ENTSO-E Draft Network Code for

Requirements for Grid Connection Applicable to all Generators

27 April 2012

Gelöscht: 24 January

Notice
This document reflect the status of the work done by TSO experts as of 10 January 2012, in line with the ACER Framework Guidelines on Electricity Grid Connections published on 20 July 2011. It is based not only on the input of an extensive informal dialogue with stakeholders and of several public workshops that took place during the pilot period between Summer of 2009 and 3 March 2011, the date on which Regulation (EC) 714/2009 entered into force, but also on further discussions after the EC mandate letter was received by ENTSO-E on 29 July 2011. **This document is issued for formal public consultation of stakeholders who are invited to submit their comments via the web-based ENTSO-E consultation tool by 20 March 2012.** **After due consideration of these comments in an open and transparent manner in compliance with Article 10 of Regulation (EC) 714/2009, ENTSO-E will adopt its "Network code for requirements for grid connection applicable to all generators" and submit it to ACER".**

PURPOSE AND OBJECTIVES

Having regard to Directive 2009/72/CE of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/CE;

Having regard to Regulation 714/2009 of the European parliament and of the Council of 13 July 2009 and especially Article 6;

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

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

Whereas :

(1) Directive 2009/72/CE of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/CE and Regulation 714/2009 of the European Parliament and of the Council of 13 July 2009 (whereas section 6) underline the need for an increased cooperation and coordination among transmission system operators within a European network of transmission system operators for electricity (ENTSO-E) to create Network Codes for providing and managing effective and transparent access to the transmission networks across borders, and to ensure coordinated and sufficiently forward-looking planning and sound technical evolution of the transmission system in the Community, including the creation of interconnection capacities, with due regard to the environment ;

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

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

(4) Secure system operation is only possible by close cooperation between owners of Power Generating Facilities and the Network Operators. In particular, the system behaviour in disturbed operating conditions depends upon the response of Power Generating Facilities to deviations from nominal values of voltage and Frequency. In context of system security the Network and the Power Generating Facilities need to be considered as one entity from a systems engineering approach. It is therefore of crucial importance that Power Generating Facilities are obliged to meet the relevant technical requirements set out in the Network Code concerning system security as a prerequisite for

Gelöscht: frequency

grid connection. Appropriate dynamic behaviour of Power Generating Facilities and their protection and control facilities are necessary in normal operating conditions and in a range of disturbed operating conditions in order to preserve or to re-establish system security. The close cooperation between owners of Power Generating Facilities and the Network Operators shall take place in due compliance with the principle of confidentiality, such as further detailed in Article 16(1) of Directive 2009/72/CE.

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

(6) EC Regulation 714/2009 Article 8(7) defines that "the network codes shall be developed for cross-border network issues and market integration issues and shall be without prejudice to the Member States' right to establish national network codes which do not affect cross-border trade".

The term "cross-border network issue" itself is not defined by this EC Regulation. Therefore for the purposes of this document a definition needs to be derived from the targets of the EC 3rd legislative package for the internal electricity market, which are:

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

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

As indicated in (4) above, TSOs cannot ensure the system security regardless of the technical capabilities of power generating facilities, TSOs call for a regular coordination at the level of generation and for an adequate performance of equipment connected to their networks with robustness to face disturbances and to help to prevent any large disturbance or to facilitate restoration of the system after the collapse.

Also as stated in (4) above, Secure system operation is only possible by close cooperation of power generating facilities connected at all voltage levels with the network operators in an appropriate way. Consequently, the transmission system and the Power Generating Modules need to be considered as one entity from a systems engineering approach. It is therefore of crucial importance that Power Generating Modules are obliged to meet the requirements and to provide the technical capabilities with relevance to system security.

Gelöscht: Units

Gelöscht: Units

To ensure system security within the interconnected transmission system and to provide adequate security level a common understanding on these requirements to power generating facilities is essential. All requirements that contribute to maintaining, preserving and restoring system security in order to facilitate proper functioning of the internal electricity market within and between synchronous areas, and to achieving cost efficiencies through technical standardization shall be regarded as "cross-border network issues".

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

Title 1

GENERAL PROVISIONS

Article 1

SUBJECT MATTER

This Network Code defines a common set of requirements for Power Generating Facilities, including Synchronous Power Generating Modules, Power Park Modules and Offshore Generation Facilities and sets up a common framework for grid connection of Power Generating Facilities.

Gelöscht: Units

Article 2

DEFINITIONS (glossary)

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

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

Gelöscht: apparent power

Active Power Frequency Response - automatic response of Active Power output from a Power Generating Facility, in response to a change in System Frequency from the Nominal System Frequency.

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

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

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

Gelöscht: voltage (in volts)

Gelöscht: current (in amperes).

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

Automatic Voltage Regulator (AVR) - the continuously acting automatic equipment controlling the terminal voltage of a Synchronous Power Generating Module by comparing the actual terminal voltage with a reference value and controlling by appropriate means the output of an Exciter, depending on the deviations.

Gelöscht: Unit

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

Gelöscht: external

Closed Distribution System Operator (CDSO) - means a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing a closed distribution network according to Article 28 of Directive 2009/72/CE in a given area and, where applicable, its interconnections with other networks and for ensuring the long-term ability of the network to meet reasonable demands for the distribution of electricity.

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

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

Compliance Testing – the process to verify that Power Generating Modules are compliant with the specifications and requirements of this Network Code, for example before starting operation of new installations. The verification should include, inter alia, the revision of documentation, the verification of the requested capabilities of the facility by practical tests.

Connection Agreement - a contract between the Network Operator and the Power Generating Facility Owner which includes the relevant site and technical specific requirements for the Power Generating Facility complementary to requirements defined in the applicable Network Code.

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

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

Cost-Benefit Analysis – is a process by which the Relevant Network Operator weighs the expected costs of alternative actions against the expected benefits in order to determine the alternative with the highest net socio-economic benefit.

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

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

Droop - the ratio of the steady state change of Frequency to the steady state change in power output.

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

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

Gelöscht: **Block Loading** - maximum step Active Power loading of reconnected demand during system restoration after black-out.¶

Gelöscht: for verifying

Gelöscht: **Testing**

Gelöscht: of verification

Gelöscht: Facilities comply

Gelöscht: provided by

Gelöscht: and simulation studies and the revision of actual measurements during trial operation

Gelöscht: location

Gelöscht: Unit

Gelöscht: public

Gelöscht: private

Gelöscht: speed or in

Gelöscht: system

Gelöscht: systems

Gelöscht: system

Equipment Certificate - a document issued by an Authorised Certifier for equipment used in Types A Power Generating Modules confirming compliance with relevant requirements of this Network Code as far as the influence on overall performance by this specific equipment. The Equipment Certificate shall define the extent of its validity in relation to parameters for which there is only a range of values defined in this document. This will identify its validity at a national or other level at which a specific value is selected from the range allowed at a European level. The Equipment Certificate will have a unique number allowing simple reference to it in Installation Document.

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

Exciter - the source of the electrical power (static or rotating) providing the field current for the excitation of an electrical machine.

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

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

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

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

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

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

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

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

Inertia - is the fact that a rotating rigid body such as an Alternator maintains its state of uniform rotational motion. Its angular momentum is unchanged, unless an external torque is applied.

Interim Operational Notification (ION) - a notification issued by the Relevant Network Operator to a Power Generating Facility Owner confirming that the Power Generating Facility Owner is entitled to operate the Power Generating Module by using the grid connection for a limited period of time and

Gelöscht: **Existing Generating Unit** – a Generating Unit which is either physically connected to the Network or under construction or for which a confirmation is provided in accordance with Article 3(4) by the Power Generating Facility Owner that a final and binding contract for the construction, assembly or purchase of the main plant, i.e. prime mover, generator, etc., of the Generating Unit exists at the day of the entry into force of this Network Code.¶

Gelöscht: Unit

Gelöscht: frequency control

Gelöscht: frequency

Gelöscht: frequency

Gelöscht: Unit

Gelöscht: **Generating Unit** - a Generating Unit is an indivisible set of installations which can generate electrical energy. If there is more than one unit generating power within a Power Generating Facility, that cannot be operated independently from each other or can reasonably be considered in a combined way, then each of the combinations of these units shall be considered as one Generating Unit. This includes more than one Generating Unit in a CCGT and multiple units in a Power Park Module. A storage devices operating in electricity generation mode is considered to be a Generating Unit.¶

Gelöscht: Units

Gelöscht: a synchronous generator

Gelöscht: **Interim Compliance Statement** - itemized statement of compliance provided by the Power Generating Facility Owner to the Relevant Network Operator as established in this Network Code and as additionally required by national legislation including the national codes.¶

Gelöscht: Unit

to undertake compliance tests to meet the technical design and operational criteria of the Network Code.

Installation Document - a simple structured document containing information about a Type A Power Generating Module and confirming compliance with the relevant requirements of this Network Code. The blank Installation Document to be available from the Relevant Network Operator for the owner of the Type A Power Generating Module or alternatively the site installer on the owner's behalf to fill in and submit to the Relevant Network Operator.

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

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

Limited Frequency Sensitive Mode – Overfrequency (LFSM-O) - a Power Generating Module operating mode which will result in Active Power output reducing, in response to a change in System Frequency above a certain value. For Power Generating Modules also providing LFSM-U, both LFSM-O and LFSM-U will be operational together.

Limited Frequency Sensitive Mode – Underfrequency (LFSM-U) - a Power Generating Module operating mode which will result in Active Power output increasing, in response to a change in System Frequency below a certain value. LFSM-U and LFSM-O are operational together.

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

Manufacturer's Data and Performance Type Certificate (MD&PTC) - a certificate issued by an Authorised Certifier and registered with Network Operators defining verified data and performance which can include models and testing for the purpose of replacing specific parts of the compliance process Type B, C and D Power Generating Modules. MD&PTCs cannot be accepted as the sole evidence indicating overall compliance of a Power Generating Module. Instead the MD&PTC verifies specific parts of data and performance. It is a certificate of validated data.

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

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

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

Network Operator - the network operator is any kind of entity that operates a Network. These represent either a TSO, a DSO or CDSO.

New Power Generating Module – a Power Generating Module for which

Gelöscht: Generating Unit in operation with ability to control speed

Gelöscht: Unit

Gelöscht: Units

Gelöscht: Unit

Gelöscht: – certificates

Gelöscht: authorised certifiers

Gelöscht: . Only for types A and

Gelöscht: Units is there the potential for these

Gelöscht: to

Gelöscht: compliance. For types C and D

Gelöscht: Units

Gelöscht: The existence of an MD&PTC in context of Types C and D does not indicate overall compliance.

Gelöscht: Unit

Gelöscht: Unit

Gelöscht: an industrial customers network

Gelöscht: Unit

Gelöscht: Unit

- a final and binding contract of purchase of the main plant has been signed after the day, which is two years after the day of the entry into force of this Network Code, or
- no confirmation is provided by the Power Generating Facility Owner that a final and binding contract of purchase of the main plant exists prior to the day, which is two years after the day of the entry into force of this Network Code.

Offshore Connection Point - a Connection Point located offshore.

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

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

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

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

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

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

Power Generating Facility Owner – any natural or legal entity owning a Power Generating Facility.

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

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

Power Park Module (PPM) - any unit or ensemble of units generating electricity, which
- is connected to the network non-synchronously or through power electronics, and
- has a single Connection Point to the network.

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

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

P-Q-Capability Diagram - describes the Reactive Power capability of a Power Generating Module in context of varying Active Power at the high-voltage terminals of the step-up transformer to the voltage level of the Connection Point taking into account its full tap-changing range.

Gelöscht: neither physically connected to the

Gelöscht: nor for which a

Gelöscht: at

Gelöscht: Interconnected

Gelöscht: System

Gelöscht: interconnection

Gelöscht: for the Offshore Power Park Module

Gelöscht: Responsible

Gelöscht: a alternator

Gelöscht: Units

Gelöscht: not synchronously

Gelöscht: . This includes any connection

Gelöscht: any ensemble of units having

Gelöscht: Unit

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

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

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

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

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

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

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

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

Short-Circuit Ratio - for the Alternator is the ratio of the field current required for the rated voltage at open circuit to the field current required for the rated Alternator terminal current at short circuit.

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

Slope - the percentage change in Voltage, based on nominal Voltage, with a change in Reactive Power infeed from 0 to maximum Reactive Power.

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

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

Synchronous Compensation Operation – operation of an Alternator without prime mover to regulate voltage dynamically by production or absorption of Reactive Power

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

- a single synchronous unit generating power within a Power Generating Facility directly connected to the network, or
- an ensemble of synchronous units generating power within a Power Generating Facility directly connected to the network with a common Connection Point, or
- an ensemble of synchronous units generating power within a Power Generating Facility directly connected to the network that cannot be operated independently from each other (e. g. units generating in a combined-cycle gas turbine facility), or
- a single synchronous storage device operating in electricity generation mode directly connected to the network, or

Gelöscht: apparent power

Gelöscht: TSO

Gelöscht: TSO in

Gelöscht: Control Area

Gelöscht: Unit

Gelöscht: to the Network

Gelöscht: Unit

Gelöscht: to

Gelöscht: Unit

Gelöscht: alternator

Gelöscht: alternator

Gelöscht: Unit –

Gelöscht: Unit

Gelöscht: voltage

Gelöscht: that result in

Gelöscht:

Gelöscht: **Speed Control** - capability of a Generating Unit to contribute to control speed by adjusting the Active Power Output in order to maintain stable system frequency.¶

Gelöscht: synchronous machine

Gelöscht: Unit

Gelöscht: synchronously operating

Gelöscht: Unit that

Gelöscht: synchronously

Gelöscht: without any frequency converters.

- an ensemble of synchronous storage devices operating in electricity generation mode directly connected to the network with a common Connection Point.

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

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

U-Q/P_{max}-profile - a profile representing the Reactive Power capability of a Power Generating Facility in context of varying voltage at the high-voltage terminals of the step-up transformer to the voltage level of the Connection Point.

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

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

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

Gelöscht: Unit

Gelöscht: system

Gelöscht: systems

Gelöscht: system

Gelöscht: **Transient Stability** - is the ability of a Generating Unit to maintain synchronism following a severe transient disturbance.¶

Gelöscht: alternator

Article 3

SCOPE

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

2. The requirements set forth by this Network Code shall apply to Existing Power Generating Modules which are significant according to the provisions of this Network Code, to the extent their applicability has been decided by the National Regulatory Authority, and if this has been proposed by the Relevant TSO, following a public consultation. The proposal by the Relevant TSO shall be made in particular on the basis of a sound and transparent quantitative Cost-Benefit Analysis, including the costs of requiring compliance that shall demonstrate the socio-economic benefit of application of the requirements set forth by this Network Code to Existing Power Generating Modules. The Relevant TSO shall have the right to re-assess the applicability of the requirements set forth by this Network Code to Existing Power Generating Modules regularly, but not more often than every three years. Prior to the Relevant TSO carrying out the quantitative Cost-Benefit Analysis an initial qualitative comparison of costs and benefits shall be undertaken in order to determine the cases of sizes of Power Generating Modules or types of Power Generating Modules or locations of Power Generating Modules or clauses of this Network Code for which there may be a viable case for application to Existing Power Generating Modules. Where this preparatory stage demonstrates that a subsequent analytical Cost-Benefit Analysis has a reasonable prospect of demonstrating positive cost-benefit, the Relevant TSO may

Gelöscht: Units

Gelöscht:

Gelöscht:

Gelöscht: Units

Gelöscht: cost-benefit analysis

Gelöscht: Units

Gelöscht: Units

Gelöscht: cost-benefit analysis

Gelöscht: cost benefit analysis

Gelöscht: generators

Gelöscht: generators

Gelöscht: generators

Gelöscht: Generators.

Gelöscht: filtering process

Gelöscht: cost-benefit

proceed with the full transparent quantitative Cost-Benefit Analysis. Where the preparatory stage or later stage demonstrate that applicability of the Network Code to Existing Power Generating Modules is not required no further action is to be undertaken.

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

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

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

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

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

   d) The Power Generating Module confirmed, in accordance with the procedure set forth in paragraphs 4 (a) to (c) above, shall be considered as an Existing Power Generating Module, provided that:

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

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

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

5. The applicability and extent of the requirements a Power Generating Modules has to comply with depends on the voltage level of their Connection Point and their Maximum Capacity according to the categories defined in paragraph 6 below.

Gelöscht: cost-benefit analysis.
Gelöscht: filtering process
Gelöscht: Units
Gelöscht: Generation Facilities
Gelöscht: Units
Gelöscht: under construction:
Gelöscht: six
Gelöscht: relevant
Gelöscht: each
Gelöscht: contract
Gelöscht: Unit
Gelöscht: on
Gelöscht: relevant
Gelöscht: auditor
Gelöscht: Unit
Gelöscht: Unit
Gelöscht: relevant
Gelöscht: Unit
Gelöscht: auditor
Gelöscht: Unit
Gelöscht: Unit
Gelöscht: Unit
Gelöscht: Units
Gelöscht: MW capacity

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

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

b) A Synchronous Power Generating Module or Power Park Module is of Type B if its Connection Point is below 110 kV and its Maximum Capacity is at or above a threshold which is decided by each Relevant TSO pursuant to Article 4(3). This defined threshold shall not be above the threshold for Type B Power Generating Modules according to table 1. The definition of the threshold shall be coordinated with adjacent TSOs and DSOs and shall be reviewed by the National Regulatory Authority. Power Generating Facility Owners shall assist and contribute to this determination of the threshold and provide the relevant data as requested by the Relevant TSO. The Relevant TSO shall have the right to re-assess the determination of the threshold regularly with public consultation, if relevant circumstances have changed materially, but not more often than every three years. Following any change to thresholds any Power Generating Module that has been moved to a new type will not automatically have to comply retrospectively to the additional requirements but will be subject to the same procedure as applied to existing generators in line with Article 32. Requirements applicable to Type B Power Generating Modules provide a wider level of automated dynamic response (generally with settings by the Relevant Network Operator) with higher resilience to more specific operational events to ensure use of this higher dynamic response and a higher level system operator control and information to utilize these capabilities. They ensure automated response to alleviate and maximize dynamic generation response to system events, greater Power Generating Module resilience of these events to ensure this dynamic response and better communication and control to leverage these capabilities.

c) A Synchronous Power Generating Module or Power Park Module is of Type C if its Connection Point is below 110 kV and its Maximum Capacity is at or above a threshold which is decided by each Relevant TSO pursuant to Article 4(3). This defined threshold shall not be above the threshold for Type C Power Generating Modules according to table 1. The definition of the threshold shall be coordinated with adjacent TSOs and DSOs and shall be reviewed by the National Regulatory Authority. Power Generating Facility Owners shall assist and contribute to this determination of the threshold and provide the relevant data as requested by the Relevant TSO. The Relevant TSO shall have the right to re-assess the determination of the threshold regularly with public consultation, if relevant circumstances have changed materially, but not more often than every three years. Following any change to thresholds any Power Generating Module that has been moved to a new type will not automatically have to comply retrospectively to the additional requirements but will be subject to the same procedure as applied to existing generators in line with Article 32. Requirements applicable to Type C Power Generating Modules provide refined, stable and highly controllable (real time) dynamic response to provide principle ancillary services to ensure security of supply. These requirements cover all operational network states with consequential detailed specification of interactions of requirements, functions, control and information to utilize these capabilities. They ensure real time system response necessary to

Gelöscht: Units

Gelöscht: Units

Gelöscht: Units

Gelöscht: A Synchronous Generating Unit or Power Park Module is of Type A if its Connection Point is below 110 kV and its Maximum Capacity is 400 W or more.

[1] verschoben

Gelöscht: Requirements applicable to Type B Generating Units

Gelöscht: generator

Gelöscht: Unit

Gelöscht: B

Gelöscht: B units

Gelöscht: including

Gelöscht: ¶

Gelöscht: Units

Gelöscht: balancing

avoid, manage and respond to system events. These requirements provide sufficient generation functionality to respond to both intact and system disturbed situations, and the need for information and control necessary to utilise this generation over this diversity of situations.

d) A Synchronous Power Generating Module or Power Park Module is of Type D if its Connection Point is at 110 kV or above. A Synchronous Power Generating Module or Power Park Module is of Type D as well if its Connection Point is below 110 kV and its Maximum Capacity is at or above a threshold which is decided by each Relevant TSO pursuant to Article 4(3). This defined threshold shall not be above the threshold for Type D Power Generating Modules according to table 1. The definition of the threshold shall be coordinated with adjacent TSOs and DSOs and shall be reviewed by the National Regulatory Authority. Power Generating Facility Owners shall assist and contribute to this determination of the threshold and provide the relevant data as requested by the Relevant TSO. The Relevant TSO shall have the right to re-assess the determination of the threshold regularly with public consultation, if relevant circumstances have changed materially, but not more often than every three years. Following any change to thresholds any Power Generating Module that has been moved to a new type will not automatically have to comply retrospectively to the additional requirements but will be subject to the same procedure as applied to existing generators in line with Article 32. Requirements applicable to Type D Power Generating Modules are in particular specific for higher voltage connected generation with impact on entire system control and operation. They ensure stable operation of the interconnected network, allowing the use of ancillary services from generation Europe wide.

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

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

e) For offshore connected Synchronous Power Generating Modules the requirements for onshore synchronous Power Generating Modules shall apply unless modified by a decision of the Relevant Network Operator pursuant to Article 4(3). The categories to be taken into account for Offshore Power Park Modules for the purpose of this Network Code are defined in Article 17(3).

f) Synchronous Compensation Operation of Pump-Storage Power Generating Modules shall not be limited in time by technical design of the Power Generating Modules. Pump-Storage variable speed Power Generating Modules shall fulfil all requirements applicable to

Gelöscht: Unit

Gelöscht: C

Gelöscht: C units

Gelöscht: including

Gelöscht: Requirements applicable to Type D Generating Units are in particular specific for higher voltage connected generation with impact on entire system control and operation. They ensure stable operation of the interconnected network, allowing the use of balancing services from generation Europe wide. A Synchronous Generating Unit or Power Park Module is of Type D if its Connection Point is at 110 kV or above. A Synchronous Generating Unit or Power Park Module is of Type D as well if its Connection Point is below 110 kV and its Maximum Capacity is at or above a threshold which is decided by each Relevant TSO pursuant to Article 4(3). This defined threshold shall not be above the threshold for Type D units according to table 1.¶

[1] nach oben: <#> The definition of the threshold shall be coordinated with adjacent TSOs and DSOs and shall be reviewed by the National Regulatory Authority. Power Generating Facility Owners shall assist and contribute to this determination of the threshold and provide the relevant data as requested by the Relevant TSO.

Gelöscht: <#>The Relevant TSO shall have the right to re-assess the determination of the threshold regularly including public consultation, if relevant circumstances have changed materially, but not more often than every three years.¶

Gelöscht: Unit

Gelöscht: Unit

Gelöscht: Unit

Gelöscht: 1

Gelöscht: 5

Gelöscht: Units

Gelöscht: Units

Gelöscht: Units

Gelöscht: 18(4

Gelöscht: storage

Gelöscht: Units

Gelöscht: fulfil all requirements in both generating and pumping operation mode. They shall

Gelöscht: designed for synchronous compensation operation for unlimited

Gelöscht: storage

Gelöscht: Units

synchronous Power Generating Modules and in addition those set forth in Article 14(2) (b), if they are of Type B, C or D.

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

h) Without prejudice to the general applicability of the requirements set forth in this Network Code, a requirement of this Network Code shall not apply to Power Generating Modules of a facility for combined heat and power production (CHP) embedded in an industrial site in the following cumulative circumstances:
   - the primary purpose of this facility is to produce steam for production processes of this industrial site;
   - the generation of steam and power are rigidly coupled to each other, i. e. any change of steam generation results inadvertently in a change of Active Power generation and vice versa;
   - the Power Generating Module is of Type A, B or C according to Article 3(6) (a) to (c); and
   - the requirement is related to the capability maintain constant Active Power output or to modulate Active Power output other than Article 7(1) (c) and (e).

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

Gelöscht: Type D

Gelöscht: Units

Gelöscht: 15

Gelöscht: Active Power output

Article 4

REGULATORY ASPECTS

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

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

3. Where reference is made to this paragraph, any decision by a Relevant Network Operator and/or a Relevant TSO or any agreement between, on the one hand, a Relevant Network Operator or a Relevant TSO and, on the other, a Power Generating Facility Owner shall be performed under the conditions of the applicable national legal framework and in accordance with the principles of transparency, proportionality and non-discrimination and, as the case may be, with the involvement of the National Regulatory Authority.

4. The costs related to the obligations referred to in this Network Code which have to be borne by the regulated Network Operators shall be taken into account in the calculation of tariffs. Regulatory authorities shall approve those costs if they are reasonable and proportionate.

Article 5

CONFIDENTIALITY OBLIGATIONS

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

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

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

Gelöscht: DSO

Gelöscht: DSO

Gelöscht:

Article 6

RELATIONSHIP WITH NATIONAL LAW PROVISIONS

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

Title 2

REQUIREMENTS

Chapter 1

GENERAL REQUIREMENTS

Article 7

GENERAL REQUIREMENTS FOR TYPE A POWER GENERATING MODULES

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

   a) With regard to Frequency ranges:

      1) In case of deviation of the Network Frequency from its nominal value, due to a deviation within the Frequency ranges and time periods specified by table 2 any automatic disconnection of a Power Generating Module from the Network shall be prohibited and power infeed shall be maintained.

Gelöscht: UNITS

Gelöscht: units

Gelöscht: frequency

Gelöscht: frequency

Gelöscht: frequency

Gelöscht: frequency

Gelöscht: Unit

Synchronous Area	Frequency Range	Time period for operation
Continental Europe	47.5 Hz – 48.5 Hz	To be decided by each TSO pursuant to Article 4(3), but not less than 30 minutes
	48.5 Hz – 49.0 Hz	To be decided by each TSO pursuant to Article 4(3), but not less than the period for 47.5 Hz – 48.5 Hz
	49.0 Hz – 51.0 Hz	Unlimited
	51.0 Hz – 51.5 Hz	30 minutes
Nordic	47.5 Hz – 48.5 Hz	30 minutes
	48.5 Hz – 49.0 Hz	To be decided by each TSO pursuant to Article 4(3), but not less than 30 minutes
	49.0 Hz – 51.0 Hz	Unlimited
	51.0 Hz – 51.5 Hz	30 minutes
Great Britain	47.0 Hz – 47.5 Hz	20 seconds
	47.5 Hz – 48.5 Hz	90 minutes
	48.5 Hz – 49.0 Hz	To be decided by each TSO pursuant to Article 4(3), but not less than 90 minutes
	49.0 Hz – 51.0 Hz	Unlimited
	51.0 Hz – 51.5 Hz	90 minutes
	51.5 Hz – 52.0 Hz	15 minutes
Ireland	47.5 Hz – 48.5 Hz	90 minutes
	48.5 Hz – 49.0 Hz	To be decided by each TSO pursuant to Article 4(3), but not less than 90 minutes
	49.0 Hz – 51.0 Hz	Unlimited
	51.0 Hz – 51.5 Hz	90 minutes
Baltic	47.5 Hz – 48.5 Hz	To be decided by each TSO pursuant to Article 4(3), but not less than 30 minutes
	48.5 Hz – 49.0 Hz	To be decided by each TSO pursuant to Article 4(3), but not less than the period for 47.5 Hz – 48.5 Hz
	49.0 Hz – 51.0 Hz	Unlimited
	51.0 Hz – 51.5 Hz	To be decided by each TSO pursuant to Article 4(3), but not less than 30 minutes

Table 2: This table shows the minimum time periods a Power Generating Module has to be able to operate for different frequencies deviating from a nominal value without disconnecting from the network.

2) Unless national law gives the Relevant TSO authority to make such decisions pursuant to Article 4(3), wider Frequency ranges or longer minimum times for operation can be agreed between the Relevant Network Operator in coordination with the Relevant TSO and the Power Generating Facility Owner to ensure the best use of the technical capabilities of a Power Generating Module if needed to preserve or to restore system security. If wider Frequency ranges or longer minimum times for operation are

Gelöscht: 90 minutes

Gelöscht: 90 minutes

Gelöscht: 90 minutes

Gelöscht: Unit

Gelöscht: frequency

Gelöscht: Unit

Gelöscht: frequency

economically and technically feasible, the consent of the Power Generating Facility Owner shall not be unreasonably withheld.

3) Notwithstanding the provisions of point 1) a Power Generating Module shall be capable of automatic disconnection at specified frequencies, if required by the Relevant Network Operator. Unless national law gives the Relevant TSO authority to make such decisions pursuant to Article 4(3), the terms and settings for automatic disconnection shall be agreed between the Relevant Network Operator and the Power Generating Facility Owner.

b) With regard to the rate of change of Frequency withstand capability, the Power Generating Module shall not disconnect from the network due to rates of change of Frequency up to a value defined by the Relevant TSO pursuant to Article 4(3) other than triggered by rate-of-change-of-Frequency-type of loss of mains protection. The Frequency shall be measured using 100 ms average.

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

1) The Power Generating Module shall be capable of activating the provision of Active Power Frequency Response according to figure 1 at a Frequency threshold between and including 50.2 Hz and 50.5 Hz with a Droop in a range of 2 – 12 %. The actual Frequency threshold and Droop settings shall be determined by the Relevant TSO. The Active Power Frequency Response shall be activated as fast as technically feasible with an initial delay that shall be as short as possible and reasonably justified if greater than 2 seconds. Below Minimum Regulating Level the Power Generating Module is allowed to disconnect from the network.

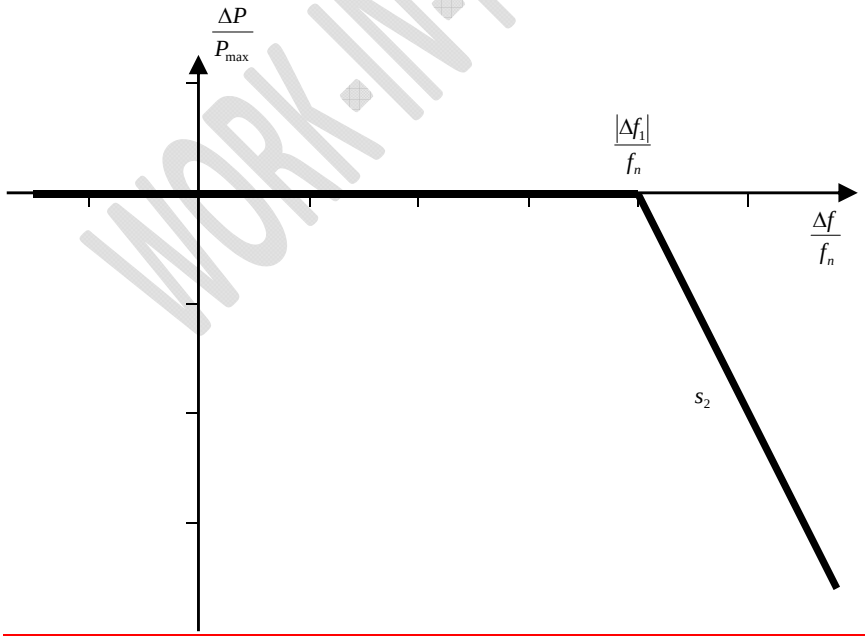


Figure 1: Active Power Frequency Response capability of Power Generating Modules in LFSM-O. P_{max} is the Maximum Capacity to which ΔP is related. ΔP is the change in Active

Gelöscht: Unit

Gelöscht: , if not regulated by the respective national grid code or by the TSO,

Gelöscht: frequency

Gelöscht: Unit

Gelöscht: frequency

Gelöscht: 2 Hz/s

Gelöscht: frequency

Gelöscht:):

Gelöscht: Unit

Gelöscht: providing

Gelöscht: . ¶
The Generating Unit shall in the LFSM-O be capable of activating Active Power

Gelöscht: Response at a frequency

Power output from the Power Generating Module. f_n is the nominal Frequency (50 Hz) in the network and Δf is the Frequency change in the network. At overfrequencies where Δf is above Δf_1 the Power Generating Module has to provide a negative Active Power output change according to the Droop S_2.

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

d) The Power Generating Module shall maintain constant output at its target Active Power value regardless of changes in Frequency, unless output shall follow the defined changes in output in the context of Article 7(1) (c) or Article 9(2) (b), and Article 9(2) (c) where applicable.

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

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

Acceptance of this reduction is limited to a selection of affected generation technologies and may be subject to further conditions decided by the Relevant TSO pursuant to Article 4(3).

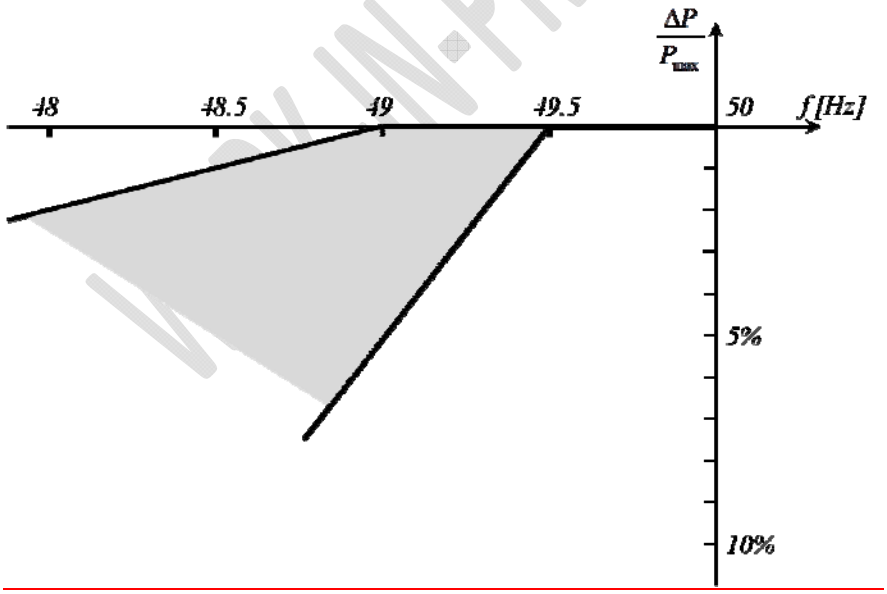


Figure 2 – Maximum power capability reduction with falling Frequency. The diagram represents the boundaries defined by the TSO pursuant to Article 4(3).

f) The Power Generating Module shall be equipped with a logic interface (I/O port) in order to cease Active Power output within less than 5 seconds following an Instruction from the

Relevant Network Operator. The Relevant Network Operator shall have the right to adopt a decision pursuant to Article 4(3) determining the requirements for further equipment to make this facility operable remotely. [2] verschoben

g) The Relevant TSO shall define pursuant to Article 4(3) the conditions under which a Power Generating Module is allowed to connect automatically to the Network. These conditions shall include:
   - Frequency ranges, within with an automatic connection is admissible, and a corresponding delay time
   - maximum admissible gradient of increase of Active Power output

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

Article 8

GENERAL REQUIREMENTS FOR TYPE B POWER GENERATING MODULES

1. In addition to fulfilling the requirements listed in Article 7, Type B Power Generating Modules shall fulfil the following requirements referring to robustness of Power Generating Modules, system restoration and to general system management through the Network.

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

   a) In order to be able to control Active Power output, the Power Generating Module shall be equipped with a interface (I/O port) in order to be able to reduce Active Power output as instructed by the Relevant Network Operator. The Relevant Network Operator shall have the right to adopt a decision pursuant to Article 4(3) determining the requirements for further equipment to make this facility operable remotely. [3] verschoben

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

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

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

   a) With regard to control schemes and settings:

      1) Unless national law gives the Relevant TSO authority to make such decisions pursuant to Article 4(3), schemes and settings of the different control devices of the Power Generating Facility relevant for transmission system stability shall be coordinated and agreed between the Relevant TSO, the Relevant Network Operator and the Power Generating Facility Owner.

2) Unless national law gives the Relevant TSO authority to make such decisions pursuant to Article 4(3), any changes to the schemes and settings of the different control devices of the Power Generating Facility, relevant for transmission system stability, shall be coordinated and agreed between the Relevant TSO, the Relevant Network Operator and the Power Generating Facility Owner, especially if they concern the circumstances referred to above under point 1).

b) With regard to priority ranking of protection and control, the Power Generating Facility shall organize their protections and control devices in compliance with the following priority ranking, organized in decreasing order of importance: [4] verschoben

- Network system and Power Generating Module protection;
- Synthetic Inertia, if applicable; [5] verschoben
- Frequency control (Active Power adjustment);
- Power Restriction; and
- Power gradient constraint.

c) With regard to information exchange: [6] verschoben

1) Power Generating Facilities shall be capable of exchanging information as defined by the Relevant Network Operator between the Power Generating Facility Owner and the Relevant Network Operator in real time or periodically with time stamping.

2) The Relevant Network Operator in coordination with the Relevant TSO shall define the contents of information exchanges and the precise list and time of data to be facilitated.

Article 9

GENERAL REQUIREMENTS FOR TYPE C POWER GENERATING MODULES

1. In addition to fulfilling the requirements listed in Articles 7 and 8, except for Article 7(1) (f) and Article 8(2) (a), Type C Power Generating Modules shall fulfil the following requirements referring to the Frequency stability, voltage stability, robustness of Power Generating Modules, system restoration and to general system management through the Network.

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

a) With regard to Active Power controllability and control range, the Power Generating Facility control system shall be capable of adjusting an Active Power Setpoint as instructed by the Relevant Network Operator to the Power Generating Facility Owner. It shall be capable of implementing the Setpoint within a period specified in the above Instruction and within a tolerance defined by the Relevant Network Operator (subject to the availability of the prime mover resource). Manual, local measures shall be possible in the case that any automatic remote control devices are out of service.

b) In addition to Article 7(1) (c) the following shall apply accumulatively with regard to Limited Frequency Sensitive Mode – Underfrequency (LFSM-U): [7] verschoben

1) The Power Generating Module shall be capable of activating the provision of Active Power Frequency Response according to figure 3 at a Frequency threshold between and Gelöscht: frequency

including 49.8 Hz and 49.5 Hz with a Droop in a range of 2 – 12 %. In the LFSM-U mode the Power Generating Module shall be capable of providing a power increase up to its Maximum Capacity. The actual delivery of Active Power Frequency Response in LFSM-U mode depends on the operating conditions of the Power Generating Module when this response is triggered, in particular limitations on operation near Maximum Capacity at low frequencies according to Article 7(1) (e) and available primary energy sources. The actual Frequency threshold and Droop settings shall be determined by the Relevant TSO. The Active Power Frequency Response shall be activated as fast as technically feasible with an initial delay that shall be as short as possible and reasonably justified if greater than 2 seconds.

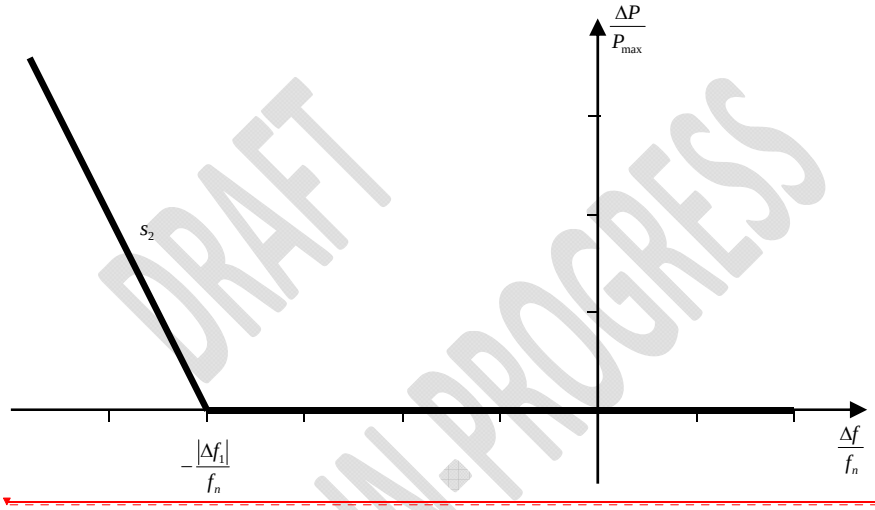


Figure 3: Active Power Frequency Response capability of Power Generating Modules in LFSM-U. P_{max} is the Maximum Capacity to which ΔP is related. ΔP is the change in Active Power output from the Power Generating Module. f_n is the nominal Frequency (50 Hz) in the network and Δf is the Frequency change in the network. At underfrequencies where Δf is below Δf_1 the Power Generating Module has to provide a positive Active Power output change according to the Droop S_2.

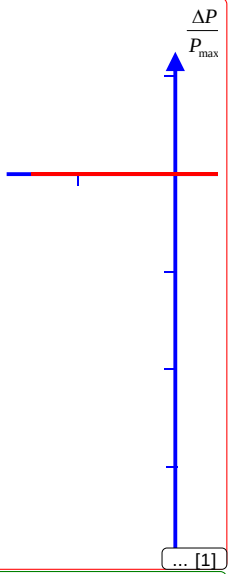
2) Stable operation of the Power Generating Module during LFSM-U operation shall be ensured. When LFSM-U is active, the LFSM-U Setpoint will prevail over any other Active Power Setpoints.

c) In addition to paragraph 2 (b) the following shall apply accumulatively, when operating in Frequency Sensitive Mode (FSM) at frequency deviations smaller than the thresholds for LFSM-U or LFSM-O:

1) The Power Generating Module shall be capable of providing Active Power Frequency Response with respect to figure 4 and in accordance with the parameters specified by each TSO within the ranges shown in table 3.

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

3) In case of underfrequency the Active Power Frequency Response is limited by Maximum Capacity. The actual delivery of Active Power Frequency Response depends on the



Gelöscht: ... [1]

[2] nach oben: . The Relevant Network Operator shall have the ... [2]

[3] nach oben: <#> The Relevant Network Operator shall have the ... [4]

[6] nach oben: <#>With regard to information exchange:¶

[7] nach oben: <#>In addition to Article 7(1) (c) the following shall ... [7]

Gelöscht: ¶
¶ ... [3]

Gelöscht: 3. . Type B units shall fulfil the following requirement referrin ... [5]

Gelöscht: <#>Power Generating Facilities shall be equipped acc ... [6]

Gelöscht: <#>The Generating Unit shall be capable of providing Ac ... [8]

Gelöscht: Unit

Gelöscht: frequency

Gelöscht: frequency

Gelöscht: Unit

Gelöscht: Unit

Gelöscht: Any contradiction between power and speed cont ... [9]

Gelöscht: operation shall be prohibited.¶ ... [10]

Gelöscht: operation, the Generating Unit

Gelöscht: simultaneously also be in LFSM-O mode

Gelöscht: c

Gelöscht:):

Gelöscht: Unit

Gelöscht: 3

Gelöscht:

operating conditions of the Power Generating Module when this response is triggered, in particular limitations on operation near Maximum Capacity at low frequencies according to Article 7(1) (e) and available primary energy sources.

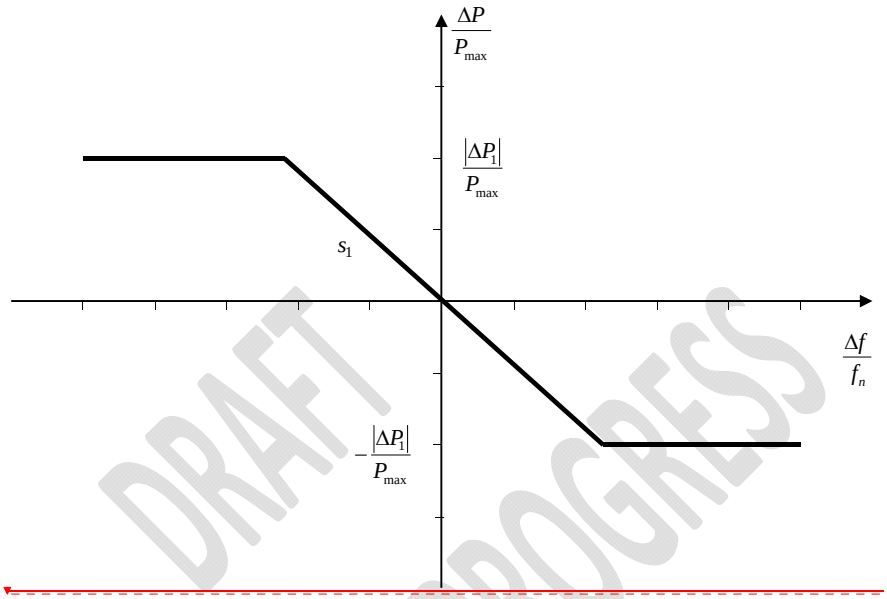


Figure 4: Active Power Frequency Response capability of Power Generating Modules in FSM. P_{max} is the Maximum Capacity to which ΔP is related. ΔP is the change in Active Power output from the Power Generating Module. f_n is the nominal Frequency (50 Hz) in the network and Δf is the Frequency deviation in the network.

Parameters		Ranges
Active Power range related to Maximum Capacity $\frac{\lvert\Delta P_1\rvert}{P_{max}}$		1.5 – 10 %
Frequency Response Insensitivity	$\lvert\Delta f_i\rvert$	10 – 30 mHz
	$\frac{\lvert\Delta f_i\rvert}{f_n}$	0.02 – 0.06 %
Frequency Response Deadband		0 – 500 mHz
Droop s_1		2 – 12 %

Table 3: Parameters for Active Power Frequency Response in FSM (explanation for figure 4)

Gelöscht:
Gelöscht: 3
Gelöscht: Units
Gelöscht: Unit
Gelöscht: frequency
Gelöscht: frequency
Gelöscht: 2
Gelöscht: 20
Gelöscht: 3

4) The Frequency Response Deadband of Frequency deviation and Droop are selected by the TSO and must be able to be reselected subsequently (without requiring to be online or remote) within the given frames in the table 3.

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

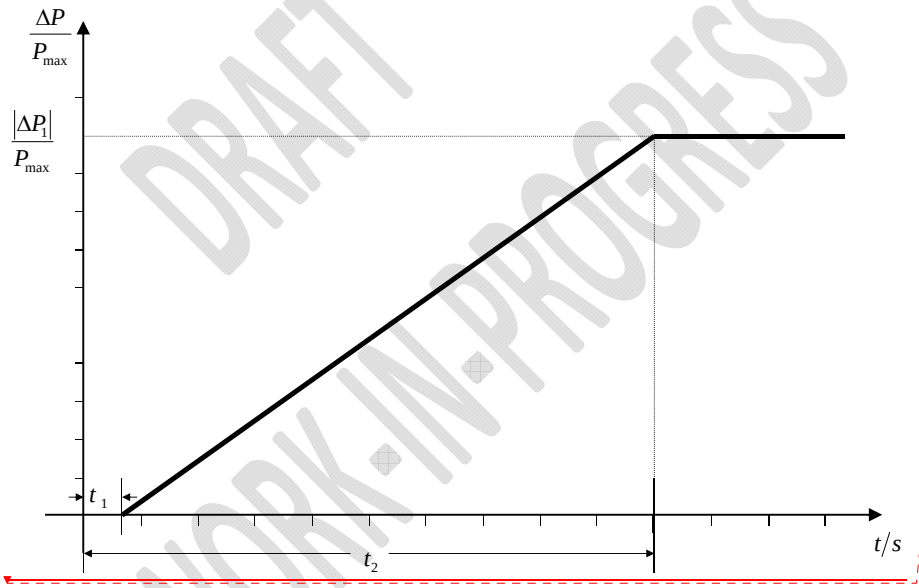


Figure 5: Active Power Frequency Response capability. P_{max} is the Maximum Capacity to which ΔP is related. ΔP is the change in Active Power output from the Power Generating Module. The Power Generating Modules have to provide Active Power Output ΔP up to the point ΔP_1 in accordance with the times t_1 and t_2 with the values of ΔP_1 and t_2 being specified by the Relevant TSO from within the ranges specified in Table 4. t_1 is the initial delay, t_2 is the time for full activation.

Parameters	Ranges or values
Active Power range related to Maximum Capacity (Frequency response range) $\frac{\lvert\Delta P_1\rvert}{P_{max}}$	2 – 10 %
Initial delay t_1	≤ 2 seconds

Gelöscht: frequency
Gelöscht: droop
Gelöscht: Unit
Gelöscht: red
Gelöscht: 4
Gelöscht: Unit
Gelöscht: relevant
Gelöscht: natural
Gelöscht:
Gelöscht: 4
Gelöscht: Unit
Gelöscht: Units
Gelöscht: which is allowed to be 2 seconds as maximum.
Gelöscht: frequency

Full activation time t_2 (taking into consideration generation technologies)	≤ 30 seconds

Table 4: Parameters for full activation of Active Power Frequency Response resulted from Frequency step change (explanation for figure 5).

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

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

d) With regard to Frequency Restoration Control, the Power Generating Facility shall provide functionalities compliant to specifications decided by the Relevant TSO pursuant to Article 4(3), aiming at restoring Frequency to its nominal value and/ or maintain power exchange flows between control areas at their scheduled values.

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

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

1) To monitor the operation of Active Power Frequency Response the communication interface shall be equipped to transfer on-line from the Power Generating Facility to the Network control centre of the Relevant Network Operator and/or the Relevant TSO on request by the Relevant Network Operator and/or the Relevant TSO at least the following signals:

- status signal of FSM (on/off);
- scheduled Active Power output;
- actual value of the Active Power output;
- actual parameter settings for Active Power Frequency Response; and
- Droop and dead band.

2) The Relevant Network Operator and the Relevant TSO shall adopt a decision pursuant to Article 4(3) defining additional signals to be provided by the Power Generating Facility for monitoring and/or 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 referring to voltage stability:

a) With regard to voltage ranges a Power Generating Module shall be capable of automatic disconnection at specified voltages at the Connection Point, if required by the Relevant Network Operator pursuant to Article 4(3) in coordination with the Relevant TSO. The terms and settings for automatic disconnection shall be set by a decision of the Relevant Network Operator pursuant to Article 4(3).

Gelöscht: frequency
Gelöscht: 4
Gelöscht: Unit
Gelöscht: Facility
Gelöscht: frequency
Gelöscht: power target regulation
Gelöscht: frequency
Gelöscht: c
Gelöscht: <#>The Active Power control facilities shall, if required by the Relevant TSO, provide a facility for selecting the target frequency between 49.9 and 50.1 Hz.¶
Gelöscht: frequency restoration control
Gelöscht: frequency
Kommentar [RPF1]: To be discussed: Do we need this requirement?
Gelöscht: pump-storage
Gelöscht: frequency response in real-time
Gelöscht: between
Gelöscht: and
Gelöscht: Setpoint value
Gelöscht: frequency response;
Gelöscht: droop
Gelöscht: ; and¶
<#>for Power Park Modules available power reflecting maximum unrestricted power, taking into account variable source, such as wind or solar conditions.¶
The Relevant Network Operator transmits the Setpoint value for automatic generation from the load-frequency controller in the system control centre to the communication interface of the Power Generating Facility
Gelöscht: frequency response
Gelöscht: Units
Gelöscht: units
Gelöscht: Unit

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

   a) In case of power oscillations, steady-state stability of a Power Generating Module is required when operating at any operating point of the P-Q-Capability Diagram. Tripping and power reduction shall be prohibited, as long as voltage and Frequency remain within the admissible limits. Active Power or Reactive Power reductions are allowed only if they contribute actively to damping the power oscillations perceived at the Connection Point.

   b) With regard to torsional stress, the Power Generating Modules shall be designed in a way that shaft torsional stress which may be excited by transient Active Power steps up to 50 % of its Maximum Capacity are considered a routine part of normal operation and shall be taken into account when specifying the shaft characteristics.

   c) Single-phase or three-phase auto-reclosures on meshed Network lines, if applicable to this Network, shall be withstood by Power Generating Modules without tripping. Details of this capability shall be subject to coordination and agreements on protection schemes and settings according to paragraph 6 (a).

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

   a) With regard to Black Start Capability:

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

      2) A Power Generating Module with a Black Start Capability shall be able to start from shut down within a timeframe decided by the Relevant Network Operator pursuant to Article 4(3) in coordination with the Relevant TSO without any external energy supply. The Power Generating Module shall be able to synchronise within the Frequency limits defined in Article 7(1) and voltage limits defined by the Relevant Network Operator or defined by Article 10(2).

      3) The Power Generating Module voltage regulation shall be enabled to ensure that load connections causing dips of voltage, are automatically regulated.

         The Power Generating Module shall:

         - be capable of regulating load connections in block load in the conditions ensuring, in the respect of principle of proportionality, equitable treatment of users as well as equitable performance of Power Generating Modules;
         - 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 capability to take part in Island Operation:

Gelöscht: units
Gelöscht: Units
Gelöscht: Steady
Gelöscht: generating Unit
Gelöscht: for
Gelöscht: in
Gelöscht: in case of power oscillations
Gelöscht: .
Gelöscht: Units
Gelöscht: With regard to auto-reclosures, the Relevant Network Operator shall have the right to adopt a decision pursuant to Article 4(3) requesting single-phase auto-reclosures on Generating Unit supply lines (radial connection of one or more Generating Units to the public network) and single
Gelöscht: to
Gelöscht: Units
Gelöscht: If the first auto-reclosure attempt is not successful, a subsequent attempt will
Gelöscht: delayed by at least 3 seconds.
Gelöscht: units
Gelöscht: adopt
Gelöscht: decision pursuant to Article 4(3) imposing
Gelöscht: on a
Gelöscht: Unit
Gelöscht: Unit shall be able to energise a part of the Network upon instruction from the Relevant Network Operator and
Gelöscht: with another Network
Gelöscht: frequency
Gelöscht: according to paragraph 3
Gelöscht: Unit
Gelöscht: The Generating Unit protection shall be stabilized against in-rush currents.
Gelöscht: Unit
Gelöscht: generators
Gelöscht: frequency
Gelöscht: Units
Gelöscht: ;

1) The capability to take part in Island Operation, if required by a decision of the Relevant Network Operator pursuant to Article 4(3) in coordination with the Relevant TSO, shall be possible within the Frequency limits defined in Article 7(1) and voltage limits decided by the Relevant Network Operator pursuant to Article 4(3) according to paragraph 3 or defined by Article 10(2).

2) If required, the Power Generating Module shall be able to operate in FSM during Island Operation, as defined in Article 9(2) (b). In the case of a power surplus, it shall be possible to reduce the Active Power Output of the Power Generating Module from its previous operating point to any new operating point within the P-Q-Capability Diagram as much as inherently technically feasible, but at least a Active Power output reduction to 55 % of its Maximum Capacity shall be possible.

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

c) With regard to quick re-synchronization capability:

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

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

3) Power Generating Modules shall be capable of continuing operation following tripping to houseload, irrespective of any auxiliary connection to the external network. The minimum operation time shall be decided by the Relevant Network Operator pursuant to Article 4(3) in coordination with the Relevant TSO taking into consideration the specific characteristics of the prime mover technology.

6. Type C Power Generating Modules shall fulfil the following general system management requirements:

a) With regard to electrical protection schemes and settings:

1) The Relevant Network Operator shall define the settings necessary to protect the Network taking into account the characteristics of the Power Generating Facility. Unless national law gives the Relevant Network Operator in coordination with the Relevant TSO authority to make such decisions pursuant to Article 4(3), protection schemes relevant for the Power Generating Facility and the Network and settings relevant for the Power Generating Facility shall be coordinated and agreed between the Relevant Network Operator and the Power Generating Facility Owner.

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

Gelöscht: frequency
Gelöscht: Unit
Gelöscht: c
Gelöscht: loading
Gelöscht: Unit
Gelöscht: load
Gelöscht: . This load reduction shall prevent the disconnection of the Generating Unit from the island due to overfrequency
Gelöscht: The Generating Unit shall perform the required behaviour when changing
Gelöscht: with using any
Gelöscht: only as additional information which cannot
Gelöscht: solely relied on
Gelöscht: Unit
Gelöscht: , unless national law gives the Relevant TSO authority to make such decisions,
Gelöscht: Unit
Gelöscht: the
Gelöscht: without using
Gelöscht: for identifying houseload operation
Gelöscht: Units
Gelöscht: All
Gelöscht: Facility control systems shall remain in automatic mode.¶ <#>With regard to re-synchronization after tripping onto auxiliary supply, it shall be performed by a circuit breaker on the voltage level of the Connection Point after a check of the synchronisation conditions.¶ 6. Type C units
Gelöscht: synchronization, when starting a Generating Unit, synchronization shall be performed by the Power Generating Facility Owner after authorization by the Relevant Network Operator. The Generating Unit shall be equipped with the necessary synchronization facilities. Synchronization of Generating Units shall be possible for frequencies within the ranges set out in table 2. Unless national law gives the Relevant TSO authority to give decisions, the Network Operator and the Power Generating Facility Owner shall agree on the settings of synchronization devices to be concluded prior to operation of the Generating Unit. An agreement ... [11]
Gelöscht: Unit
Gelöscht: Unit

3) Protection schemes can protect against the following aspects:

- external and internal short circuit;
- asymmetric load (Negative Phase Sequence);
- stator and rotor overload;
- over-/underexcitation;
- over-/undervoltage at the Connection Point;
- over-/undervoltage at the Alternator terminals;
- inter-area oscillations;
- inrush current;
- asynchronous operation (pole slip);
- protection against inadmissible shaft torsions (for example, subsynchronous resonance);
- Power Generating Module line protection;
- unit transformer protection;
- backup schemes against protection and switchgear malfunction;
- overfluxing (U/f);
- inverse power;
- rate of change of Frequency; and
- neutral voltage displacement.

4) Unless national law gives the Relevant TSO authority to make such decisions pursuant to Article 4(3), any changes to the protection schemes relevant for the Power Generating Facility and the Network and to the setting relevant for the Power Generating Facility shall be agreed between the Network Operator and the Power Generating Facility Owner and be concluded prior to the introduction of changes.

b) With regard to loss of angular stability or loss of control of a single Power Generating Module, it shall automatically disconnect from the Network in order to support preservation of system security and/or to prevent damage from the Power Generating Module. The Power Generating Facility Owner and the Relevant Network Operator shall agree on the criteria to detect loss of angular stability or loss of control.

c) With regard to instrumentation:

1) Power Generating Facilities shall be equipped with a facility to provide fault recording, dynamic system behaviour monitoring and of the following parameters:

- Voltage;
- Active Power;
- Reactive Power; and
- Frequency.

The Relevant Network Operator shall have the right to adopt a decision pursuant to Article 4(3) adding quality of supply parameters requirements to be complied with provided a reasonable prior notice is given.

2) Unless national law gives the Relevant TSO authority to make such decisions pursuant to Article 4(3), the settings of the fault recording equipment, including triggering criteria and the sampling rates shall be agreed between the Power Generating Facility Owner and the Relevant Network Operator in coordination with the Relevant TSO.

Gelöscht: include

Gelöscht: technical components

Gelöscht: alternator

Gelöscht: - robustness against power swings (for example, angle and voltage stability);¶
- over- and underfrequency;¶

Gelöscht: Unit

Gelöscht: frequency

[4] nach oben: <#>With regard to priority ranking of protection and control, the Power Generating Facility shall organize their protections and control devices in compliance with the following priority ranking, organized in decreasing order of importance:¶

Gelöscht: <#>Network system and Generating Unit protection;¶

[5] nach oben: - Synthetic Inertia, if applicable;¶
- Frequency control (Active Power adjustment);¶
- Power Restriction; and¶
- Power gradient constraint.¶

Gelöscht: Unit

Gelöscht: Unit

Gelöscht: shall comply with the criteria established by decision of the

Gelöscht: pursuant

Gelöscht: Article 4(3), to recognize

Gelöscht: and the subsequent automatic disconnection

Gelöscht: ; and

Gelöscht: Harmonics.

Gelöscht: other

Gelöscht: with

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

4) The facilities for quality of supply and dynamic system behaviour monitoring shall include arrangements for the Power Generating Facility Owner, the Relevant Network Operator and/or the Relevant TSO to access the information. Unless national law gives the Relevant TSO authority to make such decisions pursuant to Article 4(3), the communications protocols for recorded data shall be agreed between the Power Generating Facility Owner and the Relevant Network Operator and Relevant TSO.

Gelöscht: with

d) With regard to the simulation models:

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

Gelöscht: Each

Gelöscht: Unit

Gelöscht: Unit

Gelöscht: .

The decision shall include:

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

Gelöscht: requirement for simulations models

Gelöscht:

Gelöscht: they

Gelöscht: and

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

Gelöscht: verification of

Gelöscht: the

Gelöscht: all types of

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

- Alternator and prime mover;
- Speed and power control;
- Voltage control, including Power System Stabilizer (PSS), and excitation system and limiters;
- Power Generating Module protection models as agreed between the Relevant Network Operator and the Power Generating Facility Owner, unless national law gives the Relevant TSO authority to make such decisions pursuant to Article 4(3) on these Power Generating Module protection models; and
- Converter models for Power Park Modules.

Gelöscht: ,

Gelöscht: Unit

Gelöscht: Unit

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

4) The Relevant Network Operator or Relevant TSO shall have the right to adopt a decision pursuant to Article 4(3) requiring Power Generating Module recordings in order to compare the response of the model with these recordings.

Gelöscht: Unit

e) With regard to the installation of devices for system operation and/or security, if the Relevant Network Operator or the Relevant TSO considers additional devices necessary to be installed in a Power Generating Facility site in order to preserve or restore system operation or security, the Relevant Network Operator or Relevant TSO and the Power Generating Facility Owner shall investigate this request and, unless national law gives the Relevant TSO authority to make such decisions pursuant to Article 4(3), adopt an agreement on an appropriate solution.

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

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

h) With regard to power/voltage quality:

1) Power Generating Facilities shall ensure that their connection to the Network does not result in a level of distortion or fluctuation of the supply voltage on the Network, at the Connection Point, exceeding that allocated to them.

2) The Relevant Network Operator shall specify the power quality requirements consistent with national and international technical rules in force.

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

Gelöscht: in co-ordination with

Gelöscht: and

Gelöscht: by means of bilateral contracts

Gelöscht: Unit

Gelöscht: Units

Gelöscht: alternators

Article 10

GENERAL REQUIREMENTS FOR TYPE D POWER GENERATING MODULES

1. In addition to fulfilling the requirements listed in Articles 7, 8 and 9, except for Article 7(1) (f), (g), Article 8(2) (a) and Article 9(3) (a), Type D Power Generating Modules shall fulfil the following requirement referring to voltage stability through the Network.

Gelöscht: UNITS

Gelöscht: general

Gelöscht: applicable to type A, B and C units,

Gelöscht: respectively

Gelöscht: d

Gelöscht: type

Gelöscht: units

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

Gelöscht: units

a) With regard to voltage ranges:

1) In case of a deviation of the Network voltage at the Connection Point from its nominal value, any automatic disconnection from the Network of a Power Generating Module shall be prohibited due to the deviation within the voltage ranges, expressed by the voltage at the Connection Point related to nominal voltage (per unit), and within the time periods specified by tables 5.1 and 5.2.

Gelöscht: Unit, with a Connection Point at 110 kV or above,

Synchronous Area	Voltage Range	Time period for operation
Continental Europe	0.80 pu – 0.85 pu	30 minutes
	0.85 pu – 0.90 pu	60 minutes
	0.90 pu – 1.05 pu	Unlimited
	1.05 pu – 1.0875 pu	To be decided by each TSO pursuant to Article 4(3), but not less than 60 minutes
	1.0875 pu – 1.10 pu	60 minutes
Nordic	0.90 pu – 1.05 pu	Unlimited
	1.05 pu – 1.10 pu	60 minutes
Great Britain	0.90 pu – 1.05 pu	Unlimited
	1.05 pu – 1.10 pu	15 minutes
Ireland	0.90 pu – 1.05 pu	Unlimited
Baltic	0.88 pu – 0.90 pu	20 minutes
	0.90 pu – 1.10 pu	Unlimited
	1.10 pu – 1.15 pu	20 minutes

Table 5.1: This table shows the minimum time periods a Power Generating Module has to operate for voltages deviating from the nominal value at the Connection Point without disconnecting from the network. (The voltage base for pu values is between 300 kV and 400 kV.)

Gelöscht: Unit

Synchronous Area	Voltage Range	Time period for operation
Continental Europe	0.80 pu – 0.85 pu	30 minutes
	0.85 pu – 0.90 pu	60 minutes
	0.90 pu – 1.115 pu	Unlimited
	1.115 pu – 1.15 pu	60 minutes
Nordic	0.90 pu – 1.05 pu	Unlimited
	1.05 pu – 1.10 pu	60 minutes
Great Britain	0.90 pu–1.10 pu	Unlimited
Ireland	0.90 pu – 1.118 pu	Unlimited
Baltic	0.80 pu – 0.90 pu	30 minutes
	0.90 pu – 1.12 pu	Unlimited
	1.12 pu – 1.15 pu	20 minutes

Table 5.2: This table shows the minimum time periods a Power Generating Module has to operate for voltages deviating from the nominal value at the Connection Point without disconnecting from the network. (The voltage base for pu values is between 110 kV and 300 kV.)

Gelöscht: Unit

2) Notwithstanding the provisions of point 1) a Power Generating Module shall be capable of automatic disconnection at specified voltages, if required by a decision of the Relevant Network Operator pursuant to Article 4(3). Unless national law gives the Relevant TSO authority to make such decisions pursuant to Article 4(3), the terms and settings for automatic disconnection shall be agreed between the Relevant Network Operator and the Power Generating Facility Owner.

Gelöscht: Unit

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

a) With regard to synchronization, when starting a Power Generating Module, synchronization shall be performed by the Power Generating Facility Owner after authorization by the Relevant Network Operator. The Power Generating Module shall be equipped with the necessary synchronization facilities. Synchronization of Power Generating Modules shall be possible for frequencies within the ranges set out in table 2. Unless national law gives the Relevant TSO authority to give decisions, the Network Operator and the Power Generating Facility Owner shall agree on the settings of synchronization devices to be concluded prior to operation of the Power Generating Module. An agreement shall cover the following matters: voltage, Frequency, phase angle range, phase sequence, deviation of voltage and Frequency.

Chapter 2

REQUIREMENTS FOR SYNCHRONOUS POWER GENERATING MODULES

Gelöscht: UNITS

Article 11

REQUIREMENTS FOR TYPE B SYNCHRONOUS POWER GENERATING MODULES

Gelöscht: UNITS

1. In addition to fulfilling the requirements listed in Articles 7 and 8, Type B Synchronous Power Generating Modules shall fulfil the following requirement referring to voltage stability and to the robustness of Power Generating Modules.

Gelöscht: general
Gelöscht: type
Gelöscht: Units

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

Gelöscht: Units

   a) With regard to Reactive Power capability the Relevant Network Operator shall have the right to adopt a decision pursuant to Article 4(3) determining the capability of a Synchronous Power Generating Module to provide Reactive Power.

Gelöscht: Unit

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

Gelöscht: at the high-voltage terminals of the step-up transformer to the voltage level of the Connection Point or at the alternator terminals, if no step-up transformer exists,
Gelöscht: Unit
Gelöscht: alternator

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

Gelöscht: Unit
Gelöscht: Units

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

Gelöscht: Units
Gelöscht: Units

      1) Each TSO shall adopt a decision pursuant to Article 4(3) defining a voltage-against-time-profile according to figure 6 at the Connection Point for fault conditions which describes the conditions in which the Synchronous Power Generating Module shall stay connected to the network and shall continue stable operation after the power system has been disturbed by Secured Faults on the network unless the protection scheme requires the disconnection of a Power Generating Module from the network.

Gelöscht: Unit
Gelöscht: Unit

      2) This voltage-against-time-profile shall be expressed by a lower limit of the course of the phase-to-phase voltages on the network voltage level at the Connection Point during a symmetrical fault, as a function of time before, during and after the fault. This lower limit is defined by the TSO using parameters in figure 6 according to table 6.

Gelöscht: one of the three
Gelöscht: which sustains the lowest retained voltage
Gelöscht: or asymmetrical

      3) Each TSO shall adopt and make publicly available a decision pursuant to Article 4(3) defining the pre-fault and post-fault conditions for the fault ride through capability in terms of:

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

Gelöscht: irrespective of the voltage drop of the other two phase-to-phase voltages,
Gelöscht: shall be selected on the red lines or a specific line inside the shaded area delimited by the red lines
Gelöscht: 5
Gelöscht: Unit

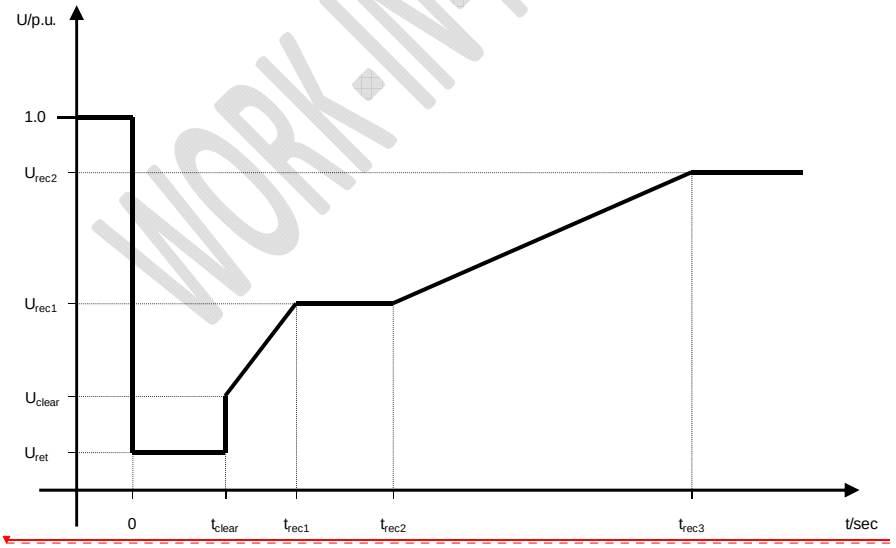
- conditions for the calculation of the post-fault minimum short circuit capacity at the Connection Point.

4) Each Relevant Network Operator shall provide on request by the Power Generating Facility Owner the pre-fault and post-fault parameters to be considered for fault ride through capability as an outcome of the calculations at the Connection Point as defined in point 3) 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;
- pre-fault voltage at the connection point; and
- post-fault minimum short circuit capacity at each Connection Point expressed in MVA.

5) The Power Generating Module shall stay connected to the network and continue stable operation when the actual course of the phase-to-phase voltages on the network voltage level at the Connection Point during a symmetrical fault, given the pre-fault and post-fault conditions according to points 3) and 4), remains above the lower limit defined in point 2), unless the protection scheme of the Power Generating Facility requires the disconnection of a Power Generating Module from the network.

6) Undervoltage protection (either fault ride through capability or minimum voltage defined at the connection point voltage) shall be set by the Power Generating Facility Owner to the widest possible technical capability of the Power Generating Module unless the Relevant Network Operator requires another setting. The settings shall be justified by the Power Generating Facility Owner in accordance with this principle.



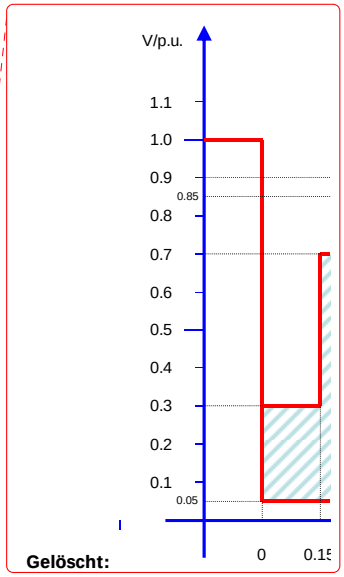


Figure 6 – Fault ride through profile of a Synchronous Power Generating Module. The diagram represents the lower limit of a voltage-against-time profile by the voltage at the Connection Point, expressed by the ratio of its actual value and its nominal value in per unit before, during and after a fault. U_{ret} is the retained voltage at the Connection

Gelöscht: adopt a decision pursuant to Article 4(3) defining
Gelöscht: the
Gelöscht: Unit
Gelöscht: and
Gelöscht: Unit
Gelöscht: one of
Gelöscht: three
Gelöscht: which sustains the lowest retained voltage
Gelöscht: or asymmetrical
Gelöscht:).
Gelöscht: , respecting the appropriate operating
Gelöscht: ranges,
Gelöscht: Unit and
Gelöscht:
Gelöscht: 5
Gelöscht: Unit
Gelöscht: boundaries for
Gelöscht: Regarding the shaded area see Article 11(3) (a) point 2).

Point During a fault, t_{clear} is the instant when the fault has been fully cleared. U_{rec1}, U_{rec2}, t_{rec1}, t_{rec2} and t_{rec3} specify certain points of voltage recovery after fault clearance.

Voltage parameters [pu]		**Time parameters [seconds]**	
U_{ret}:	0.05 – 0.3	t_{clear}:	0.15 – 0.25
U_{clear}:	0.7 – 0.9	t_{rec1}:	t_{clear}
U_{rec1}:	U_{clear}	t_{rec2}:	t_{rec1} – 0.7
U_{rec2}:	0.85 – 0.9 and ≥ U_{clear}	t_{rec3}:	t_{rec2} – 1.5

Table 6 – Parameters for figure 6.

7) Fault ride through capabilities in case of asymmetrical faults shall be specified by each TSO pursuant to Article 4(3).

b) With regard to post fault Active Power recovery, the Relevant TSO shall adopt a decision pursuant to Article 4(3) specifying a maximum recovery period for the Active Power to reach at least the level of 90 % of the pre-fault power, measured from the time the voltage at the Connection Point has recovered above 85 % of the pre-fault nominal voltage value. The maximum recovery period shall be equal to or greater than 0.5 seconds and shorter than 15 seconds.

Article 12

REQUIREMENTS FOR TYPE C SYNCHRONOUS POWER GENERATING MODULES

1. In addition to fulfilling the requirements listed in Articles 7, 8, 9 and 11, except for Article 7(1) (f), Article 8(2) (a) and Article 11(2) (a), Type C Synchronous Power Generating Modules shall fulfil the following requirement referring to Frequency stability, voltage stability and to general system management through the Network.

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

   a) With regard to Reactive Power Capability, for Synchronous Power Generating Modules where the Connection Point is not at the location of the high-voltage terminals of the step-up transformer to the voltage level of the Connection Point or at the Alternator terminals, if no step-up transformer exists, supplementary Reactive Power may be required by a decision by the Network Operator pursuant to Article 4(3) to compensate for the Reactive Power demand of the HV line, or cable, between these two points from the responsible owner of this line or cable.

   b) With regard to Reactive Power capability at Maximum Capacity:

Gelöscht: UNITS

Gelöscht: general

Gelöscht: 9 as well as the specific type B Synchronous Generating Units requirements listed in Article

Gelöscht: paragraph

Gelöscht:), type

Gelöscht: Units

Gelöscht: frequency

Gelöscht: Units

Gelöscht: frequency

Gelöscht: <#>The Power Generating Facility shall maintain constant output at its target Active Power value regardless of changes in frequency, unless output shall follow the defined changes in output in the context of Article 7(1) (c) or Article 9(2) (c), and Article 9(2) (d).¶
<#>With regard to underfrequency maximum power capability reduction for some generation technologies, some synchronous generation technologies deliver falling mechanical power with falling frequency. The TSO shall define a Maximum Capacity with falling frequency. The value chosen by the TSO shall be within the boundaries of: ¶
<#>Below 49 Hz falling up to a maximum reduction rate of 2 % of maximum capability per 1 Hz frequency drop below 49 Hz.¶
<#>49.5 Hz up to a maximum reduction rate of 10 % of Maximum Capacity per 1 Hz frequency drop below 49.5 Hz. ¶
Acceptance of this reduction is limited to a selection of affected generation technologies decided by the Relevant TSO pursuant to Article 4(3).¶
3. . Type C Synchronous Generating Units shall fulfil the following requirements referring to voltage stability:¶

1) Each Network Operator shall adopt a decision pursuant to Article 4(3) defining the Reactive Power provision capability requirement in the context of varying voltage for Synchronous Power Generating Modules. For doing so, it shall define a U-Q/P_{max}-profile that shall take any shape within the boundaries of which the Synchronous Power Generating Module shall be capable of providing Reactive Power at its Maximum Capacity.

2) The U-Q/P_{max}-profile is decided by each Network Operator pursuant to Article 4(3) for Synchronous Power Generating Modules in compliance with the following principles:

- the U-Q/P_{max}-profile shall not exceed the U-Q/P_{max}-profile envelope, represented by the inner envelope in figure 7;
- the dimensions of the U-Q/P_{max}-profile envelope are defined for each Synchronous Area in table 7;
- the position of the U-Q/P_{max}-profile envelope is defined by each Network Operator;
- the U-Q/P_{max}-profile envelope cannot be positioned outside the fixed outer envelope in figure 7.

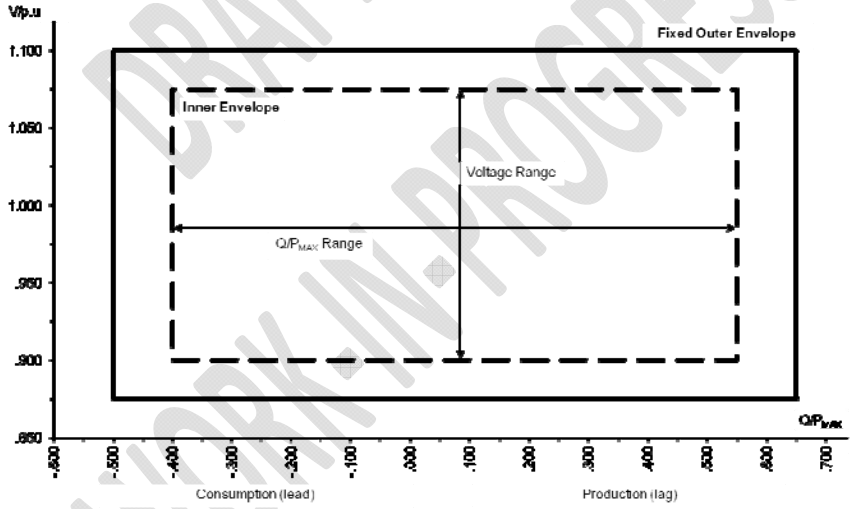


Figure 7 – U-Q/P_{max}-profile of a Synchronous Power Generating Module. The diagram represents boundaries of a U-Q/P_{max}-profile by the voltage at the Connection Point, expressed by the ratio of its actual value and its nominal value in per unit, against the ratio of the Reactive Power (Q) and the Maximum Capacity (P_{max}) of a Power Generating Modules.

Gelöscht: Units

Gelöscht: and

Gelöscht: Unit

Gelöscht: if required to do so by the Relevant Network Operator

Gelöscht: Units

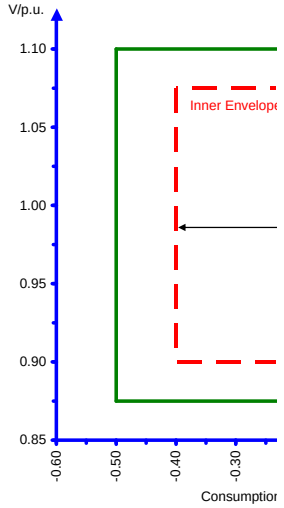
Gelöscht: 6

Gelöscht: (Reactive Power Factor range and voltage range)

Gelöscht: 6

Gelöscht: 6; and

Gelöscht: <#>in case a Synchronous Generating Unit has a Reactive Power capability beyond the voltage range specified by figure 6, the Reactive Power capability shall not be intentionally limited.¶



Gelöscht: 6

Gelöscht: Unit

Gelöscht: high-voltage terminals of the step-up transformer to the voltage level of the

Gelöscht: Units, respectively the Power Factor (cos φ).

Synchronous Area	Maximum range of Q/P_{max}	Maximum range of steady state voltage level in PU
Continental Europe	0.95	0.225
Nordic	0.95	0.150
Great Britain	0.95	0.100
Ireland	1.08	0.218
Baltic States	1.0	0.220

Table 7: Parameters for the inner envelope in figure 7

3) The Reactive Power provision capability requirement applies at the Connection Point. For profile shapes other than rectangular, the voltage range represents the highest and lowest values. The full Reactive Power range is therefore not expected to be available across the range of steady state voltages.

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

c) With regard to Reactive Power capability below Maximum Capacity, when operating at an Active Power output below the Maximum Capacity ($P<P_{max}$), the Synchronous Power Generating Modules shall be able to be operated in every possible operating point in the P-Q Capability Diagram of the Alternator of this Synchronous Power Generating Module. Even at reduced Active Power output, Reactive Power supply at the Connection Point shall fully correspond to the P-Q-Capability Diagram of the Alternator of this Synchronous Power Generating Module, taking the auxiliary supply power and the Active and Reactive Power losses of the step-up transformer, if appicable, into account.

Article 13

REQUIREMENTS FOR TYPE D SYNCHRONOUS POWER GENERATING MODULES

1. In addition to fulfilling the requirements listed in Articles 7, 8, 9, 10, 11 and 12, except for Article 7(1) (f), Article 8(2) (a), Article 9(3) (a), Article 11(2) and Article 11(3) (a), Type D Synchronous Power Generating Modules shall fulfil the following requirements referring to voltage stability and the robustness of Power Generating Modules.

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

   a) With regard to the voltage control system, parameters and settings of its components shall be agreed between the Power Generating Facility Owner and the Relevant Network Operator in coordination with the Relevant TSO, unless national law gives the Relevant TSO authority to make such decisions pursuant to Article 4(3). Such agreement shall include:

Gelöscht: 6
Gelöscht: 6
[8] verschoben
Gelöscht: high-voltage terminals of the step-up transformer to the voltage level of the
Gelöscht: Beyond the voltage range specified by the figure 6 the Reactive Power capability shall not be intentionally limited. For
Gelöscht: Units where the Connection Point is not at the location of the high-voltage terminals of this step-up transformer, supplementary Reactive Power may be required by a decision of the Network Operator pursuant to Article 4(3) to compensate for the Reactive Power demand of the HV line, or cable, between these two points from the responsible owner of this line or cable.¶
The Synchronous Generating Unit
Gelöscht: P
Gelöscht: determined by the requirements of reactive power control. The
Gelöscht: shall have the right at any time to change the Reactive Power target value within the agreed or decided Reactive Power range. Where part of the P-Q/P_{max} range is unavailable until tapping of ge ... [12]
Gelöscht: <#>The Relevant N ... [13]
Gelöscht: Generating Units of ... [14]
Gelöscht: Facility
Gelöscht: alternator
Gelöscht: Unit
Gelöscht: high-voltage termin ... [15]
Gelöscht: alternator
Gelöscht: Unit
Gelöscht: service
Gelöscht: 4. . Type C Synchron ... [16]
Gelöscht: UNITS
Gelöscht: general
Gelöscht: and
Gelöscht: as well as the specific type B
Gelöscht: C
Gelöscht: Units requirements l ... [17]
Gelöscht: Units
Gelöscht: Units
Gelöscht: :¶ ... [18]
Gelöscht: the voltage control system
Gelöscht: .

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

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

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

1) Each TSO shall adopt a decision pursuant to Article 4(3) defining a voltage-against-time-profile according to figure 6 at the Connection Point for fault conditions which describes the conditions in which the Synchronous Power Generating Module shall stay connected to the network and shall continue stable operation after the power system has been disturbed by Secured Faults on the network, unless the protection scheme requires the disconnection of a Power Generating Module from the network.

2) This voltage-against-time-profile shall be expressed by a lower limit of the course of the phase-to-phase voltages on the network voltage level at the Connection Point during a symmetrical fault, as a function of time before, during and after the fault. This lower limit is defined by the TSO using parameters in figure 6 according to table 8.

3) Each TSO shall adopt and make publicly available a decision pursuant to Article 4(3) defining the pre-fault and post-fault conditions for the fault ride through capability in terms of:

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

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

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

Gelöscht: Power Generating Facility Owners shall provide to the Relevant Network Operator all data, models

Gelöscht: studies required by this Network Code in order to evaluate the voltage control system.¶
With regard to steady-state voltage control, the

Gelöscht: shall limit the change at the Generating Unit terminal to not more than a percentage of rated term ... [19]

Gelöscht: frequency.¶ ... [20]

Gelöscht: :

Gelöscht: <#>For a step cha ... [21]

Gelöscht: . The bandwidth ... [22]

Gelöscht: frequency

Gelöscht: Units

Gelöscht: . The bandwidth ... [23]

Gelöscht: . The Underexcit ... [24]

Gelöscht: alternator

Gelöscht: . The Underexcit ... [25]

Gelöscht: The resulting ma ... [26]

Gelöscht: Unit

Gelöscht: . Any operation b ... [27]

Gelöscht: The alternator ... [28]

Gelöscht: :¶ ... [29]

Gelöscht: the Overexcitati ... [30]

Gelöscht: <#>If the stator cu ... [31]

Gelöscht: Synchronous Ge ... [32]

Gelöscht:)

Gelöscht: prevent or

Gelöscht: Unit

Gelöscht: <#>With regard to ... [33]

Gelöscht: Units

Gelöscht: Units

Gelöscht: Units

Gelöscht: Unit

Gelöscht: Unit

Gelöscht: one of the three

Gelöscht: which sustains the ... [34]

Gelöscht: or asymmetrical

Gelöscht: irrespective of the ... [35]

Gelöscht: shall be selected c ... [36]

Gelöscht: 7

Gelöscht: Unit

Gelöscht: adopt a decision p ... [37]

Gelöscht: the

- 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;
- pre-fault voltage at the connection point; and
- post-fault minimum short circuit capacity at each Connection Point expressed in MVA.

5) The Power Generating Module shall stay connected to the network and continue stable operation when the actual course of the phase-to-phase voltages on the network voltage level at the Connection Point during a symmetrical fault, given the pre-fault and post-fault conditions according to points 3) and 4), remains above the lower limit defined in point 2), unless the protection scheme of the Power Generating Facility requires the disconnection of a Power Generating Module from the network.

6) Undervoltage protection (either fault ride through capability or minimum voltage defined at the connection point voltage) shall be set by the Power Generating Facility Owner to the widest possible technical capability of the Power Generating Module, unless the Relevant Network Operator requires another setting. The settings shall be justified by the Power Generating Facility Owner in accordance with this principle.

7) Technical capabilities in order to aid angular stability under fault conditions (e. g. fast valving or braking resistor) shall be implemented if allowed or requested by the responsible TSO. Unless national law gives the Relevant TSO authority to make such decisions pursuant to Article 4(3), specifications shall be agreed between the TSO and the Power Generating Facility Owner.

8) Fault ride through capabilities in case of asymmetrical faults shall be specified by each TSO pursuant to Article 4(3).

Voltage parameters [pu]		Time parameters [seconds]	
U_{ret}:	0	t_{clear}:	0.15 – 0.25
U_{clear}:	0.25	t_{rec1}:	t_{clear} – 0.45
U_{rec1}:	0.5 – 0.7	t_{rec2}:	t_{rec1} – 0.7
U_{rec2}:	0.85 – 0.9	t_{rec3}:	t_{rec2} – 1.5

Table 8 – Parameters for figure 6.

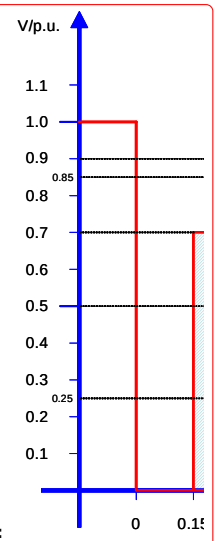


Figure 7 – Fault ride through profile of a Synchronous Generating Unit. The diagram represents the boundaries for a voltage-against-time profile by the voltage at the Connection Point, expressed by the ratio of its actual value and its nominal value in per unit before, during and after a fault. Regarding the shaded area see Article 13(3) (a) point 2).¶

Gelöscht: Unit
Gelöscht: and
Gelöscht: Unit
Gelöscht: one of
Gelöscht: three
Gelöscht: which sustains the lowest retained voltage
Gelöscht: or asymmetrical
Gelöscht:).
Gelöscht: , respecting the appropriate operating
Gelöscht: ranges,
Gelöscht: Unit and
Gelöscht:

Chapter 3

REQUIREMENTS FOR POWER PARK MODULES

Article 14

REQUIREMENTS FOR TYPE B POWER PARK MODULES

1. In addition to fulfilling the general requirements listed in Articles 7 and 8, Type B Power Park Modules shall fulfil the following requirement referring to voltage stability and to robustness of Power Generating Modules.

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

   a) With regard to Reactive Power capability the Relevant DSO or Relevant CDSO shall have the right to adopt a decision pursuant to Article 4(3) determining the capability of a Power Park Module to provide Reactive Power.

   b) With regard to fast acting additional reactive current injection at the Connection Point in case of symmetrical (3-phase) faults:

      1) Additional reactive current injection according to figure 8 shall be activated in the event of a voltage deviation of more than X % of the effective value of the voltage at the Power Park Module terminals where X is a value equal or bigger than 0 and equal or smaller than ±10 % of the effective value of the voltage at the Power Park Module terminals. This voltage control shall ensure the supply of an additional reactive current at the low-voltage terminals of the step-up transformer from the voltage level at the Power Park Module terminals with a contribution of at least 2 % of the rated current per percent of the voltage deviation (figure 8). The Power Park Module shall be capable of feeding the required additional reactive current no later than 40 milliseconds after the fault inception into the network (control response time) allowing voltage to be measured at the terminal of the units generating electricity inside the Power Park Module.

Gelöscht: A

Gelöscht: , type A

Gelöscht: :

[9] verschoben

Gelöscht: at the high-voltage terminals of the step-up transformer to the voltage level of the Connection Point or at the alternator terminals, if no step-up transformer exists

Gelöscht: ¶
¶
Article 15¶
REQUIREMENTS FOR TYPE B POWER PARK MODULES¶
1. . In addition to fulfilling the general requirements listed in Articles 7 and 8, as well as type A Power Park Modules specific requirements listed in Article 14, type B Power Park Modules shall fulfil the following requirement referring to voltage stability and to robustness of Generating Units.¶

[9] nach oben: 2. . Type B Power Park Modules shall fulfil the following requirement referring to voltage stability: ¶

Gelöscht: Reactive

Gelöscht: no

Gelöscht: a

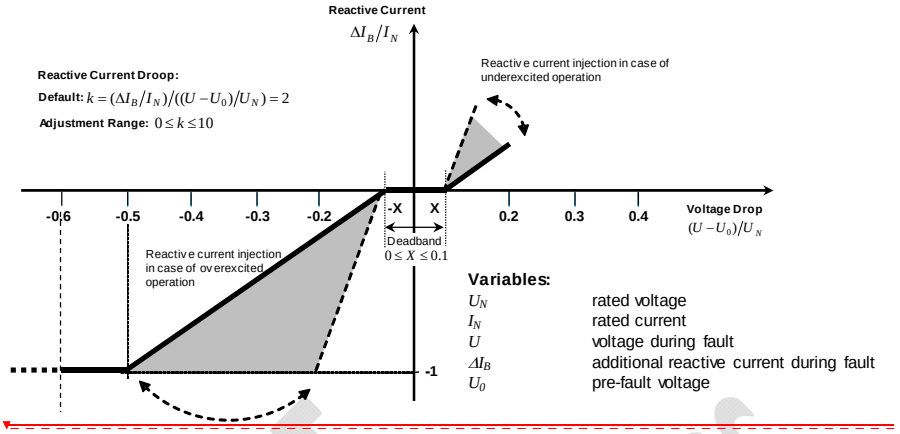


Figure 8 – Principle of voltage support by fast additional reactive current injection at the Connection Point during faults. The full line represents the required minimum additional reactive current, expressed by the ratio of the additional reactive current and the nominal reactive current in per unit, against the voltage drop, expressed by the ratio of the actual voltage value and its nominal value in per unit at the Connection Point.

2) The Relevant Network Operator shall adopt a decision pursuant to Article 4(3) defining in coordination with the Relevant TSO the parameter settings and the operating point for the fast acting additional reactive current injection.

3) The Relevant Network Operator shall adopt a decision pursuant to Article 4(3) defining the maximum period of time after fault clearances within which uncontrolled production of Reactive Power is allowed, considering advice by the Relevant TSO.

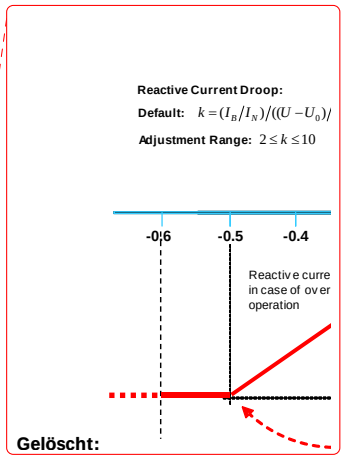
4) If required, additional reactive current supply during the fault duration shall not be less than 1 pu of the short term dynamic rating of the equipment (>=1.0 pu) between 50 % and 40 % retained voltage (respectively in case of a voltage drop between 50 % and 60 %) at the Connection Point. Below 40 % retained voltage additional reactive current shall be supplied as far as technically feasible.

c) With regard to fast acting additional reactive current injection in case of asymmetrical (1-phase or 2-phase) faults the Relevant Network Operator shall have the right to adopt a decision pursuant to Article 4(3) introducing a requirement for asymmetrical current injection in coordination the Relevant TSO.

d) With regard to failure to provide voltage support by current injection, if required by the Relevant TSO, the Power Park Module causing a Network disturbance shall be disconnected from the network, after a time delay of 0.5 seconds if both of the following two conditions occur simultaneously:

- the voltage (positive sequence system) at the Connection Point falls and remains at a value of 85 % or below of the reference voltage, with the voltage value referring to the highest value of the three phase-to-phase network voltages based on a resetting ratio of 0.98; and
- at the same time the direction of the Reactive Power at the Connection Point is into the Power Park Module (underexcited operation).

Gelöscht:



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

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

1) Each TSO shall adopt a decision pursuant to Article 4(3) defining a voltage-against-time-profile according to figure 6 at the Connection Point for fault conditions which describes the conditions in which the Power Park Module shall stay connected to the network and shall continue stable operation after the power system has been disturbed by Secured Faults on the Network, unless the protection scheme requires the disconnection of a Power Park Module from the network.

2) This voltage-against-time-profile shall be expressed by a lower limit of the course of the phase-to-phase voltages on the network voltage level at the Connection Point during a symmetrical fault, as a function of time before, during and after the fault. This lower limit is defined by the TSO using parameters in figure 6 according to table 9.

3) Each TSO shall adopt adopt and make publicly available a decision pursuant to Article 4(3) defining the pre-fault and post-fault conditions for the fault ride through capability in terms of:

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

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

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

5) The Power Park Module shall stay connected to the network and continue stable operation when the actual course of the phase-to-phase voltages on the network voltage level at the Connection Point during a symmetrical fault, given the pre-fault and post-fault conditions according to points 3) and 4), remains above the lower limit defined in point 2), unless the protection scheme of the Power Generating Facility requires the disconnection of a Power Generating Module from the network.

Voltage parameters [pu]	Time parameters [seconds]

Gelöscht: Units

[10] nach unten: <#>With regard to fault ride through capability of Power Park Modules:¶

Gelöscht: one of the three

Gelöscht: which sustains the lowest retained voltage

Gelöscht: or asymmetrical

Gelöscht: irrespective of the voltage drop of the other two phase-to-phase voltages,

Gelöscht: shall be selected

Gelöscht: on the red lines or a specific line inside the shaded area delimited by the red lines

Gelöscht: adopt a decision pursuant to Article 4(3) defining

Gelöscht: the

Gelöscht: and

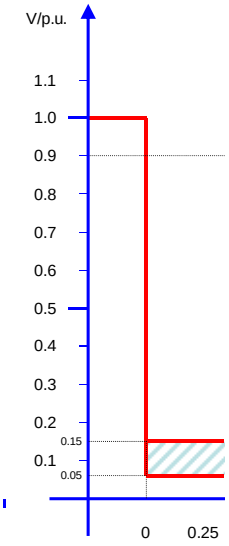
Gelöscht: one of

Gelöscht: three

Gelöscht: which sustains the lowest retained voltage

Gelöscht: or asymmetrical

Gelöscht:).



Gelöscht: ¶

Figure 9 – Fault ride through profile of a Power Park Module. The diagram represents the boundaries for a voltage-against-time profile by the voltage at the Connection Point, expressed by the ratio of its actual value and its nominal value in per unit before, during and after a fault

... [38]

U_{ret}:	0.05 – 0.15	t_{clear}:	0.15 – 0.25
U_{clear}:	U_{ret} – 0.15	t_{rec1}:	t_{clear}
U_{rec1}:	U_{clear}	t_{rec2}:	t_{rec1}
U_{rec2}:	0.9	t_{rec3}:	1.5 – 3.0

Table 9 – Parameters for figure 6.

6) Undervoltage protection (either fault ride through capability or minimum voltage defined at the connection point voltage) shall be set by the Power Generating Facility Owner to the widest possible technical capability of the Power Park Module, unless the Relevant Network Operator requires another setting. The settings shall be justified by the Power Generating Facility Owner in accordance with this principle.

7) Fault ride through capabilities in case of asymmetrical faults shall be specified by each TSO pursuant to Article 4(3).

b) With regard to post fault Active Power recovery, the Relevant TSO shall adopt a decision pursuant to Article 4(3) specifying a maximum recovery time for the Active Power to reach at least the level of 90 % of the pre-fault power, measured from the time the voltage at the Connection Point has recovered above 90 % of the pre-fault nominal voltage value. The maximum recovery time shall be specified to a value chosen within the range of 0.5 seconds and 10 seconds.

Article 15

REQUIREMENTS FOR TYPE C POWER PARK MODULES

1. In addition to fulfilling the requirements listed in Articles 7, 8, 9 and 14, except for Article 7(1) (f), Article 8(2) (a), and Article 14(2) (a) unless referred to otherwise in paragraphs 3 (d) points 3) and 4, Type C Power Park Modules shall fulfil the following requirement referring to Frequency stability, voltage stability and robustness of Power Generating Modules.

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

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

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

Gelöscht: and the

Gelöscht: establishing

Gelöscht: 85

Kommentar [RPF2]: EWEA requests this requirements to be limited to fault clearance time ≤ 140 msec and requests a recovery time to be specified between 1 second and 10 seconds otherwise.

Gelöscht: 16

Gelöscht: general

Gelöscht: 9, as well as type B Power Park Modules specific requirements listed in Article 15

Gelöscht: type A Power Park Modules specific requirements, type

Gelöscht: frequency

Gelöscht: Units

Gelöscht: frequency

Gelöscht: high or

Gelöscht: frequency

Gelöscht: frequency

2) The operating principle of this control system and the associated performance parameters shall be decided by the Relevant TSO pursuant to Article 4(3).

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

a) With regard to Reactive Power Capability, for Power Park Modules where the Connection Point is not at the location of the high-voltage terminals of its step-up transformer or at the terminals of the HV line, or cable, from the Power Park Module to the Connection Point, if no step-up transformer exits, supplementary Reactive Power may be required by a decision by the Relevant Network Operator pursuant to Article 4(3) to compensate for the Reactive Power demand of the HV line, or cable, between these two points from the responsible owner of this line or cable.

b) With regard to Reactive Power capability at Maximum Capacity**:**

1) Each Network Operator shall adopt a decision pursuant to Article 4(3) defining for Power Park Modules the Reactive Power provision capability requirements. With this purpose, it shall define a U-Q/P_{max}-profile which specifies the Reactive Power capability at the Maximum Capacity of the Power Park Module with respect to varying voltage at the Connection Point.

2) The U-Q/P_{max}-profile is decided by each Network Operator pursuant to Article 4(3) in conformity with the following principles:

- the U-Q/P_{max}-profile shall not exceed the U-Q/P_{max}-profile envelope, represented by the inner envelope in figure 9, its shape does not need to be rectangular;
- the dimensions of the U-Q/P_{max}-profile envelope (Q/P_{max} range and voltage range) are defined for each Synchronous Area in table 10;
- the position of the U-Q/P_{max}-profile envelope in terms of bias towards consumption (lead) or production (lag) is defined by each Network Operator; and
- the U-Q/P_{max}-profile envelope cannot be positioned outside the fixed outer envelope in figure 9.

Gelöscht: <sp>

Gelöscht: Relevant

Gelöscht: in the context of varying voltage

Gelöscht: 10

Gelöscht: Reactive Power Factor

Gelöscht: 7

Gelöscht: 10; and

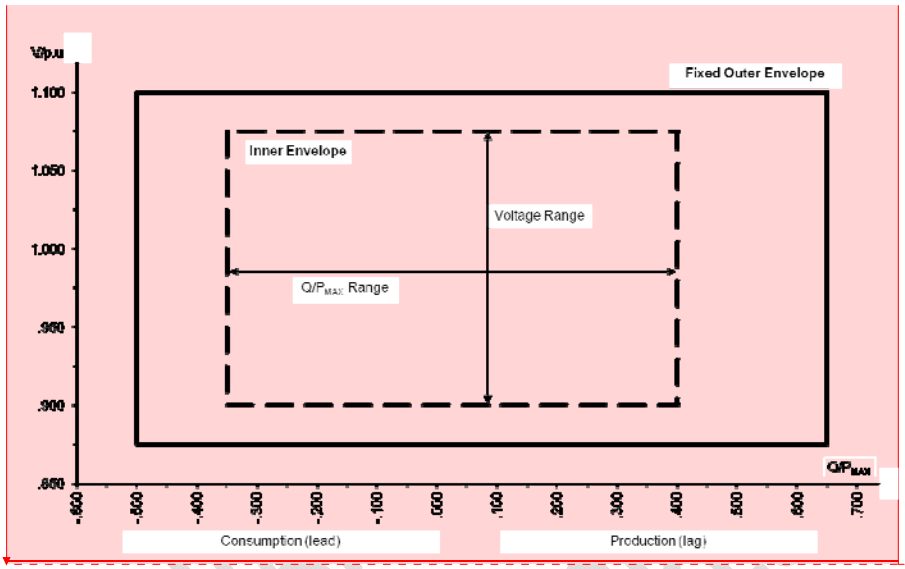


Figure 9 – U-Q/P_{max}-profile of a Power Park Module. The diagram represents boundaries of a U-Q/P_{max}-profile by the voltage at the Connection Point, expressed by the ratio of its actual voltage value U and its nominal value of U in per unit, against the ratio of the Reactive Power (Q) and the Maximum Capacity (P_{max}) of a Power Generating Module.

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

Table 10: Parameters for the inner envelope in figure 9

3) The Reactive Power provision capability requirement applies at the Connection Point. For profile shapes other than rectangular, the voltage range represents the highest and lowest values. The full Reactive Power range is therefore not expected to be available across the range of steady state voltages.

c) With regard to Reactive Power capability below Maximum Capacity:

1) Each Relevant Network Operator shall adopt a decision pursuant to Article 4(3) defining for Power Park Modules the Reactive Power provision capability requirements. With this purpose, it shall define a P-Q/P_{max}-profile which specifies the Reactive Power capability of the Power Park Module with respect to varying Active Power output at the Connection Point.

Kommentar [RPF3]: To be discussed: Many stakeholders require Reactive Power limitations at high (limitations in lagging) and low (limitations in leading) Voltages.

Gelöscht: <#>in case a Power Park Module has a Reactive Power capability beyond the voltage range specified by figure 10, the Reactive Power capability shall not be deliberately limited.¶ ... [39]

Gelöscht: 10

Gelöscht: the high-voltage terminals of the step-up transformer to the voltage level of

Gelöscht: Generating Units (in the scale at the bottom of the figu ... [40]

Gelöscht: 7

Gelöscht: 10

Gelöscht: high-voltage terminals of the last step-up transformer to the voltage level of the

Gelöscht: Beyond

Gelöscht: specified by the figure 10 the

Gelöscht: capability shall

[11] verschoben

Gelöscht: deliberately limited.

[8] nach oben: For profile shapes other than rectangular, the voltage range represents the highest a ... [41]

Gelöscht: For Power Generating Facilities where the Connection Point is not at the location of the high- ... [42]

Gelöscht: to compensate

Gelöscht: the Reactive Power demand of the HV line, or cabl ... [43]

2) The P-Q/P_{max}-profile is decided by each Network Operator pursuant to Article 4(3) in conformity with the following principles:

- the P-Q/P_{max}-profile shall not exceed the P-Q/P_{max}-profile envelope, represented by the inner envelope in figure 10, its shape shall be rectangular;
- the Q/P_{max} range of the P-Q/P_{max}-profile envelope is defined for each Synchronous Area in table 10;
- the Active Power range of the P-Q/P_{max}-profile envelope and the profile itself shall be 1 pu
- the position of the P-Q/P_{max}-profile envelope in terms of bias towards consumption (lead) or production (lag) is defined by each Network Operator; and
- the P-Q/P_{max}-profile envelope cannot be positioned outside the fixed outer envelope in figure 10.

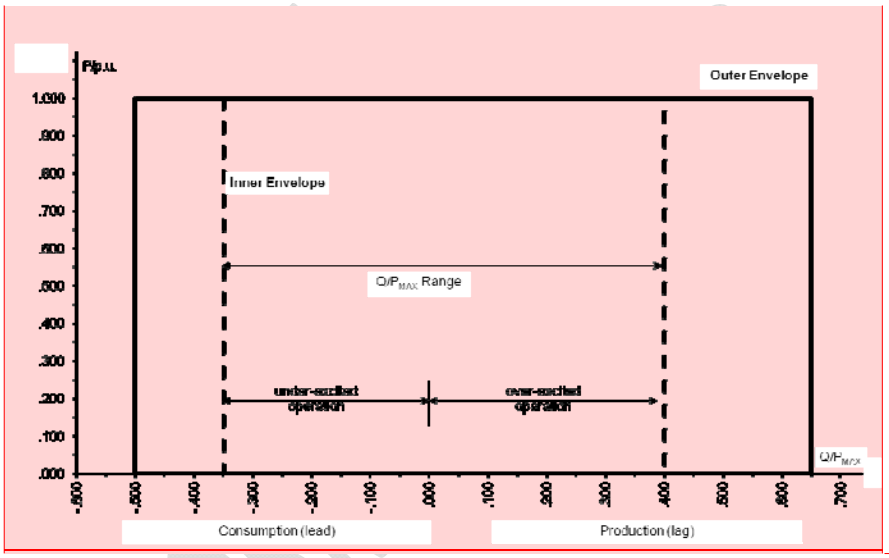


Figure 10 - P-Q/P_{max}-profile of a Power Park Module. The diagram represents boundaries of a P-Q/P_{max}-profile at the Connection Point by the Active Power, expressed by the ratio of its actual value and the Maximum Capacity in per unit, against the ratio of the Reactive Power (Q) and the Maximum Capacity (P_{max}) of a Power Generating Modules.

3) When operating at an Active Power output below the Maximum Capacity (P<P_{max}), the Power Park Module shall be capable of providing Reactive Power at any operating point inside its P-Q/P_{max}-profile, if all units of this Power Park Module, which generate power, are technically available (i. e. not out-of-service due to maintenance or failure). Otherwise the Reactive Power capability may be less taking into consideration the technical capabilities.

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

d) With regard to Reactive Power control modes:

[11] nach oben: <#>With regard to Reactive Power capability below Maximum Capacity:¶

Gelöscht: <#>When operating at an Active Power output below the Maximum Capacity (P<P_{max}), a Power Park Module shall be able to operate in every possible operating point not exceeding the outer envelope defined by the P-Q-Capability diagram in figure 11, if all Generating Units of this Power Park Module are technically available. Otherwise the Reactive Power capability may be less taking into consideration the technical capabilities. ¶ ... [44]

Kommentar [RPF4]: To be dscussed: Many stakeholders require smaller Q/Pmax-range. Many stakheolders require Reactive Power limitations below 2 ... [45]

Gelöscht: 11

Gelöscht: Units, respectively the Power Factor (cos φ).

Gelöscht: The

Gelöscht: the inner envelope in figure 11. In

Gelöscht: controlled mode it is allowed

Gelöscht: operate the Power Park Module outside

Gelöscht: specified range of

Gelöscht: .¶
The Relevant Network Operator shall have

Gelöscht: right to adopt a decision pursuant to Article 4(3) requiring the Power Park Module to install additional facilities at the Pow ... [46]

Gelöscht: (see figure 11) in timescales determined by the requirements of reactive power control. The Relevant Network ... [47]

[12] verschoben

1) The Power Park Module shall be capable of providing Reactive Power automatically by either Voltage Control mode, Reactive Power Control mode or Power Factor Control mode or by a combination of two of these.

2) For the purposes of Voltage Control mode, the Power Park Module shall be capable of contributing to voltage control at the Connection Point by provision of Reactive Power exchange with the Network with a Setpoint voltage covering at least 0.95 to 1.05 pu in steps no greater than 0.01 pu with a Slope with a range of at least 2 to 7 % in steps no greater than 0.5 %. The Reactive Power output shall be 0 when the grid voltage value at the Connection Point equals the voltage Setpoint.

   The Setpoint may be operated with or without a deadband selectable in a range from 0 to +-5 % of nominal network voltage in steps no greater than 0.5 %.

   Following a step change in voltage, the Power Park Module shall be capable of achieving 90 % of the change in Reactive Power output within a time t_1 to be specified by Relevant Network operator pursuant to Article 4(3) in the range of 1 -5 seconds and settle at the value defined by the operating Slope within a time t_2 to be specified by Relevant Network operator pursuant to Article 4(3) in the range of 5 - 10 seconds, with a steady state reactive tolerance no greater than 5 % of the maximum Reactive Power.

3) For the purposes of Reactive Power Control mode, the Power Park Module shall be capable of setting the Reactive Power Setpoint anywhere in the Reactive Power range, defined by Article 14(2) (a) and by Article 15(3) (a) and (b), with setting steps no greater than 5 Mvar or 5 % (whichever is smaller) of full Reactive Power, controlling the Reactive Power at the Connection Point to an accuracy within +-5 Mvar or +-5 % (whichever is smaller) of the full Reactive Power.

4) For the purposes of Power Factor Control mode, the Power Park Module shall be capable of controlling the Power Factor at the Connection Point within the required Reactive Power range, defined by the Relevant Network Operator according to Article 14(2) (a) or defined by Article 15(3) (a) and (b), with a target Power Factor in steps no greater than 0.01. The Relevant Network Operator shall adopt a decision pursuant to Article 4(3) determining the target Power Factor value and the tolerance expressed in Mvar or % on the Reactive Power value issued from conversion of Power Factor value, within a period of time, following a sudden change of Active Power output.

5) The control mode, parameter settings and the operating point for steady-state Reactive Power exchange at the Connection Point shall be determined by the Relevant Network Operator in coordination with the Relevant TSO.

6) The Relevant Network Operator in coordination with the Relevant TSO shall adopt a decision pursuant to Article 4(3) determining which of the above three reactive power control modes options and associated Setpoints shall apply.

e) With regard to priority to Active or Reactive Power contribution, the Relevant TSO shall decide pursuant to Article 4(3), whether Active Power contribution or Reactive Power contribution has priority during faults for which fault-ride-through capability is required. Simultaneous reactive and active current provision shall no exceed the maximum apparent current of the Power Park Module. If priority is given to Active Power contribution, its provision shall be established no later than 150 ms from the fault inception.

Kommentar [RPF5]: To be discussed: Clarifaction requested by stakeholders. Is simultaneous operation of two modes required or the capability to switch between to of them?

Kommentar [RPF6]: To be discussed: Stakeholders argue

- This requirement is typical for GB and IE, but not needed elsewhere that strong. Settlement time up to 60 seconds requested.
- The size of the step necessary to execute the full reactive power provision should be identified and should, reasonably, be larger than the applied value of droop.

[13] verschoben

f) With regard to power oscillations damping control, if required by a decision by the Relevant TSO pursuant to Article 4(3), a Power Park Module shall be capable of contributing to damping power oscillations by varying the reactive power provision of the Power Park Module.

Article 16

REQUIREMENTS FOR TYPE D POWER PARK MODULES

1. In addition to fulfilling the requirements listed in Articles 7, 8, 9, 10, 14 and 15, except for Article 7(1) (f), Article 8(2) (a), Article 9(3) (a), Article 14(2) (a) and Article 14(3) (a), Type D Power Park Modules shall fulfil the following requirement referring to robustness of Power Generating Modules.

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

1) Each TSO shall adopt a decision pursuant to Article 4(3) defining a voltage-against-time-profile according to figure 6 at the Connection Point for fault conditions which describes the conditions in which the Power Park Module shall stay connected to the network and shall continue stable operation after the power system has been disturbed by Secured Faults on the network, unless the protection scheme for internal Power Park Module faults requires the disconnection of a Power Park Module from the network.

2) This voltage-against-time-profile shall be expressed by a lower limit of the course of the phase-to-phase voltages on the network voltage level at the Connection Point during a symmetrical fault, as a function of time before, during and after the fault. This lower limit is defined by the TSO using parameters in figure 6 according to table 11.

3) Each TSO shall adopt and make publicly available a decision pursuant to Article 4(3) defining the pre-fault and post-fault conditions for the fault ride through capability in terms of:

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

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

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

[12] nach oben: <#>With regard to Reactive Power control modes:¶ <#>The Power Park Module shall be capable of providing Reactive Power automatically by either Voltage Control mode, Reactive Power Control mode or Power Factor Control mode or by a combination of two of these

Gelöscht: <#>.¶ <#>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 System with a Setpoint voltage covering at least 0.95 to 1.05 pu in steps no greater than 0.01 pu with a Slope with a range of at least 2 to 7 % in steps no greater than 0.5 %. The Reactive Power output shall be 0 when the grid voltage value at ... [48]

[13] nach oben: <#>The control mode, parameter settings and ... [49]

Gelöscht: <#>The Relevant Network Operator in coordination with ... [50]

Gelöscht: as prescribed

Gelöscht: 17

Gelöscht: general

Gelöscht: 10, as well as type B and C Power Park Modules specific ... [51]

Gelöscht: type A Power Park Modules specific requirements, and

Gelöscht: 16 type

Gelöscht: Units

[10] verschoben

Gelöscht: <#>With regard to fault ride through capability of Power Par ... [52]

Gelöscht: one of the three

Gelöscht: which sustains the lowest retained voltage

Gelöscht: or asymmetrical

Gelöscht: irrespective of the voltage drop of the other two phase-t ... [53]

Gelöscht: shall be selected on the red lines or a specific line insid ... [54]

Gelöscht: 12

Gelöscht: fault level

Gelöscht: expressed in MVA

Gelöscht: Park

Gelöscht: fault level

Gelöscht: expressed in MVA.

Gelöscht: adopt a decision pursuant to Article 4(3) defining

Gelöscht: the

Gelöscht: and

- pre-fault voltage at the connection point; and
- post-fault minimum short circuit capacity at each Connection Point expressed in MVA.

5) The Power Park Module shall stay connected to the network and continue stable operation when the actual course of the phase-to-phase voltages on the network voltage level at the Connection Point during a symmetrical fault, given the pre-fault and post-fault conditions according to points 3) and 4), remains above the lower limit defined in point 2), unless the protection scheme of the Power Generating Facility requires the disconnection of a Power Generating Module from the network.

Voltage parameters [pu]		Time parameters [seconds]	
U_{ret}:	0	t_{clear}:	0.15 – 0.25
U_{clear}:	U_{ret}	t_{rec1}:	t_{clear}
U_{rec1}:	U_{clear}	t_{rec2}:	t_{rec1}
U_{rec2}:	0.9	t_{rec3}:	1.5 – 3.0

Table 11 – Parameters for figure 6.

6) Undervoltage protection (either fault ride through capability or minimum voltage defined at the connection point voltage) shall be set by the Power Generating Facility Owner to the widest possible technical capability of the Power Park Module, unless the Relevant Network Operator requires another setting. The settings shall be justified by the Power Generating Facility Owner in accordance with this principle.

7) Fault ride through capabilities in case of asymmetrical faults shall be specified by each TSO pursuant to Article 4(3).

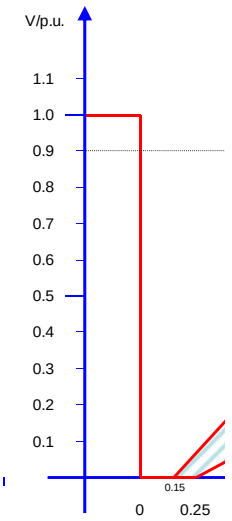


Figure 12 – Fault ride through profile for a Power Park Module. The diagram represents the boundaries for TSOs to determine a unique line for a voltage-against-time profile by the voltage at the Connection Point, expressed by the ratio of its actual value and its nominal value in per unit before, during and after a fault. Regarding the shaded area see Article 17(1) (a) point 2).

Chapter 4

REQUIREMENTS FOR OFFSHORE POWER PARK MODULES

Article 17

GENERAL PROVISIONS

1. The requirements set for in this Chapter apply to the connection to the network of Power Park Modules located offshore. A Power Park Module located offshore which does not have an Offshore Connection Point shall be considered as an Onshore Power Park Module and thus shall be compliant with the requirements set forth for the Power Park Modules situated onshore.

Gelöscht: one of
Gelöscht: three
Gelöscht: which sustains the lowest retained voltage
Gelöscht: or asymmetrical
Gelöscht: point
Gelöscht:).
Gelöscht: ¶
Undervoltage protection, respecting the appropriate operating voltage ranges,¶
Gelöscht: and the
Gelöscht:
Gelöscht: 18

2. The Offshore Connection Point of an Offshore Power Park Module shall be defined by a decision of the Relevant Network Operator pursuant to Article 4(3).

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

Gelöscht: 3. An Offshore Power Park Module may comprise of one or more Generating Units. All associated auxiliary system and secondary equipments shall be considered as parts of the Offshore Power Park Module.¶
4

a) Configuration 1: AC connection to single onshore point

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

b) Configuration 2: Meshed AC connection

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

c) Configuration 3: DC connection to single onshore point with AC collection

One or more Offshore Power Park Modules are interconnected offshore to form an Offshore AC System. The Offshore AC System is connected to the Onshore System with one or more DC connections at one Onshore Grid Interconnection Point location.

d) Configuration 4: Meshed Hybrid AC and DC connections with AC collection

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

e) Configuration 5: Meshed Multiterminal DC connection with AC Collection

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

f) Configuration 6: Meshed DC connection with DC Collection

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

Gelöscht: Units

Article 18

Gelöscht: 19

FREQUENCY STABILITY REQUIREMENTS APPLICABLE TO OFFSHORE POWER PARK MODULES

1. The Frequency stability requirements defined respectively in Article 8(2) (a) and Article 9(2) (a), (b), (e) and (g) shall apply to any Offshore Power Park Module, irrespective of its configuration.

Gelöscht: frequency

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

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

4. The Frequency stability requirements as defined in Article 7(1) (c) or Article 9(2) (b), and Article 9(2) (c) and Article 15(2) (a) shall apply to any Offshore Power Park Modules, irrespective of its configuration. Nevertheless, for configurations 3, 5 and 6 offshore Frequency or alternatively onshore Frequency signals shall be used as reference.

Article 19

VOLTAGE STABILITY REQUIREMENTS APPLICABLE TO OFFSHORE POWER PARK MODULES

1. The voltage ranges set forth in table 12 shall apply to Offshore Power Park Modules of configurations 1, 2, 3, 4 and 5 within the time periods specified by table 12. For configuration 6 the voltage range shall be defined individually.

Gelöscht: frequency
Gelöscht: frequency
Gelöscht: frequency
Gelöscht: frequency
Gelöscht: frequency
Gelöscht: c
Gelöscht: d
Gelöscht: 16
Gelöscht: frequency
Gelöscht: frequency
Gelöscht: 20
Gelöscht: 8
Gelöscht: 8

Synchronous Area	Voltage Range	Time period for operation
Continental Europe	0.80 pu – 0.85 pu	30 minutes
	0.85 pu – 0.90 pu	60 minutes
	0.90 pu – 1.05 pu	Unlimited
	1.05 pu – 1.0875 pu	To be decided by each TSO pursuant to Article 4(3), but not less than 60 minutes
	1.0875 pu – 1.10 pu	60 minutes
Nordic	0.90 pu – 1.05 pu	Unlimited
	1.05 pu – 1.10 pu	60 minutes
Great Britain	0.90 pu – 1.05 pu	Unlimited
	1.05 pu – 1.10 pu	15 minutes
Ireland	0.90 pu – 1.10 pu	Unlimited
Baltic	0.80 pu – 0.90 pu*	30 minutes
	0.90 pu – 1.12 pu*	Unlimited
	1.12 pu – 1.15 pu*	20 minutes
	0.88 pu – 0.90 pu**	20 minutes
	0.90 pu – 1.10 pu**	Unlimited
	1.10 pu – 1.15 pu**	20 minutes

* The voltage base for pu values is between 110 kV and 300 kV.

** The voltage base for pu values is between 300 kV and 400 kV.

Table 12: This table shows the minimum period an Offshore Power Park Module has to operate for different voltage ranges deviating from a nominal value without disconnecting.

2. The voltage stability requirements defined respectively in Article 14(2) (b) and (c) as well as in Article 15(3) (c) and (e) shall apply to Offshore Power Park Modules of configurations 1, 2, 3, 4 and 5.

3. The Reactive Power capability at Maximum Capacity as defined in Article 15(3) (b) shall apply to Offshore Power Park Modules of configurations 1, 2, 3, 4 and 5 except for table 10, which shall be replaced by table 13.

Gelöscht: 8

Gelöscht: 15

Gelöscht: a

Gelöscht: b

Gelöscht: 16

Gelöscht: d

Gelöscht: maximum Active Power

Gelöscht: 16

Gelöscht: 7

Gelöscht: 9

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

*) at the Offshore Connection Point for configuration 1 & 6
**) at the Offshore Connection Point for configuration 2, 3, 4 & 5

Table 13: Parameters for figure 9

4. The Reactive Power control modes as defined in Article 15(3) (d) shall apply to Offshore Power Park Modules of configurations 1, 2, 3, 4 and 5. For configuration 6 only voltage control option shall apply.

Article 20

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

1. The steady-state stability requirement as defined in Article 9(4) (a) shall apply to Offshore Power Park Modules of configurations 1, 2, 4 and 6.

2. The torsional stress requirement defined in Article 9(4) (b) shall apply to Offshore Power Park Modules of configurations 1, 2 and 4.

3. The power oscillation damping control requirement as defined in Article 15(3) (f) shall apply to Offshore Power Park Modules of configurations 1, 2, 4 and 5.

4. The fault ride through capability of Power Park Modules as defined in Article 16(1) (a) shall apply to any Offshore Power Park Module, irrespective of its configuration.

Article 21

SYSTEM RESTORATION REQUIREMENTS APPLICABLE TO OFFSHORE POWER PARK MODULES

The system restoration requirements defined respectively in Article 9(5) (a) and (b) shall apply to any Offshore Power Park Modules, irrespective of its configuration.

Gelöscht: 9
Gelöscht: 10
Gelöscht: 16
Gelöscht: e
Gelöscht: 21
Gelöscht: UNITS
Gelöscht: 16
Gelöscht: 17
[14] nach unten: ¶ ¶ Article 22¶
Gelöscht:), (b),
Gelöscht: d
[14] verschoben

Article 22

GENERAL SYSTEM MANAGEMENT REQUIREMENTS APPLICABLE TO OFFSHORE POWER PARK MODULES

Gelöscht: ¶
¶
Article 23¶

1. The general system management requirements defined respectively in Article 8, Article 9(6) (a), (b), (c), (d), (e), (f), (g), (h) and (j) shall apply to any Offshore Power Park Module, irrespective of its configuration.

Gelöscht:), (i), (j

Gelöscht: k

2. The synchronization requirement as defined in Article 10(3) (a) shall apply to Offshore Power Park Modules of configurations 1, 2, 3, 4 and 5.

Gelöscht: 9(6

Title 3

OPERATIONAL NOTIFICATION PROCEDURE FOR CONNECTION

Chapter 1

OPERATIONAL NOTIFICATION PROCEDURE FOR CONNECTION OF NEW POWER GENERATING MODULES

Gelöscht: UNITS

Article 23

Gelöscht: 24

GENERAL PROVISIONS

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

Gelöscht: Units

2. The Power Generating Facility Owner shall prove to the Relevant Network Operator its compliance with the requirements referred to in Title 2 of this Network Code by completing successfully the operational notification procedure for connection of each Power Generating Module as defined in Articles 24 to 31.

Gelöscht: below

Article 24

PROVISIONS FOR TYPE A POWER GENERATING MODULES

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

Gelöscht: :

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

[15] nach unten: <#>Energisation Operational Notification (EON);¶
<#>Interim Operational Notification (ION);and¶
<#>Final Operational Notification (FON).¶

Gelöscht: The

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

Article 25

COMMON PROVISIONS FOR TYPE B, C AND D POWER GENERATING MODULES

1. The operational notification procedure for connection for each new Type B, C and D Power Generating Module allow for the use of the Manufacturer's Data and Performance Type Certificate (MD&PTC).

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

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

Gelöscht:) registered with the Relevant Network Operators defining

Gelöscht: Unit can

Gelöscht: be used

Gelöscht: this

Gelöscht: <#>For types A and B only, these MD&PTCs might be accepted as the sole evidence of compliance. ¶ For types C and D the

Gelöscht: ¶

Gelöscht: (or its declared agent authorized to fulfil this function on its behalf)

Article 26

Gelöscht: 25

PROVISIONS FOR TYPE B AND C POWER GENERATING MODULES

1. The operational notification procedure for connection for each new Type B and C Power Generating Module shall comprise a Power Generating Module Document (PGMD). The PGMD provided by the Power Generating Facility Owner shall contain information as defined by the Relevant Network Operator, including a Statement of Compliance. The selection of the required content of the PGMD shall be defined by the Relevant Network Operator according to Article 4 (3). Its content shall be informed by the information defined in Articles 27 to 31 for Type D Power Generating Modules, but can be simplified through delivery in a single stage of operational notification as well as reduced requirements of details. The Power Generating Facility Owner shall provide the required information and submit it to the Relevant Network Operator. For subsequent Power Generating Modules separate independent PGMDs shall be provided.

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

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

Article 27

PROVISIONS FOR TYPE D POWER GENERATING MODULES

The operational notification procedure for connection for 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).

[15] verschoben

Article 28

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

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

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

Gelöscht: prior establishment
Gelöscht: grid connection facilities
Gelöscht: interfaces
Gelöscht: for
Gelöscht: and responsibilities

Article 29

Gelöscht: 26

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

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

Gelöscht: Unit

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

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

Gelöscht: following must be submitted to the
Gelöscht: by

   a) Itemized Statement of Compliance in the conditions set forth in Title 4 Chapter 5, 6 and 7 of this Network Code (Interim Statement of Compliance);
   b) Detailed technical data of the Power Generating Module(s) with relevance to the grid connection as specified by the Relevant Network Operator;
   c) MD&PTCs of Power Generating Modules, where these are relied upon as part of the evidence of compliance;
   d) Simulation models as specified by Article 9(6) (d) and as required by a decision by the Relevant Network Operator pursuant to Article 4(3) for its own steady-state and dynamic system studies;

Gelöscht: compliance
Gelöscht: Compliance
Gelöscht: Facility
Gelöscht: Units
Gelöscht: f

e) Studies demonstrating expected steady-state and dynamic performance as required by Title 4 Chapter 5, 6 or 7 of this Network Code; and
f) Details of intended practical compliance tests according to Title 3 Chapter 2.

4. The maximum period for the Power Generating Facility Owner to remain in the Interim Operational Notification (ION) status shall not exceed twenty-four months. The Relevant Network Operator is entitled to specify a shorter ION validity period (e.g. six months) in accordance with Articles 4(2) and 4(3) with ION extensions granted only if the Power Generating Facility owner has made substantial progress towards full compliance. At the time of ION extension, the outstanding issues should be explicitly identified.

Gelöscht: 24

Gelöscht: 6

Kommentar [RPF7]: Need to discuss this. See label 26.4-1. Concern: unequal treatment. Does addition provide adequate safeguard? HU view ok as it is

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

Gelöscht: 24

Article 30

Gelöscht: 27a

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

1. Final Operational Notification (FON) shall entitle the Power Generating Module by using the grid connection.

Gelöscht: Unit

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

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

   a) Confirmation of compliance in the conditions set forth in Title 4 Chapter 2, 3, 4, 5, 6 and 7 of this Network Code (Statement of Compliance); and
   b) Update of applicable technical data, simulation models and studies as referred to in Article 29(3) (b), (c), (d) and (e), including use of actual measured values during testing.

Gelöscht: 26

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

Gelöscht: Unit

Gelöscht: Unit

Gelöscht: Unit

Article 31

Gelöscht: 27b

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

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

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

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

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

   a) the unresolved issues justifying the granting of the Limited Operational Notification (LON);
   b) the responsibilities and timescales for expected solution; and
   c) a maximum period of validity which shall not exceed twelve months. The initial period granted may be shorter, with possibility for extension if evidence to the satisfaction of the Relevant Network Operator has been made which demonstrates that substantial progress has been made in terms of achieving full compliance.

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

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

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

Gelöscht: 3

Gelöscht: 12

Kommentar [RPF8]: The time period needs to be discussed by RfG, see label 27.3-1 . HU view: ok as it is.

Kommentar [RPF9]: As above. Label 27.5-1

Gelöscht: Unit

Kommentar [RPF10]: Discuss, should this be automatic? See label 27.6-1. HU view is that this ultimate sanction is needed, but in reality never used. HU preferred alternative: In such cases the RNO shall have the right to withdraw the FON

Kommentar [RPF11]: Views on comment: "End-of-life notification is missing in the operational notification process"

Chapter 2

OPERATIONAL NOTIFICATION PROCEDURE FOR EXISTING POWER GENERATING MODULES

Gelöscht: CONNECTION OF

Gelöscht: UNITS

Article 32

Gelöscht: 28

GENERAL PROVISIONS

1. In order to assess the advantages of the applicability of any requirement set forth in this Network Code to Existing Power Generating Modules, the Relevant TSO shall initiate the process referred to in Article 3(2) by a preparatory stage aimed at identifying cases of merit with the phases defined in paragraphs 2 through to 8 below. This preparatory stage shall consist of a

Gelöscht: To determine

Gelöscht: to progress to

Gelöscht: process

Gelöscht: below

Gelöscht: , the Relevant TSO shall apply a filtering process consisting

qualitative comparison of costs and benefits related to the requirement under consideration for application to Existing Power Generating Modules. If the Relevant TSO deems the cost of applying the requirement to be low and the benefit to be high then the case can proceed as defined below. If however, the cost is deemed high and or the benefit is deemed low then the Relevant TSO may not proceed further.

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

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

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

- Net Present Value;
- Return On Investment;
- Rate of Return; and
- Time to Break Even.

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

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

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

- Frequency response;
- reserve holding;
- reactive power provision;
- congestion management; and
- defence measures.

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

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

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

Gelöscht: cost-benefit analysis.

Gelöscht: no

Gelöscht: <#>A proposal by the Relevant TSO to the National Regulatory Authority on applicability of requirements set forth by this Network Code to Existing Generating Units according to Title 1 Article 3(2) shall include the following:¶

[16] nach unten: a) . an operational notification procedure in order to prove the implementation of the requirements by the Power Generating Facility Owner; ' b) . an appropriate transition period for implementing the requirements.

Gelöscht: The determination of the transition period shall take into account the category of the Generating Unit according to Article 3(6) (a) to (e) and any underlying obstacles for efficient undertaking of the equipment modification/refitting. The

Gelöscht: <#>Prior to the Relevant TSO making a proposal to the National Regulatory Authority as described in paragraph 2, the TSO shall carry out a quantitative cost-benefit analysis and a public consultation. ¶

Gelöscht: cost-benefit analysis

Gelöscht: cost-benefit analysis

Gelöscht: follows

[17] verschoben

Gelöscht: frequency

[17] nach oben: response;¶ <#>reserve holding;¶ <#>reactive power provision; ¶ <#>congestion management; and¶ <#>defence measures.¶ The quantified costs shall include as appropriate, but are not limited to:¶ <#>costs for implementing the requirement;¶ <#>any attributable loss of opportunity; and/or ¶ change in maintenance

Gelöscht: requiring compliance

[18] verschoben

[18] nach oben: This report shall be subject to public consultation.

Gelöscht: after

Gelöscht: shall be forwarded

Gelöscht: the outcome of the

requirement under consideration to Existing Power Generating Modules, shall be forwarded to the Relevant National Regulatory Authority within six months for decision.

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

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

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

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

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

[16] verschoben

Gelöscht:

Gelöscht: Units

Gelöscht: 2

Gelöscht: Units

Kommentar [RPF12]: This paragrapgh is misplaced in this Article and needs to be moved. The suitable Article for this clause is to be checked by lawyers (Article 58: ENTRY INTO FORCE?).The clause is needed to ensure, that already existing grid connectionn contracts for new Generating Units, can be changed to meet the requirements of this Network Code.

Title 4

COMPLIANCE

Chapter 1

COMPLIANCE MONITORING

Article 33

Gelöscht: 29

RESPONSIBILITY OF THE POWER GENERATING FACILITY OWNER

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

   Gelöscht: Unit

   Gelöscht: or national legislation including the national codes

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

   Gelöscht: Unit

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

   Gelöscht: Unit

   Gelöscht: or national legislation including the national codes

   Gelöscht: intentional

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

   Gelöscht: Unit

   Gelöscht: or national legislation including the national codes,

   Gelöscht: The purpose of this is to allow the Relevant Network Operator to evaluate and mitigate where necessary the consequential risks to the Network and its users.

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

   Gelöscht: Units

Article 34

Gelöscht: 30

TASKS OF THE NETWORK OPERATOR

1. The Relevant Network Operator shall regularly assess the compliance of a Power Generating Module with the requirements under this Network Code, national legislation including national codes throughout the lifetime of the Power Generating Facility.

   Gelöscht: Unit

2. The Relevant Network Operator shall have the right to request that the Power Generating Facility Owner carries out compliance tests and simulations not only during the operational notification procedures according to Title 3, but repeatedly throughout the lifetime of the Power Generating Facility and in particular after any failure, modification or replacement of any

equipment that may have impact on the Power Generating Module's compliance with the requirements under this Network Code or national legislation including national codes.

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

   a) All documentation and certificates to be provided by the Power Generating Facility Owner;
   b) Details of the technical data of the Power Generating Module with relevance to the grid connection;
   c) Requirements for models for steady-state and dynamic system studies;
   d) Timely provision of system data required to perform the studies;
   e) Studies by the Power Generating Facility Owner for demonstrating expected steady-state and dynamic performance referring to the requirements set forth in Title 4 Chapter 4 and 5 of this Network Code; and
   f) Conditions and procedures including the scope for registering MD&PTCs.
   g) Conditions and procedures for use of relevant MD&PTCs by the Power Generating Facility Owner in lieu of part of the activity for compliance as described in this Network Code.

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

5. The Relevant Network Operator may partially or totally delegate the performance of its compliance monitoring to third parties.

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

Article 35

COMMON PROVISIONS ON COMPLIANCE TESTING

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

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

   a) allow the Power Generating Facility Owner to carry out an alternative set of tests, provided that those tests are efficient and sufficient to demonstrate compliance of a Power Generating Module to the requirements under this Network Code;
   b) require the Power Generating Facility Owner to carry out an additional or alternative set of tests in case information supplied to the Relevant Network Operator by the Power Generating Facility Owner in relation to compliance testing under the provisions of Title 4

Gelöscht: Unit's

Gelöscht: Unit

Gelöscht: 31

Gelöscht: Units

Gelöscht: Unit

Gelöscht: or national legislation including national codes

Chapter 2, 3 or 4 of this Network Code are not sufficient to demonstrate compliance to the requirements under this Network Code;

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 Network Operator and the Power Generating Facility Owner shall agree on which types of fuel are tested;

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

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

5. The costs of the tests including necessary deviation from the commercially preferred operating point in order to facilitate the tests shall be covered by the Power Generating Facility Owner.

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

Article 36

COMMON PROVISIONS ON COMPLIANCE SIMULATIONS

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

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

a) allow the Power Generating Facility Owner to carry out an alternative set of simulations, provided that those simulations are efficient and sufficient to demonstrate compliance of a Power Generating Module to the requirements under this Network Code or national legislation including national codes; and

b) require the Power Generating Facility Owner to carry out an additional or alternative set of simulations in case information supplied to the Relevant Network Operator by the Power Generating Facility Owner in relation to Compliance Simulation under the provisions of Title 4 Chapter 5, 6 or 7 of this Network Code are not sufficient to demonstrate compliance to the requirements under this Network Code.

3. The Power Generating Facility Owner shall provide simulation results relevant to each and any individual Power Generating Module within the Power Generating Facility in a report form in

Gelöscht: Unit's

Gelöscht: <#>require the Power Generating Facility Owner to carry out appropriate tests as defined by the Relevant Network Operator in order to demonstrate the Generating Unit's performance when implementing additional features which are not mandatory according to this Network Code.¶

Gelöscht: both

Gelöscht: and the manufacturer

Gelöscht: 32

[19] verschoben

[19] nach oben: COMMON PROVISIONS ON COMPLIANCE SIMULATIONS¶

Gelöscht: Units

Gelöscht: compliance simulations

Gelöscht: Unit

Gelöscht: compliance simulation

Gelöscht: Unit

order to demonstrate the fulfilment of the requirements of this Network Code. The Power Generating Facility Owner shall produce and provide a validated simulation model for a Power Generating Module. The coverage of the simulation models are described in Article 9(6) (d).

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

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

Gelöscht: Unit

Gelöscht: and the format

Gelöscht: f

Gelöscht: Unit

Gelöscht: compliance simulations

Kommentar [RPF13]: To be discussed: What is the consequence, if the simulations by the PGF Owner and the Network Operator show different/contradictory results?

Chapter 2

COMPLIANCE TESTING FOR SYNCHRONOUS POWER GENERATING MODULES

Gelöscht: UNITS

Article 37

Gelöscht: 33

Gelöscht: A

Gelöscht: UNITS

COMPLIANCE TESTS FOR TYPE B SYNCHRONOUS POWER GENERATING MODULES

1. Type B Synchronous Power Generating Modules are subject to the following compliance tests. The MD&PTC may be used in lieu of part or all of the tests below, provided that they are registered with the Relevant Network Operator.

Gelöscht: <#>The MD&PTC may be used instead of part or all of the tests below, provided that they are registered with the Relevant Network Operator.¶ With regard to type A

2. With regard to the Open and Short Circuit Saturation Characteristics test:

[20] verschoben

Gelöscht: Units

Kommentar [EKW14]: Include reference to related requirement

a) The Power Generating Module shall demonstrate its open circuit running and short circuit characteristics to verify its Short-Circuit Ratio.

b) The test is deemed passed, provided that the Short-Circuit Ratio of the Power Generating Module is not less than 0.5 (Type B and C Power Generating Modules) or 3.5 (Type D Power Generating Modules).

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

Gelöscht: shall be carried out.

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

Gelöscht: For the purpose of this test, the

Gelöscht: Unit

Gelöscht: frequency control

Gelöscht: frequency

Gelöscht: insensitivity,

Gelöscht: ,

Gelöscht: range of regulation,

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

Gelöscht: frequency

Gelöscht: frequency

Gelöscht: frequency

Gelöscht: governor

Gelöscht: load controller references

Gelöscht: into

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

Gelöscht: speed governor and load controller

1) the test results, for both dynamic and static parameters, are in line with the requirements as referred to in Article 7(1) (c); and

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

Article 38

COMPLIANCE TESTS FOR TYPE C SYNCHRONOUS POWER GENERATING MODULES

1. In addition to the compliance tests for Type B Synchronous Power Generating Modules in the conditions as referred to in Article 37, Type C Synchronous Power Generating Modules are subject to the following compliance tests. For installations for which relevant MD&PTCs exist which are registered with the Relevant Network Operator, these may be used as part of verified component performance data.

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

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

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

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

      1) the test results, for both dynamic and static parameters, are in line with the requirements as referred to in Article 9(2) (b); and

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

3. With regard to the FSM response test:

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

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

Gelöscht: 34
Gelöscht: B
Gelöscht: UNITS
[20] nach oben: <#>The MD&PTC may be used in lieu of part or all of the tests below, provided that they are registered with the Relevant Network Operator.
Gelöscht: <#>¶
Gelöscht: carrying out
Gelöscht: type A
Gelöscht: Units
Gelöscht: 33, type B
Gelöscht: Units
Gelöscht: ¶
<#>With regard to the Open and Short Circuit Saturation Characteristics test: ¶
<#>The Generating Unit shall demonstrate its open circuit running and short circuit characteristics to verify its Short-Circuit Ratio. ¶
<#>The test is deemed passed, provided that the Short-Circuit Ratio of the Generating Unit is not less than 0.5 or a lower value decided by the Relevant TSO pursuant to Article 4(3).¶
¶
¶
Article 35¶
COMPLIANCE TESTS FOR TYPE C SYNCHRONOUS GENERATING UNITS¶
In addition to carrying out the compliance tests for type A and B Synchronous Generating Units in the conditions as referred to in Articles 33 and 34, type C Synchronous Generating Units are subject to the following compliance tests.
[21] verschoben
[22] verschoben
[23] verschoben
Gelöscht: Unit
Gelöscht: frequency control
Gelöscht: insensitivity,
Gelöscht: ,
Gelöscht: , range of regulation, as well as
Gelöscht: frequency
Gelöscht: frequency
Gelöscht: frequency
Gelöscht: frequency
Gelöscht: frequency
Gelöscht: references

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

1) activation time of full Active Power Frequency response range as result of a step Frequency change has been no longer than required by Article 9(2) (c);

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

3) the initial delay time has been according to Article 9(2) (c);

4) the Droop settings are available within the range defined in Article 9(2) (c) and deadband (thresholds) is not more than the value in Article 9(2) (c); and

5) insensitivity of Active Power Frequency response at any relevant operating point does not exceed the requirements set forth in Article 9(2) (c).

4. With regard to the frequency restoration control test:

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

b) The test is deemed passed, provided that the test results, for both dynamic and static parameters, are in line with the requirements as referred to in Article 9(2) (d).

5. With regard to the Black Start Capability test:

a) Power Generating Modules with Black Start Capability in accordance with Article 9(5) (a), shall demonstrate this technical capability to start from shut down without any external energy supply.

b) The test is deemed passed, provided that the start-up time has been not longer than the timeframe according to Article 9(5) (a) point 2).

6. With regard to the tripping to houseload test:

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

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

c) Further conditions for this test shall be decided by the Relevant Network Operator pursuant to Article 4(3) taking into account Article 9(5) (c).

d) The test is deemed passed, provided that tripping to houseload has been successful and stable Houseload Operation has been demonstrated for time period according to Article 9(5) (c).

7. With regard to the Reactive Power Capability test:

a) The Power Generating Module shall demonstrate its technical capability to provide leading and lagging Reactive Power capability according to Article 12(2) (b) and (c).

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

Gelöscht: whole

Gelöscht: frequency

Gelöscht: frequency

Gelöscht: as small as possible and no higher than 2 seconds

Gelöscht: <#>minimum time to achieve the Active Power frequency response is no longer than that defined for t2 according to Article 9(2) (c);¶

Gelöscht: is adjustable to the value required by the Relevant TSO

Gelöscht: less

Gelöscht: frequency

[21] nach oben: <#>With regard to the LFSM-U response test: ¶

Gelöscht: Unit shall demonstrate its technical capability to continuously modulate Active Power at operating points below Maximum Capacity to contribute to frequency control in case of large drop of frequency in the system.

[22] nach oben: ¶
<#>The test shall be carried out by simulating at appropriate Active Power load points (e.g.

Gelöscht: <#>80 %) with low frequency steps and ramps big enough to activate at least 10 % of Maximum Capacity Active Power change, taking into account the Droop settings and the deadband. Simulated frequency deviation signals shall be injected simultaneously into both the speed governor and the load controller references if required, taking into account the speed governor and the load controller scheme.¶
<#>The test is deemed passed, provided that the following conditions are both fulfilled:¶ … [55]

Gelöscht: frequency

Gelöscht: c) and (e

Gelöscht: Relevant

Gelöscht: Units specified to have

Gelöscht: capability

Gelöscht: their

Gelöscht: ability

Gelöscht: is

Gelöscht: Tripping

Gelöscht: Houseload

Gelöscht: Unit

Gelöscht: maximum Active

Gelöscht: Unit

Gelöscht: the operating point of the Generating Unit, speed control … [56]

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

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

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

Article 39

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 in the conditions as referred to in Articles 37 and 38. For installations for which relevant MD&PTCs exist which are registered with the Relevant Network Operator, these may be used as part of verified component performance data.

Chapter 3

COMPLIANCE TESTING FOR POWER PARK MODULES

Article 40

COMPLIANCE TESTS FOR TYPE B POWER PARK MODULES

1. The MD&PTC may be used in lieu of part or all of the tests below, provided that they are provided to the Relevant Network Operator.

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

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

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

   c) The test is deemed passed, provided that the test results, for both dynamic and static parameters, are in line with the requirements as referred to in Article 7(1) (c).

Kommentar [EKW15]: should last less than one hour for all given operating points

Gelöscht: <#>the Excitation System response shall present a damped oscillatory characteristic;¶ <#>after tripping, the voltage or speed controller has kept alternator voltage or frequency in the permissible range where the time for the alternator terminal voltage to reach the target value of the voltage regulator within an admissible tolerance shall be shorter than; ¶ <#>0.5 seconds – for thyristor static exciters; and¶ <#>1.5 seconds – for electromechanical exciters.¶ ... [57]

Gelöscht: Facility Owner wit ... [58]

Gelöscht: <#>minimum Act ... [59]

Gelöscht: Unit

Gelöscht: ; and

Gelöscht: <#>where part of ... [60]

Gelöscht: UNITS

Gelöscht: In addition to carryin ... [61]

Gelöscht: type A,

Gelöscht: Units

Gelöscht: 33, 34

[24] verschoben

Gelöscht: <#>35 type D Synchr ... [62]

[23] nach oben: <#>The test ... [63]

Gelöscht: <#>the Excitation ... [64]

[25] nach unten: <#>The te ... [65]

Gelöscht: <#>the resulting n ... [66]

[26] nach unten: <#>The te ... [67]

Gelöscht: <#>the resulting o ... [68]

Gelöscht: 37

Gelöscht: A

Gelöscht: registered with

Gelöscht: type A

Gelöscht: , Voltage Control Mo ... [69]

Gelöscht: <#>With regard to th ... [70]

Gelöscht: frequency control

Gelöscht: frequency

Gelöscht: insensitivity,

Gelöscht: ,

Gelöscht: range of regulation ... [71]

Gelöscht: frequency

Gelöscht: frequency

Gelöscht: frequency

Article 41

COMPLIANCE TESTS FOR TYPE C POWER PARK MODULES

1. In addition to the compliance tests for Type B Power Park Modules in the conditions as referred to in Article 40, Type C Power Park Modules are subject to the following compliance tests. For installations for which relevant MD&PTCs exist which are provided to the Relevant Network Operator, these may be used as part of verified component performance data.

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

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

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

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

      2) the Setpoint is implemented according to the requirements as referred to in Article 9(2) (a); and

      3) the accuracy of the regulation is compliant with specified value according to Article 9(2) (a).

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

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

   b) The test shall be carried out by simulating the Frequency steps and ramps big enough to activate at least 10 % of Maximum Capacity Active Power change with a starting point of no more than 80 % of Maximum Capacity, taking into account the Droop settings and the deadband. Simulated Frequency deviation signals shall be injected in the Power Park Module controller scheme, taking into account both speed governor and load controller scheme, if applicable.

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

      1) the test results, for both dynamic and static parameters, are in line with the requirements as referred to in Article 9(2) (b); and

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

4. With regard to the FSM response test:

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

Gelöscht: 38

Gelöscht: COMPLIANCE TESTS FOR TYPE B POWER PARK MODULES¶
<#>The MD&PTC may be used in lieu of part or all of the tests below, provided that they are registered with the Relevant Network Operator.¶
<#>The tests for type A Power Park Modules as referred to in Article 37, shall be carried out with regard to type B Synchronous Generating Units.¶
¶
¶
Article 39¶

Gelöscht: carrying out

Gelöscht: type A and

Gelöscht: Articles 37 and 38, type

[24] nach oben: For installations for which relevant MD&PTCs exist which are registered with the Relevant Network Operator, these may be used as part of verified component performance data.¶

Gelöscht: Limited

Gelöscht: Control Mode

[25] verschoben

[27] verschoben

Gelöscht: frequency control

Gelöscht: frequency

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

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

1) the activation time of full Active Power Frequency response range as result of a step Frequency change has been no longer than that required by Article 9(2) (c);

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

3) the initial delay has been according to Article 9(2) (c);

4) the Droop settings are available within the ranges defined in Article 9(2) (c) and deadband (thresholds) is not more than the value chosen by the TSO; and

5) the insensitivity of Active Power Frequency response does not exceed the requirement according to Article 9(2) (c).

5. With regard to the frequency restoration control test:

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

b) The test is deemed passed, provided that the test results for both dynamic and static parameters are in line with the requirements as referred to in Article 9(2) (d).

6. With regard to the Reactive Power capability test:

a) The Power Park Module shall demonstrate its technical capability to provide leading and lagging Reactive Power capability according to Article 15(3) (b) and (c).

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

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

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

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

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

1) the Power Park Module has been operating no shorter than requested duration at maximum Reactive Power, both leading and lagging, in each parameter as referred to in Article 41(6) (b);

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

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

7. With regard to the Voltage Control Mode test:

Kommentar [RPF16]: To be discussed. Rejected by stakeholders arguing that frequency step simulations can trigger portection.

Gelöscht: frequency

Gelöscht: frequency

Gelöscht: frequency

[26] verschoben

Gelöscht: <#>The test is deemed passed, provided that the following conditions are cumulatively fulfilled:¶

Gelöscht: the start of the required

Gelöscht: frequency

Gelöscht: frequency

Gelöscht: time

Gelöscht: as small as possible and no longer than 2 seconds

Gelöscht: <#>minimum time to achieve the Active Power frequency response is no longer than that defined for t2 according to Article 9(2) (c);¶

Gelöscht: no

Gelöscht: frequency

Gelöscht: requirements set forth in

Gelöscht: LFSM-U response

Gelöscht:

Gelöscht: continuously modulate Active Power to contribute to frequency

Gelöscht: in case

Gelöscht: large drop of frequency in the system.¶
The test

Gelöscht: carried out by simulating the frequency steps and ramps ... [72]

Gelöscht: following condition ... [73]

Gelöscht: ,

Gelöscht: ,

Gelöscht:); and¶

[27] nach oben: <#>undan ... [74]

Gelöscht: <#>¶ ... [75]

Gelöscht: Capability

Gelöscht: in the conditions set forth in

Gelöscht: 16

Gelöscht: maximum capacity

Gelöscht: maximum capacity

Gelöscht: maximum capacity

Gelöscht: operated

Gelöscht: 39

Gelöscht: <#>where part of ... [76]

a) The Power Park Module shall demonstrate its capability to operate in voltage control mode in the conditions set forth in Article 15(3) (d) point 2).

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

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

2) the accuracy of the regulation;

3) the insensitivity of the regulation; and

4) the time of Reactive Power activation.

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

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

2) the range of regulation and adjustable the Droop and deadband is compliant with agreed or decided characteristic parameters, according to Article 15(3) (d);

3) the insensitivity of Voltage Control is not higher than 0.01 pu, according to Article 15(3) (d); and

4) following a step change in voltage, 90 % of the change in Reactive Power output has been achieved within the times and tolerances according to Article 15(3) (d).

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

a) The Power Park Module shall demonstrate its capability to operate in Reactive Power control mode, according to the conditions referred to in Article 15(3) (d) point 3).

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

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

1) the Reactive Power Setpoint range and step;

2) the accuracy of the regulation; and

3) the time of Reactive Power activation.

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

1) the Reactive Power Setpoint range and step is ensured according to Article 15(3) (d); and

2) the accuracy of the regulation is compliant with the conditions as referred to in Article 15(3) (d).

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

a) The Power Park Module shall demonstrate its capability to operate in Power Factor control mode according to the conditions referred to in Article 15(3) (d) point 4).

Gelöscht: 16

Gelöscht: e

Gelöscht: <#>the time of Reactive Power activation as result of step voltage change has been no longer than required, according to Article 16(3) (e);¶

Gelöscht: 16

Gelöscht: e

Gelöscht: 16

Gelöscht: e

Gelöscht: 1 second

Gelöscht: settled at the value defined by the operating Slope within 5 seconds with a steady state reactive tolerance no greater than 5 %.

Gelöscht: 16

Gelöscht: e

Gelöscht: 16

Gelöscht: e

Gelöscht: 16

Gelöscht: e

Gelöscht: 16

Gelöscht: e

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

1) the Power Factor Setpoint range;

2) the accuracy of the regulation; and

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

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

1) the Power Factor Setpoint range and step is ensured according to Article 15(3) (d);

2) the time of Reactive Power activation as result of step Active Power change does not exceed the requirement according to Article 15(3) (d); and

3) the accuracy of the regulation is compliant with the value, as referred to in Article 15(3) (d).

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

Gelöscht: 16
Gelöscht: e
Gelöscht: requirements set forth in
Gelöscht: 16
Gelöscht: e
Gelöscht: 16
Gelöscht: e

Article 42 **Gelöscht: 40**

COMPLIANCE TESTS FOR TYPE D POWER PARK MODULES

Type D Power Park Modules are subject to the compliance tests for Type B and C Power Park Modules in the conditions as referred to in Articles 40 and 41. For installations for which relevant MD&PTCs exist which are provided to the Relevant Network Operator, these may be used as part of verified component performance data.

Gelöscht: The tests that must be carried out by a type
Gelöscht: those provided
Gelöscht: type A,
Gelöscht: described respectively
Gelöscht: 37, 38
Gelöscht: 39 of this
Gelöscht: Code

Chapter 4

COMPLIANCE TESTING FOR OFFSHORE POWER PARK MODULES

Article 43 **Gelöscht: 41**

COMPLIANCE TESTING APPLICABLE TO OFFSHORE POWER PARK MODULES IN ALL CONFIGURATIONS

The compliance tests as defined in Article 40(2), as well as in Article 41(2), (3), (4), (5) and (7) shall apply to any Offshore Power Park Module, irrespective of its configuration.

Gelöscht: 37(3
Gelöscht: 39

[28] verschoben

Article 44

COMPLIANCE TESTING APPLICABLE TO OFFSHORE POWER PARK MODULES of CONFIGURATIONS 1-5

The compliance tests as defined in Article 41(8) and (9) shall apply to Offshore Power Park Modules of configurations 1, 2, 3, 4 and 5.

[29] verschoben

[29] nach oben: COMPLIANCE TESTING APPLICABLE TO OFFSHORE POWER PARK MODULES of CONFIGURATIONS 1-5¶

Gelöscht: ¶
¶
Article 42¶

Gelöscht: 39

Chapter 5

COMPLIANCE SIMULATIONS FOR SYNCHRONOUS POWER GENERATING MODULES

Gelöscht: UNITS

Article 45

Gelöscht: 43

COMPLIANCE SIMULATIONS FOR TYPE B SYNCHRONOUS POWER GENERATING MODULES

Gelöscht: A

Gelöscht: UNITS

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

Gelöscht: For installations for which relevant MD&

Gelöscht: exist which are registered with the Relevant Network Operator, these may be used in lieu

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

Gelöscht: With regard to type A

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

Gelöscht: Units

a) The Power Generating Module shall demonstrate its capability to simulate Active Power modulation at high Frequency according to Article 7(1) b.

Gelöscht: shall be carried out.

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

Gelöscht: For the purpose of that simulation, the

Gelöscht: Unit

Gelöscht: in

c) The simulation is deemed passed, provided that:

Gelöscht: frequency situations to study compliance in extreme network situations.

1) the simulation model of the Power Generating Module is validated against the compliance test for LFSM-O response as referred to in Article 37(3); and

Gelöscht: frequency steps,

2) compliance with the requirement according to Article 7(1) (c) is demonstrated.

4. With regard to the Type B Fault Ride Through Capability of Synchronous Power Generating Modules simulation:

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

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

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

f) The Power Generating Module shall demonstrate its capability to simulate post fault Active Power recovery in the conditions set forth in Article 14(3) (b).

g) The simulation is deemed passed, provided that compliance with the requirement according to Article 14(3) (b) is demonstrated.

Article 46

COMPLIANCE SIMULATIONS FOR TYPE C SYNCHRONOUS POWER GENERATING MODULES

1. In addition to the Compliance Simulations for Type B Synchronous Power Generating Modules in the conditions as referred to in Article 45, Type C Synchronous Power Generating Modules are subject to the following Compliance Simulations. For installations for which relevant MD&PTCs exist which are provided to the Relevant Network Operator, these may be used as part of verified component performance data.

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

   a) The Power Generating Module shall demonstrate its capability to simulate Active Power modulation at low Frequencies according to Article 9(2) b.

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

   c) The simulation is deemed passed, provided that:

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

      2) compliance with the requirement according to Article 9(2) (b) is demonstrated.

3. With regard to the FSM response simulation:

   a) The Power Generating Module shall demonstrate its capability to modulate Active Power over the full Frequency range according to Article 9(2) (c).

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

   c) The simulation is deemed passed, provided that:

      1) the simulation model of the Power Generating Module is validated against the compliance test for LFSM-U response as referred to in Article 38(3); and

      2) compliance with the requirement according to Article 9(2) (c) is demonstrated.

4. With regard to the Jsland Operation simulation:

   a) The Power Generating Module shall demonstrate its performance during Island Operation in the conditions as referred to in Article 9(5) (b).

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

Gelöscht:

Gelöscht: Unit

Gelöscht: tests

Gelöscht: O

Gelöscht: 33.

[28] nach oben: ¶
¶
Article 44¶

Gelöscht: COMPLIANCE SIMULATIONS FOR TYPE B SYNCHRONOUS GENERATING UNITS¶
<#>In addition to the compliance simulations for type A Synchronous Generating Units in the conditions as referred to in Article 43, for type B Synchronous Generating Units the type B Fault Ride Through Capability of Synchronous Generating Units simulation shall be carried out.¶
<#>The Generating Unit shall demonstrate its capability to simulate fault ride through capability in the conditions set forth in Article 11(3) (a).¶
The simulation is deemed passed, provided that the Generating Unit demonstrates

Gelöscht: requirements set forth in

Gelöscht: 11(3) (a).¶
¶
¶
Article 45¶
COMPLIANCE SIMULATIONS FOR TYPE C SYNCHRONOUS GENERATING UNITS¶
In addition to carrying out the compliance simulations for type A and B Synchronous Generating Units in the conditions as referred to in Articles 43 and 44, type C Synchronous Generating Units are subject to the following compliance simulations

Gelöscht: Unit

Gelöscht: simulate

Gelöscht: modulation

Gelöscht: frequency

Gelöscht:) to study compliance in extreme network situations.

Gelöscht: frequency

Gelöscht: frequency

Gelöscht: the Generating Unit is validated against the compliance tests for FSM response as referred to in Article 35(2).

Gelöscht: LFSM-U response

1) the Power Generating Module reduces or increases the Active Power output from its previous operating point to any new operating point within the P-Q-Capability Diagram within the limits of Article 9(5) (b) without disconnection of the Power Generating Module from the island due to over-/underfrequency; and

2) the Power Generating Module regulates load connections in block load with a maximum size of 10 % of Maximum Capacity of the Power Generating Module without Frequency dropping dynamically by more than 1 Hz in the island.

Kommentar [RPF17]: To be discussed: Either a corresponding requirement is introduced or the simulation is removed.

5. With regard to the Reactive Power Capability simulation:

a) The Power Generating Module shall demonstrate its capability to simulate leading and lagging Reactive Power capability in the conditions referred to in Article 12(2) (b) and (c).

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

1) the simulation model of the Power Generating Module is validated against the compliance tests for Reactive Power Capability at the as referred to in Article 38(7); and

2) compliance with the requirements as referred to in Article 12(2) (b) and (c) is demonstrated.

Article 47

COMPLIANCE SIMULATIONS FOR TYPE D SYNCHRONOUS POWER GENERATING MODULES

1. In addition to the Compliance Simulations for Type B and C Synchronous Power Generating Modules in the conditions as referred to in Articles 45 and 46, except for the Type B fault ride through Capability of Synchronous Power Generating Modules as referred to in Article 45(4), Type D Synchronous Power Generating Modules are subject to the following Compliance Simulations. For installations for which relevant MD&PTCs exist which are provided to the Relevant Network Operator, these may be used as part of verified component performance data.

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

[30] verschoben

a) The Power Generating Module shall demonstrate the performance of its control system (PSS) to damp power oscillations in the conditions set forth in Article 13(2) (g).

Kommentar [EKW18]: This requirement is relevant only if the power oscillation are dealt with by the addition of a PSS to the AVR. Some new AVR architecture (matrix structure) may allow to achieve a good active power damping without the addition of a PSS. In order to avoid any misunderstanding, it has to be precised that this requirement is relevant only where aPSS is used to deal with the power oscillations

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

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

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

[31] verschoben

Gelöscht: Generating Unit

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

3. With regard to the Type D Fault Ride Through Capability of Synchronous Power Generating Modules simulation:

a) The Power Generating Module shall demonstrate its capability to simulate fault ride through capability in the conditions set forth in Article 13(3) (a).

b) The simulation is deemed passed, provided that compliance with the requirement according to Article 13(3) (a) is demonstrated.

Chapter 6

COMPLIANCE SIMULATIONS FOR POWER PARK MODULES

Article 48

COMPLIANCE SIMULATIONS FOR TYPE B POWER PARK MODULES

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

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

a) The Power Park Module shall demonstrate its capability to simulate Active Power modulation at high Frequency according to Article 7(1) b.

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

c) The simulation is deemed passed, provided that:

1) the simulation model of the Power Park Module is validated against the compliance test for LFSM-O response as referred to in Article 40(2); and

2) compliance with the requirement according to Article 7(1) (c) is demonstrated.

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

d) The Power Generating Module shall demonstrate its capability to simulate fast acting additional reactive current injection in the conditions set forth in Article 14(2) (b).

e) The simulation is deemed passed, provided that compliance with the requirement according to Article 14(2) (b) is demonstrated.

3. With regard to the Type B Fault Ride Through Capability of Power Park Modules simulation:

Gelöscht: in low frequency situations to study compliance in extreme network situations.

Gelöscht: low frequency

Gelöscht: ,

Gelöscht:

Gelöscht: Generating Unit

Gelöscht: tests

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Gelöscht: 35(3).

a) The Power Generating Module shall demonstrate its capability to simulate fault ride through capability in the conditions set forth in Article 14(3) (a).

b) The simulation is deemed passed, provided that compliance with the requirement according to Article 14(3) (a) is demonstrated.

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

a) The Power Generating Module shall demonstrate its capability to simulate post fault Active Power recovery in the conditions set forth in Article 14(3) (b).

b) The simulation is deemed passed, provided that compliance with the requirement according to Article 14(3) (b) is demonstrated.

Article 49

COMPLIANCE SIMULATIONS FOR TYPE C POWER PARK MODULES

1. In addition to the Compliance Simulations for Type B Power Park Modules in the conditions as referred to in Article 48, Type C Power Park Modules are subject to the following Compliance Simulations. For installations for which relevant MD&PTCs exist which are provided to the Relevant Network Operator, these may be used as part of verified component performance data.

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

a) The Power Park Module shall demonstrate its capability to simulate Active Power modulation at low Frequencies according to Article 9(2) b.

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

c) The simulation is deemed passed, provided that:

1) the simulation model of the Power Park Module is validated against the compliance test for LFSM-U response as referred to in Article 41(3); and

2) compliance with the requirement according to Article 9(2) (b) is demonstrated.

3. With regard to the FSM response simulation:

a) The Power Park Module shall demonstrate its capability to modulate Active Power over the full Frequency range according to Article 9(2) (c).

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

c) The simulation is deemed passed, provided that:

1) the simulation model of the Power Park Module is validated against the compliance test for LFSM-U response as referred to in Article 41(4); and

2) compliance with the requirement according to Article 9(2) (c) is demonstrated.

4. With regard to the Island Operation simulation:

a) The Power Generating Module shall demonstrate its performance during Island Operation in the conditions as referred to in Article 9(5) (b).

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

1) the Power Generating Module reduces or increases the Active Power output from its previous operating point to any new operating point within the P-Q-Capability Diagram within the limits of Article 9(5) (b) without disconnection of the Power Generating Module from the island due to over-/underfrequency; and

2) the Power Generating Module has regulated load connections in block load with a maximum size of 10 % of Maximum Capacity of the Power Generating Module without Frequency dropping dynamically by more than 1 Hz in the island.

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

a) The model of the Power Generating Module shall demonstrate its capability to simulate the
a) capability of providing Synthetic Inertia to a low Frequency event in the conditions as referred to in Article 15(2) (a).

b) The simulation is deemed passed, provided that the model demonstrates compliance with the conditions of Article 15(2) (a).

6. With regard to the Reactive Power capability simulation:

a) The Power Park Module shall demonstrate its capability to simulate leading and lagging Reactive Power capability in the conditions referred to in Article 15(3) (b) and (c).

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

1) the simulation model of the Power Park Module is validated against the compliance tests for Reactive Power Capability at the as referred to in Article 41(6); and

2) compliance with the requirements as referred to in Article 15(3) (b) and (c) is demonstrated.

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

a) The model of the Power Generating Module shall demonstrate its capability to simulate power oscillations damping capability in the conditions as referred to in Article 15(3) (f).

b) The simulation is deemed passed, provided that the model demonstrates compliance with the conditions of Article 15(3) (f).

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Gelöscht: Unit
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Gelöscht: loading
Gelöscht: Unit
Gelöscht: Unit
Gelöscht: Unit
Kommentar [RPF19]: To be d ... [78]
Gelöscht: frequency
[32] verschoben
[33] nach unten: <#>The sir ... [81]
Gelöscht: With regard to
Gelöscht: Reactive
Gelöscht: Capability simulation ... [79]
Gelöscht: Unit
Gelöscht: leading and lagging ... [80]
Gelöscht: Generating Unit is ... [82]
Gelöscht: available for the v ... [83]
[30] nach oben: <#>With reg ... [84]
Gelöscht: <#>The Generating ... [85]
[31] nach oben: <#> ¶ ... [86]
Gelöscht: <#>the PSS damps ... [87]
Gelöscht: Post Fault
Gelöscht: Active Recovery
Gelöscht: model of the Gener ... [88]
Gelöscht: post fault Active
Gelöscht: recovery
[33] verschoben
Gelöscht: 15(3) (b).
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Gelöscht: conditions of
Gelöscht:).¶ ... [90]
Gelöscht: Island Operation and ... [91]
Gelöscht: Generating Unit sha ... [92]
[32] nach oben: <#>With reg ... [93]
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Gelöscht: Unit
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Gelöscht: of providing Synthe ... [94]
Gelöscht: 16(2) (a).¶ ... [95]
Gelöscht: c).
Gelöscht: 16
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Gelöscht: <#>With regard to th ... [96]

Article 50

COMPLIANCE SIMULATIONS FOR TYPE D POWER PARK MODULES

1. In addition to the Compliance Simulations for Type B and C Power Park Modules in the conditions as referred to in Articles 48 and 49, except for the Type B fault ride through Capability of Power Park Modules as referred to in Article 48(4), Type D Power Park Modules are subject to the Type D Fault Ride Through Capability of Power Park Modules Compliance Simulation. For installations for which relevant MD&PTCs exist which are provided to the Relevant Network Operator, these may be used as part of verified component performance data.
2. The model of the Power Generating Module shall demonstrate its capability to simulate fault ride through capability in the conditions as referred to in Article 16(1) (a).
3. The simulation is deemed passed, provided that the model demonstrates compliance with the conditions of Article 16(1) (a) respectively.

Gelöscht: carrying out the compliance simulations
Gelöscht: type
Gelöscht: 47 and
Gelöscht: , type
Gelöscht: compliance simulation, which shall be carried out instead of the compliance simulation according to Article 47(2).
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Gelöscht: 17
Gelöscht: 17

Chapter 7

COMPLIANCE SIMULATIONS FOR OFFSHORE POWER PARK MODULES

Article 51

Gelöscht: 50

COMPLIANCE SIMULATIONS APPLICABLE TO OFFSHORE POWER PARK MODULES IN ALL CONFIGURATIONS

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

Gelöscht: compliance simulations
Gelöscht: 47(4
Gelöscht: 48(2
Gelöscht: 3

Article 52

Gelöscht: 51

COMPLIANCE SIMULATIONS APPLICABLE TO OFFSHORE POWER PARK MODULES of CONFIGURATIONS 1-5

The Compliance Simulations as defined in Articles 48(3) and 49(7) shall apply to Offshore Power Park Modules of configurations 1, 2, 3, 4 and 5.

Gelöscht: compliance simulations
Gelöscht: Article
Gelöscht: 4
Gelöscht: (5

Title 5

DEROGATIONS

Article 53

GENERAL PROVISIONS

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

2. It shall apply as well to Network Operators when applying for derogations for classes of both existing and new Power Generating Modules connected to their network. Such application for derogation may be appropriate to initiate following request by third parties including but not restricted to manufacturers.

3. The derogation process shall be transparent, non-discriminatory, non-biased, well documented and based in particular on the Cost-Benefit Analysis performed, in the conditions set forth by Article 32(4) and (5), by the Relevant TSO, by the Relevant DSO or by the Relevant CDSO in coordination with the Relevant TSO. Cost-Benefit Analysis does not need to be performed by the Relevant Network Operator if, on its request, an individual exemption is granted to the Relevant Network Operator by the National Regulatory Authority.

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

Article 54

REQUEST FOR DEROGATION

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

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

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

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

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

Gelöscht: 52
Gelöscht: Facility Owners
Gelöscht: Facilities, when applying
Gelöscht: individual
Gelöscht: Units
Gelöscht: Units
Gelöscht: cost-benefit analysis
Gelöscht:
Gelöscht: DSO
Gelöscht: benefit analysis needs
Gelöscht: Network Operator.
Gelöscht: 53
Gelöscht: the following information
Gelöscht: Unit

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

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

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

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

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

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

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

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

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

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

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

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

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

Article 55

DECISION ON DEROGATION

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

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

Gelöscht: following

Gelöscht: Units

Gelöscht: Units

Gelöscht: 54

Gelöscht: 3

Gelöscht: 6

Gelöscht: the request and

Gelöscht: either a cost-benefit analysis or a request for exemption from cost-benefit analysis

Gelöscht:

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

In case the request by the Power Generating Facility Owner is for a Type C or D Power Generating Module connected to a distribution network or closed distribution network the Relevant DSO or the Relevant CDSO shall obtain the assessment of the Relevant TSO and include it in its submission to the National Regulatory Authority.

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

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

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

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

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

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

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

Gelöscht: Operator

Gelöscht: Unit

Gelöscht: DSO

Gelöscht: If the Relevant Network Operator has requested an exemption from cost-benefit analysis the National Regulatory Authority shall decide on granting or rejecting this request within 1 month after the receipt of this request.

Gelöscht: 6

Gelöscht: the request and related documentation and either a cost-benefit analysis performed by the DSO or a request by the DSO for exemption from cost-benefit analysis to the National Regulatory Authority. If the DSO has requested an exemption from cost-benefit analysis the National Regulatory Authority shall decide on granting or rejecting this request within 1 month after the receipt of this request.

Gelöscht: cost-benefit analysis

Gelöscht: cost-benefit analysis

Gelöscht: cost-benefit analysis

Gelöscht: 1

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

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

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

10. The Agency may request the relevant NRA to revoke any derogation granted without due justification

11. The National Regulatory Authority shall have the right to issue a motivated decision revoking the granted derogation under the conditions and pursuant to the provisions of national law.

Article 56

COMPLIANCE OF EXISTING POWER GENERATING FACILITIES

1. An Existing Power Generating Module which is not compliant with a provision of the Network Code, that applies to it according to Article 3, shall apply for derogation according to Article 54 within twelve months from the day the requirement, of which it is not compliant with, becomes applicable.

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

Article 57

REGISTER OF DEROGATIONS TO THE NETWORK CODE

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

2. These registers shall contain in particular:

   - the requirement(s) for which the derogation is granted
   - content of the derogation
   - reasons for granting or rejecting the derogation

Gelöscht: 3

Gelöscht: issue a reasoned recommendation to

Gelöscht: National Regulatory Authority

Gelöscht: derogations.

Gelöscht: 55

Gelöscht: Unit

Gelöscht: 53

Gelöscht: 12

Gelöscht: Unit

Gelöscht: 12

Gelöscht: 56

Gelöscht: 6

Title 6

FINAL PROVISIONS

Article 58

Gelöscht: 57

ENTRY INTO FORCE

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

It shall apply as from the day of expiration of a three year period following its publication.

Gelöscht: 3

Seite 21: [1] Gelöscht Dr. Ralph Pfeiffer 27.04.2012 13:31:00

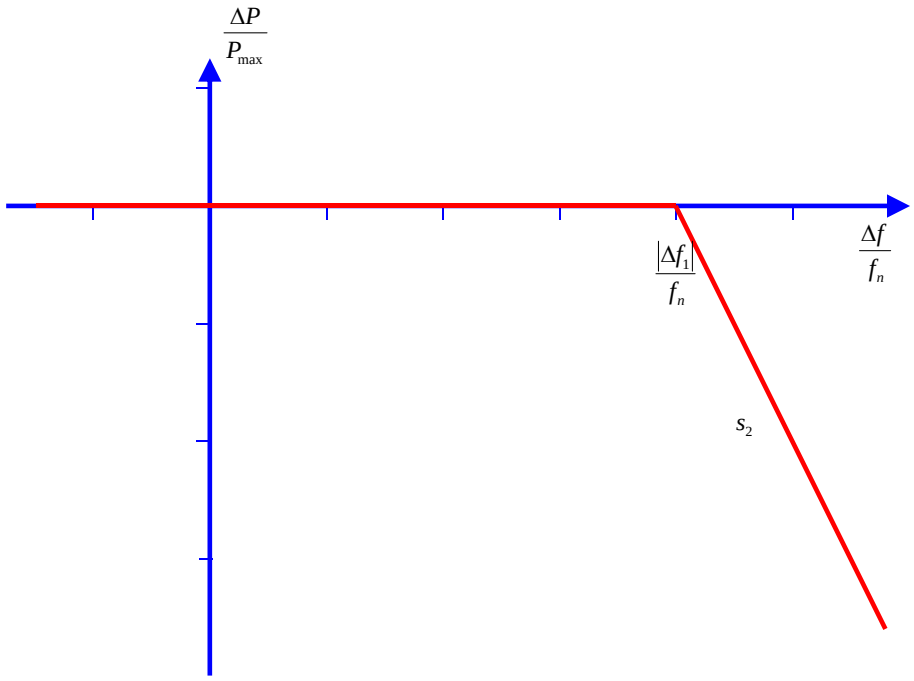

Figure 1: Active Power Frequency Response of Generating Units in LFSM-O. P_{max} is the Maximum Capacity to which ΔP is related. ΔP is the change in Active Power output from the Generating Unit. f_n is the nominal frequency (50 Hz) in the network and Δf is the frequency change in the network. At overfrequencies where Δf is above Δf_1 the Generating Unit has to provide a negative Active Power output change according to the Droop S_2.

Stable operation of the Generating Unit during LFSM-O operation shall be ensured. Any contradiction between LFSM-O speed control and power control during LFSM-O operation shall be avoided.

In order to be able to cease Active Power output, the Generating Unit shall be equipped with a logic interface (I/O port) in order to be able to disconnect it from the Network

Seite 21: [2] Auf Seite 19 verschoben (Verschiebung Nr. 2) Dr. Ralph Pfeiffer 27.04.2012 13:31:00

. The Relevant Network Operator shall have the right to adopt a decision pursuant to Article 4(3) determining the requirements for further equipment to make this facility operable remotely.

Seite 21: [3] Gelöscht Dr. Ralph Pfeiffer 27.04.2012 13:31:00

Article 8

GENERAL REQUIREMENTS FOR TYPE B UNITS

1. In addition to fulfilling the general requirements applicable to type A units and listed in Article 7, type B units shall fulfil the following requirements referring to robustness of Generating Units, system restoration and to general system management through the Network.

2. Type B units shall fulfil the following requirements referring to frequency stability**:**

With regard to controllability of Active Power, the Generating Unit shall be capable of reducing Active Power output in steps not bigger than 20 % of the Maximum Capacity by an interface.

Seite 21: [4] Auf Seite 19 verschoben (Verschiebung Nr. 3) **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

The Relevant Network Operator shall have the right to adopt a decision pursuant to Article 4(3) determining the requirements for further equipment to make this facility operable remotely.

Seite 21: [5] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

3. Type B units shall fulfil the following requirement referring to system restoration:

With regard to capability of reconnection after an incidental disconnection due to a network disturbance, the TSO shall adopt a decision pursuant to Article 4(3) defining the conditions under which a Generating Unit is entitled to reconnect to the network after an incidental disconnection has taken place due to a network disturbance. Installation of automatic reconnection systems shall be subject to prior authorization by the Relevant TSO.

4. Type B units shall fulfil the following general system management requirements:

With regard to control schemes and settings:

Unless national law gives the Relevant TSO authority to make such decisions pursuant to Article 4(3), schemes and settings of the different control devices of the Power Generating Facility relevant for system stability shall be coordinated and agreed between the Relevant TSO, Network Operator and the Power Generating Facility Owner. This concerns in particular the following circumstances:

isolated (Network) operation;
damping of oscillations; and
disturbances to the system.

Unless national law gives the Relevant TSO authority to make such decisions pursuant to Article 4(3), any changes to the schemes and settings of the different control devices of the Power Generating Facility, relevant for system stability, shall be coordinated and agreed between the Relevant TSO, Network Operator and the Power Generating Facility Owner, especially if they concern the circumstances referred to above under point 1).

Seite 21: [6] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

Power Generating Facilities shall be equipped according to the standard defined by the Relevant Network Operator pursuant to national legislation to transfer information between the Relevant Network Operator and the Power Generating Facility in real time or periodically with time stamping.

The Relevant Network Operator in coordination with the Relevant TSO shall define pursuant to national legislation the information exchanges standards and the precise list of data to be facilitated.

Article 9

GENERAL REQUIREMENTS FOR TYPE C UNITS

1. In addition to fulfilling the general requirements applicable to type A and B units, listed respectively in Articles 7 and 8, except for Article 7(1) (d) and Article 8(2) (a), type C units shall fulfil the following requirements referring to the frequency stability, voltage stability, robustness of Generating Units, system restoration and to general system management through the Network.

2. Type C units shall fulfil the following requirements referring to frequency stability:

With regard to Active Power controllability and control range**:**

The Active Power output of any Generating Unit connected to the Network shall be controllable. For this purpose, the Power Generating Facility control system shall be capable of receiving an Instruction containing a required Setpoint, given orally, manually or by automatic remote control facilities by the Relevant Network Operator and shall implement the Setpoint within a period specified in the above Instruction. Manual measures shall be possible in the case that any automatic remote control devices are out of service.

Unless advised by the Relevant Network Operator, the deviation between the scheduled value and the actual value of load at steady-state load (period specified by the Relevant Network Operator) shall not exceed a percentage of the Generating Unit capacity (subject to the availability of the prime mover resource) decided by the Relevant Network Operator pursuant to Article 4(3).

With regard to Inertia, Power Generation Facilities may be required to provide Inertia. In case a Power Generation Facility does not provide this inherently, the Relevant Network Operator in coordination with the Relevant TSO shall have the right to adopt a decision pursuant to Article 4(3) requiring a Power Generating Facility to deliver an equivalent performance by an increase of Active Power related to the rate of change of frequency.

Seite 21: [7] Auf Seite 20 verschoben (Verschiebung Nr. 7) **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

In addition to Article 7(1) (c) the following shall apply accumulatively with regard to Limited Frequency Sensitive Mode – Underfrequency (LFSM-U):

Seite 21: [8] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

The Generating Unit shall be capable of providing Active Power Frequency Response according to figure 2. The actual provision of Active Power Frequency Response in LFSM-U mode depends on the operating conditions of the Generating Unit at the moment this response is triggered.

The Generating Unit shall in the LFSM-U mode be capable of activating Active Power Frequency Response at a frequency threshold between and including 49.8 Hz and 49.5 Hz with a Droop in a range of 2 – 12 % by providing a power increase up to its Maximum Capacity, taking account of limitations for some generation technologies from operation near Maximum Capacity at low frequencies according to the provisions of this Network Code. The actual frequency threshold and Droop settings shall be determined by the Relevant TSO. The Active Power Frequency Response shall be activated as fast as technically feasible with an initial delay that shall be as short as possible and reasonably justified if greater than 2 seconds.

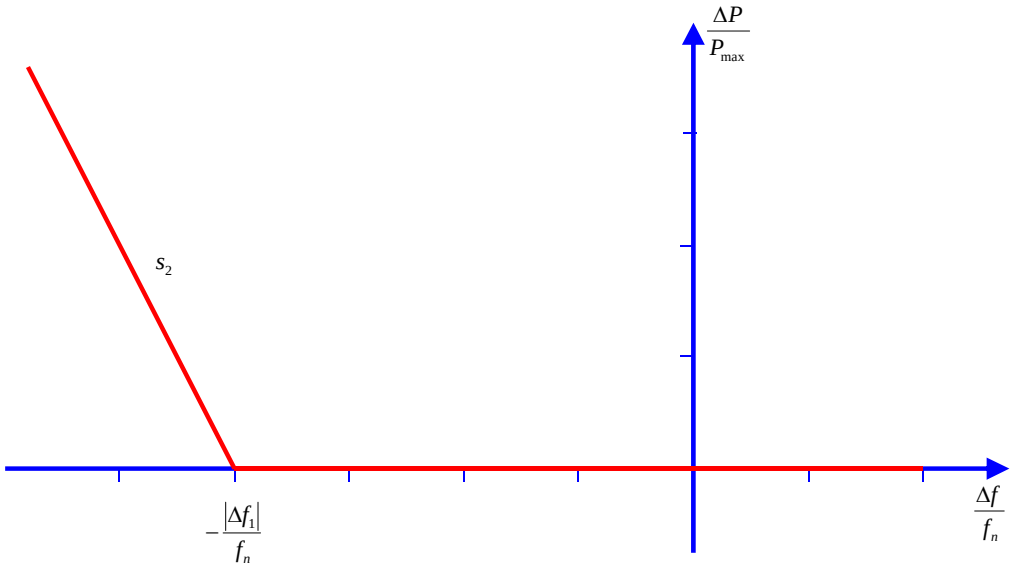

Figure 2: Active Power Frequency Response of Generating Units

Seite 21: [9] Gelöscht	Dr. Ralph Pfeiffer	27.04.2012 13:31:00

Any contradiction between power and speed control during
1)

Seite 21: [10] Gelöscht	Dr. Ralph Pfeiffer	27.04.2012 13:31:00

operation shall be prohibited.

When in
2)

Seite 26: [11] Gelöscht	Dr. Ralph Pfeiffer	27.04.2012 13:31:00

synchronization, when starting a Generating Unit, synchronization shall be performed by the Power Generating Facility Owner after authorization by the Relevant Network Operator. The Generating Unit shall be equipped with the necessary synchronization facilities. Synchronization of Generating Units shall be possible for frequencies within the ranges set out in table 2. Unless national law gives the Relevant TSO authority to give decisions, the Network Operator and the Power Generating Facility Owner shall agree on the settings of synchronization devices to be concluded prior to operation of the Generating Unit. An agreement shall cover the following matters: voltage, frequency, phase angle range, phase sequence, deviation of voltage and frequency.

With regard to
a)

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shall have the right at any time to change the Reactive Power target value within the agreed or decided Reactive Power range. Where part of the P-Q/P_{max} range is unavailable until tapping of generation transformer(s) has been completed, the Relevant Network Operator shall not require more than 15 tap movements within 4 minutes
1)

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The Relevant Network Operator shall have the right to require from the Synchronous Power Generating Facility that additional facilities are installed on the Synchronous Power Generating Facility in order to be able to carry out voltage and Reactive Power control within its area. The mode of operation is decided by the Relevant Network Operator pursuant to Article 4(3).

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Generating Units of the Synchronous

a)

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high-voltage terminals of the step-up transformer to the voltage level of the

b)

Seite 36: [16] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

4. Type C Synchronous Generating Units shall fulfil the following general system management requirements:

With regard to coordination of speed and power control of Synchronous Generating Units:

Generating Units shall be equipped with a proportional speed controller to determine the dynamic behaviour and a slower power controller which adapts the steady-state operating point.

Generating Units shall ensure stable operation during network operation and Island Operation.

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Units requirements listed in Articles 11 and 12, type D Synchronous Generating Units

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:

The Excitation System of a Synchronous Generating Unit shall include:

an Excitation System complying with the characteristics defined in Article 13(2) (c) and (d) ; and
a continuously acting Automatic Voltage Regulator (AVR) complying with the characteristics defined in Article 13(2) (c).

Unless national law gives the Relevant TSO authority to make such decisions pursuant to Article 4(3),

a)

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shall limit the change at the Generating Unit terminal to not more than a percentage of rated terminal voltage specified by the Relevant Network Operator, when the output signal is gradually changed from zero to rated Apparent Power at rated voltage, Active Power

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frequency.

With regard to

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For a step change from 90 to 100 % of the nominal voltage at the Generating Unit terminal, with the Generating Unit on open circuit, the Excitation System response shall have a damped oscillatory characteristic. For this characteristic, the time for the Generating Unit terminal voltage to reach 100 % shall be less than a value specified by the Relevant Network Operator. The time to settle within 5 % of the voltage change shall be specified by the Relevant Network Operator.

To ensure that adequate synchronizing power is maintained, when the Generating Unit is subject to a large voltage disturbance, the Exciter whose output is varied by the AVR shall be capable of providing its achievable upper and lower limit ceiling voltages to the Generating Unit field in a time not exceeding that specified by the Relevant Network Operator. The achievable upper and lower limit ceiling voltages may depend on the voltage disturbance. The Exciter shall be capable of attaining an Excitation System on load positive ceiling voltage specified by the Relevant Network Operator. The corresponding ceiling current shall be delivered for at least 10 seconds when responding to a sudden drop in voltage of 10 % or more.

The field voltage of a Synchronous Generating Unit with a static Excitation System should be capable of attaining a negative ceiling level specified by the Relevant Network Operator after the removal of the step when responding to a sudden drop in voltage of 10 % or more at the Generating Unit terminals.

Depending of the circumstances, the Relevant Network Operator shall have the right to require that:

a drop of the Generating Unit terminal voltage down to 25 % of retained rated terminal voltage shall not jeopardize the operation of the Excitation system; and
the Excitation system shall be capable of attaining a positive ceiling voltage not less than 80 % of the Excitation System On load positive ceiling Voltage upon recovery of the Generating Unit terminal voltage to 80 % of rated terminal voltage following fault clearance.

With regard to Excitation System specification:

The Excitation System shall be equipped with the following elements:

elements that limit the

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. The bandwidth shall be limited

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. The bandwidth limit shall be 3 Hz or another value specified by the Relevant TSO, and in order to be consistent with the speed of response required

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. The Underexcitation Limiter shall

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. The Underexcitation Limiter shall operate when the Excitation System is providing automatic control. The Underexcitation Limiter shall respond to changes in the Active Power and the Reactive Power, and to the square of the alternator voltage in such a direction that an increase in voltage will permit an increase in leading Reactive Power. The characteristic of the Underexcitation Limiter shall be substantially linear from no-load to the Maximum Capacity output of the Generating Unit at any setting and shall be readily adjustable.

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The resulting maximum overshoot in response to a step injection which operates the Underexcitation Limiter shall not exceed 4 % of the Generating Unit Maximum Capacity. The operating point of the Generating Unit shall return to a steady-state value at the limit line and the final settling time shall not be greater than 5 seconds. When the step change AVR reference voltage is reversed, the field voltage should begin to respond without any delay and should not be held down by the Underexcitation Limiter. Operation into or out of the preset limit levels shall ensure

that any resulting oscillations are damped so that the disturbance is within 0.5 % of the Generating Unit rated Apparent Power within a period of 5 seconds.

The Underexcitation Limiter shall also prevent the Generating Unit excitation from being reduced to a level which would endanger synchronous stability when the Excitation System is under manual control; and

an Overexcitation Limiter, which may either be provided by choice of the Power Generating Facility Owner or requested by the Relevant Network Operator. The settings of the Overexcitation Limiter shall ensure that the alternator

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. Any operation beyond the overexcitation limit shall be controlled by the Overexcitation Limiter without tripping the Generating Unit.

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The alternator Overexcitation Limiter shall also not restrict any overexcitation of the alternator when the Excitation System is under manual control, other than what is necessary to ensure the Generating Unit is operating within its design limits.

With regard to

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:

The operation of the Stator Current Limiter

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Seite 37: [30] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

the Overexcitation Limiter shall be coordinated. The Stator Current Limiter shall act delayed to the Overexcitation Limiter to fully utilise the transient overexcitation capability of the Generating Unit. The operation of the Stator Current Limiter shall not result in a reduction of the alternator terminal voltage which leads to possible failure from the auxiliary supply system due to low voltage.

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If the stator current does not reach the admissible range when the alternator voltage is at its minimum admissible value which prevents failure from the auxiliary supply system due to low voltage, the Stator Current Limiter shall either reduce the Active Power output automatically until the stator current is in the admissible range or, alternatively, the Active Power output shall be reduced manually after an alarm signal from the Stator Current Limiter. Unless national law gives the Relevant TSO authority to make such decisions pursuant to Article 4(3), it shall be agreed between the Relevant TSO and the Power Generating Facility Operator whether automatic or manual Active Power reduction shall be applied.

With regard to the voltage control system the Excitation System of

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Seite 37: [32] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

Synchronous Generating Unit shall include a Power System Stabiliser (

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Seite 37: [33] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

With regard to power oscillations damping control:

The arrangements for the supplementary control signal shall ensure that the PSS output signal relates only to changes in the supplementary control signal and not the steady-state level of the signal. Additionally the PSS shall not react to non-oscillatory power changes.

The output signal from the PSS shall be limited to not more than a value of the Generating Unit terminal voltage signal at the AVR input specified by the Relevant TSO. The stability margins shall be defined by the Relevant TSO (e. g. phase margin, delay margin, gain margin).

The PSS shall not react to non-oscillatory changes in Active Power, such as changes in steady state power or changes caused by response to variations in system frequency.

The PSS shall have the possibility to achieve optimised damping for at least 2 frequencies (e.g. local mode and inter area mode).

The PSS shall include elements that limit the bandwidth of the output signal. The bandwidth limiting shall ensure that the highest frequency of response cannot excite torsional oscillations on other Generating Units connected to the network. The bandwidth limit shall be specified by the Relevant TSO.

The PSS shall be active within the Excitation System at all times when synchronised including when the Underexcitation Limiter or Overexcitation Limiter are active. When synchronising or de-synchronising a Generating Unit or when operating at less than 10 % of Maximum Capacity, the PSS may be out of service.

A facility to inject a band limited random noise signal into the AVR voltage reference shall be provided for demonstrating the frequency domain response of the Power PSS. The tuning of the PSS shall result in improved damping of corresponding Active Power response of the AVR in combination with the PSS compared to the Active Power response of the AVR alone over a frequency range specified by the Relevant TSO.

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which sustains the lowest retained voltage [1)]

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irrespective of the voltage drop of the other two phase-to-phase voltages, [2)]

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shall be selected on the red lines or a specific line inside the shaded area delimited by the red lines [3)]

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adopt a decision pursuant to Article 4(3) defining [4)]

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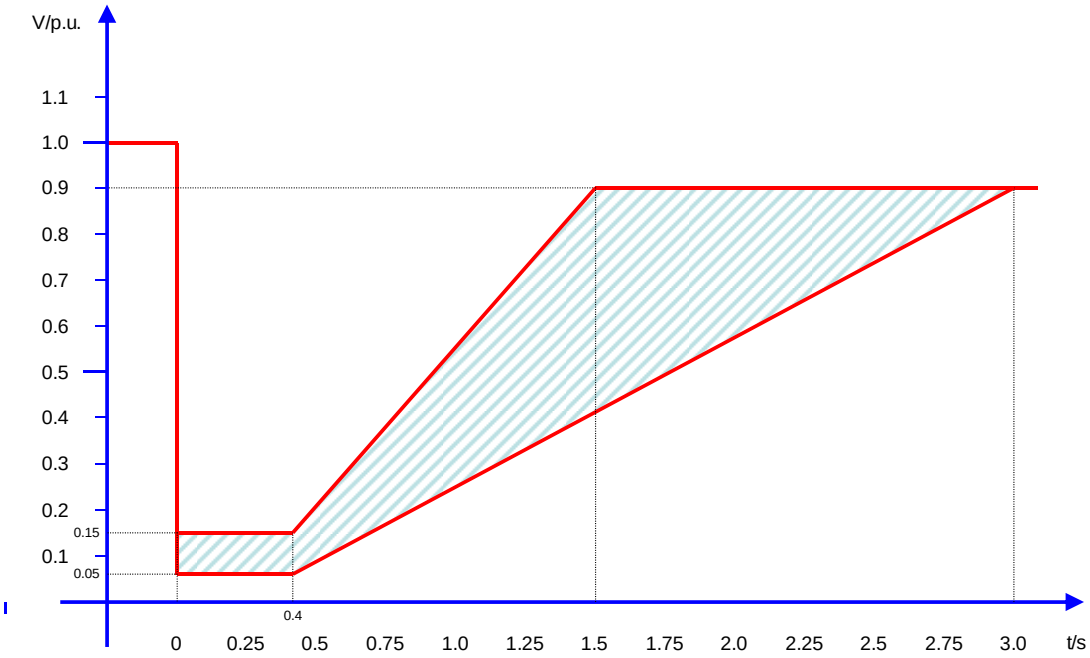

Figure 9 – Fault ride through profile of a Power Park Module. The diagram represents the boundaries for a voltage-against-time profile by the voltage at the Connection Point, expressed by the ratio of its actual value and its nominal value in per unit before, during and after a fault. For the meaning of the shaded area see Article 15(3) (a) point 2).

Undervoltage protection, respecting the appropriate operating voltage ranges,

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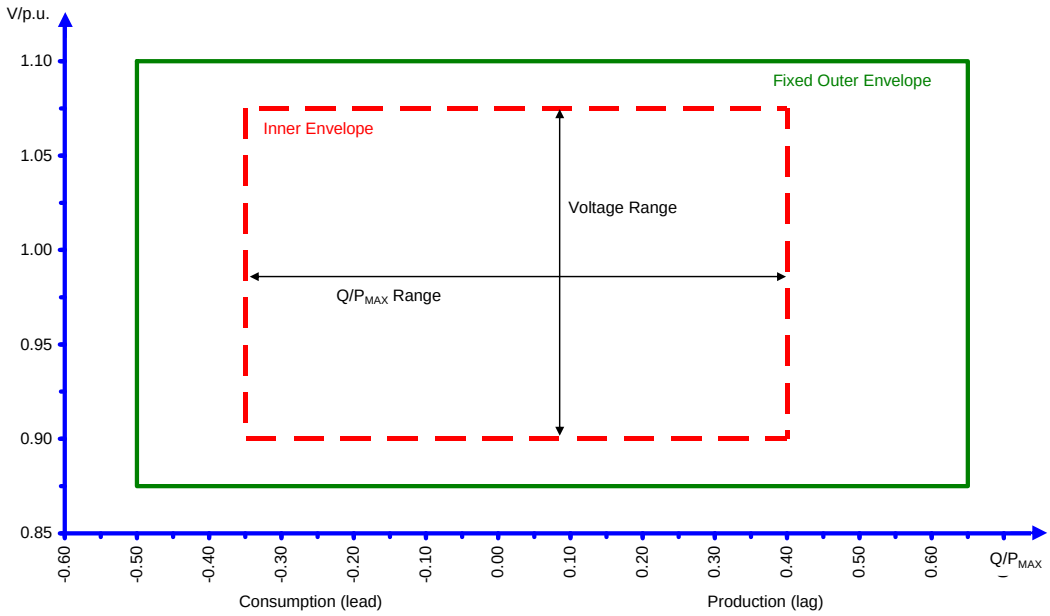
in case a Power Park Module has a Reactive Power capability beyond the voltage range specified by figure 10, the Reactive Power capability shall not be deliberately limited.



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Generating Units (in the scale at the bottom of the figure), respectively the Power Factor (cos φ) (in the scale at the top of the figure).

Seite 44: [41] Auf Seite 36 verschoben (Verschiebung Nr. 8) **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

For profile shapes other than rectangular, the voltage range represents the highest and lowest values. The full Reactive Power range is therefore not expected to be available across the range of steady state voltages.
[1)]

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For Power Generating Facilities where the Connection Point is not at the location of the high-voltage terminals of this step-up transformer, supplementary Reactive Power may be required by a decision by the
[2)]

Seite 44: [43] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

the Reactive Power demand of the HV line, or cable, between these two points from the responsible owner of this line or cable
[3)]

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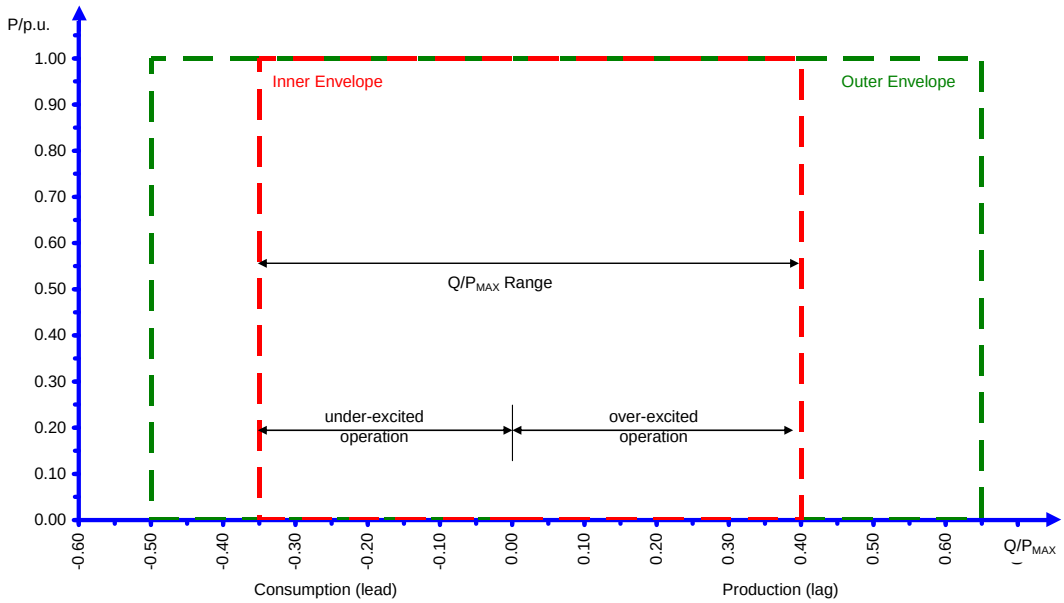
When operating at an Active Power output below the Maximum Capacity ($P<P_{max}$), a Power Park Module shall be able to operate in every possible operating point not exceeding the outer envelope defined by the P-Q-Capability diagram in figure 11, if all Generating Units of this Power Park Module are technically available. Otherwise the Reactive Power capability may be less taking into consideration the technical capabilities.



Seite 45: [45] Kommentar [RPF4] **Dr. Ralph Pfeiffer** **15.04.2012 16:01:00**

To be dscussed: Many stakeholders require smaller Q/Pmax-range. Many stakheolders require Reactive Power limitations below 20% Pmax (“lowering the skirt to the floor” is limiting technology to full converters).

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right to adopt a decision pursuant to Article 4(3) requiring the Power Park Module to install additional facilities at the Power Park Module in order to be capable of providing Reactive Power at any operating point inside the outer envelope in figure 11 [4)]

Seite 45: [47] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

(see figure 11) in timescales determined by the requirements of reactive power control. The Relevant Network Operator shall have the right at any time to change the Reactive Power target value within the agreed or decided Reactive Power range. Where part of the P-Q/P_{max} range is unavailable until tapping of generation transformer(s) has been completed, the Relevant Network Operator shall not require more than 15 tap movements within 4 minutes [5)]

Seite 47: [48] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

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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 System with a Setpoint voltage covering at least 0.95 to 1.05 pu in steps no greater than 0.01 pu with a Slope with a range of at least 2 to 7 % in steps no greater than 0.5 %. The Reactive Power output shall be 0 when the grid voltage value at the Connection point equals the voltage Setpoint.

The Setpoint may be operated with or without a deadband selectable in a range from 0 to +-10 % of nominal network voltage in steps no greater than 0.5 %.

Following a step change in voltage 90 % of the change in Reactive Power output shall be achieved within 1 second and settle at the value defined by the operating Slope within 5 seconds with a steady state reactive tolerance no greater than 5 %.

For the purposes of Reactive Power Control mode, the Power Park Module shall be capable of setting the Reactive Power target anywhere in the Reactive Power range, defined by Article 14(1) (a) and by Article 16(3) (a) and (b), with setting steps no greater than 5 Mvar or 5 % (whichever is smaller) of full Reactive Power, controlling the Reactive Power at the Connection Point to an accuracy within +-5 Mvar or +-5 % (whichever is smaller) of the full Reactive Power.

For the purposes of Power Factor Control mode, the Power Park Module shall be capable of controlling the Power Factor at the Connection Point within the required Reactive Power range, defined by the Relevant DSO according to Article 14(1) (a) or defined by Article 16(3) (a) and (b), with a target Power Factor in steps no greater than 0.01. The Relevant Network Operator shall adopt a decision pursuant to Article 4(3) determining the target Power Factor value and the tolerance expressed in Mvar or % within a period of time, following a sudden change of Active Power output or step change in voltage at the Connection Point.

Seite 47: [49] Auf Seite 46 verschoben (Verschiebung Nr. 13) **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

The control mode, parameter settings and the operating point for steady-state Reactive Power exchange at the Connection Point shall be determined by the Relevant Network Operator in coordination with the Relevant TSO.

Seite 47: [50] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

The Relevant Network Operator in coordination with the Relevant TSO will determine which of the above three reactive power control modes options and associated Setpoints shall apply.

Seite 47: [51] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

10, as well as type B and C Power Park Modules specific requirements listed in Article

Seite 47: [52] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

With regard to fault ride through capability of Power Park Modules:

Seite 47: [53] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

irrespective of the voltage drop of the other two phase-to-phase voltages,

1)

Seite 47: [54] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

shall be selected on the red lines or a specific line inside the shaded area delimited by the red lines

2)

Seite 66: [55] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

80 %) with low frequency steps and ramps big enough to activate at least 10 % of Maximum Capacity Active Power change, taking into account the Droop settings and the deadband. Simulated frequency deviation signals shall be injected simultaneously into both the speed governor and the load controller references if required, taking into account the speed governor and the load controller scheme.

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

the test results, for both dynamic and static parameters, are in line with the requirements as referred to in Article 9(2) (d); and

undamped oscillations do not occur after the step change response.

With regard to the Frequency Restoration Control test:

The Generating Unit

a)

Seite 66: [56] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

the operating point of the Generating Unit, speed control mode as well as the point of disconnection from the network as referred to in Article 9(5) (c).

a)

Seite 67: [57] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

the Excitation System response shall present a damped oscillatory characteristic;

after tripping, the voltage or speed controller has kept alternator voltage or frequency in the permissible range where the time for the alternator terminal voltage to reach the target value of the voltage regulator within an admissible tolerance shall be shorter than;

0.5 seconds – for thyristor static exciters; and
1.5 seconds – for electromechanical exciters.

all Generating Unit control systems remain in automatic mode;

manual intervention by

1)

Seite 67: [58] Gelöscht Dr. Ralph Pfeiffer 27.04.2012 13:31:00

Facility Owner within the first 3 minutes after tripping does not occur; and

the minimum houseload operation time according to Article 9(5) (c) has been demonstrated.

With regard to the Reactive Power Capability test:

The Generating Unit shall demonstrate its technical capability to provide leading and lagging Reactive Power capability according to Article 12(3) (a) and (b).

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

the Generating Unit

2)

Seite 67: [59] Gelöscht Dr. Ralph Pfeiffer 27.04.2012 13:31:00

minimum Active Power;

maximum Active Power

Seite 67: [60] Gelöscht Dr. Ralph Pfeiffer 27.04.2012 13:31:00

where part of the P-Q/P_{max} range is unavailable until tapping of generation transformer(s) has been completed, achieving the complete movement in the time allowed by a decision by the Relevant Network Operator pursuant to Article 4(3), in any case, shall not be less than 4 minutes or cover more than 15 tap movements.

Article 36

Seite 67: [61] Gelöscht Dr. Ralph Pfeiffer 27.04.2012 13:31:00

In addition to carrying out the

1.

Seite 67: [62] Gelöscht Dr. Ralph Pfeiffer 27.04.2012 13:31:00

35 type D Synchronous Generating Units are subject to the following compliance tests. For installations for which relevant MD&PTCs exist which are registered with the Relevant Network Operator, these may be used as part of verified component performance data.

With regard to the Excitation System Open Circuit Step Response test:

The Generating Unit shall demonstrate its small signal performance of the excitation system. The open circuit step response of the Excitation System will be tested by applying a voltage step change from 90 % to 100 % of the nominal Generating Unit terminal voltage, with the Generating Unit on open circuit and at rated speed.

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

for a step change from 90 % to 100 % of the nominal Generating Unit terminal voltage, with the Generating Unit on open circuit, the Excitation System response has a damped oscillatory characteristic; and

the time of getting the voltage to the rated value by the voltage regulator is in line with the requirements as referred to Article 13(2) (d).

With regard to the Excitation System On-Load Response test:

The Generating Unit shall demonstrate the steady-state and dynamic stability of the Excitation System.

Seite 67: [63] Auf Seite 65 verschoben (Verschiebung Nr. 23) Dr. Ralph Pfeiffer 27.04.2012 13:31:00

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

Seite 67: [64] Gelöscht Dr. Ralph Pfeiffer 27.04.2012 13:31:00

the Excitation System demonstrates performance in accordance with the requirements referred to in Article 13(2) (c) and (d); and

the continuously-acting automatic excitation control system provides constant terminal voltage control of the Generating Unit without instability over the entire operating range.

With regard to the Underexcitation Limiter Performance test:

The Generating Unit shall demonstrate its performance of the Underexcitation Limiter at low load points and subsequently at, or near, full load by testing its response to a step change corresponding to a 2 % decrease in AVR reference voltage an initial position in Reactive Power clear of the Underexcitation Limit, but close to it. The Underexcitation Limiter shall be active when the AVR is in auto mode. In excitation manual mode a minimum field current limitation shall act. The settings for both modes shall be readily adjustable.

Seite 67: [65] Auf Seite 68 verschoben (Verschiebung Nr. 25) Dr. Ralph Pfeiffer 27.04.2012 13:31:00

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

Seite 67: [66] Gelöscht Dr. Ralph Pfeiffer 27.04.2012 13:31:00

the resulting maximum Reactive Power overshoot (in Mvar) does not exceed 4 % of the Generating Unit's Maximum Capacity (in MW);

the operating point of the Generating Unit returns to a steady state value within 5 seconds;

the control of alternator terminal voltage presents a damped characteristic;

the automatic excitation control acts continuously and without instability;

the Underexcitation Limiter demonstrates performance in accordance with the requirements as referred to in Article 13(2) (d); and

exits the limit without delay when the step change is removed.

With regard to the Overexcitation Limiter Performance test:

The Generating Unit shall demonstrate its performance of the Overexcitation Limiter and shall provide evidence that the Overexcitation Limiter is set as high as the design limit of the alternator allows by testing its response to a steep increase in the AVR reference voltage that results in operation of the Overexcitation Limiter when operating at Maximum Capacity and within its continuous Reactive Power capability range. Unless national law gives the Relevant TSO authority to make such decisions pursuant to Article 4(3), the size of the step shall be determined by the minimum value necessary to operate the Overexcitation Limiter and shall be agreed by Network Operator and the Power Generating Facility Owner. To reduce the risk

of tripping, this test may initially be carried out with a reduced overexcitation limit setting proving its function, before it is repeated at the intended setting.

Seite 67: [67] Auf Seite 69 verschoben (Verschiebung Nr. 26) Dr. Ralph Pfeiffer 27.04.2012 13:31:00

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

Seite 67: [68] Gelöscht Dr. Ralph Pfeiffer 27.04.2012 13:31:00

the resulting operation beyond the overexcitation limit is controlled by the Overexcitation Limiter without tripping the Generating Unit;

the Overexcitation Limiter operation demonstrates an appropriate time delay to avoid overexcitation protection tripping;

the Overexcitation Limiter is set close to the machine design limit;

the Overexcitation Limiter action does not produce any apparent or Active Power oscillations and demonstrates performance in accordance with the requirements as referred to in Article 13(2) (d); and

exits the limit without delay when the step change is removed.

For the purpose of this PSS test, the Generating Unit shall demonstrate the capability of the PSS control system to contribute positive Active Power damping of power oscillations over the frequency range specified by the Relevant TSO when compared with damping with the PSS being switched out.

The test is deemed passed, provided that the PSS demonstrates performance in accordance with the requirements referred to in Article 13(2) (g).

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, Voltage Control Mode or the Reactive Power Control Mode or the Power Factor Control Mode

1.

Seite 67: [70] Gelöscht Dr. Ralph Pfeiffer 27.04.2012 13:31:00

With regard to the LFSM-O response test:

Seite 67: [71] Gelöscht Dr. Ralph Pfeiffer 27.04.2012 13:31:00

range of regulation, as well as

a)

Seite 69: [72] Gelöscht Dr. Ralph Pfeiffer 27.04.2012 13:31:00

carried out by simulating the frequency steps and ramps big enough to activate at least 10 % of Maximum Capacity Active Power change with a starting point of no more than 80 % of Maximum Capacity, taking into account the Droop settings and the deadband. Simulated frequency deviation signals shall be injected simultaneously at both speed governor and load controller references if required, taking into account speed governor and load controller scheme

a)

Seite 69: [73] Gelöscht Dr. Ralph Pfeiffer 27.04.2012 13:31:00

following conditions are cumulatively fulfilled:

the

b)

Seite 69: [74] Auf Seite 68 verschoben (Verschiebung Nr. 27) Dr. Ralph Pfeiffer 27.04.2012 13:31:00

undamped oscillations after the step change response does not occur.

c)

Seite 69: [75] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

With regard to the Frequency Restoration Control test:

The Power Park Module shall demonstrate its technical capability to participate in frequency restoration control. The cooperation of both FSM and Frequency Restoration Control shall thus be verified.

The test is deemed passed, provided that the test results for both dynamic and static parameters are in line with the requirements as referred to in Article 9(2) (c) and (e

d)

Seite 69: [76] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

where part of the P-Q/P_{max} range is unavailable until tapping of generation transformer(s) has been completed, achieving the complete movement in the time allowed by a decision of the Relevant Network Operator pursuant to Article 4(3), in any case, shall not be less than 4 minutes or cover more than 15 tap movements; and

Seite 77: [77] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

Unit shall be able to change from Interconnected System Operation to Island Operation without using any switchgear position signals for identifying an island;

the Generating Unit

1)

Seite 77: [78] Kommentar [RPF19] **Dr. Ralph Pfeiffer** **26.04.2012 21:47:00**

To be discussed: Either a corresponding requirement is introduced or the simulation is removed.

Seite 77: [79] Gelöscht **Dr. Ralph Pfeiffer** **27.04.2012 13:31:00**

Capability simulation:

The

a)

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leading and lagging Reactive Power capability in the conditions referred to in Article 12(3) (a) and (b).

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

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Generating Unit is validated against the compliance tests for Reactive Power Capability at the as referred to in Article 35(7);

the Generating Unit demonstrates compliance with the requirements across the voltage range as referred to in Article 12(3) (a); and

the Generating Unit demonstrates the level of Reactive Power

b)

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available for the voltage range according to Article 10(2) (a) respectively.

Article 46

COMPLIANCE SIMULATIONS FOR TYPE D SYNCHRONOUS GENERATING UNITS

In addition to carrying out the compliance simulations for type A and C Synchronous Generating Units in the conditions as referred to in Articles 43 and 45, type D Synchronous Generating Units are subject to the following compliance simulations.

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With regard to the Power Oscillations Damping Control simulation:

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The Generating Unit shall demonstrate the performance of its control system (PSS) to damp power oscillations in the conditions set forth in Article 13(2) (g).

c)

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

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

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the PSS damps the existing power oscillations of the Generating Unit within a frequency range of 0.1 Hz to 2.0 Hz. This frequency range shall include the eigenfrequency of the Generating Unit and the expected Network oscillations; and

the PSS has not reacted to non-oscillatory admissible power changes in Interconnected System Operation due to a sudden load reduction of 40 % of Maximum Capacity of the Generating Unit from 1p.u. to 0.6p.u. within 3 seconds.

With regard to the type D Fault Ride Through Capability of Synchronous Generating Units simulation:

The Generating Unit shall demonstrate its capability to simulate fault ride through capability in the conditions set forth in Article 13(3) (a).

The simulation is deemed passed, provided that the Generating Unit demonstrates compliance with the requirements set forth in Article 13(3) (a).

COMPLIANCE SIMULATIONS FOR POWER PARK MODULES

Article 47

COMPLIANCE SIMULATIONS FOR TYPE B POWER PARK MODULES

With regard to type B Power Park Modules the type B Fault Ride Through Capability, Fast Acting Reactive and/or Active Power Contribution During Faults and Post Fault Active Power Recovery compliance simulations shall be carried out.

With regard to the type B Fault Ride Through Capability of Power Park Modules simulation:

The model of the Generating Unit shall demonstrate its capability to simulate fault ride through capability in the conditions as referred to in Article 15(3) (a).

The simulation is deemed passed, provided that the model demonstrates compliance with the conditions of Article 15(3) (a) respectively.

With regard to the Fast Acting Reactive Power Contribution During Faults simulation:

The model of the Generating Unit shall demonstrate its capability to simulate fast acting reactive current injection

d)

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model of the Generating Unit

a)

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The simulation is deemed passed, provided that the model demonstrates

1)

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).

Article 48

COMPLIANCE SIMULATIONS FOR TYPE C POWER PARK MODULES

In addition to carrying out the compliance simulations for type B Power Park Modules in the conditions as referred to in Article 47, type C Power Park Modules are subject to the following compliance simulations

2)

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Island Operation and Block Loading

1.

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Generating Unit shall demonstrate its performance during Island Operation in the conditions as referred to in Article 9(5) (b).

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

the Generating Unit shall be able to change from Interconnected System Operation to Island Operation without using any switchgear position signals for identifying an island;

the Generating Unit reduces or increases the loading from its previous operating point to any new operating point within the P-Q-Capability Diagram within the limits of Article 9(5) (b) without disconnection of the Generating Unit from the island due to over-/underfrequency; and

the Generating Unit has regulated load connections in block load with a maximum size of 10 % of Maximum Capacity of the Generating Unit without frequency dropping dynamically by more than 1 Hz in the island.

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

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of providing Synthetic Inertia to a low frequency event

a)

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16(2) (a).

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

With regard to the Fast Acting Active Power Contribution During Faults simulation:

The model of the Generating Unit shall demonstrate its capability to simulate fast acting Active Power contribution in the conditions as referred to in Article 16

b)

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With regard to the Power Oscillations Damping Control simulation:

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

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

Article 49