braking systems which do not fall onto the definition of a power-generating module or electricity storage module, the relevant system operator in coordination with the relevant TSO may define the technical requirements that apply. If such electrical equipment is integrated to a power-generating module and used solely for the purpose of meeting the requirements of this Regulation should be considered as part of such module while their capacity should not count towards the power-generating module capacity.

- (s2) For the purposes of this Regulation, electricity storage includes electric vehicles and associated supply equipment that comply with the definition of electricity storage. Nevertheless, fully harmonised rules for grid connection for electric vehicles and associated supply equipment are set out to provide for a free movement of electric vehicles across the EU.
- (4) System security depends partly on the technical capabilities of power-generating modules. Therefore, regular coordination at the level of the transmission and distribution networks and adequate performance of the equipment connected to the transmission and distribution networks with sufficient robustness to cope with disturbances and to help to prevent any major disruption or to facilitate restoration of the system after a collapse are fundamental prerequisites.
- (5) Secure system operation is only possible if there is close cooperation between power-generating facility owners and system operators. In particular, the functioning of the system under abnormal operating conditions depends on the response of power-generating modules to deviations from the reference 1 per unit (pu) values of voltage and nominal frequency. In the context of system security, the networks and the power-generating modules should be considered as one entity from a system engineering point of view, given that those parts are interdependent. Therefore, as a prerequisite for grid connection, relevant technical requirements should be set for power-generating modules.
- (6) As secure system operation is important, the generating facility owners in close cooperation with system operators will apply the requirements provided in this Regulation in such a way in order to ensure effective operation of the network.
- (7) Regulatory authorities should consider the reasonable costs effectively incurred by system operators in the implementation of this Regulation when fixing or approving transmission or distribution tariffs or their methodologies or when approving the terms and conditions for connection and access to national networks in accordance with Article 59(1) and (7) of Directive (EU) 2019/944 and with Article 18 of Regulation (EU) 2019/943.
- (8) Different synchronous electricity systems in the Union have different characteristics which need to be taken into account when setting the requirements for generators. It is therefore appropriate to consider regional specificities when establishing network connection rules as required by Article 59(1) and (2) of Regulation (EU) 2019/943.
- (9) In view of the need to provide regulatory certainty, the requirements of this Regulation should apply to new generating facilities but should not apply to existing

generating modules and generating modules already at an advanced stage of planning but not yet completed unless the relevant regulatory authority or Member State decides otherwise based on evolution of system requirements and a full cost-benefit analysis, or where there has been substantial modernisation of those generating facilities.

- (10) Similarly, the requirements under Regulation (EU) 2016/631 should continue to apply to the power-generating modules which exist at the entry into force of this Regulation and fall within the scope of Regulation (EU) 2016/631.
- (11) The significance of power-generating modules should be based on their size and their effect on the overall system. Synchronous machines should be classed on the machine size and include all the components of a generating facility that normally run indivisibly. An installation containing a set of synchronous machines that cannot be operated independently from each other, such as combined-cycle gas turbine installation, should be assessed on the whole capacity of that installation. Non-synchronously connected power-generating units of the same underlying technology, where they are collected together to form an economic unit and where they have a single connection point should be assessed on their aggregated capacity. Moreover, to ensure an appropriate harmonisation or rules for mass-market products, capacities of units of different underlying technology, for instance, photovoltaic, electricity storage, combined heat and power installations, or V2G electric vehicles, should not necessarily be aggregated for the purpose of the determination of significance unless so agreed between the relevant system operator and the power-generating facility owner, or determined by other appropriate means, where an agreement is not required. Also, when V2G electric vehicles and associated V2G electric vehicle supply equipment are connected to a V2G electrical charging park their capacities should not be aggregated for the purpose of the determination of significance. Electricity storage integrated to a power-generating module used solely for the purpose of meeting the respective requirements of this Regulation should be considered as part of such module while its capacity should not count towards the power-generating module capacity.
- (12) In view of the different voltage level at which generators are connected and their maximum generating capacity, this Regulation should make a distinction between different types of generators by establishing different levels of requirements. This Regulation does not set the rules to determine the voltage level of the connection point to which the power-generating module shall be connected.
- (\*1) Power-generating modules are subject to the requirements of this Regulation regardless of whether they are part of a citizen energy community or a renewable energy community as defined in Directive (EU) 2019/944 and Directive (EU) 2018/2001 respectively, another entity, or a form of system users aggregation, unless such energy communities, another entity, or a form of system users aggregation constitutes an off-grid system.
- (13) The requirements applicable to type A power-generating modules should be set at the basic level necessary to ensure capabilities of generation with limited automated response and minimal system operator control. They should ensure that there is no large-scale loss of generation over system operational ranges, thereby minimising

critical events, and include requirements necessary for widespread intervention during system-critical events.

- (14) The requirements applicable to type B power-generating modules should provide for a wider range of automated dynamic response with greater resilience to operational events, in order to ensure the use of this dynamic response, and a higher level of system operator control and information to utilise those capabilities. They ensure an automated response to mitigate the impact of, and maximise dynamic generation response to, system events.
- (15) The requirements applicable to type C power-generating modules should provide for a refined, stable and highly controllable real-time dynamic response aiming to provide principle ancillary services to ensure security of supply. Those requirements should cover all system states with consequential detailed specification of interactions of requirements, functions, control and information to utilise those capabilities and ensure the real-time system response necessary to avoid, manage and respond to system events. Those requirements should also provide for sufficient capability of generating modules to respond to both intact and system disturbed situations, and should provide the information and control necessary to utilise generation in different situations.
- (16) The requirements applicable to type D power-generating modules should be specific to higher voltage connected generation with an impact on control and operation of the entire system. They should ensure stable operation of the interconnected system, allowing the use of ancillary services from generation Europe-wide.
- (17) The requirements should be based on the principles of non-discrimination and transparency as well as on the principle of optimisation between the highest overall efficiency and lowest total cost for all involved parties. Therefore those requirements should reflect the differences in the treatment of generation technologies with different inherent characteristics, and avoid unnecessary investments in some geographical areas in order to take into account their respective regional specificities. Transmission system operators ('TSOs') and distribution system operators ('DSOs') including closed distribution system operators ('CDSOs') can take those differences into account when defining the requirements in accordance with the provisions of this Regulation, whilst recognising that the thresholds which determine whether a system is a transmission system or a distribution system are established at the national level.
- (18) Due to its cross-border impact, this Regulation should aim at the same frequency-related requirements for all voltage levels, at least within a synchronous area, such as the synchronous areas of Continental Europe, , Ireland-Northern Ireland and Nordic and the power systems of Lithuania, Latvia and Estonia, together referred to as 'Baltic'. That is necessary because, within a synchronous area, a change in frequency in one Member State would immediately impact frequency and could damage equipment in all other Member States. Considering the evolution of the European networks, delineation of synchronous areas may change as a result of establishing or terminating synchronous interconnection of transmission systems. Requirements for the connection of power-generating modules should appropriately be adjusted to reflect the interconnections resulting from such change.

- (19) To ensure system security, it should be possible for power-generating modules in each synchronous area of the interconnected system to remain connected to the system for specified frequency and voltage ranges.
- (x) In the same vein, due to the physical interdependencies of interconnected systems and to ensure system stability, as well as the efficient and secure operation of electricity systems across the Union, this Regulation specifies requirements for the synchronous area Ireland-Northern Ireland. Given that Ireland and Northern Ireland constitute the synchronous area Ireland-Northern Ireland, the same requirements for generators should apply both in Ireland and Northern Ireland to ensure their cooperation in terms of security of supply of electricity, and the interoperability of the energy infrastructure connecting the territories.
- (20) This Regulation should provide for ranges of parameters for national choices for fault-ride-through capability for transmission faults in order to maintain a proportionate approach reflecting varying system needs such as the level of renewable energy sources ('RES') and existing network protection schemes, both transmission and distribution. In view of the configuration of some networks, the upper limit for fault-ride-through requirements should be 250 milliseconds. However, given that the most common fault clearing time in Europe is currently 150 milliseconds it leaves scope for the entity, as designated by the Member State to approve the requirements of this Regulation, to verify that a longer requirement is necessary before approving it.
- (21) When defining the pre-fault and post-fault conditions for the fault-ride-through capability, taking into account system characteristics such as network topology and generation mix, the relevant TSO should decide whether priority is given to pre-fault operating conditions of power-generating modules or to longer fault clearance times.
- (\*\*2) In order to avoid potential critical system situations caused by overvoltage, it should be possible for power-generating modules to remain connected to the system for a specified high voltage-against-time profile.
- (22) Ensuring appropriate reconnection after an incidental disconnection due to a network disturbance is important to the functioning of the interconnected system. Proper network protection is essential for maintaining system stability and security, particularly in case of disturbances to the system. Protection schemes can prevent aggravation of disturbances and limit their consequences.
- (23) Adequate information exchange between system operators and power-generating facility owners is a prerequisite for enabling system operators to maintain system stability and security. System operators need to have a continuous overview of the state of the system, which includes information on the operating conditions of power-generating modules, as well as the possibility to communicate with them in order to direct operational instructions.
- (24) In emergency situations which could endanger system stability and security, system operators should have the possibility to instruct that the output of power-generating modules be adjusted in a way which allows system operators to meet their responsibilities for system security.



- (\*\*3) Escalating environmental risks might hamper safe generation and secure system operation. Adequate and proportionate measures to increase the resilience of power-generating modules could be considered, reflecting the specificities of generation technologies as well as the geographical and climatic particularities of each Member State. Such measures could benefit the preparedness of the system to withstand climate change consequences, facilitate the use of power-generating module flexibility and promote the use of distributed energy resources to improve network resilience to extreme events. This is without prejudice to the weather hazards resilience requirements in accordance with Regulation (EU) 2017/2196, Regulation (EU) 2019/941 and other relevant Union legal acts.
- (25) Voltage ranges should be coordinated between interconnected systems because they are crucial to secure planning and operation of a power system within a synchronous area. Disconnections because of voltage disturbances have an impact on neighbouring systems. Failure to specify voltage ranges could lead to widespread uncertainty in planning and operation of the system with respect to operation beyond normal operating conditions.
- (26) The reactive power capability needs depend on several factors including the degree of network meshing and the ratio of in-feed and consumption, which should be taken into account when establishing reactive power requirements. When regional system characteristics vary within a system operator's area of responsibility, more than one profile could be appropriate. Reactive power production, known as lagging, at high voltages and reactive power consumption, known as leading, at low voltages might not be necessary. Reactive power requirements could put constraints on the design and operation of power-generating facilities. Therefore it is important that the capabilities actually required for efficient system operation be thoroughly assessed.
- (27) Synchronous power-generating modules have an inherent capability to resist or slow down frequency deviations, a characteristic which many converter-based technologies do not inherently provide. Therefore, countermeasures should be adopted, to avoid a larger rate of change of frequency during high converter-based production. Synthetic inertia could facilitate further expansion of converter-based technologies, which do not naturally contribute to inertia.
- (\*\*4) Rapidly increasing penetration of dispersed generation and converter-based technologies into European networks has presented new challenges in ensuring overall system security. To the extent that an adequate contribution to the dynamically transforming system depends partly on advanced capabilities, power-generating modules should be able to support the system robustness by fulfilling appropriate grid-forming and rate-of-change-of-frequency withstand requirements.
- (28) Appropriate and proportionate compliance testing should be introduced so that system operators can ensure operational security.
- (29) The regulatory authorities, Member States and system operators should ensure that, in the process of developing and approving the requirements for network connection, they are harmonised to the extent possible, in order to ensure full market integration. Established technical standards should be taken into particular consideration in the development of connection requirements. Development of non-exhaustive

requirements should, to the extent possible, be carried out by involving European standardisation organisations; therefore, permitting the evolution of product standards and, as a consequence, the adoption of the same by the industry.

- (30) A process for derogating from the rules should be set out in this Regulation to take into account local circumstances where exceptionally, for example, compliance with those rules could jeopardise the stability of the local network or where the safe operation of a power-generating module might require operating conditions that are not in line with the Regulation. In the case of particular combined heat and power plants, which bring wider efficiency benefits, applying the rules set out in this Regulation could result in disproportionate costs and lead to the loss of those efficiency benefits.
- (31) Subject to approval by the relevant regulatory authority, or other authority where applicable in a Member State, system operators should be allowed to propose derogations for certain classes of power-generating modules.
- (32) This Regulation has been adopted on the basis of Regulation (EU) 2019/943 which it supplements and of which it forms an integral part. References to Regulation (EU) 2019/943 in other legal acts should be understood as also referring to this Regulation.
- (33) The measures provided for in this Regulation are in accordance with the opinion of the Committee referred to in Article 67(1) of Regulation (EU) 2019/943.

HAS ADOPTED THIS REGULATION:

## **TITLE I**

### **GENERAL PROVISIONS**

#### *Article 1*

#### **Subject matter**

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

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

#### *Article 2*

#### **Definitions**



For the purposes of this Regulation, the definitions in Article 2 of Directive 2012/27/EU of the European Parliament and of the Council <sup>(3)</sup>, Article 2 of Regulation (EU) 2019/943, Article 2 of Commission Regulation (EU) 2015/1222 <sup>(4)</sup> Article 2 of Commission Regulation (EU) No 543/2013 <sup>(5)</sup> and Article 2 of Directive (EU) 2019/944 shall apply.

In addition, the following definitions shall apply:

- (1) 'entity' means a regulatory authority, other national authority, system operator or other public or private body appointed under national law.
- (2) 'synchronous area' means an area covered by synchronously interconnected TSOs;
- (3) 'voltage' means the difference in electrical potential between two points measured as the root-mean-square value of the positive sequence phase-to-phase voltages at fundamental frequency;
- (4) 'apparent power' means the product of voltage and current at fundamental frequency, and the square root of three in the case of three-phase systems, usually expressed in kilovolt-amperes ('kVA') or megavolt-amperes ('MVA');
- (5) 'power-generating module' means either a synchronous power-generating module or a power park module;
- (6) 'new power-generating module' means a power-generating module that did not exist at the entry into force of this Regulation according to Article 4(2);
- (7) 'power-generating facility owner' means a natural or legal entity owning a power-generating facility;
- (8) 'main generating plant' means one or more of the principal items of equipment required to convert the primary source of energy into electricity;
- (9) 'synchronous power-generating module' or 'SPGM' means a set of machines which cannot be operated independently from each other and can generate electrical energy such that the frequency of the generated voltage, the generator speed and the frequency of network voltage are in a constant ratio and thus in synchronism;
- (10) 'power-generating module document' or 'PGMD' means a document provided by the power-generating facility owner to the relevant system operator for a type B or C power-generating module which confirms that the power-generating module's compliance with the technical criteria set out in this Regulation has been demonstrated and provides the necessary data and statements, including a statement of compliance;
- (10a) 'supply equipment document' or 'SED' means a document provided by the electrical charging park owner to the relevant system operator for a EV3 V2G electric vehicle supply equipment which confirms that the supply equipment's compliance with the technical criteria set out in this Regulation has been demonstrated and provides the necessary data and statements, including a statement of compliance;
- (11) 'relevant TSO' means the TSO in whose control area a power-generating module, a demand facility, a distribution system or a HVDC system is or will be connected to the network at any voltage level;

- (12) 'network' means a plant and apparatus connected together in order to transmit or distribute electricity;
- (13) 'relevant system operator' means the transmission system operator or distribution system operator to whose system a power-generating module, demand facility, distribution system or HVDC system is or will be connected;
- (14) 'connection agreement' means a contract between the relevant system operator and either the power-generating facility owner, demand facility owner, distribution system operator or HVDC system owner, which includes the relevant site and specific technical requirements for the power-generating facility, demand facility, distribution system, distribution system connection or HVDC system;
- (15) 'connection point' means the AC electrical interface at which the power-generating module, demand facility, distribution system or HVDC system is connected to a transmission system, offshore network, distribution system, including closed distribution systems, or HVDC system, as identified in the connection agreement or as agreed between the relevant system operator and the demand facility owner, power-generating facility owner or HVDC system owner, or determined by other appropriate means, where an agreement is not required;
- (16) 'maximum capacity' or 'P<sub>max</sub>' means the maximum continuous active power which a power-generating module can produce, less any demand or losses associated solely with facilitating the operation of that power-generating module as specified in the connection agreement or as agreed between the relevant system operator and the power-generating facility owner, or determined by other appropriate means, where an agreement is not required;
- (17) 'power park module' or 'PPM' means a unit or ensemble of units that can generate electricity, which is not a synchronous power-generating module and which is either non-synchronously connected to the network or connected through power electronics, and that also has a single connection point to a transmission system, distribution system including closed distribution system or HVDC system;
- (18) 'offshore power park module' means a power park module located offshore with an offshore connection point;
- (19) 'synchronous compensation operation' means the operation of an alternator without prime mover to regulate voltage dynamically by production or absorption of reactive power;
- (20) 'active power' means the real component of the apparent power at fundamental frequency, expressed in watts or multiples thereof such as kilowatts ('kW') or megawatts ('MW');
- (21) 'pump-storage' means a hydro unit in which water can be raised by means of pumps and stored to be used for the generation of electrical energy;
- (22) 'frequency' means the electric frequency of the system expressed in hertz that can be measured in all parts of the synchronous area under the assumption of a consistent value for the system in the time frame of seconds, with only minor differences between different measurement locations. Its nominal value is 50Hz;

- (23) 'droop' means the ratio of a steady-state change of frequency to the resulting steady-state change in active power output, expressed in percentage terms. The change in frequency is expressed as a ratio to nominal frequency and the change in active power expressed as a ratio to maximum capacity or actual active power at the moment the relevant threshold is reached;
- (24) 'minimum regulating level' means the minimum active power, as specified in the connection agreement or as agreed between the relevant system operator and the power-generating facility owner, down to which the power-generating module can control active power;
- (25) 'setpoint' means the target value for any parameter typically used in control schemes;
- (26) 'instruction' means any command, within its authority, given by a system operator to a power-generating facility owner, demand facility owner, distribution system operator or HVDC system owner in order to perform an action;
- (27) 'secured fault' means a fault which is successfully cleared according to the system operator's planning criteria;
- (28) 'reactive power' means the imaginary component of the apparent power at fundamental frequency, usually expressed in kilovar ('kVAr') or megavar ('MVar');
- (29) 'fault-ride-through' means the capability of electrical devices to be able to remain connected to the network and operate through periods of low voltage at the connection point caused by secured faults;
- (30) 'alternator' means a device that converts mechanical energy into electrical energy by means of a rotating magnetic field;
- (31) 'current' means the rate at which electric charge flows which is measured by the root-mean-square value of the positive sequence of the phase current at fundamental frequency;
- (32) 'stator' means the portion of a rotating machine which includes the stationary magnetic parts with their associated windings;
- (33) 'inertia' means the property of a rotating rigid body, such as the rotor of an alternator, such that it maintains its state of uniform rotational motion and angular momentum unless an external torque is applied;
- (34) 'synthetic inertia' means a prescribed electrical dynamic performance provided by a power park module or an HVDC system at its connection point with the purpose to emulate the equivalent dynamic effect of the inertia provided by a synchronous power-generating module;
- (35) 'frequency control' means the capability of a power-generating module or HVDC system to adjust its active power output in response to a measured deviation of system frequency from a setpoint, in order to maintain stable system frequency;
- (36) 'frequency sensitive mode' or 'FSM' means the operating mode of a power-generating module or HVDC system in which the active power output changes in response to a change in system frequency, in such a way that it assists with the recovery to target frequency;

- (37) 'limited frequency sensitive mode — overfrequency' or 'LFSM-O' means a power-generating module or HVDC system operating mode which will result in active power output reduction in response to a change in system frequency above a certain value;
- (38) 'limited frequency sensitive mode — underfrequency' 'LFSM-U' means a power-generating module or HVDC system operating mode which will result in active power output increase in response to a change in system frequency below a certain value;
- (39) 'frequency response deadband' means an interval used intentionally to make the frequency control unresponsive;
- (40) 'frequency response insensitivity' means the inherent feature of the control system specified as the minimum magnitude of change in the frequency or input signal that results in a change of output power or output signal;
- (41) 'P-Q-capability diagram' means a diagram describing the reactive power capability of a power-generating module in the context of varying active power at the connection point;
- (42) 'steady-state stability' means the ability of a network or a synchronous power-generating module to revert and maintain stable operation following a minor disturbance;
- (43) 'island operation' means the independent operation of a whole network or part of a network that is isolated after being disconnected from the interconnected system, having at least one power-generating module or HVDC system supplying power to this network and controlling the frequency and voltage;
- (44) 'houeload operation' means the operation which ensures that power-generating facilities are able to continue to supply their in-house loads in the event of network failures resulting in power-generating modules being disconnected from the network and tripped onto their auxiliary supplies;
- (45) 'black start capability' means the capability of recovery of a power-generating module from a total shutdown through a dedicated auxiliary power source without any electrical energy supply external to the power-generating facility;
- (46) 'authorised certifier' means an entity that issues equipment certificates and power-generating module documents and whose accreditation is given by the national affiliate of the European cooperation for Accreditation ('EA'), established in accordance with Regulation (EC) No 765/2008 of the European Parliament and of the Council <sup>(6)</sup>;
- (47) 'equipment certificate' means a document issued by an authorised certifier for equipment used by a power-generating module, demand unit, distribution system, demand facility or HVDC system. The equipment certificate defines the scope of its validity at a national or other level at which a specific value is selected from the range allowed at a European level. For the purpose of replacing specific parts of the compliance process, the equipment certificate may include models that have been verified against actual test results;
- (48) 'excitation control system' means a feedback control system that includes the synchronous machine and its excitation system;

- (49) 'U-Q/Pmax-profile' means a profile representing the reactive power capability of a power-generating module or HVDC converter station in the context of varying voltage at the connection point;
- (50) 'minimum stable operating level' means the minimum active power, as specified in the connection agreement or as agreed between the relevant system operator and the power-generating facility owner, at which the power-generating module can be operated stably for an unlimited time;
- (51) 'overexcitation limiter' means a control device within the AVR which prevents the rotor of an alternator from overloading by limiting the excitation current;
- (52) 'underexcitation limiter' means a control device within the AVR, the purpose of which is to prevent the alternator from losing synchronism due to lack of excitation;
- (53) 'automatic voltage regulator' or 'AVR' means the continuously acting automatic equipment controlling the terminal voltage of a synchronous power-generating module by comparing the actual terminal voltage with a reference value and controlling the output of an excitation control system;
- (54) 'power system stabiliser' or 'PSS' means an additional functionality of the AVR of a synchronous power-generating module whose purpose is to damp power oscillations;
- (55) 'fast fault current' means a current injected by a power park module or HVDC system during and after a voltage deviation caused by an electrical fault with the aim of identifying a fault by network protection systems at the initial stage of the fault, supporting system voltage retention at a later stage of the fault and system voltage restoration after fault clearance;
- (56) 'power factor' means the ratio of the absolute value of active power to apparent power;
- (57) 'slope' means the ratio of the change in voltage, based on reference 1 pu voltage, to a change in reactive power in-feed from zero to maximum reactive power, based on maximum reactive power;
- (58) 'offshore grid connection system' means the complete interconnection between an offshore connection point and the onshore system at the onshore grid interconnection point;
- (59) 'onshore grid interconnection point' means the point at which the offshore grid connection system is connected to the onshore network of the relevant system operator;
- (60) 'installation document' means a simple structured document containing information about a type A power-generating module or a demand unit, with demand response connected below 1 000 V, and confirming its compliance with the relevant requirements;
- (61) 'statement of compliance' means a document provided by the power-generating facility owner, demand facility owner, distribution system operator or HVDC system owner to the system operator stating the current status of compliance with the relevant specifications and requirements;

- (62) ‘final operational notification’ or ‘FON’ means a notification issued by the relevant system operator to a power-generating facility owner, demand facility owner, distribution system operator or HVDC system owner who complies with the relevant specifications and requirements, allowing them to operate respectively a power-generating module, demand facility, distribution system or HVDC system by using the grid connection;
- (63) ‘energisation operational notification’ or ‘EON’ means a notification issued by the relevant system operator to a power-generating facility owner, demand facility owner, distribution system operator or HVDC system owner prior to energisation of its internal network;
- (64) ‘interim operational notification’ or ‘ION’ means a notification issued by the relevant system operator to a power-generating facility owner, demand facility owner, distribution system operator or HVDC system owner which allows them to operate respectively a power-generating module, demand facility, distribution system or HVDC system by using the grid connection for a limited period of time and to initiate compliance tests to ensure compliance with the relevant specifications and requirements;
- (65) ‘limited operational notification’ or ‘LON’ means a notification issued by the relevant system operator to a power-generating facility owner, demand facility owner, distribution system operator or HVDC system owner who had previously attained FON status but is temporarily subject to either a significant modification or loss of capability resulting in non-compliance with the relevant specifications and requirements.
- (66) ‘electricity storage’ means the conversion of electrical energy into a form of energy which can be stored, the storing of that energy, and the subsequent reconversion of that energy back into electrical energy;
- (67) ‘electricity storage module’ or ‘ESM’ means a synchronous power-generating module or a power park module which can inject and consume active power to and from the network for electricity storage, excluding pump-storage power-generating modules. A V2G electric vehicle and associated V2G electric vehicle supply equipment with a bidirectional functionality is regarded as an electricity storage module but are faced with distinct requirements and connection procedures if their maximum capacity is less than 1 MW;
- (68) ‘maximum consumption capacity’ means the maximum continuous active power which a demand unit or electricity storage module can consume, less any demand or losses associated solely with facilitating the operation of that demand unit or electricity storage module, as specified in the connection agreement or as agreed between the relevant system operator and the demand facility owner or power-generating facility owner, or determined by other appropriate means, where an agreement is not required.
- (69) ‘V2G electric vehicle’ means the vehicle that is powered, fully or in part, with electricity and is equipped with technology enabling the vehicle to inject electricity to the network over a V2G electric vehicle supply equipment. This definition takes



into account all solutions, regardless of whether the V2G electric vehicle contains the inverter or not.

- (70) 'V2G electric vehicle supply equipment' means the infrastructure necessary to conduct electrical energy safely from the electricity supply grid to the electric vehicle and from the electric vehicle to the electricity supply network with both generation and demand behaviour. Electrical wirings are not deemed part of an electric vehicle supply equipment. This definition takes into account all solutions, regardless of whether the V2G electric vehicle supply equipment contains the inverter or not.
- (71) 'V2G electrical charging park' means the relevant installation that has a single connection point to the relevant network and where one or more V2G electric vehicles can be simultaneously connected.
- (72) 'Electrical charging park owner' means a natural or legal entity owning a V2G electrical charging park.
- (73) 'Off-grid system' means an electrical system connecting generation, consumption and/or storage which is not part of a distribution or transmission system and which has no components/assets (for example switchgear) to connect it to the transmission or distribution system.
- (74) 'power generating unit' or 'PGU' means an aggregation of components converting a primary source of energy into electricity at the terminals of a unit generating electricity, which is synchronously connected to the network or which is either non-synchronously connected to the network or connected through power electronics.
- (75) 'component' means any active element which is part of a power-generating module whose response may have an impact on the electrical characteristics and/or compliance with the requirements of this Regulation.
- (76) 'PGU family' means a group of PGUs from the same manufacturer with equivalent characteristics to a representative unit which has undergone conformance tests (tested PGU), in terms of electrical performance. The range of applicability of the PGU family will be defined within the compliance scheme by the relevant system operator.
- (77) 'Component family' means a group of components from the same manufacturer with equivalent characteristics to the representative component which has undergone conformance tests (tested component), in terms of electrical performance. The range of applicability of the component family will be defined within the compliance scheme by the relevant system operator.
- (78) 'Certification scheme' means conformity assessment system according to internationally recognized standards, that the relevant system operator may include in the compliance scheme, which shall be related to the power-generating module, PGU or components, and their fulfilment with specific rules and procedures to demonstrate compliance.
- (79) 'Compliance scheme' means a compliance verification programme provided by the relevant system operator which shall specify all evaluation and assessment measures to be taken, aimed to demonstrate the compliance of a power-generating module, PGU and/or components with the relevant technical requirements during the operational notification procedure for connection. When equipment certificates are

applied within the compliance scheme, it shall include, or provide a reference to, a certification scheme for the equipment. The applied equipment certificates must be valid for the specific equipment installed within the power-generating module for which a connection request has been made.

### *Article 3*

#### **Scope of application**

1. This Regulation shall apply to new power-generating modules, which are considered significant in accordance with Article 5, unless otherwise provided in this Regulation.

The relevant system operator shall refuse to allow the connection of a power-generating module which does not comply with the requirements set out in this Regulation and which is not covered by a derogation granted by the regulatory authority, or other authority where applicable in a Member State pursuant to Article 60. The relevant system operator shall communicate such refusal, by means of a reasoned statement in writing, to the power-generating facility owner and, unless specified otherwise by the regulatory authority, to the regulatory authority.

2. This Regulation shall not apply to:

- (a) power-generating modules connected to the transmission system and distribution systems, or to parts of the transmission system or distribution systems, of islands of Member States of which the systems are not operated synchronously at 50 Hz with either the Continental Europe, Nordic, Ireland and Northern Ireland or Baltic synchronous area;
- (b) power-generating modules that were installed to provide back-up power and operate in parallel with the system for less than five minutes per calendar month while the system is in normal system state or to supply an off-grid system. Parallel operation during maintenance or commissioning tests of that power-generating module shall not count towards the five-minute limit;
- (c) power-generating modules that do not have a permanent connection point and are used by the system operators to temporarily provide power when normal system capacity is partly or completely unavailable;
- (d) fully integrated network components owned by system operators.

3. Where two synchronous areas are merged, connection requirements set out for the larger synchronous area shall apply to new power-generating modules.

### *Article 4*

#### **Application to existing power-generating modules**

1. Power-generating modules existing at the entry into force of this Regulation are not subject to the requirements of this Regulation, except where:

- (a) the existing power-generating module has been subject to a significant modernisation in accordance with the proposal developed according to Article 4a; or

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

2. For the purposes of this Regulation, a power-generating module shall be considered existing at the entry into force of this Regulation if:

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

(b) the power-generating facility owner has concluded a final and binding contract for the purchase of the main generating plant by two years after the entry into force of this Regulation.

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

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

For that purpose, the relevant TSO shall carry out a sound and transparent quantitative cost-benefit analysis, in accordance with Article 38 and Article 39. The analysis shall indicate:

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

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

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

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

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

(b) obtain approval from the relevant regulatory authority or, where applicable, the Member State to proceed with a quantitative cost-benefit analysis based on the preliminary qualitative comparison of costs and benefits.

5. The relevant regulatory authority or, where applicable, the Member State shall decide on the extension of the applicability of this Regulation to existing power-generating modules within six months of receipt of the report and the recommendation of the relevant TSO in accordance with Article 38(4). The decision of the regulatory authority or, where applicable, the Member State shall be published.

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

7. The relevant TSO may assess the application of some or all of the provisions of this Regulation to existing power-generating modules every three years in accordance with the criteria and process set out in paragraphs 3 to 5.

#### *Article 4a*

##### **Significant modernisation**

1. Proposals for defining significant modernisation of power-generating modules and the requirements applicable in those cases shall be subject to approval by the relevant regulatory authority or, where applicable, the Member State.

In developing the proposals, the relevant TSO shall coordinate with relevant DSOs and conduct a public consultation in accordance with Article 10.

2. The definition of significant modernisation shall take into account at least the following criteria:

- (a) an increase above the existing maximum capacity of the power-generating module, whether this increase results from one modernisation or cumulatively from several successive modernisations, of a minimum percentage to be defined in the range 5-20 % (within this range, different percentages may be defined for different technologies depending on their constraints);
- (b) a deviation from the reactive power capability of the power-generating module, whether this deviation results from one modernisation or cumulatively from several successive modernisations, of a minimum percentage to be defined in the range 10-20 %;
- (c) a change in frequency stability and active power management capabilities, whether this change results from one modernisation or cumulatively from several successive modernisations, of the power-generating module; and
- (d) a change of components/assets of a power-generating module or electricity storage module apart from maintenance and repair activities and spare parts, whether or not those parts are purchased new at the time of their incorporation in the power-generating module;

In the proposal, the relevant TSO can propose additional criteria defining a significant modernisation.

3. For each criterion listed in paragraph 2 above, the relevant TSO's proposal shall specify the requirements of this Regulation that shall apply to the entire modernised power-generating module or only to the modernised part of the power-generating module.

#### *Article 5*

##### **Determination of significance**

1. Power-generating modules shall comply with the requirements on the basis of the voltage level of their connection point and their maximum capacity according to the categories set out in paragraph 2.

2. Power-generating modules, excluding V2G electric vehicles and associated V2G electric vehicle supply equipment below 1 MW maximum capacity, within the following categories shall be considered as significant:

- (a) maximum capacity of 0,8 kW or more (type A);
- (b) where the capacity of the power-generating module is below the threshold specified in accordance with the procedure laid out in paragraph 4:
  - (i) maximum capacity at or above a threshold specified by each relevant TSO in accordance with paragraph 3 (type B). This threshold shall not be above the limits for type B power-generating modules contained in Table 1;
  - (ii) maximum capacity at or above a threshold specified by each relevant TSO in accordance with paragraph 3 (type C). This threshold shall not be above the limits for type C power-generating modules contained in Table 1; or
  - (iii) maximum capacity at or above a threshold specified by each relevant TSO in accordance with paragraph 3 (type D). This threshold shall not be above the limits for type D power-generating modules contained in Table 1;
- (c) where the capacity of the power-generating module is above or equal to the threshold, specified in accordance with the procedure laid out in paragraph 4:
  - (i) connection point below 110 kV and maximum capacity at or above type B threshold contained in Table 1;
  - (ii) connection point below 110 kV and maximum capacity at or above a threshold specified by each relevant TSO in accordance with paragraph 3 (type C). This threshold shall not be above the limits for type C power-generating modules contained in Table 1; or
  - (iii) connection point at 110 kV or above (type D). A power-generating module is also of type D if its connection point is below 110 kV and its maximum capacity is at or above a threshold specified in accordance with paragraph 3. This threshold shall not be above the limit for type D power-generating modules contained in Table 1.

*Table 1*

**Limits for thresholds for type B, C and D power-generating modules**

<b>Synchronous areas</b>	<b>Limit for a threshold of maximum capacity from which a power-</b>	<b>Limit for a threshold of maximum capacity from which a power-</b>	<b>Limit for a threshold of maximum capacity from which a power-</b>

	<b>generating module is of type B</b>	<b>generating module is of type C</b>	<b>generating module is of type D</b>
Continental Europe	1 MW	50 MW	75 MW
Nordic	1,5 MW	10 MW	30 MW
Ireland and Northern Ireland	0,1 MW	5 MW	10 MW
Baltic	0,5 MW	10 MW	15 MW

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

4. For the purpose of the determination of significance as set out in paragraph 2, voltage level at the connection point shall be considered when maximum capacity of a power-generating module is above a default threshold of 10 MW. The relevant TSO may propose to amend this threshold as follows:

(a) The threshold may be decreased below 10MW down to either:

- 5MW or
- the capacity threshold at which a power-generating module is of type C as set in paragraph 3,

whichever of the two values is higher; or

(b) The threshold may be set above 10MW up to the capacity threshold at which a power-generating module is of type D as set in paragraph 3.

In forming proposals, the relevant TSO shall coordinate with adjacent TSOs and DSOs and shall conduct a public consultation in accordance with Article 10. A proposal by the relevant TSO to change the thresholds shall not be made sooner than three years after the approval of the previous proposal.

5. Such a proposal shall be subject to approval by the relevant regulatory authority or, where applicable, the Member State. Power-generating facility owners shall assist this process and provide relevant data as requested by the relevant TSO.

6. V2G electric vehicles and associated V2G electric vehicle supply equipment, within the following categories shall be considered as significant:

(a) maximum capacity larger than or equal to 0,8 kW and less than 2,4 kW (type EV1);



- (b) maximum capacity larger than or equal to 2,4 kW and less than or equal to 50 kW (type EV2);
- (c) maximum capacity larger than 50 kW and less than 1 MW (type EV3).

Requirements applicable to types EV1 and EV2 V2G electric vehicles and associated V2G electric vehicle supply equipment are set out exhaustively in Article 13a. Type EV2 V2G electric vehicles and type EV1 V2G electric vehicles and associated V2G electric vehicle supply equipment shall possess equipment certificates, proving compliance with this Regulation. Type EV2 associated V2G electric vehicle supply equipment follow compliance provisions of Article 30a only, whereas requirements applicable to type EV3 associated V2G electric vehicle supply equipment are set out exhaustively in Article 14a and follow compliance provisions of Article 30b only.

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

8. Requirements applicable to type A power-generating modules are set out in Article 13, Article X and Article Y, requirements for type B power-generating modules are set out in Article 14, Article 17 and Article 20, whereas requirements applicable to type C are set out in Article 15, Article 18 and Article 21. Requirements applicable to type D are set out in Article 16, Article 19 and Article 22.

## *Article 6*

### **Application to offshore power-generating modules, pump-storage power-generating modules, power-generating modules embedded in the networks of industrial sites, electricity storage modules, V2G electric vehicles and associated V2G electric vehicle supply equipment, and combined heat and power facilities**

1. Offshore power-generating modules connected to the interconnected system shall meet the requirements for onshore power-generating modules, unless the requirements are modified for this purpose by the relevant system operator or unless the connection of power park modules is via a high voltage direct current connection or via a network whose frequency is not synchronously coupled to that of the main interconnected system (such as via a back-to-back convertor scheme).
2. Pump-storage power-generating modules in generating operation, pumping operation and synchronous compensation mode shall fulfil the following requirements:
  - (a) the technical design of power-generating modules shall not limit in time the synchronous compensation operation of pump-storage power-generating modules. Synchronous compensation operation of full-converter variable speed machines is performed by the converters;
  - (b) pump-storage power-generating modules with fixed speed machines and single shaft ternary machines shall be considered as synchronous power-generating modules;
  - (c) pump-storage power-generating modules with variable speed machines shall be considered as power park modules. For doubly-fed induction machines, the parameters in Table (8)3.1.1 and Table (9)3.1.2, or Table (17) 7.1.1, Table (18) 7.1.2,

and Table (19) 7.2.1 shall apply to define the voltage-against-time profile with regard to fault-ride-through capability;

- (d) the requirements of this Regulation that apply to pump-storage power-generating modules in pumping operation mode and concern active power, shall result in the same effect as the response of active power generation;
- (e) in pumping operation mode, no technical capability to remain connected and continue operation is requested if the frequency is below 49 Hz, unless the relevant TSO defines a higher frequency value or unless another value is agreed between the relevant TSO and power-generating facility owner if it is required in the context of system restoration;
- (f) to pump-storage power-generating modules with fixed speed machines in pumping operation mode and synchronous compensation operation mode, paragraphs 3, 4, 5, 6, 7, 8, 9 of Article 13, paragraphs 2, 4 and 5 of Article 15 shall not apply. In pumping operation mode, the second sentence of Article 17(3) shall not apply; in synchronous compensation operation mode, Article 17(3) shall not apply;
- (g) to pump-storage power-generating modules with single shaft ternary machines in pumping operation mode, paragraphs 5 and 6 of Article 13 and Article 15(4) shall not apply. In addition, paragraphs 3, 4, 7, 8 and 9 of Article 13, paragraphs 2 and 5(e) of Article 15 and the second sentence of Article 17(3) shall not apply, if only pumps are operated. Where Article 13(3) or Article 15(2) apply, the reference active power for LFSM-O or LFSM-U respectively is the maximum capacity of the turbine;
- (h) to pump-storage power-generating modules with single shaft ternary machines in synchronous compensation operation mode, paragraphs 3, 4, 5, 6, 7, 8, 9 of Article 13, paragraphs 2, 4 and 5(e) of Article 15 and Article 17(3) shall not apply;
- (i) to pump-storage power-generating modules with variable speed machines in pumping operation mode, paragraphs 5 and 6 of Article 13 and Article 15(4) shall not apply;
- (j) to pump-storage power-generating modules with variable speed machines, the power generating facility owner shall provide technical evidence demonstrating why a longer time is needed, if the maximum response time  $T_{resp}$  according to Figure (4)XX1 is greater than the value set out in Article 13(3)(g). The power-generating facility owner and the relevant system operator shall agree on the acceptable response time.
- (k) to pump-storage power-generating modules with variable speed machines in synchronous compensation operation mode, paragraphs 3, 4, 5, 6, 7, 8, 9 of Article 13, paragraphs 2, 4 and 5(e) of Article 15 shall not apply.

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

4. Except for requirements under paragraphs 2 and 4 of Article 13 or where otherwise stated in the national framework, requirements of this Regulation relating to the capability to maintain constant active power output or to modulate active power output

shall not apply to power-generating modules of facilities for combined heat and power production embedded in the networks of industrial sites, where all of the following criteria are met:

- (a) the primary purpose of those facilities is to produce heat for production processes of the industrial site concerned;
- (b) heat and power-generating is inextricably interlinked, namely any change of heat generation results inadvertently in a change of active power-generating and vice versa;
- (c) the power-generating modules are of type A, B, C, and in the case of the Nordic synchronous area also type D, in accordance with points (a) to (c) of Article 5(2)

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

6. Electricity storage modules and V2G electric vehicles and associated V2G electric vehicle supply equipment shall satisfy the relevant requirements of this Regulation both when the electricity storage module or V2G electric vehicle and associated V2G electric vehicle supply equipment injects and consumes active power to and from the network.

7. Notwithstanding paragraph 2, the technical design of power-generating modules shall not limit the time that the power-generating modules can operate in synchronous compensation mode. Synchronous compensation operation of non-synchronous power park modules can be performed by appropriately designed converters. The relevant system operator in co-ordination with the relevant TSO shall specify appropriate technical requirements applicable to these modules operating in synchronous compensation mode.

## *Article 7*

### **Regulatory aspects**

1. The requirements of general application to be established by relevant system operators or TSOs under this Regulation shall be subject to approval by the entity designated by the Member State and be published. The designated entity shall be the regulatory authority unless otherwise provided by the Member State.

2. For site specific requirements to be established by relevant system operators or TSOs under this Regulation, Member States may require approval by a designated entity.

3. System operators shall ensure that system users' equipment shall offer a cyber-protected data exchange interface where relevant.

4. When applying this Regulation, Member States, competent entities and system operators shall:

- (a) apply the principles of proportionality and non-discrimination;
- (b) ensure transparency;
- (c) apply the principle of optimisation between the highest overall efficiency and lowest total costs for all parties involved;

- (d) respect the responsibility assigned to the relevant TSO in order to ensure system security, including as required by national legislation;
- (e) consult with relevant DSOs and take account of potential impacts on their system;
- (f) take into consideration agreed European standards, technical specifications, implementation guidance documents developed by ENTSO-E in accordance with Article 59(15) of Regulation (EU) 2019/943, and relevant nuclear safety rules;
- (g) take into consideration local system needs in specifying power-generating modules capabilities where necessary.

5. The relevant system operator or TSO shall submit a proposal for requirements of general application, or the methodology used to calculate or establish them as appropriate, for approval by the designated entity within two years of entry into force of this Regulation. The Member State may provide for a shorter time period for all or parts of the requirements or the methodologies. In this case, the Member State shall communicate the shorter time period to the European Union Agency for the Cooperation of Energy Regulators (ACER).

6. Where this Regulation requires the relevant system operator, relevant TSO, power-generating facility owner and/or the distribution system operator to seek agreement, they shall endeavour to do so within six months after a first proposal has been submitted by one party to the other parties. If no agreement has been found within this time frame, each party may request the relevant regulatory authority to issue a decision within six months.

7. Competent entities shall take decisions on proposals for requirements or methodologies within six months following the receipt of such proposals.

8. If the relevant system operator or TSO deems an amendment to requirements or methodologies as provided for and approved under paragraph 1 and 2 to be necessary, the requirements provided for in paragraphs 4 to 9 shall apply to the proposed amendment. System operators and TSOs proposing an amendment shall take into account the legitimate expectations, if any, of power-generating facility owners, equipment manufacturers and other stakeholders based on the initially specified or agreed requirements or methodologies.

9. Any party having a complaint against a relevant system operator or TSO in relation to that relevant system operator's or TSO's obligations under this Regulation may refer the complaint to the regulatory authority which, acting as dispute settlement authority, shall issue a decision within two months after receipt of the complaint. That period may be extended by two months where additional information is sought by the regulatory authority. That extended period may be further extended with the agreement of the complainant. The regulatory authority's decision shall have binding effect unless and until overruled on appeal.

10. Where the requirements under this Regulation are to be established by a relevant system operator that is not a TSO, Member States may provide that instead the TSO be responsible for establishing the relevant requirements.

## *Article 8*

### **Multiple TSOs**

1. Where more than one TSO exists in a Member State, this Regulation shall apply to all those TSOs.
2. Member States may, under the national regulatory regime, provide that the responsibility of a TSO to comply with one or some or all obligations under this Regulation is assigned to one or more specific TSOs.

### *Article 9*

#### **Recovery of costs**

1. The costs borne by system operators subject to network tariff regulation and stemming from the obligations laid down in this Regulation shall be assessed by the relevant regulatory authorities. Costs assessed as reasonable, efficient and proportionate shall be recovered through network tariffs or other appropriate mechanisms.
2. If requested by the relevant regulatory authorities, system operators referred to in paragraph 1 shall, within three months of the request, provide the information necessary to facilitate assessment of the costs incurred.

### *Article 10*

#### **Public consultation**

1. Relevant system operators and relevant TSOs shall carry out a public consultation with stakeholders, including the competent authorities of each Member State, on the proposals to extend the applicability of this Regulation to existing power-generating modules in accordance with Article 4(3), for the proposal for thresholds in accordance with Article 5(3), and on the report prepared in accordance with Article 38(3) and the cost-benefit analysis undertaken in accordance with Article 63(2). The consultation shall last at least for a period of one month.
2. The relevant system operators or relevant TSOs shall duly take into account the views of the stakeholders resulting from the consultations prior to the submission of the draft proposal for thresholds, the report or cost benefit analysis for approval by the regulatory authority or, if applicable, the Member State. In all cases, a sound justification for including or not the views of the stakeholders shall be provided and published in a timely manner before, or simultaneously with, the publication of the proposal.

### *Article 11*

#### **Stakeholder involvement**

ACER, in close cooperation with the European Network of Transmission System Operators for Electricity (ENTSO for Electricity) and the entity of distribution system operators in the Union (the EU DSO Entity), shall organise stakeholder involvement regarding the requirements for grid connection of power-generating facilities, and other aspects of the implementation of this Regulation. This shall include regular meetings with stakeholders to identify problems and propose improvements notably related to the requirements for grid connection of power-generating facilities.

*Article 12*

**Confidentiality obligations**

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

**TITLE II  
REQUIREMENTS**

**CHAPTER 1  
General requirements**

*Article 13*

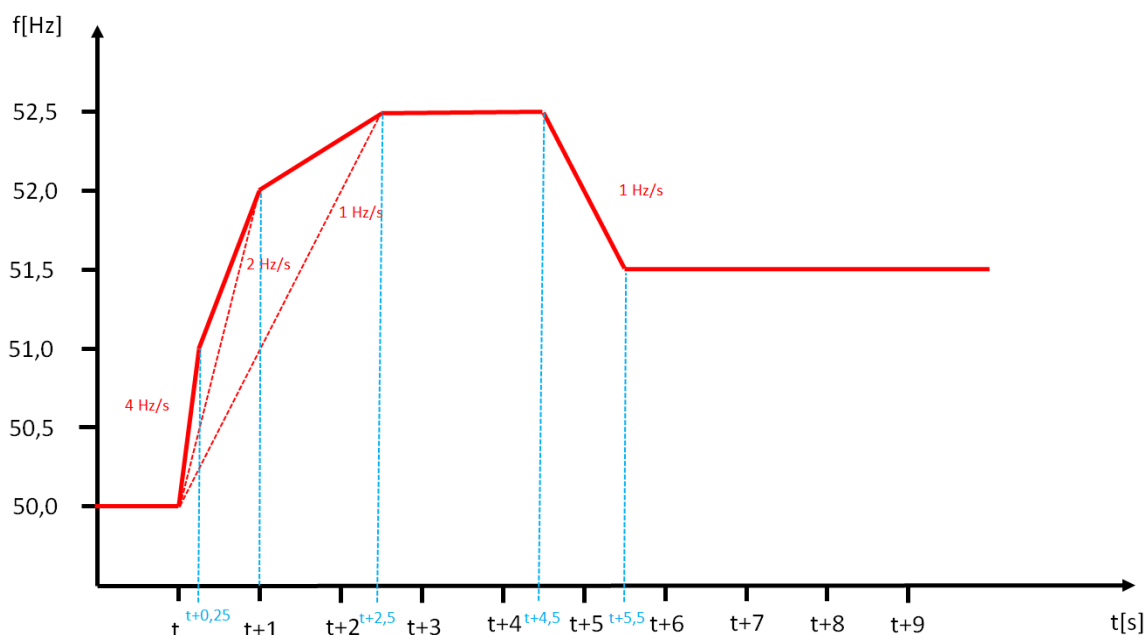
**General requirements for type A power-generating modules**

1. The power-generating module shall fulfil the requirements set out in this article.
2. The following requirements relating to frequency stability apply:
  - (a) With regard to frequency ranges:
    - (i) a power-generating module shall be capable of remaining connected to the network and operate stably within the frequency ranges and time periods specified in Table 2;
    - (ii) the relevant system operator, in coordination with the relevant TSO, and the power-generating facility owner may agree on wider frequency ranges, longer minimum times for operation or specific requirements for combined frequency and voltage deviations to ensure the best use of the technical capabilities of a power-generating module, if it is required to preserve or to restore system security;
    - (iii) the power-generating facility owner shall not unreasonably withhold consent to apply wider frequency ranges or longer minimum times for operation, taking account of their economic and technical feasibility.
  - (b) With regard to the rate-of-change-of-frequency withstand capability:

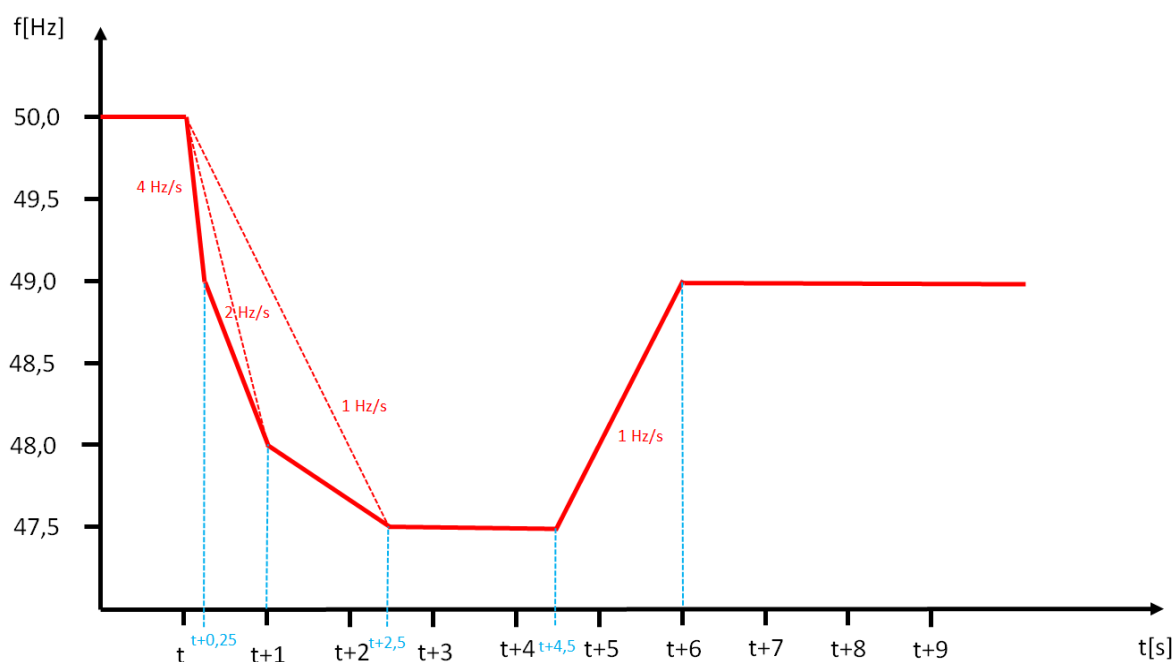


- (i) a synchronous power-generating module shall be capable of remaining connected to the network and operate at rates-of-change-of-frequency up to the following values:
- $\pm 2,0$  Hz/s over a period of 0,5 s,
  - $\pm 1,5$  Hz/s over a period of 1 s, and
  - $\pm 1,25$  Hz/s over a period of 2 s;
- (ii) a power park module shall be capable of remaining connected to the network and operate at rates-of-change-of-frequency up to the following values:
- $\pm 4,0$  Hz/s over a period of 0,25 s,
  - $\pm 2,0$  Hz/s over a period of 0,5 s,
  - $\pm 1,5$  Hz/s over a period of 1 s, and
  - $\pm 1,25$  Hz/s over a period of 2 s;
- (iii) without prejudice to paragraph (ii), a power park module shall also be capable of remaining connected to the network and operate through the sequence of rates-of-change-of-frequencies which are defined by the overfrequency against time profiles given in Figure (1)XX.a and the underfrequency against time profiles given in Figure (2)XX.b;

**Figure (1)XX.a**



**Figure (2)XX.b**



- (iv) if rate-of-change-of-frequency is used for loss of mains protection, the relevant system operator, in coordination with the relevant TSO, shall specify the threshold of this rate-of-change-of-frequency-type loss of mains protection.
- (c) Protection schemes, other than those specifically referred in paragraph (b)(iv) above, shall not jeopardise frequency-ride-through performance specified in paragraph (b).

*Table 2*

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

Synchronous area	Frequency range	Time period for operation
Continental Europe	47,5 Hz-48,5 Hz	To be specified by each TSO, but not less than 30 minutes and not more than 90 minutes
	48,5 Hz-49,0 Hz	To be specified by each TSO, but not less than the period for 47,5 Hz-48,5 Hz
	49,0 Hz-51,0 Hz	Unlimited

	51,0 Hz-51,5 Hz	30 minutes
Nordic	47,5 Hz-48,5 Hz	30 minutes
	48,5 Hz-49,0 Hz	To be specified by each TSO, but not less than 30 minutes
	49,0 Hz-51,0 Hz	Unlimited
	51,0 Hz-51,5 Hz	30 minutes
Ireland and Northern Ireland	47,5 Hz-48,5 Hz	90 minutes
	48,5 Hz-49,0 Hz	To be specified by each TSO, but not less than 90 minutes
	49,0 Hz-51,0 Hz	Unlimited
	51,0 Hz-51,5 Hz	90 minutes
Baltic	47,5 Hz-48,5 Hz	To be specified by each TSO, but not less than 30 minutes and not more than 90 minutes
	48,5 Hz-49,0 Hz	To be specified by each TSO, but not less than the period for 47,5 Hz-48,5 Hz
	49,0 Hz-51,0 Hz	Unlimited
	51,0 Hz-51,5 Hz	30 minutes

(d) the power-generating module shall be capable of remaining connected to the network and operate at the frequency between 51.5 Hz – 52.5 Hz for 10 seconds.

3. With regard to the limited frequency sensitive mode — overfrequency (LFSM-O), the following shall apply, as determined by the relevant TSO for its control area in coordination with the TSOs of the same synchronous area to ensure minimal impacts on neighbouring areas:

(a) the power-generating module shall be capable of activating the provision of active power frequency response according to Figure (3)1 at a frequency threshold specified in paragraph (c) below and droop settings specified by the relevant TSO according to paragraph (d) below;

- (b) instead of the capability referred to in paragraph (a), the relevant TSO may choose to allow within its control area automatic disconnection and reconnection of power-generating modules of Type A at randomised frequencies, ideally uniformly distributed, above a frequency threshold, as determined by the relevant TSO where it is able to demonstrate to the relevant regulatory authority, and with the cooperation of power-generating facility owners, that this has a limited cross-border impact and maintains the same level of operational security in all system states;
- (c) the frequency threshold shall be  $50\text{Hz} + \Delta f_1$ , where  $\Delta f_1$  is defined in Table (15) X of Article 15(2)(d);
- (d) the droop settings shall be between 2 % and 12 %;
- (e) the start of active power decrease (initial delay time  $T_{id}$  (Figure (4)XX1)) by the power-generating module shall not be intentionally delayed.
- (f) the relevant TSO may require that upon reaching minimum regulating level, the power-generating module be capable of either:
  - (i) continuing operation at this level; or
  - (ii) further decreasing active power output;
- (g) the power-generating module shall be capable of operating stably during LFSM-O operation. When LFSM-O is active, the LFSM-O setpoint will prevail over any other active power setpoints which would result in an increase of active power above the LFSM-O setpoint. The power-generating module shall be able to receive and react on an external signal allowing the relevant system operator to block active power LFSM-O mode in real-time. The TSO in coordination with the relevant system operator shall define the framework conditions for the use of this function.

The response time,  $T_{resp}$  in Figure (4)XX1, for active power decrease in case of increasing frequency, shall be as fast as technically feasible and as described below:

- (i) for synchronous power-generating module: less or equal to 8 seconds for an active power setpoint change of 45% maximum power.
- (ii) for power park module: less or equal to 2 seconds for an active power setpoint change of 50% maximum power.

If the response time is greater than stated above, the power-generating facility owner shall justify the delay, providing technical evidence to the relevant TSO.

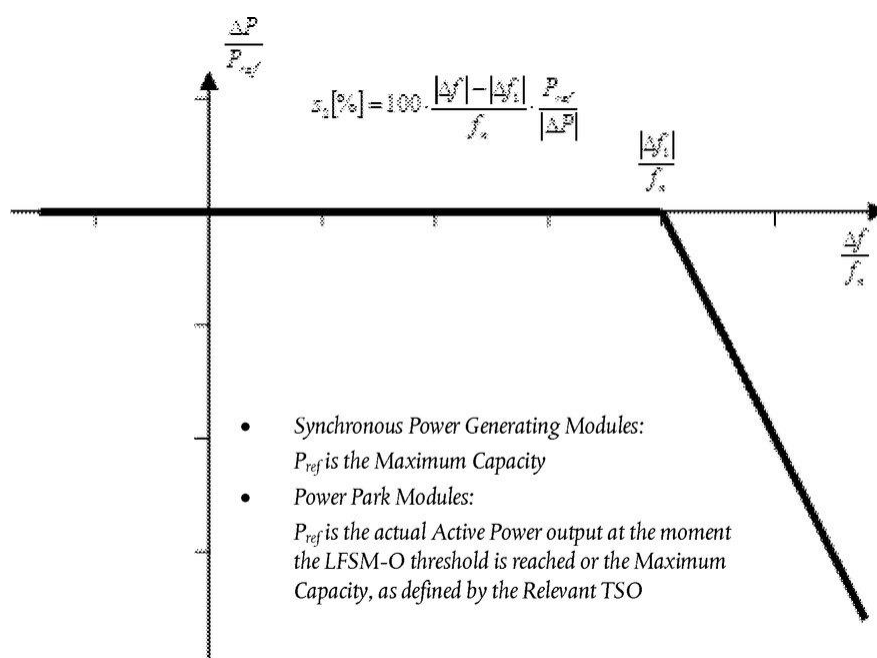
- (h) An electricity storage module shall be capable of activating the provision of active power frequency response in LFSM-O from the current active power input or output automatically up to the maximum consumption capacity according to the indicative Figure (3)1 to the extent that is technically feasible. A frequency threshold and a droop setting specified in accordance with paragraph 3(a) of this Article shall apply.

The electricity storage module shall consume power up to filling the maximum energy that it is able to store, then it may cease consumption. The relevant TSO may define a different characteristic or establish that the electricity storage module, when consuming active power, will maintain the consumption level even during the overfrequency event.

Switching from consumption to generation and vice versa should be as fast as technically feasible. The relevant system operator has the right to request the demonstration of technical evidence of the required switching time.

**Figure (3)1**

**Active power frequency response capability of power-generating modules in  
LFSM-O**

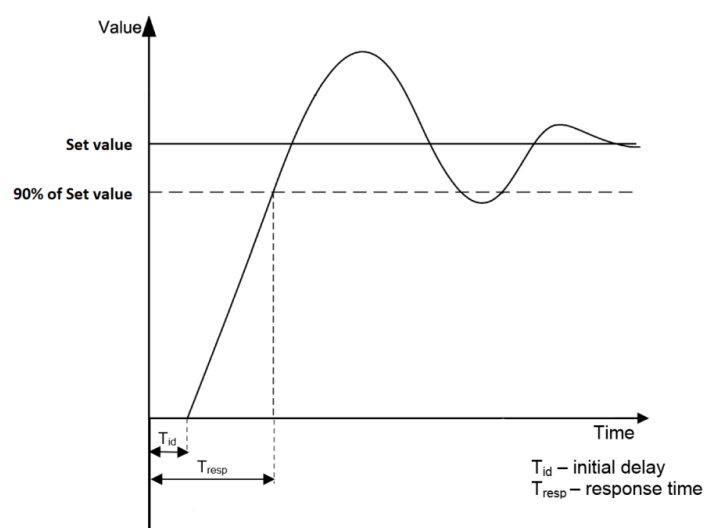


$P_{ref}$  is the reference active power to which  $\Delta P$  is related and may be specified differently for synchronous power-generating modules and power park modules.  $\Delta P$  is the change in active power output from the power-generating module.  $f_n$  is the nominal frequency (50 Hz) in the network and  $\Delta f$  is the frequency deviation in the network. At overfrequencies where  $\Delta f$  is above  $\Delta f_1$ , the power-generating module has to provide a negative active power output change according to the droop  $S_2$ .

In the case of electricity storage modules,  $P_{ref}$  could be the actual active power at the moment the LFSM-O threshold is reached or the maximum capacity or maximum consumption capacity, as specified by the relevant system operator.

**Figure (4)XX1**

**Definition of response parameters**



4. The power-generating module shall be capable of maintaining constant output at its target active power value regardless of changes in frequency, except where output follows the changes specified in the context of paragraphs 3 and 5 of this Article or points (c) and (d) of Article 15(2) as applicable.

5. The relevant TSO shall specify admissible active power reduction from maximum output with falling frequency in its control area as a rate of reduction falling within the boundaries, illustrated by the full lines in Figure (5)2:

- (a) below 49 Hz falling by a reduction rate of 2 % of the maximum capacity at 50 Hz per 1 Hz frequency drop;
- (b) below 49,5 Hz falling by a reduction rate of 10 % of the maximum capacity at 50 Hz per 1 Hz frequency drop.

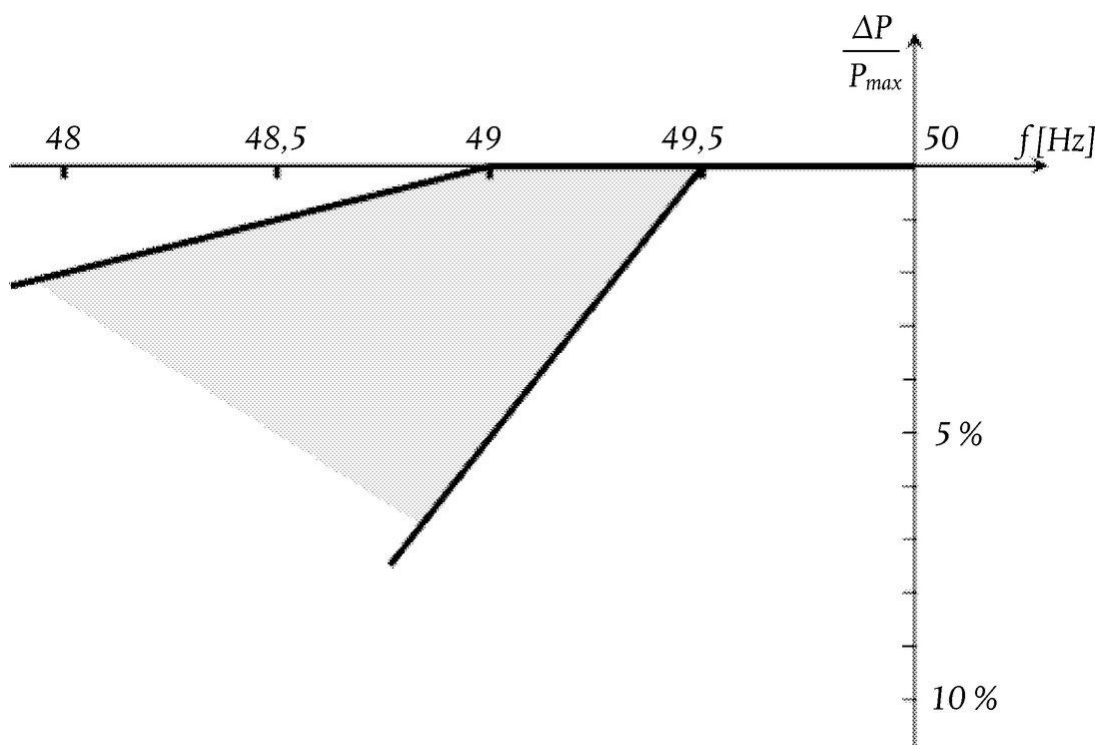
6. The admissible active power reduction from maximum output shall:

- (a) clearly specify the ambient conditions applicable;
- (b) take account of the technical capabilities of power-generating modules.

**Figure (5)2**

**Maximum power capability reduction with falling frequency**





The diagram represents the boundaries in which the capability can be specified by the relevant TSO.

7. The power-generating module shall be equipped with a communication interface (input port) in order to reduce, without undue delay, active power output following an instruction being received at the input port.

The electricity storage modules shall be capable of modulating, without undue delay, active power output and input following an instruction being received at the input port.

The relevant system operator shall have the right to specify requirements for equipment to make power-generating module operable remotely.

8. The technical capability of the power-generating module to connect to the network shall be as follows:

- (a) Voltage range at the grid connection point: within the voltage range that is defined for unlimited time operation if so applicable;
- (b) Frequency range of  $47.5 \text{ Hz} \leq f \leq 51 \text{ Hz}$ ;
- (c) Adjustable observation time: from 0 to 300 s;
- (d) Adjustable limitation of the gradient of active power increase  $\leq 20 \text{ \% of } P_{\text{max}}/\text{min}$ ; and,
- (e) Synchronizing conditions.

9. Within the capability defined in paragraph 8, the default settings for an autonomous connection, unless specified otherwise by the relevant system operator in coordination with the relevant TSO, shall be as follows:

- (a) Voltage range:  $0.9 \text{ pu} \leq U \leq 1.1 \text{ pu}$ ;

(b) Frequency range:

- Continental Europe:  $47.5 \text{ Hz} \leq f \leq 50.1 \text{ Hz}$
- Other synchronous areas  $47.5 \text{ Hz} \leq f \leq 50.5 \text{ Hz}$

(c) Minimum observation time: 60 s;

(d) Maximum gradient of active power increase  $\leq 20 \%$  of  $P_{\max}/\text{min}$

(e) Condition on voltage phase angle difference measured on each side of the switchgear:  
 $\Delta\theta < 10^\circ$

(f) Condition on the voltage magnitude difference measured on each side of the switchgear:  $\Delta U < 0.04 \text{ pu}$ ; and

(g) Condition on the frequency difference measured on each side of the switchgear:  $\Delta f < 0,2 \text{ Hz}$

Autonomous connection is allowed unless specified otherwise by the relevant system operator in coordination with the relevant TSO.

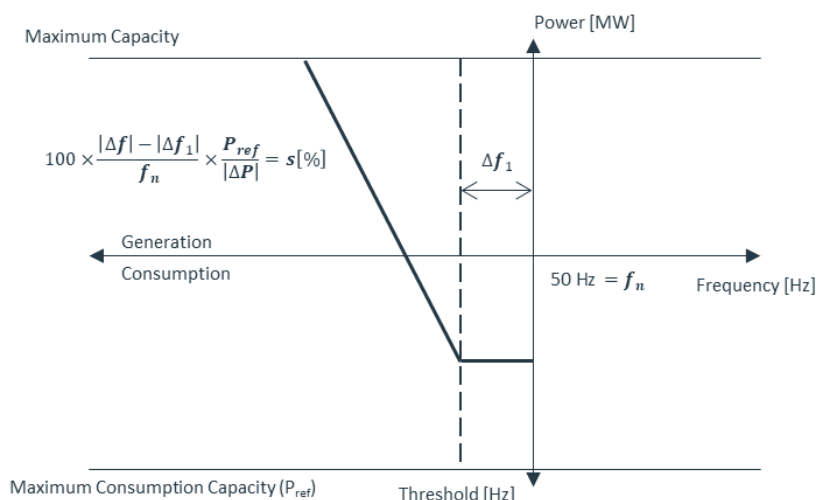
10. The relevant system operator shall have the right to specify the capability of a power-generating module to supply or absorb reactive power both when importing or exporting active power over its operating range. The power-generating module shall be capable of providing reactive power automatically by voltage control mode, reactive power control mode, power factor control mode or active power-related power factor control mode, as specified by the relevant system operator. The power-generating module shall be able to receive and react to an external signal allowing the relevant system operator to transmit reactive power or voltage control mode set points. The power-generating module controls shall implement any revised set points without delay;

11. The following requirements shall apply to electricity storage modules with regard to limited frequency sensitive mode – underfrequency (LFSM-U-ESM):

(a) An electricity storage module shall be capable of activating the provision of active power frequency response from the current active power input or output automatically up to the maximum capacity according to the indicative Figure (6)YY1. The relevant TSO shall specify a frequency threshold and a droop setting:

- (i) The droop shall be adjustable between 0,2% to 5%. The default droop s shall be 1%;
- (ii) The frequency threshold shall be adjustable between 49,8 Hz and 49,5 Hz inclusive. The default frequency threshold shall be 50 Hz reduced by  $\Delta f_1$  where  $\Delta f_1$  is defined in Table (15) X of Article 15(2)(d).

***Figure (6)YY1***



- (b) The electricity storage module shall stay and operate stably in this specific mode as long as the frequency is below the frequency threshold according to its content of energy. When LFSM-U-ESM is active, the LFSM-U-ESM setpoint shall prevail over any other active power setpoints. If the frequency recovers the electricity storage module shall follow the same power-frequency characteristic until it is back to its prior state of active power input/output. The electricity storage module shall be able to receive and react on an external signal allowing the relevant system operator to block active power LFSM-U-ESM mode in real-time. The TSO in coordination with the relevant system operator shall define the framework conditions for the use of this function.
- (c) Instead of the capability referred to in paragraph (a), the relevant TSO may choose to allow electricity storage modules of Type A in consumption mode within its control area automatic disconnection at randomized frequencies, ideally uniformly distributed, between the frequency threshold and 49 Hz.
- (d) The initial delay time  $T_{id}$  (Figure (4)XX1 in Article 13(3)) by the electricity storage modules shall not be intentionally delayed.
- (e) The response time  $T_{resp}$  (Figure (4)XX1 in Article 13(3)) for LFSM-U-ESM shall be as described below:
- for SPGM: less or equal to 8 s for an active power setpoint change of 1 pu of capacity excluding the time for switching from consumption to generation or vice versa.
  - for PPM: less or equal to 0,5 s for an active power setpoint change of 1 pu of capacity excluding the time for switching from consumption to generation or vice versa.

Switching from consumption to generation and vice versa should be as fast as technically feasible. The relevant system operator has the right to request the demonstration of technical evidence of the required switching time. If the response time is greater than stated above, the power-generating facility owner shall justify the delay, providing technical evidence to the relevant TSO.

12. With regard to voltage stability, unless otherwise provided in this Regulation, the power-generating module shall be capable of remaining connected to the network and operate continuously within the range of 0,85 pu - 1,1 pu at the connection point should that be at or below 1000V. Conversely, the power-generating module shall be capable of remaining connected to the network and operate continuously within the range of 0,9 pu - 1,1 pu at the connection point should that be above 1000V and below 110 kV.

13. With regard to weather-related hazards, the relevant system operator or TSO may specify weather hazards resilience requirements based on the cost-benefit analysis undertaken in accordance with Article 39. Those requirements shall reflect the specificities of generation technologies as well as the geographical and climatic particularities of each Member State.

#### *Article 13a*

##### **General requirements for type EV1 and EV2 V2G electric vehicles and associated V2G electric vehicle supply equipment**

1. Type EV1 and EV2 V2G electric vehicles and associated V2G electric vehicle supply equipment shall fulfil the following requirements relating to frequency stability:

(a) With regard to frequency ranges, type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment shall be capable of remaining connected to the network and operate within the frequency ranges and time periods specified in Table (3) XY;

(b) With regard to the rate-of-change-of-frequency withstand capability:

(i) A type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment shall be capable of remaining connected to the network and operate at rates-of-change-of-frequency up to the following values:

- $\pm 4,0$  Hz/s over a period of 0,25 s
- $\pm 2,0$  Hz/s over a period of 0,5 s
- $\pm 1,5$  Hz/s over a period of 1 s
- $\pm 1,25$  Hz/s over a period of 2 s

(ii) Without prejudice to paragraph 1(a), type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment shall be capable of remaining connected to the network and operate at the sequence of rates-of-change-of-frequencies which are defined considering the overfrequency against time profiles given in Figure (7)XX.c and the underfrequency against time profiles given in Figure (8)XX.d;

(iii) (iii) If the rate-of-change-of-frequency is used for loss of mains protection, the rate-of-change-of-frequency threshold shall be set at higher values than the ones defined in point (i) above;

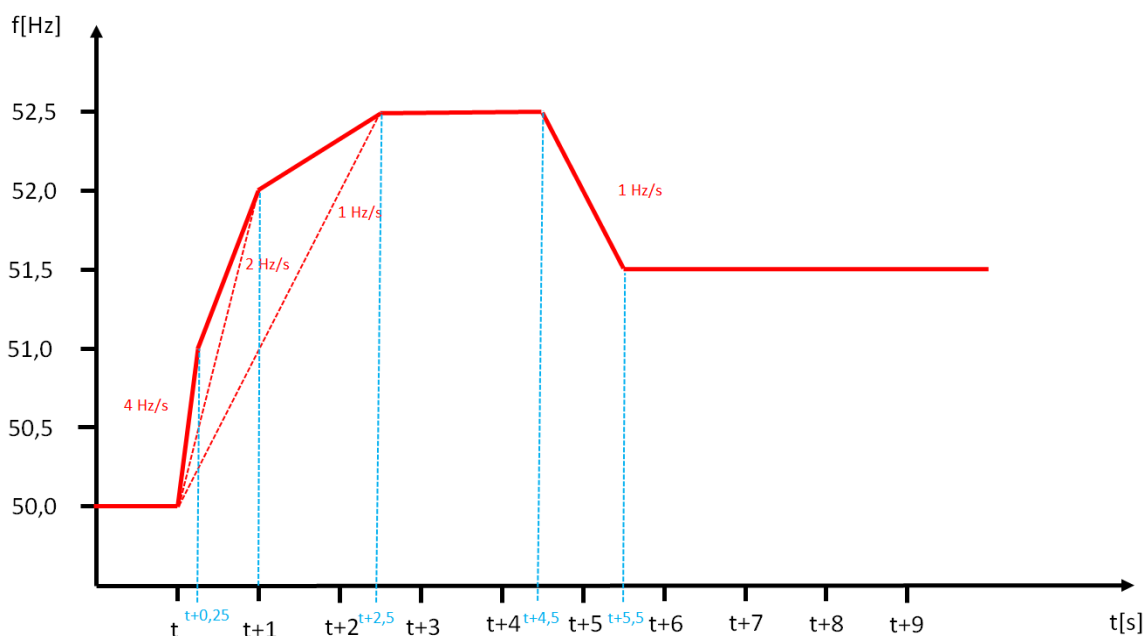
(c) The protection schemes shall not jeopardise frequency-ride-through performance specified in paragraph (b).

*Table (3) XY*

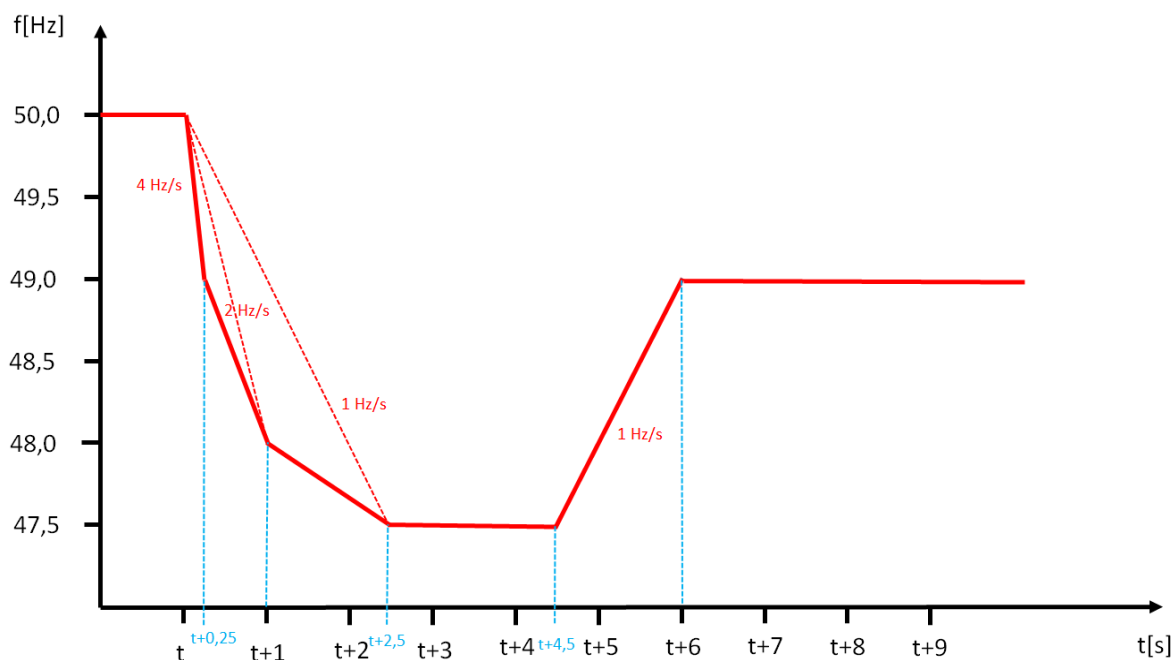
**Minimum time periods for which a type EV1 and EV2 V2G electric vehicle and an associated V2G electric vehicle supply equipment shall be capable of operating on different frequencies, deviating from a nominal value, without disconnecting from the network**

Frequency range	Time period for operation
47,5 Hz-48,5 Hz	30 minutes
48,5 Hz-49,0 Hz	30 minutes
49,0 Hz-51,0 Hz	Unlimited
51,0 Hz-51,5 Hz	30 minutes
51,5 Hz-52,5 Hz	10 seconds

*Figure (7)XX.c*



*Figure (8)XX.d*



2. A V2G electric vehicle or V2G electric vehicle supply equipment, as relevant, shall be equipped with a data exchange interface in order to modulate, without undue delay, active power output and input following an instruction being received at the input port. The relevant system operator shall have the right to specify requirements for equipment to make this facility operable remotely.

3. A type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment may autonomously connect to the network under the following conditions:

- (a) Voltage range:  $0.9 \text{ pu} \leq U \leq 1.1 \text{ pu}$ ;
- (b) Frequency range  $49.8 \text{ Hz} \leq f \leq 50.1 \text{ Hz}$ ;
- (c) Minimum observation time: 5 s.

4. A type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment may autonomously reconnect to the network after tripping due to a system disturbance under the following conditions:

- (a) Voltage range:  $0.9 \text{ pu} \leq U \leq 1.1 \text{ pu}$ ;
- (b) Frequency range  $49.8 \text{ Hz} \leq f \leq 50.1 \text{ Hz}$ ;
- (c) Minimum observation time: 60 s.

5. With regard to the limited frequency sensitive mode – underfrequency (LFSM-U-EV):

(a) A type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment shall be capable of activating the provision of active power frequency response from the current active power input/output automatically up to the maximum capacity according to the indicative Figure (9)YY2 at a frequency threshold and with the droop setting;

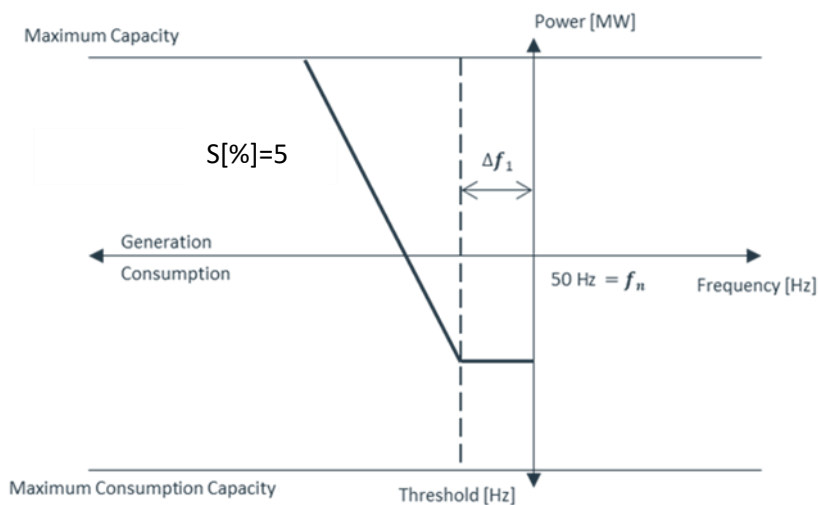
(b) The droop setting shall be 5%;



- (c) The frequency threshold shall be 49,8 Hz inclusive, except for synchronous area IE where the frequency threshold shall be 49,5 Hz inclusive;
- (d) A type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment shall stay and operate stably in this specific mode as long as the frequency is below the frequency threshold and according to its content of energy. If the frequency recovers, the V2G electric vehicle and associated V2G electric vehicle supply equipment shall follow the same power-frequency characteristic until it is back to its prior state of active power input/output;
- (e) The response time,  $T_{\text{resp}}$  in Figure (11)XX3, shall be less or equal to 0,5 s for an active power setpoint change of 100% of  $P_{\text{max}}$  excluding the time for switching from consumption to generation or vice versa, and excluding the time needed to activate from the charging pause;
- (f) Switching from consumption to generation and vice versa should be as fast as technically feasible.

**Figure (9)YY2**

## Active power frequency response capability of type EV1 and EV2 V2G electric vehicles and associated V2G electric vehicle supply equipment in LFSM-U-EV



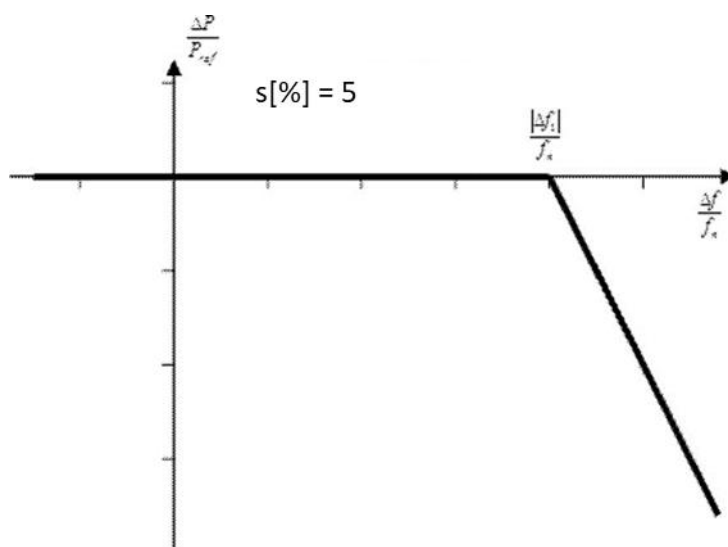
$P_{ref}$  is the actual active power at the moment the LFSM-U threshold is reached.

6. With regard to limited frequency sensitive mode – overfrequency (LFSM-O-EV):
- (a) A type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment which is consuming active power during an overfrequency event shall increase the active power consumption according to the LFSM-O characteristic, to the extent that is technically feasible. The type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment shall consume power up to filling the maximum energy that it is able to store, then it may cease consumption.
  - (b) A Type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment, which is injecting active power during an overfrequency event, shall

activate the provision of active power frequency response according to Figure (10)1X1 at the frequency threshold  $\Delta f_1$  equal to 50,2 Hz (inclusive), except for synchronous area IE where the frequency threshold shall be 50,5 Hz (inclusive);

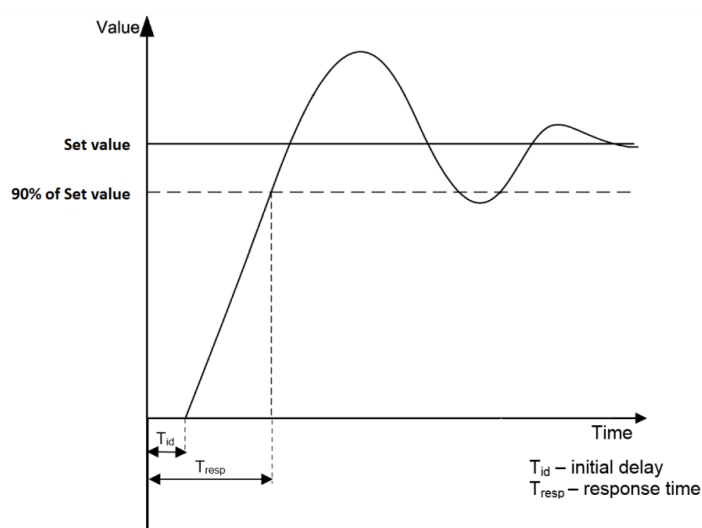
- (c) The droop setting shall be 5%;
- (d) Any unintentional delay shall be as short as possible;
- (e) The type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment shall be capable of operating stably during LFSM-O operation. When LFSM-O is active, the LFSM-O setpoint will prevail over any other active power setpoints which would result in an increase of power above the LFSM-O setpoint;
- (f) The response time  $T_{resp}$  (Figure (11)XX3) for active power decrease in case of increasing frequency, shall be as fast as technically feasible and less or equal to 2 seconds for an active power setpoint change of 50% maximum power.

**Figure (10)1X1**  
**Active power frequency response capability of type EV1 and EV2 V2G electric vehicles and associated V2G electric vehicle supply equipment in LFSM-O-EV**



$P_{ref}$  is the actual active power at the moment the LFSM-O threshold is reached

**Figure (11)XX3**



7. A type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment shall be capable of maintaining constant output at its target active power value regardless of changes in frequency, except where output follows the changes specified in the context of paragraphs 5 and 6 of this Article.

8. With regard to voltage stability, a type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment shall be capable of remaining connected to the network and operate continuously within the range of 0,85 –u - 1,1 pu at the connection point. Beyond these voltage range values, the under voltage ride through immunity limits as specified in paragraph 9 apply.

9. A type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment, when operating above the minimum stable operating level, shall be capable of remaining connected to the network and continuing to operate stably after the power system has been disturbed by faults in the transmission network according to a voltage-against-time-profile in line with Figure (12)3 at the connection point and with the set points in

10. Table (4) x.1.1 and Table (5) x.1.2.

*Table (4) x.1.1*

**Voltage parameters for Figure (12)3 for fault-ride-through capability of type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment**

<b>Voltage parameters (pu)</b>	
$U_{ret}$ :	0,05
$U_{clear}$ :	0,15
$U_{rec1}$ :	0,15

U <sub>rec2</sub> :	0,85
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*Table (5) x.1.2*

**Time parameters for Figure (12)3 for fault-ride-through capability of type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment**

Time parameters (seconds)	
t <sub>clear</sub> :	0,15
t <sub>rec1</sub> :	0,15
t <sub>rec2</sub> :	0,15
t <sub>rec3</sub> :	3,0

11. The voltage-against-time-profile expresses a lower limit of the profile of the phase-to-phase voltages (or single phase to neutral voltages for single phase type EV1 and EV2 V2G electric vehicles and associated V2G electric vehicle supply equipment) on the network voltage level during a symmetrical fault, as a function of time before, during and after the fault.

12. When the network voltage resumes, after the fault has been cleared, to a value within the voltage range of 0,85 pu – 1,1 pu, a type EV1 and EV2 V2G electric vehicle and associated V2G electric vehicle supply equipment shall recover its active power output level to its pre-fault value. The recovery time shall not exceed a maximum of 1s.

#### *Article 14*

##### **General requirements for type B power-generating modules**

1. Type B power-generating modules shall fulfil the requirements set out in Article 13, except for Article 13(3)(b) and Article 13(9).

2. The power-generating module shall fulfil the following requirements relating to voltage stability:

(a) with regard to voltage ranges of 110 kV and above:

- (i) unless otherwise provided in this Regulation, a power-generating module shall be capable of remaining 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 the reference 1 pu voltage, and for the time periods specified in Table (6) XX.1 and Table (7) XX.2 or, for voltages not included in the

tables and above voltage level 110 kV as specified by the relevant system operator in coordination with the relevant TSO;

- (ii) the relevant TSO may specify shorter periods of time during which power-generating modules shall be capable of remaining connected to the network in the event of simultaneous overvoltage and underfrequency or simultaneous undervoltage and overfrequency;
  - (iii) notwithstanding the provisions of paragraph (i), the relevant TSO in Spain may require power-generating modules to be capable of remaining connected to the network in the voltage range between 1,05 pu and 1,0875 pu for an unlimited period;
  - (iv) 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 system operator in the same synchronous area;
  - (v) the relevant TSOs in the Baltic synchronous area may require power-generating modules to remain connected to the 400 kV network in the voltage range limits and for the time periods that apply in the Continental Europe synchronous area;
  - (vi) the relevant system operator, in coordination with the relevant TSO, and the power-generating facility owner may agree on wider voltage ranges or longer minimum time periods for operation to ensure the best use of the technical capabilities of a power-generating module, if it is required to preserve or to restore system security.
- (b) Beyond the voltage range values specified above, the under and over voltage ride through immunity limits as specified in subparagraphs (a) and (c) of paragraph 3 apply.

The power-generating facility owner shall not unreasonably withhold consent to apply wider voltage ranges or longer minimum times for operation, taking account of their economic and technical feasibility;

*Table (6) XX.1*

<b>Synchronous area</b>	<b>Rated Voltage</b>	<b>Voltage range</b>	<b>Time period for operation</b>
Continental Europe	110 kV	0,85 pu-0,90 pu	60 minutes
		0,90 pu-1,118 pu	Unlimited
		1,118 pu-1,15 pu	To be specified by each TSO, but not less than 20 minutes and not more than 60 minutes
	132 kV	0,85 pu-0,90 pu	60 minutes
		0,90 pu-1,098 pu	Unlimited

		1,098 pu-1,15 pu	To be specified by each TSO, but not less than 20 minutes and not more than 60 minutes
		0,85 pu-0,90 pu	60 minutes
		0,90 pu-1,118 pu	Unlimited
		1,118 pu-1,15 pu	To be specified by each TSO, but not less than 20 minutes and not more than 60 minutes
		0,85 pu-0,90 pu	60 minutes
		0,90 pu-1,1136 pu	Unlimited
		1,113 pu-1,15 pu	To be specified by each TSO, but not less than 20 minutes and not more than 60 minutes
Nordic	110 kV	0,85 pu-0,90 pu	To be specified by each TSO, but not more than 60 minutes
		0,90 pu-1,05 pu	Unlimited
		1,05 pu-1,10 pu	60 minutes
	132 kV	0,85 pu-0,90 pu	To be specified by each TSO, but not more than 60 minutes
		0,90 pu-1,05 pu	Unlimited
		1,05 pu-1,10 pu	60 minutes
	220 kV	0,85 pu-0,90 pu	To be specified by each TSO, but not more than 60 minutes
		0,90 pu-1,05 pu	Unlimited
		1,05 pu-1,10 pu	60 minutes
Ireland and Northern Ireland	110 kV	0,85 pu-0,90 pu	To be specified by each TSO, but not more than 60 minutes
		0,90 pu-1,118 pu	Unlimited
	220 kV	0,85 pu-0,90 pu	To be specified by each TSO, but not more than 60 minutes
		0,90 pu-1,113 pu	Unlimited
	275 kV	0,85 pu-0,90 pu	To be specified by each TSO, but not more than 60 minutes
		0,90 pu-1,09 pu	Unlimited



Baltic	110 kV	0,85 pu-0,90 pu	30 minutes
		0,90 pu-1,118 pu	Unlimited
		1,118 pu-1,15 pu	20 minutes
	220 kV	0,85 pu-0,90 pu	30 minutes
		0,90 pu-1,113 pu	Unlimited
		1,113 pu-1,15 pu	20 minutes

The table shows the minimum time periods during which a power-generating module shall be capable of operating for voltages deviating from the reference 1 pu value at the connection point without disconnecting from the network, where the voltage base for pu values is from 110 kV to (not including) 300 kV.

*Table (7) XX.2*

<b>Synchronous area</b>	<b>Rated Voltage</b>	<b>Voltage range</b>	<b>Time period for operation</b>
Continental Europe	330 kV	0,85 pu-0,90 pu	60 minutes
		0,90 pu-1,05 pu	Unlimited
		1,05 pu-1,10 pu	To be specified by each TSO, but not less than 20 minutes and not more than 60 minutes
	400 kV	0,85 pu-0,90 pu	60 minutes
		0,90 pu-1,05 pu	Unlimited
		1,05 pu-1,10 pu	To be specified by each TSO, but not less than 20 minutes and not more than 60 minutes
Nordic	330 kV	0,85 pu-0,90 pu	To be specified by each TSO, but not more than 60 minutes
		0,90 pu-1,05 pu	Unlimited
		1,05 pu-1,10 pu	To be specified by each TSO, but not more than 60 minutes
	400 kV	0,85 pu-0,90 pu	To be specified by each TSO, but not more than 60 minutes
		0,90 pu-1,05 pu	Unlimited
		1,05 pu-1,10 pu	To be specified by each TSO, but not more than 60 minutes

Ireland and Northern Ireland	400 kV	0,85 pu-0,90 pu	To be specified by each TSO, but not more than 60 minutes
		0,90 pu-1,05 pu	Unlimited
Baltic	330 kV	0,88 pu-0,90 pu	20 minutes
		0,90 pu-1,097 pu	Unlimited
		1,097 pu-1,15 pu	20 minutes
	400 kV	0,88 pu-0,90 pu	20 minutes
		0,90 pu-1,05 pu	Unlimited
		1,05 pu-1,15 pu	20 minutes

The table shows the minimum time periods during which a power-generating module shall be capable of operating for voltages deviating from the reference 1 pu value at the connection point without disconnecting from the network where the voltage base for pu values is from 300 kV to 400 kV (included).

3. The power-generating module shall fulfil the following requirements in relation to robustness:

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

- (i) each TSO shall specify a voltage-against-time profile in line with Figure (12)3 at the connection point for fault conditions, which describes the conditions in which the power-generating module, when operating above the minimum stable operating level, is capable of remaining connected to the network and continuing to operate stably after the power system has been disturbed by secured faults on the transmission system;
- (ii) the voltage-against-time-profile shall express a lower limit of the actual course of the phase-to-phase voltages on the network voltage level at the connection point during a symmetrical fault, as a function of time before, during and after the fault;
- (iii) the lower limit referred to in point (ii) shall be specified by the relevant TSO using the parameters set out in Figure (12)3 and within the ranges set out in Table (8)3.1.1, Table (9)3.1.2, Table (10)3.2.1 and Table (11)3.2.2;
- (iv) each TSO shall specify and make publicly available the pre-fault and post-fault conditions for the fault-ride-through capability in terms of:
  - the calculation of the pre-fault minimum short circuit capacity at the connection point,
  - pre-fault active and reactive power operating point of the power-generating module at the connection point and voltage at the connection point, and
  - calculation of the post-fault minimum short circuit capacity at the connection point;

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

— pre-fault minimum short circuit capacity at each connection point expressed in MVA,

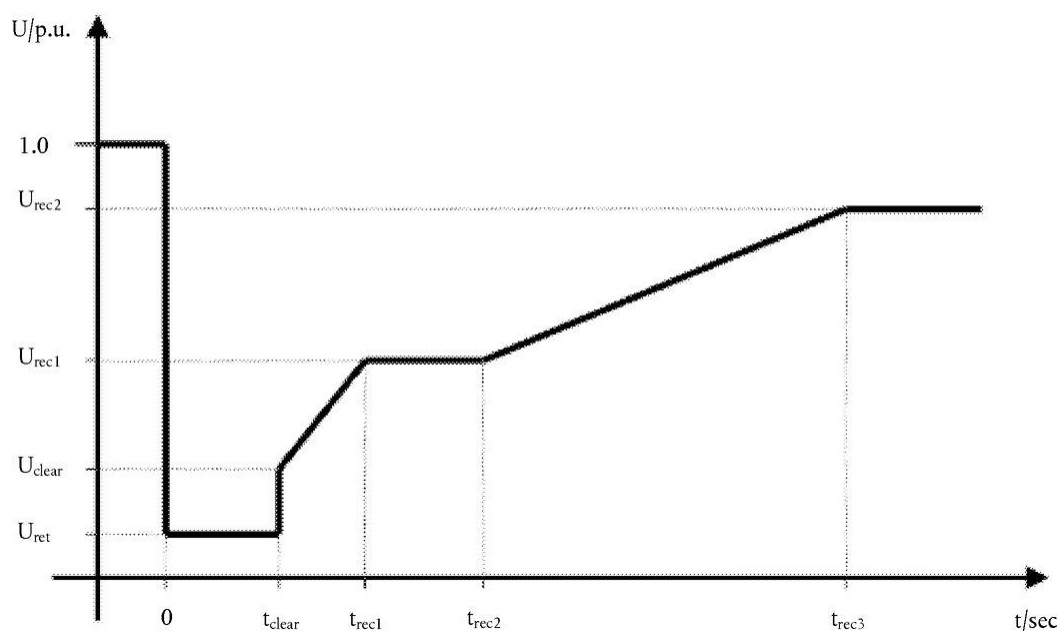
— pre-fault operating point of the power-generating module expressed in active power output and reactive power output at the connection point and voltage at the connection point, and

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

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

**Figure (12)3**

**Fault-ride-through profile of a power-generating module**



The diagram represents the lower limit of a voltage-against-time profile of the voltage at the connection point, expressed as the ratio of its actual value and its reference 1 pu value 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.

**Table (8)3.1.1**

**Voltage parameters for Figure (12)3 for fault-ride-through capability of synchronous power-generating modules**

Voltage parameters (pu)	
$U_{ret}$ :	0,05-0,3
$U_{clear}$ :	0,7-0,9 and $\leq U_{rec2}$
$U_{rec1}$ :	$U_{clear}$
$U_{rec2}$ :	Minimum voltage specified in paragraph (2) and Article 13(12)

*Table (9)3.1.2*

**Time parameters for Figure (12)3 for fault-ride-through capability of synchronous power-generating modules**

Time parameters (seconds)	
$t_{clear}$ :	0,14-0,15 (or 0,14-0,25 if justified by the system protection and secure operation needs)
$t_{rec1}$ :	$t_{clear}$
$t_{rec2}$ :	$t_{rec1}$ -0,7
$t_{rec3}$ :	$t_{rec2}$ -1,5

*Table (10)3.2.1*

**Voltage parameters for Figure (12)3 for fault-ride-through capability of power park modules**

Voltage parameters (pu)	
$U_{ret}$ :	0,05-0,15
$U_{clear}$ :	$U_{ret}$ -0,15

$U_{rec1}$ :	$U_{clear}$
$U_{rec2}$ :	Minimum voltage specified in paragraph (2) and Article 13(12)

*Table (11)3.2.2*

**Time parameters for Figure (12)3 for fault-ride-through capability of power park modules**

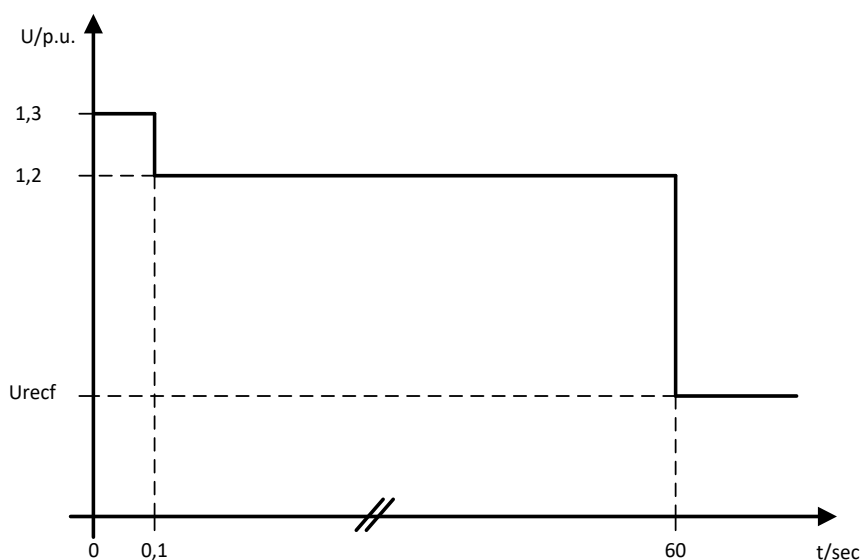
Time parameters (seconds)	
$t_{clear}$ :	0,14-0,15 (or 0,14-0,25 if justified by the system protection and secure operation needs)
$t_{rec1}$ :	$t_{clear}$
$t_{rec2}$ :	$t_{rec1}$
$t_{rec3}$ :	1,5-3,0

- (vi) the power-generating module shall be capable of remaining connected to the network and continuing to operate stably when the actual course of the phase-to-phase voltages on the network voltage level at the connection point during a symmetrical fault, given the pre-fault and post-fault conditions in points (iv) and (v) of paragraph 3(a), remain above the lower limit specified in point (ii) of paragraph 3(a), unless the protection scheme for internal electrical faults requires the disconnection of the power-generating module from the network. The protection schemes and settings for internal electrical faults must not jeopardise fault-ride-through capabilities of a power-generating module, in line with the requirements set out in this Regulation;
  - (vii) without prejudice to point (vi) of paragraph 3(a), undervoltage protection (either fault-ride-through capability or minimum voltage specified at the connection point voltage) shall be set by the power-generating facility owner according to the widest possible technical capability of the power-generating module, unless the relevant system operator requires narrower settings in accordance with point (b) of paragraph 5. The relevant settings shall be justified by the power-generating facility owner in accordance with the principle of ensuring the widest possible technical capability of the power-generating module;
- (b) fault-ride-through capabilities in case of asymmetrical faults shall be specified by each TSO.
- (c) The power-generating module shall be capable of operating stably without disconnecting from the network, if none of the phase-to-phase voltages exceeds the

voltage-against-time-profile defined in Figure (13)X at the connection point. The relevant system operator, in coordination with the relevant TSO, may define longer times for operation, if it is required to preserve or to restore system security. The power-generating facility owner shall not unreasonably withhold consent to apply longer times for operation, taking account of their economic and technical feasibility.

**Figure (13)X**

**High voltage-ride-through profile of a power-generating module**



The diagram represents the higher limit of a voltage-against-time profile of the voltage at the connection point, expressed as the ratio of its actual value and its reference 1 pu value, before, during and after a fault.  $U_{ref}$  is the maximum voltage specified in paragraph 2 and in Article 13(12).

4. The power-generating module shall fulfil the following requirements relating to system restoration:
  - (a) the use of autonomous connection function shall be subject to prior authorisation by the relevant system operator and to the reconnection conditions specified by the relevant TSO, in coordination with the relevant system operator;
  - (b) within the capability defined in Article 13(8), the relevant TSO, in coordination with the relevant system operator, shall specify the settings for an autonomous connection. If no settings are specified, the default settings for an autonomous connection of Article 13(9) shall apply.
  - (c) in case of change in the network leading to the minimum short-circuit level as defined in the connection agreement, the power-generating module shall be able to ensure robustness to its control system.

5. The power-generating module shall fulfil the following general system management requirements:

(a) with regard to control schemes and settings:

- (i) the schemes and settings of the different control devices of the power-generating module that are necessary for transmission system stability and for taking emergency action shall be coordinated and agreed between the relevant TSO, the relevant system operator and the power-generating facility owner;
- (ii) any changes to the schemes and settings, mentioned in point (i), of the different control devices of the power-generating module shall be coordinated and agreed between the relevant TSO, the relevant system operator and the power-generating facility owner, in particular if they apply in the circumstances referred to in point (i) of paragraph 5(a);

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

- (i) the relevant system operator shall specify the schemes and settings necessary to protect the network, taking into account the characteristics of the power-generating module. The protection schemes needed for the power-generating module and the network as well as the settings relevant to the power-generating module shall be coordinated and agreed between the relevant system operator and the power-generating facility owner. The protection schemes and settings for internal electrical faults must not jeopardise the technical capabilities of a power-generating module, in line with the requirements set out in this Regulation;
- (ii) electrical protection of the power-generating module shall take precedence over operational controls, taking into account the security of the system and the health and safety of staff and of the public, as well as mitigating any damage to the power-generating module;
- (iii) protection schemes may cover the following aspects:
  - external and internal short circuit,
  - asymmetric load (negative phase sequence),
  - stator and rotor overload,
  - over-/underexcitation,
  - over-/undervoltage at the connection point,
  - over-/undervoltage at the alternator terminals,
  - inter-area oscillations,
  - inrush current,
  - asynchronous operation (pole slip),
  - protection against inadmissible shaft torsions (for example, subsynchronous resonance),
  - power-generating module line protection,
  - transformer protection,



- back-up against protection and switchgear malfunction,
  - overfluxing (U/f),
  - reverse power,
  - rate of change of frequency, and
  - neutral voltage displacement.
- (iv) changes to the protection schemes needed for the power-generating module and the network, as well as, the relevant settings concerning the power-generating module shall be agreed between the system operator and the power-generating facility owner, and agreement shall be reached before any changes are made;
- (c) the power-generating facility owner shall organise its protection and control devices in accordance with the following priority ranking (from highest to lowest):
- (i) network and power-generating module protection;
  - (ii) synthetic inertia, if applicable;
  - (iii) frequency control (active power adjustment);
  - (iv) power restriction; and
  - (v) power gradient constraint;
- (d) with regard to information exchange:
- (i) power-generating facilities shall be capable of exchanging information with the relevant system operator or the relevant TSO in real time, if specified by the relevant system operator or the relevant TSO. The content of real-time data shall be consistent with the data exchange requirements laid down in Title 2 of Regulation (EU) 2017/1485;
  - (ii) if specified by the relevant system operator or the relevant TSO, power-generating facilities shall be capable of exchanging real time data for metering with the relevant system operator or the relevant TSO;
  - (iii) if specified by the relevant system operator power-generating facilities shall be capable to provide fault recording for the following parameters:
    - voltage,
    - active power,
    - reactive power, and
    - frequency;
  - (iv) the settings of the fault recording equipment, including triggering criteria and the sampling rates shall be agreed between the power-generating facility owner and the relevant system operator in coordination with the relevant TSO;
  - (v) the facilities for quality of supply and dynamic system behaviour monitoring shall include arrangements for the power-generating facility owner, and the relevant system operator and the relevant TSO to access the information. The

communications protocols for recorded data shall be agreed between the power-generating facility owner, the relevant system operator and the relevant TSO.

*Article 14a*

**Requirements for type EV3 electric vehicles and associated V2G electric vehicle supply equipment and type EV3 associated V2G electrical charging parks**

1. Type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall fulfil the requirements set out in Article 13a, except for Article 13a(9) and Article 13a(11).
2. A type EV3 electric vehicle and associated V2G electric vehicle supply equipment shall fulfil the following requirements relating to voltage stability:
  - (a) With regard to voltage stability, a type EV3 electric vehicle and associated V2G electric vehicle supply equipment shall be capable of remaining connected to the network and operate continuously within the range of 0,9 pu - 1,1 pu at the connection point should that be above 1000V and below 110 kV. Beyond these voltage range values, the under and over voltage ride through immunity limits, as specified in Article 14(3)(a) and (c) apply;
  - (b) With regard to voltage ranges of 110 kV and above:
    - (i) unless otherwise provided in this Regulation, a type EV3 electric vehicle and associated V2G electric vehicle supply equipment shall be capable of remaining 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 the reference 1 pu voltage, and for the time periods specified in Table (6) XX.1 and Table (7) XX.2 or, for rated voltages not included in the tables and above voltage level 110 kV as specified by the relevant system operator in coordination with the relevant TSO;
    - (ii) the relevant TSO may specify shorter periods of time during which type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall be capable of remaining connected to the network in the event of simultaneous overvoltage and underfrequency or simultaneous undervoltage and overfrequency;
    - (iii) notwithstanding the provisions of paragraph (i), the relevant TSO in Spain may require type EV3 electric vehicles and associated V2G electric vehicle supply equipment to be capable of remaining connected to the network in the voltage range between 1,05 pu and 1,0875 pu for an unlimited period;
    - (iv) 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 system operator in the same synchronous area;
    - (v) the relevant TSOs in the Baltic synchronous area may require type EV3 electric vehicles and associated V2G electric vehicle supply equipment to remain connected to the 400 kV network in the voltage range limits and for the time periods that apply in the Continental Europe synchronous area;

- (vi) the relevant system operator, in coordination with the relevant TSO, and the type EV3 associated electrical charging park owner may agree on wider voltage ranges or longer minimum time periods for operation to ensure the best use of the technical capabilities of type EV3 electric vehicles and associated V2G electric vehicle supply equipment, if it is required to preserve or to restore system security.

The type EV3 associated electrical charging park owner shall not unreasonably withhold consent to apply wider voltage ranges or longer minimum times for operation, taking account of their economic and technical feasibility;

3. Type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall fulfil the following requirements in relation to robustness:

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

- (i) each TSO shall specify a voltage-against-time-profile in line with Figure (12)3 at the connection point for fault conditions, which describes the conditions in which a type EV3 electric vehicle and associated V2G electric vehicle supply equipment, when operating above the minimum stable operating level, is capable of remaining connected to the network and continuing to operate stably after the power system has been disturbed by secured faults on the transmission system;
- (ii) the voltage-against-time-profile shall express a lower limit of the actual course of the phase-to-phase voltages on the network voltage level at the connection point during a symmetrical fault, as a function of time before, during and after the fault;
- (iii) the lower limit referred to in point (ii) shall be specified by the relevant TSO, in co-ordination with the relevant system operator, using the parameters set out in Figure (12)3, and within the ranges set out in Table (8)3.1.1, Table (9)3.1.2, Table (10)3.2.1 and Table (11)3.2.2;
- (iv) each TSO, in co-ordination with the relevant system operator, shall specify and make publicly available the pre-fault and post-fault conditions for the fault-ride-through capability in terms of:
  - the calculation of the pre-fault minimum short circuit capacity at the connection point,
  - pre-fault active and reactive power operating point of the type EV3 electric vehicles and associated V2G electric vehicle supply equipment at the connection point and voltage at the connection point, and
  - calculation of the post-fault minimum short circuit capacity at the connection point;
- (v) at the request of a type EV3 associated electrical charging park owner, the relevant system operator shall provide the pre-fault and post-fault conditions to be considered for fault-ride-through capability as an outcome of the calculations at the connection point as specified in point (iv) regarding:
  - pre-fault minimum short circuit capacity at each connection point expressed in MVA,

- pre-fault operating point of the type EV3 electric vehicles and associated V2G electric vehicle supply equipment expressed as active power output and reactive power output at the connection point and voltage at the connection point, and
- post-fault minimum short circuit capacity at each connection point expressed in MVA.

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

*Table (12)3.2.1*

**Voltage parameters for Figure (12)3 for fault-ride-through capability of type EV3 electric vehicles and associated V2G electric vehicle supply equipment**

Voltage parameters (pu)	
$U_{ret}$ :	0,05-0,15
$U_{clear}$ :	$U_{ret}-0,15$
$U_{rec1}$ :	$U_{clear}$
$U_{rec2}$ :	Minimum voltage specified in paragraph (2)

*Table (13)3.2.2*

**Time parameters for Figure (12)3 for fault-ride-through capability of type EV3 electric vehicles and associated V2G electric vehicle supply equipment**

Time parameters (seconds)	
$t_{clear}$ :	0,14-0,15 (or 0,14-0,25 if justified by the system protection and secure operation needs)
$t_{rec1}$ :	$t_{clear}$
$t_{rec2}$ :	$t_{rec1}$
$t_{rec3}$ :	1,5-3,0

- (vi) the type EV3 electric vehicle and associated V2G electric vehicle supply equipment shall be capable of remaining connected to the network and continuing to operate stably when the actual course of the phase-to-phase voltages on the network voltage level at the connection point during a symmetrical fault, given the pre-fault and post-fault conditions in points (iv) and (v) of paragraph 3(a), remain above

the lower limit specified in point (ii) of paragraph 3(a), unless the protection scheme for internal electrical faults requires the disconnection of the type EV3 electric vehicle and associated V2G electric vehicle supply equipment from the network. The protection schemes and settings for internal electrical faults must not jeopardise fault-ride-through capabilities of a type EV3 electric vehicle and associated V2G electric vehicle supply equipment, in line with the requirements set out in this Regulation;

- (vii) without prejudice to point (vi) of paragraph 3(a), undervoltage protection (either fault-ride-through capability or minimum voltage specified at the connection point voltage) shall be set by the type EV3 associated electrical charging park owner according to the widest possible technical capability of the type EV3 electric vehicles and associated V2G electric vehicle supply equipment, unless the relevant system operator requires narrower settings in accordance with point (b) of paragraph 5. The settings shall be justified by the type EV3 associated electrical charging park owner in accordance with this principle;
  - (b) fault-ride-through capabilities in case of asymmetrical faults shall be specified by each TSO.
  - (c) the type EV3 electric vehicle and associated V2G electric vehicle supply equipment shall be capable of operating stably without disconnecting from the network, if none of the phase-to-phase voltages exceeds the voltage-against-time-profile defined in Figure (13)X at the connection point. The relevant system operator, in coordination with the relevant TSO, shall define higher longer times for operation, if it is required to preserve or to restore system security.
4. Type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall fulfil the following requirements relating to system restoration:
- (a) the relevant TSO shall specify the conditions under which a type EV3 electric vehicle and associated V2G electric vehicle supply equipment is capable of reconnecting to the network after an incidental disconnection caused by a network disturbance; and
  - (b) installation of automatic reconnection systems shall be subject both to prior authorisation by the relevant system operator and to the reconnection conditions specified by the relevant TSO.
5. Type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall fulfil the following general system management requirements:
- (a) with regard to control schemes and settings:
    - (i) the schemes and settings of the different control devices of the type EV3 electric vehicles and associated V2G electric vehicle supply equipment that are necessary for transmission system stability and for taking emergency action shall be coordinated and agreed between the relevant TSO, the relevant system operator and the type EV3 associated electrical charging park owner;
    - (ii) any changes to the schemes and settings, mentioned in point (i), of the different control devices of the type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall be coordinated and agreed between the relevant TSO, the relevant system operator and the type EV3 associated electrical charging

park owner, in particular if they apply in the circumstances referred to in point (i) of paragraph 5(a);

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

- (i) the relevant system operator shall specify the schemes and settings necessary to protect the network, taking into account the characteristics of the type EV3 electric vehicles and associated V2G electric vehicle supply equipment. The protection schemes needed for the type EV3 electric vehicles and associated V2G electric vehicle supply equipment and the network as well as the settings relevant to the type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall be coordinated and agreed between the relevant system operator and the type EV3 associated electrical charging park owner. The protection schemes and settings for internal electrical faults must not jeopardise the technical capabilities of a type EV3 electric vehicles and associated V2G electric vehicle supply equipment, in line with the requirements set out in this Regulation;
  - (ii) electrical protection of the type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall take precedence over operational controls, taking into account the security of the system and the health and safety of staff and of the public, as well as mitigating any damage to the EV3 electric vehicles and associated V2G electric vehicle supply equipment;
  - (iii) protection schemes may cover the following aspects:
    - external and internal short circuit,
    - asymmetric load (negative phase sequence),
    - over-/undervoltage at the connection point,
    - inter-area oscillations,
    - line protection,
    - vector shift,
    - transformer protection,
    - back-up against protection and switchgear malfunction,
    - rate of change of frequency, and
    - neutral voltage displacement.
  - (iv) changes to the protection schemes needed for the type EV3 electric vehicles and associated V2G electric vehicle supply equipment and the network and to the settings relevant to the type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall be agreed between the system operator and the type EV3 associated electrical charging park owner, and agreement shall be reached before any changes are made;
- (c) the type EV3 associated electrical charging park owner shall organise its protection and control devices in accordance with the following priority ranking (from highest to lowest):

- (i) network and EV3 electric vehicles and associated V2G electric vehicle supply equipment protection;
  - (ii) synthetic inertia, if applicable;
  - (iii) frequency control (active power adjustment);
  - (iv) power restriction; and
  - (v) power gradient constraint;
- (d) with regard to information exchange:
- (i) type EV3 associated V2G electrical charging parks shall be capable of exchanging information with the relevant system operator or the relevant TSO in real time, as specified by the relevant system operator or the relevant TSO. The content of real-time data shall be consistent with the data exchange requirements laid down in Title 2 of Regulation (EU) 2017/1485;
  - (ii) type EV3 associated V2G electrical charging parks shall be capable of exchanging real time data for metering with the relevant system operator or the relevant TSO;
  - (iv) if required by the relevant system operator the type EV3 associated V2G electrical charging park shall be able capable to provide fault recording for the following parameters:
    - voltage,
    - active power,
    - reactive power, and
    - frequency;
  - (v) the settings of the fault recording equipment, including triggering criteria and the sampling rates shall be agreed between the type EV3 associated electrical charging park owner and the relevant system operator in coordination with the relevant TSO;
  - (vi) the facilities for quality of supply and dynamic system behaviour monitoring shall include arrangements for the type EV3 associated electrical charging park owner, and the relevant system operator and the relevant TSO to access the information. The communications protocols for recorded data shall be agreed between the type EV3 associated electrical charging park owner, the relevant system operator and the relevant TSO.
6. Type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall fulfil the following additional requirements in relation to voltage stability:
- (a) with regard to reactive power capability, the relevant system operator shall have the right to specify the capability of a type EV3 electric vehicles and associated V2G electric vehicle supply equipment to supply and absorb reactive power;
  - (b) where grid forming capability is not required by this Regulation, the relevant system operator in coordination with the relevant TSO shall have the right to specify that a type EV3 electric vehicles and associated V2G electric vehicle supply equipment be



capable of providing fast fault current at the connection point in case of symmetrical (3-phase) faults, regarding the following:

- (i) the type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall be capable of activating the supply of fast fault current either by:
  - ensuring the supply of the fast fault current at the connection point, or
  - measuring voltage deviations at the terminals of the individual type EV3 electric vehicle and associated V2G electric vehicle supply equipment and providing a fast fault current at their terminals;
- (ii) the relevant system operator in coordination with the relevant TSO shall specify:
  - how and when a voltage deviation is to be determined as well as the end of the voltage deviation,
  - the characteristics of the fast fault current, including the time domain for measuring the voltage deviation and fast fault current, for which current and voltage may be measured differently from the method specified in Article 2,
  - the timing and accuracy of the fast fault current, which may include several stages during a fault and after its clearance;
- (c) where grid forming capability is not required by this Regulation, with regard to the supply of fast fault current in case of asymmetrical (1-phase or 2-phase) faults, the relevant system operator in coordination with the relevant TSO shall have the right to specify a requirement for asymmetrical current injection.

7. Type EV3 electric vehicles and associated V2G electric vehicle supply equipment shall fulfil the following additional requirements in relation to robustness:

- (a) the relevant TSO shall specify the post-fault active power recovery that the type EV3 electric vehicle and associated V2G electric vehicle supply equipment is capable of providing and shall specify:
  - (i) when the post-fault active power recovery begins, based on a voltage criterion;
  - (ii) a maximum allowed time for active power recovery; and
  - (iii) a magnitude and accuracy for active power recovery;
- (b) the specifications shall be in accordance with the following principles:
  - (i) interdependency between fast fault current requirements according to points (b) and (c) of paragraph 6 and active power recovery;
  - (ii) dependence between active power recovery times and duration of voltage deviations;
  - (iii) a specified limit of the maximum allowed time for active power recovery;
  - (iv) adequacy between the level of voltage recovery and the minimum magnitude for active power recovery; and
  - (v) adequate damping of active power oscillations.

8. The relevant TSO shall have the right to request grid forming capability at its connection point from type EV3 electric vehicles and associated V2G electric vehicle supply equipment as listed in Article Y.

## *Article 15*

### **General requirements for type C power-generating modules**

1. Type C power-generating modules shall fulfil the requirements laid down in Article 13 and Article 14, except for Article 13(3)(b), (6) and (11) and Article 14(5)(d)(iii).

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

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

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

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

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

(c) In addition to Article 13(3), the following requirements shall apply to type C power-generating modules with regard to limited frequency sensitive mode — underfrequency (LFSM-U):

(i) the power-generating module shall be capable of activating the provision of active power frequency response at a frequency threshold and with a droop specified by the relevant TSO in coordination with the TSOs of the same synchronous area as follows:

- the frequency threshold shall be  $50\text{Hz} - \Delta f_1$ , where  $\Delta f_1$  is defined in Table (15) X,
- the droop settings shall be in the range 2-12 %.

This is represented graphically in Figure (14)4;

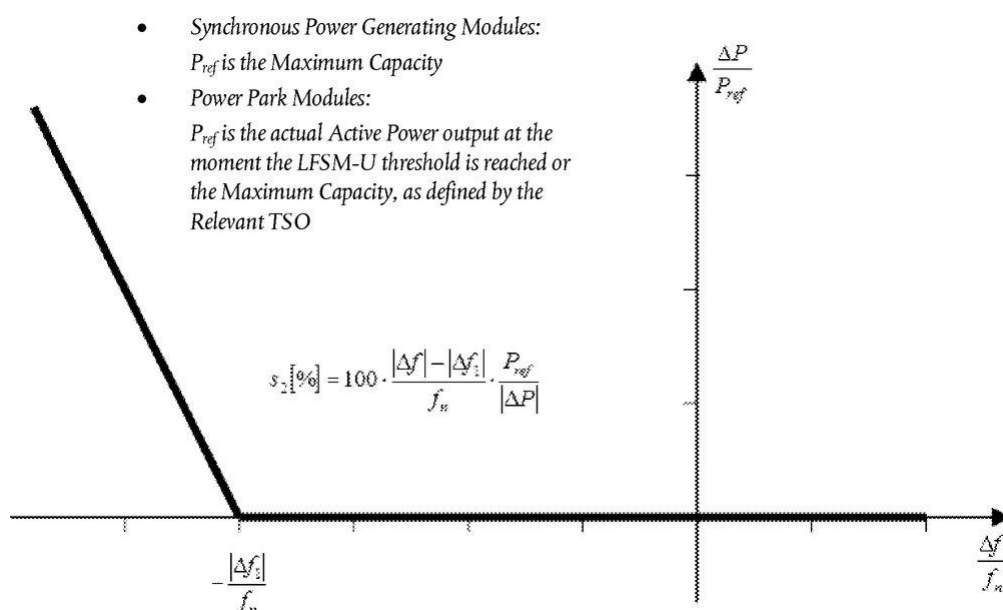
(ii) the actual delivery of active power frequency response in LFSM-U mode shall be capable of taking into account, if applicable:

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

- the availability of the primary energy sources.
  - an external signal allowing the relevant system operator to block the LFSM-U mode in real-time.
- (iii) the start of active power increase (initial delay time  $T_{id}$  (Figure (11)XX3)) by the power-generating module shall not be intentionally delayed. Any unintentional delay shall be as short as possible;
  - (iv) in LFSM-U mode the power-generating module shall be capable of providing a power increase up to its maximum capacity;
  - (v) stable operation of the power-generating module during LFSM-U operation shall be ensured; when LFSM-U is active, the LFSM-U setpoint will prevail over any other active power setpoints;

**Figure (14)4**

### Active power frequency response capability of power-generating modules in LFSM-U



$P_{ref}$  is the reference active power to which  $\Delta P$  is related and may be specified differently for synchronous power-generating modules and power park modules.  $\Delta P$  is the change in active power output from the power-generating module.  $f_n$  is the nominal frequency (50 Hz) in the network and  $\Delta f$  is the frequency deviation in the network. At underfrequencies where  $\Delta f$  is below  $\Delta f_1$  the power-generating module has to provide a positive active power output change according to the droop  $S_2$ . In the case of electricity storage modules,  $P_{ref}$  could be the actual active power at the moment the LFSM-U threshold is reached or the maximum capacity or maximum consumption capacity as agreed with the relevant system operator.

(vi) The response time  $T_{\text{resp}}$  (Figure (11)XX3) for LFSM-U shall be as fast as technically feasible and as described below:

— For SPGM: less or equal to 5 min for an active power setpoint change of 20% maximum power,

— For PPM: less or equal to 10 s for an active power setpoint change of 50% maximum power.

If the response time is greater than stated above, the power-generating facility owner shall justify the higher response times, providing technical evidence to the relevant TSO.

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

(i) the power-generating module shall be capable of providing active power frequency response in accordance with the parameters specified by each relevant TSO within the ranges shown in Table (14)4 and Table (15) X. In specifying those parameters, the relevant TSO shall take account of the following facts:

— in case of overfrequency, the active power frequency response is limited by the minimum regulating level. In the case of electricity storage modules, the active power frequency response is limited by the minimum regulating level or maximum consumption capacity, or the maximum energy content (as declared by the manufacturer) that the electricity storage module can store in its operative condition or as agreed between the power generating facility and the relevant TSO irrespective to whether the electricity storage module is independently connected to the transmission or distribution network or within a power generating facility sharing a single network connection with other power-generating modules of lower energy content or of lower export power capacity,

— in case of underfrequency, the active power frequency response is limited by maximum capacity, and, in the case of electricity storage modules, also by the maximum capacity or maximum energy content of the electricity storage module in its operative condition (as declared by manufacturer) or as agreed between the power generating facility and the relevant TSO irrespective to whether the electricity storage module is independently connected to the transmission or distribution network or within a power generating facility sharing a single network connection with other power-generating modules or demand of lower energy content or maximum consumption capacity,

— the actual delivery of active power frequency response depends on the operating and ambient conditions, as well as, on the underlying energy storage technology of the power-generating module when this response is triggered, in particular, but not limited to, limitations on operation near maximum capacity at low frequencies according to paragraphs 4 and 5 of Article 13 and available primary energy sources;

— the TSO shall take into account the time needed for some technologies of electricity storage modules to switch from consumption mode to generating

mode or vice versa and also the fact that the droop of active power frequency response characteristic in consumption and generating mode could be different;

*Table (14)4*

**Parameters for active power frequency response in FSM (explanation for Figure (15)5)**

Parameters	Ranges	
Active power range related to maximum capacity  $\frac{ \Delta P_1 }{P_{max}}$	1,5-10 %, except for electricity storage module. 1,5-100% for electricity storage module.	
Maximum combined effect of inherent frequency response insensitivity and possible intentional frequency response dead band for power-generating modules providing FSM	$ \Delta f_i $	10-15 mHz
	$\frac{ \Delta f_i }{f_n}$	0,02-0,03 %
Frequency response deadband	0-500 mHz	
Droop $s_1$	2-27 %	

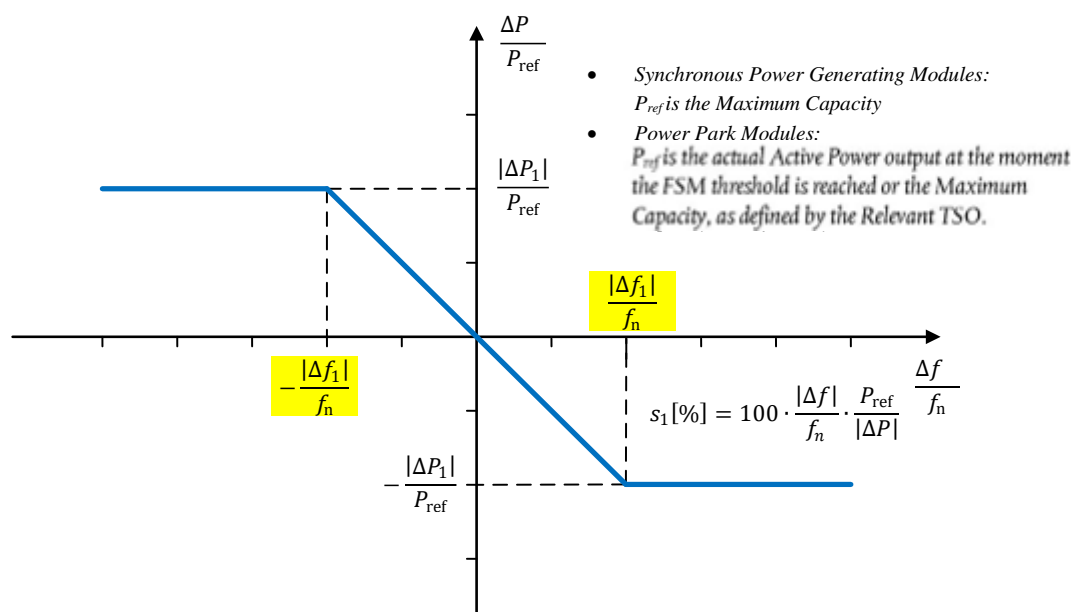
*Table (15) X*

**Definition of  $\Delta f_1$  used for FSM, LFSM-O and LFSM-U (explanation for Figure (3)1, Figure (14)4 and Figure (15)5)**

Synchronous area	$\Delta f_1$ thresholds
Continental Europe	0,2 Hz
Nordic	0,5 Hz
Ireland and Northern Ireland	0,2 Hz (for LFSM-O and FSM), 0,5 Hz (LFSM-U)
Baltic	0,2 Hz

*Figure (15)5*

## Active power frequency response capability of power-generating modules in FSM illustrating the case of zero deadband and insensitivity



$P_{ref}$  is the reference active power to which  $\Delta P$  is related.  $\Delta P$  is the change in active power output from the power-generating module.  $f_n$  is the nominal frequency (50 Hz) in the network and  $\Delta f$  is the frequency deviation in the network. In case of electricity storage module,  $P_{ref}$  could be the actual active power generated or the actual active power consumed at the moment the FSM threshold is reached or the maximum capacity or maximum consumption capacity as agreed with the relevant system operator.

- (ii) the frequency response deadband of frequency deviation and droop must be able to be reselected repeatedly;
- (iii) in the event of a frequency step change, the power-generating module shall be capable of activating full active power frequency response, at or above the full line shown in Figure (16)6 in accordance with the parameters specified by each TSO (which shall aim at avoiding active power oscillations for the power-generating module) within the ranges given in Table (16) 5. The combination of choice of the parameters specified by the TSO shall take possible technology-dependent limitations into account;
- (iv) the initial activation of active power frequency response required shall be as short as possible.

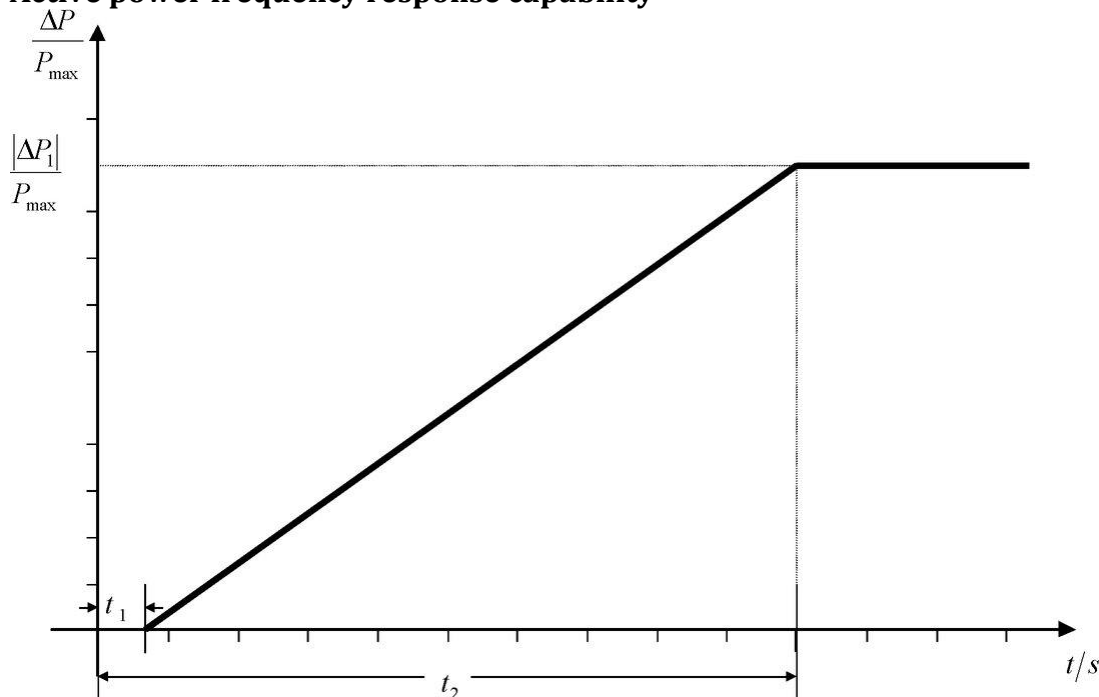
If the delay in initial activation of active power frequency response is greater than two seconds, the power-generating facility owner shall provide technical evidence demonstrating why a longer time is needed.

For power-generating modules without inertia, the relevant TSO may specify a shorter time than two seconds. If the power-generating facility owner cannot meet

this requirement they shall provide technical evidence demonstrating why a longer time is needed for the initial activation of active power frequency response;

**Figure (16)6**

**Active power frequency response capability**



$P_{max}$  is the maximum capacity to which  $\Delta P$  relates.  $\Delta P$  is the change in active power output from the power-generating module. The power-generating module has to provide active power output  $\Delta P$  up to the point  $\Delta P_1$  in accordance with the times  $t_1$  and  $t_2$  with the values of  $\Delta P_1$ ,  $t_1$  and  $t_2$  being specified by the relevant TSO according to Table (16) 5.  $t_1$  is the initial delay.  $t_2$  is the time for full activation.

- (v) the power-generating module shall be capable of providing full active power frequency response for a period of between 15 and 30 minutes as specified by the relevant TSO in coordination with the TSOs of the same synchronous area. Unless, where agreed between the relevant TSO and the power-generating facility owner, contribution is limited only by the maximum energy content of the electricity storage module or primary energy source of the power-generating module;
- (vi) within the time limits laid down in point (v) of this paragraph 2(d), active power control must not have any adverse impact on the active power frequency response of power-generating modules;
- (vii) the parameters specified by the relevant TSO in accordance with points (i), (ii), (iii), (iv) and (v) of this paragraph 2(d) shall be notified to the relevant regulatory authority. The modalities of that notification shall be specified in accordance with the applicable national regulatory framework;
- (viii) stable operation of the power-generating module during FSM operation shall be ensured.



*Table (16) 5*

**Parameters for full activation of active power frequency response resulting from frequency step change (explanation for Figure (16)6)**

Parameters	Ranges or values
Active power range related to maximum capacity (frequency response range)  $\frac{ \Delta P_1 }{P_{\max}}$	1,5-10 %
For power-generating modules with inertia, the maximum admissible initial delay $t_1$ unless justified otherwise in line with Article 15(2) (d)(iv)	2 seconds
For power-generating modules without inertia, the maximum admissible initial delay $t_1$ unless justified otherwise in line with Article 15(2) (d)(iv)	as specified by the relevant TSO.
Maximum admissible choice of full activation time $t_2$ , unless longer activation times are allowed by the relevant TSO for reasons of system stability	30 seconds for SA Continental Europe and SA Nordic. 5 sec for SA Ireland and Northern Ireland

- (e) with regard to frequency restoration control, the power-generating module shall provide functionalities complying with specifications as specified by the relevant TSO, aiming at restoring frequency to its nominal value or maintaining power exchange flows between control areas at their scheduled values;
- (f) with regard to disconnection due to underfrequency, power-generating facilities capable of acting as a load, including pump-storage power-generating modules and electricity storage modules, shall be capable of disconnecting their load in case of underfrequency. The requirement referred to in this point does not extend to auxiliary supply;
- (g) with regard to real-time monitoring of FSM:
- (i) to monitor the operation of active power frequency response, the communication interface shall be equipped to transfer in real time and in a secured manner from the power-generating facility to the network control centre of the relevant system

operator or the relevant TSO, at the request of the relevant system operator or the relevant TSO, at least the following signals:

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

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

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

- (a) in the event of power oscillations, power-generating modules shall retain steady-state stability when operating at any operating point of the P-Q-capability diagram;
- (b) without prejudice to paragraph 4 and 5 of Article 13, power-generating modules shall be capable of remaining connected to the network and operating without power reduction, as long as voltage and frequency remain within the specified limits pursuant to this Regulation;
- (c) power-generating modules shall be capable of remaining connected to the network during single-phase or three-phase auto-reclosures on meshed network lines, if applicable to the network to which they are connected. The details of that capability shall be subject to coordination and agreements on protection schemes and settings as referred to in point (b) of Article 14(5).

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

- (a) with regard to black start capability:
  - (i) black start capability is not mandatory without prejudice to the Member State's rights to introduce obligatory rules in order to ensure system security;
  - (ii) power-generating facility owners shall, at the request of the relevant TSO, provide a quotation for providing black start capability. The relevant TSO may make such a request if it considers system security to be at risk due to a lack of black start capability in its control area;
  - (iii) a power-generating module with black start capability shall be capable of starting from shutdown without any external electrical energy supply within a time frame specified by the relevant system operator in coordination with the relevant TSO;
  - (iv) a power-generating module with black start capability shall be able to synchronise within the frequency limits laid down in point (a) of Article 13(2) and within the voltage limits laid down in Article 13(12) and Article 14(2);

- (v) a power-generating module with black start capability shall be capable of automatically regulating the voltage at the connection point to limit the magnitude of voltage changes caused by connection of demand;
  - (vi) a power-generating module with black start capability shall at least:
    - be capable of regulating load connections in block load,
    - be capable of operating in LFSM-O and LFSM-U during the system restoration phase, as specified in point (c) of paragraph 2 and Article 13(3),
    - control frequency in case of overfrequency and underfrequency within the whole active power output range between minimum regulating level and maximum capacity as well as at houseload level,
    - be capable of parallel operation of a few power-generating modules within one island, and
    - control voltage automatically during the system restoration phase;
- (b) with regard to the capability to take part in island operation:
- (i) power-generating modules shall be capable of taking part in island operation if required by the relevant system operator in coordination with the relevant TSO and:
    - the frequency limits for island operation shall be those established in accordance with point (a) of Article 13(2),
    - the voltage limits for island operation shall be those established in accordance with Article 14(2);
  - (ii) power-generating modules shall be able to operate stably in FSM during island operation, as specified in point (d) of paragraph 2.
 

In the event of a power surplus, power-generating modules shall be capable of reducing the active power output from a previous operating point to any new operating point within the P-Q-capability diagram. In that regard, the power-generating module shall be capable of reducing active power output as much as inherently technically feasible, but to at least 55 % of its maximum capacity;
  - (iii) the voltage control system of a SPGM, as specified in Article 17(2)(b) and Article 19(2), or voltage control mode of a PPM, as specified in Article 21(2)(d) points (ii), (iii) and (iv), shall be able to stably operate during island operation;'
  - (iv) power-generating modules shall be able to operate stably in LFSM-O and LFSM-U during island operation, as specified in point (c) of paragraph 2 and Article 13(3);
  - (v) the power-generating module control schemes, including FSM, LFSM-O, LFSM-U and voltage control system (synchronous power-generating modules) or voltage control mode (power park modules) shall be able to continuously and stably operate during the transition from interconnected system operation to island operation without relying on information provided by the relevant system operator. Information on how robustness is achieved during the transition from interconnected system operation to island operation shall be shared with the relevant system operator or TSO. The relevant system operator and the power generating facility owner may separately agree on how islanding is detected.

- (vi) power-generation module shall be capable to regulate active power between houseload operation level and minimum stable operating level for a minimum operation time. The minimum operation time shall be specified by the relevant system operator in coordination with the relevant TSO, taking into consideration the specific characteristics of prime mover technology.

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

- (i) in case of disconnection of the power-generating module from the network, the power-generating module shall be capable of quick re-synchronisation in line with the protection strategy agreed between the relevant system operator in coordination with the relevant TSO and the power-generating facility;
- (ii) a power-generating module with a minimum re-synchronisation time greater than 15 minutes after its disconnection from any external power supply must be designed to trip to houseload from any operating point in its P-Q-capability diagram. In this case, the identification of houseload operation must not be based solely on the position signals of the system operator's switchgear';
- (iii) power-generating modules shall be capable of continuing operation following tripping to houseload, irrespective of any auxiliary connection to the external network. The minimum operation time shall be specified by the relevant system operator in coordination with the relevant TSO, taking into consideration the specific characteristics of prime mover technology.
- (iv) Power-generating module capable of tripping to houseload shall, at the request of the relevant TSO, be able to provide:
  - houseload operation during a prolonged period of time, as agreed between the relevant TSO and the power-generating facility owner, that is longer than the minimum operation time as required in point (iii) of this paragraph 4(c), and
  - the capabilities defined in paragraph 4(a)(iv), (v) and (vi).

5. The power-generating module shall fulfil the following general system management requirements:

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

(b) with regard to instrumentation:

- (i) power-generating facilities shall be equipped with a facility to provide fault recording and monitoring of dynamic system behaviour. This facility shall record the following parameters:
  - voltage,
  - active power,
  - reactive power, and

— frequency.

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

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

(c) with regard to the simulation models:

- (i) at the request of the relevant system operator or the relevant TSO, the power-generating facility owner shall provide simulation models which properly reflect the behaviour of the power-generating module for the relevant study purpose in both steady-state and dynamic simulations (root mean square) or in electromagnetic transient simulations. The simulation model requirements and data provided shall not violate manufactures intellectual property.

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

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

— alternator and prime mover,

— speed and power control,

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

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

- (iii) For the purpose of electromechanical dynamic simulations (RMS simulation studies) the relevant system operator or the relevant TSO shall have the right to specify the power park modules simulation model requirements. Without prejudice to the Member State's rights to introduce additional requirements, the simulation models of the power park modules provided by the power generation facility owner shall:

— be valid for the specified operating range and all control modes of the power-generating facility;

— include a proper representation of the converter modules and its control systems (including the synchronization module) that influence the dynamic behaviour of the power-generating module in the specified time frame;

— be open source generic model for cross border network stability studies;

- in the case that encrypted detailed RMS models are accepted by the relevant TSO, the relevant TSO shall specify the requirements of the model encryption according to national regulations (for example use of source code, the model structure and the signal interfaces to be observable in the network studies);
  - include the relevant protection function models;
- (iv) For the purpose of time domain electromagnetic transient (EMT) simulations the relevant system operator or the relevant TSO shall have the right to specify the model requirements of the power park module. Without prejudice to the Member State's rights to introduce additional requirements, the models shall contain the following:
- be valid in the frequency range 0.2 Hz – 2500 Hz for relevant interaction studies. The validity of the PPM model shall be ensured for the given frequency range at the connection point;
  - be valid for specified operating range and control modes of the PPM in the positive, negative and in the zero phase sequence;
  - reproduce the detailed response of the power-generating module and its control blocks during balanced and unbalanced AC network faults in the valid frequency range;
  - include the power plant level control and the power plant relevant functionalities if applicable;
  - include the frequency dependence of the lines and/or cables in the power-generating facility;
  - represent the PPM transformers model including saturation, resistors, filter, breaker and AC arrester in the valid frequency;
  - include all the relevant protection function models for the relevant interaction studies;
  - be capable to be used for the numerical calculation of the frequency dependent impedance of PPM at the connection point (impedance amplitude and impedance phase angle ) in the frequency range that the model is valid);
- In the case that encrypted detailed EMT models are accepted by the relevant system operator or the relevant TSO, the relevant system operator or the relevant TSO shall have the right to specify the model encryption based on national regulations (for example the model structure and the signal interfaces to be observable in the network studies);
- (v) For the purpose of frequency domain simulations for the risk assessment of the resonance stability of the power park module, the relevant system operator or the relevant TSO shall have the right to request from the power-generating facility owner the frequency dependent impedance model of the power-generating facility at the connection point. Without prejudice to the Member State's rights to introduce additional requirements, the following requirements shall apply:
- The frequency dependent impedance model of the power-generating facility shall be requested at least in the range 5.0 Hz – 2500 Hz As an additional

requirement, the relevant system operator or the relevant TSO may extend the required applicability of the model to up to 9000 Hz.

— The relevant system operator or the relevant TSO shall have the right to request the calculation of the impedance model of the power-generating facility either numerically (using the EMT model) or analytically (using transfer function);

— The relevant system operator or the relevant TSO shall have the right to request the impedance profile of the power-generating facility at the connection point through the whole operating range and control modes of operation;

— The impedance model of the power-generating facility shall be provided for the positive, negative and for the zero phase sequence;

— The power-generating facility owner shall take into account the influence of the power-generating module control and measurement system as other parts of the power-generating module which influences the output impedance in the specified frequency range;

— The power-generating facility owner shall specify and justify simplifications made in the calculation of the impedance model.

(vi) the request by the relevant system operator referred to in points (i),(ii), (iv) and (v) shall be coordinated with the relevant TSO. It shall include:

— the format in which models are to be provided,

— the provision of documentation on a model's structure and block diagrams,

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

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

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

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

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

## *Article 16*

### **General requirements for type D power-generating modules**



1. Type D power-generating modules shall fulfil the requirements laid down in Article 13, Article 14 and Article 15, except for Article 13(3)(b), (6) and (7), Article 14(5)(d)(iii) and Article 15(3).

2. With regard to voltage stability and without prejudice to Article 14(2), the relevant system operator in coordination with the relevant TSO shall have the right to specify voltages at the connection point at which type D power-generating module is capable of automatic disconnection. The terms and settings for automatic disconnection shall be agreed between the relevant system operator and the power-generating facility owner.

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

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

- (i) power-generating modules, when operating above their minimum stable operating level, shall be capable of remaining connected to the network and continuing to operate stably after the power system has been disturbed by secured faults. That capability shall be in accordance with a voltage-against-time profile at the connection point for fault conditions specified by the relevant TSO.

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

That lower limit shall be specified by the relevant TSO, using the parameters set out in Figure (12)3 and within the ranges set out in Table (17) 7.1.1, Table (18) 7.1.2, Table (19) 7.2.1, and Table (20) 7.2.2 for type D power-generating modules connected at or above the 110 kV level.

That lower limit shall also be specified by the relevant TSO, using parameters set out in Figure (12)3 and within the ranges set out in Table (8)3.1.1, Table (9)3.1.2, Table (10)3.2.1 and Table (11)3.2.2 for type D power-generating modules connected below the 110 kV level;

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

*Table (17) 7.1.1*

**Voltage parameters for Figure (12)3 for fault-ride-through capability of synchronous power-generating modules**

Voltage parameters (pu)	
$U_{ret}$ :	0

$U_{\text{clear}}$ :	0,25
$U_{\text{rec1}}$ :	0,5-0,7
$U_{\text{rec2}}$ :	Minimum voltage specified Article 14(2)

*Table (18) 7.1.2*

**Time parameters for Figure (12)3 for fault-ride-through capability of  
synchronous power-generating modules**

Time parameters (seconds)	
$t_{\text{clear}}$ :	0,14-0,15 (or 0,14-0,25 if justified by the system protection and secure operation needs)
$t_{\text{rec1}}$ :	$t_{\text{clear}}$ -0,45
$t_{\text{rec2}}$ :	$t_{\text{rec1}}$ -0,7
$t_{\text{rec3}}$ :	$t_{\text{rec2}}$ -1,5

*Table (19) 7.2.1*

**Voltage parameters for Figure (12)3 for fault-ride-through capability of power  
park modules**

Voltage parameters (pu)	
$U_{\text{ret}}$ :	0
$U_{\text{clear}}$ :	$U_{\text{ret}}$
$U_{\text{rec1}}$ :	$U_{\text{clear}}$
$U_{\text{rec2}}$ :	Minimum voltage specified in Article 14(2)

*Table (20) 7.2.2*

**Time parameters for Figure (12)3 for fault-ride-through capability of power park modules**

Time parameters (seconds)	
$t_{clear}$ :	0,14-0,15 (or 0,14-0,25 if justified by the system protection and secure operation needs)
$t_{rec1}$ :	$t_{clear}$
$t_{rec2}$ :	$t_{rec1}$
$t_{rec3}$ :	1,5-3,0

(b) at the request of a power-generating facility owner, the relevant system operator shall provide the pre-fault and post-fault conditions to be considered for fault-ride-through capability as an outcome of the calculations at the connection point as specified in point (iv) of Article 14(3)(a) regarding:

- (i) pre-fault minimum short circuit capacity at each connection point expressed in MVA;
- (ii) pre-fault operating point of the power-generating module expressed as active power output and reactive power output at the connection point and voltage at the connection point; and
- (iii) post-fault minimum short circuit capacity at each connection point expressed in MVA;

(c) fault-ride-through capabilities in case of asymmetrical faults shall be specified by each TSO.

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

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

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

synchronisation of power-generating modules shall be possible at frequencies within the ranges set out in Table 2

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

- (i) voltage;

- (ii) frequency;
- (iii) phase angle range;
- (iv) phase sequence;
- (v) deviation of voltage and frequency.

## **CHAPTER 2**

### ***Requirements for synchronous power-generating modules***

#### *Article X*

#### **Requirements for type A synchronous power-generating modules**

1. The relevant TSO shall specify if fault-ride-through capabilities shall be required for Type A synchronous power-generating modules. Where fault-ride-through capability of a Type A synchronous power-generating module is required by the relevant TSO:
  - (a) The synchronous power-generating module shall be capable of remaining connected to the network and continuing to operate stably after the power system has been disturbed by faults on the transmission system according to a voltage-against-time-profile in line with Figure (12)3 at the connection point and with the set points in Table (21) x.1.1 and Table (22) X.1.2;
  - (b) the voltage-against-time-profile expresses a lower limit of the actual profile of the phase-to-phase voltages (or single phase to neutral voltages for single phase type A synchronous power-generating modules) on the network voltage level at the connection point during a symmetrical fault, as a function of time before, during and after the fault;
  - (c) each TSO in coordination with the relevant system operator shall specify and make publicly available the pre-fault and post-fault conditions for the fault-ride-through capability in terms of:
    - the calculation of the pre-fault minimum short circuit capacity at the connection point,
    - pre-fault active and reactive power operating point of the power-generating module at the connection point and voltage at the connection point, and
    - calculation of the post-fault minimum short circuit capacity at the connection point;

*Table (21) x.1.1*

#### **Voltage parameters for Figure (12)3 for fault-ride-through capability of synchronous power-generating modules**

<b>Voltage parameters (pu)</b>	
U <sub>ret</sub> :	0,3
U <sub>clear</sub> :	0,7

U <sub>rec1</sub> :	U <sub>clear</sub>
U <sub>rec2</sub> :	0,85

*Table (22) X.1.2*

**Time parameters for Figure (12)3 for fault-ride-through capability of synchronous power-generating modules**

<b>Time parameters (seconds)</b>	
t <sub>clear</sub> :	0,15
t <sub>rec1</sub> :	t <sub>clear</sub>
t <sub>rec2</sub> :	0,7
t <sub>rec3</sub> :	1,5

(d) the synchronous power-generating module shall be capable of remaining connected to the network and continuing to operate stably when the actual course of the phase-to-phase voltages (or single phase to neutral voltages for single phase type A synchronous power-generating modules) on the network voltage level at the connection point during a symmetrical fault, given the pre-fault and post-fault conditions in paragraph 1(c), remain above the lower limit specified paragraph 1(b), unless the protection scheme for internal electrical faults requires the disconnection of the power-generating module from the network. The protection schemes and settings for internal electrical faults must not jeopardise fault-ride-through performance;

*Article 17*

**Requirements for type B synchronous power-generating modules**

1. Type B synchronous power-generating modules shall fulfil the requirements listed in Article 13, except for Article 13(3)(b), Article 13(8), Article 13(10) and Article 14.
2. Type B synchronous power-generating modules shall fulfil the following additional requirements relating to voltage stability:
  - (a) with regard to reactive power capability, the relevant system operator shall have the right to specify the capability of a synchronous power-generating module to supply and absorb reactive power, taking into account the technical characteristics of the synchronous power-generating module;
  - (b) with regard to voltage control, type B synchronous power-generating modules shall be equipped with a voltage control system that can provide constant alternator terminal voltage at a selectable setpoint without instability over the entire operating

range of the synchronous power-generating module. The voltage control system shall include at least:

- (i) an underexcitation limiter to prevent the automatic voltage regulator ('AVR') from reducing the alternator excitation to a level which would endanger angular stability;
  - (ii) an overexcitation limiter, to ensure that the alternator excitation is not limited to less than the maximum value that can be achieved, whilst ensuring that the synchronous power-generating module is operating within its design limits.
- (c) The power-generating module shall be capable of providing reactive power automatically by reactive power control mode, power factor control mode or active power-related power factor control mode, as specified by the relevant system operator;
- (d) The power-generating module shall be able to receive and react to an external signal allowing the relevant system operator to transmit reactive power or voltage control mode set points. The power-generating module controls shall implement any revised set points without delay;
3. With regard to robustness, type B synchronous power-generating modules shall be capable of providing post-fault active power recovery. The relevant TSO shall specify the magnitude and time for active power recovery.

### *Article 18*

#### **Requirements for type C synchronous power-generating modules**

1. Type C synchronous power-generating modules shall fulfil the requirements laid down in Article 13, Article 14, Article 15 and Article 17, except for Article 13(3)(b), Article 13(6), Article 13(8), Article 13(10) and Article 17(2)(a).
2. Type C synchronous power-generating modules shall fulfil the following additional requirements in relation to voltage stability:
  - (a) with regard to reactive power capability, the relevant system operator may specify supplementary reactive power to be provided if the connection point of a synchronous power-generating module is neither located at 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. This supplementary reactive power shall compensate the reactive power demand of the high-voltage line or cable between the high-voltage terminals of the step-up transformer of the synchronous power-generating module or its alternator terminals, if no step-up transformer exists, and the connection point and shall be provided by the responsible owner of that line or cable;
  - (b) with regard to reactive power capability at maximum capacity:
    - (i) the relevant system operator in coordination with the relevant TSO shall specify the reactive power provision capability requirements in the context of varying voltage. For that purpose the relevant system operator shall specify a  $U-Q/P_{\max}$ -profile within the boundaries of which the synchronous power-generating module shall be capable of providing reactive power at its maximum capacity. The

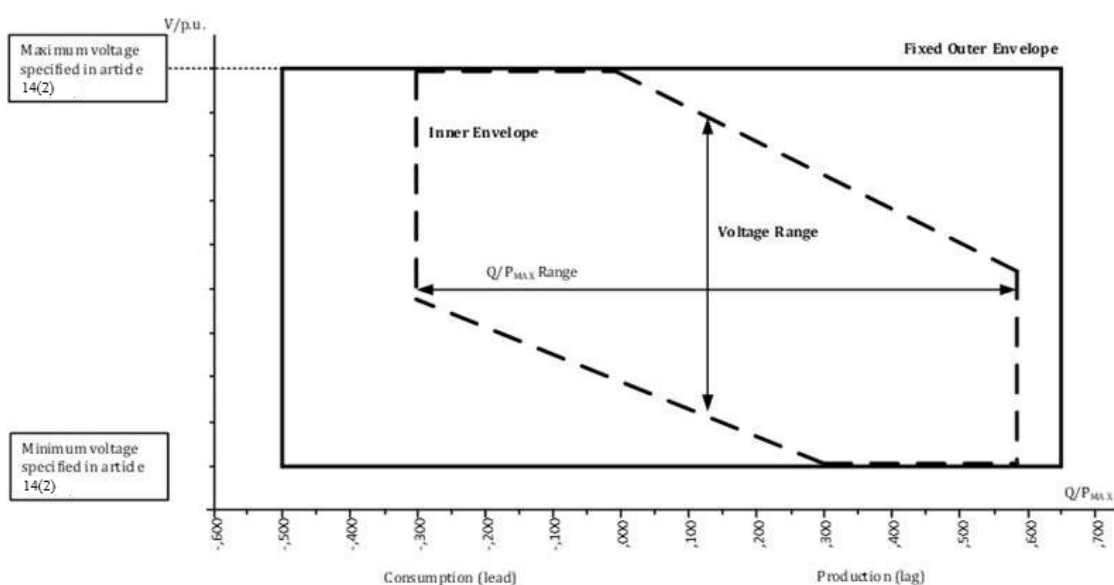
specified  $U$ - $Q/P_{\max}$  profile may take any shape, having regard to the potential costs of delivering the capability to supply reactive power at high voltages and absorb reactive power at low voltages;

(ii) the  $U$ - $Q/P_{\max}$ -profile shall be specified by the relevant system operator in coordination with the relevant TSO, 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 (17)7 ,
- the dimensions of the  $U$ - $Q/P_{\max}$ -profile envelope ( $Q/P_{\max}$  range and voltage range) shall be within the range specified for each synchronous area in Table (23) 8, and
- the position of the  $U$ - $Q/P_{\max}$ -profile envelope shall be within the limits of the fixed outer envelope in Figure (17)7;

**Figure (17)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 the reference 1 pu value, 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.

**Table (23) 8**

**Parameters for the inner envelope in Figure (17)7**



<b>Synchronous area</b>	<b>Maximum range of <math>Q/P_{\max}</math></b>	<b>Maximum range of steady-state voltage in PU</b>
Continental Europe	0,95	0,225
Nordic	0,95	0,225
Ireland and Northern Ireland	1,08	0,218
Baltic	1,0	0,220

- (iii) the reactive power provision capability requirement applies at the connection point. The voltage range represents the difference between the highest and lowest values at a certain value of  $Q/P_{\max}$ . The full reactive power range is therefore not expected to be available across the range of steady-state voltages;
  - (iv) 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 system 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-generating modules shall be capable of operating at every possible operating point in the P-Q-capability diagram of the alternator of that 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 correspond fully to the P-Q-capability diagram of the alternator of that 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 19*

#### **Requirements for type D synchronous power-generating modules**

1. Type D synchronous power-generating modules shall fulfil the requirements laid down in Article 13, except for Article 13(3)(b), Article 13(6), Article 13(7), Article 13(8) and Article 13(10) and , Article 14, Article 15, except for Article 15(3), Article 16, Article 17, except for Article 17(2) and Article 18.
2. Type D synchronous power-generating modules shall fulfil the following additional requirements in relation to voltage stability:
  - (a) equipped with an AVR having:
    - (i) an underexcitation limiter to prevent the AVR from reducing the alternator excitation to a level which would endanger angular stability;

- (ii) an overexcitation limiter to ensure that the alternator excitation is not limited to less than the maximum value that can be achieved, whilst ensuring that the synchronous power-generating module is operating within its design limits;
  - (iii) a PSS function to attenuate power oscillations, if the synchronous power-generating module size is above a value of maximum capacity specified by the relevant TSO. The PSS shall have the capability to damp inter-area power oscillations in the frequency range of, at least, 0,1 Hz – 1,0 Hz. The relevant TSO shall have the right to request and approve the tuning of the PSS by the power-generating facility owner to damp the inter-area oscillation mode based on frequency ranges specified by the relevant TSO in coordination with adjacent TSO or TSOs. The relevant TSO shall have right to request the tuning of the PSS by power-generating facility owner to damp the local oscillation mode, in which the synchronous power-generating modules is oscillating against the network.
- (b) having a voltage control system with parameters and settings of the components specified by an agreement between the power-generating module owner and the relevant system operator, in coordination with the relevant TSO. The agreement shall cover at least:
- (i) the specifications and performance of an AVR with regard to steady-state voltage and transient voltage control and the specifications and performance of the excitation control;
  - (ii) the specifications and performance of the AVR including PSS in order not to excite torsional oscillations on other power-generating modules connected to the network;
  - (iii) the presence of a stator current limiter.
3. The relevant TSO and the power-generating facility owner shall enter into an agreement regarding technical capabilities of the power-generating module to aid angular stability under fault conditions.
4. With regard to frequency stability:
- (a) requirement laid down in Article 13(2)(b) shall not apply to a synchronous power-generating modules with maximum capacity larger than or equal to 140 MW;
  - (b) synchronous power-generating modules with maximum capacity larger than or equal to 140 MW shall be capable of remaining connected to the network and operate at rate-of-change-of-frequency up to  $\pm 1,0$  Hz/s over a period of 0,5 s; the relevant system operator, in coordination with the relevant TSO, and the power-generating facility owner may agree on a higher value of rate-of-change-of-frequency to ensure the best use of the technical capabilities of a power-generating module, if it is required to preserve or to restore system security; the power-generating facility owner shall not unreasonably withhold consent to apply higher value of rate-of-change-of-frequency, taking account of their economic and technical feasibility.
  - (c) if the rate-of-change-of-frequency is used for loss of mains protection, the relevant system operator, in coordination with the relevant TSO, shall specify the threshold of this rate-of-change-of-frequency-type loss of mains protection.

## **CHAPTER 3**

### **Requirements for power park modules**

#### *Article Y*

#### **Requirements for type A power park modules**

1. The power park module shall be capable of remaining connected to the network and continuing to operate stably after the power system has been disturbed by faults on the transmission system according to a voltage-against-time-profile in line with Figure (12)3 at the connection point and with the set points in Table (24) x.2.1 and Table (25) X.2.2.
2. The voltage-against-time-profile expresses a lower limit of the actual profile of the phase-to-phase voltages (or single phase to neutral voltages for single phase type A power park modules) on the network voltage level at the connection point during a symmetrical fault, as a function of time before, during and after the fault.
3. Each TSO, in coordination with the relevant system operator, shall specify and make publicly available the pre-fault and post-fault conditions for the fault-ride-through capability in terms of:
  - (a) the calculation of the pre-fault minimum short circuit capacity at the connection point,
  - (b) pre-fault active and reactive power operating point of the power-generating module at the connection point and voltage at the connection point, and
  - (c) calculation of the post-fault minimum short circuit capacity at the connection point;
4. When the network voltage resumes, after the fault has been cleared to a value within the voltage range of 0,85pu – 1,1pu, the power park module shall recover its active power output level to its pre-fault value. The recovery time shall not exceed a maximum of 1s.

*Table (24) x.2.1*

#### **Voltage parameters for Figure (12)3 for fault-ride-through capability of power park modules**

<b>Voltage parameters (pu)</b>	
U <sub>ret</sub> :	0,05
U <sub>clear</sub> :	U <sub>ret</sub>
U <sub>rec1</sub> :	U <sub>clear</sub>
U <sub>rec2</sub> :	0,85

*Table (25) X.2.2*

**Time parameters for Figure (12)3 for fault-ride-through capability of power park modules**

<b>Time parameters (seconds)</b>	
$t_{\text{clear}}$ :	0,15
$t_{\text{rec1}}$ :	$t_{\text{clear}}$
$t_{\text{rec2}}$ :	$t_{\text{rec1}}$
$t_{\text{rec3}}$ :	3,0

5. The relevant TSO in coordination with the relevant system operator may specify that type A power park modules shall be capable of providing grid forming capability at the connection point.

The Member State or a designated entity within the meaning of Article 7(1) may require that the relevant TSO in coordination with the relevant system operator shall specify that type A power park modules shall be capable of providing grid forming capability at the connection point. In this case, the Member State or a designated entity within the meaning of Article 7(1) shall develop a roadmap within two years after entry into force of this Regulation in order to assess a roll-out of grid forming capability, that may include impact assessments on oscillations, island mode detection or other technical challenges.

6. Deviating from Article 4(2) and with regard to grid forming capability, a power park module shall be considered existing if

- (a) it is already connected to the network on the date of entry into force of this Regulation; or
- (b) the power-generating facility owner has concluded a final and binding contract for the purchase of the main generating plant by three years after the entry into force of the Regulation.

7. Where grid forming capability is specified by the relevant TSO in coordination with the relevant system operator in accordance with paragraph 5 or defined in Articles 20, 21 and 22, a power park module shall be capable of providing grid forming capability at the connection point as listed below, considering the sub-cycle character of the physical quantities where appropriate.

- (a) Within the power park module's current and energy limits, the power park module shall be capable of behaving at the terminals of the individual unit(s) as a voltage source behind an internal impedance (Thevenin source), during normal operating conditions (non-disturbed network conditions) and upon inception of a network disturbance (including voltage, frequency and voltage phase angle disturbance). The

Thevenin source is characterized by its internal voltage amplitude, voltage phase angle, frequency and internal impedance.

- (b) Upon inception of a network disturbance and while the power park module capabilities and current limits are not exceeded, the instantaneous AC voltage characteristics of the internal Thevenin source according to paragraph (a) shall be capable of not changing its amplitude and voltage phase angle while positive-sequence voltage phase angle steps or voltage magnitude steps are occurring at the connection point. The current exchanged between the power park module and the network shall flow naturally according to the main generating plant and converter impedances and the voltage difference between the internal Thevenin source and the voltage at the connection point.
- (c) After inception of a network disturbance in voltage magnitude, frequency or voltage phase angle, the following shall apply within the power park module's capability, including current limits and inherent energy storage capabilities of each individual unit.
  - (i) The relevant system operator in coordination with the TSO shall specify the temporal parameters of the dynamic performance regarding voltage stability.
  - (ii) Where current limitation is necessary, the relevant system operator in coordination with the relevant TSO may specify additional requirements regarding contribution of active and reactive power at the point of connection.
  - (iii) The power park module shall be capable of stable operation when reaching the power park module current limits, without interruption, in a continuous manner and returning to the behaviour described in paragraph (b) as soon as the limitations are no longer active. If reaching the current limit, the grid forming behaviour must be maintained for responses as specified in paragraph (b) for disturbances that require the current to vary in the opposite direction of the current limitation.

Inherent energy storage means an energy reserve available in physical components of a power park module, which has not necessarily been designed to suit the grid forming requirements of this Article, but may be used for such purposes, without affecting the design of the physical components of individual units.

## *Article 20*

### **Requirements for type B power park modules**

1. Type B power park modules shall fulfil the requirements laid down in Article 13, Article 14, except for Article 13(3)(b) and Article 13(8).
2. Type B power park modules shall fulfil the following additional requirements in relation to voltage stability:
  - (a) with regard to reactive power capability, the relevant system operator shall have the right to specify the capability of a power park module to supply and absorb reactive power;
  - (b) where grid forming capability is not required by this Regulation, the relevant system operator in coordination with the relevant TSO shall have the right to specify that a

power park module be capable of providing fast fault current at the connection point in case of symmetrical (3-phase) faults, under the following conditions:

- (i) the power park module shall be capable of activating the supply of fast fault current either by:
  - ensuring the supply of the fast fault current at the connection point, or
  - measuring voltage deviations at the terminals of the individual units of the power park module and providing a fast fault current at the terminals of these units;
- (ii) the relevant system operator in coordination with the relevant TSO shall specify:
  - how and when a voltage deviation is to be determined as well as the end of the voltage deviation,
  - the characteristics of the fast fault current, including the time domain for measuring the voltage deviation and fast fault current, for which current and voltage may be measured differently from the method specified in Article 2,
  - the timing and accuracy of the fast fault current, which may include several stages during a fault and after its clearance;
- (c) where grid forming capability is not required by this Regulation, with regard to the supply of fast fault current in case of asymmetrical (1-phase or 2-phase) faults, the relevant system operator in coordination with the relevant TSO shall have the right to specify a requirement for asymmetrical current injection.

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

- (a) the relevant TSO shall specify the post-fault active power recovery that the power park module is capable of providing and shall specify:
  - (i) when the post-fault active power recovery begins, based on a voltage criterion;
  - (ii) a maximum allowed time for active power recovery; and
  - (iii) a magnitude and accuracy for active power recovery;
- (b) the specifications shall be in accordance with the following principles:
  - (i) interdependency between fast fault current requirements according to points (b) and (c) of paragraph 2 and active power recovery;
  - (ii) dependence between active power recovery times and duration of voltage deviations;
  - (iii) a specified limit of the maximum allowed time for active power recovery;
  - (iv) adequacy between the level of voltage recovery and the minimum magnitude for active power recovery; and
  - (v) adequate damping of active power oscillations.

4. With regard to grid forming capability:

- (a) type B power park modules connected at 110 kV level or above shall fulfil the requirements laid down in Article Y(6) and (7) and paragraph 5 of this Article;
- (b) type B power park modules of P<sub>max</sub> of 10 MW or above, which are connected below the 110 kV level to a feeder dedicated to one or more power park modules connected to a substation with transformation to 110 kV or above, shall fulfil the requirements laid down in Article Y(6) and (7) and paragraph 5 of this Article;
- (c) with regard to grid forming capability of type B power park modules other than in points (a) and (b) above, Article Y(6) and (7) and paragraph 5 of this Article are applicable, taking into consideration the provisions of Article Y(5).

5. With regard to grid forming capability type B power park modules shall fulfil the following additional requirements in relation to grid forming capability:

- (a) The relevant, TSO in coordination with the relevant system operator, shall specify the contribution to synthetic inertia. The power park module shall be capable of contributing to limiting the transient frequency deviation under high frequency conditions. Additionally, the electricity storage module shall be capable of contributing to limiting the transient frequency deviation under low frequency conditions.
- (b) The dynamic performance according to Article Y(7)(c)(i) shall reflect the specified contribution to synthetic inertia.

## *Article 21*

### **Requirements for type C power park modules**

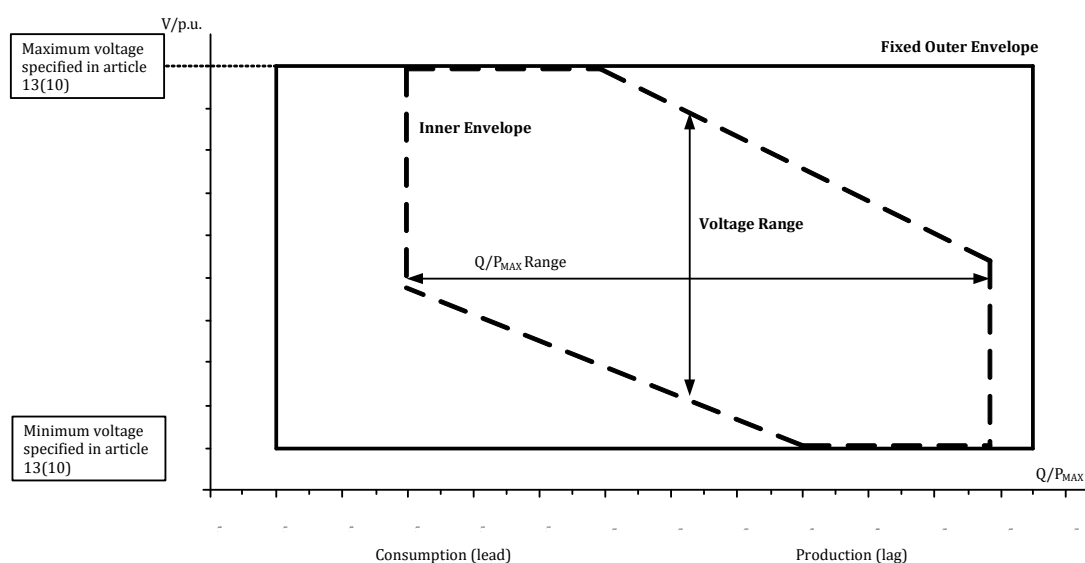
1. Type C power park modules shall fulfil the requirements listed in Article 13, Article 14, Article 15, and Article 20, except for Article 13(3)(b), Article 13(6) and Article 13(8) and Article 20(2)(a), unless referred to otherwise in point (v) of paragraph 2(d).
2. Type C power park modules shall fulfil the following additional requirements in relation to voltage stability:
  - (a) with regard to reactive power capability, the relevant system operator may specify supplementary reactive power to be provided if the connection point of a power park module is neither located at the high-voltage terminals of the step-up transformer to the voltage level of the connection point nor at the convertor terminals, if no step-up transformer exists. This supplementary reactive power shall compensate the reactive power demand of the high-voltage line or cable between the high-voltage terminals of the step-up transformer of the power park module or its convertor terminals, if no step-up transformer exists, and the connection point and shall be provided by the responsible owner of that line or cable.
  - (b) with regard to reactive power capability at maximum capacity:
    - (i) the relevant system operator in coordination with the relevant TSO shall specify the reactive power provision capability requirements in the context of varying voltage. To that end, it shall specify a U-Q/P<sub>max</sub>-profile that may take any shape within the boundaries of which the power park module shall be capable of providing reactive power at its maximum capacity;



- (ii) the  $U-Q/P_{\max}$ -profile shall be specified by each relevant system operator in coordination with the relevant TSO 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 (18)8 ,
  - the dimensions of the  $U-Q/P_{\max}$ -profile envelope ( $Q/P_{\max}$  range and voltage range) shall be within the values specified for each synchronous area in Table (26) 9,
  - the position of the  $U-Q/P_{\max}$ -profile envelope shall be within the limits of the fixed outer envelope set out in Figure (18)8, and
  - the specified  $U-Q/P_{\max}$  profile may take any shape, having regard to the potential costs of delivering the capability to supply reactive power at high voltages and absorb reactive power at low voltages;

**Figure (18)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 reference 1 pu value, 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.

**Table (26) 9**

**Parameters for the inner envelope in Figure (18)8**

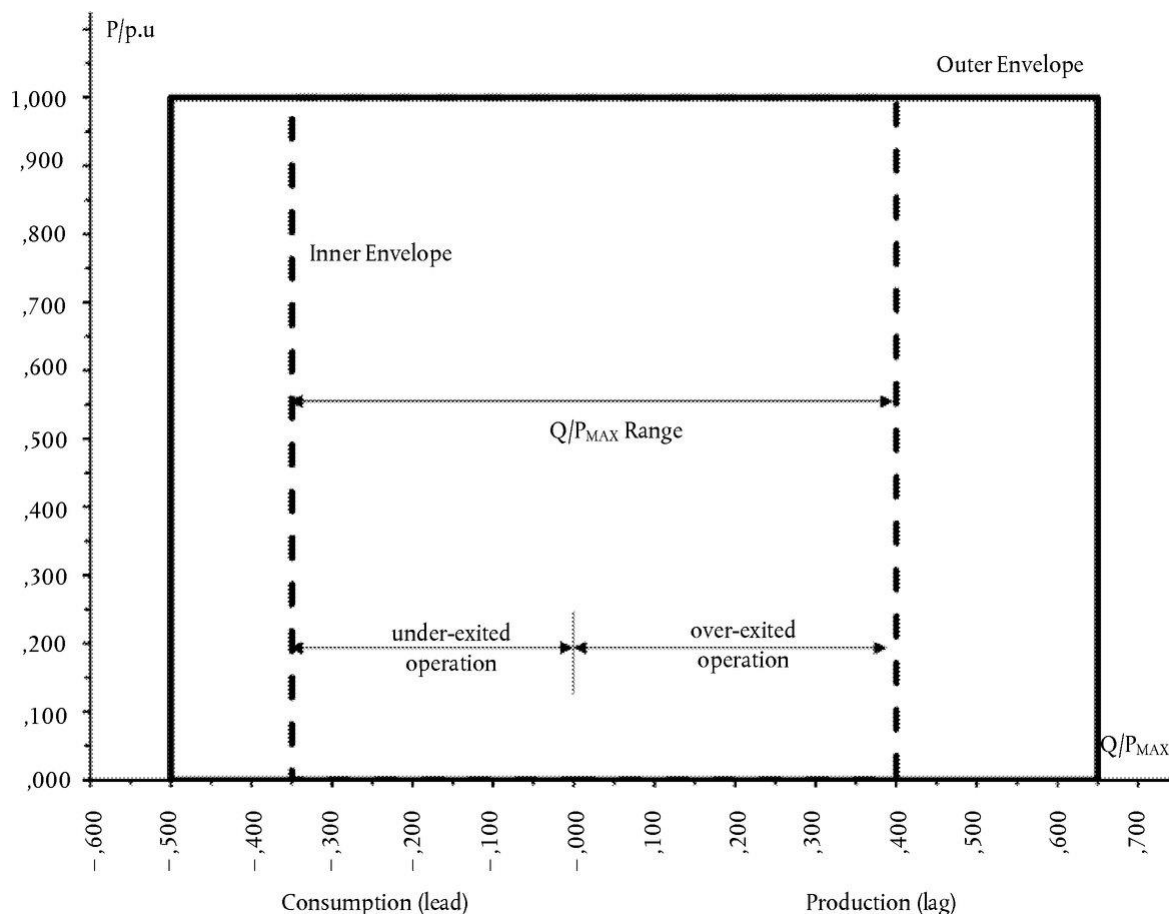
Synchronous area	Maximum range of $Q/P_{\max}$	Maximum range of steady-state voltage in PU

Continental Europe	0,75	0,225
Nordic	0,95	0, 225
Ireland and Northern Ireland	0,66	0,218
Baltic	0,80	0,220

- (iii) the reactive power provision capability requirement applies at the connection point. The voltage range represents the difference between the highest and lowest values at a certain value of  $Q/P_{\max}$ . The full reactive power range is therefore not expected to be available across the range of steady-state voltages;
- (c) with regard to reactive power capability below maximum capacity:
- (i) the relevant system operator in coordination with the relevant TSO shall specify the reactive power provision capability requirements and shall specify a  $P-Q/P_{\max}$ -profile that may take any shape within the boundaries of which the power park module shall be capable of providing reactive power below maximum capacity;
  - (ii) the  $P-Q/P_{\max}$ -profile shall be specified by each relevant system operator in coordination with the relevant TSO, 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 (19)9,
    - the  $Q/P_{\max}$  range of the  $P-Q/P_{\max}$ -profile envelope is specified for each synchronous area in Table (26) 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 shall be within the limits of the fixed outer envelope set out in Figure (19)9;
  - (iii) when operating at an active power output below maximum capacity ( $P < P_{\max}$ ), the power park module shall be capable of providing reactive power at any operating point inside its  $P-Q/P_{\max}$ -profile, if all units of that power park module which generate power are technically available, namely they are not out of service due to maintenance or failure, otherwise there may be less reactive power capability, taking into consideration the technical availabilities;

**Figure (19)9**

**$P-Q/P_{\max}$ -profile of a power park module**



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

(d) with regard to reactive power control modes:

- (i) the power park module shall be capable of providing reactive power automatically by voltage control mode, reactive power control mode, power factor control mode or active power-related power factor control mode, as specified by the relevant system operator, in coordination with the relevant TSO and with the power park module owner;
- (ii) for the purposes of voltage control mode, the power park module shall be capable of contributing to voltage control at the connection point by provision of reactive power exchange with the network with a setpoint voltage covering 0,95 pu to 1,05 pu in steps no greater than 0,01 pu, with a slope having a range of at least 2 % to 7 % in steps no greater than 0,5 %. The reactive power output shall be zero when the grid voltage value at the connection point equals the voltage setpoint. Stable operation in voltage control mode operation shall be ensured;

- (iii) the setpoint may be operated with or without a deadband selectable in a range from zero to  $\pm 5$  % of reference 1 pu network voltage in steps no greater than 0,5%;
- (iv) following a step change in voltage, the power park module shall be capable of achieving 90 % of the change in reactive power output within a time  $t_1$  to be specified by the relevant system operator in the range of 1 to 5 seconds, and must settle at the value specified by the slope within a time  $t_2$  to be specified by the relevant system operator in the range of 5 to 60 seconds, with a steady-state reactive tolerance no greater than 5 % of the maximum reactive power. The relevant system operator shall specify the time specifications;
- (v) for the purpose of reactive power control mode, the power park module shall be capable of setting the reactive power setpoint anywhere in the reactive power range, specified by point (a) of Article 20(2) and by points (a) and (b) of Article 21(2), with setting steps no greater than 5 MVar or 5 % (whichever is smaller) of maximum reactive power, controlling the reactive power at the connection point to an accuracy within plus or minus 5 MVar or plus or minus 5 % (whichever is smaller) of the maximum reactive power;
- (vi) for the purpose of power factor control mode, the power park module shall be capable of controlling the power factor at the connection point within the required reactive power range, specified by the relevant system operator according to point (a) of Article 20(2) or specified by points (a) and (b) of Article 21(2), with a target power factor in steps no greater than 0,01. The relevant system operator shall specify the target power factor value, its tolerance and the period of time to achieve the target power factor following a sudden change of active power output. The tolerance of the target power factor shall be expressed through the tolerance of its corresponding reactive power. This reactive power tolerance shall be expressed by either an absolute value or by a percentage of the maximum reactive power of the power park module. The relevant system operator shall consider the appropriate requirements when specifying power factor control at operation close to zero active power;
- (vii) for the purpose of active power-related 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, specified by the relevant system operator according to point (a) of Article 20(2) or specified by points (a) and (b) of Article 21(2). The relevant system operator shall specify power factor set point resulting from a change in active power output. The relevant system operator shall specify its tolerance and the period of time to achieve the setpoint;
- (viii) the relevant system operator, in coordination with the relevant TSO and with the power park module owner, shall specify which of the above four reactive power control mode options and associated setpoints is to apply, and what further equipment is needed to make the adjustment of the relevant setpoint or to change the applied reactive power control mode operable remotely;
- (e) with regard to prioritising active or reactive power contribution, the relevant TSO shall specify whether active power contribution or reactive power contribution has

priority during faults for which fault-ride-through capability is required. If priority is given to active power contribution, this provision has to be established no later than 150 ms from the fault inception;

- (f) with regard to power oscillations damping control, if specified by the relevant TSO a power park module shall have a power oscillation damping function which, through the control of the active power, reactive power, or both, helps to attenuate the power oscillations. The power oscillation damping shall be able to damp inter-area oscillations in the range of, at least, 0,1 Hz – 1,0 Hz. The voltage and reactive power control characteristics of power park modules must not adversely affect the damping of power oscillations.

3. In the frequency range between 0,1 Hz and 20 Hz, the control systems and design characteristics of type C power park modules shall be subject to the following requirements relative to the total active power and current forced oscillations, when system conditions are within the frequency ranges as specified in Table 2 and voltage ranges as specified in Table (27) 10:

- (a) The forced oscillations shall not exceed continuously the maximum of:
  - (i) a limit in the range of +/- 0,1% to +/- 1% of the maximum capacity, as defined by the relevant TSO. The default limit shall be +/-0,5%;
  - (ii) a limit in the range of 200 kW to 500 kW, as defined by the relevant TSO. The default limit shall be 500 kW.
- (b) In case that the limits defined in (a) are temporarily exceeded, forced oscillations shall:
  - (i) not exceed a limit in the range of +/- 0.5% to +/- 3% of the maximum capacity, as defined by the relevant TSO. The default limit shall be +/-2,5%;
  - (ii) be within the limits defined in (a) within a range of 100-180 seconds, as defined by the relevant TSO. The default limit shall be 180 sec;
  - (iii) be damped to be lower than 50% of the limit specified in (i) within 50% of the time limit specified in (ii).
- (c) Having regard the criteria defined in (b), temporarily exceedance of the limits defined in (a), not considering oscillations that are damped to be within the limits within 10 seconds, is allowed for:
  - (i) a maximum percentage of time per day, as defined by the relevant TSO in a range between 1% and 2%. The default limit shall be +/- 1%;
  - (ii) a maximum in a range of 2-4 times per hour, based on the range of the 85th to 95th percentile of hourly exceedances measured over one week, as defined by the relevant TSO. The default maximum shall be 3 times and default percentile shall be 95.
- (d) Forced oscillations originated from system support requests by the relevant system operator, such as power oscillation damping, are excluded from this requirement.

4. With regard to grid forming capability:

- (a) type C power park modules connected at 110 kV level or above shall fulfil the requirements laid down in Article Y(6) and (7) and paragraph 5 of this Article;
  - (b) type C power park modules of Pmax of 10 MW or above, which are connected below the 110 kV level to a feeder dedicated to one or more power park modules connected to a substation with transformation to 110 kV or above, shall fulfil the requirements laid down in Article Y(6) and (7) and paragraph 5 of this Article;
  - (c) with regard to grid forming capability of type C power park modules other than in points (a) and (b) above, Article Y(6) and (7) and paragraph 5 of this Article are applicable, taking into consideration the provisions of Article Y(5).
5. With regard to grid forming capability type C power park modules shall fulfil the following additional requirements in relation to grid forming capability:
- (a) The relevant TSO, in coordination with the relevant system operator, shall specify the contribution to synthetic inertia. The power park module shall be capable of contributing to limiting the transient frequency deviation under high and low frequency conditions.
  - (b) The relevant TSO may require the provision of additional energy beyond the inherent energy storage in coordination with the relevant system operator.

## *Article 22*

### **Requirements for type D power park modules**

1. Type D power park modules shall fulfil the requirements listed in Article 13, Article 14, Article 15, Article Y(6) and (7), Article 20, and Article 21, except for Article 13(3)(b), Article 13(6), Article 13(7), Article 13(8), Article 15(3), Article 20(2)(a), Article 20(4) and Article 21(4).
2. With regard to power oscillations damping control, type D power park modules shall have a power oscillation damping function which helps to attenuate the power oscillations through the control of the active power, reactive power, or both. The power oscillation damping shall be able to damp inter-area oscillations in the range of, at least, 0,1 Hz – 1,0 Hz. The relevant TSO in co-ordination with the relevant system operator shall have the right to request and approve the tuning of the power oscillation damping by the power-generating facility owner to damp the inter-area oscillation mode based on frequency ranges specified by the relevant TSO in coordination with adjacent TSO or TSOs. The relevant TSO shall have the right to request the tuning of the power oscillation damping by power-generating facility owner to damp the local oscillation mode, in which the power park modules is oscillating against the network.

The proposed power oscillation damping control shall be approved by the relevant TSO.

## **CHAPTER 4**

### ***Requirements for offshore power park modules***

## *Article 23*

### **General provisions**

1. The requirements set out in this Chapter apply to the connection to the network of AC-connected power park modules located offshore. An AC-connected power park module located offshore which does not have an offshore connection point shall be considered as an onshore power park module and thus shall comply with the requirements governing power park modules situated onshore.
2. The offshore connection point of an AC-connected offshore power park module shall be specified by the relevant system operator.
3. AC-connected offshore power park modules within the scope of this Regulation shall be categorised in accordance with the following offshore grid connection system configurations:
  - (a) configuration 1: AC connection to a single onshore grid interconnection point whereby one or more offshore power park modules that are interconnected offshore to form an offshore AC system are connected to the onshore system;
  - (b) configuration 2: meshed AC connections whereby a number of offshore power park modules are interconnected offshore to form an offshore AC system and the offshore AC system is connected to the onshore system at two or more onshore grid interconnection points.

### *Article 24*

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

AC-connected offshore power park modules shall fulfil the requirements relating to frequency stability laid down in Article 13, Article 15(2), Article 20(4) and Article 21(4), except for Article 13(3)(b), (6) and (7).

### *Article 25*

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

1. Without prejudice to point (a) of Article 14(3) and point (a) of Article 16(3), an AC-connected offshore power park module shall be capable of remaining 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 reference 1 pu voltage, and for the time periods specified in Table (27) 10 or, for voltage level below 110kV as specified by the relevant system operator.
2. Notwithstanding the provisions of paragraph 1, the relevant TSO in Spain may require AC-connected offshore power park modules to remain connected to the network in the voltage range between 1,05 pu and 1,0875 pu for an unlimited period.
3. Notwithstanding the provisions of paragraph 1, the relevant TSOs in the Baltic synchronous area may require AC-connected offshore power park modules to remain



connected to the 400 kV network in the voltage range and for the time periods that apply to the Continental Europe synchronous area.

*Table (27) 10*

<b>Synchronous area</b>	<b>Rated Voltage</b>	<b>Voltage range</b>	<b>Time period for operation</b>
Continental Europe	110 kV	0,85 pu-0,90 pu	60 minutes
		0,90 pu-1,118 pu	Unlimited
		1,118 pu-1,15 pu	To be specified by each TSO, but not less than 20 minutes and not more than 60 minutes
	132 kV	0,85 pu-0,90 pu	60 minutes
		0,90 pu-1,098 pu	Unlimited
		1,098 pu-1,15 pu	To be specified by each TSO, but not less than 20 minutes and not more than 60 minutes
	150 kV	0,85 pu-0,90 pu	60 minutes
		0,90 pu-1,118 pu	Unlimited
		1,118 pu-1,15 pu	To be specified by each TSO, but not less than 20 minutes and not more than 60 minutes
	220 kV	0,85 pu-0,90 pu	60 minutes
		0,90 pu-1,113 pu	Unlimited
		1,113 pu-1,15 pu	To be specified by each TSO, but not less than 20 minutes and not more than 60 minutes
	330 kV	0,85 pu-0,90 pu	60 minutes
		0,90 pu-1,05 pu	Unlimited

		1,05 pu-1,10 pu	To be specified by each TSO, but not less than 20 minutes and not more than 60 minutes
	400 kV	0,85 pu-0,90 pu	60 minutes
		0,90 pu-1,05 pu	Unlimited
		1,05 pu-1,10 pu	To be specified by each TSO, but not less than 20 minutes and not more than 60 minutes
Nordic	110 kV	0,90 pu-1,05 pu	Unlimited
		1,05 pu-1,10 pu	60 minutes
	132 kV	0,90 pu-1,05 pu	Unlimited
		1,05 pu-1,10 pu	60 minutes
	220 kV	0,90 pu-1,05 pu	Unlimited
		1,05 pu-1,10 pu	60 minutes
	330 kV	0,90 pu – 1,05 pu	Unlimited
		1,05 pu – 1,10 pu	To be specified by each TSO, but not more than 60 minutes
	400 kV	0,90 pu – 1,05 pu	Unlimited
		1,05 pu – 1,10 pu	To be specified by each TSO, but not more than 60 minutes
Ireland and Northern Ireland	110 kV	0,90 pu-1,10 pu	Unlimited
	220 kV	0,90 pu-1,10 pu	Unlimited
	275 kV	0,90 pu – 1,09 pu	Unlimited
	400 kV	0,90 pu – 1,10 pu	Unlimited
Baltic	110 kV	0,85 pu-0,90 pu	30 minutes
		0,90 pu-1,118 pu	Unlimited

		1,118 pu-1,15 pu	20 minutes
	220 kV	0,85 pu-0,90 pu	30 minutes
		0,90 pu-1,113 pu	Unlimited
		1,113 pu-1,15 pu	20 minutes
	330 kV	0,88 pu-0,90 pu	30 minutes
		0,90 pu-1,097 pu	Unlimited
		1,097 pu-1,15 pu	20 minutes
	400 kV	0,88 pu-0,90 pu	30 minutes
		0,90 pu-1,05 pu	Unlimited
		1,05 pu-1,15 pu	20 minutes

The table shows the minimum period during which an AC-connected offshore power park module shall be capable of operating over different voltage ranges deviating from the reference 1 pu value without disconnecting.

4. AC-connected offshore power park modules shall fulfil the requirements laid down in Article Y(6) and (7), and Article 21(2) respectively.

5. The reactive power capability at maximum capacity specified in point (b) of Article 21(2) shall apply to AC-connected offshore power park modules, except for Table (26) 9. Instead, the requirements of Table (28) 11 shall apply.

*Table (28) 11*

**Parameters for Figure (18)8**

<b>Synchronous area</b>	<b>Maximum range of <math>Q/P_{\max}</math></b>	<b>Maximum range of steady-state voltage in PU</b>
Continental Europe	0,75	0,225
Nordic	0,95	0,225

Ireland and Northern Ireland	0,66	0,218
Baltic	0,8	0,22

## *Article 26*

### **Robustness requirements applicable to AC-connected offshore power park modules**

1. AC-connected offshore power park modules shall fulfil the requirements relating to robustness laid down in Article 14(3)(a), Article 15(3), Article 16(3)(a), and Article 20(3) respectively.

2. Outside of the frequency range between 0,1 Hz and 2,0 Hz, the system stability requirement laid down in Article 21(4) shall apply to AC-connected offshore power park modules.

In the frequency range between 0,1 Hz and 2,0 Hz, the control systems and design characteristics of an AC-connected offshore power park modules shall be subject to the following requirements relative to the total active power and current forced oscillations, when system conditions are within the frequency ranges as specified in Table 2 and voltage ranges as specified in Table (27) 10:

- (a) The forced oscillations shall not exceed continuously the maximum of:
  - (i) a limit in the range of  $\pm 0,5\%$  to  $\pm 2\%$  of the actual value, as defined by the relevant TSO. The default limit shall be  $\pm 1\%$ ;
  - (ii) a limit in the range of  $\pm 0,25\%$  to  $\pm 1\%$  of the maximum capacity, as defined by the relevant TSO. The default limit shall be  $\pm 0,5\%$ .
- (b) In case that the limits defined in (a) are temporarily exceeded, forced oscillations shall:
  - (i) not exceed a limit in the range of  $\pm 2,5\%$  to  $\pm 5\%$  of the maximum capacity, as defined by the relevant TSO. The default limit shall be  $\pm 4\%$ ;
  - (ii) be within the limits defined in (a) within a range of 100-180 seconds, as defined by the relevant TSO. The default limit shall be 180 sec;
  - (iii) be damped to be lower than 50% of the limit specified in (i) within 50% of the time limit specified in (ii).
- (c) While always respecting the criteria defined in (b), temporarily exceedance of the limits defined in (a), not considering oscillations that are damped to be within the limits within 10 seconds, is allowed for:
  - (i) a maximum percentage of time per day, as defined by the relevant TSO in a range between 1% and 2%. The default limit shall be 1%;
  - (ii) a maximum in a range of 2-4 times per hour, based on the range of the 85th to 95th percentile of hourly exceedances measured over one week, as defined by the relevant TSO. The default maximum shall be 3 times and default percentile shall be 95.

- (d) Forced oscillations originated from system support requests by the relevant system operator, such as power oscillation damping, are excluded from this requirement.

#### *Article 27*

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

AC-connected offshore power park modules shall fulfil the requirements relating to system restoration laid down in Article 14(4) and Article 15(4) respectively.

#### *Article 28*

### **General system management requirements applicable to AC-connected offshore power park modules**

AC-connected offshore power park modules shall fulfil the requirements relating to system management laid down in Article 14(5), Article 15(5), Article 16(4) respectively.

## **TITLE III**

### **OPERATIONAL NOTIFICATION PROCEDURE FOR CONNECTION**

#### **CHAPTER 1**

#### ***Connection of new power-generating modules***

#### *Article 29*

### **General provisions**

1. The power-generating facility owner shall demonstrate to the relevant system operator that it has complied with the requirements set out in Title II of this Regulation by completing successfully the operational notification procedure for connection of each power-generating module described in Article 30 to Article 37.
2. The relevant system operator shall clarify and make publicly available the details of the operational notification procedure which shall include the compliance scheme in the case the relevant system operator provides for the use of equipment certificates.
3. The power-generating facility owner shall notify the relevant system operator or the competent authority of the Member State about the permanent decommissioning of a power-generating module in accordance with national legislation. The relevant system operator shall ensure that such notification can be made by third parties, including aggregators.
4. The relevant system operator shall ensure that the commissioning and decommissioning of power-generating modules can be notified electronically.

*Article 30*

**Operational notification of type A power-generating modules**

1. The operational notification procedure for connection of each new type A power-generating module shall consist of submitting an installation document. The power-generating facility owner shall ensure that the required information is provided on an installation document obtained from the relevant system operator and is submitted to the system operator. Separate installation documents shall be provided for each power-generating module within the power-generating facility.

The relevant system operator shall ensure that the required information can be submitted by third parties on behalf of the power-generating facility owner.

2. The relevant system operator shall specify the content of the installation document, which shall have at least the following information:

- (a) the location at which the connection is made;
- (b) the date of the connection;
- (c) the maximum capacity of the installation in kW;
- (d) the type of primary energy source;
- (e) reference to equipment certificates issued by an authorised certifier used for equipment that is in the site installation;
- (f) as regards equipment used, for which an equipment certificate has not been received, information shall be provided as directed by the relevant system operator; and
- (g) the contact details of the power-generating facility owner and the installer and their signatures.

**3. If required by national rules, the relevant system operator, on acceptance of a complete and adequate installation document, shall issue a final operational notification as soon as possible.**

*Article 30a*

**Procedure for type EV2 associated V2G electric vehicle supply equipment**

1. The operational notification procedure for connection of each new type EV2 associated V2G electric vehicle supply equipment shall consist of submitting an installation document. The electrical charging park owner shall ensure that the required information is filled in on an installation document obtained from the relevant system operator and is submitted to the system operator.

The relevant system operator shall ensure that the required information can be submitted by third parties on behalf of the electrical charging park owner.

2. The relevant system operator shall specify the content of the installation document, which shall have at least the following information:

- (a) the location at which the connection is made;
  - (b) the date of the connection;
  - (c) the maximum capacity of the installation in kW;
  - (d) reference to equipment certificates issued by an authorised certifier used for equipment that is in the site installation;
  - (e) as regards equipment used, for which an equipment certificate has not been received, information shall be provided as directed by the relevant system operator; and
  - (f) the contact details of the electrical charging park owner and the installer, and their signatures.
3. The relevant system operator, on acceptance of a complete and adequate installation document, shall issue a final operational notification as soon as possible.

#### *Article 30b*

##### **Procedure for type EV3 associated V2G electric vehicle supply equipment**

1. For the purpose of operational notification for connection of each new type EV3 V2G electric vehicle supply equipment, a supply equipment document ('SED') shall be provided by the electrical charging park owner to the relevant system operator and shall include a statement of compliance.
2. The format of the SED and the information to be given therein shall be specified by the relevant system operator and use established European technical standards. The relevant system operator shall have the right to request that the electrical charging park owner includes the following in the SED:
  - (a) evidence of an agreement on the protection and control settings relevant to the connection point between the relevant system operator and the electrical charging park owner;
  - (b) an itemised statement of compliance;
  - (c) detailed technical data of the V2G electric vehicle supply equipment with relevance to the grid connection as specified by the relevant system operator;
  - (d) equipment certificates issued by an authorised certifier in respect of type EV3 associated V2G electric vehicle supply equipment, where these are relied upon as part of the evidence of compliance;
  - (e) compliance test reports demonstrating steady-state and dynamic performance as required by Chapters 2, 3 and 4 of Title IV, including use of actual measured values during testing, to the level of detail required by the relevant system operator; and
  - (f) studies demonstrating steady-state and dynamic performance as required by Chapters 5, 6 or 7 of Title IV, to the level of detail required by the relevant system operator.



3. The relevant system operator, on acceptance of a complete and adequate SED, shall issue a final operational notification to the electrical charging park owner as soon as possible.

4. Member States may provide that the SED shall be issued by an authorised certifier.

#### *Article 31*

### **Operational notification of type B, C and D power-generating modules**

The operational notification procedure for connection of each new type B, C and D power-generating module shall allow the use of equipment certificates issued by an authorised certifier.

#### *Article 32*

### **Procedure for type B and C power-generating modules**

1. For the purpose of operational notification for connection of each new type B and C power-generating module, a power-generating module document ('PGMD') shall be provided by the power-generating facility owner to the relevant system operator and shall include a statement of compliance.

For each power-generating module within the power-generating facility, separate independent PGMDs shall be provided.

2. The format of the PGMD and the information to be given therein shall be specified by the relevant system operator. The relevant system operator shall have the right to request that the power-generating facility owner include the following in the PGMD:

- (a) evidence of an agreement on the protection and control settings relevant to the connection point between the relevant system operator and the power-generating facility owner;
- (b) an itemised statement of compliance;
- (c) detailed technical data of the power-generating module with relevance to the grid connection as specified by the relevant system operator;
- (d) equipment certificates issued by an authorised certifier in respect of power-generating modules, where these are relied upon as part of the evidence of compliance;
- (e) for Type C power-generating modules, simulation models as specified by point (c) of Article 15(5) and required by the relevant system operator;
- (f) compliance test reports demonstrating steady-state and dynamic performance as required by Chapters 2, 3 and 4 of Title IV, including use of actual measured values during testing, to the level of detail required by the relevant system operator; and
- (g) studies demonstrating steady-state and dynamic performance as required by Chapters 5, 6 or 7 of Title IV, to the level of detail required by the relevant system operator.

3. The relevant system operator, on acceptance of a complete and adequate PGMD, shall issue a final operational notification to the power-generating facility owner as soon as possible.

4. Member States may provide that the PGMD shall be issued by an authorised certifier.

#### *Article 33*

##### **Procedure for type D power-generating modules**

The operational notification procedure for connection of each new type D power-generating module shall comprise:

- (a) energisation operational notification ('EON');
- (b) interim operational notification ('ION'); and
- (c) final operational notification ('FON').

#### *Article 34*

##### **Energisation operational notification for type D power-generating modules**

1. An 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 specified for the connection point.
2. An EON shall be issued by the relevant system operator, subject to completion of preparations including agreement on the protection and control settings relevant to the connection point between the relevant system operator and the power-generating facility owner.

#### *Article 35*

##### **Interim operational notification for type D power-generating modules**

1. An 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 ION shall be issued by the relevant system operator, subject to completion of the data and study review process as required by this Article.
3. With regard to the data and study review, the relevant system operator shall have the right to request that the power-generating facility owner provide the following:
  - (a) itemised statement of compliance;
  - (b) detailed technical data on the power-generating module of relevance to the grid connection as specified by the relevant system operator;
  - (c) equipment certificates issued by an authorised certifier in respect of power-generating modules, where they are relied upon as part of the evidence of compliance;
  - (d) simulation models, as specified by point (c) of Article 15(5) and required by the relevant system operator;

(e) studies demonstrating the expected steady-state and dynamic performance as required by Chapter 5, 6 or 7 of Title IV; and

(f) details of intended compliance tests in accordance with Chapters 2, 3 and 4 of Title IV.

4. The maximum period during which the power-generating facility owner may maintain ION status shall be 24 months. The relevant system operator is entitled to specify a shorter ION validity period. An extension of the ION shall be granted only if the power-generating facility owner has made substantial progress towards full compliance. Outstanding issues shall be clearly identified at the time of requesting extension.

### *Article 36*

#### **Final operational notification for type D power-generating modules**

1. A FON shall entitle the power-generating facility owner to operate a power-generating module by using the grid connection.

2. A FON shall be issued by the relevant system operator, upon prior removal of all incompatibilities identified for the purpose of ION status and subject to completion of the data and study review process as required by this Article.

3. For the purposes of the data and study review, the power-generating facility owner must submit the following to the relevant system operator:

(a) an itemised statement of compliance; and

(b) an update of applicable technical data, simulation models and studies as referred to in points (b), (d) and (e) of Article 35(3), including the use of actual measured values during testing.

4. If incompatibility is identified in connection with the issuing of the FON, a derogation may be granted upon a request made to the relevant system operator, in accordance with the derogation procedure described in Title V. A FON shall be issued by the relevant system operator if the power-generating module complies with the provisions of the derogation.

Where a request for a derogation is rejected, the relevant system operator shall have the right to refuse to allow the operation of the power-generating module until the power-generating facility owner and the relevant system operator resolve the incompatibility and the relevant system operator considers that the power-generating module complies with the provisions of this Regulation.

If the relevant system operator and the power-generating facility owner do not resolve the incompatibility within a reasonable time frame, but in any case not later than six months after the notification of the rejection of the request for a derogation, each party may refer the issue for decision to the regulatory authority.

### *Article 37*

#### **Limited operational notification for type D power-generating modules**

1. Power-generating facility owners to whom a FON has been granted shall inform the relevant system operator immediately in the following circumstances:

- (a) the facility is temporarily subject to either significant modification or loss of capability affecting its performance; or
  - (b) equipment failure leading to non-compliance with some relevant requirements.
2. The power-generating facility owner shall apply to the relevant system operator for a LON, if the power-generating facility owner reasonably expects the circumstances described in paragraph 1 to persist for more than three months.
3. A LON shall be issued by the relevant system operator and shall contain the following information which shall be clearly identifiable:
- (a) the unresolved issues justifying the granting of the LON;
  - (b) the responsibilities and timescales for the expected solution; and
  - (c) a maximum period of validity which shall not exceed 12 months. The initial period granted may be shorter with the possibility of an extension if evidence is submitted to the satisfaction of the relevant system operator demonstrating that substantial progress has been made towards achieving full compliance.
4. The FON shall be suspended during the period of validity of the LON with regard to the items for which the LON has been issued.
5. A further extension of the period of validity of the LON may be granted upon a request for a derogation made to the relevant system operator before the expiry of that period, in accordance with the derogation procedure described in Title V.
6. The relevant system operator shall have the right to refuse to allow the operation of the power-generating module, once the LON is no longer valid. In such cases, the FON shall automatically become invalid.
7. If the relevant system operator does not grant an extension of the period of validity of the LON in accordance with paragraph 5 or if it refuses to allow the operation of the power-generating module once the LON is no longer valid in accordance with paragraph 6, the power-generating facility owner may refer the issue for decision to the regulatory authority within six months after the notification of the decision of the relevant system operator.

## **CHAPTER 2**

### ***Cost-benefit analysis***

#### ***Article 38***

#### **Identification of costs and benefits of application of requirements to existing power-generating modules**

1. Prior to the application of any requirement set out in this Regulation to existing power-generating modules in accordance with Article 4(3), the relevant TSO shall undertake a qualitative comparison of costs and benefits related to the requirement under consideration. This comparison shall take into account available network-based or market-based alternatives. The relevant TSO may only proceed to undertake a quantitative cost-benefit analysis in accordance with paragraphs 2 to 5, if the qualitative

comparison indicates that the likely benefits exceed the likely costs. If, however, the cost is deemed high or the benefit is deemed low, then the relevant TSO shall not proceed further.

2. Following the preparatory stage undertaken in accordance with paragraph 1, the relevant TSO shall carry out a quantitative cost-benefit analysis of any requirement under consideration for application to existing power-generating modules that have demonstrated potential benefits as a result of the preparatory stage according to paragraph 1.

3. Within three months of concluding the cost-benefit analysis, the relevant TSO shall summarise the findings in a report which shall:

- (a) include the cost-benefit analysis and a recommendation on how to proceed;
- (b) include a proposal for a transitional period for applying the requirement to existing power-generating modules. That transitional period shall not be more than two years from the date of the decision of the regulatory authority or where applicable the Member State on the requirement's applicability;
- (c) be subject to public consultation in accordance with Article 10.

4. No later than six months after the end of the public consultation, the relevant TSO shall prepare a report explaining the outcome of the consultation and making a proposal on the applicability of the requirement under consideration to existing power-generating modules. The report and proposal shall be notified to the regulatory authority or, where applicable, the Member State, and the power-generating facility owner or, where applicable, third party shall be informed on its content.

5. The proposal made by the relevant TSO to the regulatory authority or, where applicable, the Member State pursuant to paragraph 4 shall include the following:

- (a) an operational notification procedure for demonstrating the implementation of the requirements by the existing power-generating facility owner;
- (b) a transitional period for implementing the requirements which shall take into account the category of the power-generating module as specified in Article 5(2) and Article 23(3) and any underlying obstacles to the efficient implementation of the equipment modification/refitting.

### *Article 39*

#### **Principles of cost-benefit analysis**

1. Power-generating facility owners and DSOs including CDSOs shall assist and contribute to the cost-benefit analysis undertaken according to Article 13, Article 38 and Article 63 and provide the necessary data as requested by the relevant system operator or relevant TSO within three months of receiving a request, unless agreed otherwise by the relevant TSO. For the preparation of a cost-benefit-analysis by a power-generating facility owner, or prospective owner, assessing a potential derogation pursuant to Article 62, the relevant TSO and DSO, including CDSO, shall assist and contribute to the cost-benefit analysis and provide the necessary data as requested by the power-generating facility owner, or the prospective owner, within three months of receiving a request,

unless agreed otherwise by the power-generating facility owner or the prospective owner.

2. A cost-benefit analysis shall be in line with the following principles:

- (a) the relevant TSO, relevant system operator, power-generating facility owner or prospective owner shall base its cost-benefit analysis on one or more of the following calculating principles:
  - (i) the net present value;
  - (ii) the return on investment;
  - (iii) the rate of return;
  - (iv) the time needed to break even;
- (b) the relevant TSO, relevant system operator, power-generating facility owner or prospective owner shall also quantify socioeconomic benefits in terms of improvement in security of supply and shall include at least:
  - (i) the associated reduction in probability of loss of supply over the lifetime of the modification;
  - (ii) the probable extent and duration of such loss of supply;
  - (iii) the societal cost per hour of such loss of supply;
- (c) the relevant TSO, relevant system operator, power-generating facility owner or prospective owner shall quantify the benefits to the internal market in electricity, cross-border trade and integration of renewable energies, including at least:
  - (i) the active power frequency response;
  - (ii) the balancing reserves;
  - (iii) the reactive power provision;
  - (iv) congestion management;
  - (v) defence measures in accordance with the provisions established as per Article 59(2)(d) of Regulation (EU) 2019/943;
- (d) the relevant TSO shall quantify the costs of applying the necessary rules to existing power-generating modules, including at least:
  - (i) the direct costs incurred in implementing a requirement;
  - (ii) the costs associated with attributable loss of opportunity;
  - (iii) the costs associated with resulting changes in maintenance and operation.

## **TITLE IV**

### **COMPLIANCE**

#### ***CHAPTER 1***

## ***Compliance monitoring***

### ***Article 40***

#### **Responsibility of the power-generating facility owner**

1. The power-generating facility owner shall ensure that each power-generating module complies with the requirements applicable under this Regulation throughout the lifetime of the facility. For type A power-generating modules, the power-generating facility owner may rely upon equipment certificates, issued as per Regulation (EC) No 765/2008.
2. The power-generating facility owner shall notify to the relevant system operator any planned modification of the technical capabilities of a power-generating module which may affect its compliance with the requirements applicable under this Regulation, before initiating that modification.
3. The power-generating facility owner shall notify the relevant system operator of any operational incidents or failures of a power-generating module that affect its compliance with the requirements of this Regulation, without undue delay, after the occurrence of those incidents.
4. The power-generating facility owner shall notify the relevant system operator of the planned test schedules and procedures to be followed for verifying the compliance of a power-generating module with the requirements of this Regulation, in due time and prior to their launch. The relevant system operator shall approve in advance the planned test schedules and procedures. Such approval by the relevant system operator shall be provided in a timely manner and shall not be unreasonably withheld.
5. The relevant system operator may participate in such tests and record the performance of the power-generating modules.
6. The power-generating facility owner may delegate the performance of compliance testing to third parties. In such cases, the power-generating facility owner shall continue to ensure that the provisions of Article 12 are applied, and may enter into confidentiality commitments for this purpose with the third party.

### ***Article 41***

#### **Tasks of the relevant system operator**

1. The relevant system operator shall assess the compliance of a power-generating module with the requirements applicable under this Regulation, throughout the lifetime of the power-generating facility. The power-generating facility owner shall be informed of the outcome of this assessment.

For type A power-generating modules, the relevant system operator may rely upon equipment certificates issued by an authorised certifier for this assessment.

2. The relevant system operator shall have the right to request that the power-generating facility owner carry out compliance tests and simulations according to a repeat plan or general scheme or after any failure, modification or replacement of any equipment that may have an impact on the power-generating module's compliance with the requirements of this Regulation.



The power-generating facility owner shall be informed of the outcome of those compliance tests and simulations.

3. The relevant system operator shall make publicly available a list of information and documents to be provided as well as the requirements to be fulfilled by the power-generating facility owner within the framework of the compliance process. The list shall cover at least the following information, documents and requirements:

- (a) all the documentation and certificates to be provided by the power-generating facility owner;
- (b) details of the technical data on the power-generating module of relevance to the grid connection;
- (c) requirements for models for steady-state and dynamic system studies;
- (d) timeline for the provision of system data required to perform the studies;
- (e) studies by the power-generating facility owner to demonstrate the expected steady-state and dynamic performance in accordance with the requirements set out in Chapters 5 and 6 of Title IV;
- (f) conditions and procedures, including the scope, for registering equipment certificates; and
- (g) conditions and procedures for the use of relevant equipment certificates issued by an authorised certifier by the power-generating facility owner.

4. The relevant system operator shall make public the allocation of responsibilities between the power-generating facility owner and the system operator for compliance testing, simulation and monitoring.

5. The relevant system operator may totally or partially delegate the performance of its compliance monitoring to third parties. In such cases, the relevant system operator shall continue ensuring compliance with Article 12, including entering into confidentiality commitments with the assignee.

6. If compliance tests or simulations cannot be carried out as agreed between the relevant system operator and the power-generating facility owner due to reasons attributable to the relevant system operator, then the relevant system operator shall not unreasonably withhold the operational notification referred to in Title III.

#### *Article 42*

#### **Common provisions for compliance testing**

1. Testing of the performance of individual power-generating modules within a power-generating facility shall aim at demonstrating that the requirements of this Regulation have been complied with.

2. Notwithstanding the minimum requirements for compliance testing set out in this Regulation, the relevant system operator is entitled to:

- (a) allow the power-generating facility owner to carry out an alternative set of tests, provided that those tests are efficient and suffice to demonstrate that a power-generating module complies with the requirements of this Regulation;

- (b) require the power-generating facility owner to carry out additional or alternative sets of tests in those cases where the information supplied to the relevant system operator in relation to compliance testing under the provisions of Chapter 2, 3 or 4 of Title IV, is not sufficient to demonstrate compliance with the requirements of this Regulation; and
  - (c) 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 system operator and the power-generating facility owner shall agree on which types of fuel are to be tested.
3. The power-generating facility owner is responsible for carrying out the tests in accordance with the conditions laid down in Chapters 2, 3 and 4 of Title IV. The relevant system operator shall cooperate and not unduly delay the performance of the tests.
4. The relevant system operator may participate in the compliance testing either on site or remotely from the system operator's control centre. For that purpose, the power-generating facility owner shall provide the monitoring equipment necessary to record all relevant test signals and measurements as well as ensure that the necessary representatives of the power-generating facility owner are available on site for the entire testing period. Signals specified by the relevant system operator shall be provided if, for selected tests, the system operator wishes to use its own equipment to record performance. The relevant system operator has sole discretion to decide about its participation.
5. The compliance of V2G electric vehicle and V2G electric vehicle supply equipment, shall be based on individual type-test certificates issued according to Regulation (EC) No 765/2008 regarding the V2G electric vehicle supply equipment on one side and the V2G electric vehicle homologated platform (in case of AC connection of V2G electric vehicle) on the other side. The individual type-test certificates shall enable interoperability between different V2G electric vehicles and V2G electric vehicle supply equipment. Certifications on V2G electric vehicle supply equipment side shall not include the V2G electric vehicle, and certifications on V2G electric vehicle side, by means of type approval or homologation platforms, shall not include certification for V2G electric vehicle supply equipment. In this respect, certification programs and procedures shall be harmonised, cross-linked and consist of associated procedures on data exchange, communication handshake and technical power transfer.

#### *Article 43*

##### **Common provisions on compliance simulation**

1. Simulation of the performance of individual power-generating modules within a power-generating facility shall aim at demonstrating that the requirements of this Regulation have been fulfilled.
2. Notwithstanding the minimum requirements set out in this Regulation for compliance simulation, the relevant system operator may:
- (a) allow the power-generating facility owner to carry out an alternative set of simulations, provided that those simulations are efficient and suffice to demonstrate

that a power-generating module complies with the requirements of this Regulation or with national legislation; and

- (b) require the power-generating facility owner to carry out additional or alternative sets of simulations in those cases where the information supplied to the relevant system operator in relation to compliance simulation under the provisions of Chapter 5, 6 or 7 of Title IV, is not sufficient to demonstrate compliance with the requirements of this Regulation.
- 3. To demonstrate compliance with the requirements of this Regulation, the power-generating facility owner shall provide a report with the simulation results for each individual power-generating module within the power-generating facility. The power-generating facility owner shall produce and provide a validated simulation model for a given power-generating module. The scope of the simulation models is set out in point (c) of Article 15(5).
- 4. The relevant system operator shall have the right to check that a power-generating module complies with the requirements of this Regulation by carrying out its own compliance simulations based on the provided simulation reports, simulation models and compliance test measurements.
- 5. The relevant system operator shall provide the power-generating facility owner with technical data and a simulation model of the network, to the extent necessary to carry out the requested simulations in accordance with Chapter 5, 6 or 7 of Title IV.

#### *Article 43a*

##### **Common provisions on equipment certificates**

- 1. In the case that the compliance scheme specified by the relevant system operator provides for the use of equipment certificates issued by an authorised certifier in the context of Title III and/or Title IV, the equipment certificates shall comply with the following provisions:
  - (a) Any equipment certificate shall be based on a certification scheme defined within the compliance scheme that shall be specified by the relevant system operator. The equipment certificates include PGU certificates and component certificates. The equipment certificates shall demonstrate the conformity with the relevant technical requirements under this Regulation as of the national implementation. When the relevant system operator decides that the evaluation methodology provided in the certification scheme may not be applicable to conclude the conformity assessment, the relevant system operator should provide alternative methodologies for evaluation. These methodologies should, to the extent possible, be harmonised with or provide unambiguous references to established technical standards or conformity assessment schemes.
  - (b) If not otherwise specified by the certification scheme defined within the compliance scheme based on which the equipment certificate is issued according to (a), the equipment certificate shall contain the information specified by the relevant system operator as a minimum, which shall be provided to the power generating facility owner by the relevant system operator upon request.

2. Relevant system operators may accept equipment certificates, for power generating units or components, issued by authorized certifiers of Member States whose accreditation is given by the national affiliate of the European cooperation for Accreditation ('EA').

3. Relevant system operators may accept equipment certificates for PGU and/or components which belong to a PGU family and/or component family with a range of applicability defined within the compliance scheme, that shall be specified by each relevant system operator, under which the assessed PGU and/or component is certified.

## **CHAPTER 2**

### ***Compliance testing for synchronous power-generating modules***

#### *Article 44*

#### **Compliance tests for type B synchronous power-generating modules**

1. Power-generating facility owners shall undertake LFSM-O response compliance tests in relation to type B synchronous power-generating modules.

Instead of carrying out the relevant test, power-generating facility owners may rely upon equipment certificates issued by an authorised certifier to demonstrate compliance with the relevant requirement. In such a case, the equipment certificates shall be provided to the relevant system operator.

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

- (a) the power-generating module's technical capability to continuously modulate active power to contribute to frequency control in case of any large increase of frequency in the system shall be demonstrated. The steady-state parameters of regulations, such as droop and deadband, and dynamic parameters, including frequency step change response shall be verified;
- (b) the test shall be carried out by simulating frequency steps and ramps big enough to trigger at least 10 % of maximum capacity change in active power, taking into account the droop settings and the deadband. If required, simulated frequency deviation signals shall be injected simultaneously at both the speed governor and load controller of the control systems, taking into account the scheme of those control systems;
- (c) the test shall be deemed successful if the following conditions are fulfilled:
  - (i) the test results, for both dynamic and static parameters, meet the requirements set out in Article 13(3); and
  - (ii) undamped oscillations do not occur after the step change response.

#### *Article 45*

#### **Compliance tests for type C synchronous power-generating modules**

1. In addition to the compliance tests for type B synchronous power-generating modules described in Article 44, power-generating facility owners shall undertake the compliance tests set out in paragraphs 2, 3, 4 and 6 of this Article in relation to type C synchronous power-generating modules. Where a power-generating module provides black start capability, power-generating facility owners shall also undertake the tests referred to in paragraph 5. Instead of the relevant test, the power-generating facility owner may use equipment certificates issued by an authorised certifier to demonstrate compliance with the relevant requirement. In that case, the equipment certificates shall be provided to the relevant system operator.

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

- (a) it shall demonstrate that the power-generating module is technically capable of continuously modulating active power at operating points below maximum capacity to contribute to frequency control in case of a large frequency drop in the system;
- (b) the test shall be carried out by simulating appropriate active power load points, with low frequency steps and ramps big enough to trigger active power change of at least 10 % of maximum capacity, taking into account the droop settings and the deadband. If required, simulated frequency deviation signals shall be injected simultaneously into both the speed governor and the load controller references;
- (c) the test shall be deemed successful if the following conditions are fulfilled:
  - (i) the test results, for both dynamic and static parameters, comply with point (c) of Article 15(2); and
  - (ii) undamped oscillations do not occur after the step change response.

3. The following requirements with regard to the FSM response test shall apply:

- (a) it shall demonstrate that the power-generating module is technically capable of continuously modulating active power over the full operating range between maximum capacity and minimum regulating level to contribute to frequency control. 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 deviations shall be verified;
- (b) the test shall be carried out by simulating frequency steps and ramps big enough to trigger the whole active power frequency response range, taking into account the settings of droop and deadband, as well as the capability to actually increase or decrease active power output from the respective operating point. If required, 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;
- (c) the test shall be deemed successful if the following conditions are fulfilled:
  - (i) the activation time of full active power frequency response range as a result of a frequency step change is no longer than required by point (d) of Article 15(2);
  - (ii) undamped oscillations do not occur after the step change response;
  - (iii) the initial delay time complies with point (d) of Article 15(2);

- (iv) the droop settings are available within the range specified in point (d) of Article 15(2) and the deadband (threshold) is not higher than the value specified in that Article; and
  - (v) the insensitivity of active power frequency response at any relevant operating point does not exceed the requirements set out in point (d) of Article 15(2).
4. With regard to the frequency restoration control test the following requirements shall apply:
- (a) the power-generating module's technical capability to participate in frequency restoration control shall be demonstrated and the cooperation of FSM and frequency restoration control shall be checked;
  - (b) the test shall be deemed successful if the results, for both dynamic and static parameters, comply with the requirements of point (e) of Article 15(2).
5. With regard to the black start capability test the following requirements shall apply:
- (a) for power-generating modules with black start capability, this technical capability to start from shut down without any external electrical energy supply shall be demonstrated;
  - (b) the test shall be deemed successful if the start-up time is kept within the time frame set out in point (iii) of Article 15(4)(a).
6. With regard to the tripping to houseload test the following requirements shall apply:
- (a) the power-generating modules' technical capability to trip to and operate stably on house load shall be demonstrated;
  - (b) the test shall be carried out at the maximum capacity and nominal reactive power of the power-generating module before load shedding;
  - (c) the relevant system operator shall have the right to set additional conditions, taking into account point (c) of Article 15(4);
  - (d) the test shall be deemed successful if tripping to house load is successful, stable houseload operation has been demonstrated in the time period set out in point (c) of Article 15(4) and re-synchronisation to the network has been performed successfully.
7. With regard to the reactive power capability test the following requirements shall apply:
- (a) the power-generating module's technical capability to provide leading and lagging reactive power capability in accordance with points (b) and (c) of Article 18(2) shall be demonstrated;
  - (b) the test shall be deemed successful if the following conditions are fulfilled:
    - (i) the power-generating module operates at maximum reactive power for at least one hour, both leading and lagging, at:
      - minimum stable operating level,
      - maximum capacity, and



- an active power operating point between those maximum and minimum levels;
- (ii) the power-generating module's capability to change to any reactive power target value within the agreed or decided reactive power range shall be demonstrated.

#### *Article 46*

##### **Compliance tests for type D synchronous power-generating modules**

1. Type D synchronous power-generating modules are subject to the compliance tests for type B and C synchronous power-generating modules described in Article 44 and Article 45.
2. Instead of the relevant test, the power-generating facility owner may use equipment certificates issued by an authorised certifier to demonstrate compliance with the relevant requirement. In such a case, the equipment certificates shall be provided to the relevant system operator.

### **CHAPTER 3**

#### ***Compliance testing for power park modules***

#### *Article 47*

##### **Compliance tests for type B power park modules**

1. Power-generating facility owners shall undertake LFSM-O and LFSM-U-ESM response compliance tests in relation to type B power park modules.

Instead of the relevant test, the power-generating facility owner may use equipment certificates issued by an authorised certifier to demonstrate compliance with the relevant requirement. In that case, the equipment certificates shall be provided to the relevant system operator.

2. With regard to type B power park modules, the LFSM-O and LFSM-U-ESM response tests shall reflect the choice of control scheme selected by the relevant system operator.
3. With regard to the LFSM-O and LFSM-U-ESM response tests the following requirements shall apply:
  - (a) the power park module's technical capability to continuously modulate active power to contribute to frequency control in case of increase of frequency in the system shall be demonstrated. The steady-state parameters of regulations, such as droop and deadband, and dynamic parameters shall be verified;
  - (b) the test shall be carried out by simulating frequency steps and ramps big enough to trigger at least 10 % of maximum capacity change in active power, taking into account the droop settings and the deadband. To perform this test, simulated frequency deviation signals shall be injected simultaneously into the control system references;



- (c) the test shall be deemed successful in the event that the test results, for both dynamic and static parameters, comply with the requirements set out in Article 13(3) for LFSM-O and Article 13(11) for LFSM-U-ESM.

#### *Article 48*

#### **Compliance tests for type C power park modules**

1. In addition to the compliance tests for type B power park modules described in Article 47, power-generating facility owners shall undertake the compliance tests set out in paragraphs 2 to 9 in relation to type C power park modules. Instead of the relevant test, the power-generating facility owner may use equipment certificates issued by an authorised certifier to demonstrate compliance with the relevant requirement. In such a case, the equipment certificate shall be provided to the relevant system operator.
2. With regard to the active power controllability and control range test the following requirements shall apply:
  - (a) the power park module's technical capability to operate at a load level below the setpoint set by the relevant system operator or the relevant TSO shall be demonstrated;
  - (b) the test shall be deemed successful if the following conditions are fulfilled:
    - (i) the load level of the power park module is kept below the setpoint;
    - (ii) the setpoint is implemented according to the requirements laid down in Article 15(2)(a); and
    - (iii) the accuracy of the regulation complies with the value specified in point (a) of Article 15(2).
3. With regard to the LFSM-U response test the following requirements shall apply:
  - (a) the power park module's technical capability to continuously modulate active power to contribute to frequency control in case of a large frequency drop in the system shall be demonstrated;
  - (b) the test shall be carried out by simulating the frequency steps and ramps big enough to trigger at least 10 % of maximum capacity active power change with a starting point of no more than 80 % of maximum capacity, taking into account the droop settings and the deadband;
  - (c) the test shall be deemed successful if the following conditions are fulfilled:
    - (i) the test results, for both dynamic and static parameters, comply with the requirements laid down in Article 15(2)(c); and
    - (ii) undamped oscillations do not occur after the step change response.
4. With regard to the FSM response test the following requirements shall apply:
  - (a) the power park module's technical capability to continuously modulate active power over the full operating range between maximum capacity and minimum regulating level to contribute to frequency control shall be demonstrated. In the case of an

electricity storage module, the full operating range, , is between maximum consumption capacity and maximum capacity. The steady-state parameters of regulations, such as insensitivity, droop, deadband and range of regulation, as well as dynamic parameters, including frequency step change response shall be verified;

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

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

- (i) the activation time of the full active power frequency response range as a result of a frequency step change is no longer than that required by point (d) of Article 15(2);
- (ii) undamped oscillations do not occur after the step change response;
- (iii) the initial delay is in line with point (d) of Article 15(2);
- (iv) the droop settings are available within the ranges specified in point (d) of Article 15(2) and the deadband (threshold) is not higher than the value chosen by the relevant TSO; and
- (v) the insensitivity of active power frequency response does not exceed the requirement set out in point (d) of Article 15(2).

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

- (a) the power park module's technical capability to participate in frequency restoration control shall be demonstrated. The cooperation of both FSM and frequency restoration control shall be checked;
- (b) the test shall be deemed successful if the results for both dynamic and static parameters comply with the requirements of point (e) of Article 15(2).

6. With regard to the reactive power capability test the following requirements shall apply:

- (a) the power park module's technical capability to provide leading and lagging reactive power capability in accordance with points (b) and (c) of Article 21(2) shall be demonstrated;
- (b) it shall be carried out at maximum reactive power, both leading and lagging, and shall verify the following parameters:
  - (i) operation in excess of 60 % of maximum capacity for 30 min;
  - (ii) operation within the range of 30-50 % of maximum capacity for 30 min; and
  - (iii) operation within the range of 10-20 % of maximum capacity for 60 min;

the test shall be deemed successful if the following criteria are fulfilled:

- (i) the power park module operates for a duration no shorter than the requested duration at maximum reactive power, both leading and lagging, in each parameter specified in point(b) above;

- (ii) the power park module's capability to change to any reactive power target value within the agreed or decided reactive power range is demonstrated; and
- (iii) no protection action takes place within the operation limits specified by the reactive power capacity diagram.

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

(a) the power park module's capability to operate in voltage control mode referred to in the conditions set out in points (ii) to (iv) of Article 21(2)(d) shall be demonstrated;

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

- (i) the implemented slope and deadband according to Article 21(2)(d)(iii);
- (ii) the accuracy of the regulation;
- (iii) the insensitivity of the regulation; and
- (iv) the time of reactive power activation;

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

- (i) the range of regulation and adjustable droop and deadband complies with the agreed or decided characteristic parameters set out in point (d) of Article 21(2);
- (ii) the insensitivity of voltage control is not higher than 0,01 pu, in accordance with point (d) of Article 21(2); and
- (iii) following a step change in voltage, 90 % of the change in reactive power output has been achieved within the times and tolerances specified in point (d) of Article 21(2).

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

(a) the power park module's capability to operate in reactive power control mode, in accordance with point (v) of Article 21(2)(d), shall be demonstrated;

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

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

- (i) the reactive power setpoint range and increment;
- (ii) the accuracy of the regulation; and
- (iii) the time of reactive power activation.

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

- (i) the reactive power setpoint range and increment are ensured in accordance with point (d) of Article 21(2); and
- (ii) the accuracy of the regulation complies with the conditions set out in point (d) of Article 21(2).

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

- (a) the power park module's capability to operate in power factor control mode in accordance with point (vi) of Article 21(2)(d) shall be demonstrated;
  - (b) the power factor control mode test shall verify the following parameters:
    - (i) the power factor setpoint range;
    - (ii) the accuracy of the regulation; and
    - (iii) the response of reactive power due to step change of active power;
  - (c) the test shall be deemed successful if the following conditions are cumulatively fulfilled:
    - (i) the power factor setpoint range and increment are ensured in accordance with point (d) of Article 21(2);
    - (ii) the time of reactive power activation as a result of step active power change does not exceed the requirement laid down in point (d) of Article 21(2); and
    - (iii) the accuracy of the regulation complies with the value specified in point (d) of Article 21(2).
10. With regard to the tests referred to in paragraphs 7, 8 and 9, the relevant system operator may select only one of the three control options for testing.

#### *Article 49*

#### **Compliance tests for type D power park modules**

1. Type D power park modules are subject to the compliance tests for type B and C power park modules in accordance with the conditions set out in Article 47 and Article 48.
2. Instead of the relevant test, the power-generating facility owner may use equipment certificates issued by an authorised certifier to demonstrate compliance with the relevant requirement. In that case, the equipment certificates shall be provided to the relevant system operator.

### **CHAPTER 4**

#### ***Compliance testing for offshore power park modules***

#### *Article 50*

#### **Compliance tests for offshore power park modules**

Offshore power park modules are subject to the compliance tests for onshore power park modules in accordance with the conditions set out in Article 47, Article 48 and Article 49.

### **CHAPTER 5**

#### ***Compliance simulations for synchronous power-generating modules***

*Article 51*

**Compliance simulations for type B synchronous power-generating modules**

1. Power-generating facility owners shall undertake LFSM-O response simulations in relation to type B synchronous power-generating modules. Instead of the relevant simulations, the power-generating facility owner may use equipment certificates issued by an authorised certifier to demonstrate compliance with the relevant requirement. In that case, the equipment certificates shall be provided to the relevant system operator.
2. With regard to the LFSM-O response simulation the following requirements shall apply:
  - (a) the power-generating module's capability to modulate active power at high frequency in accordance with Article 13(3) shall be demonstrated by simulation;
  - (b) the simulation shall be carried out by means of high frequency steps and ramps reaching minimum regulating level;
  - (c) the simulation shall be deemed successful in the event that:
    - (i) the simulation model of the power-generating module is validated against the compliance test for LFSM-O response described in Article 44(2); and
    - (ii) compliance with the requirement set out in Article 13(3) is demonstrated.
  - (d) The relevant TSO has the right to request that compliance is demonstrated for the stability of the LFSM-O control in a close loop operation set up of the synchronous power-generating module.
3. With regard to the reactive power capability simulation, the following requirements shall apply:
  - (a) The relevant TSO has the right to request that compliance is demonstrated for the stability of the reactive power capability control in a close loop operation set up of the synchronous power-generating module.
  - (b) The simulation shall be deemed successful if compliance with the requirement set out in Article 17(2) is demonstrated.
4. With regard to the simulation of fault-ride-through capability of type B synchronous power-generating modules, the following requirements shall apply:
  - (a) the power-generating module's capability to ride through faults in accordance with the conditions set out in subparagraph (a) of Article 14(3) shall be demonstrated by simulation;
  - (b) the simulation shall be deemed successful if compliance with the requirement set out in point (a) of Article 14(3) is demonstrated.
5. With regard to the post fault active power recovery simulation the following requirements shall apply:
  - (a) the power-generating module's capability to provide post fault active power recovery referred to in the conditions set out in Article 17(3) shall be demonstrated;

(b) the simulation shall be deemed successful if compliance with the requirement set out in Article 17(3) is demonstrated.

6. With regard to the simulations on the system restoration requirement in paragraph (c) of Article 14(4), the power-generating module shall demonstrate its technical capability to operate stably in case of a step change of external short-circuit power at the connection point defined by the relevant system operator.

## *Article 52*

### **Compliance simulations for type C synchronous power-generating modules**

1. In addition to the compliance simulations for type B synchronous power-generating modules set out in Article 51, type C synchronous power-generating modules shall be subject to the compliance simulations detailed in paragraphs 2 to 5. Instead of all or part of those simulations, the power-generating facility owner may use equipment certificates issued by an authorised certifier, which shall be provided to the relevant system operator.

2. With regard to the LFSM-U response simulation the following requirements shall apply:

- (a) the power-generating module's capability to modulate active power at low frequencies in accordance with point (c) of Article 15(2) shall be demonstrated by RMS simulation;
- (b) the simulation shall be carried out by means of low frequency steps and ramps reaching maximum capacity, taking into account the droop settings and the deadband;
- (c) the simulation shall be deemed successful in the event that:
  - (i) the simulation model of the power-generating module is validated against the compliance test for LFSM-U response described in of Article 45(2); and
  - (ii) compliance with the requirement of point (c) of Article 15(2) is demonstrated.
- (d) The relevant TSO has the right to request that compliance is demonstrated for the stability of the LFSM-U control in a close loop operation set up of the synchronous power-generating module.

3. With regard to the FSM response simulation the following requirements shall apply:

- (a) the power-generating module's capability to modulate active power over the full frequency range in accordance with point (d) of Article 15(2) shall be demonstrated by RMS simulation;
- (b) the simulation shall be carried out by simulating frequency steps and ramps big enough to trigger the whole active power frequency response range, taking into account the droop settings and the deadband;
- (c) the simulation shall be deemed successful in the event that:
  - (i) the simulation model of the power-generating module is validated against the compliance test for FSM response described in Article 45 (3); and
  - (ii) compliance with the requirement of point (d) of Article 15(2) is demonstrated.

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

- (a) the power-generating module's performance during island operation referred to in the conditions set out in point (b) of Article 15(4) shall be demonstrated by RMS simulation; In addition to point (b) of Article 51(2) as well as point (c) of Article 52(2), the power-generating module shall demonstrate its technical capability to control stably the frequency within the frequency range specified in Table 2 in island operation in parallel to a load, based on FSM. Load steps leading to active power increase and decrease between 0% and 2% shall be considered; the control structure and parameters that are applied during normal network operation shall be applied during island operation. If parameter changes are necessary, they shall not affect the damping or small-signal stability;
  - (b) the simulation shall be deemed successful if 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 point (b) of Article 15(4), without disconnection of the power-generating module from the island due to over- or underfrequency.
5. With regard to the reactive power capability simulation the following requirements shall apply:
- (a) the power-generating module's capability to provide leading and lagging reactive power capability in accordance with the conditions set out in points (b) and (c) of Article 18(2) shall be demonstrated by simulation in the outer corners of the U-Q/Pmax diagram. In addition two simulations of the executed tests shall be performed with the real grid voltage and load points during the tests;
  - (b) the simulation shall be deemed successful if the following conditions are fulfilled:
    - (i) the simulation model of the power-generating module is validated against the compliance tests for reactive power capability, as far as these tests were accommodated (grid voltage deviations) described in Article 45(7) and allowed by the relevant system operator,); and
    - (ii) compliance with the requirements of points (b) and (c) of Article 18(2) is demonstrated.

### *Article 53*

#### **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 set out in Article 51 and Article 52, except for the simulation of fault-ride-through capability of type B synchronous power-generating modules referred to in Article 51(4), type D synchronous power-generating modules are subject to the compliance simulations set out in paragraphs 2 and 3. Instead of all or part of those simulations, the power-generating facility owner may use equipment certificates issued by an authorised certifier, which shall be provided to the relevant system operator.
2. With regard to the power oscillations damping control simulation the following requirements shall apply:



- (a) it shall be demonstrated that the power-generating module's performance in terms of its control system ('PSS function') is capable of damping active power oscillations in accordance with the conditions set out in paragraph 2 of Article 19;
  - (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 shall be deemed successful if the following conditions are cumulatively fulfilled:
    - (i) the PSS function damps the existing active power oscillations of the power-generating module within a frequency range specified by the relevant TSO. That frequency range shall include the local mode frequencies of the power-generating module and the expected network oscillations; and
    - (ii) a sudden load reduction of the power-generating module from 1 pu to 0,6 pu of the maximum capacity does not lead to undamped oscillations in active or reactive power of the power-generating module.
3. With regard to the simulation of fault-ride-through capability of type D synchronous power-generating modules, the following requirements shall apply:
- (a) the power-generating module's capability to provide fault-ride-through in accordance with the conditions set out in point (a) of Article 16(3) shall be demonstrated;
  - (b) the simulation shall be deemed successful if compliance with the requirement laid down in point (a) of Article 16(3) is demonstrated.

## **CHAPTER 6**

### ***Compliance simulations for power park modules***

#### ***Article 54***

#### **Compliance simulations for type B power park modules**

1. Type B power park modules are subject to the compliance simulations in paragraphs 2 to 5. Instead of all or part of those simulations, the power-generating facility owner may use equipment certificates issued by an authorised certifier, which shall be provided to the relevant system operator.
2. With regard to the LFSM-O response simulation the following requirements shall apply:
  - (a) the power park module's capability to modulate stably the active power at high frequency in accordance with Article 13(3) shall be demonstrated;
  - (b) the simulation shall be carried out by means of high frequency steps and ramps reaching minimum regulating level, taking into account the droop settings and the deadband;
  - (c) the simulation shall be deemed successful provided that:

- (i) the simulation model of the power park module is validated against the compliance test for LFSM-O response set out in Article 47(3); and
  - (ii) compliance with the requirement laid down in Article 13(3) is demonstrated.
- (d) the relevant TSO may request that compliance is demonstrated for the stability of the LFSM-O control in a close loop operation set up of the power park module.
3. With regard to the fast fault current injection simulation the following requirements shall apply:
- (a) the power park module's capability to provide fast fault current injection in accordance with the conditions set out in point (b) of Article 20(2) shall be demonstrated;
  - (b) the simulation shall be deemed successful if compliance with the requirement laid down in point (b) of Article 20(2) is demonstrated.
4. With regard to the fault-ride-through simulation capability of type B power park modules, the following requirements shall apply:
- (a) the power park module's capability to ride through faults in accordance with the conditions set out in point (a) of Article 14(3) shall be demonstrated by simulation;
  - (b) the simulation shall be deemed successful if compliance with the requirement laid down in point (a) of Article 14(3) is demonstrated.
5. The following requirements with regard to the post fault active power recovery simulation shall apply:
- (a) the power park module's capability to provide post fault active power recovery in accordance with the conditions set out in Article 20(3) shall be demonstrated;
  - (b) the simulation shall be deemed successful if compliance with the requirement laid down in Article 20(3) is demonstrated.

#### *Article 55*

#### **Compliance simulations for type C power park modules**

1. In addition to the compliance simulations for type B power park modules set out in Article 54, type C power park modules are subject to the compliance simulations set out in paragraphs 2 to 7. Instead of all or part of those simulations, the power-generating facility owner may use equipment certificates issued by an authorised certifier, which shall be provided to the relevant system operator.
2. With regard to the LFSM-U response simulation the following requirements shall apply:
- (a) the power park module's capability to stably modulate active power at low frequencies in accordance with point (c) of Article 15(2) shall be demonstrated;
  - (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 shall be deemed successful in the event that:

- (i) the simulation model of the power park module is validated against the compliance test for LFSM-U response set out in Article 48(3); and
    - (ii) compliance with the requirement laid down in point (c) of Article 15(2) is demonstrated.
  - (d) The relevant TSO has the right to request that compliance is demonstrated for the stability of the LFSM-U control in a close loop operation set up of the power park module.
3. With regard to the FSM response simulation the following requirements shall apply:
- (a) the power park module's capability to modulate active power over the full frequency range as referred to in point (d) of Article 15(2) shall be demonstrated;
  - (b) the simulation shall be carried out by simulating frequency steps and ramps big enough to trigger the whole active power frequency response range, taking into account the droop settings and the deadband;
  - (c) the simulation shall be deemed successful provided that:
    - (i) the simulation model of the power park module is validated against the compliance test for FSM response set out in Article 48(4); and
    - (ii) compliance with the requirement laid down in point (d) of Article 15(2) is demonstrated.
4. With regard to the island operation simulation, the following requirements shall apply:
- (a) the power park module's performance during island operation in accordance with the conditions set out in point (b) of Article 15(4) shall be demonstrated. In addition to point (b) of Article 54(2) as well as paragraph 2(c) of this Article, the power-generating module shall demonstrate its technical capability to control stably the frequency within the frequency range specified in Table 2 in island operation in parallel to a load, based on FSM. The load steps leading to active power increase and decrease between 0% and 2% shall be considered;
  - (b) the simulation shall be deemed successful in the event that the power park module reduces or increases the active power output from its previous operating point to any new operating point, within the P-Q-capability diagram and within the limits set out in point (b) of Article 15(4), without disconnection of the power park module from the island due to over- or underfrequency.
  - (c) for the simulations of paragraph 4(a) of this Article the relevant TSO in coordination with the relevant system operator should define an external short-circuit power and inertia to supplement the island scenario at the connection point.
5. With regard to the simulation of the capability of providing synthetic inertia, the following requirements shall apply:
- (a) the model of the power park module's capability of providing synthetic inertia to a low and high frequency event as set out in Article 21(4) shall be demonstrated;
  - (b) the simulation shall be deemed successful if the model demonstrates that it complies with the conditions set out in Article 21(4).

6. With regard to the reactive power capability simulation, the following requirements shall apply:

- (a) the power park module shall demonstrate that it can provide leading and lagging reactive power capability as set out in points (b) and (c) of Article 21(2);
- (b) the simulation shall be deemed successful if the following conditions are cumulatively fulfilled:
  - (i) the simulation model of the power park module is validated against the compliance tests for reactive power capability set out in paragraph 6 of Article 48; and
  - (ii) compliance with the requirements laid down in points (b) and (c) of Article 21(2) is demonstrated.

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

- (a) the model of the power park module shall demonstrate that it can provide active power oscillations damping capability accordance with point (f) of Article 21(2);
- (b) the simulation shall be deemed successful if the following conditions are cumulatively fulfilled:
  - (i) the simulation model of the power park module is validated against the compliance tests for reactive power capability set out in paragraph 6 of Article 48; and
  - (ii) compliance with the requirements laid down in points (b) and (c) of Article 21(2) is demonstrated.
- (c) The relevant TSO has the right to request that compliance is demonstrated for the stability of the reactive power capability control in a close loop operation set up of the power park module.

#### *Article 56*

#### **Compliance simulations for type D power park modules**

1. In addition to the compliance simulations for type B and C power park modules set out in Article 54 and Article 55, except for the fault-ride-through capability of type B power park modules referred to in Article 54(5), type D power park modules are subject to the fault-ride-through capability of power park modules compliance simulation.
2. Instead of all or part of the simulations mentioned in paragraph 1, the power-generating facility owner may use equipment certificates issued by an authorised certifier, which shall be provided to the relevant system operator.
3. The model of the power park module shall demonstrate that it is suitable for simulating the fault-ride-through capability in accordance with point (a) of Article 16(3).
4. The simulation shall be deemed successful if the model demonstrates compliance with the conditions set out in point (a) of Article 16(3).

**CHAPTER 7*****Compliance simulations for offshore power park modules******Article 57*****Compliance simulations applicable to offshore power park modules**

The compliance simulations specified in paragraph 5 of Article 54 as well as in paragraphs 4, 5 and 7 of Article 55 shall apply to any offshore power park module.

**CHAPTER 8*****Non-binding guidance and monitoring of implementation******Article 58*****Non-binding guidance on implementation**

1. No later than six months after the entry into force of this Regulation, the ENTSO for Electricity shall prepare and thereafter every two years provide non-binding written guidance to its members and other system operators concerning the elements of this Regulation requiring national decisions. The ENTSO for Electricity shall publish this guidance on its website.
2. ENTSO for Electricity shall consult stakeholders when providing non-binding guidance.
3. The non-binding guidance shall explain the technical issues, conditions and interdependencies which need to be considered when complying with the requirements of this Regulation at national level.

***Article 59*****Monitoring**

1. ACER shall monitor the implementation of this Regulation in accordance with Article 32 of Regulation (EC) No 2019/943. The monitoring shall cover in particular the following matters:

- (a) identification of any divergences in the national implementation of this Regulation;
- (b) assessment of whether the choice of values and ranges in the requirements applicable to power-generating modules under this Regulation continues to be valid.

ACER shall involve the European Stakeholder Committee in the monitoring, where relevant.

2. ACER, in cooperation with ENTSO for Electricity, shall maintain a list of the relevant information to be communicated by ENTSO for Electricity to ACER in accordance with Article 30(5) and 32(1) of Regulation (EC) No 2019/943. The list of relevant information may be subject to updates and shall be kept in line with the information contained in the implementation monitoring files to be published in accordance with paragraph 3. ENTSO

for Electricity shall maintain a comprehensive, standardised format, digital data archive of the information required by ACER.

3. Relevant TSOs and DSOs shall submit and keep updated to ACER through the national regulatory authority, the information requested by ACER to perform the tasks referred to in paragraphs 1 and 2. Relevant TSOs shall submit to ENTSO for Electricity the information required for ACER to perform the tasks referred to in paragraphs 1 and 2. TSOs shall ensure that the information is provided without undue delay and is up to date.

The EU DSO entity shall cooperate with ENTSO for Electricity on the monitoring of implementation of this Regulation in accordance with Article 55(2)(a) of Regulation (EU) 2019/943, among other activities, on the provision of information necessary for monitoring the implementation of this Regulation.

Based on a request of the regulatory authority, DSOs shall provide TSOs with information under paragraph 2 unless the information has already been obtained by the regulatory authority, ACER, the ENTSO for Electricity or the EU DSO entity in relation to their respective implementation monitoring tasks, with the objective of avoiding duplication of information. DSOs shall ensure that the information is provided without undue delay and is up to date.

ACER, in cooperation with ENTSO for Electricity, shall maintain a public online repository where relevant national information regarding the progress of implementation of this Regulation shall be made available. The information to be made available shall at least include legal texts, implementation monitoring files, summaries of all the proposals for non-exhaustive requirements, TSO and DSO requirements and compliance tests and process to be performed and links to the national implementation websites.

4. Where ENTSO for Electricity or ACER identify areas in which, based on market developments or experience gathered in the application of this Regulation, further harmonisation of the requirements under this Regulation is advisable to promote market integration, they shall propose draft amendments to this Regulation pursuant to Article 60(2) of Regulation (EU) 2019/943.

## **TITLE V**

### **DEROGATIONS**

#### *Article 60*

#### **Power to grant derogations**

1. Regulatory authorities may, at the request of a power-generating facility owner or prospective owner, relevant system operator or relevant TSO, grant power-generating facility owners or prospective owners, relevant system operators or relevant TSOs derogations from one or more provisions of this Regulation for new and existing power-generating modules in accordance with Article 61 to Article 63.

2. Where applicable in a Member State, derogations may be granted and revoked in accordance with Article 61 to Article 63 by other authorities than the regulatory authority.

## *Article 61*

### **General provisions**

1. Each regulatory authority shall specify, after consulting relevant system operators and power-generating facility owners and other stakeholders whom it deems affected by this Regulation, the criteria for granting derogations pursuant to Article 62 and Article 63. It shall publish those criteria on its website and notify them to the Commission within nine months of the entry into force of this Regulation. The Commission may require a regulatory authority to amend the criteria if it considers that they are not in line with this Regulation. This possibility to review and amend the criteria for granting derogations shall not affect the derogations already granted which shall continue to apply until the scheduled expiry date as detailed in the decision granting the exemption.
2. If the regulatory authority deems that it is necessary due to a change in circumstances relating to the evolution of system requirements, it may review and amend at most once every year the criteria for granting derogations in accordance with paragraph 1. Any changes to the criteria shall not apply to derogations for which a request has already been made.
3. The regulatory authority may decide that power-generating modules for which a request for a derogation has been filed pursuant to Article 62 and Article 63 do not need to comply with the requirements of this Regulation from which a derogation has been sought from the day of filing the request until the regulatory authority's decision is issued.

## *Article 62*

### **Request for a derogation by a power-generating facility owner**

1. Power-generating facility owners, or prospective owners, may request a derogation to one or several requirements of this Regulation for power-generating modules within their facilities.
2. A request for a derogation shall be filed with the relevant system operator and include:
  - (a) an identification of the power-generating facility owner, or prospective owner, and a contact person for any communications;
  - (b) a description of the power-generating module or modules for which a derogation is requested;
  - (c) a reference to the provisions of this Regulation from which a derogation is requested and a detailed description of the requested derogation;
  - (d) detailed reasoning, with relevant supporting documents and cost-benefit analysis pursuant to the requirements of Article 39;
  - (e) demonstration that the requested derogation would have no adverse effect on cross-border trade.
3. Within two weeks of receipt of a request for a derogation, the relevant system operator shall confirm to the power-generating facility owner, or prospective owner, whether the request is complete. If the relevant system operator considers that the request is incomplete, the power-generating facility owner, or prospective owner, shall submit the



additional required information within one month from the receipt of the request for additional information. If the power-generating facility owner, or prospective owner, does not supply the requested information within that time limit, the request for a derogation shall be deemed withdrawn.

4. The relevant system operator shall, in coordination with the relevant TSO and any affected adjacent DSO or DSOs, assess the request for a derogation and the provided cost-benefit analysis, taking into account the criteria determined by the regulatory authority pursuant to Article 61.

5. If a request for a derogation concerns a type C or D power-generating module connected to a distribution system, including a closed distribution system, the relevant system operator's assessment shall be accompanied by an assessment of the request for a derogation by the relevant TSO. The relevant TSO shall provide its assessment within two months of being requested to do so by the relevant system operator.

6. Within six months of receipt of a request for a derogation, the relevant system operator shall forward the request to the regulatory authority and submit the assessment(s) prepared in accordance with paragraphs 4 and 5. That period may be extended by one month where the relevant system operator seeks further information from the power-generating facility owner, or prospective owner and by two months where the relevant system operator requests the relevant TSO to submit an assessment of the request for a derogation.

7. The regulatory authority shall adopt a decision concerning any request for a derogation within six months from the day after it receives the request. That time limit may be extended by three months before its expiry where the regulatory authority requires further information from the power-generating facility owner, or prospective owner, or from any other interested parties. The additional period shall begin when the complete information has been received.

8. The power-generating facility owner, or prospective owner, shall submit any additional information requested by the regulatory authority within two months of such request. If the power-generating facility owner, or prospective owner, does not supply the requested information within that time limit, the request for a derogation shall be deemed withdrawn unless, before its expiry:

(a) the regulatory authority decides to provide an extension; or

(b) the power-generating facility owner, or prospective owner, informs the regulatory authority by means of a reasoned submission that the request for a derogation is complete.

9. The regulatory authority shall issue a reasoned decision concerning a request for a derogation. Where the regulatory authority grants a derogation, it shall specify its duration.

10. The regulatory authority shall notify its decision to the relevant power-generating facility owner, or prospective owner, the relevant system operator and the relevant TSO.

11. A regulatory authority may revoke a decision granting a derogation if the circumstances and underlying reasons no longer apply or upon a reasoned

recommendation of the Commission or reasoned recommendation by the Agency pursuant to Article 65(2).

12. For Type A power-generating modules, a request for a derogation under this Article may be made by a third party on behalf of the power-generating facility owner, or prospective owner. Such a request may be for a single power-generating module or multiple, identical power-generating modules. In the case of the latter, and provided the cumulative maximum capacity is specified, the third party may substitute the details required by point (a) of paragraph 2 with their details.

### *Article 63*

#### **Request for a derogation by a relevant system operator or relevant TSO**

1. Relevant system operators or relevant TSOs may request derogations for classes of power-generating modules connected or to be connected to their network.
2. Relevant system operators or relevant TSOs shall submit their requests for derogations to the regulatory authority. Each request for a derogation shall include:
  - (a) identification of the relevant system operator or relevant TSO, and a contact person for any communications;
  - (b) a description of the power-generating modules for which a derogation is requested and the total installed capacity and number of power-generating modules;
  - (c) the requirement or requirements of this Regulation for which a derogation is requested, with a detailed description of the requested derogation;
  - (d) detailed reasoning, with all relevant supporting documents;
  - (e) demonstration that the requested derogation would have no adverse effect on cross-border trade;
  - (f) a cost-benefit analysis pursuant to the requirements of Article 39. If applicable, the cost-benefit analysis shall be carried out in coordination with the relevant TSO and any adjacent DSO or DSOs.
3. Where the request for a derogation is submitted by a relevant DSO or CDSO, the regulatory authority shall, within two weeks from the day after receipt of that request, ask the relevant TSO to assess the request for a derogation in the light of the criteria determined by the regulatory authority pursuant to Article 61.
4. Within two weeks from the day after the receipt of such request for assessment, the relevant TSO shall confirm to the relevant DSO or CDSO whether the request for a derogation is complete. If the relevant TSO considers that it is incomplete, the relevant DSO or CDSO shall submit the required additional information within one month from the receipt of the request for additional information.
5. Within six months of receipt of a request for a derogation, the relevant TSO shall submit to the regulatory authority its assessment, including any relevant documentation. The six-month time limit may be extended by one month where the relevant TSO seeks further information from the relevant DSO or from the relevant CDSO.

6. The regulatory authority shall adopt a decision concerning a request for a derogation within six months from the day after it receives the request. Where the request for a derogation is submitted by the relevant DSO or CDSO, the six-month time limit runs from the day following receipt of the relevant TSO's assessment pursuant to paragraph 5.

7. The six-month time limit referred to in paragraph 6 may, before its expiry, be extended by an additional three months where the regulatory authority requests further information from the relevant system operator requesting the derogation or from any other interested parties. That additional period shall run from the day following the date of receipt of the complete information.

The relevant system operator shall provide any additional information requested by the regulatory authority within two months from the date of the request. If the relevant system operator does not provide the requested additional information within that time limit, the request for a derogation shall be deemed withdrawn unless, before expiry of the time limit:

- (a) the regulatory authority decides to provide an extension; or
- (b) the relevant system operator informs the regulatory authority by means of a reasoned submission that the request for a derogation is complete.

8. The regulatory authority shall issue a reasoned decision concerning a request for a derogation. Where the regulatory authority grants derogation, it shall specify its duration.

9. The regulatory authority shall notify its decision to the relevant system operator requesting the derogation, the relevant TSO and the Agency.

10. Regulatory authorities may lay down further requirements concerning the preparation of requests for derogation by relevant system operators. In doing so, regulatory authorities shall take into account the delineation between the transmission system and the distribution system at the national level and shall consult with system operators, power-generating facility owners and stakeholders, including manufacturers.

11. A regulatory authority may revoke a decision granting a derogation if the circumstances and underlying reasons no longer apply or upon a reasoned recommendation of the Commission or reasoned recommendation by the Agency pursuant to Article 65(2).

#### *Article 64*

##### **Register of derogations from the requirements of this Regulation**

1. Regulatory authorities shall maintain a register of all derogations they have granted or refused and shall provide the Agency with an updated and consolidated register at least once every six months. This register shall be publicly available.

2. The register shall contain, in particular:

- (a) the requirement or requirements for which the derogation is granted or refused;
- (b) the content of the derogation;
- (c) the reasons for granting or refusing the derogation;

(d) the consequences resulting from granting the derogation.

#### *Article 65*

### **Monitoring of derogations**

1. The Agency shall monitor the procedure of granting derogations with the cooperation of the regulatory authorities or relevant authorities of the Member State. Those authorities or relevant authorities of the Member State shall provide the Agency with all the information necessary for that purpose.
2. The Agency may issue a reasoned recommendation to a regulatory authority to revoke a derogation due to a lack of justification. The Commission may issue a reasoned recommendation to a regulatory authority or relevant authority of the Member State to revoke derogation due to a lack of justification.
3. The Commission may request the Agency to report on the application of paragraphs 1 and 2 and to provide reasons for requesting or not requesting derogations to be revoked.

## **TITLE VI**

### **FINAL PROVISIONS**

#### *Article 71*

### **Amendment of contracts and general terms and conditions**

1. Regulatory authorities shall ensure that all relevant clauses in contracts and general terms and conditions relating to the grid connection of new power-generating modules are brought into compliance with the requirements of this Regulation.
2. All relevant clauses in contracts and relevant clauses of general terms and conditions relating to the grid connection of existing power-generating modules subject to all or some of the requirements of this Regulation in accordance with Article 4(1) shall be amended in order to comply with the requirements of this Regulation. The relevant clauses shall be amended within three years following the decision of the regulatory authority or Member State as referred to in Article 4(1).
3. Regulatory authorities shall ensure that national agreements between system operators and owners of new or existing power-generating facilities subject to this Regulation and relating to grid connection requirements for power-generating facilities, in particular in national network codes, reflect the requirements set out in this Regulation.

#### *Article 71a*

### **Repeal**

1. Regulation (EU) 2016/631 is repealed. References to the repealed Regulation shall be construed as references to this Regulation and shall be read in accordance with the correlation table set out in Annex [ ].

2. Notwithstanding paragraph 1, Regulation (EU) 2016/631 shall continue to apply to power-generating modules which fall within its scope of application at the entry into force of this Regulation and which are not subject to the requirements of this Regulation according to Article 4(1).

## *Article 72*

### **Entry into force**

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

Without prejudice to Article 4(2)(b), Article 7, Article Y(5) subparagraph 2, Article Y(6)(b), Article 58, Article 59, Article 61 and Title VI, the requirements of this Regulation shall apply from three years after publication.

This Regulation shall be binding in its entirety and directly applicable in all Member States.

Done at Brussels, ....

*For the Commission*

*The President*

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<sup>(1)</sup> [OJ L 158, 14.6.2019, p. 54](#).

<sup>(2)</sup> Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU (recast) ([OJ L 158, 14.6.2019, p. 125](#)).

<sup>(3)</sup> Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC ([OJ L 315, 14.11.2012, p. 1](#)).

<sup>(4)</sup> Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management ([OJ L 197, 25.7.2015, p. 24](#)).

<sup>(5)</sup> Commission Regulation (EU) No 543/2013 of 14 June 2013 on submission and publication of data in electricity markets and amending Annex I to Regulation (EC) No 714/2009 of the European Parliament and of the Council ([OJ L 163, 15.6.2013, p. 1](#)).

<sup>(6)</sup> Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products and repealing Regulation (EEC) No 339/93 ([OJ L 218, 13.8.2008, p. 30](#)).

<sup>(\*)</sup> The voltage base for pu values is below 300 kV.

<sup>(\*\*)</sup> The voltage base for pu values is from 300 kV to 400 kV.

<sup>(\*\*\*)</sup> At the offshore connection point for configuration 1.

<sup>(\*\*\*\*)</sup> At the offshore connection point for configuration 2.

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