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European Network of
Transmission System Operators
for Electricity

# QUALITY OF CGMES DATASETS AND CALCULATIONS

## FOR SYSTEM OPERATIONS

VERSION 4.1.3, 8 AUGUST 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 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)

This previous 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 previous 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,

The previous 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,

- o TooManyTapChangers,
- o SvPowerFlowBranchInstances,
- o SwitchVL,
- o GenReactivePowerInfeedLim,
- o GenRCCPowerInfeed,
- o ShuntQ,
- o InconsistentCurrentLimits,
- o InfiniteVoltageSources,
- o C:301:SSH:CsConverter.targetAlpha:valueRangePairFrom,
- o C:301:SSH:CsConverter.targetGamma:valueRangePairFrom,
- o TablePointOutsideTapChangerLimits,
- o VoltageTargetConsistencyAtTN,
- o CGMSSHmismatch,
- o IgmSSHvsCgmSSH - Section 5.10 was added to the document in relation to this rule.

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# 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.
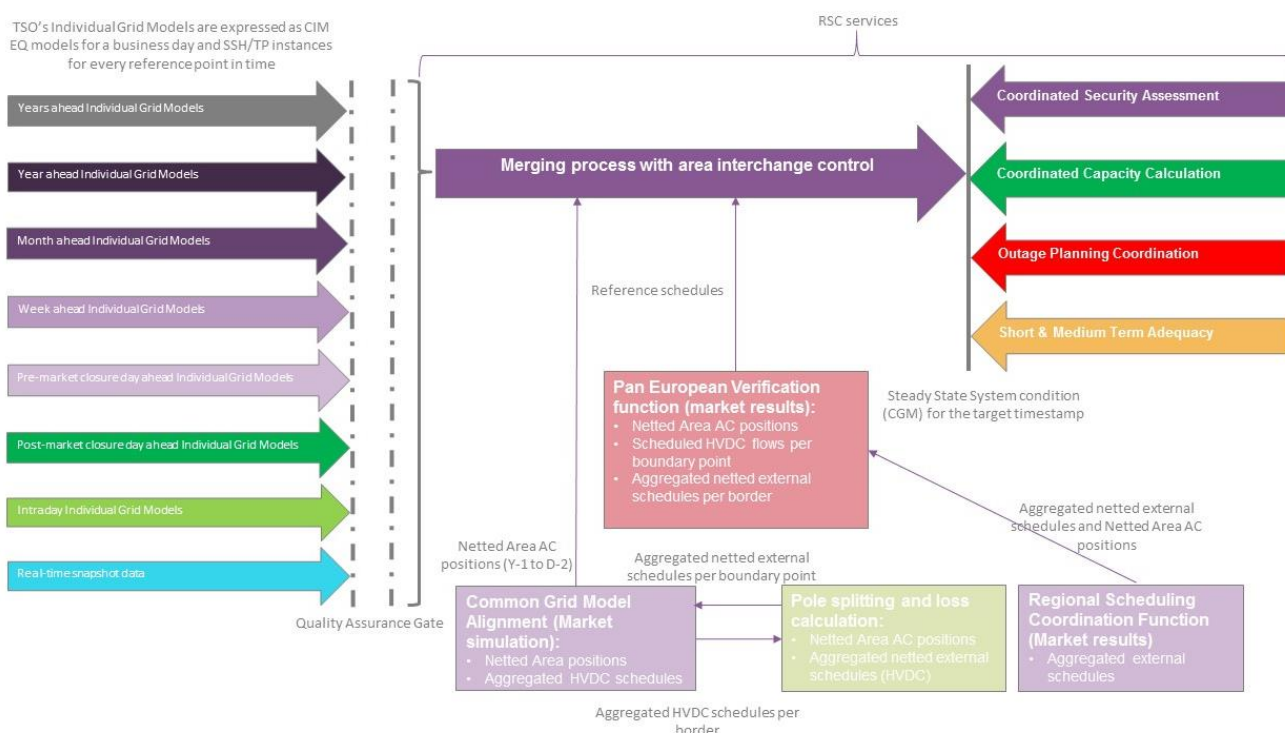


**Figure 1 Context of operational data exchanges leading to Common Grid Models**

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.

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[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. Tie-lines – object type "T", International tie lines between areas |

| Term | Definition |
|------|------------|
| | 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 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 |

| Term | Definition |
|---|---|
| | 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:<br>8 character hex number<br>a dash "-"<br>4 character hex number<br>a dash "-" |

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[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.

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| Term | Definition |
| --- | --- |
|  | 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/ *)*
- 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)

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[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.

- 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.

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[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.
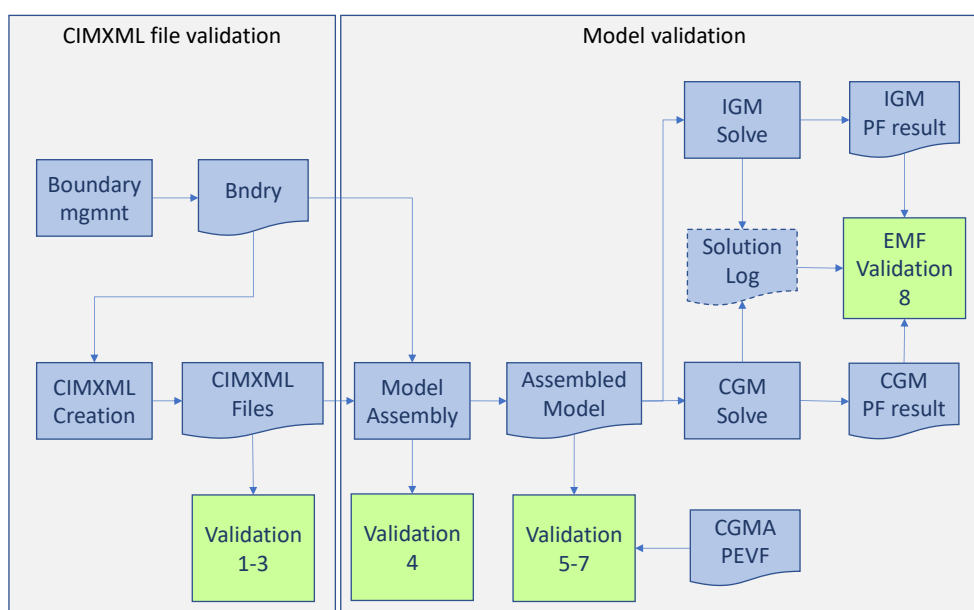


**Figure 2 The Automated process annotated with validation levels**

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 |
| 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 | 10 | 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.

## 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 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

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

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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:

- o 20180118T0930Z_1D_APG_SSH_001.xml
- o 20180117T2230Z_1D_APG_EQ_001.xml
- o 20180117T2230Z__APG_EQ_001.xml
- o 20180118T1130Z_1D_TSCNET-EU_SV_001.xml
- o 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.

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

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.

## 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<br>Scenario time in UTC<br>Example naming provided during CET (UTC+1) | PEVF:<br>date, version, delivery |
|---|---|---|---|
| 0:00h | 22:00-23:00h CET<br>on 31.12.2021.<br>Day before the ID process | 20211231T2330Z_01_APG_SV_001.xml<br>20220101T0030Z_02_APG_SV_001.xml<br>20220101T0130Z_03_APG_SV_001.xml<br>20220101T0230Z_04_APG_SV_001.xml<br>20220101T0330Z_05_APG_SV_001.xml<br>20220101T0430Z_06_APG_SV_001.xml<br>20220101T0530Z_07_APG_SV_001.xml<br>20220101T0630Z_08_APG_SV_001.xml | 20220101 v005<br>delivered at 22:30h CET<br>on 31.12.2021.<br>for intraday (A18) process |
| 8:00h | 06:00-7:00h CET<br>on 01.01.2022.<br>Day of the ID process | 20220101T0730Z_01_APG_SV_001.xml<br>20220101T0830Z_02_APG_SV_001.xml<br>20220101T0930Z_03_APG_SV_001.xml<br>20220101T1030Z_04_APG_SV_001.xml<br>20220101T1130Z_05_APG_SV_001.xml<br>20220101T1230Z_06_APG_SV_001.xml<br>20220101T1330Z_07_APG_SV_001.xml<br>20220101T1430Z_08_APG_SV_001.xml | 20220101 v014<br>delivered at 06:30h CET<br>on 01.01.2022.<br>for intraday (A18) process |
| 16:00h | 14:00-15:00h CET<br>on 01.01.2022.<br>Day of the ID process | 20220101T1530Z_01_APG_SV_001.xml<br>20220101T1630Z_02_APG_SV_001.xml<br>20220101T1730Z_03_APG_SV_001.xml<br>20220101T1830Z_04_APG_SV_001.xml<br>20220101T1930Z_05_APG_SV_001.xml<br>20220101T2030Z_06_APG_SV_001.xml<br>20220101T2130Z_07_APG_SV_001.xml<br>20220101T2230Z_08_APG_SV_001.xml | 20220101 v021<br>delivered at 14:30h CET<br>on 01.01.2022.<br>for intraday (A18) process |

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>&lt;MDE&gt;&lt;BP&gt;1D&lt;/BP&gt;&lt;TOOL&gt;PowerFactory 2021&lt;/TOOL&gt;&lt;RSC&gt;N/A&lt;/RSC&gt;&lt;TXT&gt;QoCDC v3.2 test configuration&lt;/TXT&gt;&lt;/MDE&gt; </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,<br>• if connected to boundary point or is internal cim:EquivalentInjection and<br>• 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<br>.q – can change, if connected to boundary point or is internal cim:EquivalentInjection with control defined and regulation status true |

| | .regulationTarget:<br>  - can change, if connected to a paired AC boundary point<br>  - cannot change, if connected to an unpaired boundary point<br>.regulationStatus:<br>  - can change, if connected to a paired AC boundary point<br>  - 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:<br>  - .ltcFlag true, and<br>  - cim:Terminal fnonreferenced by cim:RegulatingControl.terminal of cim:TapChangerControl is connected and in the same topological island as cim:PowerTransformer, and<br>  - control is enabled (both cim:TapChanger.controlEnabled and cim:RegulatingControl.enabled equal to true) |
| cim:ConformLoad | cim:EnergyConsumer.p – can change<br>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<br>.netInterchange – can change |
| cim:RotatingMachine | .p – can change, if:<br>  - OperatingMode.generator, and<br>  - Pmin<=Pgen<=Pmax, Pgen = - cim:RotatingMachine.p from IGM SSH<br>  - .p is changed to 0 for OperatingMode.condenser, and<br>.q – can change, if:<br>  - Pmin<=Pgen<=Pmax, Pgen = - cim:RotatingMachine.p from IGM SSH, and<br>  - regulating control is enabled (both cim:RegulatingCondEq.controlEnabled and cim:RegulatingControl.enabled equal to true)<br>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<br>.q – can change, if regulating control is enabled (both cim:RegulatingCondEq.controlEnabled and cim:RegulatingControl.enabled equal to true)<br>.referencePriority – cannot change |
| cim:SynchronousMachine | .operatingMode – cannot change<br>.referencePriority – cannot change |
| cim:AsynchronousMachine | .asynchronousMachineType – cannot change |
| cim:RegulatingControl | .enabled: - cannot change<br><br>.discrete – cannot change<br>.targetValue – cannot change<br>.targetDeadband – cannot change<br>.targetValueUnitMultiplier – cannot change |
| cim:RegulatingCondEq.controlEnabled | Cannot change |

# 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

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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

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.

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.

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[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: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.

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.
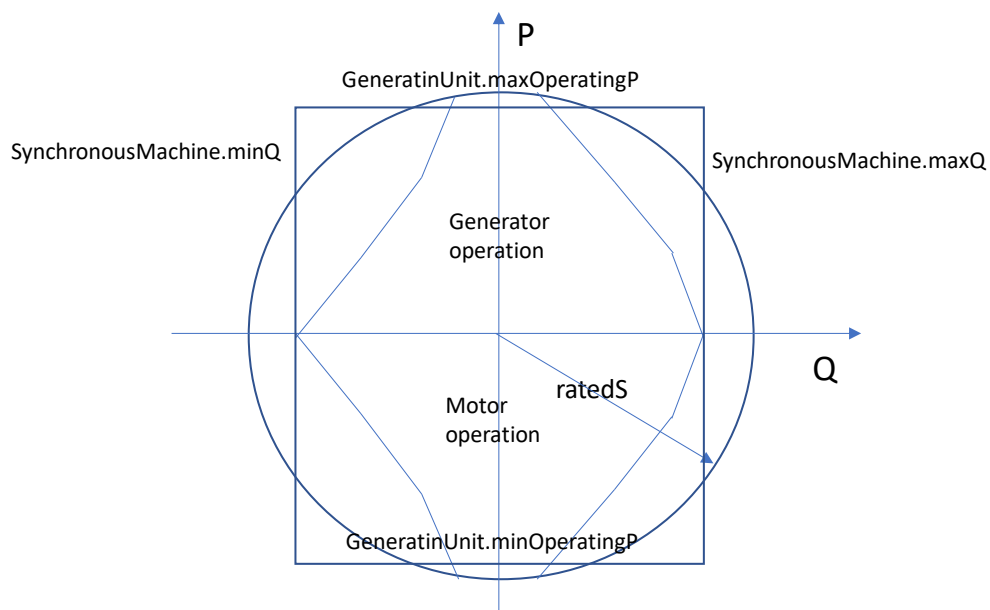


**Figure 3 Example Reactive Capability Curve**

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.

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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,
   o a positive maxOperatingP, and
   o 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.
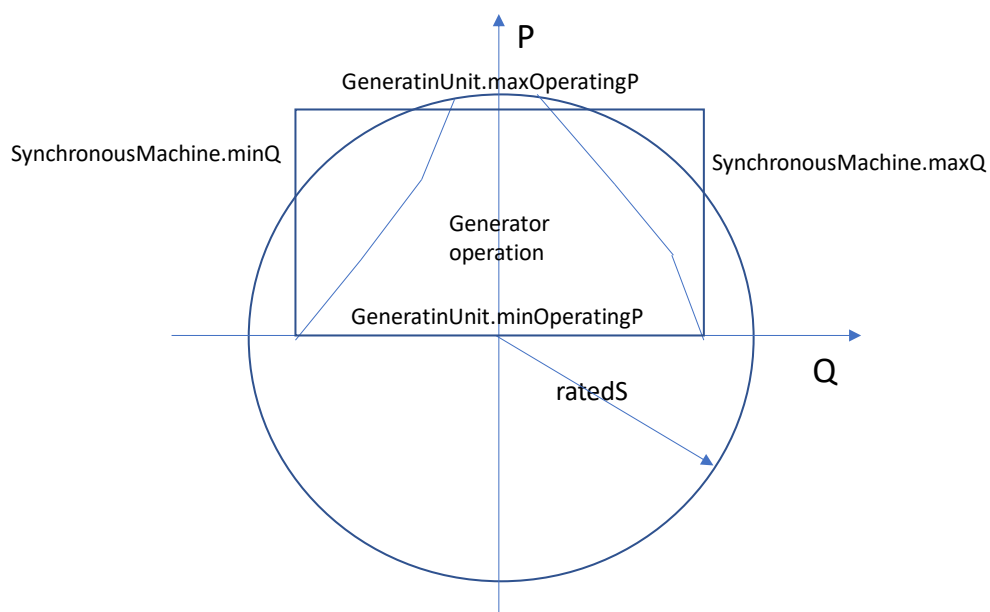


**Figure 4 Generator only**
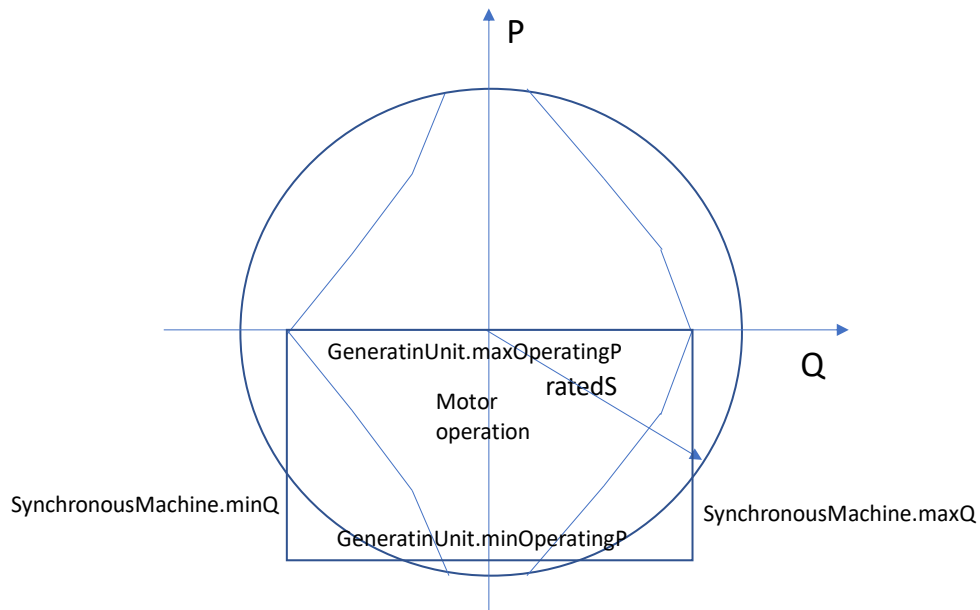
**Figure 5 Motor operation only**
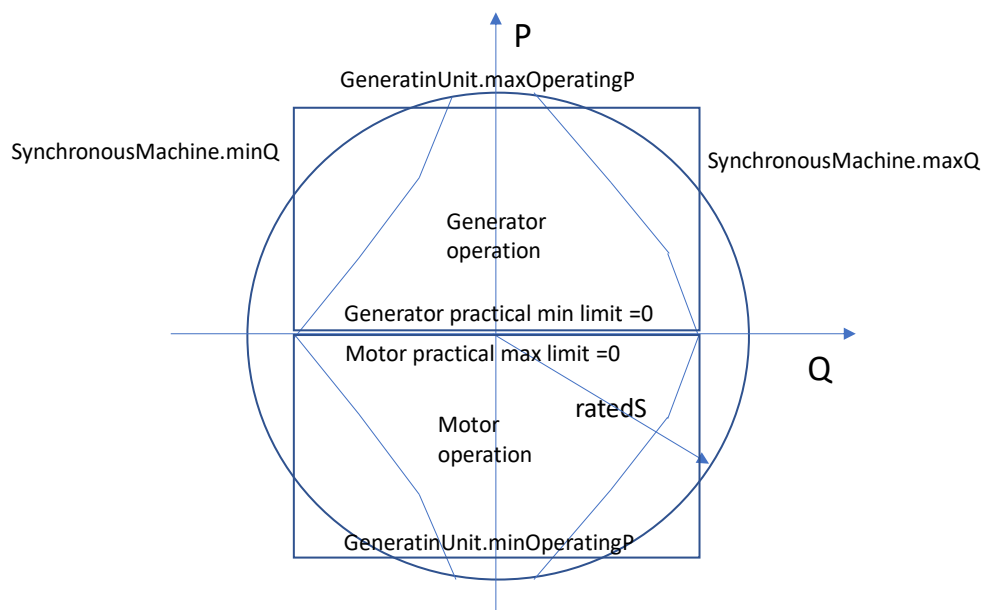


**Figure 6 Generator or motor operation**

## 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.
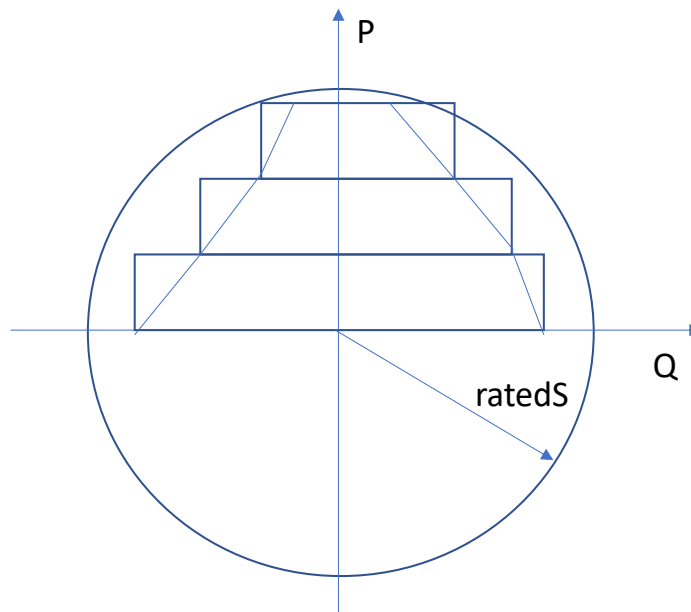


**Figure 7 Pairwise max Value**

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.
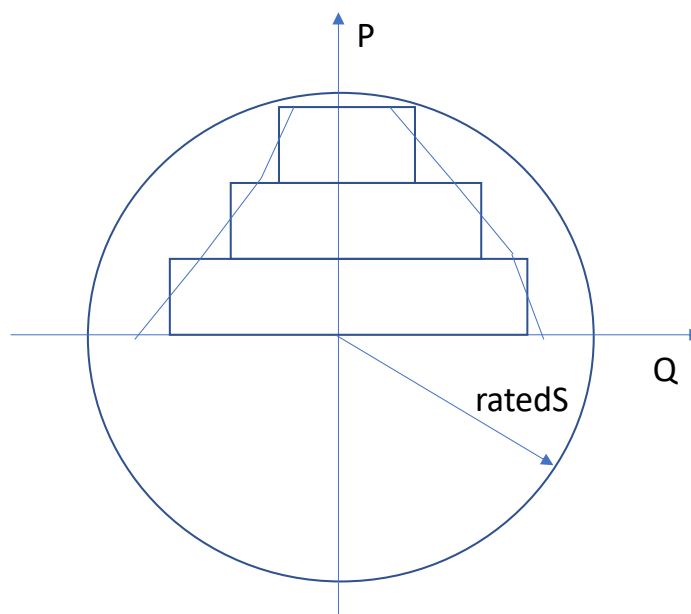


**Figure 8 Pairwise Mean Value**

In the option shown in Figure 8 a reactive power at the limit may stay within the capability curve limit.
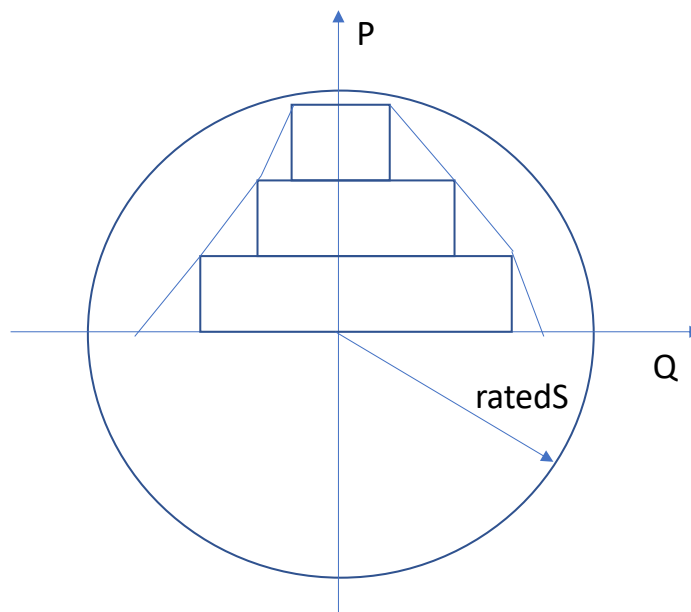
**Figure 9 Pairwise Min Value**

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:<br>1) effectiveDateTime_businessProcess_sourcingActor_modelPart_fileVersion<br>2) effectiveDateTime__sourcingActor_modelPart_fileVersion<br>The templates have fields separated by four underscores (_).<br><br>Depending on the modelPart field (allowed values are listed in rule ModelPartType) the usage of above templates is as follows:<br>- EQ shall use both template 1 and 2;<br>- SSH, TP and SV shall only use template 1;<br>- EQBD and TPBD shall only use template 2.<br><br>The field sourcingActor has sub-fields separated by dashes (-). The following three sub-templates are allowed for sourcingActor field:<br>- sourcingTSO, which is always used by a TSO;<br>- sourcingRSC-cgmRegion, which is used by RSC for a synchronous area file, e.g., a SV file;<br>- 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.<br>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.<br><br>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.<br>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.<br><br>Notes:<br>- Example of empty attribute: [cim:class.attribute/] or [cim:class.attribute][/cim:class.attribute]<br>- Example of empty rdf:resource [cim:class.attribute rdf:resouce=""/], note this is not a valid reference and it is part of rule XMLStructure.<br><br>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.<br><br>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<br>- [expected datatype] is the datatype reference defined by the profile<br>- [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.<br>2) md:Model.modelingAuthoritySet shall have one of the values specified in the QoCDC Reference Data document.<br>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<br>- MA is the URI of the MergingAgent<br>- 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.<br><br>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:<br>1) Association end cim:MutualCoupling.First_Terminal shall refer to a cim:Terminal of an cim:ACLineSegment.<br>2) Association end cim:MutualCoupling.Second_Terminal shall refer to a cim:Terminal of an cim:ACLineSegment.<br>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.<br><br>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.<br><br>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,<br>- the sum of cim:LoadResponseCharacteristic.pConstantImpedance and cim:LoadResponseCharacteristic.pConstantCurrent and cim:LoadResponseCharacteristic.pConstantPower values must be 1 and<br>- 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,<br>- A phase shift tap changer can only do the cim:RegulatingControl.mode<br>  - active power control<br>- A ratio tap changer can only do the cim:RegulatingControl.mode-s<br>  - voltage<br>  - reactivePower<br>  - powerFactor<br>- A cim:SynchronousMachine or cim:ShuntCompensator instance can only do the cim:RegulatingControl.mode-s<br>  - voltage<br>  - reactivePower<br>  - powerFactor<br>- A cim:StativeVarCompensator can only do the cim:RegulatingControl.mode-s<br>  - voltage<br>  - reactivePower<br>- A cim:BusbarSection instance can only be controlled by a cim:RegulatingControl in mode (cim:RegulatingControl.mode):<br>  - voltage<br><br>The following cim:RegulatingControl.modes are not at all allowed:<br>  - currentFlow<br>  - admittance<br>  - timeScheduled<br>  - 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<br>C:452:EQ:RatioTapChanger:controlMode<br>C:452:EQ:StaticVarCompensator:controlMode<br>C:452:EQ:SynchronousMachine:controlMode<br>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:RegulatingControl 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:<br>- condenser, one cim:CurveData instance with cim:CurveData.xvalue = 0.<br>- generator or generatorOrCondenser, at least two cim:CurveData instances with cim:CurveData.xvalue greater or equal 0.<br>- motor or motorOrCondenser, at least two cim:CurveData instances with cim:CurveData.xvalue less or equal 0.<br>- 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<br>1) greater than or equal to the cim:GeneratingUnit.minOperatingP, and<br>2) less than or equal to the cim:GeneratingUnit.maxOperatingP .<br>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:<br>- cim:PetersenCoil<br>- cim:Ground<br>- cim:GroundingImpedance<br>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<br>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.<br>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.<br>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:<br>- generator or generatorOrCondenser,<br>  - cim:GeneratingUnit.minOperatingP greater than or equal to 0,<br>  - cim:GeneratingUnit.maxOperatingP greater than 0,<br>  - cim:GeneratingUnit.maxOperatingP greater than or equal to cim:GeneratingUnit.minOperatingP.<br>- motor or motorOrCondenser,<br>  - cim:GeneratingUnit.minOperatingP less than 0,<br>  - cim:GeneratingUnit.maxOperatingP less than or equal to 0,<br>  - cim:GeneratingUnit.maxOperatingP greater than or equal to cim:GeneratingUnit.minOperatingP.<br>- generatorOrMotor or generatorOrCondenserOrMotor,<br>  - cim:GeneratingUnit.minOperatingP less than 0 and cim:GeneratingUnit.maxOperatingP greater than 0.<br><br>Note:<br>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.<br>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<br>- $x*x+y1*y1$ LE $ratedS*ratedS$ and $x*x+y2*y2$ LE $ratedS*ratedS$<br>where<br>- LE = less or equal<br>- x= cim:CurveData.xvalue<br>- y1 = cim:CurveData.y1value<br>- y2 = cim:CurveData.y2value<br>- 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<br>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<br>- cim:RegulatingControl[0..1]-[0..*]cim:RegulatingCondEq<br>- cim:TapChangerControl[0..1]-[0..*]cim:TapChanger<br>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:<br>- +/-150;<br>- +/-120;<br>- +/-90;<br>- +/-60;<br>- +/-30.<br>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**

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| 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<br>C:301:SSH:CurrentLimit.value:valueRange<br>C:301:EQ:CurrentLimit.normalValue:valueRange<br>C:301:EQ:ActivePowerLimit.normalValue:valueRange<br>C:301:SSH:ActivePowerLimit.value:valueRange<br>C:301:SSH:ApparentPowerLimit.value:valueRange<br>C:301:EQ:ApparentPowerLimit.normalValue:valueRange<br>C:301:SSH:VoltageLimit.value:valueRange<br>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:<br>- patl: acceptableDuration is not used;<br>- patlt: usage of acceptableDuration is restricted, i.e. it is not used as another way to express the severity of the limit;<br>- tatl: acceptableDuration is used to define several TATL limit types<br>- tc: acceptableDuration is not used as an immediate tripping is expected<br>- tct: acceptableDuration is used as the limit is less than the tc limit and describe how long the violation may sustain before tripping.<br>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<br>- cim:ActivePowerLimit<br>- cim:CurrentLimit or cim:ApparentPowerLimit<br>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.<br>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:<br>- cim:ControlArea.type is cim:ControlAreaTypeKind.Interchange<br>- 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<br>- abs(maxP) Less or Equal ratedS<br>- abs(minP) Less or Equal ratedS<br>- abs(maxQ) Less or Equal ratedS<br>- abs(minQ) Less or Equal ratedS<br>where<br>- maxP is cim:GeneratingUnit.maxOperatingP<br>- maxQ is cim:SynchronousMachine.maxQ<br>- minP is cim:GeneratingUnit.minOperatingP<br>- minQ is cim:SynchronousMachine.minQ<br>- 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.<br>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.<br>To be realistic and reasonable the cim:RotatingMachine.ratedS shall if an active or reactive power limit is present be less than<br>- max(abs(cim:SynchronousMachine.minQ),<br>   abs(cim:SynchronousMachine.maxQ),<br>   abs(cim:GeneratingUnit.minOperatingP,<br>   abs(cim:GeneratingUnit.maxOperatingP))*RSRF | | |

| | |
|---|---|
| | - max(abs(CurveData.xvalue),<br>    abs(CurveData.y1value),<br>    abs(CurveData.y2value))*RSRF<br>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<br>- cim:OperationalLimitDirectionKind.high<br>- 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:<br>- 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; <br> - 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: <br> - 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; <br> - 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; <br> - 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.<br>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.<br>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.<br>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.<br>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:<br>-the same md:Model.scenarioTime.<br>-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<br>- cim:VoltageLevel if not in a boundary point.<br>- 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.<br><br>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:<br>- subclasses of the cim:RotatingMachine<br>- subclasses of the cim:EnergyConsumer | | |

| | |
|---|---|
| | - cim:EquivalentInjection<br>- cim:ExternalNetworkInjection<br>- cim:ShuntCompensator<br>- cim:StaticVarCompensator<br>- 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:<br>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).<br>2) A boundary cim:TopologicalNode that is connected to an IGM shall have<br>- One cim:EquivalentInjection<br>- 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<br>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 operating in generator mode, have cim:GeneratingUnit.normalPF equal to 0. | | |
| 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<br>C:456:SSH:NA:distributedActivePowerSlack<br>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:RegulatingControl.targetValue shall be greater than zero if cim:RegulatingControl.mode is RegulatingControlModeKind.voltage.<br>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:RegulatingControl.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. RegulatingControl 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:<br>- cim:ACDCTerminal.connected side 1 (cim:ACDCTerminal.sequenceNumber=1)<br>- cim:Switch.open<br>- cim:ACDCTerminal.connected side 2 (cim:ACDCTerminal.sequenceNumber=2)<br>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. <br>– SynchronousMachine.operatingMode = "motor" shall be provided for SynchronousMachine.type in ["motor", "generatorOrMotor", "motorOrCondenser", "generatorOrCondenserOrMotor"], <br>– SynchronousMachine.operatingMode = "condenser" shall be provided for SynchronousMachine.type in ["condenser", "generatorOrCondenser", "motorOrCondenser", "generatorOrCondenserOrMotor"], and <br>– 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<br>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.<br>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.<br>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.<br>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<br>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:<br>- cim:SeriesCompensator<br>- cim:ACLineSegment<br>- cim:PowerTransformer<br>- cim:EquivalentBranch<br>- 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.<br>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.<br>1) Option 1:<br>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.<br>Validation path:<br>- cim:TopologicalIsland.AngleRefTopologicalNode\cim:TopologicalNode with SvVoltage.v different than 0<br>- cim:TopologicalIsland.AngleRefTopologicalNode\cim:Terminal\cim:RegulatingControl (continuous and enabled)<br>-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.<br><br>2) Option 2:<br>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).<br>Validation path:<br>- cim:TopologicalIsland.AngleRefTopologicalNode\cim:TopologicalNode with SvVoltage.v different than 0 |

| | |
|---|---|
| | - cim:TopologicalIsland.AngleRefTopologicalNode\cim:TopologicalNode\cim:Terminal\Equipment<br>- 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.<br><br>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: SMOperatingModePQConsistency | 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 zero. For cim:SynchronousMachine with cim:SynchronousMachine.operatingMode equal to "generator", cim:RotatingMachine.p shall be less than or equal to zero. | | |
| 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.<br>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<br>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<br>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: <br> - cim:ShuntCompensator.sections <br> - related cim:SvShuntCompensatorSections.sections <br> - cim:TapChanger.step <br> - 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: <br> 1) Each instance of cim:ShuntCompensator shall have cim:SvShuntCompensatorSections instantiated. <br> 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 <br> 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<br>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:<br>1) In case of cim:SynchronousMachineOperatingMode.generator<br>- [cim:GeneratingUnit.minOperatingP,cim:GeneratingUnit.maxOperatingP] if cim:GeneratingUnit.minOperatingP is greater than or equal to zero.<br>- [0,cim:GeneratingUnit.maxOperatingP] if cim:GeneratingUnit.minOperatingP is less than zero.<br>2) In case of cim:SynchronousMachineOperatingMode.motor<br>- [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.<br>- [cim:GeneratingUnit.minOperatingP,0] if cim:GeneratingUnit.maxOperatingP is greater than zero.<br>3) In case of cim:SynchronousMachineOperatingMode.condenser cim:RotatingMachine.p shall equal to zero as there is no active power output.<br><br>Note 1: Negation is necessary due to the load sign convention.<br>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.<br>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<br>- negated (due to the load sign convention) cim:RotatingMachine.q greater than or equal to cim:SynchronousMachine.minQ , if provided<br>- negated (due to the load sign convention) cim:RotatingMachine.q less than or equal to cim:SynchronousMachine.maxQ, if provided<br>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:<br>-a reactive capability curve is present<br>- cim:RotatingMachine.p does not equal 0<br>- cim:RotatingMachine.q does not equal 0.<br><br>The negated value of the cim:RotatingMachine.p shall be:<br>- less than or equal to the maximum value of all cim:CurveData.xvalue related to the associated cim:ReactiveCapabilityCurve, and<br>- greater than or equal to the minimum value of all cim:CurveData.xvalue related to the associated cim:ReactiveCapabilityCurve<br><br>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:<br>- less than or equal to the q_rcc_max, and<br>- 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<br>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).<br>Note 1: Negation is necessary due to the load sign convention.<br>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).<br>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.<br>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.<br>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.<br>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. <br> 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. <br> 3) According to level 5 rule SvPowerFlowInstances every cim:EquivalentInjection has a cim:SvPowerFlow. <br><br> 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. <br> Note 1: cim:ControlArea.netInterchange include AC and DC exchanges. <br> 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 & 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_LIMIT MW/Mvar. If solution tolerance is exceeded a cim:SvInjection shall be provided (the association end cim:TopologicalNode.SvInjection is required). <br><br> 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 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 | |

TABLE 212: 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:<br>-cim:RegulatingControl.enabled equals to true<br>-Associated cim:ConductingEquipment objects are switched on (cim:ACDCTerminal.connected equals to true)<br>-cim:RegulatingCondEq.controlEnabled equals to true for associated cim:ConductingEquipment<br>-cim:TapChanger.ltcFlag equals to true in case the control includes cim:TapChanger<br>-cim:RegulatingControl.mode is cim:RegulatingControlModeKind.voltage<br>-cim:EquivalentInjection.regulatingCapability equals to true in case of cim:EquivalentInjection.<br><br>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 | | | | |

| 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

| 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.<br>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 215: 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 216: 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 217: 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.<br>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 218: 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 219: 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 220: 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 221: 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 222: 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 223: ElReactivePowerInfeedDiffW

| Severity: WARNING | Name: ElReactivePowerInfeedDiffW | 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 224: 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.<br><br>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.<br>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.<br>3) According to level 5 rule SvPowerFlowInstances every cim:EquivalentInjection has a cim:SvPowerFlow.<br><br>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.<br><br>Note 1: cim:ControlArea.netInterchange include AC and DC exchanges.<br>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 225: 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 226: 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.<br>The rule applies for cim:LinearShuntCompensator that is:<br>- connected to cim:TopologicalNode with cim:SvVoltage.v greater than 0, and<br>- 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 227: 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,<br>- 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.<br>- 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 228: 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 229: 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:<br>- cim:RegulatingControl.discrete set to true<br>- cim:RegulatingControl.enabled set to true, and<br>- 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.<br>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}<br><br>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 230: 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<br>- cim:ShuntCompensator<br>- 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 | |

# 13 LEVEL 7: COORDINATION

## 13.1 STANDARD CONSTRAINTS

### 13.1.1 SEVERITY ERROR

TABLE 231: ACTielineBV

| Severity: ERROR | Name: ACTielineBV | Level: 7 | Validation scope: IGM & CGM |
|---|---|---|---|
| Description | For a cim:ControlArea of type interchange all cim:TieFlow branches, which:<br>- are not connected to an HVDC boundary point, and<br>- have a direct association to cim:BaseVoltage<br>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.<br>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 232: 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 233: 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:<br>- cim:SvPowerFlow related to boundary cim:EquivalentInjection-s must be used but with negated value.<br>- 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.<br><br>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 234: 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 235: 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:<br>- control disabled (cim:EquivalentInjection.regulationStatus = false);<br>- the sum of their active power injections (cim:EquivalentInjection.p) shall be less than or equal to SV_INJECTION_LIMIT;<br>- 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<br>- the cim:EquivalentInjection control shall be disabled to avoid duplicate controls.<br>- 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

| 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.<br><br>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 | | | |

| 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:<br>- cim:SvPowerFlow related to boundary cim:EquivalentInjection-s must be used in the summation but with negated value.<br>- 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.<br><br>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 238: 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:<br>- cim:SvPowerFlow related to boundary cim:EquivalentInjection-s must be used but with negated value.<br>- 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.<br><br>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 239: 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 240: 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 241: 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 242: 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:<br>- Full Newton Raphson power flow algorithm.<br>- Switched shunt adjustment must be set to enabled for shunts used for voltage regulation.<br>- Transformer tap adjustment is set to enabled.<br>- Q limits shall be respected for EquivalentInjection, ExternalNetworkInjection, SynchronousMachines, SVCs and SynchronousCondensers (also for slack node/swing bus).<br>- Distributed generation slack is set to enabled (proportional to GeneratingUnit.normalPF).<br>- Maximum mismatch is set to SV_INJECTION_LIMIT MW and SV_INJECTION_LIMIT MVAr per node.<br>- Zero impedance threshold is set to ZERO_IMPEDANCE_THRESHOLD.<br>- 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 243: 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:<br>- Full Newton Raphson power flow algorithm.<br>- Q limits shall be ignored (also for slack node/swing bus) meaning unlimited reactive resources.<br>- Area interchange control is set to enabled.<br>- Maximum mismatch is set to 0.5 MW and 0.5 MVAr per node.<br>- 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 244: 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:<br>- Full Newton Raphson power flow algorithm.<br>- Switched shunt adjustment must be set to enabled for shunts used for voltage regulation.<br>- Transformer tap adjustment is set to enabled.<br>- Q limits shall be respected for EquivalentInjection, ExternalNetworkInjection, SynchronousMachines, SVCs and SynchronousCondensers (also for slack node/swing bus).<br>- Area interchange control is set to enabled.<br>- Maximum mismatch is set to SV_INJECTION_LIMIT MW and SV_INJECTION_LIMIT MVAr per node.<br>- Zero impedance threshold is set to ZERO_IMPEDANCE_THRESHOLD.<br>- 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 245: 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 246: CGMTıeFlowImbalance

| **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.<br>- TFS less than or equal to cim:ControlArea.netInterchange + INTERCH_IMBALANCE_EMF MW<br>- TFS greater than or equal to cim:ControlArea.netInterchange - INTERCH_IMBALANCE_EMF MW<br>Where TFS (TieFlow sum) is computed as<br>- 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 247: 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 248: 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 249: 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 250: 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 251: 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 252: 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 253: 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 254: 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 255: 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 256: 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 257: 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 258: 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 259: 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 260: 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 261: 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 262: 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 263: 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 264: 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 265: 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 266: 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 267: 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 268: 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 269: 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 270: 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 | | | |

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**TABLE 271: 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 272: 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 273: 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 274: 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 275: 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 276: 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 277: 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 278: 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 279: C:301:SSH:VsConverter.targetUpcc:valueRange

| Severity: ERROR | Name:<br>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 280: 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 281: C:301:SSH:VSCONVERTER.TARGETPWMFACTOR:VALUERANGE

| Severity: ERROR | Name:<br>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 282: C:452:EQ:CURVEDATA.CURVE:VSCAPABILITYCURVE

| Severity: ERROR | Name:<br>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 283: 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 284: C:301:SSH:VSCONVERTER.TARGETPHASEPCC:VALUERANGE

| Severity: ERROR | Name:<br>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 285: 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 286: 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 287: C:301:EQ:ACDCCONVERTER.BASES:VALUERANGE

| Severity: ERROR | Name:<br>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 288: C:301:EQ:ACDCTERMINAL.SEQUENCENUMBER:NUMBERING**

| Severity: ERROR | Name:<br>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 289: C:301:SSH:ACDCCONVERTER.TARGETUDC:VALUERANGE**

| Severity: ERROR | Name:<br>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 290: 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 291: 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 292: 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 293: 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 294: 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:<br>- For a monopole with two converter terminals use DCPolarityKind "positive" and "negative".<br>- 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 295: 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 296: 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 297: 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 298: 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 299: 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 300: C:301:EQ:ACDCCONVERTER.DCTERMINALS:NUMBEROFTERMINALS

| Severity: ERROR | Name: C:301:EQ:ACDCConverter.DCTerminals:numberOf Terminals | 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 301: C:301:EQ:ACDCCONVERTER.SWITCHINGLOSS:VALUERANGE

| Severity: ERROR | Name: C:301:EQ:ACDCConverter.switchingLoss:valueRa nge | 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 302: C:301:EQ:CSCONVERTER.MINALPHA:VALUERANGETYPICAL

| Severity: WARNING | Name: C:301:EQ:CsConverter.minAlpha:valueRangeTypi cal | 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 303: 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 304: 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 305: 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 306: 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 307: 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 308: 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 309: 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 310: C:301:EQ:VsConverter.maxModulationIndex:valueRangeTypical

| Severity: WARNING | Name: C:301:EQ:VsConverter.maxModulationIndex:valueRangeTypical | 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 311: 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 312: 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 313: 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 | | | |

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**TABLE 314: 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 315: 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 316: 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 317: 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 318: 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 319: 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 320: 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 321: 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 322: 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.<br>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 323: 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 324: 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:

  o 318 in total. AC IGM and CGM: 242 and DC IGM related: 72

  o 63 out of 72 DC IGM constraints are from CGMES v3.0

  o 91 from 245 constrains for AC IGM and CGM are standard constraints from CGMES v2.4 and CGMES v3.0

  o 47 out of 245 constrains for AC IGM and CGM are standard constraints from CGMES v3.0

  o 104 out of 245 constrains for AC IGM and CGM are business specific.

  o 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.

# 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.
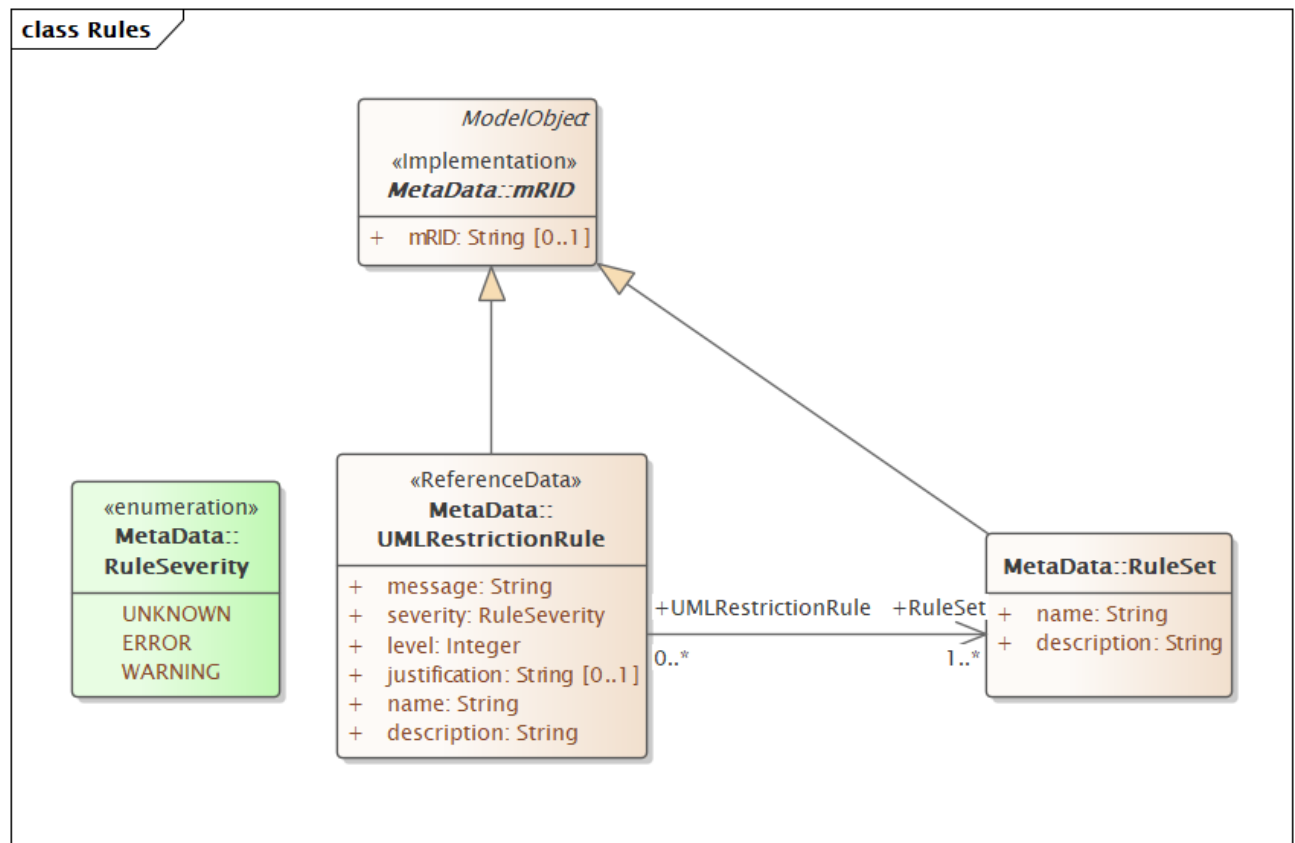


**FIGURE 15 RULE DESCRIPTION INFORMATION MODEL**

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.