APPROVED

European Network of
Transmission System Operators
for Electricity

QUALITY OF CGMES DATASETS AND CALCULATIONS

FOR SYSTEM OPERATIONS

VERSION 4.1.4, 7 OCTOBER 2025

SYSTEM OPERATIONS COMMITTEE (CGM ACTION PLAN)

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NOTE CONCERNING WORDING USED IN THIS DOCUMENT

The force of the following words is modified by the requirement level of the document in which they are used.

- MUST: This word, or the terms “REQUIRED” or “SHALL”, means that the definition is an absolute requirement of the specification.
- MUST NOT: This phrase, or the phrase “SHALL NOT”, means that the definition is an absolute prohibition of the specification.
- SHOULD: This word, or the adjective “RECOMMENDED”, means that there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications shall be understood and carefully weighed before choosing a different course.
- SHOULD NOT: This phrase, or the phrase “NOT RECOMMENDED”, means that there may exist valid reasons in particular circumstances when the particular behaviour is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behaviour described with this label.
- MAY: This word, or the adjective “OPTIONAL”, means that an item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because the vendor feels that it enhances the product while another vendor may omit the same item. An implementation which does not include a particular option MUST be prepared to interoperate with another implementation which does include the option, though perhaps with reduced functionality. In the same vein an implementation which does include a particular option MUST be prepared to interoperate with another implementation which does not include the option (except, of course, for the feature the option provides.).

VERSION NOTES:

This version (v4.1.4) of the document is a patch release to fix identified issues during the implementation of QoCDC version 4.1.3.

The following rules are modified:

- Content changes:
  - KirchhoffsFirstLawCGM – new rule
  - KirchhoffsFirstLawCGMrelaxed – new rule
  - KirchhoffsFirstLaw – change of validation scope
  - ParticipatingGeneratingUnit
  - SMOperatingModePConsistency
  - NumberOfSubstations - threshold

The constant NUMBER_OF_SUBSTATIONS is increased from 10 to 30. Added float implementation guidance/rule in section 5.4.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

This document aims to enhance the quality and consistency of power network model data that is exchanged to support CGM building process necessary to create CGMs for the following business processes (Figure 1):

- Coordinated Security Assessment;
- Coordinated Capacity Calculations;
- Unavailability Planning Coordination;
- Short-term & Medium-Term Adequacy
- After-the-fact analysis of events;
- Ad-hoc system studies;
- Inter TSO compensation;

Quality, in this context, refers to the compliance of the data with rules defined in the data exchange standards and documents related to business processes. This entails that the exchanged data should be processable, consistent and uniformly interpreted by all users (i.e., interoperable) ultimately resulting in plausible calculation results. Furthermore, this quality ensures that the data can be seamlessly processed within an automated (machine-to-machine) environment, reducing the need for manual intervention.

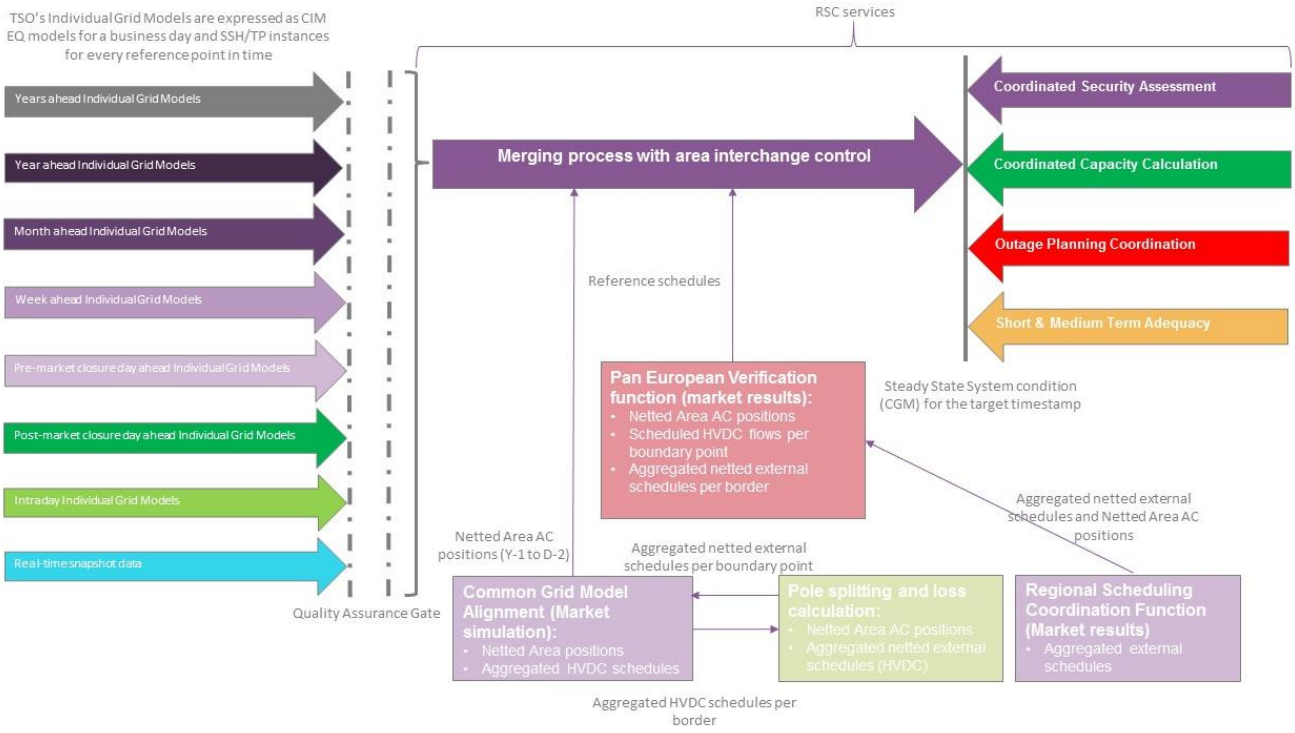

Figure 1 Context of operational data exchanges leading to Common Grid Models

Netted Area AC positions and scheduled flows on HVDC interconnectors (necessary input data for the merging process) is exchanged in the Reporting Information Market Document, based on ESMP

(European Style Market Profile), IEC 62325 series[1]. The validation of the scheduling data that is provided in these documents is not in scope of this document. The schedules themselves are used for coordination validation.

The first edition of this document was published in May 2016. This edition incorporates experience gained while running interoperability tests, revealing the need for additional validation rules and improving some existing rules. The document outlines eight levels of validation rules used in the following three Quality Gates:

- Local Quality Gate, covering first three validation levels;
- Global Quality Gate, covering levels 4-7;
- EMF Quality Gate, covering level 8.

The following principles for validation and rejection of data are followed when defining the document:

- **Fit for purpose**: the validation rules only focus on issues that may impact the business process/usability of the models. Rejection (error level) only applies if the data cannot be processed further in the business process or harms the subsequent processes.
- **Selectivity**: rejection of bad data shall be done on the smallest unit of data.
- **Traceability**: if a process fails, it shall be possible to trace back the root cause (adequate messages and diagnostics).

As the QoCDC document evolved new rules has been defined and old revised. The rules are generally aligned with CGMES 2.4.15 specification, but some of the rules are defining specification. These rules or constraints have been included in the current version of the CGMES (edition 2021 of IEC 61970-600-1 and IEC 61970-600-2), while QoCDC has still been evolving in parallel with the standard CGMES. Therefore, next versions of the QoCDC would be focused on the business rules/constraints that are not part of the data exchange standards.

Although this document is designed for system operation it includes useful rules applicable for TYNDP and other processes. Hence the rules defined here are may also be used in other processes not directly covered in this document.

The document includes three main categories of sections. Section 5 “General Rules” defines important specifications that are used when validating the rules and constraints this document outlines. Section 6 “General Guidelines” provides relevant background information and serves as a guidance. The rest of the sections define the rules and constraints that are grouped per level, type and severity.

The document includes information what parts are already defined in the CGMES v3.0 (IEC 61970-600-1:2021 and IEC 61970-600-2:2021) which facilitates transition process to next versions of the data exchange standard.

[1] IEC 62325 documents are based on transactions between parties and areas, identified by EIC mRIDs. For the CGM processes, we identify ControlArea by UUID/Legacy ID and use an attribute to specify EIC code for this area. External mapping can be applied to link instance data exchanged via the two standards.

2 TERMS AND DEFINITIONS

Table 1 specifies the terms and definitions that are used in this document. A more detailed description of some terms can be found in IEC TS 61970-600-1:2017.

Table 1 Terms used and their definitions

Term	Definition
Assembly	The process of combining information from a single Modeling Authority Set (serialized in separate instance files) into a coherent data set in which all RDF references have been resolved.
Base Voltage	Defines a system base voltage which is referenced when converting to per unit values inside power flow tools.
Boundary Information	Is a set of data related to the boundary points and related AC or DC interconnections. The boundary information includes at least identifiers and names of boundary points, substations, tie-lines.
Boundary Set	As defined in the CGMES, it is a dataset that contains all boundary points and ENTSO-E reference data necessary for a given grid model exchange. A boundary set can have different coverage depending on the requirements of the common grid model exchange. A complete boundary set is necessary to assemble a pan-European power system model.
Boundary Point (BP)	Boundary Point defines the point of common coupling between two Modeling Authority Sets (MAS). A Boundary point could be a ConnectivityNode or a TopologicalNode placed on a tie-line or in a substation. A Boundary point must be contained in a Boundary Set and must not be contained in the MAS of a TSO. A Boundary point is referenced by Terminals in the MAS of a TSO. ConnectivityNode and TopologicalNode are terms specified in IEC CIM standards.
CGM	Common Grid Model, i.e., the steady state pan-European system state for a given point in time.
CGMES	Common Grid Model Exchange Specification
DACF	Day Ahead Congestion Forecast
Dangling reference	A dangling reference is just like a broken link on the web. In a model assembly it's a reference to an identified object that should have a description in the assembly and, simply, doesn't.
EIC	The EIC (Energy Identification Coding scheme) is standardized by ENTSO-E for a unique identification of the market participants and other entities active within the Energy Internal European Market (IEM). Over and above Market Participants (Parties - object type "X"), the EIC also covers other entities by allocating a unique code to the following object types: Areas – object type "Y", Areas for inter System Operator data interchange Measuring Points – object type "Z", Energy Metering points Resource objects – object type "W", such as Production plants, consumption units, etc.

Term	Definition
	Tie-lines – object type “T”, International tie lines between areas Location – object type “V”, Physical or logical place where a market participant or IT system is located Substations – object type “A” The EIC is based on fixed length alphanumeric codes which can be broken down as follows: A 2-character number identifying the Issuing Office assigned by ENTSO-E. One Character identifying the object type that the code represents. 12 digits, uppercase characters or minus signs allocated by the issuing office 1 check character to ensure the code validity. Valid characters of an EIC code are A-Z, 0-9 and “-“.
EQ	Equipment profile in CGMES, describing the physical property of equipment and its connectivity.
EQBD	Equipment Boundary profile in CGMES.
IGM	Individual Grid Model, i.e., all instance data that is necessary to specify a scenario as input and output for a power flow tool (e.g. EQ, SSH, TP and SV).
Merging	The process of combining information from multiple Modeling Authorities and external constraints into a coherent network model with operating assumptions for a given point in time.
Modeling Authority	The organization responsible for modelling its responsibility area.
Modeling Authority Set	A URN/URI referring to the organisation or role sourcing the model in the CIMXML document. Models from the same organisation or role but for different profiles shall have the same urn/uri. Different representation of the same responsibility area, e.g., system development planning model, shall have a different URN/URI if the models are different.
mRID	Master Resource Identifier. The IdentifiedObject class contained in the Core package of the Common Information Model (CIM) is inherited by all PowerSystemResource and many other classes. This class has attributes and associations to be used for naming all CIM objects. The mRID attribute of the IdentifiedObject class provides a straight forward and rigorous means of identity for CIM objects. The IdentifiedObject.mRID is a globally unique machine-readable identifier for an object instance.
OPDE	Operational Planning Data Environment
OPDM	Operational Planning Data Management (Smart file storage and management for Operational Planning Data including validation of file names, RDF/XML structure and syntax).
RDF	Resource Description Framework, as specified in https://www.w3.org/RDF/
rdf:ID/rdf:about	In RDF the rdf:ID identification has the specific meaning that the identifier is unique within a document while the rdf:about identification

Term	Definition
	means the identifier is unique within a name space. If the UUID name space urn:uuid is used for the rdf:about identification the identifiers are globally unique. Hence CIMXML promote using rdf:about identification in the UUID name space for all identifiers. The URN form is used as CIMXML element identification as follows: The prefix “urn:uuid:” is replaced by an underscore “_”. The underscore avoids a numeric starting character for the non-base part of the identifier. Starting the non-base part of the identifier with a numeric character is invalid RDF. The underscore is added in all cases to simplify parsers, even if the UUID starts with a non-numeric character. The prefix is defined as an xml:base=“urn:uuid:” Some examples: rdf:ID=”_26cc8d71-3b7e-4cf8-8c93-8d9d557a4846” the rdf:ID” form. rdf:about=”#_26cc8d71-3b7e-4cf8-8c93-8d9d557a4846” the “hash” form. rdf:about=”urn:uuid:26cc8d71-3b7e-4cf8-8c93-8d9d557a4846” the “urn:uuid:” form.
rdf:resource	Pointer to denote an association or used to reference an enumerated value. The value of rdf:resource is a “resource-uri”, which can specify an XML resource, using the “hash” form or the “urn:uuid:” form or an external resource or enumeration using a namespace prefix (http://....)
SSH	Steady State Hypothesis profile in CGMES, describing the switch and tap positions, control targets, as well as energy generation, consumption and border exchanges at one operating point (in time).
SV	State Variables profile in CGMES, describing the state variables of a power flow solution in terms of complex voltages and power flows.
TP	Topology profile in CGMES, describing the relationship between topological nodes and terminals.
TPBD	Topology Boundary profile in CGMES.
TYNDP	Ten Year Network Development Plan.
URI	Uniform Resource Identifier, i.e., a string of characters used to identify or name a resource.
URL	Uniform Resource Locator, a specific type of URI, which is a reference to a web resource that specifies its location on a computer network and a mechanism for retrieving it.
URN	Uniform Resource Name, a specific type of URI, used to identify a resource by name in a particular namespace. A URN may be used to talk about a resource without implying its location or how to access it.
UUID	Universally Unique Identifier[2], specified as follows: 8 character hex number a dash “-“

[2] The algorithm is aligned with, and technically compatible with, IEC 9834-8:2004 Information Technology, "Procedures for the operation of OSI Registration Authorities: Generation and registration of Universally Unique Identifiers (UUIDs) and their use as ASN.1 Object Identifier components" ITU-T Rec. X.667, 2004.

Term	Definition
	4 character hex number a dash “-“ 4 character hex number a dash “-“ 4 character hex number a dash “-“ 12 character hex number where letters are lower case

3 ABBREVIATED TERMS

CGMES	Common Grid Model Exchange Standard
CIM	Common Information Model (electricity)
EIC	Energy Identification Codes
ENTSO-E	European Network of Transmission System Operators for Electricity
HVDC	High Voltage Direct Current
IEC	The International Electrotechnical Commission
MAS	Model Authority Set
mRID	CIM Master Resource Identifier
MTU	Market Time Unit
RCC	Regional Coordination Centre
RDF	Resource Description Framework
RDFS	RDF Schema
RefHour	Reference Hour
SHACL	Shapes Constraint Language
SO	System Operator
SOC	ENTSO-E System Operations Committee
SOGL	System Operations Guideline
TSO	Transmission System Operator
UCTE DEF	Union for the Coordination of the Transmission of Electricity Data Exchange Format
URI	Uniform Resource Identifier
UUID	Universally Unique Identifier
XML	Extensible Markup Language
XSD	XML Schema Definition

4 REFERENCES

4.1 GENERAL

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. Most of the listed standards or technical specifications are withdrawn by IEC (status is noted below) in the period 2020-2022 as updated versions are published by IEC. However, due to SOC decision they will be used for some time while transition to recent versions is organised in parallel.

- IEC 61968-100:2013 (withdrawn by IEC), Application integration at electric utilities – System interfaces for distribution management – Part 100: Implementation profiles
- IEC 61970-301:2016 RLV (withdrawn by IEC), Energy management system application program interface (EMS-API) - Part 301: Common information model (CIM) base
- IEC 61970-452:2017 (Edition 3.0, withdrawn by IEC), Energy management system application program interface (EMS-API) - Part 452: CIM static transmission network model profiles
- IEC 61970-453:2014 (Edition 2.0) and AMD1:2018 CSV, Energy management system application program interface (EMS-API) - Part 453: Diagram layout profile
- IEC 61970-501:2006 (Edition 1.0), Energy management system application program interface (EMS-API) - Part 501: Common Information Model Resource Description Framework (CIM RDF) schema
- IEC 61970-552: 2013 (Edition 1.0, withdrawn by IEC), Energy management system application program interface (EMS-API) - Part 552: CIMXML Model exchange format. The older ID formats according to section 6.4 is allowed.
- IEC TS 61970-600-1:2017 (withdrawn by IEC), Energy management system application program interface (EMS-API) - Part 600-1: Common Grid Model Exchange Specification (CGMES) - Structure and rule [3]
- IEC TS 61970-600-2:2017 (withdrawn by IEC), Energy management system application program interface (EMS-API) - Part 600-2: Common Grid Model Exchange Specification (CGMES) - Exchange profiles specification
- IEC 62325-451-1:2017, Framework for energy market communications – Part 451-1: Acknowledgement business process and contextual model for CIM European market
- IEC 62325-451-5:2015, Framework for energy market communications – Part 451-5: Status request business process and contextual model for CIM European market
- ISO 8601:2005, Data elements and interchange formats – Information interchange – Representation of dates and times
- Extensible Mark-up Language (XML) 1.0 (Fifth Edition), *W3C Recommendation 26 November 2008 (*https://www.w3.org/TR/2008/REC-xml-20081126/ *)*

[3] The QoCDC document provides additional normative rules not covered by the IEC TS 61970-600 specifications. In a few cases they supersede IEC TS 61970-600.

- Key words for use in RFCs to Indicate Requirement Levels, *Network Working Group Best Current Practice, Harvard University March 1997* (https://www.ietf.org/rfc/rfc2119.txt)
- QoCDC Reference Data document, the document is located in the Common Grid Model Building Process in ENTSO-E CGMES Library.

4.2 DOCUMENT HIERARCHY

The following document hierarchy is applicable:

1. CIM UML16v28 (related to IEC 61970 domain) and CIM UML 12v08 (related to IEC 61968 domain) are used as baseline for defining the data exchange.
2. CGMES 2.4.15 profiles available as a UML model in Enterprise Architect application. Refer also to Common Grid Model Building Process in ENTSO-E CGMES Library.
3. IEC TS 61970-600-1:2017 and IEC TS 61970-600-2 Ed1 (CGMES 2.4)[4] is a subset of the IEC canonical information model, adds some ENTSO-E extensions to the technical specification and specifies the profiles and their serialisation in CIM RDF XML in which the Individual grid models (IGMs) and Common Grid Models (CGMs) are exchanged.
4. EMF Requirements specification (current approved version 3.0) specifies the merging process from individual Grid Models (IGMs) to Common Grid Models (CGMs).
5. This document consolidates the identified necessary validation rules to ensure integration of all components featuring IGMs and CGMs that are fit for purpose. This document is used together with QoCDC Reference Data document.

[4] Note these specifications are withdrawn by IEC and they cannot be purchased in the IEC webstore.

5 GENERAL RULES

5.1 RULES AND CONSTRAINTS

In the current version of the document the terms rule and constraint are used interchangeably due to the need to link this version with the previous versions of the document. However, it is important to distinguish for the purpose of next versions and to bring clarity.

Both validation rules and constraints serve to maintain data integrity. Validation rules are typically applied to individual data entries to ensure their validity, while constraints are enforced by the database management system or data exchange standards to maintain overall data integrity within the data exchange. The rules and constraints can be divided by two main categories:

- **Standard**: rules and constraints that are specified in the data exchange standards, e.g. CGMES
- **Business specific**: rules and constraints that are specified for a business process or a group of business processes. These rules and constraints are defined to validate the quality of data for the purpose of the business process and can constraint the usage of the data exchange standard. However, a business specific rule or constraint shall not modify the data exchange standard. This is a prerequisite for ensuring interoperability using common data exchange standards. In case there is a need to modify data exchange specification, the conditions are specified either in the next version of the data exchange standard or in a business specific document (specification) that will both have direct impact on the applications that are used to produce or consume the data. Therefore, business specific validation rules and constraints in general aim at guiding the usage of the data exchange standard without requiring modification of applications that are used to produce or consume the data. Some of business specific rules or constraints can be considered as candidates to be included in the data exchange standard.

Due to the transitory character of this version of the QoCDC and usage of CGMES v2.4, this document does not fully conform to above mentioned principles as there are some rules that modify data exchange standards and require modification of applications that are used to produce or consume the data. However, modifications introduced in this version of the document try to minimize any modifications of the applications and prepare for the transition.

5.2 VALIDATION LEVELS

For an interrupt-free, automated exchange process (i.e., without human interference), several criteria need to be met. The criteria are specified at several levels where level 1 is the most basic and done first followed by the higher levels in order.

- Level 1 “Filenames”: covers meta data in file names and packaging of CIMXML files.
- Level 2 “Instance Data Syntax and Header”: covers the structure and syntax of the individual CIMXML files as well as the meta data header.
- Level 3 “Basic IGM/CGM Constraints”: covers constraints that can be evaluated within the scope of the CIMXML files.

- Level 4 “Model Assembly”: covers issues that can be detected during model assembly.
- Level 5 “Consistency of Assembled Models”: covers cross profile consistency of data.
- Level 6 “IGM and CGM Plausibility”: collects diagnostic information that may help solve convergence issues by identifying modelling issues that seem troublesome.
- Level 7 “Coordination”: focuses on coordination of IGMs in terms of neighbouring TSOs and reference values.
- Level 8 “Convergence and Plausibility”: focuses on convergence behaviour of IGMs and CGMs and on the plausibility of the CGM.

The steps in the automated process and where the validation levels appear in this process is shown in Figure 2.

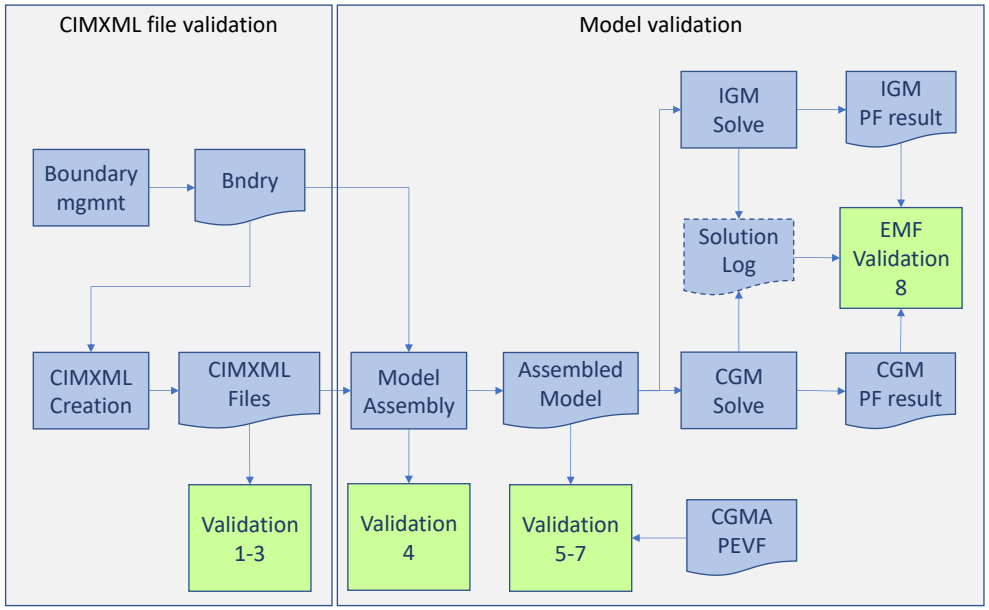

Figure 2 The Automated process annotated with validation levels

The symbols in Figure 2 have the following meaning:

- Blue box – data processing.
- Blue document – CIMXML file or another file.
- Green box – validation according to the levels 1 to 8.

The steps of the workflow are:

- Boundary management (Boundary mgmnt) where the boundary is created (Bndry). This is a manual process but has the potential to be automated. The process description is out of scope of this document.
- IGM or CGM creation where CIMXML files are created. This is a TSO or RCC/RSC internal process. This process description is out of scope of this document.
- Once CIMXML files have been created, they are automatically uploaded to OPDM (not shown in the figure Figure 2) where they are validated with levels 1 to 3 rules.

- CIMXML files are assembled per EffectiveDateTime into models. The assembly process is validated with level 4 rules.
- The assembled model is validated with level 5, 6 and 7 rules.
- The assembled model, IGM or CGM, is solved in power flow calculation for each EffectiveDateTime and the solution is validated with level 8 rules.

The rules at levels 1 to 6 shall block publication to OPDM if the severity is ERROR. The rules at levels 7 and 8 shall not block publication regardless of severity. This is managed by a configuration in the validation engine.

Constraints that have validation scope “DC IGM” are added as informative (i.e. for information on rule processing, however not blocking the publication of IGMs in case of errors).

The inclusion of rules or constraints related to the validation of DC IGM shall not trigger additional development of applications used by TSOs and RCCs. If enhancement of the applications is necessary, this shall be planned as part of the transition to CGMES v3.0 or higher version. The rules and constraints are only provided to be able to check any existing CGMES v2.4 implementations.

5.3 RULES’ CONSTANTS

Table 2 provides information on the constants used in the rules defined in this document.

Table 2 List of constants used in the rules

Constants used in the rules	Value	Unit with multiplier
NUMERIC_TOLERANCE	0.0005	Multiplication factor
SSH_SV_MAX_P_DIFF	10	MW
SSH_SV_MAX_Q_DIFF	50	Mvar
SSH_SV_TOT_P_DIFF	200	MW
SSH_SV_MAX_TAP_STEP_DIFF	2	Integer number
SSH_SV_MAX_Q_SHUNT_DIFF	1	Mvar
SV_INJECTION_LIMIT	0.1	MVA/MW/Mvar
SV_INJECTION_RELAXED_LIMIT	0.5	MVA/MW/Mvar
EQ_BRANCH_X_LIMIT	0.01	Ohm
EQ_RATEDS_REASONABILITY_FACTOR	10	Integer number
EQ_DB_REASONABILITY_FACTOR	2	Integer number
IO_NAME_LENGTH	32	Integer number
IO_DESCRIPTION_LENGTH	256	Integer number
EIC_LENGTH	16	Integer number
SHORT_NAME_LENGTH	12	Integer number
BOUNDARY_BV_MAX_DIFF	0.1	Multiplication factor
PATL_LIMIT_VALUE_DIFF	0.1	Multiplication factor
INTERCH_IMBALANCE_WARNING	50	MW
INTERCH_IMBALANCE_ERROR	200	MW

INTERCH_IMBALANCE_EMF	2	MW
NUMBER_OF_SUBSTATIONS	30	Integer number
REACTIVE_POWER_THRESHOLD	1500	Mvar
THRESHOLD_ACTIVE_P_IMBALANCE_DISTR	2	MW
ZERO_IMPEDANCE_THRESHOLD[5]	0.00001	PU

5.4 NUMBER PRECISION

Limited and possibly different precision in implementations of import/export tools as well as power flow solvers may result in small deviations of numeric values between IGMs. Hence it is advised to use a small tolerance in comparisons. The numeric tolerance is based on experience from empirical analysis of IGMs triggering the rules and is defined as a factor of NUMERIC_TOLERANCE, used in comparison of values as follows:

- In case of values greater than 1:
  - Abs(Value1 - Value2) < Abs(Value1)*NUMERIC_TOLERANCE or
  - Abs(Value1 - Value2) < Abs(Value2)*NUMERIC_TOLERANCE or
- In case of values less than or equal to 1:
  - Abs(Value1 - Value2) < NUMERIC_TOLERANCE

where the Value1 and Value2 are the values that are compared.

This approach is used in all rules that require comparisons of numbers.

See also FBOD5 from IEC TS 61970-600-1:2017.

In addition, the implementations of the constraints have to respect the following rule which is part of IEC 61970-600-2:2021

- R:600:ALL:NA:float

  An attribute that is defined as float (e.g. has a type Float or a type which is a Datatype with .value attribute of type Float) shall support ISO/IEC 60559:2020 for floating-point arithmetic using single precision floating point. A single precision float supports 7 significant digits where the significant digits are described as an integer, or a decimal number with 6 decimal digits. Two float values are equal when the significant with 7 digits are identical, e.g. 1234567 is equal 1.234567E6 and so are 1.2345678 and 1.234567E0.

5.5 VALIDATION HANDLING AND REPORTING OF VALIDATION RESULTS

The following general rules are defined:

1) Validation engines shall always use the latest version of the QoCDC Reference Data document.
2) Many rules are checking basic and fundamental requirements. Nonconformity with those rules would change the overall validation result and how it is presented to the users. In order

[5] The value will be adjusted depending on the analysis on the IGMs and CGMs during the implementation of the QoCDC.

to prevent that different implementations are providing completely different validations results and also to be able to facilitate the comparison of these results, it is recommended that users are given a possibility to select the outcome of the validation if the following rules are triggered. Either the validation is aborted, or the validation process continues, if possible, knowing there will be many errors/warnings reported due to side effect. It shall be possible to trace back the error detected by the validating processor, specifying the file name, error detected and line number in the file.

- FileNameMD,
- FileNameConsistency,
- IDuniqueness,
- DanglingReferences,
- XMLStructure.

3) Validation engines shall report validation results in a user-friendly manner following the descriptions and messages defined for each rule. Some of the descriptions and messages of the rules contain references to constants defined in this document. It is required that when the errors/warnings are reported to users the references to these constants are replated with their numerical value and unit. For instance, if the message contains "… is not >= EQ_BRANCH_X_LIMIT for a two-winding transformer … " the validation engine shall report to the user "… is not >= 0.01 Ohm for a two-winding transformer … "
4) In cases where messages provided by a validation engine shall be further processed in a reporting system, the reporting system shall either use reported numbers with the same number of decimals or apply arithmetical rounding, if necessary.
5) When comparing values with PEVF and CGMA it should be taken into account that:
    - There is no sign convention in PEVF and CGMES as all values are positive and there are different properties for "in domain" and "out domain", which provide flow direction.
    - Net Position means the netted sum of electricity exports and imports for each market time unit for a scheduling zone.
    - If "in domain" is the TSO and "out domain" is the synchronous area, it means an import to the TSO area
    - If "in domain" is the synchronous area and "out domain" is the TSO, it means an export from the TSO area
    - For QAR report and QAS portal, the import is represented by a negative value and the export by a positive value.
6) When reporting violations related to current limits in QAS, values are rounded using standard rounding to integer.
7) Validation engines shall consider that:
    - In many cases an IGM has multiple cim:TopologicalIsland objects. In the cases where an IGM contains multiple cim:TopologicalIsland objects, the island that contains the highest number of associated cim:TopologicalNode objects shall be referred to as main island. While the validation rules related to load-flow plausibility and convergency status are executed for all islands in an IGM, the status of the main island, "converged" or "diverged", shall define the overall status of an IGM.
    - The CGM is pan-European, therefore containing multiple synchronous areas and potentially, in case of partial merge, not all IGMs of the synchronous area. Therefore,

one more level of grouping is necessary for a CGM. The main island in CGM shall be defined as the cim:TopologicalIsland containing the highest number of IGMs. The number of IGMs in a cim:TopologicalIsland is calculated using the associated cim:TopologicalNode objects affiliated to each IGM part of a cim:TopologicalIsland. The status shall be reported by synchronous area.

8) In case a rule is using an optional attribute (having numerical values), which is not provided in the instance data (IGM, CGM) and depending on the rule logic, the rule is not checked.
9) In case a rule requires comparison of data with Reference data of type string, the comparison of the string shall not be case sensitive.
10) An attribute defined as xsd:float can be constrained to integer in given cases. This means that the value can include leading zero, but no decimal value or can fully conform to xsd:integer. Example of valid values are: "1", "001", "1.0", "1.000000" (as positive or negative value). Example of invalid value are: "1.", "1.1", "1.000000001".
11) Validation engines shall inform which of the rules/constraints are implemented. Different validation engines can cover parts of the rules due to integration or other limitations. For instance, ENTSO-E Rule Set Library/SUV information is provided in the user's guide.
12) Difference datasets of EQ profile (EQDIFF) are not validated separately. Validation shall be performed after EQ and EQDIFF datasets are merged, i.e. after the changes are applied to EQ.
13) CGMES validation (syntax, consistency between EQ and TP boundary datasets) of boundary set shall be performed prior the publication of new official boundary in OPDE by the entity that is preparing the boundary set for publication.
14) Validation engines shall have configuration setting if rules/constraints that apply to DC IGM validation scope are blocking IGM submission or not even for rules with severity Error.

5.6 MODIFICATIONS IN CGMES 2.4 INTRODUCED BY QOCDC

This section summarizes main changes applied to CGMES v2.4.15 in order to fix issues and align with the QoCDC constraints.

- The multiplicity of the association end Terminal.RegulatingControl is changed from 0..1 to 0..*
- In Topology profile, the inheritance from IdentifiedObject was removed for cim:ACDCTerminal and cim:DCNode
- In StateVariables profile IdentifiedObject.description is added as optional to the profile and used in TopologicalIsland to convey information on the convergence of the topological island, as a temporary solution, not mandatory to be implemented as severity of the rule TIConvergenceStatMissing in Level 8 is a WARNING.

5.7 GROSS VS NET PRODUCTION VALUES

The business process capacity allocation and congestion forecast use net production values, not gross values. Hence all production values shall be considered being net values. This also means that any instances of the GrossToNetActivePowerCurves class in an IGM shall not be present.

5.8 INTEGRATION OF VALIDATORS

Validation can be done by off-line validators that run as an executable program or script on a single file or a set of files in a folder and produce output in human readable form, and/or by client-server processes, such as designated quality portals that use “request” and “reply” messages in accordance with IEC 61968-100. The rule templates describing errors or warnings in this document are examples how tools may report errors and warnings. The XML templates are expected to be filled with the missing data when errors or warnings are reported.

5.9 FILE NAME AND FILE HEADER

According to IEC TS 61970-600-1:2017 (CGMES v2.4), rule FILX2, “There is no naming convention applied to the .xml or .zip file names. Although different business processes may define such a file naming convention, the applications shall rely solely on the information provided in the file headers in order to process the instance files.”

SOC decided (meeting on 5 November 2015) that business processes related to the operational planning shall use a file naming convention. This section defines such name convention which is applied for IGMs and CGMs exchanged using CGMES. The file names are primarily used for human consumption but are also used for validating file header content and for the storing of meta data in the OPDM. This meta data is used in OPDM for filtering and manually collecting data via the OPDM user interface. Once the business process transitions to exchange metadata in a structured way the file names will be considered only for human consumption and applications will not use file names for the purpose of metadata extraction.

As the file names contain information about file type, effective dates and version which is also specified in the file headers, this data needs to be consistent. This is validated in level 2. For details on metadata, please refer to section 8 of the CGM Implementation guide v2.0. Metadata in the file header FullModel element is described below:

- Modeling Authority (i.e. the name of the TSO or RCC) is included in the md:Model.modelingAuthoritySet attribute. If a Modeling Authority has more than one network region a region specifier is included in the md:Model.modelingAuthoritySet attribute.
- The md:Model.description attribute contains several metadata items, refer to level 2 rule ModelDescription.
- HVDC boundary TopologicalNode objects have “HVDC” as the first characters in the cim:IdentifiedObject.description.

Several metadata are embedded as enumerations in the rules. This reference data is defined in the document QoCDC Reference Data. Therefore, when reference data is modified the QoCDC Reference Data document will be updated accordingly.

The CIMXML file name convention specifies the meta data parts of the file name, separated by an underscore (‘_’) and applies to files with xml and zip file extensions.

Rule FILX1 in IEC TS 61970-600-1:2017 specifies that “a given exchange consists of multiple files. The CGMES defines that all files in a given logical exchange must be zipped together. The tools use

zip files directly when importing and exporting, but some business process may require the files to be exchanged in individual zip files". This is the case for the CGM Build process.

The following mask is to be used to have a valid file name for IGM and CGM files:

<effectiveDateTime>_<businessProcess>_<sourcingActor>_<modelPart>_<fileVersion>

The following rules apply for IGM and CGM file names with this mask:

- The parts in the file name are not allowed to contain underscores "_" or dashes "-". The dashes are reserved for sub parts within the sourcingActor.
- All four underscores shall be present.
- If a file name part is not used it shall be left empty resulting in two consecutive underscores "__".
- For <modelPart> SSH, TP and SV all five parts in the mask shall be present.
- For <modelPart> EQ and EQDIFF the <businessProcess> may be absent meaning that the CIMXML file can be used with any business process. In this case the mask to use is
  - <effectiveDateTime>__<sourcingActor>_<modelPart>_<fileVersion>
- The <sourcingActor> field has three different layouts:
  1. <sourcingTSO> which is always used by a TSO
  2. <sourcingRSC>-<cgmRegion> which is used by RSC for a synchronous area file, e.g., a SV file
  3. <sourcingRSC>-<cgmRegion>-<sourcingTSO> which is used by RSC for an updated TSO area file, e.g., a SSH file. The sourcingTSO relates to the IGM that has been used to create the CGM.

  The mapping of <sourcingTSO>, <sourcingRSC> and <cgmRegion> to the reference data is provided in the QoCDC Reference Data document in the tab "QoCDC Mapping".

  Examples:
  - 20180118T0930Z_1D_APG_SSH_001.xml
  - 20180117T2230Z_1D_APG_EQ_001.xml
  - 20180117T2230Z__APG_EQ_001.xml
  - 20180118T1130Z_1D_TSCNET-EU_SV_001.xml
  - 20180118T1130Z_1D_TSCNET-EU-APG_SSH_001.xml

The following mask is allowed for boundary files:

<effectiveDateTime>__<sourcingActor>_<modelPart>_<fileVersion>

The following rules apply for the boundary set file names mask:

- sourcingActor shall be ENTSOE.
- None of the parts in the file name are allowed to contain an underscore "_" or dash "-".
- All four file name parts shall be present.

- The number of underscores in a file name is always four.

Examples:

- 20180226T0000Z__ENTSOE_EQBD_101.xml

The effectiveDateTime is the same as the md:Model.scenarioTime in the md:FullModel header.

Each SSH, TP and SV CIMXML file are valid for specific effectiveDateTime. The effectiveDateTime is defined based on the CGMM-v3[6], for example in case of day-ahead process in Article 4(2) as "…each TSO shall build a day-ahead IGM for each market time unit of the day of delivery. The mid-point of each market time unit shall be used as the reference timestamp." So, for day-ahead IGM, the SSH, TP and SV CIMXML file is valid for a market time unit of one hour, and the reference timestamp is mid-point of an hour (HH:30, HH indicating an hour in UTC notation) represented by effectiveDateTime as YYYYMMDDT**HH30**Z.

EQ, EQDIFF, EQBD and TPBD CIMXML files do not require every hour creation and are valid starting from provided effectiveDateTime until the new EQ or EQDIFF with one of the succeeding effectiveDateTime is provided.

EQ and EQDIFF CIMXML files are to maintain the same reference timestamp being mid-point of market time unit meaning mid-point of an hour, effectiveDateTime being YYYYMMDDT**HH30**Z.

EQBD and TPBD CIMXML files are created with YYYYMMDDT**0000**Z effectiveDateTime, for both of the CIMXML files as well as the zipped package of those two.

The fileVersion is exactly three characters long positive integer number between 000 and 999, i.e., the first positive integer is 001 and the last 999.

The allowed values for "ModelingAuthority" and "ModelingAuthority URI" are defined in the QoCDC Reference Data document. The tab "QoCDC Mapping" provides the mapping between the reference data and QoCDC notations.

TSO network regions are combined into larger networks called synchronous areas described in the QoCDC Reference Data document. CGMRegions consists of GeographicalRegions or SubGeographicalRegions. For instance, Energinet has one GeographicalRegion and two SubGeographicalRegions (DKW and DKE) in different CGMRegions. Hence DKW and DKE SubGeographicalRegions are included in the QoCDC Reference Data document. If a TSO has HVDC links, they are treated as their own SubGeographicalRegions that are also included in the QoCDC Reference Data document.

The file name templates have proved to create non-unique file names and have been frequently revised due to this. The templates also require reserved characters, underscore (_) and dash (-) to guide parsing the meta data from the file name string. Hence these characters are not allowed in the metadata fields. As the file name templates are not future proof it is advised not to use them in other business processes than covered by this document.

[6] https://docstore.entsoe.eu/Documents/Network%20codes%20documents/Implementation/cacm/cgmm/CGMM-v3.pdf

5.9.1 DATASETS FOR INTRADAY PROCESS

At least 24 daily data sets shall be provided corresponding to the time frames from 0:30 to 23:30 CE(S)T. Each TSO shall provide its complete IGM data set according to last agreed exchange programs on the OPDE at least one hour:

- (Minimum Requirement) before each reference time (0:00h, 8:00h and 16:00h CE(S)T), and with at least the next 8 coming hours.

  Intraday files created for reference time:

  - 0:00h CE(S)T should be built with the market data available at the PEVF of 22:30h CE(S)T of the day before the energy delivery day
  - 8:00h CE(S)T should be built with the market data available at the PEVF of 06:30h CE(S)T of the energy delivery day.
  - 16:00h CE(S)T should be built with the market data available at the PEVF of 14:30h CE(S)T of the energy delivery day.

- (Final target) before each business time with a rolling forecast from DACF to IDCF with an hourly update (without merging DACF and IDCF processes) and with all the remaining hours of the business day. The provision of IGMs can start with 29 hours ahead (30 in case of autumn daylight saving) for all 24 data sets, up to 01 hour ahead for one data set.

  Intraday files created for IGM delivery window from (hh-1):00h ending at hh:00h CE(S)T should be built with the market data available at the Pan-European Verification Platform (PEVF) of hh-0:30 CE(S)T.

To manage the intraday process, all LFC Blocks of the synchronous areas provide the intraday exchange programs after every intraday market gate, for a given market time unit (MTU). Allowed MTUs are 1/4h, 1/2h, 1h. Starting from 18:30h CE(S)T of the day before the intraday process up to 23:30h CE(S)T of the day of the intraday process, publication of preliminary reference program by PEVF is provided to the OPDE, on the hourly basis at the moment.

For intraday, the value for <businessProcess> is a two-character string indicating the *hour-ahead* defined as *the difference between the scenario time and the gate closure time*. Allowed values are 29 hours ahead (30 in case of autumn daylight saving) to 01 hour ahead.

Example of filenames in the case of data provision for the minimum requirement scope and three referenced time is provided in Table 3.

Table 3 Example of intraday filename convention for minimum requirement IGMs provision

Reference time CET	**IGM delivery window**	**File name** Scenario time in UTC Example naming provided during CET (UTC+1)	**PEVF: date, version, delivery**
0:00h	22:00-23:00h CET on 31.12.2021. Day before the ID process	20211231T2330Z_01_APG_SV_001.xml	20220101 v005 delivered at 22:30h CET on 31.12.2021. for intraday (A18) process
		20220101T0030Z_02_APG_SV_001.xml	
		20220101T0130Z_03_APG_SV_001.xml	
		20220101T0230Z_04_APG_SV_001.xml	
		20220101T0330Z_05_APG_SV_001.xml	
		20220101T0430Z_06_APG_SV_001.xml	

		20220101T0530Z_07_APG_SV_001.xml	
		20220101T0630Z_08_APG_SV_001.xml	
8:00h	06:00-7:00h CET on 01.01.2022. Day of the ID process	20220101T0730Z_01_APG_SV_001.xml	20220101 v014 delivered at 06:30h CET on 01.01.2022. for intraday (A18) process
		20220101T0830Z_02_APG_SV_001.xml	
		20220101T0930Z_03_APG_SV_001.xml	
		20220101T1030Z_04_APG_SV_001.xml	
		20220101T1130Z_05_APG_SV_001.xml	
		20220101T1230Z_06_APG_SV_001.xml	
		20220101T1330Z_07_APG_SV_001.xml	
		20220101T1430Z_08_APG_SV_001.xml	
16:00h	14:00-15:00h CET on 01.01.2022. Day of the ID process	20220101T1530Z_01_APG_SV_001.xml	20220101 v021 delivered at 14:30h CET on 01.01.2022. for intraday (A18) process
		20220101T1630Z_02_APG_SV_001.xml	
		20220101T1730Z_03_APG_SV_001.xml	
		20220101T1830Z_04_APG_SV_001.xml	
		20220101T1930Z_05_APG_SV_001.xml	
		20220101T2030Z_06_APG_SV_001.xml	
		20220101T2130Z_07_APG_SV_001.xml	
		20220101T2230Z_08_APG_SV_001.xml	

Example of filenames in the case of data provision in full scope, after day-ahead market closure and intraday market opening, 29 hours ahead, full data sets until end of intraday process, is provided in Table 4.

Table 4 Example of intraday filename convention for full scope IGMs provision rolling process, example naming provided during CET (UTC+1)

29 hours-ahead, 24 datasets delivery	...	24 hours-ahead, 24 datasets delivery	...	12 hours-ahead, 12 datasets delivery	...	01 hour-ahead, 2 datasets delivery
IGM delivery window: 17:00-18:00 CET PEVF: day-ahead (A01), v001, delivered at 16:30 CET on 31.12.2021.		IGM delivery window: 22:00-23:00 CET PEVF: intraday (A18), v005, Delivered at 22:30 CET on 31.12.2021.		IGM delivery window: 10:00-11:00 CET PEVF: intraday (A18), v017, Delivered at 10:30 CET on 01.01.2022.		IGM delivery window: 21:00-22:00 CET on 01.01.2022. PEVF: intraday (A18), v028, Delivered at 21:30 CET on 01.01.2022.
20211231T2330Z_06_APG_SV_000.xml		20211231T2330Z_01_APG_SV_000.xml				
20220101T0030Z_07_APG_SV_000.xml		20220101T0030Z_02_APG_SV_000.xml				
20220101T0130Z_08_APG_SV_000.xml		20220101T0130Z_03_APG_SV_000.xml				
20220101T0230Z_09_APG_SV_000.xml		20220101T0230Z_04_APG_SV_000.xml				
20220101T0330Z_10_APG_SV_000.xml		20220101T0330Z_05_APG_SV_000.xml				
20220101T0430Z_11_APG_SV_000.xml		20220101T0430Z_06_APG_SV_000.xml				
20220101T0530Z_12_APG_SV_000.xml		20220101T0530Z_07_APG_SV_000.xml				
20220101T0630Z_13_APG_SV_000.xml		20220101T0630Z_08_APG_SV_000.xml				
20220101T0730Z_14_APG_SV_000.xml		20220101T0730Z_09_APG_SV_000.xml				
20220101T0830Z_15_APG_SV_000.xml		20220101T0830Z_10_APG_SV_000.xml				
20220101T0930Z_16_APG_SV_000.xml		20220101T0930Z_11_APG_SV_000.xml				
20220101T1030Z_17_APG_SV_000.xml		20220101T1030Z_12_APG_SV_000.xml				
20220101T1130Z_18_APG_SV_000.xml		20220101T1130Z_13_APG_SV_000.xml		20220101T1130Z_01_APG_SV_000.xml		
20220101T1230Z_19_APG_SV_000.xml		20220101T1230Z_14_APG_SV_000.xml		20220101T1230Z_02_APG_SV_000.xml		
20220101T1330Z_20_APG_SV_000.xml		20220101T1330Z_15_APG_SV_000.xml		20220101T1330Z_03_APG_SV_000.xml		
20220101T1430Z_21_APG_SV_000.xml		20220101T1430Z_16_APG_SV_000.xml		20220101T1430Z_04_APG_SV_000.xml		
20220101T1530Z_22_APG_SV_000.xml		20220101T1530Z_17_APG_SV_000.xml		20220101T1530Z_05_APG_SV_000.xml		
20220101T1630Z_23_APG_SV_000.xml		20220101T1630Z_18_APG_SV_000.xml		20220101T1630Z_06_APG_SV_000.xml		
20220101T1730Z_24_APG_SV_000.xml		20220101T1730Z_19_APG_SV_000.xml		20220101T1730Z_07_APG_SV_000.xml		

20220101T1830Z_25_APG_SV_000.xml	20220101T1830Z_20_APG_SV_000.xml	20220101T1830Z_08_APG_SV_000.xml	
20220101T1930Z_26_APG_SV_000.xml	20220101T1930Z_21_APG_SV_000.xml	20220101T1930Z_09_APG_SV_000.xml	
20220101T2030Z_27_APG_SV_000.xml	20220101T2030Z_22_APG_SV_000.xml	20220101T2030Z_10_APG_SV_000.xml	
20220101T2130Z_28_APG_SV_000.xml	20220101T2130Z_23_APG_SV_000.xml	20220101T2130Z_11_APG_SV_000.xml	
20220101T2230Z_29_APG_SV_000.xml	20220101T2230Z_24_APG_SV_000.xml	20220101T2230Z_12_APG_SV_000.xml	20220101T2230Z_01_APG_SV_000.xml

The consequence of the IGMs delivery according to Minimum Requirement is the re-validation of the already delivered IGMs in the QAS with the rolling delivery of PEVF files for the hours between the three referenced times. This does not impact the usability of the IGM in the CGM creation process as IGMs with matching PEVF files are being used for CGM build.

5.9.2 MD:MODEL.DESCRIPTION

The attribute md:Model.description in the header is declared as a string which means it shall be serialised as a valid string.

The content of md:Model.description and its sub-elements is defined as follows:

- there is no specific namespace for the elements of the structure;
- MDE field is required;
- BP field is required. It is indicating the business process from level 1 rule BusinessProcess;
- TOOL field is required. It is indicating tool name and version number;
- RSC field is optional for IGM and required for SV and SSH that are created and serialised by a RSC;
- TXT field is optional free text.

Based on this requirement the following XML structure is obtained:

<MDE>

<BP>1D</BP>

<TOOL>PowerFactory 2021</TOOL>

<RSC>N/A</RSC>

<TXT>QoCDC v3.2 test configuration</TXT>

</MDE>

As the XML structure shall be serialized as string representing an escaped character xml structure, the content of md:Model.description for the above structure shall be:

<md:Model.description><MDE><BP>1D</BP><TOOL>PowerFactory 2021</TOOL><RSC>N/A</RSC><TXT>QoCDC v3.2 test configuration</TXT></MDE> </md:Model.description>

5.10 IGM SSH DATASET AND UPDATED IGM SSH DATASET

During the CGM Build Process the IGM SSH dataset is being updated by the merging function and an updated IGM SSH dataset is exported as part of the CGM submitted for publication. EMF Requirements document already specifies the general conditions that needs to be followed by the

merging function. The rule IgmSSHvsCgmSSH is detailed by this section which is necessary for the purpose of defining the validation scope of the rule. Table 5 provides a list of attributes that can be modified or not.

Table 5 Attributes that can change or cannot change in the updated IGM SSH dataset

Class	Attributes that can change or cannot change in the updated IGM SSH dataset provided in a CGM
cim:EquivalentInjection	.p – can change, • if connected to boundary point or is internal cim:EquivalentInjection and • if regulating control is enabled (both cim:EquivalentInjection.regulationCapability and cim:EquivalentInjection.regulationStatus equal to true) and the cim:EquivalentInjection is in a cim:TopologicalIsland without cim:TieFlows .q – can change, if connected to boundary point or is internal cim:EquivalentInjection with control defined and regulation status true .regulationTarget: - can change, if connected to a paired AC boundary point - cannot change, if connected to an unpaired boundary point .regulationStatus: - can change, if connected to a paired AC boundary point - cannot change, if connected to an unpaired boundary point
cim:ShuntCompensator	.sections – can change, if control is enabled (both cim:RegulatingCondEq.controlEnabled and cim:RegulatingControl.enabled equal to true)
cim:TapChanger	.step – can change, if: - .ltcFlag true, and - cim:Terminal fnonreferenced by cim:RegulatingControl.terminal of cim:TapChangerControl is connected and in the same topological island as cim:PowerTransformer, and - control is enabled (both cim:TapChanger.controlEnabled and cim:RegulatingControl.enabled equal to true)
cim:ConformLoad	cim:EnergyConsumer.p – can change cim:EnergyConsumer.q – can change
cim:NonConformLoad	Cannot change
cim:EnergySource	Cannot change

cim:Switch and its subclasses	.open – can change, if terminal of a switch is connected to a boundary point
cim:StaticVarCompensator	.q – can change, if control is enabled (both cim:RegulatingCondEq.controlEnabled and cim:RegulatingControl.enabled equal to true)
cim:ControlArea	.pTolerence – cannot change .netInterchange – can change
cim:RotatingMachine	.p – can change, if: - OperatingMode.generator, and - Pmin<=Pgen<=Pmax, Pgen = - cim:RotatingMachine.p from IGM SSH - .p is changed to 0 for OperatingMode.condenser, and .q – can change, if: - Pmin<=Pgen<=Pmax, Pgen = - cim:RotatingMachine.p from IGM SSH, and - regulating control is enabled (both cim:RegulatingCondEq.controlEnabled and cim:RegulatingControl.enabled equal to true) If ReactiveCapabilityCurve is present, Pmin and Pmax are derived from the curve which takes precedence. Section 6.6 provides guidance on operational limits. Otherwise GeneratingUnit.minOperatingP and GeneratingUnit.maxOperatingP are used.
cim:Terminal	ACDCTerminal.connected – can change, if cim:Terminal of a cim:ACLineSegment, cim:PowerTransformer, cim:EquivalentInjection is connected to a boundary point
cim:GeneratingUnit	.normalPF – cannot change
cim:ExternalNetworkInjection	.p – can change, if regulating control is enabled (both cim:RegulatingCondEq.controlEnabled and cim:RegulatingControl.enabled equal to true) and the cim:ExternalNetworkInjection is in a cim:TopologicalIsland without cim:TieFlows .q – can change, if regulating control is enabled (both cim:RegulatingCondEq.controlEnabled and cim:RegulatingControl.enabled equal to true) .referencePriority – cannot change
cim:SynchronousMachine	.operatingMode – cannot change .referencePriority – cannot change
cim:AsynchronousMachine	.asynchronousMachineType – cannot change
cim:RegulatingControl	.enabled: - cannot change .discrete – cannot change .targetValue – cannot change .targetDeadband – cannot change .targetValueUnitMultiplier – cannot change
cim:RegulatingCondEq.controlEnabled	Cannot change

5.11 PARTICIPATINGGENERATINGUNIT AND SMOPERATINGMODEPCONSISTENCY

Note: Slack distribution on generators, irrelevant of the type of the distribution (normalPF, proportional to Pmax, Pgen, reserve margin...) will only use cim:SynchronousMachine(s) with:

- regulating control is enabled (both cim:RegulatingCondEq.controlEnabled and cim:RegulatingControl.enabled equal to true)
- cim:SynchronousMachine.operatingMode in SSH equal to http://iec.ch/TC57/2013/CIM-schema-cim16#SynchronousMachineOperatingMode.generator
- Pmin ≤ Pgen < Pmax (considering RCC)
- Pgen ≥ 0 (if Pmin< 0 and slack distribution would lead Pgen to become negative, OLF will not allow the sign change)

while in LF settings respecting active and reactive power limits.

6 GENERAL GUIDELINES

6.1 CIMXML SYNTAX

CGMES data is exchanged as CIM RDF[7] XML[8] files. The Resource Description Framework uses an XML based syntax, allowing relationships to be defined between XML nodes. The first level of syntax validation is to check if the document is well formed in accordance with the XML rules[9].

RDF syntax provides many ways to represent the same set of data. For example, an association between two resources can be written with a resource attribute or by nesting one element within another. This could make it difficult to use some XML tools, such as XSLT processors, with the CIMXML document.

Therefore, only a subset of the RDF Syntax is to be applied in creating CIMXML documents. This syntax simplifies the work of implementers to construct model serialization and deserialization software, as well as to improve the effectiveness of general XML tools when used with CIMXML documents. The reduced syntax is a proper subset of the standard RDF syntax; thus, it can be read by available RDF de-serialization software.

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[7] Resource Description Framework, i.e. a language recommended by the W3C for expressing meta data that machines can process easily

[8] eXtensible Markup Language, i.e. a subset of the Standard Generalized Markup Language (SGML), ISO 8879, for putting structured data in a text file

[9] The full set is specified in the W3C Recommendation, “Extensible Markup Language: Prolog and Document Type Declaration” Version 1.0, 26 November 2008, available at http://www.w3.org/TR/REC-xml/#sec-prolog-dtd

The simplified syntax is for exchanging power system models between utilities. The aim of the IEC 61970-552:2013 (Edition 1.0) specification is to make it easier for implementers to construct de-serialization software for RDF data, to simplify their choices when serializing RDF data, and to improve the effectiveness of general XML tools such as XSLT processors when used with the serialized RDF data.

The reduced syntax does not sacrifice any of the power of the RDF data model. That is, any RDF data can be exchanged using this syntax. Moreover, features of RDF such as the ability to extend a model defined in one document with statements in second document are preserved.

Errors in XML documents will stop XML applications. The W3C XML specification states that a program should stop processing an XML document if it finds an error. The reason is that XML software should be small, fast, and compatible. HTML browsers are allowed to display HTML documents with errors (like missing end tags). With XML, errors are not allowed.

The CGMES files shall have an XML prolog that declares the version of the XML and in which the encoding is set to UTF-8 (acc. to CENC10 in IEC TS 61970-600-1:2017). Missing encoding is considered an erroneous file.

6.2 RDF SCHEMA

RDF Scheme (RDFS) files, generated from the Enterprise Architect project file, describe the CGMES profiles in a machine-readable way. The RDFS contains classes, attributes and roles with cardinalities using an extended RDFS notation described in IEC 61970-501 Ed1.

The RDFS files can be downloaded from the https://www.entsoe.eu/data/cim/cim-for-grid-models-exchange/. The RDF supports extensibility, meaning that classes attributes or roles not used in the CGMES profiles still can be exchanged in CIMXML files. Hence it is allowed for a creator of a CIMXML file to include any information not in the CGMES profiles. However, a receiver of such a CIMXML file will only process the information described by the CGMES profiles defined for the exchange. Hence a creator of a CIMXML with additional information cannot expect a receiver to process the data not described in the CGMES profiles.https://www.entsoe.eu/data/cim/cim-for-grid-models-exchange/. The RDF supports extensibility, meaning that classes attributes or roles not used in the CGMES profiles still can be exchanged in CIMXML files. Hence it is allowed for a creator of a CIMXML file to include any information not in the CGMES profiles. However, a receiver of such a CIMXML file will only process the information described by the CGMES profiles defined for the exchange. Hence a creator of a CIMXML with additional information cannot expect a receiver to process the data not described in the CGMES profiles.

Any tool implementing the CGMES shall check CIMXML data and verify that:

- Class, attribute and role names appearing in a file is defined by the profile.
- CGMES constraints are respected.

The rules “NotMandatoryClass” or “NotMandatoryProperty” are used to warn about classes, attributes and roles not described by CGMES profiles.

With the class cardinality it is possible to describe if instances of a particular class are required but this feature has not been used. Instead, rules have been created specifying the number of required

instances. In UML it is possible to specify this as the cardinality on a class, but this capability has not been used for CGMES.

For the attributes and roles, the cardinality value specifies how many times an attribute value or role reference shall appear in a CIMXML file. The rule “IncorrectAttributeOrRoleCard” reports violated cardinality.

6.3 Naming Related Attributes’ Constraints

CGMES specifies (for CGMES v2.4: IEC TS 61970-600-1:2017, Annex B; for CGMES v3.0 – specific constraints) the maximum length of naming attributes for IdentifiedObject objects exchanged in different datasets and for ConnectivityNode objects and TopologicalNode objects exchanged in the Boundary datasets.

6.4 Containment Rules

Equipment containers represent ways of organizing and naming equipment typically found within a substation. There is some flexibility on which containers are used in a specific application of the CIM in order to accommodate different international practices as well as differences typically found between transmission and distribution substations. Cim:Bay, cim:VoltageLevel, cim:Substation, cim:Line, cim:DCLine and cim:DCConverterUnit are all types of cim:EquipmentContainer. In general, a cim:Bay is contained within a specific cim:VoltageLevel, which in turn is contained within a cim:Substation. Cim:Substation objects and cim:Line objects may be contained within a cim:SubGeographicalRegion and as a consequence within a cim:GeographicalRegion.

One containment hierarchy is used with the cim:IdentifiedObject class to create hierarchical naming intended for human consumption. This hierarchy is specifically used to name equipment according to its function in the power system. This is called the functional naming hierarchy. Containment is defined in Equipment datasets and in Equipment Boundary datasets.

6.5 Model Assembly

Model assembly refers to the process of fulfilling the dependencies as specified in the file headers of instance files, starting with the official ENTSO-E EquipmentBoundary and TopologyBoundary instances, followed by the EQ, SSH, TP and SV instances of a Modelling Authority or multiple Modelling Authorities. Note that the metadata md:Model.DependentOn statements describe which instance models were used when the IGM was assembled, but the official ENTSO-E boundary files[10] are always to be used for the validation and merging process, instead of any other referenced boundary set.

In model instances, rdf:ID values always refer to unique objects within in that particular model instance file, whereas rdf:about values refer to objects that are unique in the namespace. As descriptive information is provided in multiple, associated files or model parts, it needs to be checked if all the mandatory data is complete for all identified objects.

[10] The official boundary set can be recognized via the description field in the header. The most recent version is to be used at all times (highest version number)

In model instances, rdf:resource attributes always refer to objects that have been defined via a rdf:ID or rdf:about previously in the same model instance or any other model instance that is part of the assembly. It is intended to define an association to this object, acting as a pointer.

A dangling reference is just like a broken link on the web. In a model assembly it is a reference to an identified object that should have a description in the assembly and, simply, does not.

6.6 Synchronous Machine Operational Limits

Limit values for a synchronous machine are provided by reactive capability curves that define the limits at a specific operating voltage. Note that CGMES v2.4 only allows for one reactive capability curve to cover all operating voltages. Figure 3 shows an example of a reactive capability curve for a synchronous machine with the same capability in motor operating mode as in generator operating mode. The active power limits in generator operating mode are positive and in motor operating mode - negative.

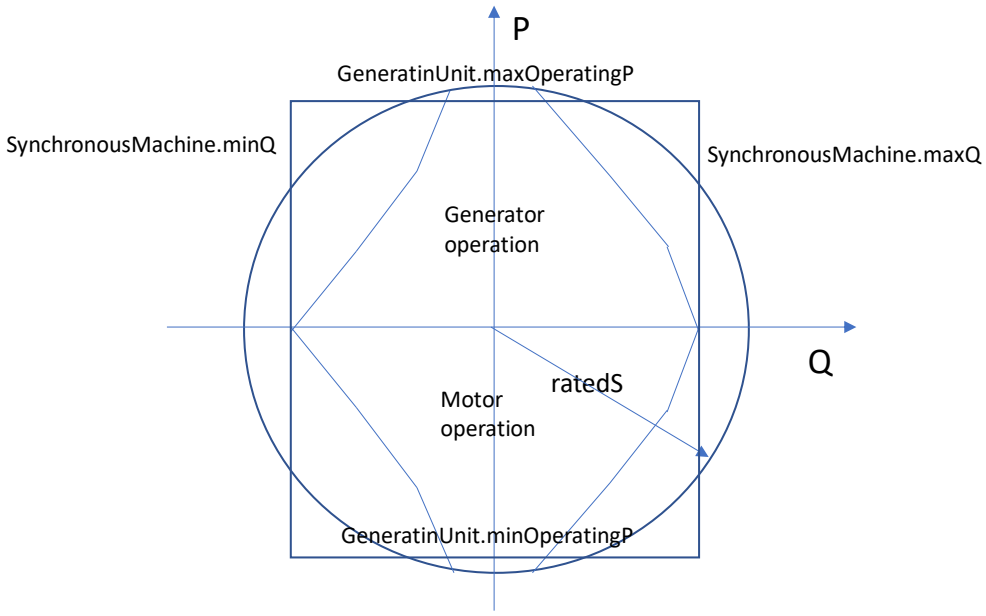

Figure 3 Example Reactive Capability Curve

A reactive capability curve has both active and reactive power limits.

In case the limits are not provided by a reactive capability curve, constant limit values are available as follows and are shown as a box in Figure 3:

- maxOperatingP and minOperatingP at the cim:GeneratingUnit class;
- maxQ and minQ at the cim:SynchronousMachine. Note that maxQ and minQ are optional attributes which are required if there is no cim:ReactiveCapabilityCurve associated with the machine.

A synchronous machine could be operated as condenser, generator, motor (typically a pump in power systems) or a mix of them. The attribute cim:SynchronousMachine.type defines the supported

mix of usages and the attribute cim:SynchronousMachine.operatingMode defines the operating mode used at the operating state represented by SSH. This results in a complex relation between

- cim:SynchronousMachine.type,
- cim:SynchronousMachine.operatingMode, and
- the four limit values.

The following three cases represent combinations for generator and motor. Note that condenser type is not included as it has no cim:GeneratingUnit associated and it cannot be used for the purpose of generating active power.

1. An as built generator shall have positive active power limits and can only operate as a generator, see Figure 4.
2. An as built motor shall have negative active power limits and can only operate as a motor, see Figure 5.
3. An as built generator and motor can operate either in generator operating mode or in motor operating mode, see Figure 6, and shall have,
    - a positive maxOperatingP, and
    - a negative minOperatingP.

Note that in case 3 the unit can only operate either in generator operating mode or in motor operating mode in a given steady state situation (described in SSH). This means that the practical minimum limit in generator operating mode shall be zero and the practical maximum limit in motor operating mode shall be zero.

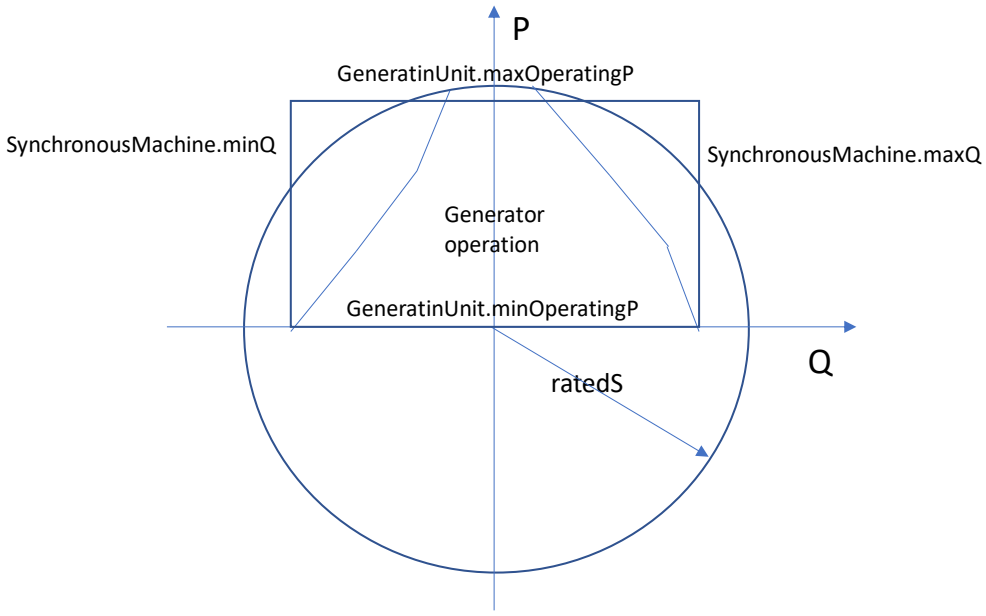

Figure 4 Generator only

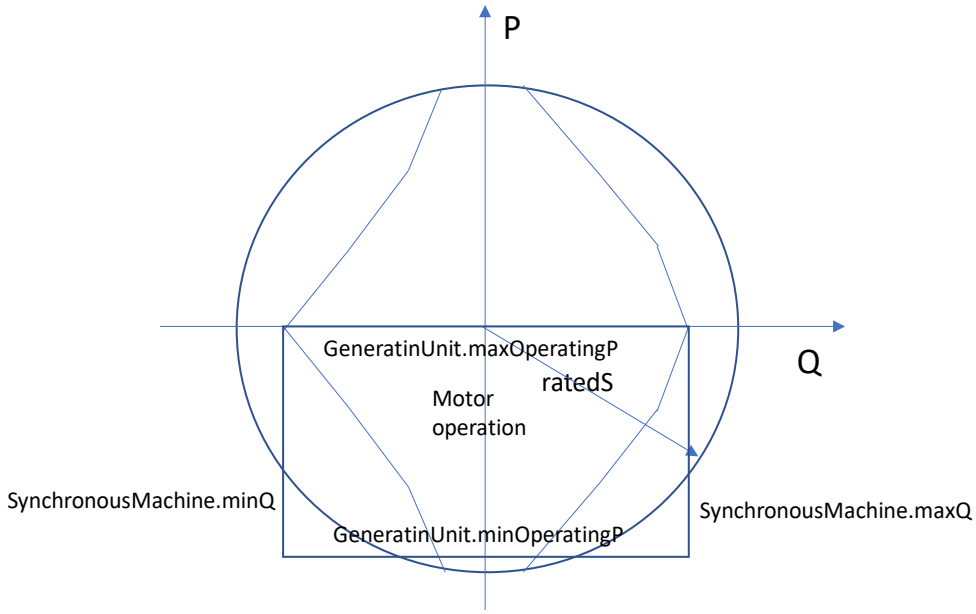

Figure 5 Motor operation only

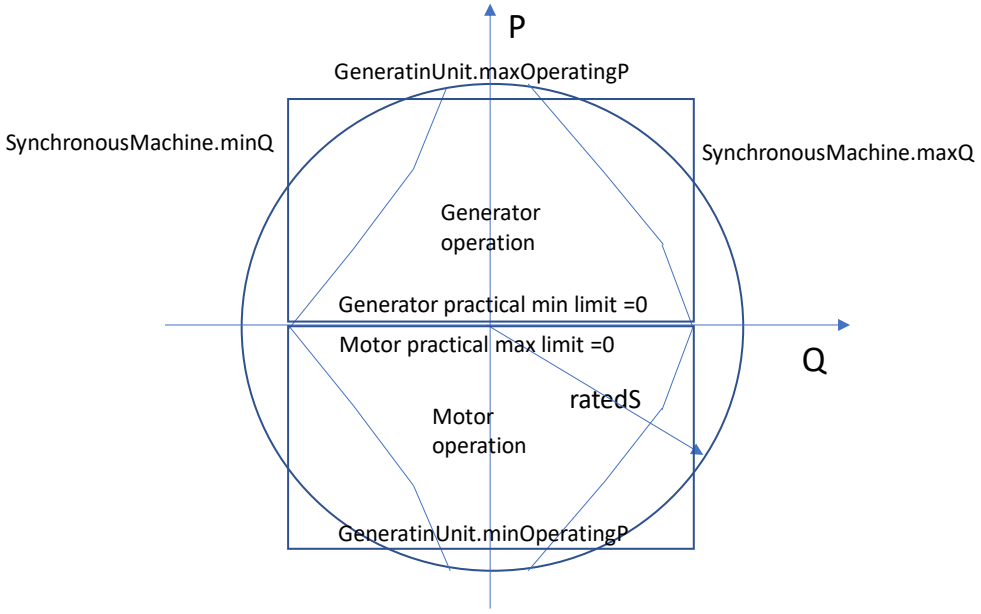

Figure 6 Generator or motor operation

6.7 INTERPOLATION IN REACTIVE CAPABILITY CURVE

A reactive capability curve typically has at least two curve points. If an interpolation function is not available three approximations are possible:

1. Min of pairwise negative Q values and max of pairwise positive Q values, see Figure 7.
2. Mean value of pairwise Q values, see Figure 8.

3. Max of pairwise negative Q values and min of pairwise positive Q values, see Figure 9.

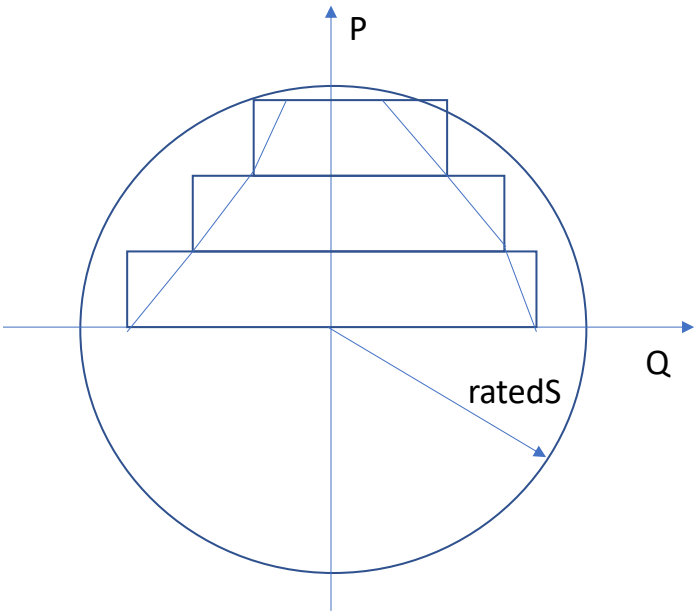

Figure 7 Pairwise max Value

The corners in the boxes in Figure 7 represent the max positive or min negative reactive limit value of the two capability curve points covered by a box. This option allows the largest deviation from the limit values. The reactive power at limit will always be greater than the capability curve limit.

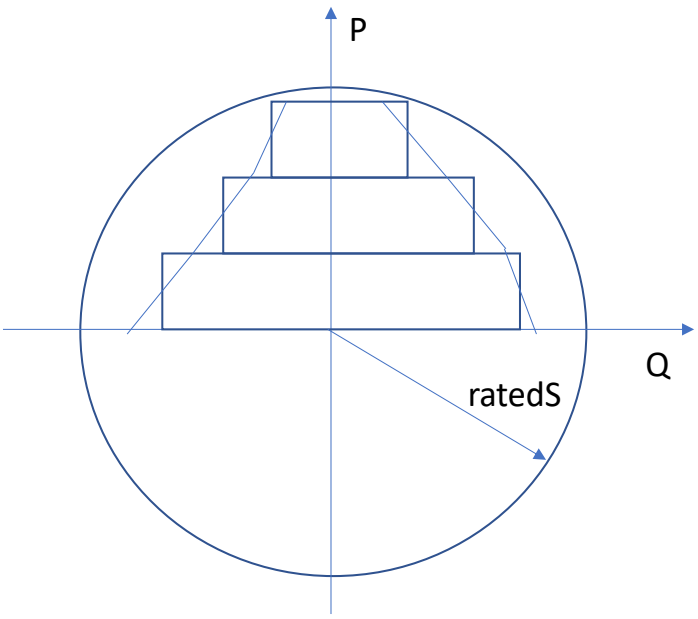

Figure 8 Pairwise Mean Value

In the option shown in Figure 8 a reactive power at the limit may stay within the capability curve limit.

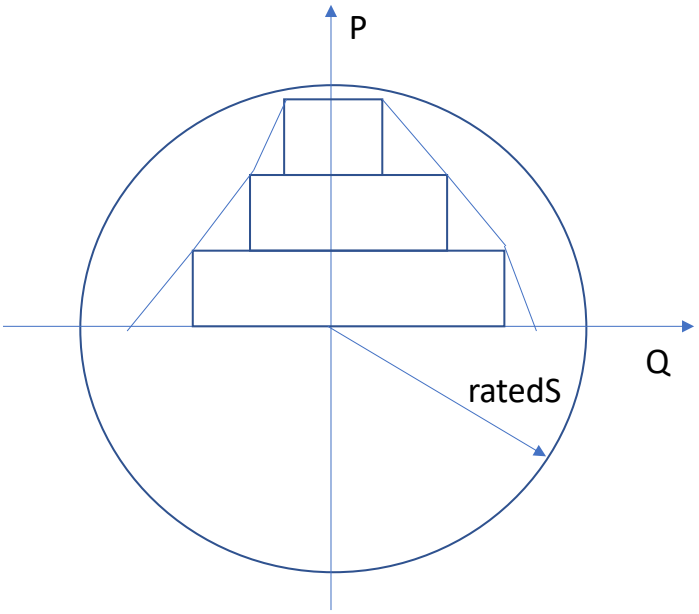

Figure 9 Pairwise Min Value

In the option shown in Figure 9 a reactive power at the limit will always be inside the reactive capability curve.

7 LEVEL 1: FILENAMES

7.1 BUSINESS CONSTRAINTS

7.1.1 SEVERITY ERROR

TABLE 6: FILENAMEMD

Severity: ERROR	**Name: FileNameMD**	**Level: 1**	**Validation scope: IGM & CGM**
Description	Two different file name templates are used: 1) effectiveDateTime_businessProcess_sourcingActor_modelPart_fileVersion 2) effectiveDateTime__sourcingActor_modelPart_fileVersion The templates have fields separated by four underscores (_). Depending on the modelPart field (allowed values are listed in rule ModelPartType) the usage of above templates is as follows: - EQ shall use both template 1 and 2; - SSH, TP and SV shall only use template 1; - EQBD and TPBD shall only use template 2. The field sourcingActor has sub-fields separated by dashes (-). The following three sub-templates are allowed for sourcingActor field: - sourcingTSO, which is always used by a TSO; - sourcingRSC-cgmRegion, which is used by RSC for a synchronous area file, e.g., a SV file; - sourcingRSC-cgmRegion-sourcingTSO, which is used by RSC for an updated TSO area file, e.g., a SSH file.		

	Note that model parts such as DL, DY, GL are not included as they are not in the implementation scope of QoCDC. This rule only checks the structure of the filename, i.e., the "_" and the "-" and does not check the content of the fields against QoCDC Reference Data document.
Message	The structure of the file name does not match the rules.
Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 7: FILENAMECONSISTENCY

Severity: ERROR	**Name: FileNameConsistency**	**Level: 1**	**Validation scope: IGM & CGM**
Description	Each cimxml file (including EQBD and TPBD) is contained by a single zip container. The file name of the cimxml file within the container must be the same as the name of the container. However, EQBD and TPBD might be zipped together in case they need to be uploaded in OPDE, which is an implementation detail.		
Message	XML instance file name is different from zip container file name.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 8: EFFECTIVEDATETIME

Severity: ERROR	**Name: EffectiveDateTime**	**Level: 1**	**Validation scope: IGM & CGM**

Description	The 'effectiveDateTime' in the file name must be a valid datetime in minute resolution in accordance with ISO 8601-2005, basic format with time designator [T] between date and time and ending with UTC designator [Z]. For example, 20180118T1130Z. Use of other date/time specifiers by characters [:.-+YMDHSWP] is not allowed.
Message	EffectiveDateTime in file name is invalid.
Justification	The relevant time resolution for the business process is minute level and the time in the file name shall match with this attribute.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 9: SOURCINGACTOR

Severity: ERROR	**Name: SourcingActor**	**Level: 1**	**Validation scope: IGM & CGM**
Description	The sourcingActor, that appears in the cimxml file name, is composed as described in rule FileNameMD. The choice on sourcingActor is made by the responsible TSO and it is recorded in the QoCDC Reference Data document. Once decided the sourcingActor should comply with the defined names in the QoCDC Reference Data document. This rule checks if the values of the following fields “sourcingRSC” and “sourcingTSO” from the sourcingActor part of the file name is one of the allowed values in the QoCDC Reference Data document. The rule does not check the field “cgmRegion”.		
Message	sourcingRSC or/and sourcingTSO parts of the file name has/have value(s) that are not included in the QoCDC Reference Data document.		
Justification	The sourcingActor shall comply with the choices made by a TSO.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 10: CGMREGION

Severity: ERROR	**Name: CGMRegion**	**Level: 1**	**Validation scope: CGM**

Description	The sourcingActor, that appears in the cimxml file name, is composed as described in rule FileNameMD. This rule checks if the value of the field “cgmRegion” from the sourcingActor part of the file name is one of the allowed values in the QoCDC Reference Data document. The rule does not check the fields “sourcingRSC” and “sourcingTSO”.
Message	cgmRegion part of the file name has value that is not included in the QoCDC Reference Data document.
Justification	Needed to uniquely identify synchronous areas for SV of CGM.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 11: BUSINESSPROCESS

Severity: ERROR	**Name: BusinessProcess**	**Level: 1**	**Validation scope: IGM & CGM**
Description	The 'businessProcess' in the file name is restricted according to a list in the QoCDC Reference Data document. See also level 2 rule ModelDescription where the BusinessProcess is required in the Model.description attribute.		
Message	Unknown business process.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 12: MODELPARTTYPE

Severity: ERROR	**Name: ModelPartType**	**Level: 1**	**Validation scope: IGM & CGM**
Description	The 'modelPart' in the file name is restricted. Note that the profile declarations in the file header are leading and shall be used as meta data to request data. The allowed model part types are as follows: DL, DY, EQ, EQBD, EQDIFF, GL, SSH, SV, TP, TPBD.		
Message	Unknown modelPart type in the filename.		

Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 13: FILEVERSIONTYPE

Severity: ERROR	**Name: FileVersionType**	**Level: 1**	**Validation scope: IGM & CGM**
Description	The 'fileVersion' in the file name must be positive integer value always represented by three numeric characters ranging from 000 to 999, i.e. the first positive integer is 001 and the last 999. Leading zeros are allowed.		
Message	File version is not a number with three numeric character positions.		
Justification	See this specification section 5.9.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1 C.3.1.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment	It is not exactly as in the standard.		

8 LEVEL 2: INSTANCE DATA SYNTAX AND HEADER

8.1 STANDARD CONSTRAINTS

8.1.1 SEVERITY ERROR

TABLE 14: PROLOG

Severity: ERROR	Name: Prolog	Level: 2	Validation scope: IGM & CGM
Description	The CIMXML file must have a prolog containing attributes version and encoding.		
Message	Prolog is missing.		
Justification	See this specification, section 6.1.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	FBOD1 in 600-1, clause 4 in 552		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:ALL:NA:FBOD1; FBOD1 in 600-1, clause 4 in 552		
Comment			

TABLE 15: ENCODING

Severity: ERROR	Name: Encoding	Level: 2	Validation scope: IGM & CGM
Description	If the encoding is different from UTF-8, it shall be considered an error. Note: the encoding is case insensitive.		
Message	Missing encoding or encoding other than UTF-8.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	GENC10		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:ALL:NA:GENC10		
Comment	However, note that missing encoding is allowed by W3C. CGMES v3 does not state explicitly that the encoding shall be declared. The default value is UTF-8 and it is not required to state it.		

TABLE 16: XMLSTRUCTURE

Severity: ERROR	Name: XMLStructure	Level: 2	Validation scope: IGM & CGM
Description	If the XML parsing fails, the process is aborted.		
Message	XML parsing error.		
Justification	https://www.w3.org/TR/REC-xml/#dt-fatal		

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	FBOD1 in 600-1, clause 4 in 552
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:ALL:NA:FBOD1; FBOD1 in 600-1, clause 4 in 552
Comment	

TABLE 17: FILEHEADER

Severity: ERROR	**Name: FileHeader**	**Level: 2**	**Validation scope: IGM & CGM**
Description	Each type of instance file shall have exactly one file header of type FullModel or DifferenceModel.		
Message	Missing file header.		
Justification	IEC 61970-552, section 5.2.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	HGEN2		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:ALL:NA:HGEN2		
Comment			

TABLE 18: URNUNIQUENESS

Severity: ERROR	**Name: URNUniqueness**	**Level: 2**	**Validation scope: IGM & CGM**
Description	A new model ID shall be generated for new instance files, only when the content of the instance data changes. A new version means a new URN. This is a process related rule and cannot be validated in standalone model of validation of an IGM.		
Message	URN of the instance file already exists.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	HREF1		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	HREF1		
Comment			

TABLE 19: MODELCREATED

Severity: ERROR	Name: ModelCreated	Level: 2	Validation scope: IGM & CGM
Description	The date and time when the model was created. It is the time of the serialization. The format is an extended format according to the ISO 8601-2005. The ENTSO-E exchanges should refer to UTC. The 'md:Model.created' attribute must be valid datetime in accordance with ISO 8601, extended format with time designator [T] between date and time ending with UTC designator [Z]. The characters [:-] shall be used. For example, 2018-01-18T11:30:12Z or 2018-01-18T11:30:12.015Z. The restriction describes the minimum required specification that a receiver shall be prepared to consume. A more precisely specified time defined by characters [+YMDHSWP] will be ignored.		
Message	Invalid Model.created attribute.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	Annex C of IEC TS 61970-600-1:2017.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:ALL:Model.created:HGEN4		
Comment			

TABLE 20: SCENARIOTIME

Severity: ERROR	Name: ScenarioTime	Level: 2	Validation scope: IGM & CGM
Description	The 'md:Model.scenarioTime' attribute must be valid datetime in accordance with ISO 8601, extended format with time designator [T] between date and time ending with UTC designator [Z]. The characters [:-] shall be used. For example, 2018-01-18T11:30:00Z, 2018-01-18T11:30:12.000Z or 2018-01-18T11:30Z. The restriction describes the minimum required specification that a receiver shall be prepared to consume. A more precisely specified time defined by characters [+.YMDHSWP] will be ignored.		
Message	Invalid Model.scenarioTime attribute.		
Justification			

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	Annex C of IEC TS 61970-600-1:2017.
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:ALL:Model.scenarioTime:HGEN4
Comment	

TABLE 21: PROFILESPECIFICATION

Severity: ERROR	**Name: ProfileSpecification**	**Level: 2**	**Validation scope: IGM & CGM**
Description	The 'md:Model.profile' description in the file header is restricted. Note: The profile declarations in the file header are leading and shall be used as meta data to request data. The enumeration values are centrally maintained in QoCDC Reference Data document.		
Message	Invalid profile specification.		
Justification	Necessary to determine which RDFS rules to use.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	FBOD2, HGEN1. Annex C of IEC/TS 61970-600-1:2017.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:ALL:Model.profile:allowedValues		
Comment	The profile version UIRs are different between CGMES v2.4 and CGMES v3.0.		

TABLE 22: ATTRIBUTEANDROLEVALUES

Severity: ERROR	**Name: AttributeAndRoleValues**	**Level: 2**	**Validation scope: IGM & CGM**
Description	Attribute and role values appearing in a CIMXML document shall have a value. The rule checks empty attributes that are not of type String. Notes: - Example of empty attribute: [cim:class.attribute/] or [cim:class.attribute][/cim:class.attribute] - Example of empty rdf:resource [cim:class.attribute rdf:resouce=""/], note this is not a valid reference and it is part of rule XMLStructure. Note: the xml angle brackets has been replaced by square parenthesis in above examples.		

Message	Empty attribute or rdf:resource is present.
Justification	Only meaningful data shall be exchanged in CIMXML documents.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	NAMC14
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	GENC17
Comment	

TABLE 23: INCORRECTDATATYPEFORMAT

Severity: ERROR	**Name: IncorrectDataTypeFormat**	**Level: 2**	**Validation scope: IGM & CGM**
Description	Data format shall conform to the datatype defined in the profile. Note: This rule reports data format issues for all datatypes. A description of the data type specific error is included in the message. The format of the message is "[Message] The [expected datatype]: [datatype detail text] is not correct.", where - [expected datatype] is the datatype reference defined by the profile - [datatype detail text] is either printing the value that does not conform or indicating the details of the issue. For example, "The Decimal: decimal comma is not correct.".		
Message	Datatype does not conform. The [expected datatype]: [datatype detail text] is not correct.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC 61970-552		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	IEC 61970-552		
Comment			

8.1.2 SEVERITY INFO

TABLE 24: NOTMANDATORYCLASS

Severity: INFO	**Name: NotMandatoryClass**	**Level: 2**	**Validation scope: IGM & CGM**

Description	An instance of a class not described in a CGMES profile is ignored and reported. If an importing tool requires a class not described in a CGMES profile issues may occur for a CGM where other IGMs do not contain instances of the class.
Message	Class instance in cimxml document is ignored.
Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	PROF11
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:ALL:NA:prof11
Comment	

TABLE 25: NOTMANDATORYPROPERTY

Severity: INFO	**Name: NotMandatoryProperty**	**Level: 2**	**Validation scope: IGM & CGM**
Description	A role or attribute not described in a CGMES profile is ignored and reported. If an importing tool require a role or attribute not described in a CGMES profile issues may occur for a CGM where other IGMs do not contain instances of the role or attribute.		
Message	Role or attribute in cimxml document is ignored.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	PROF11		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:ALL:NA:prof11		
Comment			

8.2 BUSINESS CONSTRAINTS

8.2.1 SEVERITY ERROR

TABLE 26: MAS

Severity: ERROR	Name: MAS	Level: 2	Validation scope: IGM & CGM
Description	1) md:Model.modelingAuthoritySet is required in the header of all instance files. 2) md:Model.modelingAuthoritySet shall have one of the values specified in the QoCDC Reference Data document. 3) md:Model.modelingAuthoritySet of a CGM SV instance file shall be the MAS that creates the state variables. The value of md:Model.modelingAuthoritySet is not validated against QoCDC Reference Data document, but it is recommended to be constructed as follows: MA/Region/Process, where - MA is the URI of the MergingAgent - Region is the name of the CGMRegion - Process is the name of the ProcessType.		
Message	Missing or invalid md:Model.modelingAuthoritySet specification.		
Justification	The attribute is mandatory for the CGM process.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	HGEN1, Note: This rule intentionally overrides MAPR10 and MARP11 of IEC TS 61970-600-1:2017.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:ALL:NA:HGEN1		
Comment	The recommendation for a specific structure is QoCDC specific. All the rest is covered by CGMES v3		

TABLE 27: MASPERSISTENCY

Severity: ERROR	Name: MASPersistency	Level: 2	Validation scope: IGM
Description	The 'md:Model.modelingAuthoritySet' attribute must be persistent for all CIMXML files of an IGM. Note that to test this across CIMXML files this must be done for a model where all files have been included.		
Message	md:Model.modelingAuthoritySet is not persistent across IGM files.		
Justification	See this document section 5.9.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1 table in C.3.1		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 28: SCENARIOTIMECONSISTENCY

Severity: ERROR	Name: ScenarioTimeConsistency	Level: 2	Validation scope: IGM & CGM
Description	The 'md:Model.scenarioTime' attribute shall refer to the same datetime as the 'effectiveDateTime' in the file name, considering minute resolution.		
Message	The scenarioTime specification in the file header does not match the effectiveDateTime specified in the file name.		
Justification	Necessary to produce consistent meta data for the exchange process.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 29: VERSIONCONSISTENCY

Severity: ERROR	Name: VersionConsistency	Level: 2	Validation scope: IGM & CGM
Description	The 'md:Model.version' attribute shall be the same number as the 'fileVersion' string from the file name converted to an integer.		
Message	The model version does not match the file version.		
Justification	Necessary to produce consistent meta data for the exchange process.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 30: EXCEPTION

Severity: ERROR	Name: Exception	Level: 2	Validation scope: IGM & CGM
Description	An exception shall be reported in case of a non-recoverable software error occurs. A software error is an error related to the functioning of the software itself and not due to the content of the IGMs or CGMs. For instance, programming error that does not check for null references and use them in constructs will result in an exception.		

Message	A software error has occurred, please report to the developer.
Justification	Software errors that are discovered shall be corrected.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

8.2.2 SEVERITY INFO

TABLE 31: MODELDESCRIPTION

Severity: INFO	**Name: ModelDescription**	**Level: 2**	**Validation scope: IGM & CGM**
Description	The md:Model.description attribute is required and should contain the xml structure that is described in section 5.9.2. The xml structure should be serialised in the attribute as escaped XML, i.e. still as a string.		
Message	md:Model.description is not provided or does not contain required fields.		
Justification	See this specification section 5.9.2.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

9 LEVEL 3: BASIC IGM/CGM CONSTRAINTS

9.1 STANDARD CONSTRAINTS

9.1.1 SEVERITY ERROR

TABLE 32: NAMELENGTH

Severity: ERROR	**Name: NameLength**	**Level: 3**	**Validation scope: IGM & CGM**
Description	In cases where cim:IdentifiedObject.name is a required attribute, it shall not be empty string and shall not exceed IO_NAME_LENGTH characters for all instances except for instances of subclasses of cim:ACDCTerminal where cim:IdentifiedObject.name may be omitted. Note: This rule further restricts IEC TS 61970-600-1:2017, IEC TS 61970-600-2:2017 where empty strings are allowed in cim:IdentifiedObject.name.		
Message	cim:IdentifiedObject.name is either missing, empty string or exceeds IO_NAME_LENGTH characters.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017 B.1.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:ALL:IdentifiedObject.name:stringLength		
Comment	However more characters are allowed in CGMES v3.0		

TABLE 33: DESCRIPTIONLENGTH

Severity: ERROR	**Name: DescriptionLength**	**Level: 3**	**Validation scope: IGM & CGM**
Description	In every model instance, the length of all instances of cim:IdentifiedObject.description shall not exceed IO_DESCRIPTION_LENGTH characters.		
Message	Length of description instance exceeds IO_DESCRIPTION_LENGTH characters.		
Justification			

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017 B.2.
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:ALL:IdentifiedObject.description:stringLength
Comment	However more characters are allowed in CGMES v3.0

TABLE 34: EICLENGTH

Severity: ERROR	**Name: EICLength**	**Level: 3**	**Validation scope: IGM & CGM**
Description	In every model instance, the length of all instances of entsoe:IdentifiedObject.energyIdentCodeEic must be exactly EIC_LENGTH characters.		
Message	Length of energyIdentCodeEic instance must be exactly EIC_LENGTH characters.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017 B.3.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:IdentifiedObject.energyIdentCodeEic:stringLength		
Comment			

TABLE 35: SHORTNAMELENGTH

Severity: ERROR	**Name: ShortNameLength**	**Level: 3**	**Validation scope: IGM & CGM**
Description	In every model instance, the length of all instances of entsoe:IdentifiedObject.shortName shall not exceed SHORT_NAME_LENGTH characters.		
Message	Length of shortName instance exceeds SHORT_NAME_LENGTH characters.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017 B.4.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:IdentifiedObject.shortName:stringLength		
Comment			

TABLE 36: CNFROMENDISOCODE

Severity: ERROR	Name: CNFromEndIsoCode	Level: 3	Validation scope: IGM
Description	In an EQBD document attribute value entsoe:ConnectivityNode.fromEndIsoCode must be from the country code list – field 'TsoCodeList' in the QoCDC Reference Data document which is a subset of https://www.iso.org/iso-3166-country-codes.html.		
Message	Country code used that is not in the reference data.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017 B.5.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQBD:BoundaryPoint.fromEndIsoCode:stringLength		
Comment	In CGMES v3.0 this applies to eu:BoundaryPoint and not cim:ConnectivityNode		

TABLE 37: TNFROMENDISOCODE

Severity: ERROR	Name: TNFromEndIsoCode	Level: 3	Validation scope: IGM
Description	In a TPBD document attribute value entsoe:TopologicalNode.fromEndIsoCode must be from the country code list – field 'TsoCodeList' in the QoCDC Reference Data document which is a subset of https://www.iso.org/iso-3166-country-codes.html.		
Message	Country code used that is not in the reference data.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017 B.5.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment	Not needed in CGMES v3.0		

TABLE 38: CNTOENDISOCODE

Severity: ERROR	Name: CNToEndIsoCode	Level: 3	Validation scope: IGM
Description	In an EQBD document attribute value entsoe:ConnectivityNode.toEndIsoCode must be from the country code list – field 'TsoCodeList' in the QoCDC Reference Data document which is a subset of https://www.iso.org/iso-3166-country-codes.html.		
Message	Country code used that is not in the reference data.		

Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017 B.6.
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQBD:BoundaryPoint.toEndIsoCode:valueValidity
Comment	In CGMES v3.0 this applies to eu:BoundaryPoint and not cim:ConnectivityNode

TABLE 39: TNTOENDISOCODE

Severity: ERROR	**Name: TNToEndIsoCode**	**Level: 3**	**Validation scope: IGM**
Description	In a TPBD document attribute value entsoe:TopologicalNode.toEndIsoCode must be from the country code list – field 'TsoCodeList' in the QoCDC Reference Data document which is a subset of https://www.iso.org/iso-3166-country-codes.html.		
Message	Country code used that is not in the reference data.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017 B.6.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment	Not needed in CGMES v3.0		

TABLE 40: CNFROMENDNAMELENGTH

Severity: ERROR	**Name: CNFromEndNameLength**	**Level: 3**	**Validation scope: IGM**
Description	In every EQBD model instance, the length of all instances of entsoe:ConnectivityNode.fromEndName shall not exceed IO_NAME_LENGTH characters.		
Message	Length of name attribute exceeds IO_NAME_LENGTH characters.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017 B.7.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQBD:BoundaryPoint.fromEndName:stringLength		
Comment	In CGMES v3.0 this applies to eu:BoundaryPoint and not cim:ConnectivityNode		

TABLE 41: TNFROMENDNAMELENGTH

Severity: ERROR	Name: TNFromEndNameLength	Level: 3	Validation scope: IGM
Description	In every TPBD model instance, the length of all instances of entsoe:TopologicalNode.fromEndName shall not exceed IO_NAME_LENGTH characters.		
Message	Length of name attribute exceeds IO_NAME_LENGTH characters.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017 B.7.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment	Not needed in CGMES v3.0		

TABLE 42: CNTOENDNAMELENGTH

Severity: ERROR	Name: CNToEndNameLength	Level: 3	Validation scope: IGM
Description	In every EQBD model instance, the length of all instances of entsoe:ConnectivityNode.toEndName shall not exceed IO_NAME_LENGTH characters.		
Message	Length of name attribute exceeds IO_NAME_LENGTH characters.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017 B.8.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQBD:BoundaryPoint.toEndName:stringLength		
Comment	In CGMES v3.0 this applies to eu:BoundaryPoint and not cim:ConnectivityNode		

TABLE 43: TNTOENDNAMELENGTH

Severity: ERROR	Name: TNToEndNameLength	Level: 3	Validation scope: IGM
Description	In every TPBD model instance, the length of all instances of entsoe:TopologicalNode.toEndName shall not exceed IO_NAME_LENGTH characters.		
Message	Length of name attribute exceeds IO_NAME_LENGTH characters.		
Justification			

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017 B.8.
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	Not needed in CGMES v3.0

TABLE 44: CNFROMENDNAMETSOLENGTH

Severity: ERROR	**Name: CNFromEndNameTsoLength**	**Level: 3**	**Validation scope: IGM**
Description	In every EQBD model instance, the length of all instances of entsoe:ConnectivityNode.fromEndNameTso shall not exceed IO_NAME_LENGTH characters.		
Message	Length of name attribute exceeds IO_NAME_LENGTH characters.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017 B.9.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQBD:BoundaryPoint.fromEndNameTso:stringLength		
Comment	In CGMES v3.0 this applies to eu:BoundaryPoint and not cim:ConnectivityNode		

TABLE 45: TNFROMENDNAMETSOLENGTH

Severity: ERROR	**Name: TNFromEndNameTsoLength**	**Level: 3**	**Validation scope: IGM**
Description	In every TPBD model instance, the length of all instances of entsoe:TopologicalNode.fromEndNameTso shall not exceed IO_NAME_LENGTH characters.		
Message	Length of name attribute exceeds IO_NAME_LENGTH characters.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017 B.9.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment	Not needed in CGMES v3.0		

TABLE 46: CNTOENDNAMETSOLENGTH

Severity: ERROR	Name: CNToEndNameTsoLength	Level: 3	Validation scope: IGM
Description	In every EQBD model instance, the length of all instances of entsoe:ConnectivityNode.toEndNameTso shall not exceed IO_NAME_LENGTH characters.		
Message	Length of name attribute exceeds IO_NAME_LENGTH characters.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017 B.10.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQBD:BoundaryPoint.toEndNameTso:stringLength		
Comment	In CGMES v3.0 this applies to eu:BoundaryPoint and not cim:ConnectivityNode		

TABLE 47: TNTOENDNAMETSOLENGTH

Severity: ERROR	Name: TNToEndNameTsoLength	Level: 3	Validation scope: IGM
Description	In every TPBD model instance, the length of all instances of entsoe:TopologicalNode.toEndNameTso shall not exceed IO_NAME_LENGTH characters.		
Message	Length of name attribute exceeds IO_NAME_LENGTH characters.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017 B.10.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment	Not needed in CGMES v3.0		

TABLE 48: GENERATIONCONTAINMENT

Severity: ERROR	Name: GenerationContainment	Level: 3	Validation scope: IGM
Description	For every instance of cim:HydroPump and cim:GeneratingUnit (and subclasses thereof), the cim:Equipment.EquipmentContainer referred to, must be of type cim:Substation. Missing containment is not allowed.		
Message	A cim:HydroPump and a cim:GeneratingUnit is not contained in a cim:Substation.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	Figure 15 (Core notes) of IEC TS 61970-600-2 section 6.7.11		

IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:GeneratingUnit:containment C:452:EQ:HydroPump:containment
Comment	

TABLE 49: PTCONTAINMENT

Severity: ERROR	**Name: PTContainment**	**Level: 3**	**Validation scope: IGM**
Description	For every instance of cim:PowerTransformer, the cim:Equipment.EquipmentContainer referred to, must be of type cim:Substation or of type cim:DCConverterUnit. Missing containment is not allowed.		
Message	A cim:PowerTransformer is not contained in either a cim:Substation or a cim:DCConverterUnit.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	Figure 15 (Core notes) and Figure 5 (diagram DCContainment) of IEC TS 61970-600-2 sections 6.7.11 and 6.3.9		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:PowerTransformer:containment		
Comment			

TABLE 50: SWITCHCONTAINMENT

Severity: ERROR	**Name: SwitchContainment**	**Level: 3**	**Validation scope: IGM**
Description	For every instance of Switch (and subclasses thereof), the cim:Equipment.EquipmentContainer referred to, must be of type VoltageLevel, of type Bay or of type DCConverterUnit. Missing containment is not allowed.		
Message	A cim:Switch is not contained in either a VoltageLevel, a Bay or a DCConverterUnit.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	Figure 15 (Core notes) and Figure 5 (diagram DCContainment) of IEC TS 61970-600-2 sections 6.7.11 and 6.3.9.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:ProtectedSwitch:containment		
Comment	CGMES v3.0 allows Line for Cut, Jumper, Fuse, GroundDisconnector and Disconnector.		

TABLE 51: SCCONTAINMENT

Severity: ERROR	**Name: SCContainment**	**Level: 3**	**Validation scope: IGM**

Description	For every instance of cim:SeriesCompensator, the cim:Equipment.EquipmentContainer referred to, if provided, must be of type cim:Line, of type cim:VoltageLevel or of type cim:DCConverterUnit.
Message	A cim:SeriesCompensator is not contained in either a cim:Line, a cim:VoltageLevel or a cim:DCConverterUnit.
Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	Figure 15 (diagram Core notes) in section 6.7.1 of IEC TS 61970-600-2, Figure 5 (diagram DCContainment) in section 6.3.1 of IEC TS 61970-600-2 and section 6.9.16 of IEC TS 61970-600-2.
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:SeriesCompensator:containment
Comment	

TABLE 52: INJECTIONCONTAINMENT

Severity: ERROR	**Name: InjectionContainment**	**Level: 3**	**Validation scope: IGM**
Description	For every instance of cim:EnergyConsumer subclasses, cim:RotatingMachine subclasses, cim:ShuntCompensator subclasses, cim:EnergySource, cim:EquivalentShunt, cim:ExternalNetworkInjection and cim:StaticVarCompensator, the cim:Equipment.EquipmentContainer referred to, must be of type cim:VoltageLevel. Missing containment is not allowed.		
Message	A single terminal equipment that produces/consumes power is not contained in a cim:VoltageLevel.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	6.10.10, 6.7.6 of IEC TS 61970-600-2.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:EnergyConnection:containment		
Comment			

TABLE 53: BUSBARSECTIONCONTAINMENT

Severity: ERROR	**Name: BusbarSectionContainment**	**Level: 3**	**Validation scope: IGM**
Description	For every instance of cim:BusbarSection, the cim:Equipment.EquipmentContainer referred to, must be of type cim:VoltageLevel. Missing containment is not allowed.		
Message	A cim:BusbarSection is not contained in a cim:VoltageLevel.		
Justification			

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	Figure 15 (diagram Core notes) of IEC TS 61970-600-2 section 6.10.5.
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:BusbarSection:containment
Comment	CGMES v3.0 also allows Bay

TABLE 54: EFCCONTAINMENT

Severity: ERROR	**Name: EFCContainment**	**Level: 3**	**Validation scope: IGM**
Description	For every instance of cim:EarthFaultCompensator, its subclasses and cim:Ground, the cim:Equipment.EquipmentContainer referred to, must be of type cim:VoltageLevel. Missing containment is not allowed.		
Message	A subclass of cim:EarthFaultCompensator or cim:Ground is not contained in a cim:VoltageLevel.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	Figure 15 (diagram Core notes) of IEC TS 61970-600-2 section 6.7.6.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:Ground:containment		
Comment	CGMES v3.0 also allows Bay		

TABLE 55: JUNCTIONCONTAINMENT

Severity: ERROR	**Name: JunctionContainment**	**Level: 3**	**Validation scope: IGM**
Description	For every instance of cim:Junction (Equipment Boundary file), the cim:Equipment.EquipmentContainer referred to, must be of type cim:Line. Missing containment is not allowed.		
Message	A cim:Junction is not contained in a cim:Line.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 4.4.5 of IEC TS 61970-600-2.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:Junction:containment		
Comment	CGMES v3.0 allows Bay and VolatgeLevel as the constraint is not EQ boundary specific.		

TABLE 56: ACDCCONVCONTAINMENT

Severity: ERROR	Name: ACDCConvContainment	Level: 3	Validation scope: IGM
Description	For every instance of cim:CsConverter and cim:VsConverter, the cim:Equipment.EquipmentContainer referred to, must be of type cim:DCConverterUnit. Missing containment is not allowed.		
Message	A cim:ACDCConverter is not contained in a cim:DCConverterUnit.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.3.2 of IEC TS 61970-600-2.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:ACDCConverter:containment		
Comment			

TABLE 57: DCEQCONTAINMENT

Severity: ERROR	Name: DCEQContainment	Level: 3	Validation scope: IGM
Description	For every instance of cim:DCSeriesDevice, cim:DCShunt, cim:DCBusbar, cim:DCGround, cim:DCChopper, cim:DCSwitch, cim:DCBreaker and cim:DCDisconnector, the cim:Equipment.EquipmentContainer referred to, must be of type cim:DCConverterUnit. Missing containment is not allowed.		
Message	A DC equipment is not contained in a cim:DCConverterUnit.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.3.2 of IEC TS 61970-600-2.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:DCSwitch:containment		
Comment			

TABLE 58: CNCONTAINMENT

Severity: ERROR	Name: CNContainment	Level: 3	Validation scope: IGM
Description	For cim:ConnectivityNodes according to EQ, the cim:ConnectivityNode.ConnectivityNodeContainer referred to, must be of type cim:VoltageLevel, cim:Bay or cim:Line. For cim:ConnectivityNodes according to EQBD, the cim:ConnectivityNode.ConnectivityNodeContainer referred to, must be of type cim:Line. Missing containment is not allowed.		
Message	A cim:ConnectivityNode is not contained in either a cim:VoltageLevel, cim:Bay or cim:Line for EQ models and in a cim:Line for Boundary points.		

Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	Figure 1 (diagram EquipmentBoundaryProfile), figure 15 (diagram Core Notes), section 6.7.7 of IEC TS 61970-600-2.
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:ConnectivityNode:containment
Comment	Same in CGMES v2.4. Different implementation in CGMES v3.0.

TABLE 59: GENERATINGUNITNOMINALP

Severity: ERROR	**Name: GeneratingUnitNominalP**	**Level: 3**	**Validation scope: IGM**
Description	The value of cim:GeneratingUnit.nominalP, if provided, shall be positive and less or equal to cim:RotatingMachine.ratedS.		
Message	The value is either negative, zero or greater than RotatingMachine.ratedS.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.6.5 of IEC TS 61970-600-2		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:GeneratingUnit.nominalP:valueRangePair		
Comment			

TABLE 60: CEBASEVOLTAGE

Severity: ERROR	**Name: CEBaseVoltage**	**Level: 3**	**Validation scope: IGM**
Description	All cim:ConductingEquipment except cim:ACLineSegment, cim:SeriesCompensator, cim:EquivalentBranch, cim:PowerTransformer and cim:ACDCConverter, must either have an association with cim:BaseVoltage or be located within a cim:VoltageLevel or cim:Bay. The exception is because rule BranchBaseVoltage validates similar conditions. If both cim:ConductingEquipment.BaseVoltage and containment in a cim:VoltageLevel or cim:Bay are provided, the association ends cim:ConductingEquipment.BaseVoltage and cim:VoltageLevel.BaseVoltage shall refer to the same cim:BaseVoltage.		
Message	A cim:ConductingEquipment that does not have cim:BaseVoltage or refers to different cim:BaseVoltage via different associations.		
Justification			

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.7.6 and 6.10.2 of IEC TS 61970-600-2
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:ConductingEquipment.BaseVoltage:whereRequired
Comment	CGMES v3.0 is stricter and providing more guidance.

TABLE 61: NOMINALVOLTAGE

Severity: ERROR	**Name: NominalVoltage**	**Level: 3**	**Validation scope: IGM**
Description	For every instance of cim:BaseVoltage, the cim:BaseVoltage.nominalVoltage value must be greater than zero.		
Message	Nominal voltage is not greater than zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.7.3 of IEC TS 61970-600-2		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:BaseVoltage.nominalVoltage:valueRange		
Comment			

TABLE 62: TERMINALCOUNT1

Severity: ERROR	**Name: TerminalCount1**	**Level: 3**	**Validation scope: IGM**
Description	Every instance of cim:RegulatingCondEq and its subclasses, cim:EnergyConsumer and its subclasses, cim:EquivalentInjection, cim:EquivalentShunt, subclasses of cim:Connector, cim:EnergySource, cim:Ground, cim:DCBusbar, cim:DCShunt, cim:DCGround shall only be referenced via a single cim:Terminal instance.		
Message	A single terminal equipment that is referenced by multiple terminals.		
Justification	cim:ConductingEqupment with a single electrical connection point shall only have one cim:Terminal.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference			
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:ConductingEquipment:oneTerminal		
Comment	CGMES v2.4 also provides information on this but it is open for interpretation.		

TABLE 63: TERMINALCOUNT2

Severity: ERROR	Name: TerminalCount2	Level: 3	Validation scope: IGM
Description	Every instance of cim:Conductor and its subclasses, cim:Switch and its subclasses, cim:SeriesCompensator, cim:EquivalentBranch, cim:DCLineSegment, cim:DCSeriesDevice, cim:DCChopper and subclasses of cim:DCSwitch, shall only be referenced via exactly two cim:Terminal instances.		
Message	A two terminal equipment that is not referenced by exactly two terminals.		
Justification	cim:ConductingEqupment with two electrical connection point shall have two cim:Terminals.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference			
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:ConductingEquipment:twoTerminals		
Comment	CGMES v2.4 also provides information on this but it is open for interpretation.		

TABLE 64: TERMINALSEQNUM

Severity: ERROR	Name: TerminalSeqNum	Level: 3	Validation scope: IGM
Description	Every instance of cim:Terminal must have a cim:Terminal.sequenceNumber if it belongs to an cim:EquivalentBranch or an cim:ACLineSegment with cim:MutualCoupling.		
Message	A cim:Terminal of either an cim:EquivalentBranchor a cim:ACLineSegment with cim:MutualCoupling that does not have a sequence number declared.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.7.21 and 6.10.31 of IEC TS 61970-600-2		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference			
Comment	The attribute cim:ACDCTerminal.sequenceNumber is required attribute in CGMES v3.0. Therefore, no need of the constraint in CGMES v3.0.		

TABLE 65: TERMINALSEQNUMORDER

Severity: ERROR	Name: TerminalSeqNumOrder	Level: 3	Validation scope: IGM

Description	In cases where cim:Terminal.sequenceNumber is provided for an instance of cim:ConductingEquipment or cim:DCConductingEquipment, at least one sequenceNumber shall equal to 1. The cim:Terminal.sequenceNumber of other terminals of same cim:ConductingEquipment or cim:DCConductingEquipment shall follow increasing order.
Message	Invalid sequenceNumber for a cim:Terminal.
Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.7.2 of IEC TS 61970-600-2
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:ACDCTerminal.sequenceNumber:numbering
Comment	

TABLE 66: PTTERMINALCONSISTENCY

Severity: ERROR	**Name: PTTerminalConsistency**	**Level: 3**	**Validation scope: IGM**
Description	For every instance of cim:PowerTransformerEnd, the cim:Terminal referenced by the cim:TransformerEnd.Terminal association must be associated with the cim:PowerTransformer instance, referenced via the cim:PowerTransformerEnd.PowerTransformer association.		
Message	Assignment of PowerTransformer's terminals is not consistent.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.9.31 of IEC TS 61970-600-2		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:PowerTransformerEnd:terminalConsistency		
Comment			

TABLE 67: MCFIRSTSECOND

Severity: ERROR	**Name: MCFirstSecond**	**Level: 3**	**Validation scope: IGM**
Description	The following shall conform for every instance of cim:MutualCoupling: 1) Association end cim:MutualCoupling.First_Terminal shall refer to a cim:Terminal of an cim:ACLineSegment. 2) Association end cim:MutualCoupling.Second_Terminal shall refer to a cim:Terminal of an cim:ACLineSegment.		

	3) Association ends cim:MutualCoupling.First_Terminal and cim:MutualCoupling.Second_Terminal shall refer to cim:Terminal-s of different cim:ACLineSegment-s.
Message	One of the following occurs: 1) cim:MutualCoupling.First_Terminal does not refer to a cim:Terminal of a cim:ACLineSegment, 2) cim:MutualCoupling.Second_Terminal does not refer to a cim:Terminal of a cim:ACLineSegment, 3) cim:MutualCoupling.First_Terminal and cim:MutualCoupling.Second_Terminal do not refer to cim:Terminal-s of different cim:ACLineSegment-s.
Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.9.19 of IEC TS 61970-600-2
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SC:MutualCoupling:terminalsAssignment
Comment	

TABLE 68: LRCEXPONENTMODEL

Severity: ERROR	**Name: LRCExponentModel**	**Level: 3**	**Validation scope: IGM**
Description	For every instance of cim:LoadResponseCharacteristic where cim:LoadResponseCharacteristic.exponentModel is true, cim:LoadResponseCharacteristic.pVoltageExponent and cim:LoadResponseCharacteristic.qVoltageExponent must be provided and be greater or equal than zero and less or equal to two. Note: The attributes pFrequencyExponent and qFrequencyExponent are not used. The attributes that are required for coefficient load model covered by rule LCRCoefficientModel are ignored and not validated when cim:LoadResponseCharacteristic.exponentModel equals true.		
Message	Exponent of per unit voltage effecting real and reactive power is not specified but cim:LoadResponseCharacteristic.exponentModel is true.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.10.9 of IEC TS 61970-600-2		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:LoadResponseCharacteristic.exponentModel:exponent		
Comment	CGMES v3.0 does not include the limitations on the exponent values.		

TABLE 69: LCRCOEFFICIENTMODEL

Severity: ERROR	Name: LCRCoefficientModel	Level: 3	Validation scope: IGM
Description	For every instance of cim:LoadResponseCharacteristic where cim:LoadResponseCharacteristic.exponentModel is false, cim:LoadResponseCharacteristic.pConstantImpedance and cim:LoadResponseCharacteristic.pConstantCurrent and cim:LoadResponseCharacteristic.pConstantPower and cim:LoadResponseCharacteristic.qConstantImpedance and cim:LoadResponseCharacteristic.qConstantCurrent and cim:LoadResponseCharacteristic.qConstantPower must be provided. Note: The attributes that are required for exponential load model covered by rule LRCExponentModel are ignored and not validated when cim:LoadResponseCharacteristic.exponentModel equals false.		
Message	Coefficients for ZIP load model is not specified but cim:LoadResponseCharacteristic.exponentModel is false.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.10.9 of IEC TS 61970-600-2		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:LoadResponseCharacteristic.exponentModel:coefficient		
Comment			

TABLE 70: LCRCOEFFICIENTPARAMETERS

Severity: ERROR	Name: LCRCoefficientParameters	Level: 3	Validation scope: IGM
Description	For every instance of cim:LoadResponseCharacteristic with cim:LoadResponseCharacteristic.exponentModel is false, - the sum of cim:LoadResponseCharacteristic.pConstantImpedance and cim:LoadResponseCharacteristic.pConstantCurrent and cim:LoadResponseCharacteristic.pConstantPower values must be 1 and - the sum of cim:LoadResponseCharacteristic.qConstantImpedance and cim:LoadResponseCharacteristic.qConstantCurrent and cim:LoadResponseCharacteristic.qConstantPower values must be 1.		
Message	The sum of coefficient parameters for a cim:LoadResponseCharacteristic does not equal 1.		
Justification			

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.10.9 of IEC TS 61970-600-2
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:LoadResponseCharacteristic.exponentModel:coefficientSum
Comment	

TABLE 71: MEASTERMINAL

Severity: ERROR	**Name: MeasTerminal**	**Level: 3**	**Validation scope: IGM**
Description	The association end cim:Measurement.Terminal shall reference a cim:Terminal of the cim:Equipment referenced by cim:Measurement.PowerSystemResource except in cases where cim:Measurement.measurementType is either cim:TapPosition or cim:SwitchPosition in which the association is not exchanged.		
Message	cim:Measurement.Terminal does not refer to a cim:Terminal of a cim:Equipment referenced by cim:Measurement.PowerSystemResource.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.5.18 of IEC TS 61970-600-2		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:OP:Measurement.Terminal:requiredCases		
Comment			

TABLE 72: MEASTYPE

Severity: ERROR	**Name: MeasType**	**Level: 3**	**Validation scope: IGM**
Description	For every instance of cim:Measurement, the value of cim:Measurement.measurementType is limited to 'ThreePhasePower', 'ThreePhaseActivePower', 'ThreePhaseReactivePower', 'LineCurrent', 'PhaseVoltage', 'LineToLineVoltage', 'Angle', 'TapPosition', 'SwitchPosition'.		
Message	Invalid measurement type.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.5.18 of IEC TS 61970-600-2		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:OP:Measurement.measurementType:analogValues		

Comment	In CGMES v3.0 LineToLineVoltage is changed to Voltage

TABLE 73: MEASUNIT

Severity: ERROR	**Name: MeasUnit**	**Level: 3**	**Validation scope: IGM**
Description	For every instance of cim:Measurement, the value of cim:Measurement.unitSymbol is restricted to 'cim:UnitSymbol.V', 'cim:UnitSymbol.A', 'cim:UnitSymbol.W', 'cim:UnitSymbol.VA', 'cim:UnitSymbol.VAr', 'cim:UnitSymbol.deg', 'cim:UnitSymbol.Hz', 'cim:UnitSymbol.none'.		
Message	Invalid measurement unit symbol.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.5.18 of IEC TS 61970-600-2		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:OP:Measurement.unitSymbol:analogValues		
Comment	IEC 61970-452 defines additional possible values so CGMES v3.0 is using these. The constraint does not differentiate between allowed values for Analog, Accumulator and Discrete measurements, while 61970-452 and CGMES v3 do.		

TABLE 74: CNREQUIREDINEQOPERATIONS

Severity: ERROR	**Name: CNRequiredInEQOperations**	**Level: 3**	**Validation scope: IGM**
Description	The association end cim:Terminal.ConnectivityNode is required in cases where EQ Operation profile is specified in the header. The different kinds of models are described in IEC TS 61970-600-1:2017 PROF4.		
Message	The association end cim:Terminal.ConnectivityNode is not provided for a model that contains EQ Operation profile.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.7.7 and rules PROF4 and PROF5 of IEC TS 61970-600-1:2017		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:EQ:Terminal:EXCH8ConnectivityNode		
Comment	In CGMES v3.0 ConnectivityNode objects are in Core Equipment profile. In addition, the associations were clarified. Also ConnectivityNode objects are required in CGMES v3.0 for all types of models.		

TABLE 75: ENERGYSOURCEVOLTAGE

Severity: ERROR	Name: EnergySourceVoltage	Level: 3	Validation scope: IGM
Description	For cim:EnergySource the attributes voltageMagnitude and voltageAngle are optional to include in EQ. The attributes are intended for the case when a strong network is providing power to a weak distribution network. Hence it is wrong to use these attributes in transmission studies and they shall not at all be used.		
Message	cim:EnergySource.voltageMagnitude and/or cim:EnergySource.voltageAngle are present.		
Justification	The use case for these attributes is not appropriate for transmission.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017 section E.19		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:456:SSH:EnergySource:EnergySourcePQ		
Comment	CGMES v3.0 is clearer and more restrictive.		

TABLE 76: SVCRATINGS

Severity: ERROR	Name: SVCRatings	Level: 3	Validation scope: IGM
Description	For every instance of cim:StaticVarCompensator, the value of cim:StaticVarCompensator.capacitiveRating must be positive. The value of cim:StaticVarCompensator.inductiveRating must be negative. Zero values are not allowed.		
Message	Capacitive rating is not greater than zero and/or inductive rating is not lower than zero for a SVC.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-2:2017, section 6.9.44		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:StaticVarCompensator.capacitiveRating:valueRange C:301:EQ:StaticVarCompensator.inductiveRating:valueRange		
Comment			

TABLE 77: SYNCHRONOUSCONDENSER

Severity: ERROR	Name: SynchronousCondenser	Level: 3	Validation scope: IGM
Description	A synchronous condenser (cim:SynchronousMachine.type equal to SynchronousMachineKind.condenser) has no capability for active power output. Therefore, such cim:SynchronousMachine shall not be associated with a cim:GeneratingUnit.		
Message	A synchronous condenser is associated with cim:GeneratingUnit.		
Justification	The name plate ratings are used as a reference.		

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-2:2017, section 6.9.47
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:SynchronousMachine.type:condenser
Comment	

TABLE 78: SMQLIMITS2

Severity: ERROR	**Name: SMQLimits2**	**Level: 3**	**Validation scope: IGM**
Description	For a cim:SynchronousMachine, either cim:SynchronousMachine.minQ and cim:SynchronousMachine.maxQ must be provided, or an association to a cim:ReactiveCapabilityCurve must exist. If cim:ReactiveCapabilityCurve exists cim:SynchronousMachine.minQ and cim:SynchronousMachine.maxQ shall be ignored.		
Message	Missing operating limits for a Synchronous Machine.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-2:2017, section 6.9.47		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:SynchronousMachine:reactiveLimits		
Comment	It is stricter in CGMES v3.0 with different implementation.		

TABLE 79: RATEDS

Severity: ERROR	**Name: RatedS**	**Level: 3**	**Validation scope: IGM**
Description	cim:RotatingMachine.ratedS is required and shall be greater than zero. cim:PowerTransfomerEnd.ratedS is required and shall be greater than zero.		
Message	cim:RotatingMachine.ratedS or cim:PowerTransfomerEnd.ratedS is either not provided or it is zero.		
Justification	RatedS is required for data validation.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-2:2017, section 6.9.41		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:EQ:RotatingMachine.ratedS:required		
Comment	CGMES v3.0 is more concrete while CGMES v2.4 leaves room for interpretation.		

TABLE 80: SHUNTCOMPENSATORSENSITIVITY

Severity: ERROR	Name: ShuntCompensatorSensitivity	Level: 3	Validation scope: IGM
Description	The following attribute value, if provided, shall be greater than zero cim:ShuntCompensator.voltageSensitivity.		
Message	VoltageSensitivity attribute value is not greater than zero.		
Justification	Decision from 2018-11-09 CGM_BP/EMF meeting. It was concluded that a negative value is not physically possible.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:ShuntCompensator.voltageSensitivity:valueRange		
Comment			

TABLE 81: CATIEFLOW

Severity: ERROR	Name: CATieFlow	Level: 3	Validation scope: IGM
Description	For every instance of cim:ControlArea for which the value of cim:ControlArea.type is cim:ControlAreaTypeKind.Interchange, cim:TieFlow instances must be provided.		
Message	cim:TieFlow-s are not defined for cim:ControlArea, no cim:TieFlow-s found.		
Justification	This is necessary to compute interchange.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQBD:BoundaryPoint.isExcludedFromAreaInterchange:requiredTieFlow		
Comment	In CGMES v3.0 there is different logic applied and it is nore robust solution.		

TABLE 82: OPERATIONALLIMITSETATTERMINAL

Severity: ERROR	Name: OperationalLimitSetAtTerminal	Level: 3	Validation scope: IGM
Description	The association end cim:OperationalLimitSet.Terminal is required. Note the association end cim:OperationalLimitSet.Equipment is neither checked nor reported in this rule.		
Message	The OperationalLimitSet is not linked to a Terminal.		

Justification	The limits in question are related to power flow, hence they are linked to the cim:Terminal. Less options also simplifies data exchange.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	Required association and C:452:EQ:OperationalLimitSet:limits
Comment	

TABLE 83: CONTROLMODECOMPATIBILITY

Severity: ERROR	**Name: ControlModeCompatibility**	**Level: 3**	**Validation scope: IGM**
Description	The cim:TapChangerControl or cim:RegulatingControl can only control a cim:Terminal at a cim:ConductingEquipment compatible with its type, - A phase shift tap changer can only do the cim:RegulatingControl.mode - active power control - A ratio tap changer can only do the cim:RegulatingControl.mode-s - voltage - reactivePower - powerFactor - A cim:SynchronousMachine or cim:ShuntCompensator instance can only do the cim:RegulatingControl.mode-s - voltage - reactivePower - powerFactor - A cim:StativeVarCompensator can only do the cim:RegulatingControl.mode-s - voltage - reactivePower - A cim:BusbarSection instance can only be controlled by a cim:RegulatingControl in mode (cim:RegulatingControl.mode): - voltage The following cim:RegulatingControl.modes are not at all allowed: - currentFlow - admittance - timeScheduled - temperature.		

Message	cim:TapChangerControl or cim:RegulatingControl with invalid cim:RegulatingControl.mode.
Justification	Only meaningful combinations of data are allowed.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:PhaseTapChanger:controlModeP C:452:EQ:RatioTapChanger:controlMode C:452:EQ:StaticVarCompensator:controlMode C:452:EQ:SynchronousMachine:controlMode C:452:EQ:ShuntCompensator:controlMode
Comment	CGMES v3.0 needs additional business constraint in case it is not allowed that PhaseTapChanger regulates voltage.

TABLE 84: ACLINESEGMENTR

Severity: ERROR	**Name: ACLineSegmentR**	**Level: 3**	**Validation scope: IGM**
Description	For every instance of cim:ACLineSegment the value of cim:ACLineSegment.r must be greater than or equal to zero.		
Message	A cim:ACLineSegment with negative resistance.		
Justification	Negative resistance means negative losses. This is not allowed for real equipment.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:ACLineSegment.r:valueRange		
Comment			

TABLE 85: LINEARSHUNTCOMPENSATORG

Severity: ERROR	**Name: LinearShuntCompensatorG**	**Level: 3**	**Validation scope: IGM**
Description	For every instance of cim:LinearShuntCompensator the value of cim:LinearShuntCompensator.gPerSection must be greater than or equal to zero.		
Message	cim:LinearShuntCompensator.gPerSection is not non-negative.		
Justification	The charging conductance represents the losses, which should be non-negative.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		

IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:LinearShuntCompensator.gPerSection:valueRange
Comment	

TABLE 86: SHUNTCOMPENSATORSECTIONS

Severity: ERROR	**Name: ShuntCompensatorSections**	**Level: 3**	**Validation scope: IGM**
Description	For every instance of cim:ShuntCompensator the value of cim:ShuntCompensator.normalSections must be greater than or equal to zero and less or equal to cim:ShuntCompensator.maximumSections.		
Message	cim:ShuntCompensator.normalSections is outside allowed range.		
Justification	The sections specify the shunt compensator sections in use, which should be non-negative.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:ShuntCompensator.normalSections:valueRangePair		
Comment			

TABLE 87: SVCSLOPE

Severity: ERROR	**Name: SVCSlope**	**Level: 3**	**Validation scope: IGM**
Description	The cim:StaticVarCompensator.slope must be positive or zero.		
Message	cim:StaticVarCompensator.slope is not positive or zero.		
Justification	The reactive power output of the SVC is proportional to the difference between the voltage at the regulated bus and the voltage setpoint. When the regulated bus voltage is equal to the voltage setpoint, the reactive power output is zero. cim:RequlatingControl is used as it has capabilities missing from SVC, e.g. the controlled point.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:StaticVarCompensator.slope:valueRange		
Comment			

TABLE 88: RCCYVALUES

Severity: ERROR	**Name: RCCYValues**	**Level: 3**	**Validation scope: IGM**

Description	For every instance of cim:CurveData, for which the cim:CurveData.Curve refers to a cim:ReactiveCapabilityCurve, the cim:CurveData.y2value must be greater or equal than cim:CurveData.y1value. If cim:CurveData.y2value and cim:CurveData.y1value are equal for all curve points this is considered an error.
Message	Invalid reactive capability curve data.
Justification	The name plate ratings are used as a reference.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:CurveData.Curve:reactive
Comment	

TABLE 89: RCCXVALUES2

Severity: ERROR	**Name: RCCXValues2**	**Level: 3**	**Validation scope: IGM**
Description	For a cim:SynchronousMachine with a cim:ReactiveCapabilityCurve the number of cim:CurveData instances depends on the attribute cim:SynchronousMachine.type as follows: - condenser, one cim:CurveData instance with cim:CurveData.xvalue = 0. - generator or generatorOrCondenser, at least two cim:CurveData instances with cim:CurveData.xvalue greater or equal 0. - motor or motorOrCondenser, at least two cim:CurveData instances with cim:CurveData.xvalue less or equal 0. - generatorOrMotor or generatorOrCondenserOrMotor, at least three cim:CurveData instances with at least one having cim:CurveData.xvalue greater or equal 0 and one having cim:CurveData.xvalue less or equal 0.		
Message	Invalid number of curve points in reactive capability curve data.		
Justification	A cim:ReactiveCapabilityCurve for a Pump Storage unit shall have at least three curve points. A cim:SynchronousMachine operating as either motor or generator shall have at least two curve points. A cim:SynchronousMachine operating as condenser shall have at least one curve point.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:CurveData.Curve:reactiveCountP		
Comment			

TABLE 90: RCCXVALUES3

Severity: ERROR	Name: RCCXValues3	Level: 3	Validation scope: IGM
Description	For each instance of cim:ReactiveCapabilityCurve, all instances of cim:CurveData shall have cim:CurveData.xvalue that is 1) greater than or equal to the cim:GeneratingUnit.minOperatingP, and 2) less than or equal to the cim:GeneratingUnit.maxOperatingP . cim:GeneratingUnit.minOperatingP and cim:GeneratingUnit.maxOperatingP are attributes of the cim:GeneratingUnit associated with the cim:SynchronousMachine to which the cim:ReactiveCapabilityCurve applies.		
Message	Invalid reactive capability curve data for a cim:SynchronousMachine.		
Justification	A cim:ReactiveCapabilityCurve must stay within the maximum capability of the unit.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:CurveData.xvalue:value		
Comment			

TABLE 91: PHASECODEGROUND

Severity: ERROR	Name: PhaseCodeGround	Level: 3	Validation scope: IGM
Description	Multiple cim:ConductingEquipment-s are typically connected to the same cim:TopologicalNode via their cim:Terminal-s. The phase codes of the cim:Terminal-s of the following grounding equipment shall be N: - cim:PetersenCoil - cim:Ground - cim:GroundingImpedance Note that cim:GroundDisconnector will have phase code N at the two sides.		
Message	Grounding equipment does not have phase code N.		
Justification	Ohm's and Kirchhoff's laws.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:Terminal.phases:phaseCode C:301:EQ:Terminal.phases:consistencyTopologicalNode		
Comment			

TABLE 92: TOOMANYTAPCHANGERS

Severity: ERROR	Name: TooManyTapChangers	Level: 3	Validation scope: IGM
Description	Multiple tap changers can be combined within one power transformer, but to avoid interpretation issues only one phase shifting and one ratio changing tap changer shall be modelled on any given cim:PowerTransformerEnd. Both cim:TapChanger objects shall not have their control enabled at the same time, i.e. cim:RegulatingControl.enabled and TapChanger.controlEnabled equal to true.		
Message	More than allowed cim:TapChanger objects at a cim:PowerTransformerEnd or the two cim:TapChanger objects are regulating.		
Justification	A real power transformer does not have more than one on-load tap changer of the same kind at the cim:PowerTransformerEnd or more than one manually adjustable.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:TapChanger:multipleTypes		
Comment	The condition related to control enabled is not part of the CGMES constraint.		

9.1.2 SEVERITY WARNING

TABLE 93: POWERTRANSFORMERENDRATEDU

Severity: WARNING	Name: PowerTransformerEndRatedU	Level: 3	Validation scope: IGM
Description	The cim:PowerTransformerEnd.ratedU attribute must be greater than zero.		
Message	cim:PowerTransformerEnd.ratedU is not greater than zero.		
Justification	The cim:PowerTransformerEnd.ratedU attribute is used in pu calculations.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:PowerTransformerEnd.ratedU:valueRange		
Comment	CGMES v3.0 adds additional conditions which makes the constraint stricter.		

TABLE 94: SMQLIMITS1

Severity: WARNING	Name: SMQLimits1	Level: 3	Validation scope: IGM
Description	For a cim:SynchronousMachine, the value of cim:SynchronousMachine.maxQ should be greater than or equal to the value of cim:SynchronousMachine.minQ, if provided. Note that the limits follow generation sign convention.		
Message	cim:SynchronousMachine.maxQ is not greater than or equal to cim:SynchronousMachine.minQ.		
Justification	The name plate ratings are used as a reference.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:SynchronousMachine.maxQ:valueRangePair		
Comment	It is stricter in CGMES v3.0		

TABLE 95: SMPLIMITS

Severity: WARNING	Name: SMPLimits	Level: 3	Validation scope: IGM
Description	For a cim:SynchronousMachine associated with a cim:GeneratingUnit or its subclasses, the active power limits should relate to cim:SynchronousMachine.type as follows: - generator or generatorOrCondenser, - cim:GeneratingUnit.minOperatingP greater than or equal to 0, - cim:GeneratingUnit.maxOperatingP greater than 0, - cim:GeneratingUnit.maxOperatingP greater than or equal to cim:GeneratingUnit.minOperatingP. - motor or motorOrCondenser, - cim:GeneratingUnit.minOperatingP less than 0, - cim:GeneratingUnit.maxOperatingP less than or equal to 0, - cim:GeneratingUnit.maxOperatingP greater than or equal to cim:GeneratingUnit.minOperatingP. - generatorOrMotor or generatorOrCondenserOrMotor, - cim:GeneratingUnit.minOperatingP less than 0 and cim:GeneratingUnit.maxOperatingP greater than 0. Note: 1) As there is no cim:GeneratingUnit associated with cim:SynchronousMachine in cases of condenser only type, the condenser cannot be included in this rule. 2) Depending on sign conventions of applications applied to motor operating mode, the meaning operating active power limits defined by cim:GeneratingUnit.maxOperatingP and cim:GeneratingUnit.minOperatingP maybe affected. For instance, if maxOperatingP=-5 and		

	minOperatingP=-100 the instance data will pass the validation in case it is a motor. However, for an application which has positive limits (e.g. Pmax and Pmin) for motor mode, the mapping would be Pmax = minOperatingP and Pmin = maxOperatingP.
Message	The active power limit values do not match the cim:SynchronousMachine.type.
Justification	The active power limit values depend on the cim:SynchronousMachine.type and this dependence need to be described.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:GeneratingUnit:typeDependency
Comment	It is stricter in CGMES v3.0

TABLE 96: CURVEXVALUES

Severity: WARNING	**Name: CurveXValues**	**Level: 3**	**Validation scope: IGM**
Description	For every instance of cim:CurveData, for which the cim:CurveData.Curve refers to a cim:ReactiveCapabilityCurve, the cim:CurveData.xvalue shall be different, e.g. in the case of two cim:CurveData called CD1 and CD2 the following shall give a warning when CD1.xvalue = CD2.xvalue.		
Message	Some points in the reactive capability curve have the same x value.		
Justification	All x values in a reactive capability curve shall differ for the curve to be meaningful.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:ReactiveCapabiltyCurve.CurveData:xvalue		
Comment	The implementation in CGMES v3.0 is different as curve related constraints were revised.		

TABLE 97: RCCXVALUES4

Severity: WARNING	**Name: RCCXValues4**	**Level: 3**	**Validation scope: IGM**
Description	For every instance of cim:ReactiveCapabilityCurve, each cim:CurveData instance must satisfy the following relation - x*x+y1*y1 LE ratedS*ratedS and x*x+y2*y2 LE ratedS*ratedS where - LE = less or equal - x= cim:CurveData.xvalue		

	- y1 = cim:CurveData.y1value - y2 = cim:CurveData.y2value - ratedS = cim:RotatingMachine.ratedS * (1 + NUMERIC_TOLERANCE)
Message	Invalid reactive capability curve data for a cim:SynchronousMachine.
Justification	A cim:ReactiveCapabilityCurve must cover the full operating range.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:CurveData.Curve:equationY2 C:452:EQ:CurveData.Curve:equationY1
Comment	The tolerance is not part of CGMES v3.0, i.e. the standard is stricter.

TABLE 98: RCANDTCCCONTROLLINGOBJECTS

Severity: WARNING	**Name: RCandTCCcontrollingObjects**	**Level: 3**	**Validation scope: IGM**
Description	A cim:RegulatingControl or cim:TapChangerControl shall have at least one controlling object. The cardinality - cim:RegulatingControl[0..1]-[0..*]cim:RegulatingCondEq - cim:TapChangerControl[0..1]-[0..*]cim:TapChanger are currently allowing no controlling objects.		
Message	cim:RegulatingControl or cim:TapChangerControl without controlling objects.		
Justification	A cim:RegulatingControl or cim:TapChangerControl without controlling objects cannot perform control. It is important for IGMs quality and CGM creation process to indicate these occurrences.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:RegulatingControl:RegulatingEquipment		
Comment	Cardinality of the association TapChanger.TapChangerControl was changed to require TapChanger associated. A constraint was added to CGMES v3.0 to secure that RegulatingControl has controlling object. The severity in CGMES v3.0 is violation.		

TABLE 99: WINDINGCONNECTIONANGLE

Severity: WARNING	**Name: WindingConnectionAngle**	**Level: 3**	**Validation scope: IGM**
Description	The cim:PhaseTapChangerAsymmetrical.windingConnectionAngle attribute in real grids can only have the following values:		

	- +/-150; - +/-120; - +/-90; - +/-60; - +/-30. Values can be expressed as integer or float. Non-zero decimals are not allowed in case the value is expressed as float.
Message	cim:PhaseTapChangerAsymmetrical.windingConnectionAngle value is not one of the defined values.
Justification	Asymmetrical phase tap changers are built for specific connection angles.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:PhaseTapChangerAsymmetrical.windingConnectionAngle:valueRange
Comment	CGMES v3.0 is stricter and providing more guidance.

9.1.3 SEVERITY INFO

TABLE 100: PATL5

Severity: INFO	**Name: PATL5**	**Level: 3**	**Validation scope: IGM**
Description	PATL type on voltage limits should be ignored.		
Message	PATL voltage limit is ignored.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.8.9.1 of IEC TS 61970-600-2:2017		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:LimitKind.patl:allowedType		
Comment	CGMES v3.0 is clearer and more restrictive.		

TABLE 101: ACLINESEGMENTX

Severity: INFO	**Name: ACLineSegmentX**	**Level: 3**	**Validation scope: IGM**
Description	For every instance of cim:ACLineSegment the value of cim:ACLineSegment.x should be greater than or equal to EQ_BRANCH_X_LIMIT Ohm.		

Message	Reactance value is not greater than or equal to EQ_BRANCH_X_LIMIT.
Justification	Too small impedances cause numerical instability when solving the power flow.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:ACLineSegment.x:valueRange
Comment	Threshold is not part of the standard

9.2 Business Constraints

9.2.1 Severity Error

Table 102: InstancesOfGeneralClass

Severity: ERROR	**Name: InstancesOfGeneralClass**	**Level: 3**	**Validation scope: IGM**
Description	The most specific and detailed class shall in general be instantiated. Hence more general classes shall not be instantiated. The following classes are specifically noted as not allowed to instantiate: cim:EnergyConsumer.		
Message	Instances of type cim:EnergyConsumer are present.		
Justification	The level of detail described by the more specific class are needed in studies. The approved methodologies: CGMM-v1-plus Article 9, Load, 4(c) (as well CGMM-v2-plus and CGMM-v3 referencing to CGMM-v1-plus) and GLDPM-v1: Article 2, Definitions and interpretation, point 3 and 7, Article 11, 4(9) (as well GLDPM-v2 referencing to GLDPM-v1) foresee the provision of conforming and non-conforming load flag as well as approved EMF Requirements, which implies the use specific classes of EnergyConsumer. IEC 61970-600-1:2017 Common Grid Model Exchange Specification, 5.1 General constraints, GENC11: Instance data to be exchanged must make use of the most detailed class possible within a profile, i.e. using sub-typed classes rather than general classes, e.g. NuclearGeneratingUnit instead GeneratingUnit. Note that this rule is not applied for GeneratingUnit.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		

Comment	

TABLE 103: TARGETDB

Severity: ERROR	Name: TargetDB	Level: 3	Validation scope: IGM
Description	For every instance of cim:RegulatingControl (SSH) for which the value of cim:RegulatingControl.discrete is true and cim:RegulatingControl.enabled is true, cim:RegulatingControl.targetDeadband must be provided and must be greater than 0.		
Message	Target deadband is either not provided if the regulating control is discrete and active or it is not greater than zero.		
Justification	If cim:RegulatingControl.discrete is set to true and no deadband is provided the power flow algorithm may not reach a solution but may continue to try find one which results in hunting.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:RegulatingControl.targetDeadband:applicability		
Comment	CGMES v3.0 has the constraint but still allows 0.		

TABLE 104: OPERATIONALLIMITVALUE

Severity: ERROR	Name: OperationalLimitValue	Level: 3	Validation scope: IGM
Description	For every instance of cim:VoltageLimit, the value of cim:VoltageLimit.value must be > 0. For every instance of cim:CurrentLimit, the value of cim:CurrentLimit.value must be > 0. For every instance of cim:ActivePowerLimit, the value of cim:ActivePowerLimit.value must be > 0. For every instance of cim:ApparentPowerLimit, the value of cim:ApparentPowerLimit.value must be > 0.		
Message	A OperationalLimit value is not positive.		
Justification	See section 6.8.5 of IEC TS 61970-600-2.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:ActivePowerLimit.normalValue:valueRange C:301:SSH:CurrentLimit.value:valueRange C:301:EQ:CurrentLimit.normalValue:valueRange C:301:EQ:ActivePowerLimit.normalValue:valueRange C:301:SSH:ActivePowerLimit.value:valueRange C:301:SSH:ApparentPowerLimit.value:valueRange		

	C:301:EQ:ApparentPowerLimit.normalValue:valueRange C:301:SSH:VoltageLimit.value:valueRange C:301:EQ:VoltageLimit.normalValue:valueRange
Comment	CGMES v3.0 has the constraint but still allows 0.

TABLE 105: ACCEPTABLEDURATION

Severity: ERROR	**Name: AcceptableDuration**	**Level: 3**	**Validation scope: IGM**
Description	The usage of the attribute cim:OperationalLimitType.acceptableDuration depends on the value of the entsoe:OperationalLimitType.limitType attribute as follows: - patl: acceptableDuration is not used; - patlt: usage of acceptableDuration is restricted, i.e. it is not used as another way to express the severity of the limit; - tatl: acceptableDuration is used to define several TATL limit types - tc: acceptableDuration is not used as an immediate tripping is expected - tct: acceptableDuration is used as the limit is less than the tc limit and describe how long the violation may sustain before tripping. If acceptableDuration is not used the attribute can be completely omitted or if included the acceptableDuration value shall be ignored.		
Message	cim:OperationalLimitType.acceptableDuration is not provided for TATL and TCT limit types.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.8.9.1 and 6.8.7 of IEC TS 61970-600-2		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:OperationalLimitType.acceptableDuration:usage		
Comment	The constraint conflicts CGMES v2.4 regarding PATLT. In CGMES v3.0 there is another attribute to be clearer.		

TABLE 106: PATL1

Severity: ERROR	**Name: PATL1**	**Level: 3**	**Validation scope: IGM**
Description	Every instance of cim:ACLineSegment and cim:SeriesCompensator, that is not aggregated, shall have at least one cim:OperationalLimitSet linked to one of its cim:Terminals. A cim:OperationalLimitSet shall have at least one cim:OperationalLimit of type entsoe:LimitTypeKind.patl. Equipment is aggregated when cim:Equipment.aggregate is present and set to 'true'.		

Message	PATL is missing for cim:ACLineSegment or cim:SeriesCompensator.
Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.8.7 of IEC TS 61970-600-2
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	In general, the requirement where to have limits is a business specific and CGMES v3.0 does not restrict.

TABLE 107: PATL2

Severity: ERROR	**Name: PATL2**	**Level: 3**	**Validation scope: IGM**
Description	Every instance of cim:PowerTransformer, that is not aggregated (cim:Equipment.aggregate equals to false or it is missing), shall have at least one cim:OperationalLimitSet with at least one cim:OperationalLimit of type entsoe:LimitTypeKind.patl linked to one of cim:Terminal-s of the cim:PowerTransformer.		
Message	A non-aggregated cim:PowerTrainsformer which has not a cim:OperationalLimitSet with at least one cim:OperationalLimit of type entsoe:LimitTypeKind.patl associated to any of its cim:Terminal-s.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.8.7 of IEC TS 61970-600-2		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment	In general, the requirement where to have limits is a business specific and CGMES v3.0 does not restrict.		

TABLE 108: PATL3

Severity: ERROR	**Name: PATL3**	**Level: 3**	**Validation scope: IGM**
Description	There shall be only one PATL limitType per cim:OperationalLimitSet and type - cim:ActivePowerLimit - cim:CurrentLimit or cim:ApparentPowerLimit This means that an cim:OperationalLimitSet may have two PATL values, one for cim:CurrentLimit or cim:ApparentPowerLimit and one for cim:ActivePowerLimit.		
Message	Redundant PATL is present for a OperationalLimitSet.		

Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.8.9.1 of IEC TS 61970-600-2
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	Different logic is applied in CGMES v3.0 as there are other attributes involved. CGMES v3.0 allows only one PATL while QoCDC allows 2.

TABLE 109: GENERATINGUNITMAXPGEN

Severity: ERROR	Name: GeneratingUnitMaxPGen	Level: 3	Validation scope: IGM
Description	For every instance of cim:GeneratingUnit, cim:HydroGeneratingUnit, cim:NuclearGeneratingUnit, cim:SolarGeneratingUnit, cim:ThermalGeneratingUnit and cim:WindGeneratingUnit, with cim:SynchronousMachine.type equal to generator (cim:SynchronousMachineKind.generator), the value of cim:GeneratingUnit.maxOperatingP must be greater than zero. Note that the limits follow generation sign convention.		
Message	A cim:GeneratingUnit.maxOperatingP is not greater than zero.		
Justification	The name plate ratings are used as a reference.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment	It is stricter in CGMES v3.0 with different implementation.		

TABLE 110: CURVESTYLE

Severity: ERROR	Name: CurveStyle	Level: 3	Validation scope: IGM
Description	The cim:Curve.curveStyle enumerated value cim:CurveStyle.constantYValue is not allowed.		
Message	A cim:CurveStyle.constantYValue enumeration is declared.		
Justification	The cim:CurveStyle.constantYValue gives too inaccurate compared with cim:CurveStyle.straightLineYValues.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		

IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	The two values of the enumerations are allowed in CGMES v3.0. This is done to help resolving other issues. As the topic is covered in more general way the constraint is not needed in CGMES v3.0.

TABLE 111: CONTROLAREAINSTANCE

Severity: ERROR	**Name: ControlAreaInstance**	**Level: 3**	**Validation scope: AC IGM**
Description	Exactly one cim:ControlArea instance per AC IGM with following attributes must be defined: - cim:ControlArea.type is cim:ControlAreaTypeKind.Interchange - an entsoe:IdentifiedObject.energyIdentCodeEic shall be one of the codes defined in the QoCDC Reference Data document in column “RegionEic”.		
Message	cim:ControlArea instance of type cim:ControlAreaTypeKind.Interchange is missing or does not have correct entsoe:IdentifiedObject.energyIdentCodeEic.		
Justification	The cim:ControlArea of type interchange is the model equivalent of a SchedulingArea.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 112: SUBLOADAREAMISSING

Severity: ERROR	**Name: SubLoadAreaMissing**	**Level: 3**	**Validation scope: IGM**
Description	The reference cim:LoadGroup->cim:SubLoadArea is required. The class cim:LoadGroup in in EQ core while cim:SubLoadArea is in operation. Hence a BB model using classes cim:ConformLoad and cim:NonConformLoad will get an error if cim:SubLoadArea instances are missing. As a CGM may contain both NB and BB models the cardinality for the BB models need to be 0..1 but for the NB models 1. This is solved by making the reference cim:LoadGroup->cim:SubLoadArea optional and have this rule checking that NB models do have the references.		
Message	The reference cim:LoadGroup.SubLoadArea is missing.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		

IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	Modifies CGMES v2.4. It is not applicable for CGMES v3.0 as in CGMES v3.0 both LoadArea and SubLoadArea are in EQ profile, associations are required, all models are built with ConnectivityNode objects.

TABLE 113: ENERGYAREAMISSING

Severity: ERROR	**Name: EnergyAreaMissing**	**Level: 3**	**Validation scope: IGM**
Description	The reference cim:ControlArea->cim:EnergyArea is required for NB models but not for BB models.		
Message	The reference cim:ControlArea.EnergyArea is missing.		
Justification	Required for NB models according to diagram note in CGMES2.4.15.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment	CGMES v2.4 is not that explicit. It is not applicable for CGMES v3.0 as in CGMES v3.0 both LoadArea and SubLoadArea are in EQ profile, associations are required, all models are built with ConnectivityNode objects.		

TABLE 114: GENERATINGUNITSM

Severity: ERROR	**Name: GeneratingUnitSM**	**Level: 3**	**Validation scope: IGM**
Description	A cim:GeneratingUnit or any of its subclasses is not allowed to have more than one cim:RotatingMachine.		
Message	More than one cim:RotatingMachine defined for a cim:GeneratingUnit.		
Justification	Having more than one cim:RotatingMachine with a cim:GeneratingUnit will make active and reactive limits dynamically dependent of the number of operational cim:RotatingMachine-s which makes scheduling difficult as this information is missing.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 115: NOFLOWCONTROLATNONRETAINEDSW

Severity: ERROR	Name: NoFlowControlAtNonRetainedSW	Level: 3	Validation scope: IGM
Description	cim:RegulatingControl.Terminal can reference a cim:Terminal of a non-retained cim:Switch (i.e. where cim:Switch.retained is set to false) only if cim:RegulatingControl.mode is cim:RegulatingControlModeKind.voltage.		
Message	A non-retained cim:Switch has flow control, i.e. cim:RegulatingControl.Terminal refers to a cim:Terminal of that cim:Switch.		
Justification	Non-retained cim:Switch-es are not included in a power flow solution, hence it is not possible for the power flow calculation to control their cim:Terminal-s. cim:Terminal-s of retained cim:Switch-es can be included in flow control.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 116: INFINITEVOLTAGESOURCES

Severity: ERROR	Name: InfiniteVoltageSources	Level: 3	Validation scope: IGM
Description	For each cim:SynchronousMachine and cim:ExternalNetworkInjection that is associated with an active cim:RegulatingControl objects (cim:RegulatingControl.enabled equals to true) and cim:EquivalentInjection that has cim:EquivalentInjection.regulatingStatus equals to true, the absolute value of reactive power limits (obtained as maximum value of minQ, maxQ and reactive capability curve, where applicable) or output (SvPowerFlow.q) shall not be greater than REACTIVE_POWER_THRESHOLD MVAr.		
Message	The equipment has reactive power limits or output above the threshold.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 117: BASEVOLTAGEVSCONTAINERVOLTAGE

Severity: ERROR	Name: BaseVoltageVsContainerVoltage	Level: 3	Validation scope: IGM
Description	cim:BaseVoltage.nominalVoltage of the cim:TopologicalNode.BaseVoltage shall be the same as cim:BaseVoltage.nominalVoltage of the cim:Bay and/or cim:VoltageLevel containers that are in the scope of creation of a cim:TopologicalNode.		
Message	TopologicalNode {rdfID} has different cim:BaseVoltage.nominalVoltage from the value of related container {rdfID}.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 118: ACIGMWITHDCCLASSES

Severity: ERROR	Name: AcIGMwithDCclasses	Level: 3	Validation scope: IGM
Description	A detailed HVDC interconnection, which by definition models the converters DC equipment, shall be exchanged as a separate DC IGM per HVDC Link. Therefore, an AC IGM shall not contain DC classes defined in CGMES.		
Message	An AC IGM contains DC classes.		
Justification	Specific CGM Build process requirement defined in the CGM IG.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 119: TABLEPOINTOUTSIDETAPCHANGERLIMITS

Severity: ERROR	Name: TablePointOutsideTapChangerLimits	Level: 3	Validation scope: IGM
Description	For every cim:RatioTapChangerTable and cim:PhaseTapChangerTable, all the associated cim:TapChangerTablePoint (cim:RatioTapChangerTablePoint, cim:PhaseTapChangerTablePoint) shall have cim:TapChangerTablePoint.step defined within limits of corresponding cim:TapChanger (cim:RatioTapChanger, cim:PhaseTapChangerTabular) [cim:TapChanger.lowStep; cim:TapChanger.highStep].		

Message	cim:TapChangerTablePoint.step is outside [cim:TapChanger.lowStep; cim:TapChanger.highStep] of either cim:RatioTapChanger or cim:PhaseTapChangerTabular.
Justification	cim:TapChangerTablePoint.step-s shall be consistent and inside the range defined by the corresponding cim:TapChanger.highStep and cim:TapChanger.lowStep.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 120: TNNOTINISLAND

Severity: ERROR	**Name: TNnotInIsland**	**Level: 3**	**Validation scope: IGM**
Description	Each cim:TopologicalNode with cim:SvVoltage.v different than 0 shall be part of a cim:TopologicalIsland.		
Message	cim:TopologicalNode with voltage different from 0 is not part of a cim:TopologicalIsland.		
Justification	Not including results of cim:TopologicalNode objects that are energized suggests that either the topological process and solution are not correct.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 121: EQUIPMENTTERMINALS

Severity: ERROR	**Name: EquipmentTerminals**	**Level: 3**	**Validation scope: IGM**
Description	cim:Terminal objects that are associated with an equipment that has more than one cim:Terminal shall be connected to different cim:ConnectivityNode objects.		
Message	Multiterminal equipment which has two or more terminals connected to same cim:ConnectivityNode.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		

IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

9.2.2 SEVERITY WARNING

TABLE 122: NUMBEROFSUBSTATIONS

Severity: WARNING	**Name: NumberOfSubstations**	**Level: 3**	**Validation scope: IGM**
Description	An IGM should normally have a site with one or multiple substations. Each substation has its own voltage levels. Therefore, the number of cim:VoltageLevel objects should be greater than the number of cim:Substation objects. The number of cim:VoltageLevel objects could equal to the number of cim:Substation objects if there are less than NUMBER_OF_SUBSTATIONS cim:Substation objects.		
Message	The number of cim:Substation objects is outside defined limitations.		
Justification	The number of cim:Substations should reflect the design of the power system.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:EQ:Substation:count		
Comment	CGMES v3.0 contains this rule but without the threshold.		

TABLE 123: SMQLIMITS3

Severity: WARNING	**Name: SMQLimits3**	**Level: 3**	**Validation scope: IGM**
Description	For every instance of cim:SynchronousMachine with exactly one cim:GeneratingUnit the following rules applies - abs(maxP) Less or Equal ratedS - abs(minP) Less or Equal ratedS - abs(maxQ) Less or Equal ratedS - abs(minQ) Less or Equal ratedS where - maxP is cim:GeneratingUnit.maxOperatingP - maxQ is cim:SynchronousMachine.maxQ - minP is cim:GeneratingUnit.minOperatingP - minQ is cim:SynchronousMachine.minQ		

	- ratedS is cim:RotatingMachine.ratedS.
Message	Inconsistent cim:SynchronousMachine and cim:GeneratingUnit limits.
Justification	The limit values should be inside the rated capability.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	Implemented differently in CGMES v3.0

TABLE 124: SMRATEDSUNREALISTIC

Severity: WARNING	**Name: SMRatedSunrealistic**	**Level: 3**	**Validation scope: IGM**
Description	If a cim:SynchronousMachine has a rated power way beyond the specified active and reactive limit values or way outside the reactive capability curve the rated power value is not realistic. A EQ_RATEDS_REASONABILITY_FACTOR (RSRF) is used to determine if a rated power is reasonable for a non aggregated cim:SynchronousMachine, i.e. cim:Equipment.aggregate equals false or cim:Equipment.aggregate is not defined. In case of inconsistency between cim:Equipment.aggregate reported on cim:SynchronousMachine and the associated cim:GeneratingUnit (or its subtype), the constraint is checked as if cim:Equipment.aggregate equals to false. To be realistic and reasonable the cim:RotatingMachine.ratedS shall if an active or reactive power limit is present be less than - max(abs(cim:SynchronousMachine.minQ), abs(cim:SynchronousMachine.maxQ), abs(cim:GeneratingUnit.minOperatingP, abs(cim:GeneratingUnit.maxOperatingP))*RSRF - max(abs(CurveData.xvalue), abs(CurveData.y1value), abs(CurveData.y2value))*RSRF for all x, y1 and y2 values.		
Message	Unrealistic cim:RotatingMachine.ratedS is specified for a non-aggregated synchronous machine.		
Justification	Rated powers may be given a large and unrealistic value that will impact other rules which may result in erroneous reporting by them.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		

IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	In CGMES v3.0 it is covered by combination of different constraints and setup. Therefore, it is not needed if CGMES v3.0 is used.

TABLE 125: TARGETDEADBANDOUTOFRANGE

Severity: WARNING	**Name: TargetDeadbandOutOfRange**	**Level: 3**	**Validation scope: IGM**
Description	If the cim:RegulatingControl.targetDeadband has a value similar to the cim:RegulatingControl.targetValue this means that it has no effect and that the cim:RegulatingControl is in practice disabled. Disabling a cim:RegulatingControl this way shouldn't be used, instead use the cim:RegulatingControl.enabled flag. cim:RegulatingControl.targetDeadband/EQ_DB_REASONABILITY_FACTOR should be less than the cim:RegulatingControl.targetValue. With a value of 2 for the EQ_DB_REASONABILITY_FACTOR this means that if the cim:RegulatingControl.targetDeadband is greater than twice the cim:RegulatingControl.targetValue this means that the target will always stay inside the dead band. The rule is only activated when cim:RegulatingControl.discrete="true", cim:RegulatingControl.enabled="true" and cim:RegulatingControl.mode= RegulatingControlModeKind.voltage.		
Message	cim:RegulatingControl has been potentially disabled with a large cim:RegulatingControl.targetDeadband.		
Justification	Using other ways than cim:RegulatingControl.enabled flag shouldn't be used.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 126: VOLTAGELIMITDIRECTION

Severity: WARNING	**Name: VoltageLimitDirection**	**Level: 3**	**Validation scope: IGM**
Description	A cim:VoltageLimit should be specified with a direction high or low, i.e. the cim:OperationalLimitType.direction value should be one of - cim:OperationalLimitDirectionKind.high - cim:OperationalLimitDirectionKind.low		

Message	cim:OperationalLimitType.direction is either 1) not provided or 2) it is not set to cim:OperationalLimitDirectionKind.high or cim:OperationalLimitDirectionKind.low.
Justification	If the direction is missing it is not possible to check the voltage value.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 127: VOLTAGELIMITSCONSISTENCY

Severity: WARNING	**Name: VoltageLimitsConsistency**	**Level: 3**	**Validation scope: IGM**
Description	cim:VoltageLimit within a given cim:OperationalLimitSet with direction cim:OperationalLimitDirectionKind.high should be greater than cim:VoltageLimit with direction cim:OperationalLimitDirectionKind.low.		
Message	cim:VoltageLimit values are not consistent with the specified directions.		
Justification	cim:VoltageLimit not consistent with the specified direction are meaningless.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 128: FLOWLIMITSDIRECTIONCONSISTENCY

Severity: WARNING	**Name: FlowLimitsDirectionConsistency**	**Level: 3**	**Validation scope: IGM**
Description	Branch flow limits cim:CurrentLimit, cim:ApparentPowerLimit and cim:ActivePowerLimit should have a cim:OperationalLimitType.direction with value cim:OperationalLimitDirectionKind.absoluteValue.		
Message	Branch flow limits with other direction than absoluteValue.		
Justification	Branch flow can go in both directions on the branch. Hence the direction should be specified as an absoluteValue.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		

IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 129: ASYMMETRICALEQUIVALENT

Severity: WARNING	**Name: AsymmetricalEquivalent**	**Level: 3**	**Validation scope: IGM**
Description	cim:EquivalentBranch with EquivalentBranch.r not equal to EquivalentBranch.r21 or EquivalentBranch.x not equal to EquivalentBranch.x21 should not be used.		
Message	cim:EquivalentBranch with asymmetrical impedances.		
Justification	Equivalents with different impedance in different directions may result in poor convergence, hence reporting the difference support error tracing in data.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 130: POSITIVETRANSFORMERB

Severity: WARNING	**Name: PositiveTransformerB**	**Level: 3**	**Validation scope: IGM**
Description	Two-winding transformer with positive shunt (cim:PowerTransformerEnd.b > 0) that are not equivalenced (cim:Equipment.aggregate = false) should not have positive PowerTransformerEnd.b.		
Message	Two winding transformer with a positive shunt.		
Justification	Two winding transformers are reactive and should not have positive cim:PowerTransformerEnd.b.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:PowerTransformerEnd.b:valueRange		
Comment	CGMES v3.0 allows 0, i.e. this constraint further restricts CGMES v3.0.		

9.2.3 SEVERITY INFO

TABLE 131: CNTERMINALS

Severity: INFO	Name: CNTerminals	Level: 3	Validation scope: IGM
Description	Not connected cim:ConnectivityNode-s should not be present in the models. For a cim:ConnectivityNode to be considered connected it should have at least one cim:ConductingEquipment, which is a multiterminal equipment (i.e. has more than one cim:Terminal).		
Message	The cim:ConnectivityNode is not connected to equipment that has more than one cim:Terminal.		
Justification	Isolated or dead end cim:ConnectivityNode-s may indicate a connectivity issue.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 132: PATL4

Severity: INFO	Name: PATL4	Level: 3	Validation scope: IGM
Description	For an instance of cim:ACLineSegment or cim:SeriesCompensator the limit values of the same cim:OperationalLimitType.limitType (defined in all relevant cim:OperationalLimitSet objects) should not differ more than PATL_LIMIT_VALUE_DIFF between the two sides, e.g. a cim:CurrentLimit of type PATL.		
Message	Differing limit values on two sides of the equipment above PATL_LIMIT_VALUE_DIFF.		
Justification	Based on engineering practice.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 133: SERIESCOMPENSATORX

Severity: INFO	Name: SeriesCompensatorX	Level: 3	Validation scope: IGM
Description	For every instance of cim:SeriesCompensator the value of abs(cim:SeriesCompensator.x) should be greater than or equal to EQ_BRANCH_X_LIMIT Ohm.		
Message	Reactance value is not greater than or equal to EQ_BRANCH_X_LIMIT.		
Justification	Too small impedances cause numerical instability when solving the power flow.		

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 134: EQUIVALENTBRANCHX

Severity: INFO	**Name: EquivalentBranchX**	**Level: 3**	**Validation scope: IGM**
Description	For every instance of EquivalentBranch (EB) the total impedance should be greater than or equal to EQ_BRANCH_X_LIMIT Ohm. The total impedance is computed by sqrt(EB.x * EB.x + EB.x21 * EB.x21). In cases where EB.x21 is not provided, it is equal to zero in the equation for calculation of the total impedance.		
Message	Total impedance is not greater than or equal to EQ_BRANCH_X_LIMIT Ohm.		
Justification	Too small impedances cause numerical instability when solving the power flow.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 135: POWERTRANSFORMERENDR

Severity: INFO	**Name: PowerTransformerEndR**	**Level: 3**	**Validation scope: IGM**
Description	cim:PowerTransformerEnd.r should conform to the following rules: - Be equal to 0 Ohm for the 2nd winding (the winding with cim:TransformerEnd.endNumber = 2, i.e. lower voltage end) of a two-winding transformer; - Be greater than or equal to EQ_BRANCH_X_LIMIT Ohm for the 1st winding (the winding with cim:TransformerEnd.endNumber = 1, i.e. highest voltage end) of a two-winding transformer; - Be greater than or equal to EQ_BRANCH_X_LIMIT Ohm for all windings of a three-winding transformer.		
Message	PowerTransformerEnd.r is either: 1) different than 0 Ohm for 2nd winding of a two-winding transformer or 2) not greater than or equal to EQ_BRANCH_X_LIMIT Ohm for all windings of a three-winding		

	transformer or 3) not greater than or equal to EQ_BRANCH_X_LIMIT Ohm for 1st winding of a two-winding transformer.
Justification	Negative resistance means negative losses. This is not allowed for real equipment.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:PowerTransformerEnd.r:valueRange
Comment	Threshold is not part of the standard

TABLE 136: POWERTRANSFORMERENDX

Severity: INFO	**Name: PowerTransformerEndX**	**Level: 3**	**Validation scope: IGM**
Description	cim:PowerTransformerEnd.x should conform to the following rules: - Be greater than or equal to EQ_BRANCH_X_LIMIT Ohm for the 1st winding (the winding with cim:TransformerEnd.endNumber = 1, i.e. highest voltage end) of a two-winding transformer; - Be equal to 0 Ohm for the 2nd winding (the winding with cim:TransformerEnd.endNumber = 2, i.e. lower voltage end) of a two-winding transformer; - the abs(cim:PowerTransformerEnd.x) be greater than or equal to EQ_BRANCH_X_LIMIT Ohm for all windings of a three-winding transformer.		
Message	One of the following occurs: 1) The value of 1st winding (cim:TransformerEnd.endNumber = 1) is not greater than or equal to EQ_BRANCH_X_LIMIT Ohm for a two-winding transformer. 2) The value of 2nd winding (cim:TransformerEnd.endNumber = 2) is not 0 Ohm. 3) The absolute value is not greater than or equal to EQ_BRANCH_X_LIMIT Ohm for each of the windings of a three-winding transformer.		
Justification	Transformers with zero series reactance do not exist. At a two winding transformer the series reactance is specified at the high voltage side and the low voltage side isn't used.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:PowerTransformerEnd.x:PowerTransformerEndX		
Comment	Threshold is not part of the standard		

10 LEVEL 4: MODEL ASSEMBLY

10.1 STANDARD CONSTRAINTS

10.1.1 SEVERITY ERROR

TABLE 137: TPBDEQBD

Severity: ERROR	**Name: TPBDEQBD**	**Level: 4**	**Validation scope: IGM & CGM**
Description	Every TPBD file shall have an 'md:Model.DependentOn' reference to the EQBD file.		
Message	Invalid md:Model.DependentOn statement(s) in TPBD.		
Justification	Dependent IDs refer to IDs of the dependent files at the time of the export.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017, requirement HREF2, PROF10		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference			
Comment	Not applicable for CGMES v3.0 as there is no TPBD dataset.		

TABLE 138: EQEQBD

Severity: ERROR	**Name: EQEQBD**	**Level: 4**	**Validation scope: IGM & CGM**
Description	Every EQ file shall have an 'md:Model.DependentOn' reference to the EQBD file that was used for the serialization.		
Message	Invalid md:Model.DependentOn statement(s) in EQ.		
Justification	Dependent IDs refer to IDs of the dependent files at the time of the export.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017, requirement HREF2, PROF10		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:ALL:NA:PROF10		
Comment	In CGMES v3.0 this is covered in a generic way.		

TABLE 139: TPEQTPEQDIFF

Severity: ERROR	Name: TPEQTPEQDIFF	Level: 4	Validation scope: IGM & CGM
Description	Every TP file shall have an 'md:Model.DependentOn' reference to a EQ or EQDIFF file. Note: This is a minimum requirement so more references may be present.		
Message	Invalid md:Model.DependentOn statement(s) in TP.		
Justification	Dependent IDs refer to IDs of the dependent files at the time of the export.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017, requirement HREF2, PROF10		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:ALL:NA:PROF10		
Comment	In CGMES v3.0 this is covered in a generic way.		

TABLE 140: SSHEQSSHEQDIFF

Severity: ERROR	Name: SSHEQSSHEQDIFF	Level: 4	Validation scope: IGM & CGM
Description	Every SSH file shall have an 'md:Model.DependentOn' reference to a EQ or EQDIFF file. Note: This is a minimum requirement so more references may be present.		
Message	Invalid md:Model.DependentOn statement(s) in SSH.		
Justification	Dependent IDs refer to IDs of the dependent files at the time of the export.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017, requirement HREF2, PROF10		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:ALL:NA:PROF10		
Comment	In CGMES v3.0 this is covered in a generic way.		

TABLE 141: DYEQDYEQDIFF

Severity: ERROR	Name: DYEQDYEQDIFF	Level: 4	Validation scope: IGM & CGM
Description	Every DY file shall have an 'md:Model.DependentOn' reference to a EQ or EQDIFF file. Note: This is a minimum requirement so more references may be present.		

Message	Invalid md:Model.DependentOn statement(s) in DY.
Justification	Dependent IDs refer to IDs of the dependent files at the time of the export.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017, requirement HREF2, PROF10
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:ALL:NA:PROF10
Comment	In CGMES v3.0 this is covered in a generic way.

TABLE 142: SVSSHSVTPSVTPBD

Severity: ERROR	**Name: SVSSHSVTPSVTPBD**	**Level: 4**	**Validation scope: IGM & CGM**
Description	Every SV file shall have 'md:Model.DependentOn' references to the files - SSH input files to the power flow calculation. - TP files with the power flow busses used in the power flow calculation. - TPBD files with the power flow busses in the boundary Note: This is a minimum requirement so more references may be present.		
Message	Invalid md:Model.DependentOn statement(s), SV does not have reference to TP, SSH and TPBD (used as input data for the power flow calculations).		
Justification	Dependent IDs refer to IDs of the dependent files at the time of the export.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017, requirement HREF2, PROF10		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:ALL:NA:PROF10		
Comment	In CGMES v3.0 this is covered in a generic way.		

TABLE 143: GLEQGLEQBD

Severity: ERROR	**Name: GLEQGLEQBD**	**Level: 4**	**Validation scope: IGM & CGM**
Description	Every GL model file has 'md:Model.DependentOn' references to the EQ model file and EQBD model file that were used for the serialization. The reference to the EQ model file is required and EQBD model file is optional. Note: This is a minimum requirement so more references may be present.		
Message	Invalid md:Model.DependentOn statement(s), GL does not have reference to EQ.		

Justification	Dependent IDs refer to IDs of the dependent files at the time of the export.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017, requirement HREF2, PROF10
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:ALL:NA:PROF10
Comment	In CGMES v3.0 this is covered in a generic way.

TABLE 144: DLEQDLEQDIFFDLTPDLDY

Severity: ERROR	**Name: DLEQDLEQDIFFDLTPDLDY**	**Level: 4**	**Validation scope: IGM & CGM**
Description	Every DL file shall have 'md:Model.DependentOn' references to the EQ or EQDIFF file, the TP file and to the DY file that were used for the serialization. The reference to the EQ model file is required and the references to TP and DY model files are optional. Note: This is a minimum requirement so more references may be present.		
Message	Invalid md:Model.DependentOn statement(s), DL does not have reference to EQ.		
Justification	Dependent IDs refer to IDs of the dependent files at the time of the export.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017, requirement HREF2, PROF10		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:ALL:NA:PROF10		
Comment	In CGMES v3.0 this is covered in a generic way.		

TABLE 145: EQDIFFEQ

Severity: ERROR	**Name: EQDIFFEQ**	**Level: 4**	**Validation scope: IGM & CGM**
Description	Every EQDIFF file shall only have a md:Model.Supersedes references to the EQ file it updates as it is not correct to use md:Model.DependentOn for a CIMXML file that replaces or supersedes another.		
Message	Invalid md:Model.Supersedes statement(s), only reference to EQ is allowed.		
Justification	EMF meeting decision in Rome 2018-10-05. This rule restricts use of difference models and is CGM Build process specific.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017 annex C.2		

IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	IEC 61970-552
Comment	

TABLE 146: DANGLINGREFERENCE

Severity: ERROR	**Name: DanglingReference**	**Level: 4**	**Validation scope: IGM & CGM**
Description	For all references (part of the CGMES profiles and additional, if existing), the mRID specified in every rdf:resource in the assembly of cimxml instance files shall be defined in an existing rdf:ID and rdf:about part of the data exchange.		
Message	Dangling reference found.		
Justification	The CGMES requires that at the receiving end of the exchange all references in the instance files pointing to instance files from other profiles which are part of the exchange should be satisfied. Therefore, the complete set of instance files necessary for the grid model must have fulfilled references (no dangling references are allowed).		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017, FBOD4		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:ALL:NA:FBOD4		
Comment			

TABLE 147: INCORRECTATTRIBUTEORROLECARD

Severity: ERROR	**Name: IncorrectAttributeOrRoleCard**	**Level: 4**	**Validation scope: IGM & CGM**
Description	All mandatory attributes and associations must be provided for the assembled model according to cardinalities given by profiles specified in md:Model.profile for each of the assembled CIMXML files.		
Message	Cardinality violated for an attribute or a role, too many or too few values or references provided.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017, PROF5 and PROF7.		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	GENC12, GENC13, GENC14, PROF7		
Comment			

10.2 BUSINESS CONSTRAINTS

10.2.1 SEVERITY ERROR

TABLE 148: EQDIFFOPERATIONALLIMIT

Severity: ERROR	Name: EQDIFFOperationalLimit	Level: 4	Validation scope: IGM
Description	An EQDIFF file is only allowed to contain subclasses of OperationalLimit (cim:VoltageLimit, cim:CurrentLimit, cim:ActivePowerLimit, cim:ApparentPowerLimit). This is a temporary solution for exchange of limit values in EQ that in the future will be in SSH.		
Message	Not allowed CIM class in EQDIFF file.		
Justification	EMF meeting decision in Rome 2018-10-05. This rule restricts use of difference models and is CGM Build process specific.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1:2017 annex C.2		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment	Not needed in CGMES v3.0 as there limits are exchanged in SSH.		

TABLE 149: CGMSVSSHVERSIONMISMATCH

Severity: ERROR	Name: CgmSvSshVersionMismatch	Level: 4	Validation scope: CGM
Description	A CGM will have updated SSH files (referencing to original data by Supersede statement) for each IGM and a single SV file with the complete solution for the included IGMs. The updated SSH CIMXML files and the resulting CIMXML SV file should have: -the same md:Model.scenarioTime. -a new md:Model.version number that is the same for the SV and SSH CIMXML files.		
Message	Different fileVersion or effectiveDateTime in SSH and SV from CGM.		
Justification	Versioning of CGM is important for sustainable CGM build process. Section 6.6 of the ENTSO-E CGM Building process Implementation guide AC and DC part, version 2.0, 25 Aug 2023 provides details on IGM substitution and rules related to md:Model.scenarioTime.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		

IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 150: INVALIDTAPCHANGERRATIO

Severity: ERROR	**Name: InvalidTapChangerRatio**	**Level: 4**	**Validation scope: IGM**
Description	cim:TapChangerTablePoint.ratio shall be a positive value.		
Message	The cim:TapChangerTable [rdf:ID] has a cim:RatioTapChangerTablePoint with negative ratio.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

11 LEVEL 5: CONSISTENCY OF ASSEMBLED MODELS

11.1 STANDARD CONSTRAINTS

11.1.1 SEVERITY ERROR

TABLE 151: GEOGRAPHICALREGION

Severity: ERROR	**Name: GeographicalRegion**	**Level: 5**	**Validation scope: IGM**
Description	An IGM shall have a single cim:GeographicalRegion. cim:SubGeographicalRegion-s in an IGM shall refer to a single cim:GeographicalRegion.		
Message	More than one GeographicalRegion in IGM or cim:SubGeographicalRegion-s refer to multiple cim:GeographicalRegion-s.		
Justification	cim:GeographicalRegion is used to organise equipment geographically and regions that corresponds to a network model managed by a TSO which is also the ModelingAuthority for the network. Each IGM shall be described by one cim:GeographicalRegion.		

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-1 E.13
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:EQ:GeographicalRegion:EQ__4
Comment	

TABLE 152: LINECONTAINMENT

Severity: ERROR	**Name: LineContainment**	**Level: 5**	**Validation scope: IGM**
Description	For every instance of cim:ACLineSegment, the cim:Equipment.EquipmentContainer referred to, if provided, must be of type cim:Line.		
Message	cim:ACLineSegments is not contained in a cim:Line.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	Figure 15 (diagram Core notes) and section 6.9.16 of IEC TS 61970-600-2		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:Conductor:containment		
Comment			

TABLE 153: EQUIVALENTINJECTIONCONTAINMENT

Severity: ERROR	**Name: EquivalentInjectionContainment**	**Level: 5**	**Validation scope: IGM**
Description	Every cim:EquivalentInjection shall be contained by a - cim:VoltageLevel if not in a boundary point. - If in a boundary point, preferably it is contained in a cim:Line or not contained at all with provided association to cim:BaseVoltage.		
Message	cim:EquivalentInjection containment error.		
Justification	All equipment shall be contained, also cim:EquivalentInjection, but as it is allowed not to have cim:EquivalentInjection contained this is allowed for backwards compatibility.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-2 6.7.6		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:EquivalentInjection:containment		
Comment			

TABLE 154: TAPCHANGERNEUTRALU

Severity: ERROR	Name: TapChangerNeutralU	Level: 5	Validation scope: IGM
Description	The cim:TapChanger.neutralU shall be the same as cim:PowerTransformerEnd.ratedU.		
Message	The neutralU differs from ratedU.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section E.2.2. of IEC TS 61970-600-1:2017		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:EQ:TapChanger.neutralU:ValueRangePair		
Comment			

TABLE 155: CONTROLLINKEDTOTOPOLOGY

Severity: ERROR	Name: ControlLinkedToTopology	Level: 5	Validation scope: IGM
Description	The association end cim:Terminal.TopologicalNode is required in cases where a cim:RegulatingControl is associated with a cim:Terminal.		
Message	Terminal controlled by cim:RegulatingControl or cim:TapChangerControl is not linked to a cim:TopologicalNode.		
Justification	If a cim:RegulatingControl or cim:TapChangerControl is not linked to a cim:TopologicalNode the changes in the control variables will not affect the target value in the power flow calculation. For instance, in case cim:Switch cim:Terminals are not included in Topology Profile and if the controlled point is a cim:Switch cim:Terminal the controlled point is lost.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	E.12 of IEC TS 61970-600-1:2017		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:EQ:Terminal:EXCH8ConnectivityNode		
Comment			

TABLE 156: BRANCHBASEVOLTAGE

Severity: ERROR	Name: BranchBaseVoltage	Level: 5	Validation scope: IGM
Description	Every instance of cim:ACLineSegment, cim: SeriesCompensator or cim:EquivalentBranch must have an association cim:ConductingEquipment.BaseVoltage.		

	Note: PowerTransformerEnd already has required association with cim:TransformerEnd.BaseVoltage.
Message	Either cim:ACLineSegment, cim:EquivalentBranch, or cim:SeriesCompensator has no cim:BaseVoltage.
Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.7.6, 6.10.42, 6.12.2 and 6.10.2 of IEC TS 61970-600-2
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:ConductingEquipment.BaseVoltage:whereRequired
Comment	

TABLE 157: SVTAPSTEPINSTANCES

Severity: ERROR	**Name: SvTapStepInstances**	**Level: 5**	**Validation scope: IGM & CGM**
Description	A cim:SvTapStep instance is expected for all cim:TapChanger instances defined in EQ.		
Message	Missing cim:SvTapStep for a cim:TapChanger.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section E.9.3. of IEC TS 61970-600-1:2017		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:SV:SvTapStep:SV__4		
Comment	In CGMES v3.0 it applies only to TapChangers connected to energized TopologicalNode objects as deenergized objects are not present in SV dataset.		

TABLE 158: SVPOWERFLOWINSTANCES

Severity: ERROR	**Name: SvPowerFlowInstances**	**Level: 5**	**Validation scope: IGM & CGM**
Description	cim:SvPowerFlow class is required to be instantiated for the following classes: - subclasses of the cim:RotatingMachine - subclasses of the cim:EnergyConsumer - cim:EquivalentInjection - cim:ExternalNetworkInjection - cim:ShuntCompensator		

	- cim:StaticVarCompensator - cim:EnergySource.
Message	Missing cim:SvPowerFlow for an equipment.
Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 9.5.4 of IEC TS 61970-600-2
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	R:456:SV:SvPowerFlow:instance
Comment	

TABLE 159: SVPOWERFLOWBRANCHINSTANCES

Severity: ERROR	**Name: SvPowerFlowBranchInstances**	**Level: 5**	**Validation scope: IGM**
Description	The following shall conform: 1) For cim:TieFlow, which association end cim:TieFlow.ControlArea refers to a cim:ControlArea with cim:ControlArea.type equal to cim:ControlAreaTypeKind.Interchange, the association end cim:TieFlow.Terminal shall refer to a cim:Terminal of either cim:ACLineSegment, cim:PowerTransformer or cim:Switch and its subclasses. The cim:Terminal referenced by the association end cim:TieFlow.Terminal shall be associated with a boundary cim:TopologicalNode that conforms to item 2). 2) A boundary cim:TopologicalNode that is connected to an IGM shall have - One cim:EquivalentInjection - One of the following equipment: cim:ACLineSegment, cim:PowerTransformer or a retained cim:Switch (cim:Switch.retained=true) and its subclasses.		
Message	One of the following occurs: 1) A cim:TieFlow with a cim:TieFlow.Terminal referring to either a cim:Terminal that is not connected to a boundary cim:TopologicalNode or it is not a cim:Terminal of one of the following: cim:ACLineSegment, cim:PowerTransformer or a retained cim:Switch and its subclasses; 2) A boundary cim:TopologicalNode connected to the IGM that does not have one cim:EquivalentInjection and one of the following: cim:ACLineSegment, cim:PowerTransformer, or a retained cim:Switch and its subclasses.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	BPPL1 of IEC TS 61970-600-1:2017		

IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:EQ:BoundaryPoint:bppl1Bppl2 C:600:EQ:BoundaryPoint:bppl3
Comment	

TABLE 160: DISCONNECTEDTERMINAL

Severity: ERROR	**Name: DisconnectedTerminal**	**Level: 5**	**Validation scope: IGM & CGM**
Description	If the associated cim:ACDCTerminal.connected status is false, the flow specified in the cim:SvPowerFlow.p and cim:SvPowerFlow.q shall be zero.		
Message	Non-zero flow exchanged for a disconnected terminal.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 9.5.4. of IEC TS 61970-600-2		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference			
Comment	The constraint is not needed in CGMES v3.0 as there is no flow exported if there is no flow calculated.		

TABLE 161: TOPOLOGICALISLANDINSTANCE

Severity: ERROR	**Name: TopologicalIslandInstance**	**Level: 5**	**Validation scope: IGM & CGM**
Description	In case a solved model is exchanged for a single MAS the state variables profile must include at least one instance of cim:TopologicalIsland.		
Message	Missing cim:TopologicalIsland.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section E.6 of IEC TS 61970-600-1:2017		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:456:SV:TopologicalIsland:instance		
Comment			

TABLE 162: SWITCHTERMINALS

Severity: ERROR	**Name: SwitchTerminals**	**Level: 5**	**Validation scope: IGM**

Description	For every instance of cim:Switch, cim:Breaker, cim:Disconnector, cim:GroundDisconnector and cim:LoadBreakSwitch, it is not allowed to have its cim:Terminals connected to the same cim:ConnectivityNode.
Message	A switch that has its terminals connected to the same cim:ConnectivityNode.
Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section E.17 of IEC TS 61970-600-1:2017
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:Terminal:connection
Comment	

TABLE 163: SWITCHTN1

Severity: ERROR	**Name: SwitchTN1**	**Level: 5**	**Validation scope: IGM**
Description	For every instance of cim:Switch, cim:Breaker, cim:Disconnector, cim:GroundDisconnector and cim:LoadBreakSwitch, with cim:Switch.retained is true, its cim:Terminals shall be associated with different cim:TopologicalNodes.		
Message	A retained cim:Switch with cim:Terminal-s associated with the same cim:TopologicalNode.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section E.17 of IEC TS 61970-600-1:2017		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:456:TP:Terminal:switch		
Comment			

TABLE 164: PARTICIPATINGGENERATINGUNIT

Severity: ERROR	**Name: ParticipatingGeneratingUnit**	**Level: 5**	**Validation scope: IGM**
Description	In order to enable distribute slack by generation, if cim:GeneratingUnit objects are present in a cim:TopologicalIsland, it is not allowed that all energised cim:GeneratingUnit objects,have cim:GeneratingUnit.normalPF equal to 0. Note: For further details, refer to Chapter 5.11.		
Message	All energised GeneratingUnit objects in the cim:TopologicalIsland have .normalPF equal to 0.		
Justification	GeneratingUnits cannot pick-up mismatch if this data is unspecified.		

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	clause 6.13.2, clause 7.7.2 in IEC TS 61970-600-2
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:456:SSH:GeneratingUnit.normalPF:values C:456:SSH:NA:distributedActivePowerSlack C:456:SSH:NA:singleActivePowerSlack
Comment	

TABLE 165: IDUNIQUENESS

Severity: ERROR	**Name: IDuniqueness**	**Level: 5**	**Validation scope: IGM & CGM**
Description	All mRIDs (rdf:ID or rdf:about) in a model shall be unique.		
Message	mRID (rdf:ID or rdf:about) is not unique within model.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC 61970-552 and IEC TS 61970-600-1:2017 GENC1		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:ALL:NA:GENC1		
Comment			

TABLE 166: SVCVOLTAGE

Severity: ERROR	**Name: SVCVoltage**	**Level: 5**	**Validation scope: IGM**
Description	The association end cim:RegulatingCondEq.RegulatingControl is required. cim:RequlatingControl.targetValue shall be greater than zero if cim:RequlatingControl.mode is RegulatingControlModeKind.voltage. The attributes cim:StaticVarCompensator.sVCControlMode and cim:StaticVarCompensator.voltageSetPoint are ignored at both model validation and control logic of the SVC.		
Message	cim:RegulatingCondEq.RegulatingControl is not provided or cim:RequlatingControl.targetValue is not greater than zero.		
Justification	The reactive power output of the SVC is proportional to the difference between the voltage at the regulated bus and the voltage setpoint. When the regulated bus voltage is equal to the voltage setpoint, the reactive power output is zero. RequlatingControl is used as it has capabilities missing from SVC, e.g. the controlled point.		

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-2:2017, section 6.9.44
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:StaticVarCompensator:controlMode C:456:SSH:RegulatingControl.targetValue:value
Comment	CGMES v2.4 does not cover this fully.

TABLE 167: SWITCHVL

Severity: ERROR	**Name: SwitchVL**	**Level: 5**	**Validation scope: IGM**
Description	Cim:Switch and its subclasses (cim:Breaker, cim:Disconnector, cim:GroundDisconnector and cim:LoadBreakSwitch) shall only connect to cim:ConnectivityNode objects or cim:TopologicalNode objects that are contained in either the same cim:VoltageLevel or in different cim:VoltageLevel objects, which have the same cim:BaseVoltage. The rule is only checked when both ends of the switch and its subclasses are contained in a cim:VoltageLevel.		
Message	A cim:Switch that connects to cim:ConnectivityNode or cim:TopologicalNode objects in different cim:BaseVoltage.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section E.17 of IEC TS 61970-600-1:2017		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:Switch:connection		
Comment	The check in CGMES v3.0 is only on ConnectivityNode objects as the models are built with ConnentivityNode objects.		

TABLE 168: SWITCHOPENVSCONNECTED

Severity: ERROR	**Name: SwitchOpenVsConnected**	**Level: 5**	**Validation scope: IGM**
Description	The attribute cim:ACDCTerminal.connected shall always be set to true for terminals of cim:Switch or its subclasses.		
Message	cim:ACDCTerminal.connected is not set to true for a cim:Switch or its subclasses.		
Justification	A cim:Terminal has switching capability due to the attribute cim:ACDCTerminal.connected flag, a cim:Equipment can be disconnected with this flag. For cim:Switch-es this means it is possible to break the conducting path at three places: - cim:ACDCTerminal.connected side 1 (cim:ACDCTerminal.sequenceNumber=1) - cim:Switch.open		

	- cim:ACDCTerminal.connected side 2 (cim:ACDCTerminal.sequenceNumber=2) Evaluating switch status then means inspecting the three flags for every switch.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	IEC 61970-301 UML
Comment	In CGMES v3.0: The ACDCTerminal.connected at the two sides of the switch shall not be considered for assessing switch connectivity, i.e. only Switch.open, .normalOpen and .locked are relevant.

TABLE 169: SMOPERATINGMODECONSISTENCY

Severity: ERROR	**Name: SMOperatingModeConsistency**	**Level: 5**	**Validation scope: IGM**
Description	The SynchronousMachine.operatingMode shall be consistent with the SynchronousMachine.type. – SynchronousMachine.operatingMode = “motor” shall be provided for SynchronousMachine.type in ["motor", "generatorOrMotor", "motorOrCondenser", "generatorOrCondenserOrMotor"], – SynchronousMachine.operatingMode = “condenser" shall be provided for SynchronousMachine.type in ["condenser", "generatorOrCondenser", "motorOrCondenser", "generatorOrCondenserOrMotor"], and – SynchronousMachine.operatingMode = “generator” shall be provided for SynchronousMachine.type in ["generator", "generatorOrMotor", "generatorOrCondenser", "generatorOrCondenserOrMotor"].		
Message	The cim:SynchronousMachine.operatingMode is inconsistent with cim:SynchronousMachine.type.		
Justification	A cim:SynchronousMachine can only operate with the modes it is built for.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:456:SSH:SynchronousMachine.operatingMode:matchType		
Comment			

11.1.2 SEVERITY WARNING

TABLE 170: NOLTCTAPCHANGERCONTROL

Severity: WARNING	**Name: NoLTCTapChangerControl**	**Level: 5**	**Validation scope: IGM**

Description	If cim:TapChanger.ltcFlag is false, no TapChangerControl object should be referenced by cim:TapChanger.TapChangerControl.
Message	A TapChangerControl found for a TapChanger that cannot be changed under load.
Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section E.9.3. of IEC TS 61970-600-1:2017
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:TapChanger.ltcFlag:tapChangerControl
Comment	

TABLE 171: SYNCHRONOUSCONDENSERMODE

Severity: WARNING	**Name: SynchronousCondenserMode**	**Level: 5**	**Validation scope: IGM & CGM**
Description	For a synchronous condenser (cim:SynchronousMachine.operationMode equals to condenser) there is no capability for real power output. In this case, cim:RotatingMachine.p should be 0.		
Message	cim:RotatingMachine.p for a synchronous condenser is different than 0.		
Justification	The name plate ratings are used as a reference.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-2:2017, section 6.9.47		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:SynchronousMachine.type:condenser C:452:EQ:GeneratingUnit:typeDependency		
Comment			

TABLE 172 SMNULLP

Severity: WARNING	**Name: SMNullP**	**Level: 5**	**Validation scope: IGM & CGM**
Description	For cim:SynchronousMachine, if cim:RotatingMachine.p equals zero and cim:RotatingMachine.q is different than zero the cim:SynchronousMachine.operatingMode should be equal to "condenser".		
Message	cim:SynchronousMachine has condenser behaviour but it does not operate as condenser.		
Justification			

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	NA
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	NA
Comment	

TABLE 173: BASEVOLTAGENOTINBOUNDARY

Severity: WARNING	**Name: BaseVoltageNotInBoundary**	**Level: 5**	**Validation scope: IGM**
Description	All cim:BaseVoltages should be agreed on by modeling authorities and be in the boundary. If a matching base voltage is already in the boundary, it should be used. If a matching base voltage is not in the boundary, consider adding it in the boundary so that it can be reused by others.		
Message	cim:BaseVoltage not in boundary.		
Justification	An agreement on the base voltages is required to get interoperability. Rule added at CGM BP meeting in Zagreb 2019-05-23.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	EQBD2		
Comment			

TABLE 174: CONTROLOFANOTHERISLAND

Severity: WARNING	**Name: ControlOfAnotherIsland**	**Level: 5**	**Validation scope: IGM**
Description	A cim:RegulatingControl or cim:TapChangerControl should not control a cim:TopologicalNode in another cim:TopologicalIsland than its controlling equipment is located. The rule is applied for cim:RegulatingControl.enabled equal true. In addition, the rule applies to objects only within the IGM as references to objects in another MAS will be reported as dangling references.		
Message	A controlled cim:TopologicalNode is in another cim:TopologicalIsland than the controlling equipment.		
Justification	There is no feedback loop to the control in this case.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		

IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:EQ:RegulatingControl:point
Comment	

TABLE 175: TCCREMOTEREACTIVEFLOW

Severity: WARNING	**Name: TCCRemoteReactiveFlow**	**Level: 5**	**Validation scope: IGM**
Description	A cim:TapChangerControl (TCC) controlling reactive power flow should control the flow at one of the cim:Terminal-s belonging to cim:PowerTransformerEnd-s in the cim:PowerTransformer where the cim:TapChanger is located. Control a remote cim:Terminal (even if it is within the MAS) not belonging to the cim:PowerTransformer with the cim:TapChanger is not allowed. Note: A result of this is that multiple cim:TapChanger-s cannot be controlled by the same TCC.		
Message	A cim:TapChangerControl for reactive power flow is controlling a cim:Terminal that is not connected to one of the cim:PowerTransformerEnd-s.		
Justification	A power transformer cannot efficiently control reactive power flow other than on its own terminals.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:TapChangerControl:remoteQcontrol		
Comment			

11.1.3 SEVERITY INFO

TABLE 176: EQUIVALENTINJECTIONCONTROLENABLED

Severity: INFO	**Name: EquivalentInjectionControlEnabled**	**Level: 5**	**Validation scope: IGM**
Description	Boundary cim:EquivalentInjections should have control disabled, cim:EquivalentInjection.regulationCapability should be false, and cim:EquivalentInjection.regulationStatus should also be set to false. An cim:EquivalentInjection may have control enabled if it represents an HVDC system, a reduced grid or it is used as active power slack. If control is enabled realistic reactive power limits should be provided. Note: An HVDC Boundary Point has a cim:IdentifiedObject.description attribute equal to 'HVDC'.		
Message	A boundary cim:EquivalentInjection representing AC network controls voltage.		
Justification	Excessive reactive resources do not properly reflect power system behaviour.		

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:456:SSH:EquivalentInjection:regulation C:600:EQ:EquivalentInjection.regulationCapability:notHvdc
Comment	It is stricter in CGMES v3.0 with different implementation.

TABLE 177 SMALLTOPOLOGICALISLAND

Severity: INFO	**Name: SmallTopologicalIsland**	**Level: 5**	**Validation scope: IGM & CGM**
Description	A small cim:TopologicalIsland with TNs having zero voltage is in most cases meaningless and should not be exchanged. A cim:TopologicalIsland with three or fewer cim:TopologicalNodes is small.		
Message	Small cim:TopologicalIsland found.		
Justification	A small cim:TopologicalIsland is typically not energized and does not contribute to the interconnected network solution. The number of three cim:TopologicalNodes as a small island is selected to catch disconnected three winding transformers.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference			
Comment	In CGMES v3.0 solution is exported only for energized nodes.		

11.2 BUSINESS CONSTRAINTS

11.2.1 SEVERITY ERROR

TABLE 178: SVPOWERFLOWBRANCHINSTANCES2

Severity: ERROR	**Name: SvPowerFlowBranchInstances2**	**Level: 5**	**Validation scope: IGM & CGM**
Description	Branches shall have cim:SvPowerFlow instantiated at its cim:Terminals for the following branch classes: - cim:SeriesCompensator		

	- cim:ACLineSegment - cim:PowerTransformer - cim:EquivalentBranch - cim:Switch where cim:Switch.retained is true.
Message	Missing cim:SvPowerFlow for a branch.
Justification	The power flow result for branches cannot be reviewed without cim:SvPowerFlow. This is needed when solutions for the same IGM or CGM computed by different tools are compared. Note that computing the flows by scripts based on solved voltages may not give the same result as the original power flow.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 179: SLACKNODE

Severity: WARNING	**Name: SlackNode**	**Level: 5**	**Validation scope: IGM**
Description	cim:TopologicalIsland.AngleRefTopologicalNode refers to an energised cim:TopologicalNode which is selected as an angle reference node, i.e. not necessarily the node that also plays a role of a single power reference node. There is no requirement that the referenced cim:TopologicalNode is a controlled node. To monitor the modelling of angle reference node, the following options are validated to indicate cases where the angle reference node is a non-controlled node. However, this is not considered an issue. 1) Option 1: cim:TopologicalIsland.AngleRefTopologicalNode shall refer to a cim:TopologicalNode (with SvVoltage.v different than 0) which has continuous voltage regulation enabled. This means that voltage control is enabled on a cim:Terminal that connects to the cim:TopologicalNode designated as angle reference topological node and the equipment that provides the control is energised. Validation path: - cim:TopologicalIsland.AngleRefTopologicalNode\cim:TopologicalNode with SvVoltage.v different than 0 - cim:TopologicalIsland.AngleRefTopologicalNode\cim:Terminal\cim:RegulatingControl (continuous and enabled) -the equipment that has the cim:RegulatingControl shall be energised (connected to cim:TopologicalNode with SvVoltage.v different than 0). In case the equipment is cim:EquivalentInjection it shall have enabled regulation capability and status.		

	2) Option 2: cim:TopologicalNode which is referred by cim:TopologicalIsland.AngleRefTopologicalNode shall be energized (i.e. with SvVoltage.v different than 0) and shall have a cim:Terminal of an equipment capable to provide voltage control even if the control is regulating on a remote location (i.e. not at the cim:TopologicalNode referred by cim:TopologicalIsland.AngleRefTopologicalNode). Validation path: - cim:TopologicalIsland.AngleRefTopologicalNode\cim:TopologicalNode with SvVoltage.v different than 0 - cim:TopologicalIsland.AngleRefTopologicalNode\cim:TopologicalNode\cim:Terminal\Equipment - the equipment shall have the cim:RegulatingControl as continuous control and be enabled. In case the equipment is cim:EquivalentInjection it shall have enabled regulation capability and status. All equipment that is capable to provide voltage control is considered in this constraint (e.g. a cim:SynchronousMachine, cim:ExternalNetworkInjection, cim:EquivalentInjection, etc.) except cim:SynchronousMachine operating as a condenser.
Message	There is no voltage regulation enabled for the cim:TopologicalNode that is designated as angle reference topological node.
Justification	The rule is necessary as there is a gap in the standards and due to changes of condition on what can be slack and which node can be selected for angle reference node.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section E.4 of IEC TS 61970-600-1:2017
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	This is in addition to CGMES v2.4 and CGMES v3.0 and it is modifying the setup around the slack node.

TABLE 180: BASEVOLTAGETNVSTRANSFORMER

Severity: ERROR	**Name: BaseVoltageTNvsTransformer**	**Level: 5**	**Validation scope: IGM**
Description	cim:BaseVoltage.nominalVoltage of the cim:TopologicalNode.BaseVoltage shall be the same as cim:BaseVoltage.nominalVoltage of the cim:PowerTransformerEnd.BaseVoltage		
Message	cim:PowerTransformerEnd {rdfID} that has different cim:BaseVoltage.nominalVoltage from the value of cim:TopologicalNode.		
Justification			

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 181: IGMSSHVSCGMSSH

Severity: ERROR	**Name: IgmSSHvsCgmSSH**	**Level: 5**	**Validation scope: CGM**
Description	The rule applies for energized elements only. Energised elements are connected to a cim:TopologicalNode with cim:SvVoltage.v greater than 0 and have either cim:SvPowerFlow.p or cim:SvPowerFlow.q different than 0. The information on allowed attribute changes between CGM SSH CIMXML dataset and the original IGM SSH CIMXML dataset are defined in the section 5.10 of the QoCDC.		
Message	Unexpected differences between IGM SSH dataset and respective SSH dataset included in CGM.		
Justification	The validation scope follows the EMF requirements document and CGM Build Process principles. The EMF function is allowed to change some data and it is obliged to keep other set of data unchanged.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 182: SMOPERATINGMODEPCONSISTENCY

Severity: ERROR	**Name: SMOperatingModePConsistency**	**Level: 5**	**Validation scope: IGM**
Description	For cim:SynchronousMachine with cim:SynchronousMachine.operatingMode equal to "motor", cim:RotatingMachine.p shall be greater than or equal to - NUMERIC_TOLERANCE. For cim:SynchronousMachine with cim:SynchronousMachine.operatingMode equal to "generator", cim:RotatingMachine.p shall be less than or equal to + NUMERIC_TOLERANCE. Note: For further details, refer to Chapter 5.11.		
Message	Inconsistency between operating mode and values for active power.		
Justification			

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 183: SMREFPRIORITY

Severity: ERROR	**Name: SMrefPriority**	**Level: 5**	**Validation scope: IGM**
Description	If multiple cim:SynchronousMachine objects have cim:SynchronousMachine.referencePriority equal to 1 (the highest priority), all these cim:SynchronousMachine objects shall be connected to the same cim:TopologicalNode.		
Message	Multiple cim:SynchronousMachine objects that have referencePriority equal to 1 connect to different cim:TopologicalNode objects.		
Justification	In case there are multiple cim:SynchronousMachine objects that control same cim:TopologicalNode it is allowed that these machines have the same cim:SynchronousMachine.referencePriority equal to 1 (as it is required that a cim:SynchronousMachine that regulates a cim:TopologicalNode designated as an angle reference has highest priority 1). However one of the units shall have highest cim:GeneratingUnit.normalPF. In cases where the topological node is also used as a single active power slack, tools capable of group regulation should use all equipment that regulates this topological node, while tools that are not capable of group regulation should select one equipment for the active power slack.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment	This is in addition to CGMES v2.4 and CGMES v3.0 and it is modifying the setup around the slack node.		

11.2.2 SEVERITY WARNING

TABLE 184: GEOGRAPHICALREGIONBD

Severity: WARNING	**Name: GeographicalRegionBD**	**Level: 5**	**Validation scope: IGM**

Description	cim:GeographicalRegion-s should be agreed on by modelling authorities and be described in the equipment boundary.
Message	cim:GeographicalRegion from the boundary is not used.
Justification	cim:GeographicalRegion is used to organise equipment geographically and regions that corresponds to a network model managed by a TSO which is also the ModelingAuthority for the network.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:EQ:GeographicalRegion:EQ__4
Comment	CGMES v3.0 does not require that this is exchnaged in equipment boundary dataset.

TABLE 185: OPENNONRETAINEDSWITCHVSTN

Severity: WARNING	**Name: OpenNonRetainedSwitchVsTN**	**Level: 5**	**Validation scope: IGM**
Description	A non-retained (cim:Switch.retained equals to false) cim:Switch which is open (cim:Switch.open equals true) or any of its subclasses, shall have its cim:Terminal objects associated with different cim:TopologicalNode objects.		
Message	Opened non-retained cim:Switch [rdf:ID] has both cim:Terminals connected to same cim:TopologicalNode [rdf:ID].		
Justification	An opened non retained cim:Switch or subsclass, cim:Breaker, cim:Disconnector, must be connected on both ends to different cim:TopologicalNode objects.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 186: CLOSEDNONRETAINEDSWITCHVSTN

Severity: WARNING	**Name: ClosedNonRetainedSwitchVsTN**	**Level: 5**	**Validation scope: IGM**
Description	A non-retained (cim:Switch.retained equals to false) cim:Switch which is closed (cim:Switch.open equals false) or any of its subclasses, shall have its cim:Terminal objects associated with the same cim:TopologicalNode object.		
Message	A closed non-retained cim:Switch [rdf:ID] has both cim:Terminals connected to different cim:TopologicalNode-s [rdf:ID1] and [rdf:ID2].		

Justification	A closed non-retained cim:Switch or subsclass, cim:Breaker, cim:Disconnector, must be connected on both ends to the same cim:TopologicalNode.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

12 LEVEL 6: IGM AND CGM PLAUSIBILITY

12.1 STANDARD CONSTRAINTS

12.1.1 SEVERITY ERROR

TABLE 187: SCSECTIONS

Severity: ERROR	**Name: SCSections**	**Level: 6**	**Validation scope: IGM & CGM**
Description	For every instance of cim:ShuntCompensator, cim:LinearShuntCompensator and cim:NonLinearShuntCompensator, the value of cim:ShuntCompensator.sections should be lower than or equal to the value of cim:ShuntCompensator.maximumSections.		
Message	Number of sections is out of range.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:SV:SvShuntCompensatorSections.sections:SV__4 C:600:SV:SvShuntCompensatorSections:SV__4		
Comment			

TABLE 188: ENERGIZEDBOUNDARYTN

Severity: ERROR	Name: EnergizedBoundaryTN	Level: 6	Validation scope: IGM & CGM
Description	A boundary cim:TopologicalNode with a non-zero cim:EquivalentInjection.p or cim:EquivalentInjection.q is supposed to be energized and shall have a solved voltage, i.e. cim:SvVoltage.v shall not be zero.		
Message	Boundary cim:TopologicalNode with injecting cim:EquivalentInjection without solved cim:SvVoltage.v.		
Justification	All boundary cim:TopologicalNodes in a power flow model shall have a solved voltage.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:456:SV:SvVoltage.v:absoluteLimit SV__4 in the IEC 61970-600-1		
Comment			

TABLE 189: INVALIDVOLTAGE

Severity: ERROR	Name: InvalidVoltage	Level: 6	Validation scope: IGM & CGM
Description	cim:SvVoltage.v shall be either 0 per unit or greater than 0.4 per unit.		
Message	Voltage magnitude is outside allowed range.		
Justification	Voltage lower than 0.4 per unit is not reasonable. The 0 is allowed to cover situations such as deenergized nodes or non converging power flow.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:456:SV:SvVoltage.v:absoluteLimit		
Comment	Different implementation in CGMES v3.0		

TABLE 190: DISCRETECONTROL

Severity: ERROR	Name: DiscreteControl	Level: 6	Validation scope: IGM & CGM
Description	For every instance of cim:RegulatingControl (SSH) for which the value of cim:RegulatingControl.discrete is true and cim:RegulatingControl.enabled is true the control variables must move in discrete steps. Hence the values of the following attributes shall not have non-zero decimals considering the precision of xsd:float:		

	- cim:ShuntCompensator.sections - related cim:SvShuntCompensatorSections.sections - cim:TapChanger.step - related cim:SvTapStep.position.
Message	A discrete control is declared, but the value has non-zero decimals.
Justification	If cim:RegulatingControl.discrete is set to true it is not possible to move the control variables continuously.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:TapChanger.step:valueType; C:456:SV:SvTapStep.position:value; C:456:SV:SvShuntCompensatorSections.sections:value; C:456:SSH:TapChanger.step:value
Comment	

TABLE 191: REQUIREDSVVOLTAGE

Severity: ERROR	**Name: RequiredSvVoltage**	**Level: 6**	**Validation scope: IGM & CGM**
Description	Instances of cim:SvVoltage is required for all cim:TopologicalNodes. If power flow didn't create a solution for a cim:TopologicalNode cim:SvVoltage angle and voltage shall be set to zero.		
Message	cim:SvVoltage is missing for cim:TopologicalNode.		
Justification	Instances of cim:SvVoltage is required to know where power flow managed to solve.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:SV:SvVoltage:SV__4		
Comment			

TABLE 192: REQUIREDSVSCSECTIONS

Severity: ERROR	**Name: RequiredSvSCSections**	**Level: 6**	**Validation scope: IGM & CGM**
Description	The following shall be satisfied for cim:ShuntCompensator: 1) Each instance of cim:ShuntCompensator shall have cim:SvShuntCompensatorSections instantiated.		

	2) For a cim:ShuntCompensator that is not used in control by power flow (no cim:RegulatingControl associated or if cim:RegulatingControl.enabled equals false) the value of SvShuntCompensatorSections.sections shall be the same as cim:ShuntCompensator.sections.
Message	cim:SvShuntCompensatorSections is missing for shunt compensator or the cim:SvShuntCompensatorSections.sections is not the same as cim:ShuntCompensator.sections.
Justification	Instances of cim:SvShuntCompensatorSections is required to tell the number of sections that was used in the solution.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:SV:SvShuntCompensatorSections.sections:SV__4 C:600:SV:SvShuntCompensatorSections:SV__4
Comment	

TABLE 193: REQUIREDSVTAPSTEP

Severity: ERROR	**Name: RequiredSvTapStep**	**Level: 6**	**Validation scope: IGM & CGM**
Description	For a cim:TapChanger that is not used in control (no cim:TapChangerControl associated or if cim:RegulatingControl.enabled equals false) by power flow the value of SvTapStep.position shall be the same as cim:TapChanger.step.		
Message	cim:SvTapStep.position is not the same as cim:TapChanger.step.		
Justification	Instances of cim:SvTapStep is required to tell the step number that was used in the solution.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:SV:SvTapStep:SV__4 C:600:SV:SvTapStep.position:SV__4		
Comment			

12.1.2 SEVERITY WARNING

TABLE 194: VALIDDER

Severity: WARNING	Name: ValidDER	Level: 6	Validation scope: IGM & CGM
Description	For every instance of a DistributedEnergyResource (DER), e.g. cim:EnergySource, the value of cim:EnergySource.activePower should be lower than or equal to zero.		
Message	DER infeed acts as a load.		
Justification	Due to the load sign convention, decentralized infeed must be negative or zero.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	IEC TS 61970-600-2:2017 section 7.8.6		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:EnergySource.activePower:consumer		
Comment			

TABLE 195: GENACTIVEPOWERINFEEDLIM

Severity: WARNING	Name: GenActivePowerInfeedLim	Level: 6	Validation scope: IGM & CGM
Description	The negated value of cim:RotatingMachine.p shall be within the following range depending on the value of cim:SynchronousMachine.operatingMode: 1) In case of cim:SynchronousMachineOperatingMode.generator - [cim:GeneratingUnit.minOperatingP,cim:GeneratingUnit.maxOperatingP] if cim:GeneratingUnit.minOperatingP is greater than or equal to zero. - [0,cim:GeneratingUnit.maxOperatingP] if cim:GeneratingUnit.minOperatingP is less than zero. 2) In case of cim:SynchronousMachineOperatingMode.motor - [cim:GeneratingUnit.minOperatingP,cim:GeneratingUnit.maxOperatingP] if cim:GeneratingUnit.minOperatingP is less than zero and cim:GeneratingUnit.maxOperatingP is less than or equal to zero. - [cim:GeneratingUnit.minOperatingP,0] if cim:GeneratingUnit.maxOperatingP is greater than zero. 3) In case of cim:SynchronousMachineOperatingMode.condenser cim:RotatingMachine.p shall equal to zero as there is no active power output. Note 1: Negation is necessary due to the load sign convention. Note 2: A cim:SynchronousMachine with cim:RotatingMachine.p = 0 is considered out of service if cim:SynchronousMachine.operatingMode is either cim:SynchronousMachineOperatingMode.motor or cim:SynchronousMachineOperatingMode.generator.		

	Note 3: In cases where the operating mode is cim:SynchronousMachineOperatingMode.condenser the synchronous machine might in reality output small amounts of active power. This rule will generate warning that can be assessed. It could then be advised that as such amounts do not have substantial effect on the IGM, condensers shall be modelled with zero active power.
Message	Active power output of the cim:SynchronousMachine is out of range.
Justification	Load sign convention is used for the power infeed, whereas nameplate ratings are used for the operating limits.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:456:SSH:RotatingMachine.p:limits
Comment	

TABLE 196: GENREACTIVEPOWERINFEEDLIM

Severity: WARNING	**Name: GenReactivePowerInfeedLim**	**Level: 6**	**Validation scope: IGM & CGM**
Description	The reactive power provided to the network by a cim:SynchronousMachine shall stay within limits regardless if it is controlling or not - negated (due to the load sign convention) cim:RotatingMachine.q greater than or equal to cim:SynchronousMachine.minQ , if provided - negated (due to the load sign convention) cim:RotatingMachine.q less than or equal to cim:SynchronousMachine.maxQ, if provided The rule is applied for all cim:SynchronousMachine objects with and without associated cim:ReactiveCapabilityCurve that have cim:RotatingMachine.p and cim:RotatingMachine.q different than 0.		
Message	Generation reactive power infeed is out of range.		
Justification	The reactive power infeed should be within limits.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:456:SSH:RotatingMachine.q:limits		
Comment			

TABLE 197: GENRCCPOWERINFEED

Severity: WARNING	Name: GenRCCPowerInfeed	Level: 6	Validation scope: IGM & CGM
Description	The power provided to the network by a cim:SynchronousMachine should stay within limits regardless if it is controlling or not. This rule applies when: -a reactive capability curve is present - cim:RotatingMachine.p does not equal 0 - cim:RotatingMachine.q does not equal 0. The negated value of the cim:RotatingMachine.p shall be: - less than or equal to the maximum value of all cim:CurveData.xvalue related to the associated cim:ReactiveCapabilityCurve, and - greater than or equal to the minimum value of all cim:CurveData.xvalue related to the associated cim:ReactiveCapabilityCurve The negated value of the cim:RotatingMachine.q shall be within the reactive capability curve. Linear interpolation is applied between cim:CurveData.y1value (or cim:CurveData.y2value) related to the two nearest to cim:RotatingMachine.p cim:CurveData objects. The obtained value based on the reactive capability curve and related to y1value is denoted as q_rcc_min. The obtained value based on the reactive capability curve and related to y2value is denoted as q_rcc_max. Therefore, the negated value of the cim:RotatingMachine.q shall be: - less than or equal to the q_rcc_max, and - greater than or equal to the q_rcc_min.		
Message	Generation active and/or reactive power infeed is out of range.		
Justification	The active and reactive power infeed should be within limits.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:456:SSH:RotatingMachine:pAndQcapabilityCurve		
Comment			

TABLE 198: VALIDLOAD

Severity: WARNING	Name: ValidLoad	Level: 6	Validation scope: IGM & CGM

Description	For every instance of cim:StationSupply, cim:ConformLoad and cim:NonConformLoad, the value of cim:EnergyConsumer.p should be greater than or equal to zero.
Message	Load infeed acts as a generator.
Justification	Due to the load sign convention, all loads should be positive or zero. Decentralized generation should be modelled explicitly. See IEC TS 61970-600-2:2017 section 7.8.5.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:456:SSH:EnergyConsumer.p:ValueRange C:456:SSH:EnergyConsumer.q:ValueRange
Comment	CGMES v3.0 is more restrictive.

TABLE 199: ENIACTIVEPOWERINFEEDLIM

Severity: WARNING	**Name: ENIActivePowerInfeedLim**	**Level: 6**	**Validation scope: IGM & CGM**
Description	The negated value of cim:ExternalNetworkInjection.p should be within the range [cim:ExternalNetworkInjection.minP, cim:ExternalNetworkInjection.maxP]. The validation takes into account that both cim:ExternalNetworkInjection.minP and cim:ExternalNetworkInjection.maxP will be negative if the equivalent injection is representing load operating range as cim:ExternalNetworkInjection.minP and cim:ExternalNetworkInjection.maxP are following generator sign convention (i.e. positive sign when generating power). Note 1: Negation is necessary due to the load sign convention. Note 2: An instance with cim:ExternalNetworkInjection.p = 0 is considered out of service.		
Message	ExternalNetworkInjection active power infeed is out of range.		
Justification	Load sign convention is used for the power infeed. The operating point should be within defined limits.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:456:SSH:ExternalNetworkInjection.p:limits		
Comment			

TABLE 200: ENIREACTIVEPOWERINFEEDLIM

Severity: WARNING	**Name: ENIReactivePowerInfeedLim**	**Level: 6**	**Validation scope: IGM & CGM**

Description	The negated value of cim:ExternalNetworkInjection.q should be within the range [cim:ExternalNetworkInjection.minQ, cim:ExternalNetworkInjection.maxQ]. The validation takes into account that both cim:ExternalNetworkInjection.minQ and cim:ExternalNetworkInjection.maxQ will be negative if the equivalent injection is representing load operating range as cim:ExternalNetworkInjection.minQ and cim:ExternalNetworkInjection.maxQ are following generator sign convention (i.e. positive sign when generating power). Note 1: Negation is necessary due to the load sign convention.
Message	ExternalNetworkInjection reactive power infeed is out of range.
Justification	Load sign convention is used for the power infeed. The operating point should be within defined limits.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:456:SSH:ExternalNetworkInjection.q:limits
Comment	

TABLE 201: EIACTIVEPOWERINFEEDLIM

Severity: WARNING	**Name: EIActivePowerInfeedLim**	**Level: 6**	**Validation scope: IGM & CGM**
Description	The negated value of non-boundary cim:EquivalentInjection.p should be within the range [cim:EquivalentInjection.minP, cim:EquivalentInjection.maxP]. The validation takes into account that both cim:EquivalentInjection.maxP and cim:EquivalentInjection.minP will be negative if the equivalent injection is representing load operating range as cim:EquivalentInjection.minP and cim:EquivalentInjection.maxP are following generator sign convention (i.e. positive sign when generating power). Note 1: Negation is necessary due to the load sign convention. Note 2: An instance with cim:EquivalentInjection.p = 0 is considered out of service.		
Message	EquivalentInjection active power infeed is out of range.		
Justification	Load sign convention is used for the power infeed. The operating point should be within defined limits.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:456:SSH:EquivalentInjection.p:limits		
Comment			

TABLE 202: EIREACTIVEPOWERINFEEDLIM

Severity: WARNING	Name: EIReactivePowerInfeedLim	Level: 6	Validation scope: IGM & CGM
Description	The negated value of non-boundary cim:EquivalentInjection.q should be with the range [cim:EquivalentInjection.minQ, cim:EquivalentInjection.maxQ]. The validation takes into account that both cim:EquivalentInjection.maxQ and cim:EquivalentInjection.minQ will be negative if the equivalent injection is representing load operating range as cim:EquivalentInjection.minQ and cim:EquivalentInjection.maxQ are following generator sign convention (i.e. positive sign when generating power). Note 1: Negation is necessary due to the load sign convention.		
Message	EquivalentInjection reactive power infeed is out of range.		
Justification	Load sign convention is used for the power infeed. The operating point should be within defined limits.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:456:SSH:EquivalentInjection.q:limits		
Comment			

TABLE 203: VOLTAGETARGETSATTN

Severity: WARNING	Name: VoltageTargetsAtTN	Level: 6	Validation scope: IGM & CGM
Description	For all cim:RegulatingControl instances, with cim:RegulatingControl.discrete=false (including its subclass cim:TapchangerControl) regulating the same cim:TopologicalNode their cim:RegulatingControl.targetValues should be equal. This rule is for continuous controls, for which RegulatingControl.mode equals RegulatingControlModeKind.voltage and RegulatingControl.enabled equals true.		
Message	Conflicting target values of cim:RegulatingControl regulating voltage at the same cim:TopologicalNode.		
Justification	The power flow solver need a single voltage target per cim:TopologicalNode and the cim:RegulatingControl.targetValues differ the power flow will have to pick a value. If different Power Flow applications use different strategies to pick a value the voltage solution will differ between them which is the reason to warn.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		

IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:RegulatingControl:samePoint
Comment	CGMES v3.0 does not specify the condition related to .discrete and it is note general.

12.1.3 SEVERITY INFO

TABLE 204: FAKEVOLTAGE

Severity: INFO	**Name: FakeVoltage**	**Level: 6**	**Validation scope: IGM & CGM**
Description	A cim:TopologicalNode with a solved voltage equal to the cim:BaseVoltage.nominalVoltage is suspected to copy that value rather than solving to power flow.		
Message	Voltage at cim:TopologicalNode reported in SV profile equals cim:BaseVoltage.nominalVoltage.		
Justification	This is to prevent from faking the voltage.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:SV:SvVoltage:SV__4		
Comment	Different implementation in CGMES v3.0		

12.2 BUSINESS CONSTRAINTS

12.2.1 SEVERITY ERROR

TABLE 205: GENACTIVEPOWERINFEEDDIFFE

Severity: ERROR	**Name: GenActivePowerInfeedDiffE**	**Level: 6**	**Validation scope: IGM & CGM**
Description	The aggregated sum of the values of cim:RotatingMachine.p shall not deviate more than SSH_SV_TOT_P_DIFF MW from the aggregated sum of the values of cim:SvPowerFlow.p for the terminals connected to synchronous machines. Note that disconnected synchronous machines should have zero values in SSH.		

Message	Assumed aggregated active power generation infeed deviates from calculated generation infeed more than SSH_SV_TOT_P_DIFF MW.
Justification	The SSH data should be based on a solved power flow (CGMM) and as a consequence, the values in SSH (input) and SV (calculation results) should not be far away.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 206: DERACTIVEPOWERINFEEDDIFFE

Severity: ERROR	**Name: DERActivePowerInfeedDiffE**	**Level: 6**	**Validation scope: IGM & CGM**
Description	The aggregated sum of the values of cim:EnergySource.activePower shall not deviate more than SSH_SV_TOT_P_DIFF MW from the aggregated sum of the values of cim:SvPowerFlow.p for the terminals connected to cim:EnergySource. Note that disconnected DER should have zero values in SSH.		
Message	Assumed aggregated active power generation infeed deviates from calculated generation infeed more than SSH_SV_TOT_P_DIFF MW.		
Justification	The SSH data should be based on a solved power flow (CGMM) and as a consequence, the values in SSH (input) and SV (calculation results) should not be far away.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 207: LOADACTIVEPOWERINFEEDDIFFE

Severity: ERROR	**Name: LoadActivePowerInfeedDiffE**	**Level: 6**	**Validation scope: IGM & CGM**
Description	The aggregated sum of the values of cim:EnergyConsumer.p shall not deviate more than SSH_SV_TOT_P_DIFF MW from the aggregated sum of the values of cim:SvPowerFlow.p for the associated terminals.		

	Note that disconnected loads should have zero values in SSH.
Message	Assumed aggregated consumption deviates from calculated consumption more than SSH_SV_TOT_P_DIFF MW.
Justification	The SSH data should be based on a solved power flow (CGMM) and as a consequence, the values in SSH (input) and SV (calculation results) should not be far away.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 208: ENIACTIVEPOWERINFEEDDIFFE

Severity: ERROR	**Name: ENIActivePowerInfeedDiffE**	**Level: 6**	**Validation scope: IGM & CGM**
Description	The aggregated sum of the values of cim:ExternalNetworkInjection.p shall not deviate more than SSH_SV_TOT_P_DIFF MW from the aggregated sum of the values of cim:SvPowerFlow.p for the associated terminals.		
Message	Assumed aggregated sum of external injections deviates from calculated more than SSH_SV_TOT_P_DIFF MW		
Justification	The SSH data should be based on a solved power flow (CGMM) and as a consequence, the values in SSH (input) and SV (calculation results) should not be far away. Note: cim:ExternalNetworkInjection should not be used frequently considering its purpose.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 209: EIACTIVEPOWERINFEEDDIFFE

Severity: ERROR	**Name: EIActivePowerInfeedDiffE**	**Level: 6**	**Validation scope: IGM & CGM**

Description	The aggregated sum of the values of non-boundary cim:EquivalentInjection.p shall not deviate more than SSH_SV_TOT_P_DIFF MW from the aggregated sum of the values of cim:SvPowerFlow.p for the associated terminals.
Message	Assumed non-boundary cim:EquivalentInjection aggregated injection deviates from calculated more than SSH_SV_TOT_P_DIFF MW.
Justification	The SSH data should be based on a solved power flow (CGMM) and as a consequence, the values in SSH (input) and SV (calculation results) should not be far away. Note: cim:EquivalentInjection should not be used frequently considering its purpose.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 210: NETINTERCHANGE2

Severity: ERROR	**Name: NetInterchange2**	**Level: 6**	**Validation scope: IGM & CGM**
Description	For a cim:ControlArea of type interchange the aggregated sum of the values of cim:SvPowerFlow.p for cim:Terminals referenced by cim:TieFlow.Terminal shall not deviate from the value of cim:ControlArea.netInterchange with more than INTERCH_IMBALANCE_ERROR MW. There are some implications from other rules to be considered: 1) According to level 5 rule SvPowerFlowBranchInstances the cim:Terminal referenced by a cim:TieFlow.Terminal is located at a boundary cim:TopologicalNode, hence the attribute cim:TieFlow.positiveFlowIn is always true. 2) According to level 5 rule SvPowerFlowBranchInstances2 the cim:Terminal of cim:ACLineSegment, cim:PowerTransformer or retained cim:Switch, etc. should have a cim:SvPowerFlow. 3) According to level 5 rule SvPowerFlowInstances every cim:EquivalentInjection has a cim:SvPowerFlow. As a consequence cim:SvPowerFlow related to boundary cim:EquivalentInjection-s must be used in the summation but with negated value. cim:SvPowerFlow participates in the sum if the cim:Terminal is a terminal of cim:EquivalentInjection, which is connected to a boundary cim:TopologicalNode, referenced by a cim:Terminal, which is also associated to a cim:TieFlow through cim:TieFlow.Terminal. Note 1: cim:ControlArea.netInterchange include AC and DC exchanges.		

	Note 2: An HVDC Boundary TopologicalNode has a cim:IdentifiedObject.description attribute with leading characters 'HVDC'.
Message	Netted Area position severely not respected for more than INTERCH_IMBALANCE_ERROR MW.
Justification	Area interchange control uses ControlArea.netInterchange as set point, the TieFlow terminals as State Variables and the ConformLoad within the ControlArea as Control Variables.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 211: KIRCHHOFFSFIRSTLAW

Severity: ERROR	**Name: KirchhoffsFirstLaw**	**Level: 6**	**Validation scope: IGM**
Description	The sum of cim:SvPowerFlow.p and sum of cim:SvPowerFlow.q for all cim:SvPowerFlow-s connected to a cim:TopologicalNode shall be within the solution tolerance provided by SV_INJECTION_LIMIT MW/Mvar. If solution tolerance is exceeded a cim:SvInjection shall be provided (the association end cim:TopologicalNode.SvInjection is required). Note: cim:SvPowerFlow-s of non-retained cim:Switch (cim:Switch.retained is false) shall be excluded. The power flow in non-retained cim:Switch-es may not have been correctly computed and may be inconsistent with the other power flows on the cim:TopologicalNode. Hence non-retained cim:Switch-es shall be excluded from the summation to achieve a more robust result.		
Message	The sum of the cim:SvPowerFlow-s reported on a cim:TopologicalNode is not within the solution tolerance and there is no SvInjection provided.		
Justification	The sum of power flow into a node is zero according to Kirchhoff's first law.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 212: KIRCHHOFFSFIRSTLAWCGM

Severity: ERROR	**Name: KirchhoffsFirstLawCGM**	**Level: 6**	**Validation scope: CGM**

Description	The sum of cim:SvPowerFlow.p and sum of cim:SvPowerFlow.q for all cim:SvPowerFlow-s connected to a cim:TopologicalNode shall be within the solution tolerance provided by SV_INJECTION_RELAXED_LIMIT MW/Mvar. If solution tolerance is exceeded a cim:SvInjection shall be provided (the association end cim:TopologicalNode.SvInjection is required). Note: cim:SvPowerFlow-s of non-retained cim:Switch (cim:Switch.retained is false) shall be excluded. The power flow in non-retained cim:Switch-es may not have been correctly computed and may be inconsistent with the other power flows on the cim:TopologicalNode. Hence non-retained cim:Switch-es shall be excluded from the summation to achieve a more robust result.
Message	The sum of the cim:SvPowerFlow-s reported on a cim:TopologicalNode is not within the solution tolerance and there is no SvInjection provided.
Justification	The sum of power flow into a node is zero according to Kirchhoff's first law.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 213: VOLTAGETARGETCONSISTENCYATTN

Severity: ERROR	**Name: VoltageTargetConsistencyAtTN**	**Level: 6**	**Validation scope: IGM**
Description	For all cim:RegulatingControl and cim:EquivalentInjection instances regulating on cim:Terminal connected to the same cim:TopologicalNode, all cim:RegulatingControl.targetValue shall be equal in case: -cim:RegulatingControl.enabled equals to true -Associated cim:ConductingEquipment objects are switched on (cim:ACDCTerminal.connected equals to true) -cim:RegulatingCondEq.controlEnabled equals to true for associated cim:ConductingEquipment -cim:TapChanger.ltcFlag equals to true in case the control includes cim:TapChanger -cim:RegulatingControl.mode is cim:RegulatingControlModeKind.voltage -cim:EquivalentInjection.regulatingCapability equals to true in case of cim:EquivalentInjection. This rule is valid for both discrete (cim:RegulatingControl.discrete equals to true) and continuous controls (cim:RegulatingControl.discrete equals to false).		

Message	Inconstistent cim:RegulatingControl.targetValue-s at the following cim:TopologicalNode {rdf:ID}.
Justification	When multiple cim:RegulatingControl-s are regulating on the same node, the target value to be reached during load flow calculation should be consistent between all of them despite being in continuous or discrete regulation. The verification for consistent target values on switched-off equipment or with disabled control is not necessary.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:RegulatingControl:samePoint
Comment	

TABLE 214: CGMSSHMISMATCH

Severity: WARNING	**Name: CGMSSHmismatch**	**Level: 6**	**Validation scope: CGM**
Description	The absolute difference of the sums (IGM SSH and updated CGM SSH) of cim:RotatingMachine.p for cim:SynchronousMachine shall be less than or equal to THRESHOLD_ACTIVE_P_IMBALANCE_DISTR per IGM. The rule applies for: 1) cim:SynchronousMachine in energized islands, i.e. machine which is connected to cim:TopologicalNode that has cim:SvVoltage.v greater than 0 and the cim:Terminal of cim:SynchronousMachine has cim:SvPowerFlow.p or cim:SvPowerFlow.q different than 0; 2) cim:SynchronousMachine which is in cim:TopologicalIsland that has cim:TieFlow object. 3) cim:SynchronousMachine where the operating mode is not condenser.		
Message	The CGM has significant active power mismatch (between IGM SSH [rdf:about of IGM SSH] and CGM SSH [rdf:about of CGM SSH]).		
Justification	Purpose of this rule is to check if the EMF tool is performing the scaling in accordance with EMF requirements.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

12.2.2 SEVERITY WARNING

TABLE 215: GENACTIVEPOWERINFEEDDIFFW

Severity: WARNING	**Name: GenActivePowerInfeedDiffW**	**Level: 6**	**Validation scope: IGM & CGM**
Description	For every instance of cim:SynchronousMachine, the value of cim:RotatingMachine.p should not deviate more than SSH_SV_MAX_P_DIFF MW from the value of cim:SvPowerFlow.p for the associated terminal. Note that disconnected synchronous machines should have zero values in SSH.		
Message	Assumed generation infeed of cim:SynchronousMachine deviates from calculated generation infeed more than SSH_SV_MAX_P_DIFF.		
Justification	The SSH data should be based on a solved power flow (CGMM) and as a consequence, the values in SSH (input) and SV (calculation results) should not be far away.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 216: GENREACTIVEPOWERINFEEDDIFFW

Severity: WARNING	**Name: GenReactivePowerInfeedDiffW**	**Level: 6**	**Validation scope: IGM & CGM**
Description	For every instance of cim:SynchronousMachine, the value of cim:RotatingMachine.q should not deviate more than SSH_SV_MAX_Q_DIFF MVAr from the value of cim:SvPowerFlow.q for the associated terminal. Note that disconnected synchronous machines should have zero values in SSH.		
Message	Potential reactive power problem located for cim:SynchronousMachine, assumed reactive power generation of cim:SynchronousMachine deviates from calculated more than SSH_SV_MAX_Q_DIFF MVAr.		
Justification	Considering the Power Flow settings, the reactive power shift should be minimal.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		

IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 217: DERACTIVEPOWERINFEEDDIFFW

Severity: WARNING	**Name: DERActivePowerInfeedDiffW**	**Level: 6**	**Validation scope: IGM & CGM**
Description	For every instance of cim:EnergySource, the value of cim:EnergySource.activePower should not deviate more than SSH_SV_MAX_P_DIFF MW from the value of cim:SvPowerFlow.p for the associated terminal. Note that disconnected DER should have zero values in SSH.		
Message	Assumed generation infeed of cim:EnergySource deviates from calculated generation infeed more than SSH_SV_MAX_P_DIFF MW.		
Justification	The SSH data should be based on a solved power flow (CGMM) and as a consequence, the values in SSH (input) and SV (calculation results) should not be far away.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 218: DERREACTIVEPOWERINFEEDDIFFW

Severity: WARNING	**Name: DERReactivePowerInfeedDiffW**	**Level: 6**	**Validation scope: IGM & CGM**
Description	For every instance of cim:EnergySource, the value of cim:EnergySource.reactivePower should not deviate more than SSH_SV_MAX_Q_DIFF MVAr from the value of cim:SvPowerFlow.q for the associated terminal. Note that disconnected DER should have zero values in SSH.		
Message	Assumed generation infeed of cim:EnergySource deviates from calculated generation infeed more than SSH_SV_MAX_Q_DIFF MVAr.		
Justification	The SSH data should be based on a solved power flow (CGMM) and as a consequence, the values in SSH (input) and SV (calculation results) should not be far away.		

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 219: LOADACTIVEPOWERINFEEDDIFFW

Severity: WARNING	**Name: LoadActivePowerInfeedDiffW**	**Level: 6**	**Validation scope: IGM & CGM**
Description	For every instance of cim:StationSupply, cim:ConformLoad and cim:NonConformLoad, the value of cim:EnergyConsumer.p should not deviate more than SSH_SV_MAX_P_DIFF MW from the value of cim:SvPowerFlow.p for the associated terminal. Note that disconnected loads should have zero values in SSH.		
Message	Assumed consumption deviates from calculated consumption more than SSH_SV_MAX_P_DIFF MW.		
Justification	The SSH data should be based on a solved power flow (CGMM) and as a consequence, the values in SSH (input) and SV (calculation results) should not be far away.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 220: LOADREACTIVEPOWERINFEEDDIFFW

Severity: WARNING	**Name: LoadReactivePowerInfeedDiffW**	**Level: 6**	**Validation scope: IGM & CGM**
Description	For every instance of cim:StationSupply, cim:ConformLoad and cim:NonConformLoad, the value of cim:EnergyConsumer.q should not deviate more than SSH_SV_MAX_Q_DIFF MVAr from the value of cim:SvPowerFlow.q for the associated terminal. Note that disconnected loads should have zero values in SSH.		
Message	Potential reactive power problem located for load instance, assumed reactive power deviates from calculated more than SSH_SV_MAX_Q_DIFF MVAr.		
Justification	Considering the Power Flow settings, the reactive power shift should be minimal.		

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 221: ENIACTIVEPOWERINFEEDDIFFW

Severity: WARNING	**Name: ENIActivePowerInfeedDiffW**	**Level: 6**	**Validation scope: IGM & CGM**
Description	For every instance of cim:ExternalNetworkInjection, the value of cim:ExternalNetworkInjection.p should not deviate more than SSH_SV_MAX_P_DIFF MW from the value of cim:SvPowerFlow.p for the associated terminal.		
Message	Assumed external injection deviates from calculated more than SSH_SV_MAX_P_DIFF MW.		
Justification	The SSH data should be based on a solved power flow (CGMM) and as a consequence, the values in SSH (input) and SV (calculation results) should not be far away. Note: cim:ExternalNetworkInjection should not be used frequently considering its purpose.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 222: ENIREACTIVEPOWERINFEEDDIFFW

Severity: WARNING	**Name: ENIReactivePowerInfeedDiffW**	**Level: 6**	**Validation scope: IGM & CGM**
Description	For every cim:ExternalNetworkInjection the value of cim:ExternalNetworkInjection.q should not deviate more than SSH_SV_MAX_Q_DIFF MVAr from the value of cim:SvPowerFlow.q for the associated terminal. Note that disconnected loads should have zero values in SSH.		
Message	Potential reactive power problem located for cim:ExternalNetworkInjection, assumed reactive power deviates from calculated more than SSH_SV_MAX_Q_DIFF MVAr		
Justification	Considering the Power Flow settings, the reactive power shift should be minimal.		

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 223: EIACTIVEPOWERINFEEDDIFFW

Severity: WARNING	**Name: EIActivePowerInfeedDiffW**	**Level: 6**	**Validation scope: IGM & CGM**
Description	For every non-boundary cim:EquivalentInjection, the value of cim:EquivalentInjection.p should not deviate more than SSH_SV_MAX_P_DIFF MW from the value of cim:SvPowerFlow.p for the associated terminal.		
Message	Assumed non-boundary cim:EquivalentInjection injection deviates from calculated more than SSH_SV_MAX_P_DIFF MW.		
Justification	The SSH data should be based on a solved power flow (CGMM) and as a consequence, the values in SSH (input) and SV (calculation results) should not be far away. Note: cim:EquivalentInjection should not be used frequently considering its purpose.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 224: EIREACTIVEPOWERINFEEDDIFFW

Severity: WARNING	**Name: EIReactivePowerInfeedDiffW**	**Level: 6**	**Validation scope: IGM & CGM**
Description	For every instance of cim:EquivalentInjection, the value of cim:EquivalentInjection.q should not deviate more than SSH_SV_MAX_Q_DIFF Mvar from the value of cim:SvPowerFlow.q for the associated terminal.		
Message	Assumed generation infeed of cim:EquivalentInjection deviates from calculated generation infeed more than SSH_SV_MAX_Q_DIFF Mvar.		
Justification	The SSH data should be based on a solved power flow (CGMM) and as a consequence, the values in SSH (input) and SV (calculation results) should not be far away.		

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 225: NETINTERCHANGE1

Severity: WARNING	**Name: NetInterchange1**	**Level: 6**	**Validation scope: IGM & CGM**
Description	For a cim:ControlArea of type interchange the aggregated sum of the values of cim:SvPowerFlow.p for cim:Terminals referenced by cim:TieFlow.Terminal shall not deviate from the value of cim:ControlArea.netInterchange with more than cim:ControlArea.pTolerance, if provided. In cases where cim:ControlArea.pTolerance is not provided the value of INTERCH_IMBALANCE_WARNING MW is used in the comparison. There are some implications from other rules to be considered: 1) According to level 5 rule SvPowerFlowBranchInstances the cim:Terminal referenced by a cim:TieFlow.Terminal is located at a boundary cim:TopologicalNode, hence the attribute cim:TieFlow.positiveFlowIn is always true. 2) According to level 5 rule SvPowerFlowBranchInstances2 the cim:Terminal of cim:ACLineSegment, cim:PowerTransformer or retained cim:Switch, etc. should have a cim:SvPowerFlow. 3) According to level 5 rule SvPowerFlowInstances every cim:EquivalentInjection has a cim:SvPowerFlow. As a consequence cim:SvPowerFlow related to boundary cim:EquivalentInjection-s must be used in the summation but with negated value. cim:SvPowerFlow participates in the sum if the cim:Terminal is a terminal of cim:EquivalentInjection, which is connected to a boundary cim:TopologicalNode, referenced by a cim:Terminal, which is also associated to a cim:TieFlow through cim:TieFlow.Terminal. Note 1: cim:ControlArea.netInterchange include AC and DC exchanges. Note 2: An HVDC Boundary cim:TopologicalNode has a cim:IdentifiedObject.description attribute with leading characters 'HVDC'.		
Message	Netted Area position not respected more than INTERCH_IMBALANCE_WARNING MW or cim:ControlArea.pTolerance, if provided.		

Justification	Area interchange control uses ControlArea.netInterchange as set point, the TieFlow terminals as State Variables and the ConformLoad within the ControlArea as Control Variables.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 226: TAPPOSITION

Severity: WARNING	**Name: TapPosition**	**Level: 6**	**Validation scope: IGM & CGM**
Description	For every instance of cim:RatioTapChanger, cim:PhaseTapChangerLinear, cim:PhaseTapChangerSymmetrical and cim:PhaseTapChangerAsymmetrical, which has cim:RegulatingControl.enabled equal to true, the value of cim:TapChanger.step should not deviate more than SSH_SV_MAX_TAP_STEP_DIFF from the value of cim:SvTapStep.position.		
Message	Initial tap position deviates more than SSH_SV_MAX_TAP_STEP_DIFF from calculated.		
Justification	Considering the Power Flow settings, the tap position shift should be minimal. The SSH data should be based on a solved power flow (CGMM) and as a consequence, the values in SSH (input) and SV (calculation results) should not be far away.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 227: SHUNTQ

Severity: WARNING	**Name: ShuntQ**	**Level: 6**	**Validation scope: IGM & CGM**
Description	The rule is checking if cim:SvPowerFlow.q of a cim:LinearShuntCompensator is consistent with cim:SvShuntCompensatorSections.sections. Therefore, for every instance of cim:LinearShuntCompensator, which has cim:RegulatingControl.enabled equals true, the value of cim:SvPowerFlow.q should not deviate more than SSH_SV_MAX_Q_SHUNT_DIFF MVAr from the negated product of the value of cim:SvShuntCompensatorSections.sections, the value of		

	cim:LinearShuntCompensator.bPerSection and the squared value of cim:SvVoltage.v at the cim:TopologicalNode where the cim:LinearShuntCompensator is connected to. The rule applies for cim:LinearShuntCompensator that is: - connected to cim:TopologicalNode with cim:SvVoltage.v greater than 0, and - having its cim:Terminal connected, i.e. cim:ACDCTerminal.connected equals true.
Message	Calculated reactive power output of cim:LinearShuntCompensator differs from cim:SvPowerFlow.q of a cim:LinearShuntCompensator with more than SSH_SV_MAX_Q_SHUNT_DIFF Mvar.
Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 228: SVINJECTIONLIMIT

Severity: WARNING	**Name: SvInjectionLimit**	**Level: 6**	**Validation scope: IGM & CGM**
Description	cim:SvInjection shall not be instantiated if calculated P and Q mismatches are within respective the power flow calculation settings' tolerances. Therefore, - there shall not be an instance of cim:SvInjection if the absolute values of cim:SvInjection.pInjection and cim:SvInjection.qInjection are less than the SV_INJECTION_LIMIT MW/Mvar. - there shall not be an instance of cim:SvInjection if power flow calculation meets the solution tolerance defined by SV_INJECTION_LIMIT MW/Mvar.		
Message	cim:SvInjection is instantiated. If value is greater than SV_INJECTION_LIMIT MW/Mvar, it suggests the model did not converge, i.e., meet the tolerances.		
Justification	The cim:SvInjection values gives the accuracy of the power flow solution. Large values of cim:SvInjection.pInjection and cim:SvInjection.qInjection indicates a poorly converged power flow solution. Lots of cim:SvInjection instances below limit will clutter the SV file.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		

Comment	The limitation is business specific, but the usage of the class is according to standards and there is no difference between CGMES v2.4 and CGMES v3.0.

TABLE 229: VOLTAGEPROFILE

Severity: WARNING	**Name: VoltageProfile**	**Level: 6**	**Validation scope: IGM & CGM**
Description	Where a cim:VoltageLimit exists for an energized cim:TopologicalNode, the value of cim:SvVoltage.v should be lower than or equal to the value of cim:VoltageLimit.value associated with cim:OperationalLimitType.limitType=highVoltage and higher than or equal to the value of cim:VoltageLimit.value associated with cim:OperationalLimitType.limitType=lowVoltage. In case of multiple limits, the most restrictive shall be used.		
Message	Calculated voltage is out of range.		
Justification	Considering the Power Flow settings, all voltages should be within defined operational limits. See IEC TS 61970-600-2:2017 section 6.8.7.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 230: VOLTAGETARGETANDDEADBANDATTN

Severity: WARNING	**Name: VoltageTargetAndDeadbandAtTN**	**Level: 6**	**Validation scope: IGM & CGM**
Description	For all cim:RegulatingControl (including its subclass cim:TapChangerControl) instances at a cim:TopologicalNode with one or more cim:RegulatingControls that have: - cim:RegulatingControl.discrete set to true - cim:RegulatingControl.enabled set to true, and - cim:RegulatingControl.mode set to cim:RegulatingControlModeKind.voltage, shall have cim:RegulatingControl.targetValue within the intersection of regulating ranges formed by all discrete cim:RegulatingControl regulating a cim:TopologicalNode. The range for a discrete control (cim:RegulatingControl.discrete set to true) is {cim:RegulatingControl.targetValue - cim:RegulatingControl.targetDeadband/2, cim:RegulatingControl.targetValue + cim:RegulatingControl.targetDeadband/2}		

	Note: the rule is validating both if the ranges of discrete regulating control form intersection and if the target values of all regulating controls are within the intersection regulating range.
Message	Either 1) Regulating ranges of discrete regulating controls do not create intersection or 2) the target values of regulating controls are not within the intersection range.
Justification	The power flow solver need a single deadband per cim:TopologicalNode and if the deadbands differ the power flow will have to pick a value. If different Power Flow applications use different strategies to pick a value the voltage solution will differ between them which is the reason to warn.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	A lot of elements of this rule are covered in CGMES v3.0. Additional standardisation maybe needed.

TABLE 231: CONTINUOUSCONTROL

Severity: WARNING	**Name: ContinuousControl**	**Level: 6**	**Validation scope: IGM & CGM**
Description	For every instance of cim:RegulatingControl (SSH) for which the value of cim:RegulatingControl.discrete is false and cim:RegulatingControl.enabled is true means continuous control. For devices natively being discrete this means an imprecise modelling of the behaviour for - cim:ShuntCompensator - cim:TapChanger.		
Message	cim:ShuntCompensator or cim:TapChanger are used with a continuous control.		
Justification	If cim:RegulatingControl.discrete is false continuous control is used which is an imprecise model. For as built equipment the most precise model should be used.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 232: KIRCHHOFFSFIRSTLAWCGMRELAXED

Severity: WARNING	**Name: KirchhoffsFirstLawCGMrelaxed**	**Level: 6**	**Validation scope: CGM**

Description	The sum of cim:SvPowerFlow.p and sum of cim:SvPowerFlow.q for all cim:SvPowerFlow-s connected to a cim:TopologicalNode is within the range of allowed solution tolerances, i.e. it is greater than or equal to SV_INJECTION_LIMIT MW/Mvar and it is less than or equal to SV_INJECTION_RELAXED_LIMIT MW/Mvar. If solution tolerance is exceeded a cim:SvInjection shall be provided (the association end cim:TopologicalNode.SvInjection is required). Note: cim:SvPowerFlow-s of non-retained cim:Switch (cim:Switch.retained is false) shall be excluded. The power flow in non-retained cim:Switch-es may not have been correctly computed and may be inconsistent with the other power flows on the cim:TopologicalNode. Hence non-retained cim:Switch-es shall be excluded from the summation to achieve a more robust result.
Message	The sum of the cim:SvPowerFlow-s reported on a cim:TopologicalNode is not within the solution tolerance of primary settings, but it is within the range of relaxed settings and there is no SvInjection provided.
Justification	The sum of power flow into a node is zero according to Kirchhoffs first law.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

13 LEVEL 7: COORDINATION

13.1 STANDARD CONSTRAINTS

13.1.1 SEVERITY ERROR

TABLE 233: ACTIELINEBV

Severity: ERROR	**Name: ACTielineBV**	**Level: 7**	**Validation scope: IGM & CGM**
Description	For a cim:ControlArea of type interchange all cim:TieFlow branches, which:		

	- are not connected to an HVDC boundary point, and - have a direct association to cim:BaseVoltage shall have a cim:BaseVoltage.nominalVoltage that deviates no more than BOUNDARY_BV_MAX_DIFF from the cim:BaseVoltage.nominalVoltage of the boundary point obtained from the association end cim:TopologicalNode.BaseVoltage. Note: An HVDC Boundary Point has a cim:IdentifiedObject.description attribute equal to 'HVDC'.
Message	AC Tie line nominalVoltage deviates from the boundary point base voltage more than BOUNDARY_BV_MAX_DIFF.
Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.10.2 of IEC TS 61970-600-2:2017
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:600:EQ:ACLineSegment:BaseVoltageDiff
Comment	CGMES v3.0 implements this a bit different.

13.2 BUSINESS CONSTRAINTS

13.2.1 SEVERITY ERROR

TABLE 234: ACSCHEDULEMATCH2

Severity: ERROR	**Name: ACScheduleMatch2**	**Level: 7**	**Validation scope: IGM & CGM**
Description	The sum of cim:SvPowerFlow.p tie flows should match the value of the external AC schedule with the same cim:ControlArea EIC 'Y' code within INTERCH_IMBALANCE_ERROR MW threshold. The following conditions apply when creating the sum: - cim:SvPowerFlow related to boundary cim:EquivalentInjection-s must be used in the summation but with negated value. - cim:SvPowerFlow participates in the sum if the cim:Terminal is a terminal of cim:EquivalentInjection which is connected to a boundary cim:TopologicalNode (HVDC Boundary TopologicalNode-s are excluded), referenced by a cim:Terminal which is also associated to a cim:TieFlow through cim:TieFlow.Terminal.		

	Note: An HVDC Boundary TopologicalNode has a cim:IdentifiedObject.description attribute with leading characters 'HVDC'.
Message	AC tie flows does not match the scheduled interchange values more than INTERCH_IMBALANCE_ERROR MW.
Justification	In the Reporting Information Market Document, issued by PEVF or CGMA, the EIC 'Y' code is found in the domain.mRID, in the IGM it is the value of attribute entsoe:IdentifiedObject.EnergyIdentCodeEic for the ControlArea instance.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 235: HVDCSCHEDULEMATCH2

Severity: ERROR	**Name: HVDCScheduleMatch2**	**Level: 7**	**Validation scope: IGM & CGM**
Description	The cim:SvPowerFlow.p value shall match the value of the external schedule for the same cim:ControlArea EIC 'Y' code and with the same connectingLine_RegisteredResource EIC 'T' code within INTERCH_IMBALANCE_ERROR MW threshold. The following conditions apply: - cim:SvPowerFlow related to boundary cim:EquivalentInjection-s must be used but with negated value. - cim:SvPowerFlow participates in the comparison if the cim:Terminal is a terminal of cim:EquivalentInjection which is connected to a boundary cim:TopologicalNode (HVDC Boundary TopologicalNode), referenced by a cim:Terminal, which is also associated to a cim:TieFlow through cim:TieFlow.Terminal. Note: An HVDC Boundary cim:TopologicalNode has a cim:IdentifiedObject.description attribute with leading characters 'HVDC'.		
Message	HVDC flow does not match the scheduled interchange value more than INTERCH_IMBALANCE_ERROR MW		
Justification	In the Reporting Information Market Document, issued by PEVF or CGMA, the EIC 'Y' code is found in the domain.mRID, in the IGM it is the value of attribute entsoe:IdentifiedObject.EnergyIdentCodeEic for the cim:ControlArea instance. The EIC 'T' code is found in the TimeSeries in the connectingLine_RegisteredResource.mRID, in the IGM it is the value of attribute		

	entsoe:IdentifiedObject.EnergyIdentCodeEic for the Boundary point instance, the terminal is connected to.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 236: NETINTERCHANGEMATCH2

Severity: ERROR	**Name: NetInterchangeMatch2**	**Level: 7**	**Validation scope: IGM & CGM**
Description	For every cim:ControlArea of type interchange, the value of cim:ControlArea.netInterchange should not deviate more than INTERCH_IMBALANCE_ERROR MW from the sum of the netted area AC and DC positions in the aggregated netted external schedules (PEVF or CGMA) for the same scenarioTime and with the same EIC 'Y' code. If no netted area AC or DC positions or netted external schedule can be found for the control area this rule skipped.		
Message	cim:ControlArea netInterchange deviates more than INTERCH_IMBALANCE_ERROR MW from netted area position.		
Justification	In the Reporting Information Market Document, issued by PEVF or CGMA, the EIC 'Y' code is found in the domain.mRID, in the IGM it is the value of attribute entsoe:IdentifiedObject.EnergyIdentCodeEic for the cim:ControlArea instance.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 237: PAIREDEICOMPATIBILITY

Severity: ERROR	**Name: PairedEICompatibility**	**Level: 7**	**Validation scope: CGM**
Description	The rule is checking SSH information of a paired boundary point in a CGM. The two cim:EquivalentInjection-s at a boundary cim:TopologicalNode shall have: - control disabled (cim:EquivalentInjection.regulationStatus = false);		

	- the sum of their active power injections (cim:EquivalentInjection.p) shall be less than or equal to SV_INJECTION_LIMIT; - the sum of their reactive power injections (cim:EquivalentInjection.q) shall be less than or equal to SV_INJECTION_LIMIT.
Message	Either any of the cim:EquivalentInjection-s at a paired boundary has control enabled or the sum of active/reactive power is greater than SV_INJECTION_LIMIT.
Justification	A cim:EquivalentInjection represents the power flow towards a boundary cim:TopologicalNode. If the neighbouring IGM has voltage control capability this could be modelled by enabling the cim:EquivalentInjection control (cim:EquivalentInjection.regulationStatus set to true). When a CGM is built and both networks are connected at a boundary - the cim:EquivalentInjection control shall be disabled to avoid duplicate controls. - the sum of their active and reactive powers must be within the tolerance SV_INJECTION_LIMIT.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

13.2.2 SEVERITY WARNING

TABLE 238: UNPAIREDTIEFLOW

Severity: WARNING	**Name: UnpairedTieFlow**	**Level: 7**	**Validation scope: CGM**
Description	A paired boundary cim:TopologicalNode should be consistent in terms of cim:TieFlow-s associated with cim:Terminal-s connected to this cim:TopologicalNode. If one side of the border has cim:TieFlow the other side should also have one, and vice versa. Note: An AC boundary cim:TopologicalNode which has two branches and two cim:EquivalentInjection-s linking two IGMs is a paired boundary cim:TopologicalNode.		
Message	A paired AC boundary point has inconsistent cim:TieFlow.		
Justification	cim:TieFlow is typically calculated at the AC Tie Line terminal, connected to the boundary point for AC Tie Lines (regardless of its position on the Tie line) and at the Point of Common Coupling for HVDC links.		

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 239: ACSCHEDULEMATCH1

Severity: WARNING	**Name: ACScheduleMatch1**	**Level: 7**	**Validation scope: IGM & CGM**
Description	The sum of cim:SvPowerFlow.p should match the value of the external AC schedule with the same cim:ControlArea EIC 'Y' code within INTERCH_IMBALANCE_WARNING MW threshold. The following conditions apply when creating the sum: - cim:SvPowerFlow related to boundary cim:EquivalentInjection-s must be used in the summation but with negated value. - cim:SvPowerFlow participates in the sum if the cim:Terminal is a terminal of cim:EquivalentInjection which is connected to a boundary cim:TopologicalNode (HVDC Boundary TopologicalNode-s are excluded), referenced by a cim:Terminal, which is also associated to a cim:TieFlow through cim:TieFlow.Terminal. Note: An HVDC Boundary cim:TopologicalNode has a cim:IdentifiedObject.description attribute with leading characters 'HVDC'.		
Message	AC tie flows does not match the scheduled interchange value more than INTERCH_IMBALANCE_WARNING MW.		
Justification	In the Reporting Information Market Document, issued by PEVF or CGMA, the EIC 'Y' code is found in the domain.mRID, in the IGM it is the value of attribute entsoe:IdentifiedObject.EnergyIdentCodeEic for the ControlArea instance.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 240: HVDCSCHEDULEMATCH1

Severity: WARNING	Name: HVDCScheduleMatch1	Level: 7	Validation scope: IGM & CGM
Description	The cim:SvPowerFlow.p value should match the value of the external schedule for the same cim:ControlArea EIC 'Y' code and with the same connectingLine_RegisteredResource EIC 'T' code within INTERCH_IMBALANCE_WARNING MW threshold. The following conditions apply: - cim:SvPowerFlow related to boundary cim:EquivalentInjection-s must be used but with negated value. - cim:SvPowerFlow participates in the comparison if the cim:Terminal is a terminal of cim:EquivalentInjection which is connected to a boundary cim:TopologicalNode (HVDC Boundary TopologicalNode), referenced by a cim:Terminal, which is also associated to a cim:TieFlow through cim:TieFlow.Terminal. Note: An HVDC Boundary cim:TopologicalNode has a cim:IdentifiedObject.description attribute with leading characters 'HVDC'.		
Message	HVDC flow does not match the scheduled interchange value more than INTERCH_IMBALANCE_WARNING MW.		
Justification	In the Reporting Information Market Document, issued by PEVF or CGMA, the EIC 'Y' code is found in the domain.mRID, in the IGM it is the value of attribute entsoe:IdentifiedObject.EnergyIdentCodeEic for the cim:ControlArea instance. The EIC 'T' code is found in the TimeSeries in the connectingLine_RegisteredResource.mRID, in the IGM it is the value of attribute entsoe:IdentifiedObject.EnergyIdentCodeEic for the Boundary point instance, the terminal is connected to.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 241: NETINTERCHANGEMATCH1

Severity: WARNING	Name: NetInterchangeMatch1	Level: 7	Validation scope: IGM & CGM
Description	For every cim:ControlArea of type interchange, the value of cim:ControlArea.netInterchange should not deviate more than INTERCH_IMBALANCE_WARNING MW from the sum of the netted area AC and DC positions in the aggregated netted external schedules (PEVF or CGMA) for the same scenarioTime		

	and with the same EIC 'Y' code. If no netted area AC or DC positions or netted external schedule can be found for the control area this rule skipped.
Message	cim:ControlArea netInterchange deviates more than INTERCH_IMBALANCE_WARNING MW from netted area position.
Justification	In the Reporting Information Market Document, issued by PEVF or CGMA, the EIC 'Y' code is found in the domain.mRID, in the IGM it is the value of attribute entsoe:IdentifiedObject.EnergyIdentCodeEic for the cim:ControlArea instance.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

13.2.3 SEVERITY INFO

TABLE 242: INCONSISTENTCURRENTLIMITS

Severity: INFO	**Name: InconsistentCurrentLimits**	**Level: 7**	**Validation scope: IGM in QAS**
Description	The value of cim:CurrentLimit.value is expected to be the same for a tie line on both sides of the boundary point. In case there is no operational limit defined at terminals connected to the boundary point, limit values assigned to other end of the tie-line segment are considered for the comparison. The rule applies only for cim:CurrentLimit which has association end cim:OperatingLimit.OperatingLimitType referencing a cim:OperatingLimitType with entsoe:OperatingLimitType.limitType equal to entsoe:LimitTypeKind.patl. The lowest limit should be used in studies. To allow for a small deviation the limit values standard rounding to integer is applied before comparing and provided for the reporting.		
Message	Current limits of type PATL are inconsistent at a tie line.		
Justification	Tie line data is supposed to be coordinated by TSOs.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		

Comment	

TABLE 243: INCONSISTENTTNBASEVOLTAGE

Severity: INFO	**Name: InconsistentTnBaseVoltage**	**Level: 7**	**Validation scope: IGM**
Description	All equipment with a direct association to cim:BaseVoltage connected to a cim:TopologicalNode should have a cim:BaseVoltage.nominalVoltage that deviates no more than BOUNDARY_BV_MAX_DIFF from the cim:BaseVoltage.nominalVoltage of the cim:BaseVoltage referenced by the association end cim:TopologicalNode.BaseVoltage.		
Message	cim:BaseVoltages.nominalVoltage at a cim:TopologicalNode differs more than BOUNDARY_BV_MAX_DIFF from the cim:BaseVoltage.nominalVoltage of the connected equipment.		
Justification	If the cim:BaseVoltage.nominalVoltage differs this may indicate a topology error.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment	Not needed in CGMES v3.0		

14 LEVEL 8: CONVERGENCE AND PLAUSIBILITY

14.1 BUSINESS CONSTRAINTS

14.1.1 SEVERITY ERROR

TABLE 244: IGMCONVERGENCE

Severity: ERROR	**Name: IGMConvergence**	**Level: 8**	**Validation scope: IGM**
Description	It shall be possible to solve the power flow with the following power flow settings: - Full Newton Raphson power flow algorithm. - Switched shunt adjustment must be set to enabled for shunts used for voltage regulation. - Transformer tap adjustment is set to enabled.		

	- Q limits shall be respected for EquivalentInjection, ExternalNetworkInjection, SynchronousMachines, SVCs and SynchronousCondensers (also for slack node/swing bus). - Distributed generation slack is set to enabled (proportional to GeneratingUnit.normalPF). - Maximum mismatch is set to SV_INJECTION_LIMIT MW and SV_INJECTION_LIMIT MVAr per node. - Zero impedance threshold is set to ZERO_IMPEDANCE_THRESHOLD. - Controlled node voltage error convergence tolerance = 0.0001 pu (The largest difference between actual and scheduled voltage magnitude in per unit at each node where voltage is subject to control to a set point, and for which at least one of the devices participating in the control of bus voltage to its set point is not at a reactive power limit, must be less than the controlled bus voltage error convergence tolerance).
Message	Power flow could not be calculated for IGM with required settings. Check diagnostic messages.
Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 245: CGMCONVERGENCERELAXED

Severity: ERROR	**Name: CGMConvergenceRelaxed**	**Level: 8**	**Validation scope: CGM**
Description	It shall be possible to solve the power flow with the following power flow settings: - Full Newton Raphson power flow algorithm. - Q limits shall be ignored (also for slack node/swing bus) meaning unlimited reactive resources. - Area interchange control is set to enabled. - Maximum mismatch is set to 0.5 MW and 0.5 MVAr per node. - Controlled node voltage error convergence mismatch = 0.0001 pu (The largest difference between actual and scheduled voltage magnitude in per unit at each node where voltage is subject to control to a setpoint, and for which at least one of the devices participating in the control of bus voltage to its setpoint is not at a reactive power limit, must be less than the controlled bus voltage error convergence mismatch).		
Message	Power flow could not be calculated for CGM with relaxed Q limits. Check diagnostic messages.		
Justification			

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

14.1.2 SEVERITY WARNING

TABLE 246: CGMCONVERGENCE

Severity: WARNING	**Name: CGMConvergence**	**Level: 8**	**Validation scope: CGM**
Description	It shall be possible to solve the power flow with the following power flow settings: - Full Newton Raphson power flow algorithm. - Switched shunt adjustment must be set to enabled for shunts used for voltage regulation. - Transformer tap adjustment is set to enabled. - Q limits shall be respected for EquivalentInjection, ExternalNetworkInjection, SynchronousMachines, SVCs and SynchronousCondensers (also for slack node/swing bus). - Area interchange control is set to enabled. - Maximum mismatch is set to SV_INJECTION_LIMIT MW and SV_INJECTION_LIMIT MVAr per node. - Zero impedance threshold is set to ZERO_IMPEDANCE_THRESHOLD. - Controlled node voltage error convergence tolerance = 0.0001 pu (The largest difference between actual and scheduled voltage magnitude in per unit at each node where voltage is subject to control to a set point, and for which at least one of the devices participating in the control of bus voltage to its set point is not at a reactive power limit, must be less than the controlled bus voltage error convergence tolerance).		
Message	Power flow could not be calculated for CGM with required settings. Check diagnostic messages.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 247: CONGESTION

Severity: WARNING	Name: Congestion	Level: 8	Validation scope: IGM & CGM
Description	There should be no base case violations considering PATL limits. The rule is applied only for PATL limits in cases where there is a cim:SvPowerFlow at the terminal where the cim:OperationalLimitSet is.		
Message	Base case violation is present.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 248: CGMTIEFLOWIMBALANCE

Severity: WARNING	Name: CGMTieFlowImbalance	Level: 8	Validation scope: CGM
Description	The sum of the solved tie flows for each cim:ControlArea of type interchange shall equal the cim:ControlArea.netInterchange plus/minus an INTERCH_IMBALANCE_EMF MW. i.e. - TFS less than or equal to cim:ControlArea.netInterchange + INTERCH_IMBALANCE_EMF MW - TFS greater than or equal to cim:ControlArea.netInterchange - INTERCH_IMBALANCE_EMF MW Where TFS (TieFlow sum) is computed as - TFS = sum(cim:SvPowerFlow.p) of cim:EquivalentInjection-s which cim:Terminal connects to the same boundary point (cim:TopologicalNode) where there is a cim:Terminal referenced by the association end cim:TieFlow.Terminal. Note: This rule is built on the fact that the CGM SV instance file and the updated SSH instance files of IGMs are consistent hence contain updated values of cim:SvPowerFlow. i.e. cim:EquivalentInjection has the same output as the flow of the interconnection in the CGM SV instance file.		
Message	The sum of solved tie flows for a cim:ControlArea deviates from the cim:ControlArea interchange tolerance INTERCH_IMBALANCE_EMF MW.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		

IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

14.1.3 SEVERITY INFO

TABLE 249: TICONVERGENCESTATMISSING

Severity: INFO	**Name: TIConvergenceStatMissing**	**Level: 8**	**Validation scope: IGM & CGM**
Description	cim:IdentifiedObject.description is added to State Variables profile as required attribute. The cim:IdentifiedObject.description of cim:TopologicalIsland should have one the following string values: “converged” and “diverged” which represents the convergence status of the cim:TopologicalIsland.		
Message	Convergence status (cim:IdentifiedObject.description) is not provided for cim:TopologicalIsland.		
Justification	It should be possible to conclude if a cim:TopologicalIslands has diverged or converged.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment	It changes CGMES v2.4 specification and it is not applicable in CGMES v3.0.		

TABLE 250: TICONVERGENCESTATDIVERGED

Severity: INFO	**Name: TIConvergenceStatDiverged**	**Level: 8**	**Validation scope: IGM & CGM**
Description	Convergence status for cim:TopologicalIsland is diverged. The cim:IdentifiedObject.description of the cim:TopologicalIsland should then contain the text "diverged".		
Message	Convergence status is declared as diverged for cim:TopologicalIsland		
Justification	It should be possible to conclude if a cim:TopologicalIslands has diverged or converged.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment	It changes CGMES v2.4 specification and it is not applicable in CGMES v3.0.		

15 DC IGM

15.1 STANDARD CONSTRAINTS

15.1.1 SEVERITY ERROR

TABLE 251: DCLINECONTAINMENT

Severity: ERROR	Name: DCLineContainment	Level: 5	Validation scope: DC IGM
Description	For every instance of cim:DCLineSegment, the cim:Equipment.EquipmentContainer referred to, must be of type cim:DCLine. In the case of modelling back to back configuration the association shall point to EquipmentContainer of type cim:Substation. Missing containment is not allowed.		
Message	cim:DCLineSegment is not contained in either a cim:DCLine or a cim:Substation.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	section 6.3.15 of IEC TS 61970-600-2		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:DCLineSegment:containment		
Comment			

TABLE 252: DCLINESEGMENTR

Severity: ERROR	Name: DCLineSegmentR	Level: 3	Validation scope: DC IGM
Description	For every instance of cim:DCLineSegment the value of cim:DCLineSegment.resistance and the value of the associated cim:PerLengthDCLineParameter.resistance must be greater than zero.		
Message	A cim:DCLineSegment with negative resistance.		
Justification	Negative resistance means negative losses. This is not allowed for real equipment.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:DCLineSegment.resistance:valueRange		

Comment	In CGMES v3.0 the part PerLengthDCLineParameter is not needed as the class in not in the CGMES v3.0.

TABLE 253: VSCYVALUES

Severity: ERROR	**Name: VSCYValues**	**Level: 3**	**Validation scope: DC IGM**
Description	For every instance of cim:CurveData, for which the cim:CurveData.Curve refers to a cim:VsCapabilityCurve, the cim:CurveData.y2value must be greater than cim:CurveData.y1value.		
Message	Invalid cim:VsCapabilityCurve data.		
Justification	The name plate ratings are used as a reference.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:CurveData.Curve:VsCapabilityCurve		
Comment			

TABLE 254: VSCXVALUES

Severity: ERROR	**Name: VSCXValues**	**Level: 3**	**Validation scope: DC IGM**
Description	For every instance of cim:CurveData, for which the cim:CurveData.Curve refers to a cim:VSCapabilityCurve, at least two instances of the cim:CurveData are associated.		
Message	Invalid cim:VSCapabilityCurve data.		
Justification	A curve consists of at least two curve points.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:CurveData.Curve:VsCapabilityCurveCount		
Comment			

TABLE 255: TARGETVALUEPPCC

Severity: ERROR	**Name: targetValuePpcc**	**Level: 3**	**Validation scope: DC IGM**
Description	Control is real power at point of common coupling. The target value is provided by ACDCConverter.targetPpcc.		
Message	ACDCConverter.targetPpcc is not provided for a converter with VsPpccControlKind.pPcc.		

Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:VsPpccControlKind.pPcc:targetValuePpcc
Comment	

TABLE 256: TARGETVALUEPPCCANDUDCDROOPWITHCOMPENSATION

Severity: ERROR	**Name: targetValuepPccAndUdcDroopWithCompensation**	**Level: 3**	**Validation scope: DC IGM**
Description	Targets are provided by ACDCConverter.targetPpcc, ACDCConverter.targetUdc, VsConverter.droop and VsConverter.droopCompensation.		
Message	One or all among ACDCConverter.targetPpcc, ACDCConverter.targetUdc, VsConverter.droop and VsConverter.droopCompensation are not provided for a converter with VsPpccControlKind.pPccAndUdcDroopWithCompensation.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:VsPpccControlKind.pPccAndUdcDroopWithCompensation:targetValuepPccAndUdcDroopWithCompensation		
Comment			

TABLE 257: TARGETVALUEPPCCANDUDCDROOPPILOT

Severity: ERROR	**Name: targetValuepPccAndUdcDroopPilot**	**Level: 3**	**Validation scope: DC IGM**
Description	Targets are provided by ACDCConverter.targetPpcc, ACDCConverter.targetUdc and VsConverter.droop.		
Message	One or all among ACDCConverter.targetPpcc, ACDCConverter.targetUdc and VsConverter.droop are not provided for a converter with VsPpccControlKind.pPccAndUdcDroopPilot.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		

IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:VsPpccControlKind.pPccAndUdcDroopPilot:targetValuepPccAndUdcDroopPilot
Comment	

TABLE 258: TARGETVALUEUDC

Severity: ERROR	**Name: targetValueUdc**	**Level: 3**	**Validation scope: DC IGM**
Description	Control is DC voltage with target value provided by ACDCConverter.targetUdc.		
Message	ACDCConverter.targetUdc is not provided for a converter with VsPpccControlKind.udc.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:VsPpccControlKind.udc:targetValueUdc		
Comment			

TABLE 259: TARGETVALUEPPCCANDUDCDROOP

Severity: ERROR	**Name: targetValuepPccAndUdcDroop**	**Level: 3**	**Validation scope: DC IGM**
Description	Target values are provided by ACDCConverter.targetPpcc, ACDCConverter.targetUdc and VsConverter.droop.		
Message	One or all among ACDCConverter.targetPpcc, ACDCConverter.targetUdc and VsConverter.droop are not provided for a converter with VsPpccControlKind.pPccAndUdcDroop.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:VsPpccControlKind.pPccAndUdcDroop:targetValuepPccAndUdcDroop		
Comment			

TABLE 260: TARGETVALUEPHASEPCC

Severity: ERROR	**Name: targetValuephasePcc**	**Level: 3**	**Validation scope: DC IGM**
Description	Control is phase at point of common coupling. Target is provided by VsConverter.targetPhasePcc.		
Message	VsConverter.targetPhasePcc is not provided for a converter with VsPpccControlKind.phasePcc.		

Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:VsPpccControlKind.phasePcc:targetValuephasePcc
Comment	

TABLE 261: C:456:SSH:ACDCCONVERTER:TARGETS

Severity: ERROR	**Name: C:456:SSH:ACDCConverter:targets**	**Level: 3**	**Validation scope: DC IGM**
Description	The target values and related attributes for ACDCConverter and its subclasses are optional in SSH. However, depending on the control mode of the converter some of the attributes shall be considered as required. The description of the control modes in the enumerations CsPpccControlKind, VsPpccControlKind and VsQpccControlKind provide information on necessary attributes which are then considered required attributes for each control mode in SSH.		
Message	Target values for ACDCConverter are not consistent.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:456:SSH:ACDCConverter:targets		
Comment			

TABLE 262: C:301:EQ:CSCONVERTER.MINGAMMA:VALUERANGE

Severity: ERROR	**Name: C:301:EQ:CsConverter.minGamma:valueRange**	**Level: 3**	**Validation scope: DC IGM**
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:CsConverter.minGamma:valueRange		

Comment	

TABLE 263: C:301:EQ:CSCONVERTER.MAXALPHA:VALUERANGE

Severity: ERROR	**Name: C:301:EQ:CsConverter.maxAlpha:valueRange**	**Level: 3**	**Validation scope: DC IGM**
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:CsConverter.maxAlpha:valueRange		
Comment			

TABLE 264: C:301:EQ:CSCONVERTER.MINALPHA:VALUERANGE

Severity: ERROR	**Name: C:301:EQ:CsConverter.minAlpha:valueRange**	**Level: 3**	**Validation scope: DC IGM**
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:CsConverter.minAlpha:valueRange		
Comment			

TABLE 265: C:301:SSH:CSCONVERTER.TARGETALPHA:VALUERANGEPAIRFROM

Severity: ERROR	**Name: C:301:SSH:CsConverter.targetAlpha:valueRangePairFrom**	**Level: 3**	**Validation scope: DC IGM**
Description	Allowed values are within the range minAlpha<=targetAlpha<=maxAlpha.		
Message	The value is less than CsConverter.minAlpha.		

Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:CsConverter.targetAlpha:valueRangePairFrom
Comment	

TABLE 266: C:301:SSH:CSCONVERTER.TARGETGAMMA:VALUERANGE

Severity: ERROR	**Name: C:301:SSH:CsConverter.targetGamma:valueRange**	**Level: 3**	**Validation scope: DC IGM**
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:CsConverter.targetGamma:valueRange		
Comment			

TABLE 267: C:301:SSH:CSCONVERTER.TARGETGAMMA:VALUERANGEPAIRTO

Severity: ERROR	**Name: C:301:SSH:CsConverter.targetGamma:valueRangePairTo**	**Level: 3**	**Validation scope: DC IGM**
Description	Allowed values are within the range minGamma<=targetGamma<=maxGamma.		
Message	The value is greater than CsConverter.maxGamma.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:CsConverter.targetGamma:valueRangePairTo		
Comment			

TABLE 268: C:301:SV:CSCONVERTER.ALPHA:VALUERANGE

Severity: ERROR	Name: C:301:SV:CsConverter.alpha:valueRange	Level: 3	Validation scope: DC IGM
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SV:CsConverter.alpha:valueRange		
Comment			

TABLE 269: C:301:SV:CSCONVERTER.GAMMA:VALUERANGE

Severity: ERROR	Name: C:301:SV:CsConverter.gamma:valueRange	Level: 3	Validation scope: DC IGM
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SV:CsConverter.gamma:valueRange		
Comment			

TABLE 270: C:301:SSH:CSCONVERTER.TARGETALPHA:VALUERANGEPAIRTO

Severity: ERROR	Name: C:301:SSH:CsConverter.targetAlpha:valueRangePairTo	Level: 3	Validation scope: DC IGM
Description	Allowed values are within the range minAlpha<=targetAlpha<=maxAlpha.		
Message	The value is greater than CsConverter.maxAlpha.		
Justification			

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:CsConverter.targetAlpha:valueRangePairTo
Comment	

TABLE 271: C:301:EQ:CSCONVERTER.MINIDC:VALUERANGE

Severity: ERROR	**Name: C:301:EQ:CsConverter.minIdc:valueRange**	**Level: 3**	**Validation scope: DC IGM**
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:CsConverter.minIdc:valueRange		
Comment			

TABLE 272: C:301:SSH:CSCONVERTER.TARGETGAMMA:VALUERANGEPAIRFROM

Severity: ERROR	**Name: C:301:SSH:CsConverter.targetGamma:valueRangePairFrom**	**Level: 3**	**Validation scope: DC IGM**
Description	Allowed values are within the range minGamma<=targetGamma<=maxGamma.		
Message	The value is less than CsConverter.minGamma.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:CsConverter.targetGamma:valueRangePairFrom		
Comment			

TABLE 273: C:301:EQ:CSCONVERTER.RATEDIDC:VALUERANGE

Severity: ERROR	Name: C:301:EQ:CsConverter.ratedIdc:valueRange	Level: 3	Validation scope: DC IGM
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:CsConverter.ratedIdc:valueRange		
Comment			

TABLE 274: C:301:EQ:CSCONVERTER.MAXGAMMA:VALUERANGE

Severity: ERROR	Name: C:301:EQ:CsConverter.maxGamma:valueRange	Level: 3	Validation scope: DC IGM
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:CsConverter.maxGamma:valueRange		
Comment			

TABLE 275: C:301:SSH:CSCONVERTER.TARGETALPHA:VALUERANGE

Severity: ERROR	Name: C:301:SSH:CsConverter.targetAlpha:valueRange	Level: 3	Validation scope: DC IGM
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		

IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:CsConverter.targetAlpha:valueRange
Comment	

TABLE 276: C:301:SSH:CSCONVERTER.TARGETIDC:VALUERANGE

Severity: ERROR	**Name: C:301:SSH:CsConverter.targetIdc:valueRange**	**Level: 3**	**Validation scope: DC IGM**
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:CsConverter.targetIdc:valueRange		
Comment			

TABLE 277: C:301:EQ:CSCONVERTER.MAXIDC:VALUERANGE

Severity: ERROR	**Name: C:301:EQ:CsConverter.maxIdc:valueRange**	**Level: 3**	**Validation scope: DC IGM**
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:CsConverter.maxIdc:valueRange		
Comment			

TABLE 278: C:301:SSH:VSCONVERTER.TARGETPOWERFACTORPCC:VALUERANGE

Severity: ERROR	**Name: C:301:SSH:VsConverter.targetPowerFactorPcc:valueRange**	**Level: 3**	**Validation scope: DC IGM**
Description	The attribute shall be a positive value.		

Message	The value is negative or zero.
Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:VsConverter.targetPowerFactorPcc:valueRange
Comment	

TABLE 279: C:301:SV:VSCONVERTER.DELTA:VALUERANGE

Severity: ERROR	**Name: C:301:SV:VsConverter.delta:valueRange**	**Level: 3**	**Validation scope: DC IGM**
Description	The attribute shall be a positive value or zero.		
Message	The value is negative.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SV:VsConverter.delta:valueRange		
Comment			

TABLE 280: C:452:EQ:CURVEDATA.CURVE:VSCAPABILITYCURVECOUNT

Severity: ERROR	**Name: C:452:EQ:CurveData.Curve:VsCapabilityCurveCount**	**Level: 3**	**Validation scope: DC IGM**
Description	If CurveData.Curve is a VsCapabilityCurve at least two CurveData shall be associated.		
Message	Less than two instances of CurveData are associated.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:CurveData.Curve:VsCapabilityCurveCount		
Comment			

TABLE 281: C:301:SSH:VSCONVERTER.TARGETUPCC:VALUERANGE

Severity: ERROR	Name: C:301:SSH:VsConverter.targetUpcc:valueRange	Level: 3	Validation scope: DC IGM
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:VsConverter.targetUpcc:valueRange		
Comment			

TABLE 282: C:301:SV:VSCONVERTER.UV:VALUERANGE

Severity: ERROR	Name: C:301:SV:VsConverter.uv:valueRange	Level: 3	Validation scope: DC IGM
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SV:VsConverter.uv:valueRange		
Comment			

TABLE 283: C:301:SSH:VSCONVERTER.TARGETPWMFACTOR:VALUERANGE

Severity: ERROR	Name: C:301:SSH:VsConverter.targetPWMfactor:valueRange	Level: 3	Validation scope: DC IGM
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:VsConverter.targetPWMfactor:valueRange
Comment	

TABLE 284: C:452:EQ:CURVEDATA.CURVE:VSCAPABILITYCURVE

Severity: ERROR	**Name: C:452:EQ:CurveData.Curve:VsCapabilityCurve**	**Level: 3**	**Validation scope: DC IGM**
Description	If CurveData.Curve is a VsCapabilityCurve, the CurveData.y2value shall be greater than CurveData.y1value.		
Message	CurveData.y2value is not greater than CurveData.y1value		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:CurveData.Curve:VsCapabilityCurve		
Comment			

TABLE 285: C:301:SSH:VSCONVERTER.DROOP:VALUERANGE

Severity: ERROR	**Name: C:301:SSH:VsConverter.droop:valueRange**	**Level: 3**	**Validation scope: DC IGM**
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:VsConverter.droop:valueRange		
Comment			

TABLE 286: C:301:SSH:VSCONVERTER.TARGETPHASEPCC:VALUERANGE

Severity: ERROR	Name: C:301:SSH:VsConverter.targetPhasePcc:valueRange	Level: 3	Validation scope: DC IGM
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:VsConverter.targetPhasePcc:valueRange		
Comment			

TABLE 287: C:301:SSH:VSCONVERTER.DROOPCOMPENSATION:VALUERANGE

Severity: ERROR	Name: C:301:SSH:VsConverter.droopCompensation:valueRange	Level: 3	Validation scope: DC IGM
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:VsConverter.droopCompensation:valueRange		
Comment			

TABLE 288: C:301:SSH:VSCONVERTER.QSHARE:VALUERANGE

Severity: ERROR	Name: C:301:SSH:VsConverter.qShare:valueRange	Level: 3	Validation scope: DC IGM
Description	The attribute shall be a positive value or zero.		
Message	The value is negative.		
Justification			

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:VsConverter.qShare:valueRange
Comment	

TABLE 289: C:301:EQ:ACDCCONVERTER.BASES:VALUERANGE

Severity: ERROR	**Name: C:301:EQ:ACDCConverter.baseS:valueRange**	**Level: 3**	**Validation scope: DC IGM**
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:ACDCConverter.baseS:valueRange		
Comment			

TABLE 290: C:301:EQ:ACDCTERMINAL.SEQUENCENUMBER:NUMBERING

Severity: ERROR	**Name: C:301:EQ:ACDCTerminal.sequenceNumber:numbering**	**Level: 3**	**Validation scope: DC IGM**
Description	The sequence numbering starts with 1 and additional terminals should follow in increasing order. The first terminal is the "starting point" for a two terminal branch.		
Message	There is no terminal with sequenceNumber=1 or the numbering is not unique.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:ACDCTerminal.sequenceNumber:numbering		
Comment			

TABLE 291: C:301:SSH:ACDCCONVERTER.TARGETUDC:VALUERANGE

Severity: ERROR	Name: C:301:SSH:ACDCConverter.targetUdc:valueRange	Level: 3	Validation scope: DC IGM
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:ACDCConverter.targetUdc:valueRange		
Comment			

TABLE 292: C:301:EQ:ACDCCONVERTER.MINUDC:VALUERANGE

Severity: ERROR	Name: C:301:EQ:ACDCConverter.minUdc:valueRange	Level: 3	Validation scope: DC IGM
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:ACDCConverter.minUdc:valueRange		
Comment			

TABLE 293: C:301:SV:ACDCCONVERTER.UC:VALUERANGE

Severity: ERROR	Name: C:301:SV:ACDCConverter.uc:valueRange	Level: 3	Validation scope: DC IGM
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		

IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SV:ACDCConverter.uc:valueRange
Comment	

TABLE 294: C:301:EQ:ACDCCONVERTER.IDLELOSS:VALUERANGE

Severity: ERROR	**Name: C:301:EQ:ACDCConverter.idleLoss:valueRange**	**Level: 3**	**Validation scope: DC IGM**
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:ACDCConverter.idleLoss:valueRange		
Comment			

TABLE 295: C:301:SV:ACDCCONVERTER.UDC:VALUERANGE

Severity: ERROR	**Name: C:301:SV:ACDCConverter.udc:valueRange**	**Level: 3**	**Validation scope: DC IGM**
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SV:ACDCConverter.udc:valueRange		
Comment			

TABLE 296: C:301:EQ:ACDCCONVERTERDCTERMINAL.POLARITY:USAGE

Severity: ERROR	**Name: C:301:EQ:ACDCConverterDCTerminal.polarity:usage**	**Level: 3**	**Validation scope: DC IGM**
Description	Depending on the converter configuration the value shall be set as follows:		

	- For a monopole with two converter terminals use DCPolarityKind “positive” and “negative”. - For a bi-pole or symmetric monopole with three converter terminals use DCPolarityKind “positive”, “middle” and “negative”.
Message	Converter configuration is not complete.
Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:ACDCConverterDCTerminal.polarity:usage
Comment	

TABLE 297: C:452:EQ:ACDCCONVERTER:CONTAINMENT

Severity: ERROR	**Name: C:452:EQ:ACDCConverter:containment**	**Level: 3**	**Validation scope: DC IGM**
Description	For ACDCConverter (CsConverter, VsConverter) the association Equipment.EquipmentContainer is required and shall point to DCEquipmentContainer of type DCConverterUnit. In this case the association DCConverterUnit.Substation is required.		
Message	The containment is either missing or it is not DCConverterUnit. The DCConverterUnit.Substation association is either missing or not pointing to a Substation.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:452:EQ:ACDCConverter:containment		
Comment			

TABLE 298: C:301:EQ:ACDCCONVERTER.RATEDUDC:VALUERANGE

Severity: ERROR	**Name: C:301:EQ:ACDCConverter.ratedUdc:valueRange**	**Level: 3**	**Validation scope: DC IGM**
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:ACDCConverter.ratedUdc:valueRange
Comment	

TABLE 299: C:301:SV:ACDCCONVERTER.POLELOSSP:VALUERANGE

Severity: ERROR	**Name: C:301:SV:ACDCConverter.poleLossP:valueRange**	**Level: 3**	**Validation scope: DC IGM**
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SV:ACDCConverter.poleLossP:valueRange		
Comment			

TABLE 300: C:301:EQ:ACDCCONVERTER.MAXUDC:VALUERANGE

Severity: ERROR	**Name: C:301:EQ:ACDCConverter.maxUdc:valueRange**	**Level: 3**	**Validation scope: DC IGM**
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:ACDCConverter.maxUdc:valueRange		
Comment			

TABLE 301: C:301:EQ:ACDCCONVERTER.RESISTIVELOSS:VALUERANGE

Severity: ERROR	Name: C:301:EQ:ACDCConverter.resistiveLoss:valueRange	Level: 3	Validation scope: DC IGM
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:ACDCConverter.resistiveLoss:valueRange		
Comment			

TABLE 302: C:301:EQ:ACDCCONVERTER.DCTERMINALS:NUMBEROFTERMINALS

Severity: ERROR	Name: C:301:EQ:ACDCConverter.DCTerminals:numberOfTerminals	Level: 3	Validation scope: DC IGM
Description	A converter has two DC converter terminals.		
Message	The converter does not have two terminals, i.e. two instances of ACDCConverterDCTerminal.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:ACDCConverter.DCTerminals:numberOfTerminals		
Comment			

TABLE 303: C:301:EQ:ACDCCONVERTER.SWITCHINGLOSS:VALUERANGE

Severity: ERROR	Name: C:301:EQ:ACDCConverter.switchingLoss:valueRange	Level: 3	Validation scope: DC IGM
Description	The attribute shall be a positive value.		
Message	The value is negative or zero.		
Justification			

IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:ACDCConverter.switchingLoss:valueRange
Comment	

15.1.2 SEVERITY WARNING

TABLE 304: C:301:EQ:CSCONVERTER.MINALPHA:VALUERANGETYPICAL

Severity: WARNING	**Name: C:301:EQ:CsConverter.minAlpha:valueRangeTypical**	**Level: 3**	**Validation scope: DC IGM**
Description	The attributes minAlpha and maxAlpha define the range of firing angles for rectifier operation between which no discrete tap changer action takes place. The range is typically 10-18 degrees.		
Message	The value is less than 10 or greater than CsConverter.maxAlpha		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:CsConverter.minAlpha:valueRangeTypical		
Comment			

TABLE 305: C:301:SV:CSCONVERTER.ALPHA:VALUERANGETYPICAL

Severity: WARNING	**Name: C:301:SV:CsConverter.alpha:valueRangeTypical**	**Level: 3**	**Validation scope: DC IGM**
Description	Typical value between 10 degrees and 18 degrees for a rectifier.		
Message	The value is outside the range: 10-18 degrees.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		

IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SV:CsConverter.alpha:valueRangeTypical
Comment	

TABLE 306: C:301:EQ:CSCONVERTER.MINGAMMA:VALUERANGETYPICAL

Severity: WARNING	**Name: C:301:EQ:CsConverter.minGamma:valueRangeTypical**	**Level: 3**	**Validation scope: DC IGM**
Description	The attributes minGamma and maxGamma define the range of extinction angles for inverter operation between which no discrete tap changer action takes place. The range is typically 17-20 degrees.		
Message	The value is less than 17 or greater than CsConverter.maxGamma		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:CsConverter.minGamma:valueRangeTypical		
Comment			

TABLE 307: C:301:SSH:CSCONVERTER.TARGETALPHA:APPLICABILITY

Severity: WARNING	**Name: C:301:SSH:CsConverter.targetAlpha:applicability**	**Level: 3**	**Validation scope: DC IGM**
Description	It is only applicable for rectifier if continuous tap changer control is used.		
Message	CsConverter.targetAlpha is provided for an inverter or discrete tap changer control is used or RegulatingControl is not provided.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:CsConverter.targetAlpha:applicability		
Comment			

TABLE 308: C:301:SSH:CSCONVERTER.TARGETGAMMA:APPLICABILITY

Severity: WARNING	Name: C:301:SSH:CsConverter.targetGamma:applicability	Level: 3	Validation scope: DC IGM
Description	It is only applicable for inverter if continuous tap changer control is used.		
Message	CsConverter.targetGamma is provided for a rectifier or discrete tap changer control is used or RegulatingControl is not provided.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SSH:CsConverter.targetGamma:applicability		
Comment			

TABLE 309: C:301:EQ:CSCONVERTER.MAXGAMMA:VALUERANGETYPICAL

Severity: WARNING	Name: C:301:EQ:CsConverter.maxGamma:valueRangeTypical	Level: 3	Validation scope: DC IGM
Description	The attributes minGamma and maxGamma define the range of extinction angles for inverter operation between which no discrete tap changer action takes place. The range is typically 17-20 degrees.		
Message	The value is greater than 20.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:CsConverter.maxGamma:valueRangeTypical		
Comment			

TABLE 310: C:301:EQ:CSCONVERTER.MAXALPHA:VALUERANGETYPICAL

Severity: WARNING	Name: C:301:EQ:CsConverter.maxAlpha:valueRangeTypical	Level: 3	Validation scope: DC IGM
Description	The attributes minAlpha and maxAlpha define the range of firing angles for rectifier operation between which no discrete tap changer action takes place. The range is typically 10-18 degrees.		

Message	The value is greater than 18.
Justification	
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:CsConverter.maxAlpha:valueRangeTypical
Comment	

TABLE 311: C:301:SV:CSCONVERTER.GAMMA:VALUERANGETYPICAL

Severity: WARNING	**Name: C:301:SV:CsConverter.gamma:valueRangeTypical**	**Level: 3**	**Validation scope: DC IGM**
Description	Typical value between 17 degrees and 20 degrees for an inverter.		
Message	The value is outside the range: 17-20 degrees.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:SV:CsConverter.gamma:valueRangeTypical		
Comment			

TABLE 312: C:301:EQ:VSCONVERTER.MAXMODULATIONINDEX:VALUERANGETYPICAL

Severity: WARNING	**Name: C:301:EQ:VsConverter.maxModulationIndex:value RangeTypical**	**Level: 3**	**Validation scope: DC IGM**
Description	A factor typically less than 1.		
Message	The value is greater than 1.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:VsConverter.maxModulationIndex:valueRangeTypical		
Comment			

TABLE 313: C:301:EQ:ACDCCONVERTER.PCCTERMINAL:VALUETYPE

Severity: WARNING	Name: C:301:EQ:ACDCConverter.PccTerminal:valueType	Level: 3	Validation scope: DC IGM
Description	It is typically the terminal on the power transformer (or switch) closest to the AC network.		
Message	The terminal is not a terminal of a PowerTransformer or a Switch.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:ACDCConverter.PccTerminal:valueType		
Comment			

15.2 BUSINESS CONSTRAINTS

15.2.1 SEVERITY ERROR

TABLE 314: CONVERTERLOSSES

Severity: ERROR	Name: ConverterLosses	Level: 3	Validation scope: DC IGM
Description	For every instance of cim:CsConverter and cim:VsConverter, the value of cim:ACDCConverter.idleLoss, cim:ACDCConverter.switchingLoss and cim:ACDCConverter.resistiveLoss, if provided, must be greater than or equal to zero.		
Message	The losses of a Converter are not greater than or equal to zero.		
Justification	Losses cannot be negative.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	C:301:EQ:ACDCConverter.idleLoss:valueRange		
Comment	Conflicts CGMES v3.0 where 0 is not allowed.		

TABLE 315: DCEQUIPMENTCONTAINERMAPPING

Severity: ERROR	Name: DCEquipmentContainerMapping	Level: 3	Validation scope: DC IGM
Description	For each cim:DCConverterUnit and cim:DCLine instance the attribute entsoe:IdentifiedObject.energyIdentCodeEic is required. The third character of the EIC code shall be 'T'.		
Message	EIC code for cim:DCConverterUnit or cim:DCLine is either not provided or it is not a 'T' code.		
Justification	The mapping of reference schedules for HVDC links is done via the EIC T codes. The EIC T code is also used to identify DC equipment containers that belong to the same HVDC pole.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 316: DCBOUNDARY

Severity: ERROR	Name: DCboundary	Level: 3	Validation scope: DC IGM
Description	An IGM representing DC MAS shall have connection to even number of ConnectivityNode objects that are designated as BoundaryPoint. The minimum is connection to two BoundaryPoint objects.		
Message	A DC IGM does not connect to Boundary Points objects or the number of connections is not an even number.		
Justification			
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	BPPL4		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	BPPL4		
Comment	ENTSO-E Boundary and Reference Data Exchange Application Specification adds additional specifications.		

TABLE 317: DCIGMCONTROLAREA

Severity: ERROR	Name: DcIGMControlArea	Level: 3	Validation scope: DC IGM
Description	A DC IGM shall have a cim:ControlArea with an IdentifiedObject.energyIdentCodeEic which shall be one of the codes defined in the QoCDC Reference Data document in column “RegionEic” representing		

	the Virtual Scheduling Area (VSA) and the HVDC Link losses (note that this is the sum of the losses for the HVDC Poles in the HVDC Link).
Message	A DC IGM either without a cim:ControlArea defined or the EIC is not matching the VirtualScheduling Area.
Justification	Specific CGM Build process requirement defined in the CGM IG.
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 318: DCIGMCONTROLAREAFORECAST

Severity: ERROR	**Name: DcIGMControlAreaForecast**	**Level: 3**	**Validation scope: DC IGM**
Description	The cim:ControlArea in a DC IGM shall have the type set to Forecast. This is an identification of a VSA and is a temporary solution.		
Message	The cim:ControlArea in a DC IGM does not have the type set to Forecast		
Justification	Specific CGM Build process requirement defined in the CGM IG.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 319: PCCTERMINALBOUNDARY

Severity: ERROR	**Name: PccTerminalBoundary**	**Level: 3**	**Validation scope: DC IGM**
Description	cim:ACDCConverter.PccTerminal shall be associated (connected) with the boundary point.		
Message	cim:ACDCConverter.PccTerminal is not associated (connected) with the boundary point.		
Justification	CIM and HVDC modelling concepts defined in IEC HVDC standards require distinguishing between a point of common coupling (PCC) and a PccTerminal. In addition, a boundary point may be located in different places depending on HVDC configuration. Therefore, the statement that a boundary point is located at PCC is no longer valid. However, it is required that the cim:ACDCConverter.PccTerminal is associated (connected) directly with the boundary point related to a branch end of an HVDC Pole. In CIM, branches are represented by a retained cim:Switch (and subclasses), cim:ACLineSegment,		

	cim:SeriesCompensator, and cim:PowerTransformer. A convenient way to find the boundary point at a converter is to use the cim:ACDCConverter.PccTerminal
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 320: DCPOLECONVERTERS

Severity: ERROR	**Name: DCPoleConverters**	**Level: 3**	**Validation scope: DC IGM**
Description	An HVDC Bipole consists of two HVDC Poles described by a pair of cim:Line objects (during transition to DCPole) or nc:DCPole objects. A pole shall have two DCConverterUnit objects. The relations between DC poles can be found by following other associations, e.g. topology and containment.		
Message	A DC pole that does not have two converters.		
Justification	Specific CGM Build process requirement defined in the CGM IG.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 321: DCUNITCONVERTERS

Severity: ERROR	**Name: DCunitConverters**	**Level: 3**	**Validation scope: DC IGM**
Description	A 12 pulse current source converter shall be contained by a single cim:DCConverterUnit with a single cim:CsConverter.		
Message	There is more than one cim:CsConverter contained in a cim:DCConverterUnit.		
Justification	Specific CGM Build process requirement defined in the CGM IG.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		

Comment	

TABLE 322: NUMBEROFVALVES

Severity: ERROR	**Name: NumberOfValves**	**Level: 3**	**Validation scope: DC IGM**
Description	cim:ACDCConverter.numberOfValves shall be a number divisible by 3. Note the value is 6 for a 6-pulse and 12 for a 12-pulse ACDCConverter.		
Message	The value of cim:ACDCConverter.numberOfValves is not divisible by 3.		
Justification	Specific CGM Build process requirement defined in the CGM IG.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

16 CROSS VALIDATION - OPC RULES

16.1 BUSINESS CONSTRAINTS

16.1.1 SEVERITY WARNING

TABLE 323: UAPDATAPRESENT

Severity: WARNING	**Name: UAPdataPresent**	**Level: 2**	**Validation scope: IGM**
Description	The OPDM client shall contain Unavailability plan data with validity time that matches with the IGM Model.created.		
Message	OPC Unavailability Plan Data is missing, invalid or older than [X] days than IGM Model.created.		
Justification	Quality of OPC outputs is dependent on alignment between Unavailability plan and IGM status data.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		

IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	

TABLE 324: EQMISSINGINIGM

Severity: WARNING	**Name: EqMissingInIGM**	**Level: 7**	**Validation scope: IGM**
Description	The mRID of an equipment defined in the Unavailability Plan shall be found as rdf:ID (which is "_“ and mRID of the equipment from UAP) of an equipment in an IGM.		
Message	Equipment missing or not-identified in the IGM.		
Justification	Quality of OPC outputs is dependent on alignment between Unavailability plan and IGM status data. CGMM Article 13.2.b. The equipment that will be cross-validated (i.e. checked for consistency in availability) shall be present in both OPC Unavailability Plans and IGMs.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment			

TABLE 325: EQSTATUSIGMOUTOPCIN

Severity: WARNING	**Name: EqStatusIGMoutOPCin**	**Level: 7**	**Validation scope: IGM**
Description	Equipment status in IGM and OPC Unavailability Plan Data must be consistent. IGM status is unavailable in IGM at timestamp but is available in OPC Unavailability Plan Data for at least part of the same timestamp.		
Message	The equipment is not available in the IGM, but available in OPC.		
Justification	Quality of OPC outputs is dependent on alignment between Unavailability plan and IGM status data. CGMM Article 13.2.b.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		

IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A
Comment	Rule implementation details will be elaborated in a design document and QoCDC will be updated.

TABLE 326: EQSTATUSIGMINOPCOUT

Severity: WARNING	**Name: EqStatusIGMinOPCout**	**Level: 7**	**Validation scope: IGM**
Description	Equipment status in IGM and OPC Unavailability Plan Data must be consistent. IGM status is available in IGM at timestamp but is unavailable in OPC Unavailability Plan Data for at least part of the same timestamp.		
Message	The equipment is available in the IGM, but not available in OPC.		
Justification	Quality of OPC outputs is dependent on alignment between unavailability plan and IGM status data. CGMM Article 13.2.b.		
IEC TS 61970-600-1/-2:2017 (CGMES v2.4.15) Reference	N/A		
IEC 61970-600-1/-2:2021 (CGMES v3.0) Reference	N/A		
Comment	Rule implementation details will be elaborated in a design document and QoCDC will be updated.		

17 ANNEX A: SUPPORTING DOCUMENTS AND HISTORY OF CHANGES (FOR INFORMATION ONLY)

17.1 INTRODUCTION

This section contains references to documents that support the rules and background information on the QoCDC document.

17.2 QOCDC REFERENCE DATA DOCUMENT

The QoCDC Reference Data document provides all reference data e.g., enumerations and shared resources needed when validating the rules defined in this QoCDC document.

17.3 RULE DESCRIPTIONS

In section 18 a format for documenting rules is described. The rules are documented in XML files based on this format and one XML document per level exists. The XML documents are machine processable enabling translation to other formats to avoid copy and pasting from the QoCDC word document. The xml documents are provided for information only.

The XML documents can be found in the archive “QoCDCRules.zip” that is available for download from ENTSO-E file repository together with this QoCDC document.

17.4 QOCDC DOCUMENT HISTORY

2019-12-20 LOO First draft of QoCDCv3.2

2020-05-13 LOO Since v3.1 the following rules has been added, renamed or deleted

Level 1

SynchronousArea renamed to CGMRegion

SourcingTSO renamed to SourcingActor

Level 3

SMRatedSunrealistic

TargetDeadbandOutOfRange

WindingConnectionAngle

VoltageLimitDirection

VoltageLimitsConsistency

FlowLimitsDirectionConsistency

AsymmetricalEquivalent

PositiveTransformerB

GeneratingUnitSM

SMPLimits

SubLoadAreaMissing

EnergyAreaMissing

CurveXYValue renamed to CurveXValue

SMQLimits4 has been removed as covered by SMPLimits

RCCXValues1 has been removed as covered by RCCXValues2

DCNodeContainment removed as covered by cardinality

Level4

IncompleteObject renamed to IncorrectAttributeOrRoleCard

CgmSvSshVersionMismatch

Level 5

SvPowerFlowBranchInstances2

SynchronousCondenserMode

TCCRemoteReactiveFlow

EquivalentInjectionContainment moved from level 3 to level5

DCLineContainment moved from level 3 to level5

Level 6

FakeVoltage

Level 7

InconsistentTnBaseVoltage

ACScheduleMatch1

ACScheduleMatch2

Level 8

TIConvergenceStatMissing

TIConvergenceStatDiverged

2020-03-27 Rule SynchronousArea renamed to CGMRegion and field <synchronousArea> renamed to <cgmRegion>

2020-03-31 sanity check, adding missing cim: prefixes and format check.

2020-04-06 Rule RCCYValues simplified with text from CGMES3.0. Rule LRCExponentModel changed to allow exponents in the range 0 =< exp =<2. Rule RatedS exception for aggregated flag=false removed.

2020-04-06 LRCExponentModel exponent values restricted.

2020-04-06 Rule RatedS changed to ignore aggregate flag.

2020-04-06 Rule CGMRegion severity not correct, changed WARNING->ERROR

2020-04-21 Rule severity revised to match CGM_BP requirements.

- SourcingActor WARNING->ERROR

- SVCSlope WARNING->ERROR
- PhaseCodeGround WARNING->ERROR
- SVCVoltage WARNING->ERROR

2020-04-21 Consistency checks made, e.g. match between severity and shall/should, presence of “cim:” prefixes, spelling, reference to limits etc.

2020-05-11 Changes according to comments from Jun Zhu.

2020-05-12 Updates based on CGM ICT comments. New section “Supporting documents” added.

2020-05-13 Prepared for publish.

2020-05-19 EquivalentInjection moved from rule BranchBaseVoltage to CEBaseVoltage. SeriesCompensator is tested by rules BranchBaseVoltage and CEBaseVoltage, it is removed from rule BranchBaseVoltage. Equivalent shunt added to rule CEBaseVoltage.

2020-06-10 Rule MASPersistency moved back to level 2 from level 5.

2020-06-10 Spelling errors corrected and incorrect sign statement in rule GeneratingUnitNominalP corrected.

2021-06-14 A new version v3.2.1 (release candidate) of QoCDC is opened. This is a track change version. Summary of changes in version 3.2.1:

- Various editorial changes are applied
- For reference data the reference to QoCDC Reference Data document is used in the whole document
- The following rules are modified to decrease the level of ambiguity: FileNameMD, FileNameConsistency, EffectiveDateTime, NameLength, EFCContainment, OperationalLimitSetAtTerminal, PATL2, PowerTransformerEndR, PowerTransformerEndX, RatedS, WindingConnectionAngle, VoltageLimitDirection, GeographicalRegionBD, SVCVoltage, BranchBaseVoltage, CEBaseVoltage, ParticipatingGeneratingUnit, RequiredSvSCSections, RequiredSvTapStep, MAS, MASPersistency, PhaseCodeGround, ValidResourceValue, URNUniqueness, AttributeAndRoleValues, DCEquipmentContainerMapping, SvInjectionLimit, TIConvergenceStatMissing, TargetDB, TargetDeadbandOutOfRange, EquivalentBranchX, TerminalCount1, TerminalCount2, TerminalSeqNumOrder, MeasTerminal, AcceptableDuration, CNRequiredInEQOperations, ControlModeCompatibility, ModelDescription, SwitchOpenVsConnected, SvPowerFlowBranchInstances, InconsistentCurrentLimits, CGMCongestion, InconsistentTnBaseVoltage, ACTielineBV, ControlOfAnotherIsland, VoltageTargetsAtTN, EquivalentInjectionControlEnabled, TapChangerTargetRange, TCCRemoteReactiveFlow, ShuntQ, DERActivePowerInfeedDiffE, NetInterchange1, NetInterchange2, VoltageTargetAndDeadbandAtTN, ControlAreaInstance. UnpairedTieFlow, GenActivePowerInfeedLim, SynchronousCondenser, DCLineContainment, CGMTieFlowImbalance, GeneratingUnitMaxPGen, LRCExponentModel, LCRCoefficientModel, SMPLimits, EIActivePowerInfeedLim, ENIActivePowerInfeedLim, EIReactivePowerInfeedLim, ENIReactivePowerInfeedLim, ModelCreated, ScenarioTime, PowerTransformerEndRatedU, TapPosition, RCCXValues3.

- The following ruled are modified/deleted to fit to the present way of exchanging: ModelingAuthority is deleted, MCFirst and MCSecond are replaced by rule MCFirstSecond, ReactiveControlAtBus is deleted, EIReactivePowerInfeedDiffW was replaced, CGMVoltageProfile is deleted, GeneratingUnitLimits is deleted.
- The rules that require references to ISO country codes use codes for countries defined in QoCDC Reference data document.
- Table 2 is modified.
- Section 2.11 is modified and most of the content is moved to section 12. Further changes are expected in section 12, but this is informational section and not critical.
- Section 2.12 is introduced.
- Section 3.2 is introduced and parts revised.
- Section 5.4.1. was added to provide additional information regarding generation limits. Various rules are built on that information.

Summary of changes in version 3.3 compared to v3.2.1:

- New rule constant “SIZE_OF_ISLAND_WITHOUT_CONTROL” added and used by rule ControlOfIslandIsMissing
- Section 2.12 was updated adding item 6) related to the current limits rounding for the purpose of QAS reporting
- Section 2.13 was added to document modifications of CGMES 2.4 introduced by QoCDC.
- Section 3.2.1 was added to explain the file naming convention for datasets for intraday process.
- The following new rules were added: IncorrectDataTypeFormat, Exception, TooManyTapChangers, NoFlowControlAtNonRetainedSW, SMOperatingModeConsistency, ControlOfIslandIsMissing, KirchhoffsFirstLaw, PairedEICompatibility
- The following rules were replaced by IncorrectDataTypeFormat rule : ValidResourceValue, ValidAboutValue, ValidIDValue, DecimalComma, NotaNumber
- The following rules were modified, the type of the change is indicated for each rule: CEBaseVoltage (functional), ControlModeCompatibility (clarification), RCCYValues (clarification), TargetDeadbandOutOfRange (functional), DanglingReference (functional), SvPowerFlowBranchInstances2 (clarification), DisconnectedTerminal (clarification), SwitchTerminals (clarification), SwitchVL (clarification), SwitchTN1 (clarification), ControlOfAnotherIsland (functional), GenReactivePowerInfeedLim (functional), GenRCCPowerInfeed (clarification), NetInterchange1 (functional), NetInterchange2 (functional), RequiredSvTapStep (functional), InconsistentCurrentLimits (functional), UnpairedTieFlow (functional), SlackNode (functional), NoLTCTapChangerControl (clarification), ShuntCompensatorSensitivity (clarification), IGMConvergence (clarification), CGMConvergence (clarification), EffectiveDateTime (clarification), ScenarioTime (clarification).
- Editorial changes were applied in the document

- Annex B was updated to be aligned with the implementation.

Summary of changes in version 3.3.1 compared to v3.3:

- The references to RDFS were replaced by a link to the website. RDFS for CGMES v2.4.15 will not be updated even if outdated.
- Section 2.12 is updated with additional rules related to comparisons with reference data and float numbers.
- The following constraints are modified: CNTerminals, DiscreteControl, UnpairedTieFlow, PairedEICCompatility, CGMRegion, FileNameMD, SourcingActor, InconsistentCurrentLimits, InvalidVoltage, ControlOfIslandIsMissing.
- Messages of the rules were updated to reflect on what is violated.

Summary of changes in version 4.0.0 compared to v4.1:

- This version of the document introduces some new rules, and it modifies existing based on the recommendations collected since version 3.3.1 was approved. Details on the previous changes of the document can be found in section 17.4. Section 15 on DC IGM constraints is by now added as informative (i.e. for information on rule processing, however not blocking the publication of IGMs in case of errors). The same applies for OPC related rules includes in section 16.
- Summary of constraints/rules in this version:
  - 318 in total. AC IGM and CGM: 242 and DC IGM related: 72
  - 63 out of 72 DC IGM constraints are from CGMES v3.0
  - 91 from 245 constrains for AC IGM and CGM are standard constraints from CGMES v2.4 and CGMES v3.0
  - 47 out of 245 constrains for AC IGM and CGM are standard constraints from CGMES v3.0
  - 104 out of 245 constrains for AC IGM and CGM are business specific.
  - 4 constraints are specific for cross validation with OPC data.
- The statistics stated below are excluding DC IGM rules and OPC rules.
- New constraints in this version (15): InfiniteVoltageSources, BaseVoltageVsContainerVoltage, AcIGMwithDCclasses, TablePointOutsideTapChangerLimits, VoltageTargetConsistencyAtTN, TNnotInIsland, OpenNonRetainedSwitchVsTN, ClosedNonRetainedSwitchVsTN, InvalidTapChangerRatio, CGMSSHmismatch, BaseVoltageTNvsTransformer, IgmSSHvsCgmSSH, SMOperatingModePConsistency, SMrefPriority, EquipmentTerminals, SMNullP
- Modified constraints – Content changes (4): NumberOfSubstations, ControlAreaInstance, SMRatedSunrealistic, SynchronousCondenserMode
- Modified constraints – Content and Severity changes (5): GeneratingUnitNominalP, ControlLinkedToTopology, EquivalentInjectionControlEnabled, SlackNode, ParticipatingGeneratingUnit

- Modified constraints – Changes of severity (19 only two are Error the rest changed to Info): ModelDescription, NotMandatoryClass, NotMandatoryProperty, CNTerminals, OperationalLimitSetAtTerminal, PATL4, PATL5, ACLineSegmentX, SeriesCompensatorX, EquivalentBranchX, PowerTransformerEndR, PowerTransformerEndX, SVCRatings, SmallTopologicalIsland, FakeVoltage, InconsistentCurrentLimits, InconsistentTnBaseVoltage, TIConvergenceStatMissing, TIConvergenceStatDiverged
- Modified constraints – Editorial changes (3): EQDIFFEQ, EQDIFFOperationalLimit, SvInjectionLimit. Note this list does not include other small editorial changes such as typos, spaces, etc.
- Deleted constraints – TapChangerTargetRange, ControlOfIslandIsMissing
- The document was restructured to facilitate transition to between different CGMES versions. The rules are categorised by standard and business specific.

Version 4.1.0
This version of the document was a minor release to fix identified issues during the implementation of QoCDC version 4.0.0.

The following rules were modified:

- Editorial changes:
  - Exception,
  - KirchhoffsFirstLaw
- Severity changes:
  - GeneratingUnitNominalP,
  - TNnotInIsland,
  - EquipmentTerminals

  Note that the severity of the rules is kept unchanged in QoCDC, but in the specification of the validation engine these rules are set as “non-blocking” ERRORs for the publication of the IGMs or CGMs until next release of OPDE. This is done to facilitate the transition of implementing these rules by the TSOs and RCCs. Although the publication of the IGMs is not blocked non-compliance with these rules may result in IGM substitution in CGM creation.
- Content changes:
  - PATL4,
  - TooManyTapChangers,
  - SvPowerFlowBranchInstances,
  - SwitchVL,
  - GenReactivePowerInfeedLim,
  - GenRCCPowerInfeed,
  - ShuntQ,
  - InconsistentCurrentLimits,
  - InfiniteVoltageSources,
  - C:301:SSH:CsConverter.targetAlpha:valueRangePairFrom,
  - C:301:SSH:CsConverter.targetGamma:valueRangePairFrom,
  - TablePointOutsideTapChangerLimits,
  - VoltageTargetConsistencyAtTN,
  - CGMSSHmismatch,
  - IgmSSHvsCgmSSH - Section 5.10 was added to the document in relation to this rule.

Version 4.1.1
This version 4.1.1. of the document was a minor release to fix identified issues during the implementation of QoCDC version 4.1.

The following rule was modified:

- Content changes:
  - CGMSSHmismatch,

Version 4.1.2 (15 Mar 2025)
This version 4.1.2 of the document is a patch release to fix identified issues during the implementation of QoCDC version 4.1.1.

The following rules are modified:

- Content changes:
  - CGMSSHmismatch,
  - SlackNode
  - IgmSSHvsCgmSSH
  - related section 5.10
- Severity changes:
  - SlackNode (changed from Error to Warning)

The rule ParticipatingGeneratingUnit is set as “non-blocking” in the specification of the validation engine.

This version 4.1.3 of the document is a patch release to fix identified issues during the implementation of QoCDC version 4.1.2

The following rule is modified:

- Severity changes:
  - CGMSSHmismatch (changed from Error to Warning)

18 ANNEX B: DESCRIPTION OF RULES (FOR INFORMATION ONLY)

This section provides information on how the rules are described in the specific implementation in OPDM and SUV. A UML model that describes the rules has been created, see Figure 15.

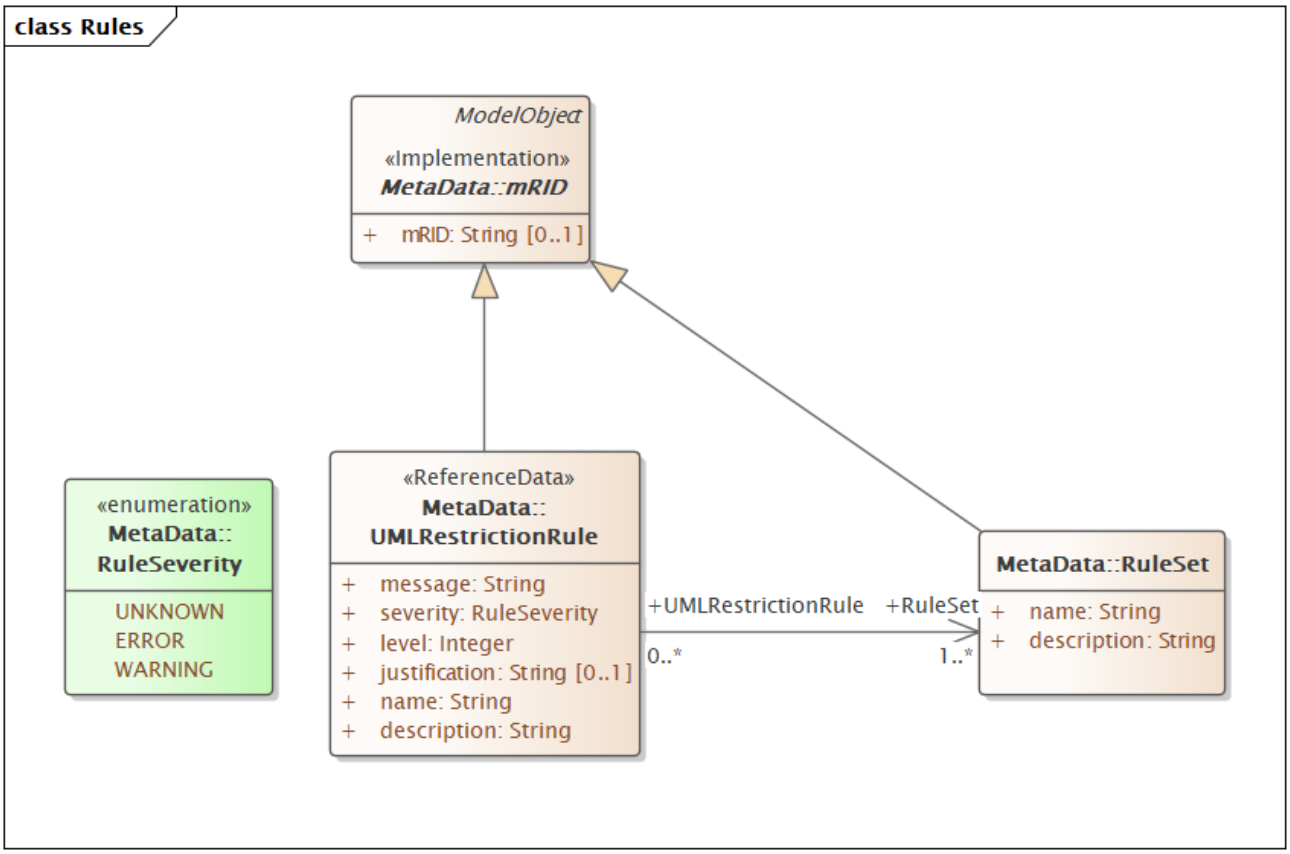

FIGURE 15 RULE DESCRIPTION INFORMATION MODEL

The UML model is converted to the ecore format so it can be loaded in Eclipse Modelling Framework (EMF).

All rules are described in the xml file UMLDescriptionRules.xml that is compliant with the UML model. The file UMLDescriptionRules.xml is also loaded together with the IGM or CMG data in EMF which means it is validated together with the IGM/CGM.

All rule texts in previous sections are generated from UMLDescriptionRules.xml and the texts are also included in the messages sent to the Quality Portal.