European Network of
Transmission System Operators
for Electricity

entsoe

GENERAL GUIDANCE ON COMPLIANCE VERIFICATION – COMPLIANCE TESTING AND USE OF EQUIPMENT CERTIFICATES

ENTSO-E guidance document for national implementation of network codes on grid connection – compliance testing and application of equipment certificates in the verification process.

Revised clean version | 30 July 2021

From: Steering Group Connection Network Codes

DESCRIPTION

Introduction

As per the EU Connection Network Codes (CNCs), newly connected or significantly modernised system users must be compliant with the relevant CNC technical requirements, and compliance must be verified at the time of the request for an operational notification and monitored throughout the life cycle.

For any new or significantly modernised equipment, initial compliance verification must be obtained using onsite tests and simulations during the operational notification process.

The overall purpose of this IGD is to guide the Relevant System Operator (RSO) and the relevant TSO on compliance verification at the facility Connection Point (CP), which is the focus of CNCs, to clearly distinguish it from compliance verification at unit / component / equipment terminals.

To make sure that the connected facilities remain compliant with CNC requirements during its life cycle, the RSO and where applicable the relevant TSO has the right to request the owner of power-generating facilities, demand facilities and HVDC facilities to carry out compliance verification tests and develop, maintain, and validate representative electrical simulation models according to a compliance verification programme. In particular:

- Demonstrated compliance via onsite testing and develop and verify a representative electrical simulation model for the facility during the operational notification issuing process.
- Carry out compliance tests and relevant simulation studies to be carried out in accordance with a compliance monitoring programme, after any failure, modification or replacement of any equipment or component that may have an impact on compliance with applicable requirements as described by RSOs and in line with CNCs, throughout the life cycle of the facility.

Based on the above, the following major phases of the compliance verification process might include but are not limited to the following actions:

1. Authorized certifiers to issue the relevant Equipment Certificate (EqC) as requested by the facility owner with the purpose of partly or completely demonstrating the compliance of components, units or modules with the required functionalities based on the specifications in the relevant CNC and the corresponding national implementation and based on compliance tests and/or simulations.
2. Facility owners to perform Compliance Verification Test (CVT) as onsite tests according to test specifications defined by the relevant CNC, the corresponding national implementation of CNCs and agreed between the facility owner and the RSO. The CVT is an activity that takes place during the operational notification issuing process with the purpose of demonstrating compliance with CNC specified minimum required functionalities, based on the relevant onsite tests according to the minimum compliance verification requirements stated in the CNCs - NC RfG, NC DCC and NC HVDC. The RSO may participate in the execution of the CVTs and record the test results obtained in onsite tests. The compliance verification process is finalised with the RSO acceptance

of the provided documentation including the relevant EqCs if applicable and a statement of compliance with the purpose of issuing an operational notification for the facility and signing of a final grid connection agreement.

3. Facility owners to develop and validate a Compliance Verification Simulation model (CVS) with the purpose of demonstrating compliance with the required functionalities using for this purpose an adequate electrical simulation model according to the relevant CNC requirements (NC RfG Article 15(6)(c), NC DCC Article 21, NC HVDC Article 54). Electrical simulations models used to verify compliance are required where onsite testing is not applicable or reasonable due to the possible impact on the facility or the grid. If the Member State decide so the simulation model will need to be qualified by an authorized certifier in line with relevant CNC requirements. More detailed guidance on electrical simulation models is presented in the specific IGD on "Compliance Verification using Simulation Models"[1].
4. RSOs and if applicable the relevant TSO to perform a Compliance Monitoring (CM) process to ensure that all connected facilities remain compliant with the required functionality and parameter ranges according to the relevant CNC requirements after issuing the operational notification and throughout the life cycle until the facility is decommissioned and disconnected, or until the operational notification is revoked or expires. More detailed guidance on the CM is presented in the specific IGD on "Compliance Verification – Compliance Monitoring after operational notification"[2].

These stated requirements are in line with the ACER Framework Guidelines on Connection Codes, Article 2.4 "the basis of the Compliance testing, compliance monitoring and enforcement" and correspond to national processes through which RSOs seek assurance that equipment connected to their grid systems is technically sound and meets company standards in terms of technical capability, behaviour, or provision of services.

Scope of document	The scope of the present document is to guide the RSOs and if applicable the relevant TSO on the application of equipment certificates in the process of demonstrating compliance partly or completely and to make guidance on the mandatory and supplementary onsite tests required to demonstrate full compliance with the grid connection requirements for granting a grid connection and the operational notification according to the signed connection agreement. The scope of the document does not include the specifications for issuing equipment certificates as this is up to the relevant standardization bodies and the authorized certifiers and authorized Laboratories to agree on a harmonized set of conditions and specifications for issuing EqCs applicable for demonstrating compliance according to the relevant CNC.

[1] IGD on Compliance Verification applying Simulation Models - this document is expected to be published in H1, 2022

[2] IGD on Compliance Verification – Compliance Monitoring after operational notification – this document is expected to be published in H2, 2022.

Acronyms applied

CDSO: Closed Distribution System Operator

CP: Connection Point

CVT: Compliance Verification Test (onsite test)

CVS: Compliance Verification Simulation (electrical simulation model)

DF: Demand Facility

DRUD: Demand Response Unit Document

DU: Demand Unit

EqC: Equipment Certificate

EON: Energisation operational notification

FACTS: Flexible Alternating Current Transmission System (a family of power electronics-based devices able to enhance AC system controllability and stability)

FON: Final operational notification

HVDC: High Voltage Direct Current

IGD: Implementation Guidance Document

ION: Interim operational notification

LON: Limited operational notification

NC RfG: Network Code for all Generators

NC DCC: Network Code for Demand Connection

NC HVDC: Network Code for HVDC systems

NPGU: Non-synchronous Power Generating Unit

NPPGU: Non-synchronous Power Park Generating Unit

PGF: Power Generating Facility

PPC: Power Park Controller

PGM: Power Generating Module

PGMD: Power Generating Module Document

PGU: Power Generating Unit

PPGU: Power Park Generating Unit (a part of a PPM and can be either SPPGU of NPPGU)

PPM: Power Park Module (unit or an ensemble of units which can be understood as an aggregation of one or more PPGUs)

RSO: Relevant System Operator (TSO, DSO or CDSO)

SPGM: Synchronous Power Generating Module (an indivisible set of installations which can be understood as aggregation of one or more SPGUs)

SPGU: Synchronous Power Generating Unit

SPPGU: Synchronous Power Park Generating Unit (e.g., Permanent Magnet Synchronous Generator – a commercially available wind turbine generator system)

UML: Unified Modelling Language (applied in this document to describe relation between the various certificates)

Definitions and terms applied

Throughout the document, the following definitions and terms are applied.

PGM type definition

The EU regulation 2016/631 defines four types of PGM A, B, C and D in Article 5 "Determination of significance".

The fundamental rationale for creating the PGM type definition is that the size of a power-generating module impacts the stability of the grid – the larger the PGM, the higher the grid impact.

Requirements in the regulation mentioned are cumulative, with some exceptions, and sorted into the four PGM types. Compliance testing and simulation of power-generating modules follow the same basic principle.

The following terms are used in this document.

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

Compliance Verification Programme: verification scheme specifying the applied EqCs, onsite tests and/or simulations aimed to demonstrate the compliance of the equipment with the requirements of the relevant CNC during the operational notification issuing process. This should be provided by the PGF owner and agreed with the RSO, including details related to the applied EqCs and supplementary onsite testing and/or the required electrical simulation models. The applied EqCs must be valid for the specific PGM, demand unit and HVDC system for which a connection request has been made.

Equipment certificate (EqC): a document issued by an authorized certifier for any kind of equipment used in compliance verification of a power-generating facility, or a demand facility or an HVDC system.

An equipment certificate may cover either a single component, a unit, a module, or the main generating plant. Consequently, at an aggregated level, one or more EqCs may be applicable to demonstrate compliance.

The following two figures depict the conceptual relation between a power-generating module, power-generating units, and components. Equipment certificates can be issued by authorized certifiers for a module, one or more power-generating units and/or one or more components as regards to compliance verification at the connection point of the module. The compliance verification for the facility in connection point based on one or more EqCs can use the principle of parents - child as the UML diagram in Figure 4 and Figure 7 illustrates.

Considering the structure of the PGM in relation to the connection point, the RSO can accept EqC for a module or for power-generating units and/or components as compliance

verification of requirements in the connection point. The compliance EqC in the connection point may use the parent-child principle as illustrated in the figure's UML diagram.

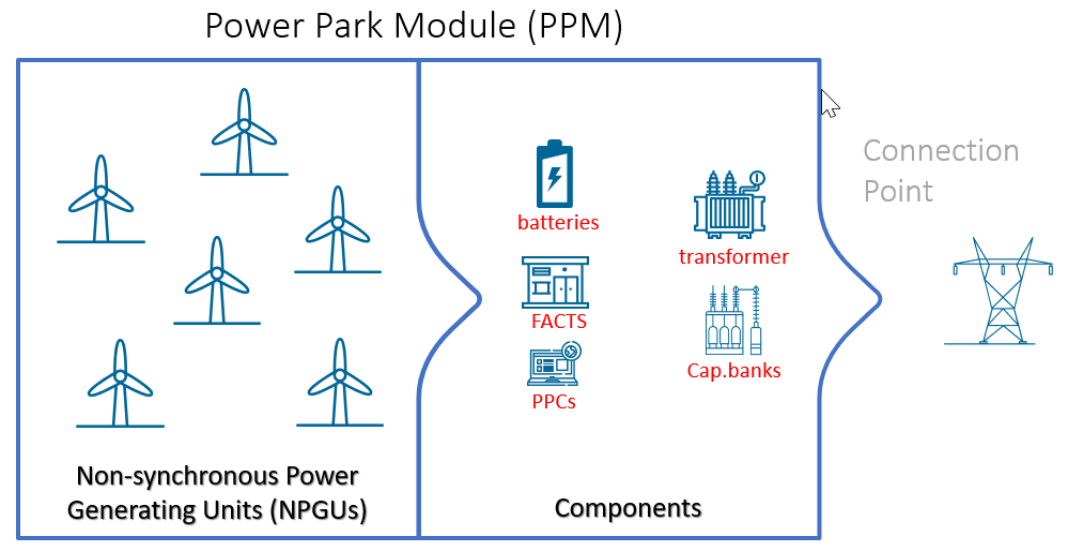


Figure 1. Relation between a PGM, NPGUs and components – non-synchronous

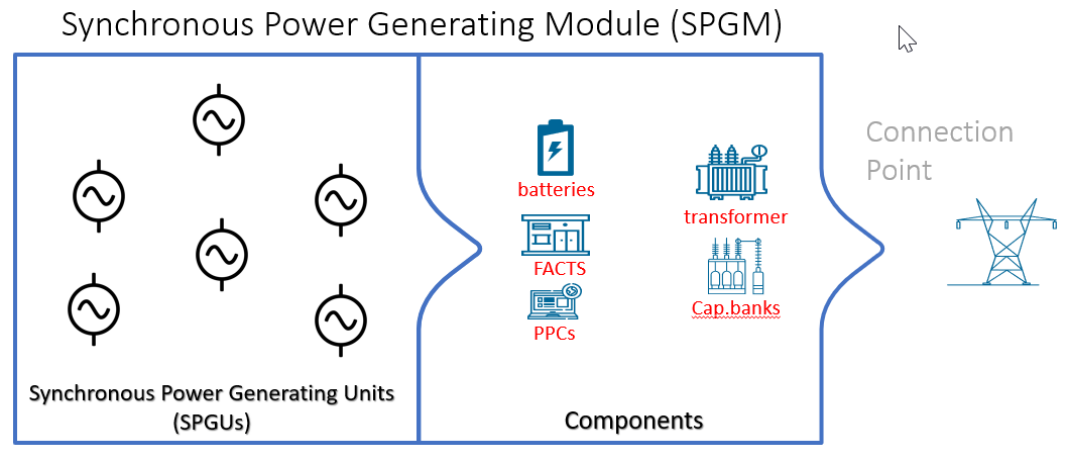


Figure 2. Relation between a SPGM, SPGUs and components – synchronous

The use of EqCs to demonstrate compliance at the facility level can be illustrated by the UML description as follows:

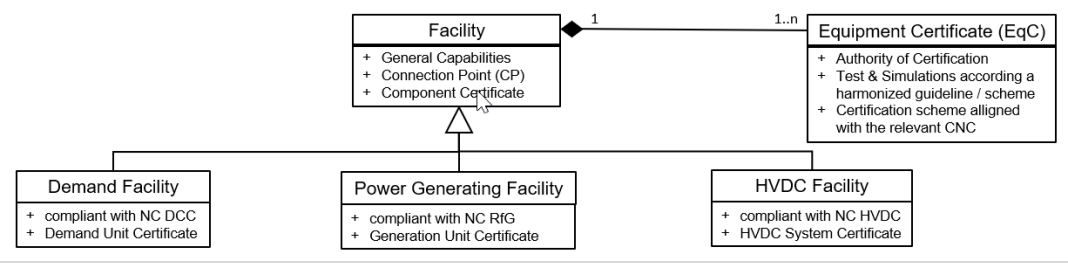


Figure 3. Relation between facility and EqCs

Note: A facility aggregates one or several EqCs (multiplicity in UML). A facility inherits its capabilities (here: general capabilities, connection point, component certificates) to the specialized classes Demand Facilities, Power Generating Facility and HVDC Facilities. For further explanation of the UML principle and relationship between UML classes – please find the details in the Annex 1.

The relation between a generation facility – PGM – generating units and components can be illustrated as follows:

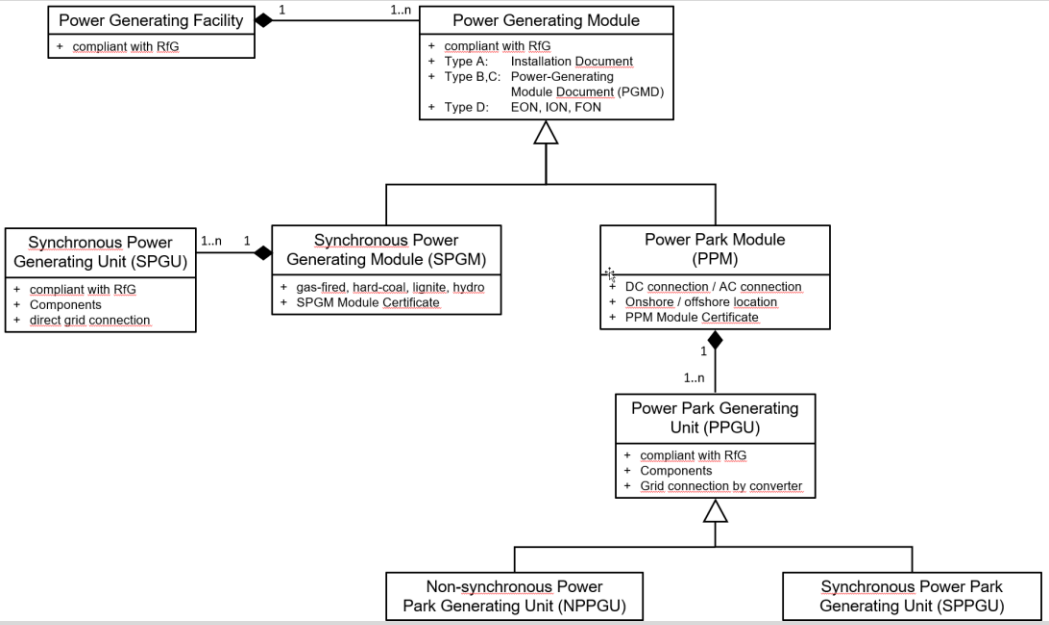


Figure 4. Relation between power generation facility and EqCs

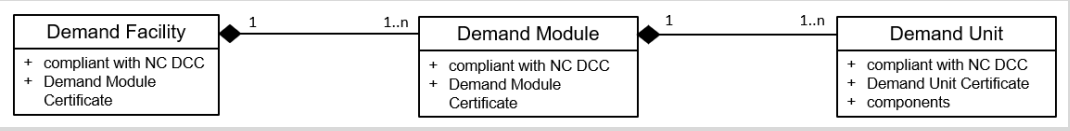


Figure 5. Relation between demand facilities and EqCs

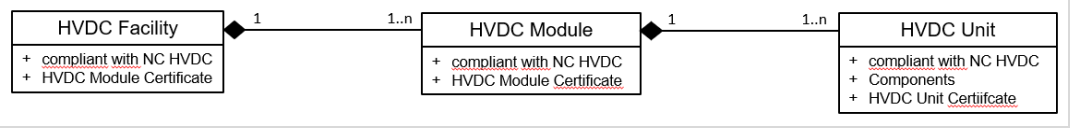


Figure 6. Relation between HVDC facilities EqCs

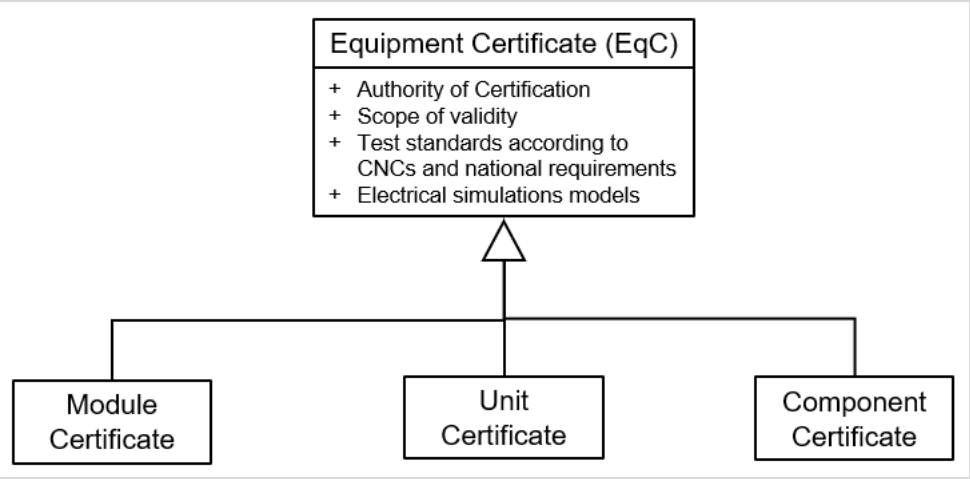


Figure 7. Relation between module, unit, component and EqCs

As shown in the UML-class diagram in Figure 7 above, the term "equipment certificate" covers one or multiple certificates – components, units, and module.

Module certificate: a module is defined as a PGM, PPM, SPGM, demand unit, or an HVDC module. Module certificates might be applicable at the connection point and in this case would demonstrate compliance with the CNC requirements. In the context of this IGD a PGMD is only addressing generation facilities. A module certificate can be understood as an umbrella term (which mean a basic class in the UML notation).

Unit certificate: A unit is defined as an aggregation of components converting a primary source of energy into electricity at the terminals of the unit. The main unit functional requirements (frequency-related functionality, voltage fault ride-through capability) are transferred to the connection point. The unit certificate might be applicable at the unit terminals. To demonstrate compliance at the connection point, the extrapolation from one or more-unit certificates to demonstrate facility/module compliance might be obtained by onsite tests and/or by application of an electrical simulation model as described in tables 1 – 3. As examples, units can be FACT devices, storage devices, a wind turbine generator system, a synchronous condenser system, etc. In case of a demand unit, a module certificate refers to the term "main demand equipment".

Component certificate: a component is defined as any hardware element or software application having an impact on the electrical characteristics and /or operation of a facility, module, and unit. As examples, components can be an electrical generator, a transformer, an automatic voltage controller system, a governor speed controller, a safety system controller, a subsystems controller, a power plant controller, a synchronous condenser, an HVDC converter station arrester, HVDC converter station switching blocks, etc.

Documents required to demonstrate compliance

The following documents are required as part of the compliance verification programme or to fulfil the complete compliance verification programme, depending on the PGM type and/or facility type. For HVDC facilities, only statements of compliance and relevant EqCs are requested.

Installation document: a simply structured document containing information about a type A power-generating module or a demand unit with demand response connected below 1000V, confirming its compliance with the relevant CNC requirements.

The installation document must include all applicable equipment certificates or unit certificates referring to the units applied in the PGM and/or components certificates.

Power Generating Module Document (PGMD): a document provided by the power-generating facility owner to the relevant system operator for a type B or C power-generating module which confirms that the power-generating modules complies with the technical criteria as set out in the NC RfG regulation has been demonstrated and provides the necessary data and statements, including a statement of compliance. The document might include one or more equipment certificates or unit certificates referring to the entire PGM or a sum of equipment/unit certificates for its units and/or components.

Demand Response Unit Document (DRUD): a document, issued either by the demand facility owner or the CDSO to the relevant system operator for demand units with demand response connected at a voltage level above 1,000 V, which confirms the compliance of the demand unit and main demand equipment with the technical requirements set out in the demand connection regulation and provides necessary data and statements, including a statement of compliance.

Statement of compliance according to the operational notification process in NC RfG Article 32, NC DCC Article 24, and NC HVDC Articles 57, 58, 62, and 67: a document provided by the power-generating facility owner, demand facility owner, distribution system owner or an HVDC system owner to the RSO, stating the status of compliance at the connection point and addressing all relevant compliance verification requirements.

Compliance Verification Programme and use of equipment certificates	The compliance assessment process must follow a Compliance Verification Programme (CVP) required by the RSO and where applicable the relevant TSO. In the CVP the EqCs can be a substantial part of compliance demonstration during compliance assessment. Equipment certificates can be used to substitute onsite tests to verify the compliance of components and or units. As a fundamental principle, the final onsite tests based on the agreed compliance verification test specifications provided by the facility owner must supplement the EqCs provided to demonstrate compliance. The equipment certificates define the scope of their validity at national level, at which a specific values is selected from the ranges specified in the relevant NC. In the specific case of units and components, however, the scope of the certificates must be related to the demonstration of the relevant capabilities. To replace specific parts of the compliance verification process, equipment certificates may include validated[3] electrical simulation models that are adequate for the demonstrating compliance of the relevant capability. Depending on the requirements to be verified during the certification process, the sensitive components - affected by these requirements - must be identified and checked, using the method specified in the certification scheme/programme, c.f. ISO/IEC/EN 17065 or

[3] The details on the validation of simulation models will be included in the Implementation Guidance Document on Compliance verification – applying Compliance Simulation.

ISO/IEC/EN 17025, separately or together as the set of components or an assembly of components forming a unit or and aggregation of units into a module.

Different methodologies can be used for compliance assessments, e.g.:

- Physical tests in an authorized laboratory, or as onsite tests carried out by an authorized certifier
- Assessment based on a validated electrical simulations model or an ensemble of models
- Combination of physical tests and validated electrical simulations model(s).

The methodology defining how to verify the capabilities of the equipment must be specified in a certification programme selected and issued by the authorized certifier.

The RSO has the right, c.f. NC RfG Article 41(3), NC DCC Article 32 (2), and NC HVDC Article 57 and Article 70 to define a list of information and documents to be provided as well as the requirements to be fulfilled by the facility owner within the framework of the compliance verification process. This information must be publicly available.

For power generating facilities.

Based on NC RfG art. 41(3)(a), (f) and (g), the RSO shall specify the following:

- all the documentation and certificates to be provided by the power-generating facility owner
- conditions and procedures, including the scope, for registering equipment certificates
- the conditions and procedures for the use of relevant equipment certificates issued by an authorized certifier.

Taking the information above into account as well as the fact that a certificate for a complete PGM includes the requirements applicable at all modules sub-levels, the RSO has a right to accept the use of the different types of equipment certificates (Module, Unit, and component certificates). The RSO have the right to approve or reject the applied certification guideline proposed by the authorized certifier or authorized laboratory.

Thus, the PGM owner, in compliance with the conditions and procedures made publicly available by the RSO, has the right to provide equipment certificates to demonstrate compliance instead of onsite tests or compliance simulations.

For demand facilities.

The RSO has the right, c.f. NC DCC Article 32 (2) and Article 35(3) to define a list of information representing the installation document. This information must be publicly available.

Based on NC DCC Article 32 (6) (c) and Article 35(3)(f)(g), the RSO shall specify the demand unit certificate and the equipment certificate issued by an authorised certifier, as relevant for the demand response service, or if not available, equivalent information.

	According to NC DCC Article 37 (8), Art 38 (2), Art 39 (7), Article 40 (2) and Article 41 (1) (d), equipment certificates may be used instead of part of the tests. For HVDC facilities. The RSO has the right, c.f. NC HVDC Article 70(3)(f)(g) and Art 57(3)(c) - (g), to define a list of information and documents to be provided as well as the requirements to be fulfilled by the HVDC system owner or DC-connected power park module owner in the frame of the compliance process. The list information and documents must be publicly available. Based on NC HVDC Article 71(1), Article 72(1), Article 73(1), and Article 74(1), the RSO shall specify the HVDC unit certificate, and the equipment certificate issued by an authorised certifier, as relevant for the demonstrating compliance.
Compliance test requirements	The compliance testing requirements according to the network codes specifies the level to which the facility owner shall demonstrate compliance with the technical requirements set out in the CNC to obtain a final operational notification for the grid connection. The RSO can according to the CNCs obligations extend the compliance verification requirements in needed. Each CNC includes requirements that vary, based on minimum technical capability, parameter ranges, module sizes, and the ability of the owner of a facility to do onsite tests or justify compliance using an electrical simulation model. Justifications for applying EqCs as a part of the demonstration can be accepted as well as demonstrating compliance via the application of validated electrical simulation models for specific functions and capabilities of the PGM where tests are considered disproportionate, e.g., a three-phase short-circuit failure to demonstrate the capability of the LVRT / FRT functionality. The responsibility for creating CVT procedures, test specifications and any related effort to fulfil CVT requirements lies with the facility owner. The roles of the RSO and the relevant TSO are • to define through publicly available conditions and procedures the acceptance criteria for the facility owner to demonstrate compliance with the requirements set out in the CNC's, • to accept/approve the proposed CVT procedures and test specifications, • to require additional tests, and • to accept corresponding EqCs as compliance evidence for specific parts of the CVT procedure. As a general indication, the Compliance Verification Programme, and hence the CVT procedures, must be approved by the RSO before entering the operational notification issuing process. However, timing could change at national level based on the procedures in place. The CVT requirements are specified in the CNCs in the following articles.

EU Regulation 2016/631 (NC RfG)

Title IV Compliance: Chapters 2-7 – Compliance testing & simulations

Chapter 2 – Compliance Testing for Synchronous Power Generating Modules

Article 44 – Compliance tests for type B synchronous power-generating modules

Article 45 – Compliance tests for type C synchronous power-generating modules

Article 46 – Compliance tests for type D synchronous power-generating modules

Chapter 3 – Compliance Testing for Power Park Modules

Article 47 – Compliance tests for type B power park modules

Article 48 – Compliance tests for type C power park modules

Article 49 – Compliance tests for type D power park modules

Chapter 4 – Compliance Testing for Offshore Power Park Modules

(Note that this is only for AC connections. DC-connected offshore PPMs are governed by 2016/1447). Selected criteria only from articles 44 and 48.

EU Regulation 2016/1388 (NC DCC)

Title IV Compliance: Chapters 2-3 – Compliance testing & simulations

Chapter 2 – Compliance Testing

Article 36 – Common provisions for compliance testing

Article 37 – Compliance testing for disconnection and reconnection of transmission-connected distribution facilities

Article 38 – Compliance testing for information exchange of transmission-connected distribution facilities

Article 39 – Compliance testing for disconnection and reconnection of transmission-connected demand facilities

Article 40 – Compliance testing for information exchange of transmission-connected demand facilities

Article 41 – Compliance testing for demand response active power control, reactive power control and transmission constraint management

EU Regulation 2016/1447 (NC HVDC)

Title VI Compliance: Chapters 2-3 – Compliance testing & simulations

Chapter 2 – Compliance Testing

Article 69 – Compliance testing for HVDC systems

Article 70 – Compliance testing for DC-connected PPMs and remote end HVDC convertor units

Operational Notification Procedure	Initial compliance of all new installations shall be demonstrated during the operational notification procedure according to the provisions of each CNC as part of the process of connecting to the system. Each of the CNCs includes similar provisions as summarised below. **NC RfG 2016/631 – Power Generating Facilities** ***Title III Chapter 1 - Operational Notification Procedure for New Power Generating Modules*** This chapter sets out the requirements for new generators to demonstrate their compliance with title II (articles 13-28), stating the detailed technical specifications for generators, as part of their connection process. The operational notification process sets out the steps through which demonstration of compliance with these requirements can be done, including steady state and dynamic performance as required by chapters 2-7 of title IV. The operational notification procedure is specified for each type A-D of power-generating modules and are, broadly defined, as follows. ***Type A PGM:*** Submission of an installation document as required by the RSO to a minimum standard as detailed in article 30. For type A, EqC will preferably cover the whole PGM. In principle, EqCs should be the base documents used in the compliance process during the notification procedure. The scope of the use of EqCs is specified by the authorized certifier. The RSO must specify according to NC RfG, Article 41(3)(g): Conditions and procedures for the use of relevant equipment certificates issued by an authorized certifier and make it public available. EqCs typically certify the compliance of specific equipment, but not of the entire power generating module. However, EqCs may provide essential information such as type-test results, proved manufacturer information (e.g., parameter ranges and functional characteristics) and a validated equipment model and, hence, contribute to the subsequent assessment at PGM level at the connection point. There is no specific requirement in title IV to demonstrate performance, since Articles 40 and 41 specify that the owner of the power-generating facility may rely upon EqCs. For type A, the installation document must include the EqCs and other relevant information.

Types B, C, D PGM: – use of equipment certificates (EqCs)

For Type B, C and D PGMs site-specific compliance shall be evidenced in addition to the type tests performed once, for example, during its unit certification process.

However, as per type A, EqCs typically certify the compliance of specific equipment but not of the entire power generating module. However, EqCs may provide essential information such as type-test results, proved manufacturer information (e.g., parameter ranges and functional characteristics) and a validated equipment model and, hence, contribute to the subsequent assessment at PGM level at the connection point.

As part of the evidence used to prove compliance with the relevant grid codes in a corresponding assessment as detailed below, the use of EqCs issued by an authorized certifier is allowed.

Type B-C PGM:

A Power Generating Module Document (PGMD) is to be provided to the RSO for each power-generating module by the power-generating facility owner (or authorized certifiers, based on national implementation of the RfG) including a statement of compliance. The PGMD is to include information as specified by the RSO within the scope set out in article 32 and must include, as required, compliance test reports as required in chapters 2-4 of title IV, including the use of actual, measured values during tests and studies demonstrating steady state and dynamic performance as required in chapters 5-7 of title IV. Simulations can be based on validated equipment models provided by the EqCs. On acceptance of a complete and satisfactory PGMD, the RSO will issue a final operational notification to the facility owner.

The PGMD could include EqCs for the various parts of a unit, a module or the facility.

Type D PGM:

For type D generators, the Operational Notification issuing process is more complex, considering their size and potential impact on the system. Due to the extent of the services and technical capabilities that this type of generator should be able to provide or demonstrate, these must undergo more detailed testing procedures.

The operational notification procedure for **type D** generators comprises:

Energisation operational notification (EON)

An EON entitles the facility owner to energise the equipment using the grid connection, but not to generate power, and is subject to the agreement with the RSO on protection and control settings.

Interim operational notification (ION)

An ION entitles the facility owner to operate the power-generating module and to generate power for a limited period, which is specified by the RSO but will not extend beyond 24 months (an extension of this period may be granted if a request for derogation is made to the RSO before the expiry of that period in accordance with the derogation procedure specified in article 60). Issue of an ION is subject to completion of the data and study review as specified/requested by the RSO and must include simulation models and studies demonstrating steady state and dynamic performance as required by chapters 5-7 of title IV, and details of intended compliance tests to be undertaken to fulfil requirements in chapters

2-4 of title IV. Tests may, to some extent, be substituted by the provision of EqCs. Simulations can be based on validated equipment models provided by the EqCs.

Final operational notification (FON)

A FON confirms the completion of the operational notification process and allows the power-generating facility owner to operate a power-generating module using the grid connection.

To be granted an FON, the facility owner must already hold an ION. Completion of the FON is subject to completion of any outstanding requirements set out in the ION and must include submission, by the facility owner, of an itemized statement of compliance and an update of the technical data, studies and models provided as part of the ION, but now also validated and using actual values found in tests and/or simulations.

As part of the FON, the RSO and the facility owner should reach an agreement on how compliance will be monitored over the life cycle of the generator, considering possible changes in generator software, hardware, and changes in the connection point characteristics, like short-circuit power and frequency impedance characteristics. This will be further detailed in the IGD on Compliance Monitoring.[4]

Limited Operational Notification (LON)

A type D generator holding an FON must inform the RSO with whom a connection agreement has been made if the equipment is affected by a temporary loss of capability, is subject to significant modification affecting performance, or is affected by equipment failure affecting performance, whenever this is expected to last for more than 3 months.

Issue of a LON by the RSO should be subject to identification of the means and timescales by which the non-compliance will be resolved and can last for a maximum of 12 months without requiring further derogation. An extension of the period of validity of the LON may be granted upon a request for a derogation made by the RSO before the expiry of that period, in accordance with the derogation described in Title V.

NC DCC 2016/1388 – Demand Facilities

Title II Connection of Transmission Connected Demand Facilities, Transmission Connected Distribution Facilities and Distribution Systems

Chapter 3 – Operational Notification Procedure

The requirements in 2016/1388 are like those in 2016/631. This chapter states that each transmission-connected demand facility owner or DSO to which one or more of the requirements in Title II (articles 12-21) apply shall confirm to the RSOs its ability to satisfy these by following an operational notification procedure.

Unlike in EU regulation 2016/631, there is no distinction in terms of scale or connection voltage to the process which comprises:

Energisation Operational Notification (EON)

[4] The details of the Compliance Monitoring in the framework of a Compliance Verification Program will be covered in the dedicated Implementation Guidance Document.

This allows energisation of the facility subject to satisfying the RSO of preparations, including agreement of protection and control settings.

Interim Operational Notification (ION)

As with 2016/631, an ION entitles the facility owner to operate connected to the system for a limited period – which is to be specified by the RSO but will not extend beyond 24 months. An extension of this period may be granted if a request for derogation is made to the relevant TSO before the expiry of that period in accordance with the derogation procedure specified in article 50.

Issue of an ION is subject to completion of the data and study review as specified and must include simulation models as specified in article 21 and studies demonstrating steady state and dynamic performance as required in articles 43 and 46(7).

An itemised statement of compliance supported by any EqC cited in this is also required.

Final operational notification (FON)

An FON confirms the completion of the operational notification process and allows the facility to operate without a time limitation.

To be granted an FON, the facility owner must already hold an ION. Completion of the FON is subject to completion of any outstanding requirements set out in the ION and must include submission, by the facility owner, of an itemized statement of compliance and an update of the technical data, studies and models provided as part of the ION but now also validated and using actual values from tests performed.

NC HVDC 2016/1447 – HVDC Facilities

Title V Operational Notification Procedure for Connection

The HVDC requirements are very similar to those in EU regulation 2016/631, but are subdivided into two sections as follows:

Chapter 1 – Connection of New HVDC Systems

Chapter 2 – Connection of New DC-connected Power Park Modules

Each HVDC system owner is required to demonstrate to the TSO that it complies with the relevant requirements set out in Titles II-IV articles 11-37 and 46-54 for general HVDC systems, and additionally title III for DC connected PPMs (articles 38-45 but also articles 13-22 of 2016/631) at the connection point through the operational notification procedure.

Similarly, to 2016/1388, but again unlike EU regulation 2016/631, there is no distinction in terms of scale or connection voltage to the process which comprises:

Energisation Operational Notification (EON)

This allows connection and energisation of the facility subject to satisfying the TSO of preparations, including agreement of protection and control settings at the connection point.

Interim Operational Notification (ION)

As with 2016/631, an ION entitles the facility owner to operate connected to the system for a limited period – which is to be specified by the TSO but will not extend beyond 24 months (an extension of this period may be granted if a request for derogation is made to the RSO

	before the expiry of that period in accordance with the derogation procedure specified in Title VII). Issue of an ION is subject to completion of the data and study review as specified and must include simulation models as specified in article 54 and studies demonstrating steady state and dynamic performance as required in titles II-IV. An itemised statement of compliance supported by any EqCs cited in this is also required plus details of any intended compliance tests according to article 70 and article 71 (DC-connected PPMs). *Final operational notification (FON)* A FON confirms the completion of the operational notification process and allows the facility to operate without a time limitation. To be granted an FON, the facility owner must already hold an ION. Completion of the FON is subject to completion of any outstanding requirements set out in the ION and must include submission, by the facility owner, of an itemised statement of compliance and an update of the technical data, studies and models provided as part of the ION but now also validated and using actual values found through tests. *Limited Operational Notification (LON)* A DC-connected PPM with an FON must inform the RSO with whom a connection agreement has been made if the equipment is affected by a temporary loss of capability, is subject to significant modification affecting performance, or is affected by equipment failure affecting performance, whenever this is expected to last for more than 3 months. Issue of a LON by the RSO should be subject to identification of the means and timescales by which the non-compliance will be resolved and can last for a maximum of 12 months without requiring further derogation.
Derogations to the CNCs	**Derogations to 2016/631, 2016/1388, 2016/1447:** In case of a derogation request, the connection procedure for the Operational Notification should be put on hold. Details to be provided in the derogation process depending on the relevant regulatory authority.

Summary of guidance on use of EqCs, CVTs and CVS in the compliance assessment process	The following three tables provide a non-binding guideline on the requirements for which the compliance could be verified via application of equipment certificates, supplementary onsite compliance tests and/or supplementary compliance simulations based on a verified electrical simulation model. To demonstrate the compliance of the required capability the power-generating facility owner may use equipment certificates to demonstrate the compliance issued by an authorised certifier to demonstrate compliance with the NC requirement. In that case, the equipment certificates shall be provided to the RSO as a part of the installation document or the PGMD. The tables below indicate the fundamental basis for issuing an EqC based on either testing and/or simulation. A detailed harmonized guideline published by a standardisation organisation applied by authorized certifier or authorized laboratory for issuing an EqC will be the document specifying the requirements for obtaining an EqC. The relevant parties are still discussing how to establish a harmonized guideline. It at the discretion of the RSO to decide whether a EqC is deemed sufficient or additional test/simulation is required. The detailed list of accepted EqCs must be specified by the RSO at a national level. The capability requirements listed in the table below are the minimum requirements for being granted a grid connection. Capability requirements marked with * are optional. National implementation could require additional capabilities if the grid system needs more specific services as specified in the NC RfG, but this is a national consideration. The NC RfG requirements specifying the minimum compliance verification requirements are as follows: **EU Regulation 2016/631 (NC RfG)** ***Title IV Compliance: Chapters 2-7 – Compliance testing & simulations*** *Chapter 2 – Compliance Testing for Synchronous Power Generating Modules* Article 44 – Compliance tests for type B synchronous power-generating modules Article 45 – Compliance tests for type C synchronous power-generating modules Article 46 – Compliance tests for type D synchronous power-generating modules *Chapter 3 – Compliance Testing for Power Park Modules* Article 47 – Compliance tests for type B power park modules Article 48 – Compliance tests for type C power park modules Article 49 – Compliance tests for type D power park modules *Chapter 4 – Compliance Testing for Offshore Power Park Modules* (Note that this is only for AC-connections. DC-connected offshore PPMs are governed by 2016/1447). Selected criteria only from articles 44 and 48. The following Table 1 provides an overview of NC RfG compliance verification requirements and related capability requirements.

The following table is a recommendation for the different way of demonstrating the compliance in the connection point using EqC and/or additional verification.

The first four columns depict for each NC requirement and the related NC article stating the compliance requirement.

The last three columns depict the compliance assessment methodology with onsite testing CVT and/or CVS supplementing the relevant EqCs.

The harmonized guideline for issuing an EqC is stating the conditions and methodology to be applied.

For PGM type A and B application of EqC is recommended, but it's up to the RSO to decided which compliance assessment method the PGM owner must follow.

EU regulation 2016/631 NC RfG compliance tests and simulations:

NC RfG requirements – capability and compliance verification				Compliance assessment based on EqC and CVT / CVS		
NC RfG Articles Title II – Requirements	Description of capability requirement	PGM Type	NC RfG Articles Title IV - Compliance	EqC (minimum requirement)		CVT / CVS PPM&SPGM
				PPM	SPGM	
13(2)	Limited Frequency Sensitive Mode – Overfrequency (LFSM-O)	≥A	44, 47, 51(1)(2), 54(2)	T for A; T&S for ≥B	T for A; T&S for ≥B	M (≥C)
15(2)(a)(b)	Active power controllability	≥C	48(2)	T	-	M
15(2)(e)	Frequency restoration control*	≥C	45(4), 48(5)	Co(T)	Co(T)	Co
15(2)(d)	Frequency Sensitive Mode (FSM)	≥C	45(3), 48(4), 51(3), 55(3)	T&S	T&S	M
15(2)(c)	Limited Frequency Sensitive Mode-Underfrequency (LFSM-U)	≥C	45(2), 48(3), 51(2). 55(2)	T&S	T&S	M
21(2)	Synthetic inertia during very fast frequency variations*	≥C	55(5)	Co(S)	-	-
17(3), 20(3)	Recovery of active power after a fault	≥B	51(4), 54(5)	S	S	-
14(3)	Fault ride-through capability < 110 kV	B	51(3)	S	S	-
		C	54(4)	S	S	-
16(3)	Fault ride-through capability ≥ 110 kV	D	53(3), 56(3)	S	S	-
15(5)(a)	Black start capability*	≥C	45(5)	-	Co(T)	Co
15(5)(b)	Capability to take part in island operation*	≥C	51(4)	-	S	Co
15(5)(c)	Quick re-synchronisation capability	≥C	45(6)	-	T	-
18(2)(b)	Reactive power capability at maximum capacity	≥C	45(7), 51(5)	-	T&S	M
18(2)(c)	Reactive power capability below maximum capacity	≥C	45(7), 51(5)	-	T&S	M
19(2), 21(3)(f)	Power oscillation damping control*	D	55(7)	Co(S)	Co(S)	Co
20(2)(b), (c)	Fast fault current injection*	≥B	54(3)	Co(S)	-	-
21(3)(b)	Reactive power capability at maximum capacity	≥C	48(6), 55(6)	T&S	-	M
21(3)(c)	Reactive power capability below maximum capacity	≥B	48(6), 55(6)	T&S	-	M
21(3)(d)	Reactive power control modes	≥B	48(7), 48(8), 48(9)	T	-	M

Note 1: Compliance verification requirements for AC-connected offshore PPMs are like those for onshore PPMs**.**
Note 2: In the column "**PGM** Type", the text:
≥A means that it applies to **PGM** Types A, B, C and D;
≥C means that it applies to **PGM** Types C and D.

Table legend	
-	Not applicable
*	Non-mandatory capability
Co	Conditional – if the functionality exists or is required by the RSO, it must be verified by verification tests or by simulations
CVS	Compliance verification supplementary to the EqC: CVS: Compliance Verification based on electrical Simulation model
CVT	Compliance verification supplementary to the EqC: CVT: Compliance Verification based on onsite Testing
EqC	Equipment Certificate – based on T / S
M	Mandatory capability to be verified by T and/or S
NR	**N**ational Requirements for compliance verification – recommended to be established in Member State regulation
O	Optional – EqC may be used instead of some of the tests
S	EqC certificate is based on Simulations
T	EqC certificate is based on Tests
T&S	EqC certificate is based on both simulations and tests

Table 1. The NC RfG Compliance verification requirements overview

The NC DCC requirements specifying the minimum compliance verification requirements are as follows:

EU Regulation 2016/1388 (NC DCC)

Title IV Compliance: Chapters 2-3 – Compliance testing & simulations

Chapter 2 – Compliance Testing

Article 36 – Common provisions for compliance testing

Article 37 – Compliance testing for disconnection and reconnection of transmission-connected distribution facilities

Article 38 – Compliance testing for information exchange of transmission-connected distribution facilities

Article 39 – Compliance testing for disconnection and reconnection of transmission-connected demand facilities

Article 40 – Compliance testing for information exchange of transmission-connected demand facilities

Article 41 – Compliance testing for demand response active power control, reactive power control and transmission constraint management

The following Table 2 provides an overview of the NC DCC compliance verification requirements and related capability requirements.

The following table is a recommendation for the different way of demonstrating the compliance in the connection point using EqC and/or additional verification.

The first four columns depict for each NC requirement and the related NC article stating the compliance requirement.

The last three columns depict the compliance assessment methodology with onsite testing CVT and/or CVS supplementing the relevant EqCs.

The harmonized guideline for issuing an EqC is stating the conditions and methodology to be applied.

EU regulation 2016/1388 NC DCC compliance tests and simulations:

NC DCC requirements – capability and compliance verification for a transmission-connected demand facility, transmission-connected distribution facility, or closed distribution system			**Compliance assessment based on EqC and CVT/CVS**	
NC DCC articles Title II – Requirements	**Description of capability requirement**	**Article NC DCC (Title IV - Compliance)**	EqC (minimum requirement) Equipment / components	CVT/CVS
12	General frequency requirements	36 (1)	T	M
13	General voltage requirements	36 (1)	T	M
19	Disconnection and reconnection of transmission-connected distribution facilities	37(1)	T	M (T)
18(3)	Information exchange of transmission-connected distribution facilities	38(1)	T	M (T)
19	Disconnection and reconnection of transmission-connected demand facilities	39(1)	T	M (T)
18(3)	Information exchange of transmission-connected demand facilities	40(1)	T	M (T)
15	Reactive power capability simulation	43.1(c)	-	M (S)
15(3)	Active control of reactive power	43.2	-	M (S)
15(1), 15(2)	Reactive power capability	44(1)(c), 41(2)(c)	-	M (S)
28(2)(a), 12(1), (2)	Operating across the frequency ranges	NR	-	-
28(2)(k)	Not disconnect from the system due to RoCoF	NR	-	-
28(2)(b)(c)	Operating across the voltage ranges specified in Article 13, standards, Article 6, and Article 9(1)	NR	-	-
28(2)(d)(f)(g)(h), 28(l)	Demand modification	41 (1)	T	M (T)
28 (3)	Disconnection or reconnection of static compensation facilities	41 (2)	T	M (T)
29(2)(a)	Operating across the frequency ranges specified in Article 12(1) and the extended range specified in Article 12(2)	NR	-	Co
29(2)(b)	Operating across the voltage ranges specified in Article 13, standards, Article 6, and Article 9(1)	NR	-	-
30	Demand units with demand response very fast active power control	45 (1), (2)	-	M (S)

Table legend	
-	Not applicable

*	Non-mandatory capability
Co	Conditional – if the functionality exists or is required by the RSO, it must be verified by verification tests or by simulations
CVS	Compliance verification supplementary to the EqC: CVS: Compliance Verification based on electrical Simulation model
CVT	Compliance verification supplementary to the EqC: CVT: Compliance Verification based on onsite Testing
EqC	Equipment certificate – based on T / S
M	Mandatory capability to be verified by T and/or S
NR	National Requirements for compliance verification – recommended to be established in Member State regulation
S	EqC certificate is based on Simulations
T	EqC certificate is based on Tests
T&S	EqC certificate is based on both tests and simulations

Table 2. The NC DCC Compliance verification requirements overview

The NC HVDC requirements specifying the minimum compliance verification requirements are as follows:

EU Regulation 2016/1447 (NC HVDC)

Title VI Compliance: Chapters 2-3 – Compliance testing & simulations

Chapter 2 – Compliance Testing

Article 69 – Compliance testing for HVDC systems

Article 70 – Compliance testing for DC-connected PPMs and remote end HVDC convertor units

The following Table 3 provides an overview of the NC HVDC compliance verification requirements and related capability requirements.

The following table is a recommendation for the different way of demonstrating the compliance in the connection point using EqC and/or additional verification.

The first four columns depict for each NC requirement and the related NC article stating the compliance requirement.

The last three columns depict the compliance assessment methodology with onsite testing CVT and/or CVS supplementing the relevant EqCs.

The harmonized guideline for issuing an EqC is stating the conditions and methodology to be applied.

EU regulation 2016/1447 NC HVDC compliance tests and simulations:

NC HVDC - Requirements – capability and compliance verification			Compliance assessment based on EqC and CVT/CVS	
NC HVDC articles Title II & III requirements	**Description of capability requirement**	**NC HVDC Articles Title VI - Compliance**	**EqC (minimum requirement) DC connected - PPM**	**CVT/CVS HVDC**
69	Roles and responsibilities	69	-	-
57, 70(3)(f), 70.3(g)	Conditions and procedures for use of relevant equipment certificates	70(3)	-	-
13(1)(a), 13(1)(d), 41, 48(3) NC RfG	Active power controllability	71(9), 72(10)	T	M
20, 48	Reactive power capability	71(4), 72(2), 72(3)	T	M
21(3) NC RfG	Power factor control	71(5), 72(6)	T	M
22(3), 22(4), 22(5), 40, 48	Voltage control mode	71(5), 72(4)	T	M
Article 48(4) NC RfG	FSM response	71(6), 72(11)	T	M
Article 47.3 NC RfG	LFSM-O response	71(7), 72(8)	T	M
Article 48.3 NC RfG	LFSM-U response	71(8), 72(9)	T	M
Article 45.5 NC RfG	Frequency restoration control	72(12)	T&S	M
13.2	Ramp rates	71(10)	T&S	M
37	Black start capability*	71(11)	-	Co(T)
39 Article 13, 15 NC RfG	Frequency stability – response requirements	72(12)	-	M
44	Power Quality	NR	-	NR

Table legend	
-	Not applicable
*	Non-mandatory capability
Co	Conditional – if the functionality exists or is required by the RSO, it must be verified by verification tests or by simulations
CVS	Compliance verification supplementary to the EqC: CVS: Compliance Verification based on electrical Simulation model
CVT	Compliance verification supplementary to the EqC: CVT: Compliance Verification based on onsite Testing
EqC	Equipment certificate – based on T / S
I/C	Individually or collectively as part of demand aggregation - Role of demand aggregator?
M	Mandatory capability to be verified by T and/or S

NR	National Requirements for compliance verification – recommended to be established in Member State regulation
O	Optional – EqC may be used instead of some of the tests
S	EqC certificate is based on Simulations
T	EqC certificate is based on Tests
T&S	EqC certificate is based on both simulations and tests

Table 3. The NC HVDC compliance verification requirements overview

Role of Third Parties	Third parties could be any additional stakeholder to the owner of a PGM or SPGM. In this document, "third party" is understood as authorized certifiers and/or authorized laboratories. The role of authorized certifiers and authorized laboratories is to assure harmonized methodology, criteria, and degree of evaluation of equipment or components versus CNC requirements (mandatory and non-mandatory) as was specified in EC regulation and national regulation for EU countries. The activity of authorized certifiers is based on regulation (EC) No. 765/2008, EN/ISO/IEC 17065 (authorized certifiers), and the EN/ISO/IEC 17025 (authorized laboratories) standards. The activities according to the standards can be summarized as follows: • authorized certifiers / laboratories are responsible for defining a common rule in the EqC and components certification issuing activity, to provide the same degree of confidence in the same requirement. The harmonization of types of tests, models, simulations, and certification is essential to each type of requirement and member state specificity. • In the diversity of non-mandatory requirements, or specific projects, authorized certifiers / laboratories can develop the same type of tests or simulations to ensure that all authorized certifiers / laboratories provide similar certificates. • Authorized certifiers / laboratories may harmonize the methodology of providing EqC by type or by requirements, but unit certificates for an overall family of equipment in various combinations are not acceptable. • The process of certification consists of four phases: Application Review – Evaluation – Review – Certification issue. **Application** The application refers either to equipment certificates or component certificates and it is defined in two different contexts of compliance testing within EU regulation 2016/631: 1. As a module/unit/component certificate 2 At facility level, after operational notification have been issued. The use of EqCs, issued by an authorized certifier, might be a part of the observance of the compliance assessment process.

	According to NC RfG art. 41(3) (g), the RSO must elaborate and make public conditions and procedures for the use of equipment certificates which can be used in the compliance verification and monitoring process.
Involvement of Third Parties	The RSO must identify the advantages and disadvantages of implementing different compliance verification strategies. The following is a non-exhaustive list of examples. 1. CVP completely performed by RSOs (not applicable for some Member States): • High level of expertise needed • Compliance verification test procedure developed by the RSO • Highest level of control of the verification specifications and the process. 2. Partially delegated to third parties • Compliance test specifications developed by facility owner • Compliance test specifications reviewed and accepted by the RSO • Third party verification guideline /scheme reviewed and accepted by the RSO • EqCs issued by an authorized certifier / laboratory • Medium level of control of the verification specifications and the process. 3. Totally delegated to third parties • Requires a very detailed compliance verification procedure to make sure that different certification entities have the same criteria • Reduced work burden for the RSO once the compliance test specifications are signed by the facility owner, received, and accepted, including the relevant certificates • Lowest level of control of the verification specifications and the process. The RSO is responsible for creating procedures / guidelines for compliance verification (CVT and CVS) and for issuing the EqCs the standardization organization / the association of certifiers / laboratories is responsible for creating procedures and a harmonized guideline. The overall recommendation to the RSO is to engage the standardization organization / the association of certifiers to developing a harmonized guideline on the requirements and conditions for issuing EqCs according to the minimum CNC capability requirements and applying EqCs as the fundamental compliance verification document for small-scale PGMs – i.e., primarily types A and B. A harmonized guideline for issuing equipment certificates must include at least, but not limited to, the following information: • the technical specification of the equipment covered by the equipment certificate • the results of equipment-specific measurements, including certifier assessments that tests have been conducted in compliance with given standards, and that results comply with given certification criteria • a qualified evaluation of respective manufacturer declarations, where tests are neither technically nor financially feasible

- an electrical simulation model for the equipment, that has been validated against measurement results with respect to given validation criteria (procedure, thresholds, tolerances); including the certifier's assessment that the validation has been conducted in compliance with given standards.

INTER-DEPENDENCIES	
Within CNCs	This IGD covers the compliance verification activities related to applying EqC and compliance verification tests and/or compliance simulations required in the three Connection Network CNCs –2016/631 NC RfG; 2016/1388 NC DCC; 2016/1447 NC HVDC.
In other NCs	Yes, optional services (such as black start which is detailed in the operational NC Emergency & Restoration (NC ER)) will be subject to compliance verification according to the TSO and RSO requirements on Black Start services and monitoring under the scope of NC ER and SO GL.
System characteristics	All compliance verification activities must relate to the connection point for the facility.
Technology characteristics	N/A
COORDINATION	
TSO – MS-NRA	If compliance is not established, the right to connect to the system or to import/export power through the connection point can be withheld or removed from the facility owner by the RSO; alternatively, a derogation could be requested from the NRA.
TSO – facility owner – DSO-CDSO	Compliance Monitoring[5] is joint task for the TSO/RSO and the facility owner and is required as part of the connection procedure and must be maintained during the life cycle of the facility. The compliance monitoring subject will be addressed in detail in the IGD on compliance verification – compliance monitoring.

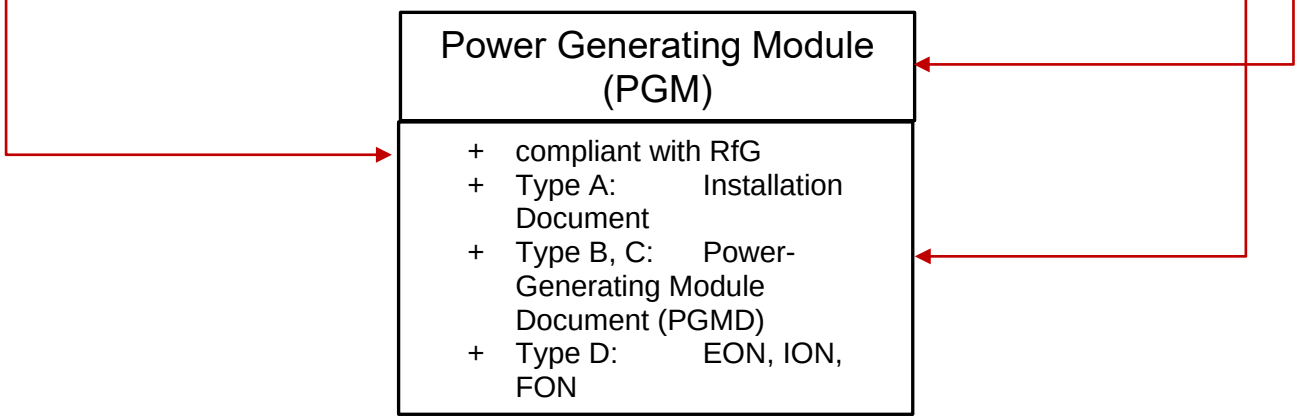
[5] The details on the compliance monitoring requirements will be included in the Implementation Guidance Document on Compliance verification – monitoring after operational notification.

ANNEX 1 – Unified Modelling Language

In UML, a "class diagram" is a static structure diagram and describes the structure of a system (not only a software system but any kind of hierarchy!). The class diagram shows the system's classes, their properties (so-called "attributes", operations (so-called "methods") and the static relationships among other objects.

- Classes are represented by boxes and there can be up to three compartments in one box:
  - The top compartment contains the name of the class.
  - The middle compartment contains the attributes of the class.
  - The third compartment contains the methods of the class (not necessarily applicable in the context of the IGD).
- Visibility of the class member
  - +: public access, unlimited external access
  - #: protected access, only class itself and derived classes
  - -: private access, only class itself
  - "Public" means accessibility of attribute (e.g., to TSO, certifier, or NRA) must be guaranteed, otherwise PGM is not RfG compliant or has no legal operational notification.
  - "Protected" and "private" access are not meaningful use cases in the context of this IGD.

'



UML distinguishes between class-level relationships and instance-level relationships.

Class-level relationships (generalization/inheritance relationship) are as follows:

- A hollow triangle shape (△) in a class diagram indicates the relationship between the parent or super class and its derived child or sub-class.
- The child class inherits all public and protected attributes and methods of its parent class (like in "real life").
- Additionally, the child class can add new attributes (and methods) and becomes specialized in this way (like in "real life").
- The inheritance relationship is also called a "child – parent" relationship.

Instance-level relationships are as follows:

- The association presented by a simple arrow expresses the relationship between classes or by usage of numbered multiplicity the relationship between a certain number of objects (instances) of classes.
- The aggregation presented by a hollow diamond shape indicates the collection of other classes (and their objects) but without a strong life cycle dependency on the container. The container's content still exists when the container is destroyed.
- The composition presented by a filled diamond shapes has the container function as the aggregation, but with a much stronger life cycle dependency on the container. The container's content depends on the existence-composing container.

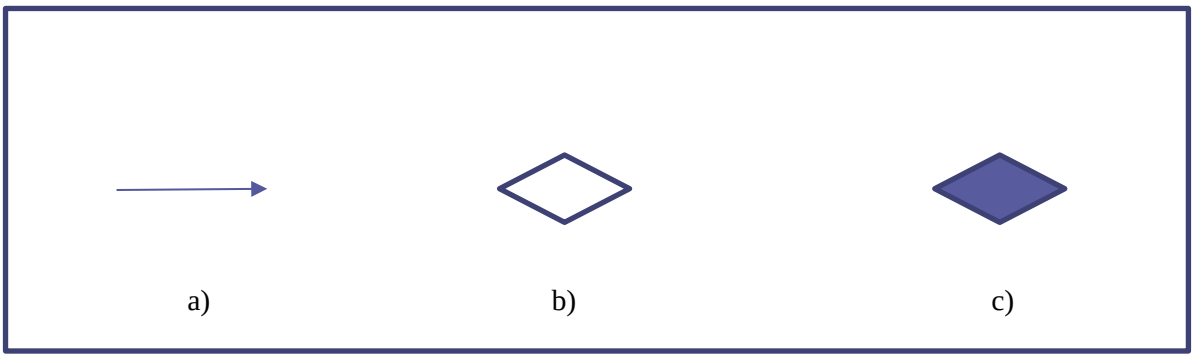


Figure 8. Inheritance relationships symbols: association (a), aggregation (b), composition (c)

The application of class-level (inheritance) relationships and instance-level relationships leads to the presentation shown in Figure 9.

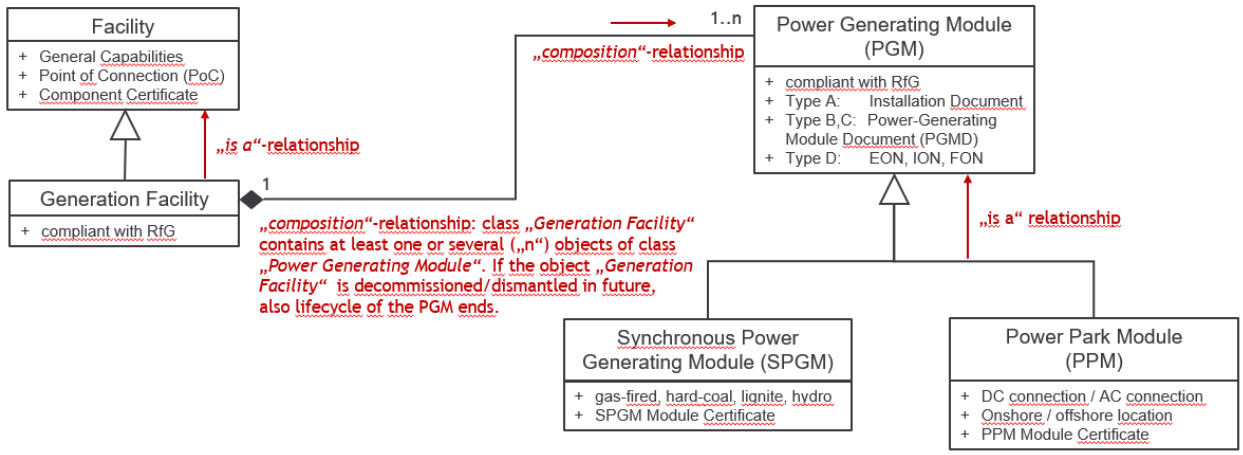


Figure 9. UML class diagram with the different kinds of generation facilities