



European Network of Transmission System Operators for Electricity

QUALITY OF CGMES DATASETS AND CALCULATIONS

FOR SYSTEM OPERATIONS

3.2 EDITION

10 JUNE 2020

COMMON GRID MODEL BUILDING PROCESS (CGM_BP)

Page 1 of 115



² **COPYRIGHT NOTICE:**

3 Copyright © ENTSO-E. All Rights Reserved.

This document and its whole translations may be copied and furnished to others, and derivative works that comment on or otherwise explain it or assist in its implementation may be prepared, copied, published and distributed, in whole or in part, without restriction of any kind, provided that the above copyright notice and this paragraph are included on all such copies and derivative works. However, this document itself may not be modified in any way, except for literal and whole translation into languages other than English and under all circumstances, the copyright notice or references to ENTSO-E may not be removed.

11 This document and the information contained herein is provided on an "as is" basis.

12 ENTSO-E DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT 13 LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT 14 INFRINGE ANY RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS 15 FOR A PARTICULAR PURPOSE.

16 This document is maintained by the ENTSO-E CGM_BP, former ENTSO-E PT CGM WP2 and 17 WP4.

18 NOTE CONCERNING WORDING USED IN THIS DOCUMENT

- 19 The force of the following words is modified by the requirement level of the document in which they 20 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. 34 35 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 36 37 vendor may omit the same item. An implementation which does not include a particular option MUST be prepared to interoperate with another implementation 38 which does include the option, though perhaps with reduced functionality. In the 39 40 same vein an implementation which does include a particular option MUST be 41 prepared to interoperate with another implementation which does not include the option (except, of course, for the feature the option provides.). 42
- 43

Page 2 of 115



44	Change History
45	2019-12-20 LOO First draft of QoCDCv3.2
46	2020-05-13 LOO Since v3.1 the following rules has been added, renamed or deleted
47	Level 1
48	SynchronousArea renamed to CGMRegion
49	SourcingTSO renamed to SourcingActor
50	Level 3
51	SMRatedSunrealistic
52	TargetDeadbandOutOfRange
53	WindingConnectionAngle
54	VoltageLimitDirection
55	VoltageLimitsConsistency
56	FlowLimitsDirectionConsistency
57	AsymmetricalEquivalent
58	PositiveTransformerB
59	GeneratingUnitSM
60	SMPLimits
61	SubLoadAreaMissing
62	EnergyAreaMissing
63	CurveXYValue renamed to CurveXValue
64	SMQLimits4 has been removed as covered by SMPLimits
65	RCCXValues1 has been removed as covered by RCCXValues2
66	DCNodeContainment removed as covered by cardinality
67	Level4
68	IncompleteObject renamed to IncorrectAttributeOrRoleCard
69	CgmSvSshVersionMismatch
70	Level 5
71	SvPowerFlowBranchInstances2
72	SynchronousCondenserMode
73	TCCRemoteReactiveFlow
74	EquivalentInjectionContainment moved from level 3 to level5
75	DCLineContainment moved from level 3 to level5
76	Level 6
77	FakeVoltage
78	Level 7
79	InconsistentTnBaseVoltage
80	ACScheduleMatch1

Page 3 of 115



81ACScheduleMatch282Level 883TIConvergenceStatMissing84TIConvergenceStatDiverged85

Page 4 of 115





- 2020-03-27 Rule SynchronousArea renamed to CGMRegion and field <synchronousArea>
 renamed to <cgmRegion>
 2020-03-21 capity check, adding missing cim: profixes and format check
- 88 2020-03-31 sanity check, adding missing cim: prefixes and format check.
- 892020-04-06 Rule RCCYValues simplified with text from CGMES3.0. Rule LRCExponentModel90changed to allow exponents in the range 0 =< exp =<2. Rule RatedS exception for aggregated</td>91flag=false removed.
- 92 2020-04-06 LRCExponentModel exponent values restricted.
- 93 2020-04-06 Rule RatedS changed to ignore aggregate flag.
- 94 2020-04-06 Rule CGMRegion severity not correct, changed WARNING->ERROR
- 95 2020-04-21 Rule severity revised to match CGM_BP requirements.
- 96 SourcingActor WARNING->ERROR
- 97 SVCSlope WARNING->ERROR
- 98 PhaseCodeGround WARNING->ERROR
- 99 SVCVoltage WARNING->ERROR
- 1002020-04-21 Consistency checks made, e.g. match between severity and shall/should,101presence of "cim:" prefixes, spelling, reference to limits etc.
- 102 2020-05-11 Changes according to comments from Jun Zhu.
- 1032020-05-12 Updates based on CGM ICT comments. New section "Supporting documents"104added.
- 105 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.
- 109 2020-06-10 Rule MASPersistency moved back to level 2 from level 5.
- 1102020-06-10 Spelling errors corrected and incorrect sign statement in rule111GeneratingUnitNominalP corrected.

112 **TABLE OF CONTENTS**

113 **1 SUMMARY9**

114 **2** INTRODUCTION......**10**

 115 116 117 118 119 120 121 122 123 124 125 	2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 2.10 2.11	OVERVIEW PRECONDITIONS FOR AUTOMATED MERGING GUIDING PRINCIPLES NORMATIVE REFERENCES DOCUMENT HIERARCHY INFORMATION MODELS NUMBER PRECISION GROSS VS NET PRODUCTION VALUES INTEGRATION OF VALIDATORS TERMS AND DEFINITIONS DESCRIPTION OF RULES.	10 11 13 13 14 14 15 15 15 20
125	2.11	DESCRIPTION OF RULES	20





126	3	LEVEL 1 VALIDATION: META DATA IN FILE NAMES	28
127 128	3.1 3.2	INTRODUCTION VALIDATION RULES	28 32
129 130	4	LEVEL 2 VALIDATION: STRUCTURE SYNTAX AND METADATA	35
131 132 133 134	4.1 4.2 4.3 4.4	INTRODUCTION RDF SCHEMA METADATA VALIDATION RULES.	35 36 37 37
135	5	LEVEL 3 VALIDATION: CONSTRAINTS AND MAPPING	43
136 137 138 139 140 141	5.1 5.2 5.3 5.4 5.5 5.6	CONSTRAINTS FOR NAMING ATTRIBUTES CONTAINMENT RULES CONSTRAINTS DEFINED BY CGMES CONSTRAINTS DEFINED BY BEST PRACTICES MAPPING REQUIREMENTS DEFINED BY CGM CONTEXT VALIDATION RULES	43 43 43 43 43 44 45
142	6	LEVEL 4 VALIDATION: MODEL ASSEMBLY	74
143 144 145 146	6.1 6.2 6.3 6.4	INTRODUCTION FILE HEADERS – DEPENDENCIES FILE HEADERS – GENERAL REQUIREMENTS VALIDATION RULES	74 75 76 79
147 148	7	LEVEL 5 VALIDATION: CONSISTENCY OF ASSEMBLED	83
149 150	7.1 7.2	INTRODUCTION VALIDATION RULES	83 83
151	8	LEVEL 6 VALIDATION: IGM AND CGM PLAUSIBILITY	92
152 153 154 155	8.1 8.2 8.3 8.4	INTRODUCTION INDICATORS (AFTER LOAD FLOW CALCULATION) INTERPOLATION IN REACTIVE CAPABILITY CURVE VALIDATION RULES	92 92 92 92 94
156	9	LEVEL 7 VALIDATION: COORDINATION10	07
157 158	9.1 9.2	INTRODUCTION VALIDATION RULES	107 108

Page 6 of 115





10 LEVEL 8 VALIDATION: CONVERGENCE BEHAVIOUR 159 160

161	10.1	Convergence behaviour of IGM	112
162	10.2	PLAUSIBILITY OF CGM	. 112
163	10.3	VALIDATION RULES	. 112

11 SUPPORTING DOCUMENTS, FOR INFORMATION ONLY 115 164

165	11.1	INTRODUCTION	115
166	11.2	CGMPROCESSCONFIGURATIONDATA	115
167	11.3	RULE DESCRIPTIONS	115

LIST OF FIGURES 168

169	FIGURE 1 CONTEXT OF OPERATIONAL DATA EXCHANGES LEADING TO COMMON GRID MODEL	_s10
170	FIGURE 2 THE AUTOMATED PROCESS ANNOTATED WITH VALIDATION LEVELS	12
171	FIGURE 3 RULE TEMPLATE TYPES	21
172	FIGURE 4 RULE TEMPLATE FOR FILE RELATED ERRORS	22
173	FIGURE 5 RULE TEMPLATE FOR OBJECT RELATED ERRORS	23
174	FIGURE 6 RULE TEMPLATE FOR MODEL RELATED ERRORS	24
175	FIGURE 7 DEPENDENCIES OF CGMES MODEL INSTANCES	75
176	FIGURE 8 USE OF DEPENDENTON AND SUPERSEDES IN IGMS	76
177	FIGURE 9 EXAMPLE OF RELATIONS BETWEEN IGM AND CGM FILES	77
178	FIGURE 10 APPLICATION OF DIFF FILES	78
179	FIGURE 11 APPLYING THE EQDIFF AT THE MIDDLEWARE	78
180	FIGURE 12 PAIRWISE MAX VALUE	93
181	FIGURE 13 PARWISE MEAN VALUE	94
182	FIGURE 14 PAIRWISE MIN VALUE	94

LIST OF TABLES 183

184	TABLE 1 TERMS USED AND THEIR DEFINITIONS	15
185	TABLE 2 THE CONSTANTS USED IN OCL RULES	24
186	TABLE 3 ATTRIBUTES OF QODC:RULEFILE, QODC:RULEOBJECT AND QODC:RULEMODEL	25
187	TABLE 4 ADDITIONAL ELEMENTS OF QODC:RULEFILE AND QODC:RULEOBJECT	25
188	TABLE 5 ATTRIBUTES AND ELEMENTS OF QODC:OBJECT	25
189	TABLE 6 ATTRIBUTES OF QODC:PROPERTY	26
190	TABLE 7 ATTRIBUTES OF ENUMERATION VALUES	26
191	TABLE 8 ELEMENTS OF QODC:RULEMODEL	26
192	TABLE 9 ATTRIBUTES AND ELEMENTS OF QODC:MODEL	26

Page 7 of 115



193	TABLE 10 ATTRIBUTES AND ELEMENTS OF QODC: AGGREGATE	.26
194	TABLE 11 ATTRIBUTES OF QODC: VARIABLE	.27
195	TABLE 12 EXAMPLE OF ENUMERATIONS FROM MODELINGAUTHORITY AND MAS RULES	.28
196	TABLE 13 RDF SCHEMA DESCRIPTIONS	.36
197		

Page 8 of 115



198 **1 SUMMARY**

199 The document "Quality of CGMES Datasets and Calculations" aims to increase the quality and 200 consistency of power network model data that is exchanged to support the following processes:

- Coordinated security assessment;
- Coordinated Capacity Calculations;
- Unavailability Planning Coordination;
- Short-term & Medium-Term Adequacy
- After-the-fact analysis of events;
- Ad-hoc system studies;
- System development planning;
- Dynamic Stability Assessment;
- TYNDP and other strategic system studies;
- Inter TSO compensation;

Quality is a concept that can be expressed as the "fitness for purpose" for a target process. This entails that the exchanged data can be processed, is consistent and is interpreted the same way by all users (in other words: is interoperable) and will lead to plausible calculation results. It also means that the data can be processed smoothly in an automated (machine to machine) environment without the explicit need for human intervention. This document contains 8 levels of validation further described below.

217



218 **2** INTRODUCTION

219 **2.1 OVERVIEW**

The purpose of this document is to consolidate and structure the necessary quality criteria and quality indicators that are applicable to the CGMES instances files used by TSOs and RSCs in order to produce plausible Individual Grid Models (IGMs) and Common Grid Models (CGMs) that are fit for purpose for subsequent business processes, such as:

- Coordinated security analysis
- Coordinated Capacity Calculation
- Unavailability Planning Coordination
- Short-term & Medium-Term Adequacy
- After-the-fact analysis of events
- 229 Ad-hoc system studies
- System development planning
- Dynamic Stability Assessment
- 232 TYNDP and other strategic system studies
- 233 Inter TSO compensation
- 234

The first four bullets are defined as RSC services, the following bullets are processes covered by

regional processes and TYNDP.



237

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

Page 10 of 115

239 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 series¹. 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 issued on the 2nd of May 2016. The second edition of this document was approved by ENTSO-E System Operations Committee on the 12th of October 2016 to act as input for the design of the three Quality Gates:

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

This edition incorporates experience gained while running interoperability tests, revealing the need for additional validation rules and improving some existing rules.

As the QoCDC document evolved new rules has been defined and old revised. The rules are aligned with CGMES 2.4.15 specification and the consolidated CGMES specification that is evolving in parallel with the QoCDC.

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.

This document collects experiences from implementing CIM and CGMES and can be seen also as an input to the CGMES roadmap and potentially integrated in future releases of CIM and CGMES documents.

Hopefully the document can also influence developing extensions of CIM as well as profiling methods
 supporting more efficient integration of market and network data.

263 **2.2 PRECONDITIONS FOR AUTOMATED MERGING**

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 covers meta data in file names and packaging of CIMXML files.
- Level 2 covers the structure and syntax of the individual CIMXML files as well as the meta data header.
- 270 Level 3 covers constraints that can be evaluated within the scope of the CIMXML files.
- 271 Level 4 covers issues that can be detected during model assembly.
- 272 Level 5 covers cross profile consistency of data

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.

Level 6 collects diagnostic information that may help solve convergence issues by identifying modelling issues that seem troublesome.

275 Level 7 focuses on coordination of IGMs in terms of neighbouring TSOs and reference values.

276 Level 8 focuses on convergence behaviour of IGMs and CGMs and on the plausibility of the CGM.

277 The steps in the automated process and where the validation levels appear in this process is shown

in Figure 2.

279

280 Figure 2 The Automated process annotated with validation levels

- 281 The symbols in Figure 2 has the following meanings:
- Blue box data processing.
- Blue document CIMXML file or another file.
- Green box validation.
- The green boxes in Figure 2 show where the validation according to the levels 1 to 8 appears in the automated workflow.
- 287 The workflow steps are:
- Boundary management (Boundary mgmnt) where the boundary is created (Bndry),
 this is a manual process at this point, should be automated eventualy. The process
 description is out of scope of this document.
- IGM or CGM creation where CIMXML files are created. This is a TSO or 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 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.

Page 12 of 115

- The assembled model is validated with level 5, 6 and 7 rules.
- The assembled model, IGM or CGM, is solved in power flow for each EffectiveDateTime and the solution is validated with level 8 rules.

The rules at levels 1 to 6 should block publication to OPDM if the severity is ERROR. The rules at levels 7 and 8 should not block publication regardless of severity. It is advisable to have this as a configuration option in the implementation of the rules.

303 **2.3 GUIDING PRINCIPLES**

- 304 The following principles for validation and rejection of data apply:
- 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.
- **<u>Selectivity</u>**: rejection of bad data shall be done on the smallest unit of data.
- <u>Traceability</u>: if a process fails, it shall be possible to trace back the root cause (adequate messages and diagnostics).
- **Harmonization**: power flow settings and automatic corrections are predefined.
- Maintainability: validation rules are specified in XML syntax of the rules is specified in XSD.
 Instructions for implementation of the validation rules are provided in the XML.

314 **2.4 NORMATIVE REFERENCES**

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.

- IEC 61968-100:2013, Application integration at electric utilities System interfaces for distribution
 management Part 100: Implementation profiles
- IEC 61970-301:2016 RLV (Red Line Version), Energy management system application program
 interface (EMS-API) Part 301: Common information model (CIM) base
- IEC 61970-452:2017 (Edition 3.0), 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
- 326 IEC 61970-501:2006 (Edition 1.0), Energy management system application program interface (EMS-
- 327 API) Part 501: Common Information Model Resource Description Framework (CIM RDF) schema
- 328 IEC 61970-552: 2013 (Edition 1.0), Energy management system application program interface
- 329 (EMS-API) Part 552: CIMXML Model exchange format. The older ID formats according to section330 6.4 is allowed.

Page 13 of 115

- IEC TS 61970-600-1:2017, Energy management system application program interface (EMS-API) Part 600-1: Common Grid Model Exchange Specification (CGMES) Structure and rule ²
- 333 IEC TS 61970-600-2:2017, Energy management system application program interface (EMS-API) -
- 334Part 600-2: Common Grid Model Exchange Specification (CGMES) Exchange profiles specification
- IEC 62325-451-1, Framework for energy market communications Part 451-1: Acknowledgement
 business process and contextual model for CIM European market
- IEC 62325-451-5, 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
 (<u>https://www.w3.org/TR/2008/REC-xml-20081126/</u>)
- Key words for use in RFCs to Indicate Requirement Levels, *Network Working Group Best Current Practice, Harvard University March 1997* (<u>https://www.ietf.org/rfc/rfc2119.txt</u>)

345 **2.5 DOCUMENT HIERARCHY**

- 346 The following document hierarchy is applicable:
- IEC 61970 CIM UML16v28 and IEC 61968 CIM UML 12v08 are used as the standard for the
 network model exchanges
- CGMES 2.4.15 profile available as a UML information model with file name ENTSOE CGMES_v2.4.15_Aug2014_XMI.zip, Refer also to https://www.entsoe.eu/digital/common information-model/
- IEC TS 61970-600-1:2017 and IEC TS 61970-600-2 Ed1 (CGMES 2.4) is a subset of the IEC canonical information model and adds some ENTSO-E extensions to the standard and specifies the profiles in CIM RDF XML in which the Individual grid models (IGMs) and Common Grid Models (CGMs) are exchanged
- EMF Requirements specification (current approved version 2.0) specifies the merging process
 from individual Grid Models (IGMs) to Common Grid Models (CGMs). Refer also to:
 https://extra.entsoe.eu/SOC/IT/WP%204/EMF%20requirements%20specification%20v2_final.p
 df
- This document consolidates the identified necessary validation rules to ensure integration of all
 components featuring IGMs and CGMs that are fit for purpose

362 **2.6 INFORMATION MODELS**

The validation rules in this document relate to information models that describe the network data being exchanged, i.e. CGMES 2.4. The CIM/XML format (IEC 61970-552) used in this exchange has a header with meta data about the exchanged network data. As CIM/XML header does not cover all

² The QoCDC document provides additional normative rules not covered by the IEC TS 61970-600 specifications. In a few cases they supersedes IEC TS 61970-600.

meta data needed, hence the file names have been used to carry additional meta data. To do this
the file name string has been divided in pieces where each piece describes a specific meta data.
Additionally, human readable file names were considered an important requirement, at least in the
initial phases where the automated processes are not fully commissioned.

370 **2.7 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 was decided based on experience from empirical analysis of IGMs triggering the rules and is defined as a factor of 0.0005, used in comparison of values as follows:

- 376 Value1
- 377 Value2
- Abs(Value1 Value2) < Abs(Value1)*0.0005 or
- 379 Abs(Value1 Value2) < Abs(Value2)*0.0005
- 380 The future amendments of this document may lead to change of the numerical tolerance, so it is 381 advised to have this factor as configurable in the implementation of the rules.
- 382 See also FBOD5 from IEC TS 61970-600-1:2017.

383 **2.8 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.

387 **2.9 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. Implementations are expected to report all errors for each validation level (i.e. not stop at the first error encountered). 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.

395 2.10 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.

398 Table 1 Terms used and their definitions

Page 15 of 115

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 "7" 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
	Location – object type "V", Physical or logical place where a market participant or IT system is located
	Substations – object type "A"
	broken down as follows:

Page 16 of 115

Term	Definition
	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 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

Page 17 of 115

Term	Definition
	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 (<u>http://</u>)
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.
ТР	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 ³ , specified as follows:
	8 character hex number
	a dash "-"
	4 character hex number
	a dash "-"
	4 character hex number
	a dash "-"
	4 character hex number
	a dash "-"

³ The algorithm is aligned with, and technically compatible with, IEC 9834-8:2004 Information Technology, "Procedures for the operation of OSI Registration Authorities: Generation and registration of Universally Unique Identifiers (UUIDs) and their use as ASN.1 Object Identifier components" ITU-T Rec. X.667, 2004.

Term	Definition
	12 character hex number
	where letters are lower case

Page 19 of 115

400 **2.11 DESCRIPTION OF RULES**

401 This section is for information only and suggests possible solutions.

The rules in XML format are created to support implementers to they can use rule descriptions, severity, level, message etc. in their development if they want. The reporting format is just an example and has not been coordinated with existing tools reporting rule errors or warnings.

405 Creation of a complier-based solution, as suggested below, is by no means required by this 406 document. It is just a hint that this is possible based on existing solutions, e.g. Eclipse Modelling 407 Framework (EMF).

The validation rules are described by XML templates where several XML elements describe the information. The template describes not only the rule but also additional information useful in error or warning messages. The XML format is not so easy to read, hence the rules listed in the following sections are listed in a format that is easier to read. The simplified format contains the following information

- Rule name that also identifies the rule.
- Rule level, 1 to 8.
- Rule severity, ERROR or WARNING.
- Template used, RuleFile, RuleObject or RuleModel.
- Details that describe the rule.
- Justification for the rule.
- Message text.
- SourceFile.

The severity ERROR should block publishing an IGM or CGM in level 1 to 6. This document does not limit use of additional severities that an implementation may want to use, e.g. ALERT, INFO, COMMENT etc.

For each rule the XML template is filled in with information describing the specific rule. The template also contains information about a detected error or warning which means that the template contains two types of information:

- Description of the rule itself that is created at design time included in this document
- Description of actual errors or warnings created at validation time.

The XML template is described by an XML Schema (XSD) which means that the rule descriptions in this document as well as reported error or warning can be validated by the XSD.

The conditions that cause errors or warnings are described by English text in the rules. This means that this text needs to be translated into machine readable and executable code to perform the validation. UML contain a language for this, the Object Constraint Language (OCL), that is machine readable. The OCL code can be executed

• By translation into some executable language as Java, C#, C++, C, Python etc.

Page 20 of 115

- By translation to a XML based language that can be validated by an XSD, note that the XML tempates in this document do not have this capability.
- Directly by an OCL engine
- The translation referred in the two first bullets can be either done manually or by a compiler. As existing rules are expected to change, and new rules will be created, manual translation shall not be used.
- 442 Three types of rule templates are defined, Figure 3.

- 443
- 444 Figure 3 Rule template types
- 445 Rule templates describing CIMXML file related errors are described in Figure 4.

447 Figure 4 Rule template for file related errors

448 Rule templates describing object related errors are described in Figure 5.

Page 22 of 115

450 Figure 5 Rule template for object related errors

451 Rule templates describing errors related to the whole model are described in Figure 6.

Page 23 of 115

453 Figure 6 Rule template for model related errors

454 Table 2 The constants used in OCL rules

Constants used in OCL 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	Integer number
SV_INJECTION_LIMIT	0.1	MVA
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

Page 24 of 115

INTERCH_IMBALANCE_WARNING	50	MW
INTERCH_IMBALANCE_ERROR	200	MW
INTERCH_IMBALANCE_EMF	2	MW

456 The following tables specify the XML elements and attributes.

457 Table 3 Attributes of qodc:RuleFile, qodc:RuleObject and qodc:RuleModel

Attribute name	Description
qodc:ruleID	String that holds the name of the rule, the name shall be unique.
qodc:severity	Enumerated values that specify the behaviour of the validator: "ERROR" means that the data will be rejected "WARNING" means that the data will be used in further processing, but impacts the quality of the calculation results

458 Table 4 Additional elements of qodc:RuleFile and qodc:RuleObject

Element name	Description
qodc:Level	Integer value indicating the validation level as described in section 0.
qodc:RuleDetails	English text that describe the condition causing a report of an error or warning. As discussed in the introductory part of this section there is if possible a corresponding OCL rule describing the condition.
qodc:Constants	An optional named constant. Rules may have constant values, e.g. limits, that are used in several rules. Multiple appearances of the same value allows for mistakes in case the value is changed. Hence the named constant define the allowed value and any change will then result in validation errors which makes it easy to find and correct the values that need to be changed.
qodc:Justification	String that specifies what the rule is based on (optional).
qodc:SourceFile	String that specifies the XML file Name of the XML file being validated.
qodc:Message	String that specifies the message that must be displayed.
qodc:Object	Specification of an CIM object causing a report.
qodc:Property	Specification of a property with value belonging to the CIM object causing a report.
qodc:Enumeratio nValues	An enumeration list of alowed values. The element as an optioinal qodc:description attribute that can be used to further describe the meaning of the qodc:EnumerationValues.

459 Table 5 Attributes and elements of qodc:Object

Attribute name	Description
qodc:cimref	The CGMES class of the object causing a report.
qodc:mRID	Identification of the object causing a report.

Page 25 of 115

460 **Table 6 Attributes of qodc:Property**

Attribute name	Description
qodc:cimref	The CGMES attribute or role name of the property.

461 Table 7 Attributes of EnumerationValues

Attribute name	Description
qodc:enumeration	A enumeration member
qodc:value	The enumeration value.
qodc:description	An optional description of the qodc:value

462 Table 8 Elements of qodc:RuleModel

463 For elements common with RuleFile and RuleObject refer to Table 3 to Table 7.

Element name	Description
qodc:Model	The Model class in the IEC 61970-552.
qodc:Aggregate	Implies that an aggregate calculation shall be made for a collection of objects. The calculation may be a sum, mean value, max value etc.

464 Table 9 Attributes and elements of qodc:Model

Element name	Description
qodc:cimref	The IEC 61970-552 Model class.
qodc:mRID	Identification of the Model object causing a report.
qodc:Property	Specification of a property with value belonging to the IEC 61970-552 Model class. For details refer to Table 6.
qodc:Variable	A variable that holds a value that is computed in the validation rules. The purpose of variables is to allow inclusion of computed values in the error or warning report.

465 Table 10 Attributes and elements of qodc:Aggregate

Attribute name	Description
qodc:cimref	The CGMES class for which the aggregate is calculated.
qodc:type	The type of aggregate calculation, e.g. sum. The XSD include the currently supported aggregate calculations.
qodc:Property	Specification of a property with the aggregate value included in the calculation. For details refer to Table 6.

Page 26 of 115

466 Table 11 Attributes of qodc:Variable

Attribute name	Description
qodc:nameOfVariable	A variable has a name that describes the meaning of the variable and indicates how the value is computed, hence the variable name may be long.

467

468 Below follow the examples of XML rule templates.

469	<pre><qodc:rules "u2="" <="" eng(2001()="" pre="" wlcebe="" wmlmeuvei=""></qodc:rules></pre>	<pre>xmlns:qodc="http://entsoe.eu/CGMES2_4_15/Qo re_instance"</pre>	CDC/3/2"
470 471	xmins:xs1= w3.org/2001/XMLSchel	Ma-instance CGMES2 / 15/0cCDC/3/x file:0cDCRules ysd">	
472	<pre>xs1.schemalocation= entsbe.eu/cdmEsz_4_i5/gocbc/3/x file.gobckules.xsu ></pre>		
473	<pre><quetaleus co<="" coolsection="" th=""><th>></th><th></th></quetaleus></pre>	>	
474	<pre><godc:ruledetails></godc:ruledetails></pre>	·	
475	For every instance of Hvd	roPumps and GeneratingUnit (and subclasses	
476	thereof), the cim:Equipme	nt.EquipmentContainer referred to,	
477	must be of type Substatio	n. Missing containment is not allowed.	
478		0	
479	<pre><qodc:justification></qodc:justification></pre>		
480	See Figure 15 (Core notes) of IEC TS 61970-600-2	
481			
482	<qodc:sourcefile></qodc:sourcefile>		
483	Name of the XML fi</th <th>ile></th> <th></th>	ile>	
484			
485	<qodc:message></qodc:message>		
486	HydroPumps and Generating	Unit must be contained in a Substation	
487			
488	<qodc:model qodc:cimref="</th><th><pre>" qodc:mrid=""></qodc:model>		
489	md:FullModel</th <th>or dm:DifferenceModel class name giv</th> <th>en in</th>	or dm:DifferenceModel class name giv	en in
490	<pre>qodc:Model/@qodc:cimref></pre>		
491			
492	<qodc:object qodc:cimret="</th"><th>qodc:mRID=""></th><th></th></qodc:object>	qodc:mRID="">	
493	Class name given i</th <th>in qodc:Ubject/@qodc:cimret></th> <th></th>	in qodc:Ubject/@qodc:cimret>	
494	<pre><qoac:property pre="" qoac:cin<=""></qoac:property></pre>	<pre>mret= cim:identifiedObject.name ></pre>	
495	<pre><!-- Name of object</pre--></pre>	>	
490		mof_"cim:Equipmont EquipmontContainon"	
497		iner class peterence given in	
490	and Phononty / An	addicing	
499 500	(and c: Property)		
501			
502			
503	, doucture collect,		

3 LEVEL 1 VALIDATION: META DATA IN FILE NAMES

506 3.1 INTRODUCTION

According to IEC 61970-600-1:2017 (Common Grid Model Exchange Specification 2.4), 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."

511 It was agreed in the 38th SOC meeting on 5 November 2015 that business processes related to the 512 operational planning shall use a file naming convention. This section defines such name convention 513 which is applied for Individual Grid Models and Common Grid Models exchanged in CGMES. The 514 file names are primarily used for human consumption but are also used for validating file header 515 content and for the storing of meta data in the OPDM. This meta data is used in OPDM for filtering 516 and manually collecting data via the OPDM user interface

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. Meta data is specified both in the file header and the file name. Meta data in the file header FullModel element as described below:

- Modeling Authority (i.e. the name of the TSO or RSC) is included in the
 Model.modelingAuthoritySet attribute.
- If a Modeling Authority has more than one network region a region specifier is included in the 524 Model.modelingAuthoritySet attribute (further described below).
- The Model.description attribute contains a substructure with several meta data items, refer to level 2 rule ModelDescription.
- HVDC boundary TopologicalNodes has "HVDC" as the first characters in the IdentifiedObject.description.

Several meta data are embedded as enumerations in the rules. A consequence is that when an 529 enumeration changes this document need to be revised. As frequent changes are foreseen this will 530 generate many document revisions. This is avoided by changing the enumerations to data and move 531 532 them to centrally managed configuration file. the document is called а CgmProcessConfigurationData. 533

A first draft of the enumerations converted to data is shown in Table 12.

535 **Table 12 Example of enumerations from ModelingAuthority and MAS rules**

<sourcingactor> Current</sourcingactor>	MA/RSC	MA URI	MAS URI	Region	<sourcingactor> new</sourcingactor>
50Hertz	50Hertz	http://www.50hertz.com	http://www.50hertz.com/OperationalPlanning	D8	50Hertz-D8
IPTO	Admie	http://www.admie.gr	http://www.admie.gr/OperationalPlanning	GR	Admie-GR
D7	Amprion	http://www.amprion.net	http://www.amprion.net/OperationalPlanning	D7	Amprion-D7
APG	APG	http://www.apg.at	http://www.apg.at/OperationalPlanning	AT	APG-AT
AST	AST	http://www.ast.lv	http://www.ast.lv/OperationalPlanning	LV	AST-LV
CEPS	CEPS	http://www.ceps.cz	http://www.ceps.cz/OperationalPlanning	CZ	CEPS-CZ
CGES	CGES	http://www.cges.me	http://www.cges.me/OperationalPlanning	ME	CGES-ME
CREOS	CREOS	http://www.creos-net.lu	http://www.creos-net.lu/OperationalPlanning	LU	CREOS-LU
EIRGRIDSONI	EIRGRIDGROUP	http://www.eirgridgroup.com	http://www.eirgridgroup.com/OperationalPlanning	NIIE	EIRGRIDGROUP-NIIE
ELERING	ELERING	http://www.elering.ee	http://www.elering.ee/OperationalPlanning	EE	ELERING-EE
ELES	ELES	http://www.eles.si	http://www.eles.si/OperationalPlanning	SI	ELES-SI
ELIA	ELIA	http://www.elia.be	http://www.elia.be/OperationalPlanning	BE	ELIA-BE
EMS	EMS	http://www.ems.rs	http://www.ems.rs/OperationalPlanning	RS	EMS-RS

Page 28 of 115

DKE	Energinet	http://www.energinet.dk	http://www.energinet.dk/OperationalPlanning?Region=DKE	DKE	Energinet-DKE
DKW	Energinet	http://www.energinet.dk	http://www.energinet.dk/OperationalPlanning?Region=DKW	DKW	Energinet-DKW
-	Energinet	http://www.energinet.dk	http://www.energinet.dk/OperationalPlanning?Region=Kontiscan	Kontiscan	Energinet-Kontiscan
ENTSOE	ENTSOE	http://www.entsoe.eu	http://www.entsoe.eu/OperationalPlanning	PE	ENTSOE-PE
ESO	ESO	http://www.eso.bg	http://www.eso.bg/OperationalPlanning	BG	ESO-BG
FI	Fingrid	http://www.fingrid.fi	http://www.fingrid.fi/OperationalPlanning	FI	Fingrid-FI
HOPS	HOPS	http://www.hops.hr	http://www.hops.hr/OperationalPlanning	HR	HOPS-HR
-	KOSTT	http://www.kostt.com	http://www.kostt.com/OperationalPlanning	KS	KOSTT-KS
LITGRID	LITGRID	http://www.litgrid.eu	http://www.litgrid.eu/OperationalPlanning	LT	LITGRID-LT
MAVIR	MAVIR	http://www.mavir.hu	http://www.mavir.hu/OperationalPlanning	HU	MAVIR-HU
MEPSO	MEPSO	http://www.mepso.com.mk	http://www.mepso.com.mk/OperationalPlanning	MK	MEPSO-MK
NG	Nationalgrideso	http://www.nationalgrideso.com	http://www.nationalgrideso.com/OperationalPlanning	GB	Nationalgrideso-GB
NOSBIH	NOSBIH	http://www.nosbih.ba	http://www.nosbih.ba/OperationalPlanning	BA	NOSBIH-BA
OST	OST	http://www.ost.al	http://www.ost.al/OperationalPlanning	AL	OST-AL
PSE	PSE	http://www.pse.pl	http://www.pse.pl/OperationalPlanning	PL	PSE-PL
REE	REE	http://www.ree.es	http://www.ree.es/OperationalPlanning	ES	REE-ES
REN	REN	http://www.ren.pt	http://www.ren.pt/OperationalPlanning	PT	REN-PT
RTEFRANCE	RTEFRANCE	http://www.rte-france.com	http://www.rte-france.com/OperationalPlanning	FR	RTEFRANCE-FR
SEPS	SEPS	http://www.sepsas.sk	http://www.sepsas.sk/OperationalPlanning	SK	SEPS-SK
STATNETT	STATNETT	http://www.statnett.no	http://www.statnett.no/OperationalPlanning	NO	STATNETT-NO
SVK	SVK	http://www.svk.se	http://www.svk.se/OperationalPlanning	SE	SVK-SE
SWISSGRID	SWISSGRID	http://www.swissgrid.ch	http://www.swissgrid.ch/OperationalPlanning	СН	SWISSGRID-CH
TEIAS	TEIAS	http://www.teias.gov.tr	http://www.teias.gov.tr/OperationalPlanning	TR	TEIAS-TR
TTG	TenneTDE	http://www.tennet.eu/de	http://www.tennet.eu/de/OperationalPlanning	D2	TenneTDE-D2
TTN	TenneTNL	http://www.tennet.eu/nl	http://www.tennet.eu/nl/OperationalPlanning	NL	TenneTNL-NL
TERNA	TERNA	http://www.terna.it	http://www.terna.it/OperationalPlanning	IT	TERNA-IT
TRANSELECTRICA	TRANSELECTRICA	http://www.transelectrica.ro	http://www.transelectrica.ro/OperationalPlanning	RO	TRANSELECTRICA-RO
Ukrenergo	Ukrenergo	http://www.ukrenergo.energy.gov.ua	http://www.ukrenergo.energy.gov.ua/OperationalPlanning	UA	Ukrenergo-UA
	BatlicRSC	http://www.baltic-rsc.eu		BA	BatlicRSC-BA
	CORESO	http://www.coreso.eu		CE	CORESO-CE
	NordicRSC	http://www.nordic-rsc.net		NO	NordicRSC-NO
	SCCRSC	http://www.scc-rsci.com		CE	SCCRSC-CE
	TSCNET	http://www.tscnet.eu		CE	TSCNET-CE

537 The CIMXML file name convention specifies the meta data parts of the file name, separated by an 538 underscore ('_') and applies to both the xml name and the zip name.

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 Common Grid Model building process.

- 543 The following mask is to be used to have a valid file name:
- 544 <effectiveDateTime>_<businessProcess>_<sourcingActor>_<modelPart>_<fileVersion>
- 545 The following additional rules applies for IGM and CGM file names with this mask
- The parts in the file name are not allowed to contain an underscores "_" or dashes "-547 ". 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 CIMXMLfile can be used with any business process. The mask to use is then
- <effectiveDateTime>__<sourcingActor>_<modelPart>_<fileVersion>
- 556 The <sourcingActor> field has three different layouts:
- 557 1. <sourcingTSO>[-<region>] is used to identify the source of IGMs
- 2. <sourcingRSC>-<cgmRegion> is used for SV files of CGM relating to the cgmRegion from
 an RSC

Page 29 of 115

3. <sourcingRSC>-<cgmRegion>-<sourcingTSO>[-<region>] is used for updated SSH files of
 IGMs relating to a CGM from an RSC, where the sourcingTSO relates to the IGM that has
 been used to create the CGM.

563 The allowed <sourcingTSO> names are to be listed in the CgmProcessConfigurationData document.

564 The <region> is optional as indicated by the angle brackets [] and allowed names are to be listed in 565 the CgmProcessConfigurationData document. If <region> is not defined it shall be given as an empty 566 string in CgmProcessConfigurationData document.

- 567 The allowed <sourcingRSC> names are to be listed in the CgmProcessConfigurationData 568 document.
- 569 The allowed <cgmRegion> names are listed in the CgmProcessConfigurationData, it shall always 570 be included as shown in the right most column in Table 12.
- 571 Examples:
- 572 20180118T0930Z_1D_APG_SSH_001.xml
- 20180117T2230Z_1D_APG_EQ_001.xml
- 20180117T2230Z__APG_EQ_001.xml
- 20180118T1130Z_1D_TSCNET-CE_SV_001.xml
- 20180118T1130Z_1D_TSCNET-CE-APG_SSH_001.xml
- 577 The following mask is allowed for boundary files:
- 578 <effectiveDateTime>__<sourcingActor>_<modelPart>_<fileVersion>
- 579 The following additional rules apply for file names with this mask:
- sourcingActor shall be ENTSOE.
- None 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.
- 584 Examples:

583

• 20180226T0000Z__ENTSOE_EQBD_101.xml

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

587 Each SSH, TP and SV CIMXML file are valid for specific effectiveDateTime. The effectiveDateTime 588 is defined based on the CGMM-v3⁴, for example in case of day-ahead process in Article 4(2) as 589 "...each TSO shall build a day-ahead IGM for each market time unit of the day of delivery. The mid-590 point of each market time unit shall be used as the reference timestamp." So, for day-ahead IGM, 591 the SSH, TP and SV CIMXML file is valid for a market time unit of one hour, and the reference 592 timestamp is mid-point of an hour (HH:30, HH indicating an hour in UTC notation) represented by 593 effectiveDateTime as YYYYMMDDT**HH30**Z.

⁴ <u>https://docstore.entsoe.eu/Documents/Network%20codes%20documents/Implementation/cacm/cgmm/CGMM-v3.pdf</u>

594 EQ, EQDIFF, EQBD and TPBD CIMXML files do not require every hour creation and are valid 595 starting from provided effectiveDateTime until the new EQ or EQDIFF with one of the succeeding 596 effectiveDateTime is provided.

- 597 EQ and EQDIFF CIMXML files are to maintain the same reference timestamp being mid-point of 598 market time unit meaning mid-point of an hour, effectiveDateTime being YYYYMMDDT**HH30**Z.
- 599 EQBD and TPBD CIMXML files are created with YYYYMMDDT**0000**Z effectiveDateTime, for the 600 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.
- The ModelingAuthorities in Table 12 are examples and need to be defined and agreed before final
- entry in the CgmProcessConfigurationData document. The requirement for ModelingAuthority
 names (column MA/RSC in Table 12) is that they are unique. Compliance is checked in level 1, rule
 "ModelingAuthority".
- 606 ModelingAuthority URIs are to be defined by the organisation and examples are given in Table 12 607 column MA URI. The requirement is that they are unique.
- The ModelingAuthority Set (MAS) URI in the Model header is created by attaching a usage and region specifier to the MA URI:
- http://{modeling authority}/{usage}/{region}
- 611 In case only the usage specifier is defined and there is no region, based on the exemplary list in 612 Table 12, the following apply:
- http://www.svk.se/OperationalPlanning
- http://www.energinet.dk/OperationalPlanning
- 615 Some ModelingAuthorities may have more than one network, this is described by defining a region 616 in the following way:
- Add a query component to the URI using the "?" syntax.
- The question mark is followed by query string that is an attribute value pair with a separator inbetween.
- The attribute value is "region" and the separator is "=".
- Example values are given in Table 12, column MAS URI. They are to be agreed, unique and checked in the level 2 rule "MAS". Examples of MAS URIs are e.g.
- http://www.svk.se/OperationalPlanning
- http://www.energinet.dk/OperationalPlanning?Region=DKE
- http://www.energinet.dk/OperationalPlanning?Region=DKW

Some TSOs may have separate ModelingAuthorities for different regions. If this is the case the
 region is indicated in the ModelingAuthority name by extending the URI path as shown in Table 12
 for TenneT:

- http://www.tennet.eu/de for TenneT Germany
- http://www.tennet.eu/nl for TenneT Netherlands

Page 31 of 115

TSO network regions are combined into larger networks called synchronous areas to be described in the CgmProcessConfigurationData document. CGMRegions consists of GeographicalRegions or SubGeographicalRegions. Energinet has two SubGeographicalRegions DKW and DKE in different CGMRegions. Hence DKW and DKE SubGeographicalRegions could be included in the CgmProcessConfigurationData document. If a TSO has HVDC links, they are treated as their own SubGeographicalRegions that are also included in the CgmProcessConfigurationData 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 meta data 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.

642 3.2 VALIDATION RULES

643

644 Rule: FileNameMD Level: 1 Severity: ERROR Template: RuleFile 645 646 Details: 647 Two different file name templates are used 648 1) effectiveDateTime_businessProcess_sourcingActor_modelPart_fileVersion 649 2) effectiveDateTime__sourcingActor_modelPart_fileVersion 650 The templates have fields separated by four underscores (_). 651 Depending of the model part (see rule ModelPartType) the templates are 652 - EQ may use both template 1 and 2 653 - SHH, TP and SV may only use template 1 654 - EQBD and TPBD may only use template 2 655 The field sourcingActor has sub fields separated by dashes (-) 656 and the square brackets [] indicates optional field. 657 Three templates are allowed 658 3) sourcingTSO[-region] 659 4) sourcingRSC-cgmRegion 660 5) sourcingRSC-cgmRegion-sourcingTSO[-region] 661 Depending of the source the templates to use are 662 - A TSO sourcing a file shall always use template 3 663 - An RSC sourcing a file shall use 664 template 4 for a synchronous area file, e.g. a SV file 665 template 5 for an updated TSO area file, e.g. a SSH file 666 667 Justification: 668 669 Message: Number of meta data fields in file name does not match the rules 670 671 672 Rule: FileNameConsistency Level: 1 Severity: ERROR Template: RuleFile 673 674 Details: 675 Each cimxml file is contained by a single zip container, 676 except for the boundary data. 677 The file name of the cimxml file within the container 678 must be the same as the name of the container. 679 680 Justification:

Page 32 of 115

European Network of Transmission System Operators for Electricity

681		
682		Message:
683		XML instance file name is different from zip container file name.
684		
685	Rule:	EffectiveDateTime Level: 1 Severity: ERROR Template: RuleFile
686	nuize.	
687		Details
600		The 'affactiveDateTime' in the file name must be valid datetime
000		in minute manalution in companyers with TCO 0001 2005, havin Commet
009		in minute resolution in accordance with ISO 8601-2005, Dasic Format
690		with time designator [1] between date and time and ending with
691		UIC designator [Z]. The characters [:-+YMDHSWP] are not allowed,
692		see example below
693		- 20180118T1130Z
694		The restriction describes the minimum required specification that a
695		receiver shall be prepared to consume. A more precisely specified
696		time will be ignored.
697		
698		Justification:
699		The relevant time resolution for the business process is minute level and
700		the time in the file name shall match with this attribute
700		
701		Managa 201
702		Message:
703		EffectiveDatelime is invalid
704		
705	Rule:	ModelingAuthority Level: 1 Severity: ERROR Template: RuleFile
706		
707		Details:
708		The 'modelingAuthority' (MA) in the file name is restricted according to
709		the agreed list in the CgmProcessConfigurationData document. The text is not case
710	sensit	cive.
711		
712		Justification:
713		
714		
715		Message:
716		Modeling Authority not recognized
717		
718		
710	Rulo	SourcingActor Level: 1 Sevenity: ERROR Template: RuleFile
720	Nure.	SourchingActor Lever. I Severity. Ennon remplate. Ruterite
720		Detailer
721		Decalls:
722		The sourcingActor, that appears in the cimxmi file name, is composed from the
723		ISO name and the optional region name as described in rule FileNameMD. The ISO
724		name and the optional region name are chosen by the TSO responsible for the
725		region and the chosen names are recorded in the CgmProcessConfigurationData
726		document. Once decided the sourcingActor should comply with the chosen names
727		in the CgmProcessConfigurationData document.
728		
729		Justification:
730		The sourcingActor shall comply with the choices made by a TSO.
731		
732		Message:
733		Undefined TSO or network region names specified
734		
735	Rule:	CGMRegion Level: 1 Severity: ERROR Template: RuleFile
736		

Page 33 of 115

737		Details:
738		TSO networks are organized in synchronous areas including
739		multiple TSO network regions. Each synchronous area is
740		assigned unique identifiers in file names.
741		The allowed synchronous areas are listed in the
7/2		Cambridge System of the areas are firsted in the
742		cgmprocessconfigurationData document.
743		
744		Justification:
745		Needed to uniquely identity synchronous areas for SV of CGM.
746		
747		Message:
748		Unidentified synchronous area specified in SV instance filename of CGM
749		
750		
751		
752	Dulor	PusinessDresses Loval: 1 Sovenity: EPPOP Template: PuloFile
752	Ruie:	businessprocess level: I severity. Error template. Rulerile
753		
754		Details:
755		The 'businessProcess' in the file name is restricted according
756		to a list in the CgmProcessConfigurationData document.
757		See also level 2 rule ModelDescription where the BusinessProcess
758		is required in the Model description attribute.
759		
760		Justification
700		Justification.
701		
762		Message:
763		Unknown business process
764		
765		
766		
767	Rule:	ModelPartTvpe Level: 1 Severity: ERROR Template: RuleFile
768		
760		Details
703		The 'modelDent' in the file neme is nestnicted
774		The model and the file file fame is restricted.
//1		Note that the profile declarations in the file header are
772		leading and shall be used as meta data to request data.
773		
774		Justification:
775		
776		Message:
777		Unknown modelPart Type
778		
770		Enumeration: Allowed model nart types
700		Di D
700		
781		
782		EQ
783		EQBD
784		EQDIFF
785		GL
786		SSH
787		SV
788		TP
789		TPBD
700		עט דו
790	D1 - /	FileVencionTune Lougle 1 Coveniture EDDOD Templeter DulaFile
791	ките:	FILEVERSIONTYPE LEVEL: I SEVERITY: ERROR TEMPLATE: RUTEFILE
792		

Page 34 of 115

793	Details:
794	The 'fileVersion' in the file name must be an integer value always
795	represented by three numeric characters ranging from 000 to 999.
796	Leading zeros are allowed.
797	
798	Justification:
799	See this specification section 3.1 and IEC TS 61970-600-1 C.3.1.
800	
801	Message:
802	File version must be a number with three numeric character positions

4 LEVEL 2 VALIDATION: STRUCTURE SYNTAX AND METADATA

4.1 INTRODUCTION

CGMES data is exchanged as CIM RDF⁵ XML⁶ 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 rules⁷.

808 RDF syntax provides many ways to represent the same set of data. For example, an association 809 between two resources can be written with a resource attribute or by nesting one element within 810 another. This could make it difficult to use some XML tools, such as XSLT processors, with the 811 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 deserialization 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.

825 Errors in XML documents will stop XML applications. The W3C XML specification states that a 826 program should stop processing an XML document if it finds an error. The reason is that XML

⁵ Resource Description Framework, i.e. a language recommended by the W3C for expressing meta data that machines can process easily

⁶ eXtensible Markup Language, i.e. a subset of the Standard Generalized Markup Language (SGML), ISO 8879, for putting structured data in a text file

⁷ 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 <u>http://www.w3.org/TR/REC-xml/#sec-prolog-dtd</u>

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.

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.

4.2 RDF SCHEMA

CGMES data is exchanged as CIMXML files, as specified in IEC 61970-552:2013 (Edition 1.0). The
 older ID formats according to section 6.4 is allowed.

- 835 RDFS files, generated from the UML, describe the CGMES profile classes, attributes and roles with 836 cardinalities using an extended RDFS notation described in IEC 61970-501 Ed1.
- The RDFS files can be downloaded from the <u>ENTSO-E website</u>. The Resource Description Framework 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 read 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.
- 843 described in the CGMES profiles.
- 844 The following table specifies which RDFS file is to be used for validation.
- 845 **Table 13 RDF schema descriptions**

ModelProfile value	RDF schema description
http://entsoe.eu/CIM/EquipmentBoundary/3/1	EquipmentBoundaryProfileRDFSAugmented-v2_4_15-16Feb2016.rdf
http://entsoe.eu/CIM/TopologyBoundary/3/1	TopologyBoundaryProfileRDFSAugmented-v2_4_15-16Feb2016.rdf
http://entsoe.eu/CIM/EquipmentCore/3/1	EquipmentProfileCoreRDFSAugmented-v2_4_15-4Jul2016.rdf
http://entsoe.eu/CIM/EquipmentCore/3/1	EquipmentProfileCoreOperationRDFSAugmented-v2_4_15-4Jul2016.rdf
http://entsoe.eu/CIM/EquipmentOperation/3/1	
http://entsoe.eu/CIM/EquipmentCore/3/1	EquipmentProfileCoreShortCircuitRDFSAugmented-v2_4_15-
http://entsoe.eu/CIM/EquipmentShortCircuit/3/1	4Jul2016.rdf
http://entsoe.eu/CIM/EquipmentCore/3/1	EquipmentProfileCoreShortCircuitOperationRDFSAugmented-v2_4_15-
http://entsoe.eu/CIM/EquipmentOperation/3/1	4Jul2016.rdf
http://entsoe.eu/CIM/EquipmentShortCircuit/3/1	
http://entsoe.eu/CIM/SteadyStateHypothesis/1/1	SteadyStateHypothesisProfileRDFSAugmented-v2_4_15-16Feb2016.rdf
http://entsoe.eu/CIM/Topology/4/1	TopologyProfileRDFSAugmented-v2_4_15-16Feb2016.rdf
http://entsoe.eu/CIM/StateVariables/4/1	StateVariablesProfileRDFSAugmented-v2_4_15-16Feb2016.rdf
http://entsoe.eu/CIM/DiagramLayout/3/1	DiagramLayoutProfileRDFSAugmented-v2_4_15-16Feb2016.rdf
http://entsoe.eu/CIM/GeographicalLocation/2/1	GeographicalLocationProfileRDFSAugmented-v2_4_15-16Feb2016.rdf
http://entsoe.eu/CIM/Dynamics/3/1	DynamicsProfileRDFSAugmented-v2_4_15-16Feb2016.rdf

846

- 847 Any tool implementing the CGMES profile shall check CIMXML data and verifying that
- Class, attribute and role names appearing in a file is defined by the profile.
- Cardinality contraints are respected.

Page 36 of 115




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, e.g. the rule "ControlAreaInstance" that requires exactly one instance of the ControlArea class in an IGM. In UML it is possible to specify this as the cardinality on a class, but this capability hasn't 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

859 "IncorrectAttributeOrRoleCard" reports violated cardinaltity.

860 **4.3 METADATA**

The Model header from IEC 61970-552 is validated and cross checked with the meta data in the file name if present in both places.

863 **4.4 VALIDATION RULES**

864 Rule: Prolog Level: 2 Severity: ERROR Template: RuleFile 865 866 Details: 867 The CIMXML file must have a prolog containing attributes 868 version and encoding. 869 870 Justification: 871 See this specification, section 4.1 872 873 Message: 874 Prolog is missing 875 876 Rule: Encoding Level: 2 Severity: ERROR Template: RuleFile 877 878 Details: If the encoding is different from UTF-8, it shall be considered an error 879 880 Note: the encoding is case insensitive 881 882 Justification: 883 See IEC TS 61970-600-1:2017 GENC10 884 885 Message: Missing encoding or encoding other than UTF-8 886 887 888 Rule: XMLStructure Level: 2 Severity: ERROR Template: RuleFile 889 890 Details: 891 If the XML parsing fails, the process is aborted 892 893 Justification: 894 https://www.w3.org/TR/REC-xml/#dt-fatal 895 896 Message:

Page 37 of 115



897		XML parsing error
898		
899	ките:	FileHeader Level: 2 Severity: ERROR Template: RuleFile
900		Dete (1)
901		Details:
902		Each type of instance file shall have exactly one file header of type
903		FullModel or DifferenceModel
904		
905		JUSTITICATION:
900		Requirement HGENZ OF IEC 15 61970-600-1.2017, IEC 61970-552, Section 5.2
907		Magazza
900		Message. Missing file bodon
909		hissing life header.
011	Bulot	URNUniqueness lovel: 2 Sevenity: ERBOR Template: BuleFile
012	Ruie.	OKNONIQUENESS LEVEL. 2 Severity. EKKOK Tempiate. Kulerile
012		Detaile
01 <i>/</i>		A new model TD shall be generated for new instance files only when
015		the content of the instance data changes. A new version means a new IIRN
016		the content of the instance data changes. A new version means a new own.
917		Justification
918		Requirement HREE1 HREE5 of TEC TS 61970-600-1.2017
919		
920		Message
921		URN of the instance file already exists
922		on of the instance file difeduy exists
923	Rule	MAS Level: 2 Severity: ERROR Template: RuleObject
924		
925		Details:
926		The 'md:Model.modelingAuthoritySet' attribute must be specified
927		in the file header and must be a valid URL.
928		The value shall be aligned with the modelingAuthority in the file name
929		specified in rule ModelingAuthority extended with the region specifier
930		and the usage, following the pattern
931		"http://{modeling authority}/{usage}/{region}"
932		The allowed values for 'md:Model.modelingAuthoritySet' are listed
933		in the CgmProcessConfigurationData document.
934		
935		Justification:
936		Requirement HGEN1, HGEN5 of IEC TS 61970-600-1:2017.
937		The attribute is mandatory for the CGM process.
938		
939		Message:
940		Invalid Modeling Authority Set specification
941		
942	Rule:	MASPersistency Level: 2 Severity: ERROR Template: RuleModel
943		
944		Details:
945		The 'md:Model.modelingAuthoritySet' attribute must be persistent
946		for all CIMXML files of an IGM exchanges within the operational planning process.
947		The allowed values are listed in CgmProcessConfigurationData document,
948		reter also to level 2 rule MAS.
949		Note that to test this across CIMXML files this must be done for a model where
950		all files have been included.
951		
952		Justification:

Page 38 of 115





953 See this document section 3.1 and IEC TS 61970-600-1 table in C.3.1. 954 955 Message: 956 Modeling Authority Set specification must be persistent 957 958 959 Rule: ModelCreated Level: 2 Severity: ERROR Template: RuleObject 960 961 Details: 962 The date and time when the model was created. 963 It is the time of the serialization. 964 The format is an extended format according to the ISO 8601-2005. 965 The ENTSO-E exchanges should refer to UTC. 966 The 'md:Model.created' attribute must be valid datetime in accordance 967 with ISO 8601, extended format with time designator [T] between date 968 and time ending with UTC designator [Z]. 969 The characters [:-] shall be used 970 and the characters [.+YMDHSWP] are not allowed 971 see example below 972 - 2018-01-18T11:30:12Z. 973 974 Justification: 975 Annex C of IEC TS 61970-600-1:2017 976 977 Message: 978 Invalid Model.created attribute 979 980 Rule: ScenarioTime Level: 2 Severity: ERROR Template: RuleObject 981 982 Details: The 'md:Model.scenarioTime' attribute must be valid datetime in 983 984 accordance with ISO 8601, extended format with time designator [T] 985 between date and time ending with UTC designator [Z]. 986 The characters [:-] shall be used 987 and the characters [.+YMDHSWP] are not allowed 988 see example below 989 - 2018-01-18T11:30:12Z. 990 Justification: 991 992 Annex C of IEC TS 61970-600-1:2017 993 994 Message: 995 Invalid Model.scenarioTime attribute 996 997 Rule: ScenarioTimeConsistency Level: 2 Severity: ERROR Template: RuleObject 998 999 Details: 1000 The 'md:Model.scenarioTime' attribute shall refer to the same datetime 1001 as the 'effectiveDateTime' in the file name, considering minute 1002 resolution. 1003 1004 Justification: 1005 Necessary to produce consistent meta data for the exchange process 1006 1007 Message: 1008 The scenarioTime specification in the file header does not match the

Page 39 of 115



1009		effectiveDateTime specified in the file name
1010	Bulot	VancianCancistancy Loyal, 2 Sovenity, EPPOP Template, BuloObject
1011	Ruie.	versionconsistency level. 2 Severity. Error Template. Ruleobject
1012		Detailer
1013		Decdiis. The 'md'Model yencien' attribute shall be the same number
1014		The mulmodel.version allribute shall be the same number
1015		as the fileversion string from the file name converted to an integer.
1010		
1017		JUSTITICATION:
1018		Necessary to produce consistent meta data for the exchange process
1019		Manager
1020		Message:
1021		The model version does not match the file version
1022	D1	DrafileCracification Levels 2 Coverity CDDOD Templetes DuloObject
1023	Ruie:	ProfileSpecification Level: 2 Severity: ERROR Template: RuleObject
1024		Detailer
1020		Decidits. The 'md.Model profile' decomination in the file booden is postmicted
1020		Neter The profile declarations in the file header are leading and
1027		shall be used as meta data to request data
1020		The enumeration values are controlly maintained in
1029		ComProcessConfigurationData document
1030		cgmprocessconriguraciondata document.
1031		Justification
1032		JUSCITICATION.
1033		Poquinoment EPOD2 HEEN1 of TEC TS 61970 600 1.2017
1034		Apply C of EC/TS (1070 600 1:2017
1035		Annex C 01 1EC/13 01970-000-1.2017.
1030		Merrade
1037		Invalid profile specification
1030		
1035		
1040	Rule	ModelDescription Level: 2 Severity: FRROR Template: RuleObject
1041	Nuic.	Houerbeschiption level. 2 Sevenity. Ennon Template. Naieobjeet
1043		Details
1044		The 'md.Model description' attribute must be specified in the file header
1045		and contains data embedded in an xml structure as described by the
1046		and contains added empedded in an Amr Scheded in the add: MDE subelements
1047		describe how to fill in the data.
1048		<aodc:mde> required</aodc:mde>
1049		<pre><aodc:bp> required</aodc:bp></pre>
1050		Business process from level 1 rule BusinessProcess
1051		
1052		<pre><godc:tool> required</godc:tool></pre>
1053		Tool name and version number
1054		
1055		<pre><godc:rsc> required if profile is SV or SSH for a CGM</godc:rsc></pre>
1056		The name of the RSC from level 1 rule ModelingAuthority
1057		
1058		<pre><qodc:txt> optional</qodc:txt></pre>
1059		Free text
1060		
1061		.
1062		
1063		Justification:
1064		See this specification section 3.1.

Page 40 of 115



1065 1066 1067		Message: Missing md:Model.description
1068 1069 1070	Rule:	NotMandatoryClass Level: 2 Severity: WARNING Template: RuleObject
1071 1072		Details: An instance of a class not described in the CGMES
1073 1074		profile is ignored and reported. If an importing tool requires a class not described in a CGMES
1075 1076 1077		profile issues may occur for a CGM where other IGMs do not contain instances of the class.
1078		Justification:
1079 1080		Requirement PROF11 of IEC/IS 61970-600-1:2017.
1081 1082 1083		Message: Class instance in cimxml document is ignored
1084 1085	Rule:	NotMandatoryProperty Level: 2 Severity: WARNING Template: RuleObject
1086		Details:
1087		A role or attribute not described in a CGMES profile is ignored and reported.
1088		If an importing tool require a role or attribute not described in a CGMES
1089 1090 1091		profile issues may occur for a CGM where other IGMs do not contain instances of the role or attribute.
1092		Justification:
1093 1094		Requirement PROF11 of IEC/TS 61970-600-1:2017.
1095		Message:
1096 1097		Role or attribute in cimxml document is ignored.
1098 1099	Rule:	AttributeAndRoleValues Level: 2 Severity: ERROR Template: RuleObject
1100		Details:
1101 1102		Attribute and role values appearing in a CIMXML document shall have a value. Empty elements or attributes are not allowed, see examples below:
1103		<pre>- [cim:class.attribute/] - [cim:class.attribute.ndf:resource=""/]</pre>
1105		The above example results in no value, i.e. a null value.
1106		Empty strings are allowed, see examples below:
1107		- [cim:class.attribute][/cim:class.attribute]
1108		The above example results in a string with no characters, i.e. an empty string.
1109		Name related attributes of the IdentifiedObject that are required can be exchanged
1110		as empty string i.e. [IdentifiedObject.name][/IdentifiedObject.name]
1111		Note: the xml angle brackets has been replaced by square parenthesis in
1112		above examples.
1114		
1115		Justification:
1116		Only meaningful data shall be exchanged in CIMXML documents.
1117		See also IEC TS 61970-600-1 NAMC14.
1118		Manager
1119 1120		Message: Empty element or attribute value present
1120		Empty element of accidute value present

Page 41 of 115





1121 1122 Rule: ValidResourceValue Level: 2 Severity: ERROR Template: RuleObject 1123 1124 Details: 1125 If '#_' or 'urn:uuid:' do not prefix the value of rdf:resource, the reference is invalid. The 'urn:uuid:' form is used in the md:Model.Supersedes and 1126 1127 md:Model.DependentOn references. 1128 1129 Justification: 1130 See IEC 61970-552 1131 1132 Message: 1133 Invalid reference 1134 1135 Rule: ValidAboutValue Level: 2 Severity: ERROR Template: RuleObject 1136 1137 Details: If '#_' or 'urn:uuid:' do not prefix the value of rdf:about, the mRID 1138 is invalid. The 'urn:uuid:' form is used in the object definition 1139 1140 attribute md:FullModel rdf:about. 1141 1142 Justification: 1143 See IEC 61970-552 1144 1145 Message: 1146 Invalid mRID about 1147 1148 Rule: ValidIDValue Level: 2 Severity: ERROR Template: RuleObject 1149 1150 Details: If '_' do not prefix the value of rdf:ID, the mRID is invalid. 1151 1152 1153 Justification: 1154 See IEC 61970-552 1155 1156 Message: 1157 Invalid mRID 1158 Rule: DecimalComma Level: 2 Severity: ERROR Template: RuleObject 1159 1160 1161 Details: Decimal comma is not allowed in floating point numbers. 1162 1163 Shall be decimal point. 1164 Justification: 1165 1166 IEEE 754. 1167 Note: A locale settings may select either comma or full stop and a particular 1168 locale settings do not support both comma and full stop. Due to this a mix of 1169 comma and full stop prevent interoperability, hence one must be selected. 1170 1171 Message: 1172 Decimal comma is not allowed in floating point numbers 1173 Rule: NotaNumber Level: 2 Severity: ERROR Template: RuleObject 1174 1175 1176 Details:

Page 42 of 115





1177	If data is missing for a CIM/CGMES attribute, or if 'NaN', 'INF' or
1178	'-nan(ind)' etc. is used when a numeric value is expected, the model
1179	is considered erroneous.
1180	If a code is allowed for a numeric value this shall be specifically stated
1181	for that attribute.
1182	
1183	Justification:
1184	Not a Number values cannot be processed correctly
1185	
1186	Message:
1187	No valid value provided

1188 **5** LEVEL 3 VALIDATION: CONSTRAINTS AND MAPPING

1189 **5.1 CONSTRAINTS FOR NAMING ATTRIBUTES**

1190 IEC TS 61970-600-1:2017, Annex B, specifies the maximum length of naming attributes for
 1191 IdentifiedObject classes in all profile instance files and for ConnectivityNodes and TopologicalNodes
 1192 in Boundary instance files.

1193 **5.2 CONTAINMENT RULES**

Equipment containers represent ways of organizing and naming equipment typically found within a 1194 1195 substation. As may be seen, there is some flexibility provided in which containers are used in a specific application of the CIM in order to accommodate different international practices as well as 1196 differences typically found between transmission and distribution substations. Bay, VoltageLevel, 1197 Substation, Line, DCLine and DCConverterUnit are all types of EquipmentContainer. In general, a 1198 Bay is contained within a specific VoltageLevel, which in turn is contained within a Substation. 1199 Substations and Lines may be contained within a SubGeographicalRegion and as a consequence 1200 1201 within a GeographicalRegion.

One containment hierarchy is used with the 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 instance files and in Equipment Boundary instance files.

1206 5.3 CONSTRAINTS DEFINED BY CGMES

1207 The IEC TS 61970-600-2 specifies additional constraints to the attribute values, conditional 1208 associations and enumerations.

1209 **5.4 CONSTRAINTS DEFINED BY BEST PRACTICES**

1210 This paragraph specifies a number of equipment modelling business rules that have their origin from 1211 best practices and common sense in Power Flow calculations. Rationales and justifications are 1212 provided in the rules.

Page 43 of 115





1213 **5.5 MAPPING REQUIREMENTS DEFINED BY CGM CONTEXT**

1214 The quality checks in this section refer to information that is required to be able to use scheduled

and aligned netted area AC positions and target flows on HVDC links as set points in the CGMprocess.

Page 44 of 115



1217 **5.6 VALIDATION RULES**

1218 1219	Rule:	NameLength Level: 3 Severity: ERROR Template: RuleObject
1220		Details:
1221		cim:IdentifiedObject name shall exist and not exceed
1221		TO NME LENGTH characters for all instances except for instances
1222		IO_NAME_LENGTH CHARACTERS FOR ALL INStances except for instances
1223		of subclasses of cim:ACDClerminal where cim:IdentifiedObject.name
1224		may be omitted.
1225		
1226		Justification:
1227		See IEC TS 61970-600-1:2017 B.1, IEC TS 61970-600-2:2017 R.4.10.13.
1228		· ·
1229		Message:
1230		Length of name instance is missing or exceeds TO NAME LENGTH characters
1220		
1201	D	Decemintical anoth lovel, 2 Coverity, EDDOD Templeter DuloObject
1232	Ruie:	DescriptionLength Level: 3 Severity: ERROR Template: RuleObject
1233		
1234		Details:
1235		In every model instance, the length of all instances of
1236		cim:IdentifiedObject.description shall not exceed
1237		IO DESCRIPTION LENGTH characters.
1238		
1239		Justification:
1240		See TEC TS 61970-600-1.2017 B 2
1241		
1241		Maccago
1242		Message.
1243		Length of description instance exceeds IU_DESCRIPTION_LENGTH characters
1244		
1245	Rule:	EICLength Level: 3 Severity: ERROR Template: RuleObject
1246		
1247		Details:
1248		In every model instance, the length of all instances of
1249		entsoe:IdentifiedObject.energyIdentCodeEic must be exactly
1250		EIC LENGTH characters.
1251		-
1252		Justification:
1253		See TEC TS 61970-600-1.2017 B 3
1250		500 110 15 015/0 000 1.201/ 5.5
1254		Maccago
1255		Message.
1200		Length of energyidentcodeEic instance must be exactly EIC_LENGTH characters
1257	- 1	
1258	Ruie:	ShortNameLength Level: 3 Severity: ERROR Template: RuleObject
1259		
1260		Details:
1261		In every model instance, the length of all instances of
1262		entsoe:IdentifiedObject.shortName shall not exceed
1263		SHORT_NAME_LENGTH characters.
1264		
1265		Justification:
1266		See IEC TS 61970-600-1:2017 B.4
1267		
1268		Message
1269		Length of shortName instance exceeds SHORT NAME LENGTH characters
1270		

Page 45 of 115





1271 Rule: CNFromEndIsoCode Level: 3 Severity: ERROR Template: RuleObject 1272 1273 Details: In an EQBD document attribute value entsoe:ConnectivityNode.fromEndIsoCode 1274 1275 must be from the country code list 1276 https://www.iso.org/iso-3166-country-codes.html 1277 1278 Justification: 1279 See IEC TS 61970-600-1:2017 B.5 1280 1281 Message: 1282 Country code is not in the list 1283 https://www.iso.org/iso-3166-country-codes.html 1284 1285 Rule: TNFromEndIsoCode Level: 3 Severity: ERROR Template: RuleObject 1286 1287 Details: 1288 In a TPBD document attribute value entsoe:TopologicalNode.fromEndIsoCode 1289 must be from the country code list 1290 https://www.iso.org/iso-3166-country-codes.html 1291 1292 Justification: 1293 See IEC TS 61970-600-1:2017 B.5 1294 1295 Message: 1296 Country code is not in the list 1297 https://www.iso.org/iso-3166-country-codes.html 1298 1299 Rule: CNToEndIsoCode Level: 3 Severity: ERROR Template: RuleObject 1300 1301 Details: 1302 In an EQBD document attribute value entsoe:ConnectivityNode.toEndIsoCode 1303 must be from the country code list 1304 https://www.iso.org/iso-3166-country-codes.html. 1305 1306 Justification: 1307 See IEC TS 61970-600-1:2017 B.6 1308 1309 Message: 1310 Country code not in the list 1311 https://www.iso.org/iso-3166-country-codes.html 1312 1313 Rule: TNToEndIsoCode Level: 3 Severity: ERROR Template: RuleObject 1314 1315 Details: 1316 In a TPBD document attribute value entsoe:TopologicalNode.toEndIsoCode 1317 must be from the country code list 1318 https://www.iso.org/iso-3166-country-codes.html. 1319 1320 Justification: 1321 See IEC TS 61970-600-1:2017 B.6 1322 1323 Message: 1324 Country code is not in the list 1325 https://www.iso.org/iso-3166-country-codes.html 1326

Page 46 of 115





1327 Rule: CNFromEndNameLength Level: 3 Severity: ERROR Template: RuleObject 1328 1329 Details: 1330 In every EQBD model instance, the length of all instances of 1331 entsoe:ConnectivityNode.fromEndName shall not exceed IO_NAME_LENGTH 1332 characters. 1333 1334 Justification: 1335 See IEC TS 61970-600-1:2017 B.7 1336 1337 Message: 1338 Length of name attribute exceeds IO NAME LENGTH characters 1339 1340 Rule: TNFromEndNameLength Level: 3 Severity: ERROR Template: RuleObject 1341 1342 Details: 1343 In every TPBD model instance, the length of all instances of 1344 entsoe:TopologicalNode.fromEndName shall not exceed IO_NAME_LENGTH 1345 characters. 1346 1347 Justification: 1348 See IEC TS 61970-600-1:2017 B.7 1349 1350 Message: 1351 Length of name attribute exceeds IO NAME LENGTH characters 1352 1353 Rule: CNToEndNameLength Level: 3 Severity: ERROR Template: RuleObject 1354 1355 Details: 1356 In every EQBD model instance, the length of all instances of 1357 entsoe:ConnectivityNode.toEndName shall not exceed IO_NAME_LENGTH 1358 characters. 1359 1360 Justification: 1361 See IEC TS 61970-600-1:2017 B.8 1362 1363 Message: 1364 Length of name attribute exceeds IO NAME LENGTH characters 1365 Rule: TNToEndNameLength Level: 3 Severity: ERROR Template: RuleObject 1366 1367 1368 Details: 1369 In every TPBD model instance, the length of all instances of 1370 entsoe:TopologicalNode.toEndName shall not exceed IO_NAME_LENGTH 1371 characters. 1372 1373 Justification: 1374 See IEC TS 61970-600-1:2017 B.8 1375 1376 Message: 1377 Length of name attribute exceeds IO_NAME_LENGTH characters 1378 1379 Rule: CNFromEndNameTsoLength Level: 3 Severity: ERROR Template: RuleObject 1380 1381 Details: 1382 In every EQBD model instance, the length of all instances of

Page 47 of 115





1383		<pre>entsoe:ConnectivityNode.fromEndNameTso shall not exceed IO_NAME_LENGTH </pre>
1384		characters.
1385		
1386		
1387		See IEC IS 61970-600-1:2017 B.9
1388		
1389		Message:
1390		Length of name attribute exceeds IO_NAME_LENGTH characters
1391		
1392	Rule:	TNFromEndNameTsoLength Level: 3 Severity: ERROR Template: RuleObject
1393		
1394		Details:
1395		In every TPBD model instance, the length of all instances of
1396		entsoe:TopologicalNode.fromEndNameTso shall not exceed IO_NAME_LENGTH
1397		characters.
1398		
1399		Justification:
1400		See IEC TS 61970-600-1:2017 B.9
1401		
1402		Message:
1403		Length of name attribute exceeds IO NAME LENGTH characters
1404		
1405	Rule:	CNToEndNameTsolength level: 3 Severity: ERROR Template: RuleObject
1406		
1407		Details
1408		In every FORD model instance, the length of all instances of
1/00		entsoe:ConnectivityNode toEndNameTso shall not exceed TO NAME LENGTH
1403		chapactons
1410		
1411 1410		Justification
1412		JUSTITICATION: See TEC TS (1070, 600, 1, 2017, \mathbf{P} 10
1413		See IEC 13 01970-000-1:2017 B.10
1414 1415		Magaza
1410		Message:
1410		Length of name attribute exceeds IO_NAME_LENGTH characters.
1417		See rule for value of IO_NAME_LENGIH.
1418		
1419	Rule:	INTOEndNameIsoLength Level: 3 Severity: ERROR Template: RuleObject
1420		
1421		Details:
1422		In every TPBD model instance, the length of all instances of
1423		entsoe:TopologicalNode.toEndNameTso shall not exceed IO_NAME_LENGTH
1424		characters.
1425		
1426		Justification:
1427		See IEC TS 61970-600-1:2017 B.10
1428		
1429		Message:
1430		Length of name attribute exceeds IO_NAME_LENGTH characters
1431		
1432	Rule:	ShuntCompensatorSensitivity Level: 3 Severity: ERROR Template: RuleObject
1433		
1434		Details:
1435		The following attribute value shall be greater than zero
1436		- cim:ShuntCompensator.voltageSensitivity
1437		
1438		Justification:

Page 48 of 115



1439 Decision from 2018-11-09 CGM BP/EMF meeting. 1440 It was concluded that a negative value is not physically possible. 1441 1442 Message: 1443 VoltageSensitivity attribute value shall be greater than zero. 1444 1445 Rule: NumberOfSubstations Level: 3 Severity: WARNING Template: RuleObject 1446 1447 Details: 1448 The following number of cim:Substations in an IGM are considered suspicious 1449 - a single cim:Substation which is the min limit. 1450 - one cim:Substation per cim:VoltageLevel which is the max limit. 1451 The upper limit for the number of cim:Substations equals the number of 1452 Cim:VoltageLevels. 1453 1454 Justification: 1455 The number of cim:Substations should reflect the design of the power system. 1456 1457 Message: The number of cim:Substations does not reflect the design of the power system. 1458 1459 1460 Rule: GenerationContainment Level: 3 Severity: ERROR Template: RuleObject 1461 1462 Details: 1463 For every instance of cim:HydroPump and cim:GeneratingUnit (and subclasses 1464 thereof), the cim:Equipment.EquipmentContainer referred to, 1465 must be of type cim:Substation. Missing containment is not allowed. 1466 1467 Justification: 1468 See Figure 15 (Core notes) of IEC TS 61970-600-2 section 6.7.11. 1469 1470 Message: 1471 cim:HydroPump and cim:GeneratingUnit must be contained in a cim:Substation 1472 1473 Rule: PTContainment Level: 3 Severity: ERROR Template: RuleObject 1474 1475 Details: 1476 For every instance of cim:PowerTransformer, the 1477 cim:Equipment.EquipmentContainer referred to, must be of type 1478 cim:Substation or of type cim:DCConverterUnit. Missing containment is not allowed. 1479 1480 Justification: 1481 See Figure 15 (Core notes) and Figure 5 (diagram DCContainment) 1482 of IEC TS 61970-600-2 sections 6.7.11 and 6.3.9. 1483 1484 Message: 1485 A cim:PowerTransformer must be contained in a cim:Substation 1486 or a cim:DCConverterUnit 1487 1488 Rule: SwitchContainment Level: 3 Severity: ERROR Template: RuleObject 1489 1490 Details: 1491 For every instance of Switch (and subclasses thereof), the 1492 cim:Equipment.EquipmentContainer referred to, must be of type 1493 VoltageLevel, of type Bay or of type DCConverterUnit. 1494 Missing containment is not allowed.

Page 49 of 115





1495		
1496		Justification:
1497		See Figure 15 (Core notes) and Figure 5 (diagram DCContainment)
1498		of TEC TS 61970-600-2 sections 6.7.11 and 6.3.9
1499		
1500		Message
1500		Switches must be contained in a Voltagelevel a Bay on a DCConventerUnit
1501		Switches must be contained in a voitagelever, a bay of a beconverteronit
1502	Bulot	SCContainment Loval, 2 Sovenity, EPBOR Template, BuleObject
1503	Ruie.	Secontariament Lever. 5 Sevenity. Error Temprate. Rureobject
1504		Detailer
1505		Decidits.
1500		For every instance of cim.seriescompensator, the
1507		cimiequipment.EquipmentContainer referred to, if provided, must be of
1506		type cimiline, of type cimivoltagelevel of of type cimibclonverteronit.
1509		
1510		
1511		See Figure 15 (diagram Core notes) in section 6.7.1 of IEC IS 61970-600-2,
1512		Figure 5 (diagram DCContainment) in section 6.3.1 of IEC IS 61970-600-2
1513		and section 6.9.16 of IEC TS 61970-600-2
1514		
1515		Message:
1516		A cim:SeriesCompensator can only be contained in a cim:Line, a cim:VoltageLevel
1517		or a cim:DCConverterUnit.
1518		
1519	Rule:	InjectionContainment Level: 3 Severity: ERROR Template: RuleObject
1520		
1521		Details:
1522		For every instance of cim:EnergyConsumer subclasses, cim:RotatingMachine
1523		subclasses, cim:ShuntCompensator subclasses, cim:EnergySource,
1524		cim:EquivalentShunt, cim:ExternalNetworkInjection and cim:StaticVarCompensator,
1525		the cim:Equipment.EquipmentContainer referred to, must be of type
1526		cim:VoltageLevel. Missing containment is not allowed.
1527		
1528		Justification:
1529		See 6.10.10, 6.7.6 of IEC TS 61970-600-2
1530		
1531		Message:
1532		Injections must be contained in a cim:VoltageLevel
1533		
1534	Rule:	BusbarSectionContainment Level: 3 Severity: ERROR Template: RuleObject
1535		
1536		Details:
1537		For every instance of cim:BusbarSection, the cim:Equipment.EquipmentContainer
1538		referred to, must be of type cim:VoltageLevel. Missing containment is not allowed.
1539		
1540		Justification:
1541		See Figure 15 (diagram Core notes) of IEC TS 61970-600-2 section 6.10.5.
1542		
1543		Message:
1544		A cim:BusbarSection must be contained in a cim:VoltageLevel
1545		-
1546	Rule:	EFCContainment Level: 3 Severity: ERROR Template: RuleObject
1547		
1548		Details:
1549		For every instance of cim:EarthFaultCompensator and subclasses and cim:Ground,
1550		the cim:Equipment.EquipmentContainer referred to, must be of type

Page 50 of 115





1551		cim:VoltageLevel. Missing containment is not allowed.
1552		
1553		Justification:
1004		See Figure 15 (diagram core notes) of iec 15 61970-600-2 Section 6.7.6.
1555		Message
1550		ressage. A cim:EarthEaultCompensator must be contained in a cim:VoltageLevel
1558		
1559	Rule:	JunctionContainment Level: 3 Severity: ERROR Template: RuleObject
1560		, , , , , , , , , , , , , , , , , , ,
1561		Details:
1562		For every instance of cim:Junction (Equipment Boundary file), the
1563		cim:Equipment.EquipmentContainer referred to, must be of type cim:Line.
1564		Missing containment is not allowed.
1565		
1566		
1567		See section 4.4.5 of IEC IS 61970-600-2
1560		Message
1505		A cimelunction must be contained in a cimeline
1571		A clim. Sunction must be concurred in a clim. Line
1572	Rule:	ACDCConvContainment Level: 3 Severity: ERROR Template: RuleObject
1573		
1574		Details:
1575		For every instance of cim:CsConverter and cim:VsConverter, the
1576		cim:Equipment.EquipmentContainer referred to, must be of type
1577		cim:DCConverterUnit. Missing containment is not allowed.
1578		
1579		JUSTITICATION: See section ()) of IFC IS (1070, 600,)
1500		See Section 6.3.2 of IEC 13 61970-600-2
1582		Message:
1583		A cim:ACDCConverter must be contained in a cim:DCConverterUnit
1584		
1585	Rule:	DCEQContainment Level: 3 Severity: ERROR Template: RuleObject
1586		
1587		Details:
1588		For every instance of cim:DCSeriesDevice, cim:DCShunt, cim:DCBusbar, cim:DCGround,
1589		cim:DCChopper, cim:DCSwitch, cim:DCBreaker and cim:DCDisconnector, the
1590		cim:Equipment.EquipmentContainer referred to, must be of type
1591		cim:Dcconverterunit. Missing containment is not allowed.
1592		Justification:
1594		See section 6.3.2 of TEC TS 61970-600-2
1595		
1596		Message:
1597		All DC equipment, except cim:DCLineSegment must be contained in a
1598		cim:DCConverterUnit
1599		
1600	Rule:	CNContainment Level: 3 Severity: ERROR Template: RuleObject
1601		
1602		Detalls: For cim:ConnectivityNedes according to 50, the
1604		run commectivityNode ConnectivityNodeContainen nefenned to must be
1605		of type cim:Voltagelevel, cim:Bay or cim·line
1606		For cim:ConnectivityNodes according to EOBD, the
		, ,

Page 51 of 115





1607 cim:ConnectivityNode.ConnectivityNodeContainer referred to, 1608 must be of type cim:Line. Missing containment is not allowed. 1609 1610 Justification: 1611 See Figure 1 (diagram EquipmentBoundaryProfile), figure 15 (diagram 1612 Core Notes), section 6.7.7 of IEC TS 61970-600-2 1613 1614 Message: 1615 cim:ConnectivityNode must be contained in a cim:VoltageLevel, cim:Bay 1616 or cim:Line for EQ models and in a cim:Line for Boundary points 1617 1618 Rule: CNTerminals Level: 3 Severity: WARNING Template: RuleObject 1619 1620 Details: 1621 cim:ConnectivityNodes that: 1622 - are isolated and do not have any Terminals connecting to equipment. 1623 - have one Terminal that connect to a dead equipment end. 1624 1625 Justification: Isolated or dead end cim:ConnectivityNodes may indicate a connectivity issue. 1626 1627 1628 Message: 1629 Isolated or dead end ConnectivityNodes may indicate a connectivity issue 1630 1631 Rule: GeneratingUnitNominalP Level: 3 Severity: WARNING Template: RuleObject 1632 1633 Details: 1634 According to CGMES the value of cim:GeneratingUnit.nominalP should be positive 1635 and less or equal to cim:RotatingMachine.ratedS. 1636 1637 Justification: 1638 See section 6.6.5 of IEC TS 61970-600-2 1639 1640 Message: 1641 cim:GeneratingUnit.nominalP outside allowed range 1642 1643 Rule: CEBaseVoltage Level: 3 Severity: ERROR Template: RuleObject 1644 1645 Details: 1646 All cim:ConductingEquipment except cim:ACLineSegment, cim:EquivalentBranch 1647 and cim:PowerTransformer must either have an association with cim:BaseVoltage 1648 or be located within a cim:VoltageLevel or cim:Bay. 1649 If both are set the cim:VoltageLevel's cim:BaseVoltage must equal 1650 that of the cim:ConductingEquipment. cim:ConductingEquipment at a boundary 1651 may not have a cim:BaseVoltage assigned before merge with the boundary, hence 1652 they are checked in rule BranchBaseVoltage at level 5. 1653 1654 Justification: 1655 See section 6.7.6 and 6.10.2 of IEC TS 61970-600-2 1656 1657 Message: 1658 cim:ConductingEquipment must be with cim:BaseVoltage via cim:VoltageLevel, 1659 cim:Bay or direct link to cim:BaseVoltage 1660 1661 Rule: NominalVoltage Level: 3 Severity: ERROR Template: RuleObject 1662

Page 52 of 115



1663 1664 1665		Details: For every instance of cim:BaseVoltage, the cim:BaseVoltage.nominalVoltage value must be greater than zero.
1666 1667 1668 1669		Justification: See section 6.7.3 of IEC TS 61970-600-2
1670 1671 1672		Message: Nominal voltage must be greater than zero
1673 1674	Rule:	InstancesOfGeneralClass Level: 3 Severity: ERROR Template: RuleObject
1675		Details:
1676		The most specific and detailed class shall in general be instantiated.
1677		Hence more general classes shall not be instantiated. The following classes
1678		are specifically noted as not allowed to instantiate
1679		- cim:EnergyConsumer
1680		
1681		Justification:
1682		The level of detail described by the more specific class are needed in studies.
1683		The approved methodologies:
1684		CGMM-v1-plus.Article 9, Load, 4(c) (as well CGMM-v2-plus.and CGMM-v3 referencing
1685		to CGMM-v1-plus) and GLDPM-v1: Article 2, Definitions and interpretation,
1686		point 3 and 7, Article 11, 4(9) (as well GLDPM-v2.referencing to GLDPM-v1) foresee
1687		the provision of conforming and non-conforming load flag as well as approved EMF
1688		Requirements.which implies the use specific classes of EnergyConsumer.
1689		IEC 61970-600-1:2017.Common Grid Model Exchange Specification.pdf, 5.1
1690		General constraints, GENC11: Instance data to be exchanged must make use of the
1691		most detailed class possible within a profile, i.e.
1692		using sub-typed classes rather than general classes e.g. NuclearGeneratingUnit
1693		instead GeneratingUnit. specify it as mandatory for application.
1694		Note that this rule is not applied for GeneratingUnit.
1695		
1696		Message:
1697		Instances of type cim:EnergyConsumer is not an allowed, the use of
1698		its subclasses is mandatory
1699	_	
1700	Rule:	TerminalCount1 Level: 3 Severity: ERROR Template: RuleObject
1701		
1702		Details:
1703		Every instance of cim:RegulatingCondEq and its subclasses, cim:EnergyConsumer
1704		and its subclasses, cim:Equivalentinjection, cim:EquivalentShunt, subclasses of
1705		cim:Lonnector and cim:EarthFaultCompensator, cim:EnergySource, cim:Ground,
1700		cim:DCBusbar, cim:DCSnunt, cim:DCGround and subclasses of cim:DCConverterUnit
1707		shall only be referenced via a single cim:Terminal instance
1700		Justification
1709		JUSTITICATION:
1710		one cim: Conducting Equipment with a single electrical connection point shall only have
1710		
1712		Meccade
1714		Single terminal devices must not be referenced by multiple terminals
1715		Single community devices must not be referenced by mutciple community
1716 1717	Rule:	TerminalCount2 Level: 3 Severity: ERROR Template: RuleObject
1718		Details:

Page 53 of 115





1719 1720 1721 1722 1723		Every instance of cim:Conductor and its subclasses, cim:Switch and its subclasses, cim:ACLineSegment, cim:SeriesCompensator, cim:EquivalentBranch, cim:DCLineSegment, cim:DCSeriesDevice, cim:DCSwitch and cim:DCChopper, shall only be referenced via exactly two cim:Terminal instances
1724 1725 1726 1727		Justification: cim:ConductingEqupment with two electrical connection point shall have two cim:Terminals
1728 1729 1720		Message: Two terminal devices must be referenced by exactly two terminals
1730 1731 1732	Rule:	TerminalSeqNum Level: 3 Severity: ERROR Template: RuleObject
1733		Details:
1734 1735 1736		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.
1737		Justification:
1739 1740		See section 6.7.21 and 6.10.31 of IEC TS 61970-600-2
1741		Message:
1742 1743 1744		or a cim:ACLineSegment with cim:MutualCoupling
1745 1746	Rule:	TerminalSeqNumOrder Level: 3 Severity: ERROR Template: RuleObject
1747 1748 1749 1750 1751 1752		Details: For every instance of cim:ConductingEquipment and cim:DCConductingEquipment of which its terminal(s) have a cim:Terminal.sequenceNumber, at least one sequenceNumber must be equal to 1 and any following sequenceNumber shall be increased by one.
1753 1754 1755		Justification: See section 6.7.2 of IEC TS 61970-600-2
1756 1757 1758		Message: Invalid sequenceNumber for cim:Terminal
1759 1760	Rule:	PTTerminalConsistency Level: 3 Severity: ERROR Template: RuleObject
1761		Details:
1762 1763 1764		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
1765 1766		cim:PowerTransformerEnd.PowerTransformer association.
1767 1768 1769		Justification: See section 6.9.31 of IEC TS 61970-600-2
1770 1771		Message: Terminals for PowerTransformers must be defined unambiguously
1772 1773 1774	Rule:	MCFirst Level: 3 Severity: ERROR Template: RuleObject

Page 54 of 115



1775 1776		Details: Every instance of cim:MutualCoupling.First_Terminal must belong to an
1777 1778		cim:ACLineSegment.
1779		Justification:
1780 1781		See section 6.9.19 of IEC TS 61970-600-2
1782		Message:
1783 1784		<pre>cim:MutualCoupling.First_Terminal must link to a cim:ACLineSegment cim:Terminal</pre>
1785 1786	Rule:	MCSecond Level: 3 Severity: ERROR Template: RuleObject
1787		Details:
1788		Every instance of cim:MutualCoupling.Second_Terminal must belong to an
1789 1790		cim:ACLineSegment.
1791		Justification:
1792 1793		See section 6.9.19 of IEC TS 61970-600-2
1794		Message:
1795 1796		<pre>cim:MutualCoupling.Second_Terminal must link to a cim:ACLineSegment cim:Terminal</pre>
1797 1798	Rule:	LRCExponentModel Level: 3 Severity: ERROR Template: RuleObject
1799		Details:
1800		For every instance of cim:LoadResponseCharacteristic with
1801		<pre>cim:LoadResponseCharacteristic.exponentModel is true,</pre>
1802		cim:LoadResponseCharacteristic.pVoltageExponent and
1803		cim:LoadResponseCharacteristic.qVoltageExponent must be provided and
1804 1805		be greater or equal than zero and less or equal to two.
1806		Justification:
1807 1808		See section 6.10.9 of IEC TS 61970-600-2
1809		Message:
1810		Exponent of per unit voltage effecting real and reactive power must be
1811 1812		<pre>specified if cim:LoadResponseCharacteristic.exponentModel is true</pre>
1814	Rule:	LCRCoefficientModel Level: 3 Severity: ERROR Template: RuleObject
1815		
1816		Details:
1817		For every instance of cim:LoadResponseCharacteristic with
1818		cim:LoadResponseCharacteristic.exponentModel is false,
1819		cim:LoadResponseCharacteristic.pConstantImpedance and
1820		cim:LoadResponseCharacteristic.pConstantCurrent and
1821		cim:LoadResponseCharacteristic.pConstantPower and
1822		cim:LoadResponseCharacteristic.qConstantImpedance and
1023		cim:LoadResponseCharacteristic.qConstantCurrent and
1024 1925		cimicoauxesponsecharacteristic.qconstantPower must be provided.
1020		Justification
1827		See section 6 10 9 of TEC TS $61070-600-2$
1828		See Section 0.10.9 OF TEC 13 01970-000-2
1829		Message:
1830		Coefficients for ZIP load model must be specified

Page 55 of 115





1831 1832 Rule: LCRCoefficientParameters Level: 3 Severity: ERROR Template: RuleObject 1833 1834 Details: 1835 For every instance of cim:LoadResponseCharacteristic with 1836 cim:LoadResponseCharacteristic.exponentModel is false, the sum of 1837 cim:LoadResponseCharacteristic.pConstantImpedance and 1838 cim:LoadResponseCharacteristic.pConstantCurrent and 1839 cim:LoadResponseCharacteristic.pConstantPower values must be 1 and 1840 the sum of cim:LoadResponseCharacteristic.qConstantImpedance and 1841 cim:LoadResponseCharacteristic.qConstantCurrent and 1842 cim:LoadResponseCharacteristic.qConstantPower values must be 1. 1843 1844 Justification: See section 6.10.9 of IEC TS 61970-600-2 1845 1846 1847 Message: Invalid coefficient parameters for cim:LoadResponseCharacteristic 1848 1849 Rule: MeasTerminal Level: 3 Severity: ERROR Template: RuleObject 1850 1851 1852 Details: 1853 For every instance of cim:Measurement, the cim:Terminal reference by 1854 cim:Measurement.Terminal must belong to the same cim:PowerSystemResource 1855 as referenced in cim:Measurement.PowerSystemResource. 1856 1857 Justification: 1858 See section 6.5.18 of IEC TS 61970-600-2 1859 1860 Message: 1861 The measurement terminal must belong to the same PSR the measurement 1862 belongs to 1863 1864 Rule: MeasType Level: 3 Severity: ERROR Template: RuleObject 1865 1866 Details: 1867 For every instance of cim:Measurement, the value of 1868 cim:Measurement.measurementType is limited to 'ThreePhasePower', 'ThreePhaseActivePower', 'ThreePhaseReactivePower', 'LineCurrent', 1869 'PhaseVoltage', 'LineToLineVoltage', 'Angle', 'TapPosition', 1870 'SwitchPosition'. 1871 1872 1873 Justification: See section 6.5.18 of IEC TS 61970-600-2 1874 1875 1876 Message: 1877 Invalid measurement type 1878 1879 Rule: MeasUnit Level: 3 Severity: ERROR Template: RuleObject 1880 1881 Details: 1882 For every instance of cim:Measurement, the value of 1883 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', 1884 1885 1886 'cim:UnitSymbol.none'.

Page 56 of 115



1887		
1888		Justification:
1889		See section 6.5.18 of IEC TS 61970-600-2
1890		
1891		Message:
1892		Invalid measurement unit symbol
1893		
1894	Rule:	CATieFlow Level: 3 Severity: ERROR Template: RuleObject
1895		
1896		Details:
1897		For every instance of cim:ControlArea for which the value of
1898		cim:ControlArea.type is cim:ControlAreaTypeKind.Interchange,
1899		cim:TieFlow instances must be provided.
1900		
1901		Justification:
1902		This is necessary to compute interchange.
1903		, , , , , , , , , , , , , , , , , , ,
1904		Message:
1905		cim·TieElows must be defined for cim·ControlArea no cim·TieElows found
1906		
1007	Pulo	TangatDR Loval: 2 Sovenity: EPPOR Template: BuleObject
1000	Ruie.	Talgetob Level. 5 Severity. Ennon Tempiate. Ruleobject
1900		Deteiler
1909		
1910		For every instance of cim:RegulatingControl (SSH) for which the value of
1911		cim:RegulatingControl.discrete is true and cim:RegulatingControl.enabled
1912		is true, cim:RegulatingControl.targetDeadband must be provided and must be > 0
1913		
1914		Justification:
1915		If cim:RegulatingControl.discrete is set to true and no deadband
1916		is provided the power flow algorithm may not reach a solution but may continue
1917		to try find one which results in hunting.
1918		
1919		
1920		Message:
1921		Target deadband must be provided if the regulating control is discrete and active
1922		
1022	Rulo	OperationallimitValue Level: 3 Severity: ERROR Template: RuleObject
1020	Nuic.	operationallimitevalue level. 5 Severity. Ennon Tempiace. Naicobject
1025		Detailet
1920		Decalls.
1920		For every instance of cim.voltageLimit, the value of cim.voltageLimit.value
1927		must be > 0. For every instance of cim:currentLimit, the value
1928		of cim:currentLimit.value must be > 0. For every instance of
1929		cim:ActivePowerLimit, the value of cim:ActivePowerLimit.value must be > 0.
1930		For every instance of cim:ApparentPowerLimit, the value of
1931		cim:ApparentPowerLimit.value must be > 0.
1932		
1933		Justification:
1934		See section 6.8.5 of IEC TS 61970-600-2
1935		
1936		Message:
1937		OperationalLimit values must be positive
1938		
1939	Rule:	AcceptableDuration Level: 3 Severity: ERROR Template: RuleObiect
1940		· · · · · · · · · · · · · · · · · · ·
1941		Details:
1942		The use of the attribute acceptable cim:OperationalLimitType.acceptableDuration

Page 57 of 115



1943 1944		<pre>depends on the value of the entsoe:OperationalLimitType.limitType attribute as follows</pre>
1045		natl: accontableDunation is not used
1046		- patt, acceptableDupation is not used as the limit is loss that the natl limit
1940		- part, acceptableDuration is not used as the limit is ress that the part limit
1947		- tall; acceptableDuration is used as the limit is greater that the path limit
1940		- tc; acceptableDuration is not used as immediate tripping is expected
1949		- tot; acceptableDuration is used as the limit is less than the to limit and
1950		describe how long the violation may sustain before tripping.
1951		It acceptableDuration duration is not used the attribute can be completely omitted
1952		or if included the acceptableDuration value shall be ignored.
1953		
1954		Justification:
1955		See section 6.8.9.1 and 6.8.7 of IEC TS 61970-600-2.
1956		
1957		Message:
1958		OperationalLimitType.acceptableDuration missing for non PATL limit.
1959		
1960	Rule:	OperationalLimitSetAtTerminal Level: 3 Severity: WARNING Template: RuleObject
1961		
1962		Details:
1963		A cim:OperationalLimitSet shall be linked to a cim:Terminal, not the equipment.
1964		Any or all cim:Terminals in case of multiple terminal equipment may be used.
1965		This rule applies to all equipment regardless of its number of cim:Terminals.
1966		
1967		Justification:
1968		The limits in question are related to power flow, hence they are
1969		linked to the cim:Terminal.
1970		Less options also simplifies data exchange.
1971		
1972		Message:
1973		The OperationalLimitSet should not be linked to the Equipment but to a Terminal.
1974		
1975	Rule:	PATL1 Level: 3 Severity: ERROR Template: RuleObject
1976		
1977		Details:
1978		Every instance of cim:ACLineSegment and cim:SeriesCompensator,
1979		that is not aggregated, shall have at least one
1980		cim:OperationalLimitSet linked to one of its cim:Terminals.
1981		A cim:OperationalLimitSet shall have at least one.
1982		cim:OperationalLimit of type entsoe:PATL.
1983		Equipment is aggregated when cim:Equipment.aggregate is present
1984		and set to 'true'.
1985		
1986		Justification:
1987		See section 6.8.7 of TEC TS 61970-600-2
1988		
1989		Message.
1990		PATL missing for cim·ACLineSegment or cim·SeriesCompensator
1991		
1992	Rule	PATL2 Level: 3 Severity: ERROR Template: RuleObject
1993		The Letter 5 Severity, Ennow rempiate, Natebolice
1994		Details:
1995		Every instance of cim:PowerTransformer, that is not aggregated shall have
1996		a single cim.OnerationallimitSet linked to one of its cim.Terminals and
1997		ontional vadditional cim.Operational imitSets linked to the other cim.Terminals
1998		A cim:OperationalLimitSet shall have at least one cim:OperationalLimit

Page 58 of 115



1999 of type entsoe:PATL. 2000 Equipment is aggregated when cim:Equipment.aggregate is present 2001 and set to 'true'. 2002 2003 Justification: See section 6.8.7 of IEC TS 61970-600-2 2004 2005 2006 Message: 2007 PATL missing for cim:PowerTransformer 2008 2009 Rule: PATL3 Level: 3 Severity: ERROR Template: RuleObject 2010 2011 Details: 2012 There shall be only one PATL limitType per cim:OperationalLimitSet and type 2013 cim:ActivePowerLimit 2014 - cim:CurrentLimit or cim:ApparentPowerLimit 2015 This means that an cim:OperationalLimitSet may have two PATL values one, for 2016 cim:CurrentLimit or cim:ApparentPowerLimit and one for cim:ActivePowerLimit. 2017 2018 Justification: 2019 See section 6.8.9.1 of IEC TS 61970-600-2 2020 2021 Message: 2022 Redundant PATL not allowed for OperationalLimitSet 2023 2024 Rule: PATL4 Level: 3 Severity: WARNING Template: RuleObject 2025 2026 Details: 2027 For an instance of cim:ACLineSegment or cim:SeriesCompensator the limit values 2028 of the same cim:OperationalLimitType.limitType shall not differ more than 2029 PATL_LIMIT_VALUE_DIFF between the two sides, e.g. a cim:CurrentLimit 2030 of type PATL. 2031 2032 Justification: 2033 Based on engineering practice. 2034 2035 Message: 2036 Differing limit values on two sides of the equipment above PATL LIMIT VALUE DIFF 2037 2038 Rule: PATL5 Level: 3 Severity: WARNING Template: RuleObject 2039 2040 Details: 2041 PATL type on voltage limits shall be ignored. 2042 2043 Justification: 2044 See section 6.8.9.1 of IEC TS 61970-600-2:2017 2045 2046 Message: 2047 PATL voltage limit is ignored 2048 2049 Rule: CNRequiredInEQOperations Level: 3 Severity: ERROR Template: RuleObject 2050 2051 Details: 2052 cim:ConnectivityNodes are required in operational models where the 2053 EQ Operation profile is specified in the header. 2054 The different kinds of models are described in IEC TS 61970-600-1:2017 PROF4.

Page 59 of 115



2055 2056		Justification:
2057		See section 6.7.7 and rules PROF4 and PROF5 of IEC TS 61970-600-1:2017.
2058		Message
2060 2061		Reference to Connectivity node missing in Terminal for operational model.
2062	Rule:	ReactiveControlAtBus Level: 3 Severity: ERROR Template: RuleObject
2064		Details:
2065		A cim:RegulatingControl or cim:TapchangerControl doing reactive
2066		<pre>power control (cim:RegulatingControl.mode = reactivePower and powerFactor)</pre>
2067		require that the controlled cim:Terminal is in a path
2000		Hence doing reactive nower control on a cim:BusharSection cim:Terminal is
2003		not possible.
2071		
2072		Justification:
2073		General physics. See IEC TS 61970-600-1:2017 section E.12.
2074		Magazza
2075		Message: Reactive nower cannot be controlled on cim:BusharSection cim:Terminal
2070		
2078	Rule:	EnergySourceVoltage Level: 3 Severity: ERROR Template: RuleObject
2079		
2080		Details:
2081 2082		For cim:EnergySource the attributes voltageMagnitude and voltageAngle are optional to include in EQ. The attributes are intended for the
2083		case when a strong network is providing power to a weak
2084		distribution network. Hence it is wrong to use these attributes
2085		in transmission studies and they shall not at all be used.
2000		Justification:
2088		The use case for that attributes not appropriate for transmission.
2089		See IEC TS 61970-600-1:2017 section E.19.
2090		Management
2091		Message: The use case for cim:EnergySource attributes veltageMagnitude
2092		and voltageAngle is not allowed for transmission
2094		
2095	Rule:	ControlModeCompatibility Level: 3 Severity: ERROR Template: RuleObject
2096		
2097		Details:
2098		The cim:TapChangerControl can only do control compatible with its type,
2099		- A phase shift tap changer can only do the cim:RegulatingControl.mode
2100		- A ratio tap changer can only do the cim:RegulatingControl.modes
2102		- voltage
2103		- reactivePower
2104		- powerFactor
2105		- A cim:SynchronousMachine or cim:ShuntCompensator instance can only
2106 2107		ao the RegulatingControl.Modes
2107		- reactivePower
2109		- powerFactor
2110		- A cim:StativeVarCompensator can only do the RegulatingControl.modes

Page 60 of 115



2111 - voltage 2112 - reactivePower 2113 The following cim:RegulatingControl.modes are not at all allowed 2114 currentFlow 2115 - admittance - timeScheduled 2116 2117 - temperature 2118 Flow type of controls are not possible at cim:BusbarSection cim:Terminal. 2119 2120 Justification: 2121 Only meaningful combinations of data are allowed. 2122 2123 Message: 2124 cim:TapChangerControl or cim:RegulatingControl with invalid 2125 cim:RegulatingControl.mode. 2126 2127 Rule: ACLineSegmentR Level: 3 Severity: ERROR Template: RuleObject 2128 2129 Details: 2130 For every instance of cim:ACLineSegment the value of 2131 cim:ACLineSegment.r must be greater than or equal to zero 2132 2133 Justification: 2134 Negative resistance means negative losses. 2135 This is not allowed for real equipment 2136 2137 Message: 2138 Negative resistance not allowed for cim:ACLineSegment 2139 2140 Rule: ACLineSegmentX Level: 3 Severity: WARNING Template: RuleObject 2141 2142 Details: 2143 For every instance of cim:ACLineSegment the value of 2144 cim:ACLineSegment.x should be greater than or equal to EQ_BRANCH_X_LIMIT Ohm 2145 2146 Justification: 2147 Too small impedances cause numerical instability when 2148 solving the power flow. 2149 2150 Message: 2151 Reactance value should be greater than or equal to EQ BRANCH X LIMIT 2152 2153 Rule: SeriesCompensatorX Level: 3 Severity: WARNING Template: RuleObject 2154 2155 Details: 2156 For every instance of cim:SeriesCompensator the value of 2157 abs(cim:SeriesCompensator.x) should be greater than or equal to 2158 EQ_BRANCH_X_LIMIT Ohm 2159 2160 Justification: 2161 Too small impedances cause numerical instability when 2162 solving the power flow. 2163 2164 Message: 2165 Reactance value should be greater than or equal to EQ_BRANCH_X_LIMIT 2166

Page 61 of 115





2167 Rule: EquivalentBranchX Level: 3 Severity: WARNING Template: RuleObject 2168 2169 Details: 2170 For every instance of EquivalentBranch (EB) the value of absolute value for 2171 cim:EquivalentBranch.x and cim:EquivalentBranch.x21 should be greater 2172 than or equal to EQ_BRANCH_X_LIMIT Ohm. The absolute value is computed as sqrt(EB.x * EB.x + EB.x21 * EB.x21). 2173 2174 2175 Justification: 2176 Too small impedances cause numerical instability when 2177 solving the power flow. 2178 2179 Message: 2180 Reactance value should be greater than or equal to EQ BRANCH X LIMIT 2181 2182 Rule: DCLineSegmentR Level: 3 Severity: ERROR Template: RuleObject 2183 2184 Details: 2185 For every instance of cim:DCLineSegment the value of 2186 cim:DCLineSegment.resistance and the value of the associated 2187 cim:PerLengthDCLineParameter.resistance must be greater than zero. 2188 2189 Justification: 2190 Negative resistance means negative losses. 2191 This is not allowed for real equipment 2192 2193 Message: 2194 Negative resistance not allowed for cim:DCLineSegment 2195 2196 Rule: PowerTransformerEndR Level: 3 Severity: WARNING Template: RuleObject 2197 2198 Details: 2199 For cim:PowerTransformerEnds the following rules applies 2200 - two-winding transformer the high voltage end 2201 cim:PowerTransformerEnd.r shall be modelled at the high voltage side and 2202 be greater than EQ_BRANCH_X_LIMIT Ohm. 2203 - two-winding transformer shall be modelled at the low voltage side and should be 2204 zero (cim:PowerTransformerEnd.r = 0) 2205 - three-winding transformer all ends cim:PowerTransformerEnd.r should 2206 be greater than EQ_BRANCH_X_LIMIT Ohm. 2207 2208 Justification: 2209 Negative resistance means negative losses. 2210 This is not allowed for real equipment. 2211 2212 Message: 2213 PowerTransformerEnd resistance should be non-negative and greater than or 2214 equal to EQ_BRANCH_X_LIMIT 2215 2216 Rule: PowerTransformerEndRatedU Level: 3 Severity: WARNING Template: RuleObject 2217 2218 Details: 2219 The cim:PowerTransformerEnd.ratedU attribute must be greater than zero. 2220 2221 Justification: 2222 The cim:PowerTransformerEnd.ratedU attribute is used in pu calculations.

Page 62 of 115





2223		
2224		Message:
2225		cim:PowerTransformerEnd.ratedU should be greater than zero
2226		
2227	Rule:	PowerTransformerEndX Level: 3 Severity: WARNING Template: RuleObject
2220		Dete 11 -
2229		Details:
2230		For cim:PowerTransformerEnds the following rules applies
2231		- two-winding transformer the high voltage end
2232		cim:PowerTransformerEnd.x should have a non-zero value and
2233		should be greater than EQ_BRANCH_X_LIMIT Ohm
2234		- two-winding transformer the low voltage end
2235		cim:PowerTransformerEnd.x = 0
2236		 three-winding transformer all ends abs(cim:PowerTransformerEnd.x) should
2237		be greater than EQ_BRANCH_X_LIMIT Ohm
2238		
2239		Justification:
2240		Transformers with zero series reactance do not exist.
2241		At a two winding transformer the series reactance is specified
2242		at the high voltage side and the low voltage side isn't used.
2243		
2244		Message:
2245		PowerTransformerEnd reactance should be non-zero value greater than or equal
2246		to EQ_BRANCH_X_LIMIT for the two winding transformer high voltage end and
2247		zero for the two winding transformer low voltage end.
2248		For three winding transformers all ends should have a non-zero value and
2249		should be greater than or equal to EQ BRANCH X LIMIT
2250		
2251	Rule:	LinearShuntCompensatorG Level: 3 Severity: ERROR Template: RuleObject
2252		
2253		Details:
2254		For every instance of cim:LinearShuntCompensator the value of
2255		cim:LinearShuntCompensator.gPerSection must be greater than or
2256		equal to zero.
2257		
2258		Justification:
2259		The charging conductance represents the losses, which should
2260		he non-negative.
2261		be non negacirer
2262		Meccage.
2263		cim:LinearShuntCompensator gPerSection must be non-negative
2264		
2265	Rule	ShuntCompensatorSections Level: 3 Severity: FRROR Template: RuleObject
2266	nuic.	Shareeompensator sections level. S severity. Ennon remptate. Rateosjeet
2267		Detaile
2268		For every instance of cim:ShuntCompensator the value of
2200		cim:ShuntCompensator normalSections must be greater than on equal to zero
2209		and loss on equal to cim; ShuntComponention maximumSections
2270		and ress of equal to clm. Shuffcompensator. maximum sections.
2271		Justification
2212		Justification.
2213		which should be non-negative
2214		WITCH SHOUTD DE HOH-HEBALIVE.
2213		Mossago
2210		ricssage.
2211 2278		cim. Shuncompensator, normatsections outside attowed range
2210		

Page 63 of 115



2279 Rule: ConverterLosses Level: 3 Severity: ERROR Template: RuleObject 2280 2281 Details: 2282 For every instance of cim:CsConverter and cim:VsConverter, the value 2283 of cim:ACDCConverter.idleLoss, cim:ACDCConverter.switchingLoss and 2284 cim:ACDCConverter.resistiveLoss, if provided, must be greater than 2285 or equal to zero. 2286 2287 Justification: 2288 Losses cannot be negative 2289 2290 Message: 2291 Negative losses are not allowed for Converter, losses must 2292 be greater than or equal to zero 2293 2294 Rule: SVCRatings Level: 3 Severity: WARNING Template: RuleObject 2295 2296 Details: 2297 For every instance of cim:StaticVarCompensator, the value of 2298 cim:StaticVarCompensator.capacitiveRating must be positive. The 2299 value of cim:StaticVarCompensator.inductiveRating must be negative. 2300 Zero values are not allowed. 2301 2302 Justification: 2303 See IEC TS 61970-600-2:2017, section 6.9.44 2304 2305 Message: 2306 Capacitive rating should be greater than zero, inductive rating should 2307 be lower than zero for SVC 2308 2309 Rule: SVCSlope Level: 3 Severity: ERROR Template: RuleObject 2310 2311 Details: 2312 The cim:StaticVarCompensator.slope must be positive or zero. 2313 2314 Justification: 2315 The reactive power output of the SVC is proportional to the 2316 difference between the voltage at the regulated bus and the voltage setpoint. When the regulated bus voltage is equal to the voltage 2317 2318 setpoint, the reactive power output is zero. 2319 cim:RequlatingControl is used as it has capabilities missing from SVC, 2320 e.g. the controlled point. 2321 2322 Message: 2323 cim:StaticVarCompensator.slope must be positive or zero 2324 2325 Rule: GeneratingUnitLimits Level: 3 Severity: WARNING Template: RuleObject 2326 2327 Details: 2328 For every instance of cim:GeneratingUnit, cim:HydroGeneratingUnit, 2329 cim:NuclearGeneratingUnit, cim:SolarGeneratingUnit, cim:ThermalGeneratingUnit or 2330 cim:WindGeneratingUnit, the value of cim:GeneratingUnit.maxOperatingP must 2331 be greater than or equal to the value of cim:GeneratingUnit.minOperatingP. 2332 2333 Justification: 2334 The name plate ratings are used as a reference.

Page 64 of 115



2335 2336 2337 2338		Message: Invalid operating limits for cim:GeneratingUnit
2339 2340	Rule:	GeneratingUnitMaxPGen Level: 3 Severity: ERROR Template: RuleObject
2341		Details:
2342		For every instance of cim:GeneratingUnit, cim:HydroGeneratingUnit,
2343		cim:NuclearGeneratingUnit, cim:SolarGeneratingUnit, cim:ThermalGeneratingUnit or
2344		cim:WindGeneratingUnit, with cim:SynchronousMachine of type generator the value
2345 2346 2347		of cim:GeneratingUnit.maxOperatingP must be greater than or equal to zero. Note that the limits follow generation sign convention.
2348		Justification:
2349		The name plate ratings are used as a reference.
2350		
2351		Message:
2352		Invalid operating limit, cim:GeneratingUnit.maxOperatingP must
2353 2354		be greater than or equal to zero
2355 2356	Rule:	SynchronousCondenser Level: 3 Severity: ERROR Template: RuleObject
2357		Details:
2358		For a synchronous condenser there is no capability for real power output, the
2359		cim:SynchronousMachine is not required to be associated with a cim:GeneratingUnit.
2360		In this case, the type attribute must be set to condenser.
2301		Justification
2362		JUSLITICATION. The name plate ratings are used as a reference
2364 2365		See IEC TS 61970-600-2:2017, section 6.9.47.
2366		Message:
2367		A synchronous condenser shall not have a generating unit
2368		
2369 2370	Rule:	SMQLimits1 Level: 3 Severity: WARNING Template: RuleObject
2371		Details:
2372		For a cim:SynchronousMachine, the value of
2373		cim:SynchronousMachine.maxQ should be greater than or equal to the value
2374		of cim:SynchronousMachine.minQ, if provided.
2375		Note that the limits follow generation sign convention.
2376		
23/1		Justification
2370		JUSTITICATION:
2380		The name prace facings are used as a ferefence.
2381		Message:
2382		Invalid operating limits for Synchronous Machine
2383		
2384	Rule:	SMQLimits2 Level: 3 Severity: ERROR Template: RuleObject
2385		
2386		Details:
2387		For a cim:SynchronousMachine, either
2388 2389 2390		<pre>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</pre>

Page 65 of 115



2391		and cim:SynchronousMachine maxO shall be ignored
2392		and clim.synem onoushachine.maxy shall be ignored.
2393		Justification
2304		See TEC TS $61970_{-}600_{-}2.2017$ section 6.9 47
2305		See ile is 01970-000-2.2017, Section 0.9.47
2306		Mossago
2390		Missing openating limits for Sunchronous Machine
2391		MISSING OPERALING IIMILES FOR Synchronous Machine
2390	D1	Deted Level 2 Covertive EDDOD Templeter DuleObject
2399	Ruie:	Rateus Level: 3 Severity: ERROR Template: Ruleubject
2400		Dete: 1.
2401		
2402		cim:RotatingMachine.ratedS is required, cim:RotatingMachine.ratedS and
2403		cim:PowerTransfomerEnd.ratedS shall be greater than Zero.
2404		Justification:
2405		RatedS is required for data validation.
2406		See IEC TS 61970-600-2:2017, section 6.9.41.
2407		
2408		Message:
2409		Missing or zero ratedS
2410		
2411	Rule:	SMQLimits3 Level: 3 Severity: WARNING Template: RuleObject
2412		
2413		Details:
2414		For every instance of cim:SynchronousMachine with exactly one cim:GeneratingUnit
2415		the following rules applies
2416		- abs(maxP) Less or Equal ratedS
2417		- abs(minP) Less or Equal ratedS
2418		- abs(maxQ) Less or Equal ratedS
2419		- abs(minQ) Less or Equal ratedS
2420		where
2421		 maxP is cim:GeneratingUnit.maxOperatingP
2422		<pre>- maxQ is cim:SynchronousMachine.maxQ</pre>
2423		- minP is cim:GeneratingUnit.minOperatingP
2424		- minQ is cim:SynchronousMachine.minQ
2425		- ratedS is cim:RotatingMachine.ratedS
2426		U
2427		Justification:
2428		The limit values should be inside the rated capability.
2429		
2430		Message:
2431		Inconsistent cim:SynchronousMachine and cim:GeneratingUnit limits
2432		
2433		
2434		
2435	Rulo	SMPLimits Level: 3 Sevenity: WARNING Template: RuleObject
2436	Nuic.	Sin Limits Level. 5 Severity. Walking Template. Raieobjeet
2400		Details
2438		For a cim:SynchronousMachine with a cim:GeneratingUnit the active nower limits
2430		should relate to cim: Synchronous Machine type as follows
2433		- condenser
2440		cim:GeneratingUnit minOnenatingP = 0 and
2442		cim. GeneratingUnit mayOneratingP = 0 and $cim. GeneratingUnit mayOneratingP = 0$
2442		- generator or generatorOrCondenser
2773		- seneration of generation of condenser,
2444 2115		cim.GeneratingUnit.minoperatingP greater UP equal to 8 and
2740		- motor or motorOrCondenser
2770		

Page 66 of 115



2447		cim:GeneratingUnit.minOperatingP less than 0 and
2448		cim:GeneratingUnit.maxOperatingP less or equal to 0.
2449		- generatorOrMotor or generatorOrCondenserOrMotor,
2450		cim:GeneratingUnit.minOperatingP less than 0 and
2451		cim:GeneratingUnit.maxOperatingP greater than 0.
2452		
2453		Justification:
2454		The active nower limit values depend on the cim.SynchronousMachine type
2455		and this dependence need to be described
2456		
2450		Mossago
2401		Message.
2400		The active power limit values do not match the clm.synchronousmachine.type
2409	D 1	
2460	Rule:	CurveStyle Level: 3 Severity: ERROR Template: RuleObject
2461		
2462		Details:
2463		The cim:Curve.curveStyle enumerated value cim:CurveStyle.constantYValue
2464		is not allowed.
2465		
2466		Justification:
2467		The cim:CurveStyle.constantYValue gives too inaccurate
2468		compared with cim:CurveStvle.straightLineYValues.
2469		
2470		Message.
2471		The cim:CurveStyle constantVValue enumeration is not allowed
2477		The clim.cul vestyle.constantivatue enumeration is not allowed
2412	Bulot	PCCVV/alues Lovel: 2 Sovenity: EPPOP Template: BuleObject
2413	Ruie.	Receivatues Level. 5 Severity. Error Template. Ruleobject
2474		Dete (1)
2475		Details:
2476		For every instance of cim:curveData, for which the cim:curveData.curve
2477		refers to a cim:ReactiveCapabilityCurve, the cim:CurveData.y2value
2478		must be greater or equal than cim:CurveData.y1value.
2479		If cim:CurveData.y2value and cim:CurveData.y1value are equal for all
2480		curve points this is considered an error. It is not allowed that
2481		all CurveData.y2value values are equal to CurveData.y1value values.
2482		
2483		Justification:
2484		The name plate ratings are used as a reference.
2485		
2486		Message:
2487		Invalid reactive capability curve data
2488		· · · · · · · · · · · · · · · ·
2489	Rule	CurveXValues Level: 3 Severity: WARNING Template: RuleObject
2490	nuic.	eurvervarues lever, s severiey. White rempiace, hareobjeet
2400		Detaile
2400		Decalls.
2492		For every instance of cim.curveData, for which the cim.curveData.curve
2493		refers to a clm:ReactiveCapabilityCurve, the clm:CurveData.xvalue shall
2494		be different, e.g. in the case of two cim:CurveData called CD1 and CD2 the
2495		following shall give a warning when CD1.xvalue = CD2.xvalue.
2496		
2497		Justification:
2498		All x values in a reactive capability curve
2499		shall differ for the curve to be meaningful.
2500		
2501		Message:
2502		Some points in the reactive capability curve have the same x value

Page 67 of 115





2503 2504 2505	Rule:	RCCXValues2 Level: 3 Severity: ERROR Template: RuleObject
2506	nuize.	
2507		Details:
2508 2509		cim:CurveData instances depends on the attribute cim:SynchronousMachine.type
2510		as follows
2511		- condenser, one cim:CurveData instance with cim:CurveData.xvalue = 0.
2512		- generator or generatorOrCondenser, at least two cim:CurveData instances with
2513		cim:CurveData.xvalue greater or equal 0.
2514 2515		- motor or motororcondenser, at least two clm:CurveData instances with cim:CurveData xyalue less on equal 0
2516		- generatorOrMotor or generatorOrCondenserOrMotor, at least three cim:CurveData
2517		instances with at least
2518		one having cim:CurveData.xvalue greater or equal 0 and
2519		and one having cim:CurveData.xvalue less or equal 0.
2520		
2521		JUSTITICATION: A cim:PoactiveCanabilityCunve for a Rumn Stenage unit shall have
2522		at least three curve points Δ cim. Synchronous Machine operating as
2524		either motor or generator shall have at least two curve points. A
2525		cim:SynchronousMachine operating as condenser shall have at least one curve point.
2526		
2527		Message:
2528		Invalid number of curve points in reactive capability curve data
2529 2530	Pulo	PCCYValues2 Lovel: 2 Sevenity: EPPOP Template: PuloObject
2530	Ruie.	Recruatuess Level. 5 Severity. Error Temptate. Ruleobject
2532		Details:
2533		For every instance of cim:ReactiveCapabilityCurve, a cim:CurveData instance
2534		must exist with a value of cim:CurveData.xvalue that is greater than or equal
2535		to the cim:GeneratingUnit.minOperatingP of the cim:GeneratingUnit associated
2536		with the cim:SynchronousMachine to which the curve applies and a cim:CurveData
2538		than or equal to the cim.GeneratingUnit maxOperatingP of the cim.GeneratingUnit
2539		associated with the cim:SynchronousMachine to which the curve applies.
2540		
2541		Justification:
2542		A cim:ReactiveCapabilityCurve must stay within the maximum capability of the unit.
2543		Maggaga
2544		message. Invalid reactive canability curve data for cim:SynchronousMachine
2546		invaria reactive capability carve accarlor cim.synem onousnachine
2547	Rule:	RCCXValues4 Level: 3 Severity: WARNING Template: RuleObject
2548		
2549		Details:
2550		For every instance of cim:ReactiveCapabilityCurve, each cim:CurveData instance
2552		must satisty the tollowing relation _ v*v+v1*v1 E ratedS*ratedS and v*v+v2*v2 E ratedS*ratedS
2553		where
2554		- LE = less or equal
2555		- x= cim:CurveData.xvalue
2556		- y1 = cim:CurveData.y1value
2557		$-y_2 = cim:CurveData.y_2value$
2000		- raceus = cimikolalingmachine.raleus * (I + NUMERIC_IULEKANCE)

Page 68 of 115



2559		
2560		Justification:
2561		A cim:ReactiveCapabilityCurve must cover the full operating range.
2002		Mossago
2564		Thesage. Invalid reactive canability curve data for cim:SynchronousMachine
2565		
2566	Rule:	VSCYValues Level: 3 Severity: ERROR Template: RuleObject
2567		Deteiler
2000		Decalls:
2570		refers to a cim:VsCanabilityCurve the cim:CurveData v2value must
2571		be greater than cim:CurveData.v1value
2572		
2573		Justification:
2574		The name plate ratings are used as a reference.
2575		
2576		Message:
2577		Invalid cim:VsCapabilityCurve data
2578		
2579	Rule:	VSCXValues Level: 3 Severity: ERROR Template: RuleObject
2580		Detaile
2582		For every instance of cim:CurveData for which the cim:CurveData Curve
2583		refers to a cim.VSCanabilityCurve at least two instances of the
2584		cim:CurveData are associated.
2585		
2586		Justification:
2587		A curve consists of at least two curve points.
2588		
2589		Message:
2590		Invalid cim:VSCapabilityCurve data
2591	Bulat	PhaseCodeCround Loval, 2 Covenity, EPPOR Template, BulaChiest
2092	Ruie:	PhasecodeGround Level: 3 Severity: ERROR Template: Ruleobject
2595		Details
2595		Multiple conducting equipment is typically connected to the same
2596		cim:TopologicalNode via their cim:Terminals. The phase codes at the
2597		cim:Terminals must match the grounding equipment by having phase
2598		code N specified. No other phase codes are allowed, e.g. ABC is
2599		not allowed.
2600		Grounding equipment are
2601		- cim:PetersenCoil
2602		- cim:Ground
2603		- cim:Groundingimpedance
2604		combination of phases ABC on the equipment side
2606		combination of phases abe on the equipment side.
2607		Justification:
2608		Ohms and Kirchoffs laws.
2609		
2610		Message:
2611		Grounding equipment shall have phase code N only
2612		
2613	Dular	ControlAnonInstance Lovel, 2 Covenity, EDDOD Territor Dulcobiest
2014	ките:	CONTROLATED TISTANCE LEVEL: 3 SEVENITY: ERROR TEMPLATE: RULEUDJECT

Page 69 of 115





2615		
2616		Details
2617		Exactly one cim:ControlAnes instance with following attributes
2017		which he defined
2010		must be defined:
2619		- Cim:ControlArea.type is cim:ControlArealypeKind.Interchange
2620		- an entsoe:IdentifiedObject.energyIdentCodeEic where the third character is 'Y'.
2621		The code shall be verified against the enumeration list of ENTSO-E
2622		Energy Identification Codes (EIC) availble at the ENTSO-E web site.
2623		
2624		Justification:
2625		The cim:ControlArea of type interchange is the model equivalent of
2626		a SchedulingArea
2627		
2628		Μοςςοσο
2020		ricssage.
2029		CIMICONTROLATED INSTANCE IS MISSING OF HAS EFFOREOUS ALTERDULE VALUES
2630		
2631	Rule:	DCEquipmentContainerMapping Level: 3 Severity: ERROR Template: RuleObject
2632		
2633		Details:
2634		For each cim:DCConverterUnit and cim:DCLine instance an
2635		entsoe:IdentifiedObject.energyIdentCodeEic attribute has been defined,
2636		for which the third character is 'T'.
2637		
2638		Justification
2630		The manning of reference schedules for HVDC links is done via
2000		the EIC T codes. The EIC T code is also used to identify DC equipment
2040		the fit i codes. The fit i code is also used to identify be equipment
2641		containers that belong to the same HVDC pole.
2642		
2643		Message:
2644		EIC T code missing for cim:DCConverterUnit or cim:DCLine
2645		
2646	Rule:	RCandTCCcontrollingObjects Level: 3 Severity: WARNING Template: RuleObject
2647		
2648		Details:
2649		A cim:RegulatingControl or cim:TapChangerControl shall have at least one
2650		controlling object. The cardinality
2651		- cim·RegulatingControl[0 1]-[0 *]cim·RegulatingCondEq
2652		- cim:TanChangerControl[0 1]-[0 *]cim:TanChanger
2002		and cumpontly allowing no controlling objects
2000		are currently allowing no concrolling objects.
2004		
2000		
2656		A cim:RegulatingControl or cim:TapChangerControl without controlling objects
2657		cannot perform control.
2658		It is important for IGMs quality and CGM creation process to indicate
2659		these occurrences.
2660		
2661		Message:
2662		cim:RegulatingControl or cim:TapChangerControl without controlling objects
2663		
2664	Rule·	SMRatedSuprealistic Level: 3 Severity: WARNING Template RuleOhiect
2665	NULC.	Simulture current of severity, while the full interview
2666		Details
2000		VELAILS. If a cimeCunchronousMachina has a nated neuron way beyond the specifical
2007		IT a CIM.Synchronousmachine has a rated power way beyond the specified
2008		active and reactive limit values or way outside the reactive capability curve
2669		the rated power value is not realistic.
2670		A EQ_KAIEDS_REASONABILITY_FACTOR (RSRF) is used to determine if a rated power

Page 70 of 115



2671		is reasonable.
2672		To be realistic and reasonable the cim:RotatingMachine.ratedS shall if an active
2673		or reactive power limit is present be less than
2674		- max(abs(cim:SynchronousMachine.min0).
2675		abs(cim:SynchronousMachine max0)
2676		abs(cim:GononatingUnit_minOnonatingD
2070		abs(cim.Generating)):
2077		abs(CIM:GeneralingUnit.maxOperalingP))*KSKF
2678		- max(abs(CurveData.xvalue),
2679		abs(CurveData.y1value),
2680		abs(CurveData.y2value))*RSRF
2681		for all x, y1 and y2 values.
2682		
2683		Justification:
2684		Rated nowers may be given a large and unrealistic value that will impact other
2685		rules which may result in erroneous reporting by them
2000		rules which may result in erroneous reporting by them.
2000		M
2687		Message:
2688		Unrealistic cim:RotatingMachine.ratedS specified
2689		
2690	Rule:	TargetDeadbandOutOfRange Level: 3 Severity: WARNING Template: RuleObject
2691		
2692		Details:
2693		If the cim:RegulatingControl_targetDeadband has a value similar to the
2604		cim RegulatingControl tangetValue this means that it has no effect and
2034		that the cim: Pogulating Control is in practice disabled. Disabling a
2095		that the tim. Regulating control is in practice disabled. Disabiling a
2090		cim:RegulatingControl this way shouldn't be used, instead use the
2697		cim:RegulatingControl.enabled flag.
2698		cim:RegulatingControl.targetDeadband/EQ_DB_REASONABILITY_FACTOR
2699		should be less than the cim:RegulatingControl.targetValue.
2700		With a value of 2 for the EQ_DB_REASONABILITY_FACTOR this means that
2701		if the cim:RegulatingControl.targetDeadband is greater than twice the
2702		cim:RegulatingControl.targetValue this means that the target will always stay
2703		inside the dead hand.
2704		The rule is only activated when RegulatingControl discrete-"true"
2705		The full is only activated when Regulatingcontrollaristicted that .
2705		
2706		JUSTIFICATION:
2707		Using other ways than cim:RegulatingControl.enabled flag shouldn't be used.
2708		
2709		Message:
2710		cim:RegulatingControl has been potentially disabled with a large
2711		cim:RegulatingControl.targetDeadband
2712		
2713	Rule:	WindingConnectionAngle Level: 3 Severity: WARNING Template: RuleObject
2714	Nuic.	windingconnection, agie level, 5 Severity, waaring reapidee, adreobjeet
2715		Detailer
2710		
2/10		The cim:PhaseTapChangerAsymmetrical.windingConnectionAngle attribute in real
2/1/		grids can only have the following values
2718		- +/-150
2719		- +/-120
2720		- +/-90
2721		- +/-60
2722		- +/-30
2723		
2724		Justification
2725		Asymmetrical phase tan changers and huilt for one of the connection angles
2120		Asymmetrical phase cap changers are pulle for one of the connection digits
2120		TISTED IN DECALLS.

Page 71 of 115



2727		Message
2729 2730		Given cim:PhaseTapChangerAsymmetrical.windingConnectionAngle value is not real grid value
2731 2732 2733	Rule:	VoltageLimitDirection Level: 3 Severity: WARNING Template: RuleObject
2734 2735 2736 2737		Details: A cim:VoltageLimit should be specified with a direction high or low, i.e. the cim:OperatinalLimitType.direction value should be one of - cim:OperationalLimitDirectionKind.high
2738 2739		- cim:OperationalLimitDirectionKind.low
2740 2741 2742		Justification: If the direction is missing it is not possible to check the voltage value.
2743 2744		Message: cim:OperatinalLimitType.direction is missing
2745 2746 2747	Rule:	VoltageLimitsConsistency Level: 3 Severity: WARNING Template: RuleObject
2748 2749 2750 2751 2752		Details: cim:VoltageLimit within a given cim:OperationalLimitSet with direction cim:OperationalLimitDirectionKind.high should be greater than cim:VoltageLimit with direction cim:OperationalLimitDirectionKind.low.
2753 2754 2755 2756		Justification: cim:VoltageLimit not consistent with the specified direction are meaningless.
2757 2758 2750		Message: cim:VoltageLimit values are not consistent with the specified directions
2760 2761	Rule:	FlowLimitsDirectionConsistency Level: 3 Severity: WARNING Template: RuleObject
2762 2763 2764 2765 2766		Details: Branch flow limits cim:CurrentLimit, cim:ApparentPowerLimit and cim:ActivePowerLimit should have a cim:OperationalLimitType.direction with value cim:OperationalLimitDirectionKind.absoluteValue.
2767 2768 2769 2770		Justification: Branch flow can go in both directions on the branch. Hence the direction should be specified as an absoluteValue.
2771 2772 2773		Message: Branch flow limits with other direction than absoluteValue
2774 2775	Rule:	AsymmetricalEquivalent Level: 3 Severity: WARNING Template: RuleObject
2776 2777 2778 2779		Details: cim:EquivalentBranch with EquivalentBranch.r not qual to EquivalentBranch.r21 or EquivalentBranch.x not qual to EquivalentBranch.x21 shouldn't be used.
2780 2781 2782		Justification: Equivalents with different impedance in different directions may result in poor convergence, hence reporting the difference support error tracing in data.

Page 72 of 115




2783		
2784		Message:
2785		cim:EquivalentBranch with asymmetrical impedances
2786		
2787		
2788 2789	Rule:	PositiveTransformerB Level: 3 Severity: WARNING Template: RuleObject
2790		Details:
2791		Two-winding transformer with positive shunt (cim:PowerTransformerEnd.b > 0)
2792		that are not equivalenced (cim:Equipment.aggregate = false)
2793		shouldn't have positive PowerTransformerEnd.b.
2794		
2795		Justification:
2796		Two winding transformers are reactive and should not have
2797		positive cim:PowerTransformerEnd.b
2798		
2799		Message:
2800		Two winding transformer with positive shunt
2801		
2802	Rule:	SubLoadAreaMissing Level: 3 Severity: ERROR Template: RuleObject
2803	nuice.	
2804		Details
2805		The reference cim:LoadGroun-Scim:SubLoadArea is required. The class cim:LoadGroun
2806		in in FO core while cim:SubloadArea is in operation. Hence a BB model using
2807		classes cim: Conform ord and cim: NonConform ord will get an error if cim: SubloadArea
2808		instances are missing. As a CGM may contain both NR and BR models the
2000		condinality for the RR models need to be Q 1 but for the NR models 1
2009		This is solved by making the peference similardGroup ssimisubleadAper entional
2010		and have this nule checking that NP models de have the neferences
2011		and have this rule thetking that NB models do have the references.
2012		Justification
2013		This is a bug fix of COMESO 4 1E
2014		THIS IS A DUG TIX OF COMES2.4.15.
2010		Magazza
2010		Message.
2017		The reference cim;LoadGroup->cim;SubloadArea is missing
2818		
2819	Ruie:	EnergyAreamissing Level: 3 Severity: ERROR Template: RuleObject
2820		
2821		Details:
2822		The reference cim:ControlArea->cim:EnergyArea is required for NB models
2823		but not for BB models.
2824		
2825		Justification:
2826		Required for NB models according to diagram note in CGMES2.4.15.
2827		
2828		Message:
2829		The reference cim:ControlArea->cim:EnergyArea is missing
2830		
2831	Rule:	GeneratingUnitSM Level: 3 Severity: ERROR Template: RuleObject
2832		
2833		Details:
2834		A cim:GeneratingUnit or any of its subclasses is not allowed to have more
2835		than one cim:SynchronousMachine.
2836		
2837		Justification:
2838		Having more than one cim:SynchronousMachine with a cim:GeneratingUnit will make

Page 73 of 115



2839active and reactive limits dynamically dependent of the number of operational2840cim:SynchronousMachines which makes scheduling difficult as this information2841is missing.284228432843Message:2844A cim:GeneratingUnit is not allowed to have more than one cim:SynchronousMachine28452846

2847 6 LEVEL 4 VALIDATION: MODEL ASSEMBLY

2848 **6.1 INTRODUCTION**

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 meta data <md:Model.DependentOn> statements describe which instance models were used when the IGM was assembled, but the official ENTSO-E boundary files⁸ are always to be used for the validation and merging process, instead of any other referenced boundary set.

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

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's a reference to an identified object that should have a description in the assembly and, simply, doesn't.

⁸ 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)



2865 **6.2 FILE HEADERS – DEPENDENCIES**



2866

2867 Figure 7 Dependencies of CGMES model instances

Figure 7 is an easier to read version of the figure from PROF10 in IEC TS 61970-600-1 Ed 1.

The references in Figure 7 are required and rules for them has been implemented in section 6.4. IGMs may include references between CIMXML files other than the ones in Figure 7, such references are ignored.

2872 CGMES Individual Grid Models and Common Grid Models are exchanged in separate EQ instance 2873 files (model parts) which may be reused for multiple scenario times. Instance files may contain objects with associations to objects which will be packaged in a different instance file. This situation 2874 2875 means that the instance file by itself is 'incomplete' - it may have dangling references and cannot be used except when combined with one or more other instance file as specified in the file header 2876 2877 dependencies. When this occurs, validation for completeness can only be performed when all the 2878 parts are present. The md:Model.DependentOn role with multiplicity [0..*] in a CIMXML file header is used to list other CIMXML files that this CIMXML file depend on. This is explained in Annex C and 2879 2880 rule PROF10 of TS 61970-600-1:2017.

2881 For the Common Grid Model process, the boundary set is considered as reference data.

Page 75 of 115



2882 6.3 FILE HEADERS – GENERAL REQUIREMENTS

Model exchange typically involves the exchange of a collection of CIMXML files (model parts), each of which contains instance data, referred to as a model, and a header. The structure and semantics of each model are described by a profile, which is not included in the exchanged data. The exchange of CIMXMLfiles is governed by a collection of profiles described in IEC TS 61970-600 parts 1 and 2.

A header section describes the content of the model section contained in the CIMXML file e.g. the date the model was created, description etc. The header may also identify other models and their relationship to them. Such information is important when the models are part of a work flow where, for example, the models have relations to each other, e.g. a Supersedes and/or DependentOn referring to other CIMXML files. The Model class that has the above relations that are described in IEC 61970-552 Ed2.

The use of DependentOf and Supersedes for IGMs is shown in Figure 8. The figure is described in more detail further down in the document.



Supersedes axis and scenario time

2896 Figure 8 Use of DependentOn and Supersedes in IGMs

- 2897 Supersedes is restricted to the usecases
- Update of the same limit values multiple times.
- Complete replacement of SSH files at CGM creation.
- 2900 The relation between IGM and CGM files is shown by the example in Figure 9.
- 2901

Page 76 of 115

²⁸⁹⁵





2902

- 2903 Figure 9 Example of relations between IGM and CGM files
- Figure 9 show two IGMs to the left and one CGM that is merging the IGMs to the right.
- The header section shall always be the first element in a CIMXML document. The header section elements are:
- FullModel element
- DifferenceModel element
- The data in the model section following the header is defined by one or more profiles listed within the header.
- Elements or objects in a CIMXML file may have references to elements (objects or resources) in other CIMXML documents. The references are exemplified in Figure 8 and Figure 9 above.
- To use a CIMXML difference file it must be applied to the CIMXML file it Supersedes, i.e the difference description in the DifferenceModel element is applied to the superseded CIMXML file and the operations to apply are
- Addition of new objects
- Deletion of existing objects
- Update of attribute values

Page 77 of 115





These operations result in a new CIMXML file that contains the combination of superseding and the superseded files as shown in Figure 10.



DependentOn is described by non dashed arrows Supersedes is described by dashed arrows

2921

2922 Figure 10 Application of DIFF files

In Figure 10 the FullModel EQ file EQx is Superseded by the difference file EQDIFF. Applying the differences in EQDIFF result in a new EQ file EQy. EQy has the same meta data as EQDIFF which means the mRID, scenario time, description, profiles, MAS etc. are the same. Hence the DependentOn references from TP and SSH to the original EQDIFF are not affected and also work with the new EQy.

Figure 11 shows that the application of the Supersedes to the EQx file happens in the middleware (MW; OPDE in this case) which means that Receivers (see Figure 11, the Receiver is the client using CIMXML files, e.g. an RSC) don't need to bother with EQDIFF files nor the Supersedes reference.



2932

2933 Figure 11 Applying the EQDIFF at the middleware

In Figure 11 the EQDIFF file is transferred to the middleware (OPDE) where it is applied to the Superseded EQx file to create the EQy file. This is required also for the validation of the EQDIFF as the validation can only be made on the EQy file, not on the EQDIFF alone.

Page 78 of 115



2937 6.4 VALIDATION RULES

2938 2939	Rule:	TPBD->EQBD Level: 4 Severity: ERROR Template: RuleObject
2000		Details
2040		Eveny TDRD file shall have an 'md:Model DependentOn'
2042		notononco to the EOPD file
2942		
2943		
2944		Justification:
2945		IEC TS 61970-600-1:2017, requirement HREF2: "Dependent IDs refer to
2946		IDs of the dependent files at the time of the export".
2947		IEC TS 61970-600-1:2017, requirement PROF10.
2948		
2949		Message:
2950		Invalid md:Model.DependentOn statement(s) in TPBD
2951		
2952	Rule:	EO->EOBD Level: 4 Severity: ERROR Template: RuleObject
2953		
2954		Details:
2955		Every EO file shall have an 'md:Model DependentOn'
2000		reference to the FORD file that was used for the
2000		senialization
2951		
2900		Tustification
2959		JUSTITICATION:
2960		IEC IS 61970-600-1:2017, requirement HKEF2: Dependent IDS refer to
2961		IDs of the dependent files at the time of the export".
2962		IEC TS 61970-600-1:2017, requirement PROF10.
2963		
2964		Message:
2965		Invalid md:Model.DependentOn statement(s) in EQ
2966		
2967	Rule:	TP->EQ,TP->EQDIFF Level: 4 Severity: ERROR Template: RuleObject
2968		
2969		Details:
2970		Every TP file shall have an
2971		'md:Model.DependentOn' reference to a EQ or EQDIFF file.
2972		Note: This is a minimum requirement so more references may be present.
2973		
2974		Justification:
2975		TEC TS 61970-600-1:2017, requirement HREE2: "Dependent TDs refer to
2976		TDs of the dependent files at the time of the export".
2977		TEC TS 61970-600-1:2017 requirement PROF10
2078		11e 15 01570 000 1.2017, requirement ritorio.
2070		Massaga
2919		ressage.
2900		invalid mu.model.Dependenton statement(s) in TP
2901	D1	CCU + FO CCU + FODTEE Lawsle 4 Coursettur FDDOD Tampleter DulaObiest
2902	Ruie:	SSH->EQ,SSH->EQUIFF Level: 4 Severity: ERROR Template: Ruleubject
2983		Det e 11 e c
2984		Detalls:
2985		Every SSH file shall have an
2986		ma:moael.DependentUn reference to a EQ or EQDIFF file.
2987		Note: This is a minimum requirement so more references may be present.
2988		
2989		Justification:
2990		IEC TS 61970-600-1:2017, requirement HREF2: "Dependent IDs refer to

Page 79 of 115





2991 2992		IDs of the dependent files at the time of the export". IEC TS 61970-600-1:2017, requirement PROF10.
2993		M
2994 2995 2996		Message: Invalid md:Model.DependentOn statement(s) in SSH
2997 2998	Rule:	DY->EQ,DY->EQDIFF Level: 4 Severity: ERROR Template: RuleObject
2999		Details:
3000		Every DY file shall have an
3001		'md:Model.DependentOn' reference to a EQ or EQDIFF file.
3002 3003		Note: This is a minimum requirement so more references may be present.
3004		Justification:
3005		IEC TS 61970-600-1:2017, requirement HREF2: "Dependent IDs refer to
3006		IDs of the dependent files at the time of the export".
3007		IEC TS 61970-600-1:2017, requirement PROF10.
3008		
3009		Message:
3010		<pre>Invalid md:Model.DependentOn statement(s) in DY</pre>
3011		
3012 3013	Rule:	SV->SSH,SV->TP,SV->TPBD Level: 4 Severity: ERROR Template: RuleObject
3014		Details:
3015		Every SV file shall have 'md:Model.DependentOn' references to the files
3016		- SSH input files to the power flow calculation.
3017		- TP files with the power flow busses used in the power flow calculation.
3018		- TPBD files with the power flow busses in the boundary
3019		Note: This is a minimum requirement so more references may be present.
3020		
3021		Justification:
3022		IEC IS 61970-600-1:2017, requirement HREF2: "Dependent IDs refer to
3023		IDs of the dependent files at the time of the export".
3024		IEC IS 61970-600-1:2017, requirement PROF10.
3025		
3026		Message:
3027		Invalid md:Model.DependentOn statement(s), SV must have reference to IP, SSH
3028		and IPBD (used as input data for the power flow calculations)
3029	- 1	
3030	Rule:	GL->EQ,GL->EQBD Level: 4 Severity: ERROR Template: RuleObject
3031		
3032		Details:
3033		Every GL model file has 'md:Model.DependentOn'
3034		references to the EQ model file and EQBD model file that
3035		were used for the serialization. The reference to the EQ model file is required
3036		and EQBD model file is optional.
3037		Note: This is a minimum requirement so more references may be present.
3038		
3039		
3040		IEC IS 619/0-600-1:2017, requirement HREF2: "Dependent IDs refer to
3041		IDs of the dependent files at the time of the export".
3042		IEC IS 01970-000-1:2017, requirement PKUF10.
3043		Magaza
3044 2045		Message: Invalid marModel Dependent (n statement (s) () must have reference to 50
3040 2046		invalla maimodel.Dependention statement(s), or must have reference to EQ
3040		

Page 80 of 115





<pre>le: DL->EQ,DL->EQDIFF,DL->TP,DL->DY Level: 4 Severity: ERROR Template: RuleObjec</pre>
Details
Every DL file shall have 'md.Model DenendentOn'
references to the EO or EODIEE file the TP file and to
the DV file that were used for the serialization. The
notononco to the EQ model file is neguined and the notonocos to
TD and DV model files and entional
IP and DY model files are optional.
Note: This is a minimum requirement so more references may be present.
IEC IS 619/0-600-1:201/, requirement HREF2: "Dependent IDs refer to
IDs of the dependent files at the time of the export".
IEC IS 61970-600-1:2017, requirement PROF10.
Message:
Invalid md:Model.DependentOn statement(s), DL must have reference to EQ
le: EQDIFF-≻EQ Level: 4 Severity: ERROR Template: RuleObject
Details:
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.
The elements of the following types are allowed in the EQDIFF document
- cim:VoltageLimit
- cim:CurrentLimit
- cim:ActivePowerLimit
- cim:ApparentPowerLimit
This rule restricts use of difference models and is CGM_BP specific.
Justification:
IEC TS 61970-600-1:2017 annex C.2.
EMF meeting decision in Rome 2018-10-05.
Message:
Invalid md:Model.Supersedes statement(s), reference to EO only allowed
le: EODIFFOperationalLimit Level: 4 Severity: ERROR Template: RuleObiect
Details:
An FODIFE file is only allowed to contain subclasses of OperationalLimit.
This is a temporary solution for exchange of limit values in EO
that in the future will be in SHH.
This rule restricts use of difference models and is CGM BP specific
This full festillets use of ultrefence models and is calls, specifie,
Justification
$TEC TS 61070_600_1.2017 annex C 2$
EME meeting decision in Rome $2018_{-}10_{-}05$
FIL MEETINE ACCIDION IN NOME 2010-10-03.
Message
Not allowed CTM class in FODTEE file
NOC ATTOWCH CTU CTASS TH LUDTH ITTE
le: DanglingReference Level: 4 Severity: ERROR Template: RuleModel
Details:

Page 81 of 115





3103 3104 3105 3106 3107 3108 3109 3110		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). The mRID specified in every rdf:resource attribute in the assembly of cimxml instance files has been defined in an existing rdf:ID, rdf:about or enumeration.
3111 3112 3113 3114		Justification: See IEC TS 61970-600-1:2017 Requirement FBOD4
3115 3116 3117		Message: Dangling reference found
3118 3119	Rule:	IncorrectAttributeOrRoleCard Level: 4 Severity: ERROR Template: RuleModel
3120 3121 3122 3123		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.
3124 3125 3126 3127		Justification: See IEC TS 61970-600-1:2017 Requirement.PROF5 and PROF7.
3128 3129 3130 3131		Message: Cardinality violated for attribute or role, too many or too few values or references provided
3132 3133	Rule:	CgmSvSshVersionMismatch Level: 4 Severity: ERROR Template: RuleModel
3134 3135 3136 3137 3138 2120		Details: A CGM will have updated SSH files (referencing to original data by Supersede statement) for each IGM and a single SV file with the complete solution for the included IGMs. The updated SSH CIMXML files and the resulting CIMXML SV file should have the same
3139 3140 3141		- ma:Model.scenariorime. - a new md:Model.version number that is the same for the SV and SSH CIMXML files.
3142 3143 3144		In the case an IGM have invalid SV, SSH or TP CIMXML files for a md:Model.scenarioTime they will not be availalble from OPDM. These files may then be substituted with files having another md:Model.scenarioTime than
3145 3146 3147 3148		the time for which the study is made. The SSH and TP CIMXML files used in the replacement are given the md:Model.scenarioTime for the study which is different from the md:Model.scenarioTime in the original CIMXML files which is one reason for differences between md:Model.scenarioTimes.
3149 3150 3151 3152		Justification: Versioning of CGM is important for sustainable CGM building process.
3153 3154 3155		Message: Different fileVersion or effectiveDateTime in SSH and SV from CGM.



3156 **7** LEVEL 5 VALIDATION: CONSISTENCY OF ASSEMBLED MODEL

3157 **7.1 INTRODUCTION**

In this level, consistency between equipment characteristics in EQ and scenario data from the other instance data files is validated.

3160 **7.2 VALIDATION RULES**

3161 Rule: GeographicalRegionBD Level: 5 Severity: WARNING Template: RuleObject 3162 3163 Details: 3164 cim:GeographicalRegions should be agreed on by modeling authorities and be 3165 described in the equipment boundary. The cim:GeographicalRegion name should be 3166 the same as the modeling authority names described in level 1 rule 3167 ModelingAuthority. 3168 3169 Justification: 3170 cim:GeographicalRegion is used to organise equipment geographically and regions 3171 that corresponds to a network model managed by a TSO which is also the 3172 ModelingAuthority for the network. 3173 3174 Message: 3175 cim:GeographicalRegion not in boundary 3176 3177 Rule: GeographicalRegion Level: 5 Severity: ERROR Template: RuleObject 3178 3179 Details: 3180 An IGM shall have a single cim:GeographicalRegion. 3181 3182 Justification: 3183 cim:GeographicalRegion is used to organise equipment geographically and regions 3184 that corresponds to a network model managed by a TSO which is also the 3185 ModelingAuthority for the network. Each IGM shall be described by one cim:GeographicalRegion. 3186 See also IEC TS 61970-600-1 E.13. 3187 3188 3189 Message: 3190 More than one GeographicalRegion in IGM 3191 3192 3193 Rule: LineContainment Level: 5 Severity: ERROR Template: RuleModel 3194 3195 Details: 3196 For every instance of cim:ACLineSegment, the cim:Equipment.EquipmentContainer 3197 referred to, if provided, must be of type cim:Line 3198 Justification: 3199 3200 See Figure 15 (diagram Core notes) and 3201 section 6.9.16 of IEC TS 61970-600-2 3202 3203 Message: 3204 cim:ACLineSegments can only be contained in a cim:Line

Page 83 of 115





3205		
3206	Rule:	EquivalentInjectionContainment Level: 5 Severity: ERROR Template: RuleModel
3207		
3208		Details:
3209		Every cim:EquivalentInjection shall be contained by a
3210		- cim:VoltageLevel if not in a boundary point.
3211		- If in a boundary point, preferably it is contained in a cim: line or
3212		not contained at all with provided association to cim:BaseVoltage.
3213		
3214		Justification
3215		All equipment shall be contained also cim.EquivalentInjection but as it is
3216		allowed not to have cim:EquivalentInjection contained this is
3210		allowed for backwards compatibility
3218		See also TEC TS $61070_{-}600_{-}2 \in 7 \in 1000$
2210		See also ile 15 01970-000-2 0.7.0.
2219		Magazza
3220		Message.
2221		
3222		
3223	D1	DelinaContainment Lougle E Coupritur EDDOD Tampletor DuloMadal
3224	Ruie:	DCLINECONTAINMENT LEVEL: 5 Severity: EKKOR TEMPIATE: RUIEMODEL
3225		Det e 11 e c
3220		Details:
3227		For every instance of cim:Dulinesegment, the cim:Equipment.EquipmentContainer
3228		referred to, must be of type cim:DCLine. Missing containment is not allowed.
3229		
3230		Justification:
3231		See section 6.3.15 of IEC TS 61970-600-2
3232		
3233		Message:
3234		cim:DCLineSegment must be contained in a cim:DCLine
3235		
3236	_	
3237	Rule:	BaseVoltageNotInBoundary Level: 5 Severity: WARNING Template: RuleModel
3238		
3239		Details:
3240		All cim:BaseVoltages should be agreed on by modeling authorities and
3241		be in the boundary.
3242		If a matching base voltage is already in the boundary it
3243		should be used.
3244		If a matching base voltage is not in the boundary consider
3245		to add it in the boundary so that it can be reused by others.
3246		
3247		
3248		Justification:
3249		An agreement on the base voltages is required to get interoperability.
3250		Rule added at CGM_BP meeting in Zagreb 2019-05-23.
3251		
3252		Message:
3253		cim:BaseVoltage not in boundary
3254		
3255		
3256	Rule:	SVCVoltage Level: 5 Severity: ERROR Template: RuleModel
3257		
3258		Details:
3259		The control variables in an SVC are duplicate with
3260		RequlatingControl. The RequlatingControl values

Page 84 of 115





3261 are used, not the SVC values. The following values are used: 3262 RequlatingControl.targetValue, 3263 must be greater than zero if voltage control 3264 - RegulatingControl.enabled 3265 - RequlatingControl.mode 3266 - RequlatingControl.Terminal, for the controlled point 3267 3268 Justification: 3269 The reactive power output of the SVC is proportional to the 3270 difference between the voltage at the regulated bus and the voltage 3271 setpoint. When the regulated bus voltage is equal to the voltage 3272 setpoint, the reactive power output is zero. 3273 RequlatingControl is used as it has capabilities missing from SVC, 3274 e.g. the controlled point. 3275 See IEC TS 61970-600-2:2017, section 6.9.44 3276 3277 Message: 3278 The voltage set point for a SVC must be positive 3279 3280 3281 Rule: TapChangerNeutralU Level: 5 Severity: ERROR Template: RuleModel 3282 3283 Details: 3284 The cim:TapChanger.neutralU shall be the same as cim:PowerTransformerEnd.ratedU. 3285 3286 Justification: 3287 See section E.2.2. of IEC TS 61970-600-1:2017 3288 3289 Message: 3290 The neutralU differs from ratedU 3291 3292 Rule: ControlLinkedToTopology Level: 5 Severity: WARNING Template: RuleModel 3293 3294 Details: 3295 The controlled cim:Terminal at a cim:RegulatingControl (RC) or 3296 cim:TapChangerControl (TCC) must be linkedto a cim:TopologicalNode (TN). 3297 In case cim:Switch cim:Terminals are not included in TP and if the 3298 controlled point is a cim:Switch cim:Terminal the controlled point is lost. The cardinality for cim:Terminal.TopologicalNode is 1 so it is required, 3299 3300 hence all cim:Terminals must be present in TP regardless of the type of 3301 conducting equipment, it is linked to. 3302 This rule shouldn't be needed if all cim:Terminals where present in TP. 3303 3304 Justification: 3305 If a RC or TCC is not linked to a TN the changes in the control variables will not 3306 affect the target value in the power flow calculation. 3307 See section E.12 of IEC TS 61970-600-1:2017. 3308 3309 Message: 3310 Terminal controlled by cim:RegulatingControl or cim:TapChangerControl is not 3311 linked to a cim:TopologicalNode 3312 3313 Rule: BranchBaseVoltage Level: 5 Severity: ERROR Template: RuleModel 3314 3315 Details: 3316 Every instance of cim:ACLineSegment or cim:EquivalentBranch

Page 85 of 115





3317		must have an association cim:ConductingEquipment.BaseVoltage.
3318		Every PowerTransformerEnd must have an association with
3319		cim:TransformerEnd.BaseVoltage.
3320		
3321		Justification
2221		Subscripting $(7, 6, 6, 10, 42, 6, 12, 2)$ and $(10, 2)$ and $(10, 2)$ and $(10, 2)$
3322		See Section 6.7.6, 6.10.42, 6.12.2 and 6.10.207 let 15 61970-600-2
3323		
3324		Message:
3325		ACLineSegment, EquivalentBranch, SeriesCompensator or PowerTransformerEnd
3326		has no BaseVoltage
3327		5
3338	Pulo	Equivalent Triaction Control Enabled Lovel: E Sovenity: WARNING Template: PuloMedel
2220	Nuie.	Equivalentifijettioncontrollhabied Level. 5 Severity. Wakning Template. Kulehouel
2229		
3330		Details:
3331		Boundary cim:EquivalentInjections should have control disabled
3332		and cim:EquivalentInjection.regulationCapability should be false.
3333		An cim:EquivalentInjection may have control enabled only if it represents an
3334		HVDC converter.
3335		cime Equivalent Injections that are result of network reduction may have control
2226		analidatif se noolistis postive neven limits shall be provided
3330		enabled, it so realistic reactive power filmers shall be provided.
3331		Note: An HVDC Boundary Point has a cim:identifiedobject.description
3338		attribute equal to 'HVDC'
3339		
3340		Justification:
3341		Excessive reactive resources do not properly reflect power system behaviour.
3342		
33/3		Massaga
2243		ressage.
3344		Boundary cim:Equivalentinjections representing Ac networks should
3345		not control voltage
3346		
3347	Rule:	NoLTCTapChangerControl Level: 5 Severity: WARNING Template: RuleModel
3348		
3349		Details:
3350		If cim TanChanger ltcElag is false no TanChangerControl object is
2251		nofenenced by circletterbangen TarchangenControl
0050		referenced by clim. Tapchanger. Tapchanger. Control.
3352		
3353		Justification:
3354		See section E.9.3. of IEC TS 61970-600-1:2017
3355		
3356		Message
3357		TanchangerControl found for Tanchanger sten that cannot be changed under load
2250		Tapenanger control round for Tapenanger.step that cannot be changed under roud
3330	D 1	
3359	Ruie:	SVTapStepInstances Level: 5 Severity: ERROR Template: RuleModel
3360		
3361		Details:
3362		A cim:SvTapStep instance is expected for all cim:TapChanger instances
3363		defined in FO
3364		
3365		Justification:
3305		
3300		See section E.9.3. Of IEC IS 619/0-600-1:201/
3367		
3368		Message:
3369		Missing SvTapStep for TapChanger
3370		- · · · · ·
3371	Rule	SvPowerElowInstances Level: 5 Severity: FRROR Template: RuleModel
3372		enter and a second so second y enter a second y enter a second seco
0012		

Page 86 of 115



3373		Details:
3374		cim:SvPowerElow class is required to be instantiated for the following classes:
3375		sublactor of the sim-PotatingMachine
2276		subclasses of the clinit for a clinit
3370		- Subclasses of the climitenergyconsumer
3377		- cim:Equivalentinjection
3378		- cim:ExternalNetworkInjection
3379		- cim:ShuntCompensator
3380		- cim:StaticVarCompensator
3381		- cim:EnergySource.
3382		
3383		Justification:
3384		See section 9.5.4 of TEC TS 61970_600_2
3385		
2202		Maggaga
3300		message.
3387		Missing SvPowerFlow for Equipment
3388		
3389		
3390	Rule:	SvPowerFlowBranchInstances Level: 5 Severity: ERROR Template: RuleModel
3391		
3392		Details:
3393		For a boundary cim.TopologicalNode to be complete it shall have
3304		one cim Equivalent Injection and one branch connected
2205		Branches of the following twee may connect
3395		Branches of the following types may connect
3396		- cim:ACLineSegment
3397		- cim:PowerTransformer
3398		- subtypes of cim:Switch. A cim:Switch shall be retained.
3399		Branches may have one cim:TieFlow connected to the branch
3400		cim:Terminal at the boundary point.
3401		Note: The cim:EquivalentInjection has an cim:SvPowerFlow according to
3402		rule SvPowerFlowInstances. Hence the branch flow can be picked
3403		un from the cim.SyPowerElow with the sign changed
3404		up from the cimportower in with the sign changes.
2405		Justification
3405		Justification.
3406		The branch flows are used to check that the interchange match the tie flows.
3407		See BPPL1 of IEC IS 61970-600-1:2017.
3408		
3409		Message:
3410		The boundary cim:TopologicalNode is incomplete and is missing at least
3411		one of the following
3412		- a branch, e.g. cim:AClineSegment, cim:PowerTransformer or cim:Switch
3413		a TieFlow linked to the branch present if the branch is a tie flow
3/1/		- an cimitalentInjection
2414		
3413	D 1	
3416	Ruie:	SVPOWErFlowBranchinstances2 Level: 5 Severity: WARNING Template: RuleModel
3417		
3418		Details:
3419		Branches should have cim:SvPowerFlow instantiated at its cim:Terminals for
3420		the following branch classes:
3421		- cim:SeriesCompensator
3422		- cim:AClineSegment
3423		- cim:PowerTransformer
3424		- cim:Switch where cim:Switch netained is thus
3125		$CIM_{SWITCH} WHELE CIM_{SWITCH} I CCAINCUIS UC_{C}$
0420		Tustification
3420		JUSTITICATION:
3427		ine power tiow result for branches cannot be reviewed without cim:SvPowerFlow.
3428		This is needed when solutions for the same IGM or CGM computed by different

Page 87 of 115

European Network of Transmission System Operators for Electricity



3429		tools are compared.
3430		Note that computing the flows by scripts based on solved voltages may not
3431		give the same result as the original power flow.
3432		
3433		Message:
3434		Missing cim:SyPowerElow for branch
3/35		
2/26	Bulot	Disconnected Tenminal Lovel: E Sevenity: EPROP Template: BuleMedel
2420	Ruie.	DISCONNECCEUTERNILINAL LEVEL. 5 SEVENICY. EKKOK TEMPIACE. KULENDUEL
0401 0400		Deteiler
3430		Details:
3439		If the associated cim:lerminal.connected status is false, the flow
3440		specified in the cim:SvPowerFlow.p and cim:SvPowerFlow.q shall be zero
3441		
3442		Justification:
3443		See section 9.5.4. of IEC TS 61970-600-2
3444		
3445		Message:
3446		Zero flow expected for disconnected terminal
3447		
3448	Rule:	TopologicalIslandInstance Level: 5 Severity: ERROR Template: RuleModel
3449		
3450		Details:
3451		In case a solved model is exchanged for a single MAS the state variables
3/52		nofile must include at least one instance of cim:TopologicalIsland
3/52		profile muse include at least one instance of clm. Topologicalistand
3450		Justification:
2455		Substitute to E of TEC TS 61070 600 1.2017
2455		See Section E.0 01 IEC 13 01970-000-1.2017
2450		Magazza
3437		Message.
3430		Missing cim: Topologicalistand
3459	D1	Consider and the second the MADNING Templeter DuleMadel
3460	Ruie:	Smalllopologicalistand Level: 5 Severity: WARNING Template: RuleModel
3461		
3462		Details:
3463		A small cim:TopologicalIsland with TNs having zero voltage is in most cases
3464		meaningless and should not be exchanged.
3465		A cim:TopologicalIsland with three or fewer cim:TopologicalNodes is small.
3466		
3467		Justification:
3468		A small cim: Topological Island is typically not energized and does not contribute
3469		to the interconnected network solution. The number of three cim:TopologicalNodes
3470		as a small island is selected to cath disconnected three winding transformers.
3471		
3472		Message:
3473		Small cim:TopologicalIsland found
3474		
3475	Rule:	SlackNode Level: 5 Severity: WARNING Template: RuleModel
3476		
3477		Details.
3478		For every cim:TopologicalIsland the
3470		cim·TopologicalIsland AngleRefTopologicalNode should refer to the
3/20		cim.TopologicalNode with a cim.SynchronousMachine baying the highest
2/01		cim. Topological Node with a clim. Synchronous Machine Having the Highest
2401		A not included in clock node determination
3482		- v not included in slack node determination.
3483		- 1 15 THE NIGHEST.
3484		- 2 and on are decreasing priorities. If no cim:SynchronousMachine with

Page 88 of 115





3485 cim:SynchronousMachine.referencePriority specified is available the 3486 cim:TopologicalIsland.AngleRefTopologicalNode can be set to any 3487 cim:TopologicalNode. 3488 3489 Justification: 3490 See section E.4 of IEC TS 61970-600-1:2017 3491 If different power flow solutions have the same angle reference 3492 for the same network solutions are easier to compare. 3493 If not, the linear offset is to be expected. 3494 3495 Message: 3496 A cim:SynchronousMachine with valid ReferencePriority exists 3497 but is not used for defining the angle reference node in topological island 3498 3499 Rule: SwitchTerminals Level: 5 Severity: ERROR Template: RuleModel 3500 3501 Details: 3502 For every instance of cim:Switch, cim:Breaker, cim:Disconnector, 3503 cim:GroundDisconnector, cim:LoadBreakSwitch and cim:ProtectedSwitch, 3504 it is not allowed to have its cim: Terminals connected to the 3505 same cim:ConnectivityNode. 3506 3507 Justification: 3508 See section E.17 of IEC TS 61970-600-1:2017 3509 3510 Message: 3511 A switch cannot have its terminals connect the same cim:ConnectivityNode 3512 3513 Rule: SwitchVL Level: 5 Severity: ERROR Template: RuleModel 3514 3515 Details: 3516 For every instance of cim:Switch, cim:Breaker, cim:Disconnector, 3517 cim:GroundDisconnector, cim:LoadBreakSwitch and cim:ProtectedSwitch, 3518 it is not allowed to connect cim:ConnectivityNode or cim:TopologicalNode 3519 in different cim:VoltageLevels. 3520 3521 Justification: 3522 See section E.17 of IEC TS 61970-600-1:2017 3523 3524 Message: 3525 A cim:Switch cannot connect to cim:ConnectivityNodes or cim:TopologicalNodes 3526 in different cim:VoltageLevels 3527 3528 Rule: SwitchTN1 Level: 5 Severity: ERROR Template: RuleModel 3529 3530 Details: 3531 For every instance of cim:Switch, cim:Breaker, cim:Disconnector, 3532 cim:GroundDisconnector, cim:LoadBreakSwitch and cim:ProtectedSwitch, 3533 with cim:Switch.retained is true, 3534 its cim:Terminals shall be associated with different cim:TopologicalNodes. 3535 3536 Justification: 3537 See section E.17 of IEC TS 61970-600-1:2017 3538 3539 Message: 3540 Retained cim:Switch cim:Terminals cannot be associated with the same

Page 89 of 115



3541 cim:TopologicalNode 3542 3543 Rule: SwitchOpenVsConnected Level: 5 Severity: ERROR Template: RuleModel 3544 3545 Details: 3546 A cim:Terminal has switching capability due to the attribute 3547 cim:ACDCTerminal.connected flag. 3548 Equipment can be disconnected with this flag. For switches this means 3549 it is possible the break the conducting path at three places 3550 - cim:ACDCTerminal.connected side 1 3551 - cim:Switch.open 3552 - cim:ACDCTerminal.connected side 2 3553 Evaluating switch status then means inspecting the three flags for every switch. 3554 The attribute cim:Switch.open shall not conflict with the 3555 cim:Terminal connected statuses, hence the 3556 attribute cim:ACDCTerminal.connected shall always be true for instances 3557 of cim:Switches or its subclasses. 3558 3559 Justification: A user need not consider cim:ACDCTerminal.connected. 3560 3561 3562 Message: 3563 cim:ACDCTerminal.connected is not true for a cim:Switch 3564 3565 Rule: ParticipatingGeneratingUnit Level: 5 Severity: WARNING Template: RuleModel 3566 3567 Details: 3568 This rule applies when generation slack is used. As 3569 cim:GeneratingUnits do not have a link with cim:ControlArea generation 3570 slack can only be used for IGMs. cim:GeneratingUnits that pick-up mismatch shall have a cim:GeneratingUnit.normalPF 3571 3572 greater than 0. At least one such unit is required in every electrical island. 3573 3574 Justification: 3575 GeneratingUnits cannot pick-up mismatch if this data is unspecified. 3576 3577 Message: 3578 No GeneratingUnit with NormalPF > 0 in Island 3579 3580 Rule: ControlOfAnotherIsland Level: 5 Severity: WARNING Template: RuleModel 3581 3582 Details: A cim:RegulatingControl or cim:TapChangerControl is controlling a 3583 3584 cim:TopologicalNode in another cim:TopologicalIsland than its 3585 controlling equipment is located. 3586 3587 Justification: 3588 There is no feedback loop to the control in this case. 3589 3590 Message: 3591 A controlled cim:TopologicalNode is in another cim:TopologicalIsland 3592 than the controlling equipment 3593 3594 Rule: TapChangerTargetRange Level: 5 Severity: WARNING Template: RuleModel 3595 3596 Details:

Page 90 of 115





3597		A tap changer cannot reach a cim:RegulatingControl.targetValue outside its
3598		capability.
3599		The tap changer upper capability limit in per unit is
3600		- TCUC = 1+cim:RatioTapChanger.stepVoltageIncrement/100*
3601		(cim:TapChanger.highStep-cim:TapChanger.neutralStep)
3602		The tap changer lower capability limit in per uit is
3603		- TCLC = 1-cim:RatioTapChanger.stepVoltageIncrement/100*
3604		(cim:TapChanger.neutralStep-cim:TapChanger.lowStep)
3605		The TCUC and TCLC are in per unit (PU)
3606		The target value in PU is TargetValuePU =
3607		cim:RegulatingControl.targetValue/cim:BaseVoltage.nominalVoltage
3608		where the cim:BaseVoltage is from the controlled Terminal.
3609		The rule is
3610		- min(TCLC,TCHC) GreaterOrEqual TargetValuePU LessOrEqual max(TCLC,TCHC)
3611		Note1: The cim:TapChanger.controlEnabled and
3612		cim:RequlatingControl.eanbled flags are to be considered.
3613		Note2: cim:TapChangerControlMode shall be set to voltage control.
3614		
3615		Justification:
3616		The transformer cannot meet the requested target value.
3617		
3618		Message:
3619		The cim:RegulatingControl.targetValue outside the cim:TapChanger
3620		capability
3621		
3622	Rule:	IDuniqueness Level: 5 Severity: ERROR Template: RuleModel
3623		
3624		Details:
3625		All mRIDs (rdf:ID or rdf:about) in a model shall
3626		be unique.
3627		
3628		
3629		All mkibs (rdf:1D or rdf:about) shall be globally uniqe
3030		as stated in IEC 61970-552.
3031		See IEC 15 61970-600-1:2017 GENCI.
3032		Managan
3033		Message:
3034		WKID (Pat: D or Pat: about) not unique within model
3035	D1	TCCDemeteDepetiveEleve Level, E. Covenitive LADNING Templeter DuleMedel
2627	Ruie:	ICCREMOTEREACTIVEFIOW LEVEL: 5 Severity: WARNING TEmplate: RuleModel
2620		Detailer
2620		Decidits.
2640		A clm. Tapenanger control (TCC) controlling reactive power flow is only
2640		allowed to control the flow at one of the clm; renminals belonging
2642		co cim:Power(ranstormerenus in the cim:Power(ranstormer where the
2642		Control a nemete cimeTenminal net belonging to the cimeBevenThancformen
2643		with the cim:TanChangen is not allowed
2645		Note: A negult of this is that multiple simiTanChangens samet he
2645		controlled by the came TCC
3640		concrotied by the same rcc.
3648		Justification:
3649		A nower transformer cannot efficiently control reactive nower flow
3650		other than on its own terminals
3651		other than on It's own terminals.
3652		Message.
0002		1.0550BC1

Page 91 of 115





3653		A cim:TapChangerControl for reactive power flow is controlling a
3654		<pre>cim:Terminal that is not connected to one of the cim:PowerTransformerEnd(s)</pre>
3655		
3656	Rule:	SynchronousCondenserMode Level: 5 Severity: WARNING Template: RuleModel
3657		
3658		Details:
3659		For a synchronous condenser (cim:SynchronousMachine.type = condenser)
3660		there is no capability for real power output.
3661		In this case, the cim:SynchronousMachine.operationMode should be condenser.
3662		
3663		Justification:
3664		The name plate ratings are used as a reference
3665		See IEC TS 61970-600-2:2017, section 6.9.47.
3666		
3667		Message:
3668		A synchronous condenser should have cim:SynchronousMachine.operatingMode
3669		set to condenser
3670		

3671 8 LEVEL 6 VALIDATION: IGM AND CGM PLAUSIBILITY

3672 **8.1 INTRODUCTION**

3673 In this category, the focus is on identifying modelling assumptions in scenarios that impact 3674 convergence behaviour. From experience, the following root causes have been identified:

- Multiple electrical islands in an individual grid model;
- 3676 Insufficient voltage control capabilities;
- 3677 (Large) negative loads;
- Large reactive power values on PQ nodes;
- Unrealistic voltage target values (outside voltage limits of TSOs);
- Impact of cables not modelled (affects the power factor when performing load scaling);
- Low impedance equipment (short cables or low impedance transformers).

3682 **8.2 INDICATORS (AFTER LOAD FLOW CALCULATION)**

- Large slack node deviation value (active power).
- Solved state variables far from initial (complex) voltage values.
- Oscillation in voltage deviations during iterations.
- A lot of iterations needed before convergence tolerance is met.
- Multiple synchronous machines are bound (switched to PQ nodes).
- Mathematical solution cannot be found (diverging voltage deviations between iterations).

3689 **8.3 INTERPOLATION IN REACTIVE CAPABILITY CURVE**

3690 A reactive capability curve typically has at least two curve points. If an interpolation function is not 3691 available three possible aproximations are possible

Page 92 of 115



- 3692 1. Min of parwise negative Q values and max of parwise positive Q values, see Figure 12
- 3693 2. Mean value of parwise Q values, see Figure 13.
- 3694 3. Max of parwise negative Q values and min of parwise positive Q values, see Figure 14.

3695



3696

3697 Figure 12 Pairwise max Value

The corners in the boxes in Figure 12 represents the max positive or min negative reactive limit value of the two capability curve points covered by a box. This is option allows the largest deviation from the limit values. The reactive power at limit will always be greater than the capability curve limit.



3701

Page 93 of 115





3702 Figure 13 Parwise Mean Value

3703 For this option a reactive power at the limit may stay within the capability curve limit.



- 3704
- 3705 Figure 14 Pairwise Min Value
- For this is option a reactive power at the limit will always be inside the reactive capability curve.

3708 8.4 VALIDATION RULES

3709 Rule: SCSections Level: 6 Severity: ERROR Template: RuleModel 3710 3711 Details: 3712 For every instance of cim:ShuntCompensator, cim:LinearShuntCompensator and 3713 cim:NonLinearShuntCompensator, the value of cim:ShuntCompensator.sections 3714 should be lower than or equal to the value of 3715 cim:ShuntCompensator.maximumSections 3716 3717 Justification: 3718 3719 Message: 3720 Number of sections out of range 3721 3722 Rule: GenActivePowerInfeedLim Level: 6 Severity: WARNING Template: RuleModel 3723 Details: 3724 The negated value of cim:RotatingMachine.p should be smaller than or 3725 3726 equal to cim:GeneratingUnit.maxOperatingP and must be greater than or equal to cim:GeneratingUnit.minOperatingP of the associated generating 3727 3728 unit. 3729 Note1: Negation is necessary due to the load sign convention. 3730 Note2: A SM with cim:RotatingMachine.p = 0 is considered out of service.

Page 94 of 115





3731		
3732		Justification:
3733		Load sign convention is used for the nower infeed, whereas namenlate ratings are
373/		used for the operating limits
2725		used for the operating finites.
3735		Magazza
3/30		message:
3737		Generation active power infeed out of range
3738		
3739	Rule:	GenActivePowerInfeedDiffW Level: 6 Severity: WARNING Template: RuleModel
3740		
3741		Details:
3742		For every instance of cim:SynchronousMachine, the value of
3743		cim RotatingMachine n should not deviate more than SSH SV MAX P DIFE MW
3744		from the value of cim:SvDewenElow n for the accordated terminal
0745		Note that disconnected surplus machines should have some values in CCU
3745		Note that disconnected synchronous machines should have zero values in SSH.
3746		
3747		Justification:
3748		The SSH data should be based on a solved power flow (CGMM) and as a consequence,
3749		the values in SSH (input) and SV (calculation results) should not be far away.
3750		
3751		Message:
3752		Assumed generation infeed of cim.SynchronousMachine deviates from calculated
3753		generation infood more than SSH SV MAY D DIEE
0754		generation inteed more than SSH_SV_MAX_P_DIFF
3754		
3755	Rule:	GenActivePowerInteedDittE Level: 6 Severity: ERROR Template: RuleModel
3756		
3757		Details:
3758		The aggregated sum of the values of cim:RotatingMachine.p shall not
3759		deviate more than SSH SV TOT P DIFF MW from the aggregated sum of the values of
3760		cim:SvPowerFlow.p for the terminals connected to synchronous machines.
3761		Note that disconnected synchronous machines should have zero values in SSH
3762		
0702		
3/03		
3764		The SSH data shouldbe based on a solved power flow (CGMM) and as a consequence,
3765		the values in SSH (input) and SV (calculation results) should not be far away.
3766		
3767		Message:
3768		Assumed aggregated active power generation infeed deviates from calculated
3769		generation infeed more than SSH SV TOT P DIFF MW
3770		Perer action intera more chain portorit print and
2771	Dulot	ConPosetiveDowenInfoodDiffu Lovel: 6 Sevenity: WARNING Template: RuleModel
0770	Ruie.	denkeactivePowerinneedDiriw Level. 6 Severity. wakning remptate. Kulenouel
3//2		
3773		Details:
3774		For every instance of cim:SynchronousMachine, the value of
3775		cim:RotatingMachine.q should not deviate more than SSH_SV_MAX_Q_DIFF MVAr
3776		from the value of cim:SvPowerFlow.q for the associated terminal.
3777		Note that disconnected synchronous machines should have zero values in SSH.
3778		
3779		Justification
3780		Considering the Deven Eleverentings, the possible never shift
2704		considering the rower flow settings, the reactive power shift
3701		
3182		
3783		Message:
3784		Potential reactive power problem located for cim:SynchronousMachine, assumed
3785		reactive power generation of cim:SynchronousMachine deviates from calculated
3786		more than SSH_SV_MAX_Q_DIFF MVAr

Page 95 of 115





3787 3788 2780	Rule:	GenReactivePowerInfeedLim Level: 6 Severity: WARNING Template: RuleModel
2700		Deteiler
3790		Details.
3791		The reactive power provided to the network by a clm:synchronousmachine shall
3792		stay within limits regardless if it is controlling or not
3793		- negated cim:RotatingMachine.q greater or equal than cim:SynchronousMachine.minQ
3794		if provided
3795		 negated cim:RotatingMachine.q less or equal than cim:SynchronousMachine.maxQ
3796		if provided
3797		Note1: cim:RotatingMachine.q shall be negated due to the load sign convention.
3798		
3799		
3800		Justification:
3801		The reactive nower infeed at PO nodes should be within limits
3802		The redective power infect de ry nodes should be within itmites
3803		Mercade
3804		Generation reactive nower infeed out of range
3805		deneration reactive power infeed out of range
3806	Rule	GenRCCPowerInfeed Level: 6 Severity: WARNING Template: RuleModel
3807	Nuic.	demicer ower infeed level, o severity, waaring femplate, autenouel
3808		Details
3809		The nower provided to the network by a cim.SynchronousMachine should stay
3810		within limits regardless if it is controlling on not. This rule applies
3811		when a poactive capability curve is present. Active newer is postricted as
3812		PCCCD - PCC mPTD-CD[CD Cupyo]
3813		$PM \text{ p } \downarrow F \text{ max}(PCCCD/CD \text{ yyaluo}) \text{ and}$
2013		$PM = CE_{min}(RCCCD/CD_{NValue})$
2014		
2010		The notation shows is an VDath expression
2017		PCC - cim:PoactiveCanabilityCunve
2010		- KCC = CIM. Reactive capability curve
2010		- KCD = me clim.curveData points that belongs to the KCC
2019		-CD = CIM.CUIVeData
2020		$- \text{KM} = \text{CIM} \cdot \text{KOUGUINgMACHINE, HOLE CHIS IS IOAU SIGN CONVENTION}$
2021		- LE = LESS OF Equal
3822		- GE = Greater or Equal
3823		Reactive power is restricted as
3824		- CDI = min(RCCD[CD.xvalue LE -RM.p])
3825		- CD2 = min(RCCD[CD.XValue GE -RM.p])
3826		- RM.q LE interpolate(CD2/CD.y2value, CD2/CD.xvalue, CD1/CD.y2value,
3827		CDI/CD.xvalue, -RM.p)
3828		- RM.q GE interpolate(CD2/CD.yivalue, CD2/CD.xvalue, CD1/CD.yivalue,
3829		CD1/CD.xvalue, -RM.p)
3830		where
3831		- CD1 = nearest lower active power limit point
3832		- CD2 = nearest higher active power limit point
3833		- interpolate(w1, z1, w2, z2, w) is a fuction with parameters
3834		- w1 and z1 = the first coordinate point
3835		- w2 and z2 = the second coordinate point
3836		- w = the value along the w axis to interpolate the value along
3837		the z axis
3838		In case interpolation is not used, the mean value between w1
3839		and w2 should be used as limit.
3840		
3841		Justification:
3842		The active and reactive power infeed at PQ nodes should be within limits

Page 96 of 115



3843 3844 Message: 3845 Generation reactive power infeed out of range 3846 3847 Rule: ValidDER Level: 6 Severity: WARNING Template: RuleModel 3848 3849 Details: 3850 For every instance of a DistributedEnergyResource (DER), e.g. 3851 cim:EnergySource, the value of cim:EnergySource.activePower 3852 should be lower than or equal to zero. 3853 3854 Justification: 3855 Due to the load sign convention, decentralized infeed must be 3856 negative or zero. See IEC TS 61970-600-2:2017 section 7.8.6. 3857 3858 3859 Message: 3860 DER infeed acts as a load 3861 Rule: DERActivePowerInfeedDiffW Level: 6 Severity: WARNING Template: RuleModel 3862 3863 3864 Details: 3865 For every instance of cim:EnergySource, the value of 3866 cim:EnergySource.activePower should not deviate more than SSH_SV_MAX_P_DIFF MW 3867 from the value of cim:SvPowerFlow.p for the associated terminal. 3868 Note that disconnected DER should have zero values in SSH. 3869 3870 Justification: 3871 The SSH data should be based on a solved power flow (CGMM) and as a consequence, 3872 the values in SSH (input) and SV (calculation results) should not be far away. 3873 3874 Message: 3875 Assumed generation infeed of cim:EnergySource deviates from calculated generation 3876 infeed more than SSH_SV_MAX_P_DIFF MW 3877 3878 Rule: DERActivePowerInfeedDiffE Level: 6 Severity: ERROR Template: RuleModel 3879 3880 Details: The aggregated sum of the values of cim:EnergySource.activePower shall not 3881 3882 deviate more than SSH_SV_TOT_P_DIFF MW from the aggregated sum of the values of 3883 cim:SvPowerFlow.p for the terminals connected to synchronous machines. 3884 Note that disconnected DER should have zero values in SSH. 3885 3886 Justification: 3887 The SSH data should 3888 be based on a solved power flow (CGMM) and as a consequence, the values in 3889 SSH (input) and SV (calculation results) should not be far away. 3890 3891 Message: 3892 Assumed aggregated active power generation infeed deviates from calculated 3893 generation infeed more than SSH_SV_TOT_P_DIFF MW 3894 3895 Rule: DERReactivePowerInfeedDiffW Level: 6 Severity: WARNING Template: RuleModel 3896 3897 Details: For every instance of cim:EnergySource, the value of 3898

Page 97 of 115





3899 3900 3901		<pre>cim:EnergySource.reactivePower should not deviate more than SSH_SV_MAX_Q_DIFF MVAr from the value of cim:SvPowerFlow.q for the associated terminal. Note that disconnected DER should have zero values in SSH.</pre>
3902 3903		Justification:
3904		The SSH data should be based on a solved power flow (CGMM) and as a consequence.
3905 3906		the values in SSH (input) and SV (calculation results) should not be far away.
3907		Message:
3908 3909 3910		Assumed generation infeed of cim:EnergySource deviates from calculated generation infeed more than SSH_SV_MAX_Q_DIFF MVAr
3911 3912	Rule:	ValidLoad Level: 6 Severity: WARNING Template: RuleModel
3913		Details:
3914		For every instance of cim:StationSupply, cim:ConformLoad and
3915 3916		cim:NonConformLoad, the value of cim:EnergyConsumer.p should be greater than or equal to zero
3917		Justification
3919		Due to the load sign convention, all loads should be
3920		positive or zero. Decentralized generation should be modelled explicitly.
3921		See IEC TS 61970-600-2:2017 section 7.8.5.
3922		
3923		Message:
3924		Load infeed acts as a generator
3925 3926 3927	Rule:	LoadActivePowerInfeedDiffW Level: 6 Severity: WARNING Template: RuleModel
3928		Details:
3929		For every instance of cim:StationSupply, cim:ConformLoad and
3930		cim:NonConformLoad, the value of cim:EnergyConsumer.p should not deviate
3931		more than SSH_SV_MAX_P_DIFF MW from the value of cim:SvPowerFlow.p for the
3932		associated terminal. Note that disconnected loads should have zero values in SSH.
3034		Justification
3935		The SSH data should be based on a solved nower flow (CGMM) and as a consequence.
3936 3937		the values in SSH (input) and SV (calculation results) should not be far away.
3938		Message:
3939		Assumed consumption deviates from calculated consumption more than
3940		SSH_SV_MAX_P_DIFF MW
3941 3942	Rule:	LoadActivePowerInfeedDiffE Level: 6 Severity: ERROR Template: RuleModel
3943		
3944		Details:
3945		The aggregated sum of the values of cim:EnergyConsumer.p shall not
3946 3947 3948		deviate more than SSH_SV_TOT_P_DIFF MW from the aggregated sum of the values of cim:SvPowerFlow.p for the associated terminals. Note that disconnected loads should have zero values in SSH.
3949 3050		Justification
3951		The SSH data should be based on a solved nower flow (CGMM) and as a consequence
3952		the values in SSH (input) and SV (calculation results) should not be far away.
3953 3954		Message:

Page 98 of 115





3955 3956 3957		Assumed aggregated consumption deviates from calculated consumption more than SSH_SV_TOT_P_DIFF MW
3958 3959	Rule:	LoadReactivePowerInfeedDiffW Level: 6 Severity: WARNING Template: RuleModel
3960 3961 3962 3963 3964		Details: 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.
3965 3966 3967 3968 2060		Justification: Considering the Power Flow settings, the reactive power shift should be minimal.
3909 3970 3971 3972 3973		Message: Potential reactive power problem located for load instance, assumed reactive power deviates from calculated more than SSH_SV_MAX_Q_DIFF MVAr
3974 3975	Rule:	ENIActivePowerInfeedLim Level: 6 Severity: WARNING Template: RuleModel
3976 3977 3978 3979 3980		Details: The negated value of cim:ExternalNetworkInjection.p should be smaller than or equal to cim:ExternalNetworkInjection.maxP and must be greater than or equal to cim:ExternalNetworkInjection.minP. Note1: Negation is necessary due to the load sign convention.
3981 3982 3983		Note2: An instance with cim:ExternalNetworkInjection.p = 0 is considered out of service.
3984 3985 3986 3987		Justification: Load sign convention is used for the power infeed, whereas nameplate ratings are used for the operating limits.
3988 3989 3990		Message: ExternalNetworkInjection active power infeed out of range
3991 3992	Rule:	ENIReactivePowerInfeedLim Level: 6 Severity: WARNING Template: RuleModel
3993 3994 3995 3996 3997 2008		Details: The negated value of cim:ExternalNetworkInjection.q should be smaller than or equal to cim:ExternalNetworkInjection.maxQ and must be greater than or equal to cim:ExternalNetworkInjection.minQ. Note1: Negation is necessary due to the load sign convention.
3999 3999 4000 4001 4002		Justification: Load sign convention is used for the power infeed, whereas nameplate ratings are used for the operating limits.
4003 4004 4005		Message: ExternalNetworkInjection reactive power infeed out of range
4006 4007	Rule:	ENIActivePowerInfeedDiffW Level: 6 Severity: WARNING Template: RuleModel
4008 4009 4010		Details: For every instance of cim:ExternalNetworkInjection, the value of cim:ExternalNetworkInjection.p should not deviate more than SSH_SV_MAX_P_DIFF MW

Page 99 of 115





4011		from the value of cim:SvPowerFlow.p for the associated terminal
4012		
4013		Justification:
4014		The SSH data should be based on a solved power flow (CGMM)
4015		and as a consequence, the values in SSH (input) and SV (calculation results)
4016		should not be far away.
4017		Note: cim:ExternalNetworkInjection should not be used frequently considering its
4018		
1010		
4020		Morrago
4020		Message.
4021		Assumed external injection deviates from calculated
4022		more than SSH_SV_MAX_P_DIFF MW
4023		
4024	Rule:	ENIActivePowerInteedDittE Level: 6 Severity: ERROR Template: RuleModel
4025		
4026		Details:
4027		The aggregated sum of the values of cim:ExternalNetworkInjection.p shall
4028		not deviate more than SSH_SV_TOT_P_DIFF MW from the aggregated sum of the
4029		values of cim:SvPowerFlow.p for the associated terminals
4030		
4031		Justification:
4032		The SSH data should be based on a solved power flow (CGMM) and as a consequence.
4033		the values in SSH (input) and SV (calculation results) should not be far away
1000		Note: cim:ExternalNetworkInjection should not be used frequently considering its
4034		note. Climitativetworkingettion should not be used mequencity considering its
4035		pul pose:
4030		Magaza
4037		Message:
4030		Assumed aggregated sum of external injections deviates from calculated
4039		more than SSH_SV_IUI_P_DIFF MW
4040		
4041	Ruie:	ENIReactivePowerInfeedDiffW Level: 6 Severity: WARNING Template: RuleModel
4042		
4043		Details:
4044		For every cim:ExternalNetworkInjection the value of
4045		cim:ExternalNetworkInjection.q should not deviate
4046		more than SSH_SV_MAX_Q_DIFF MVAr from the value of cim:SvPowerFlow.q for the
4047		associated terminal.
4048		Note that disconnected loads should have zero values in SSH.
4049		
4050		Justification:
4051		Considering the Power Flow settings, the reactive power shift
4052		should be minimal.
4053		
4054		Message:
1055		Potential neactive nower problem located for cim:ExternalNetworkInjection
4000		assumed reactive nower deviates from calculated more than
4057		SSH SV MAY O DIEE MVAn
4057		
4000	D1	ETActiveDevenInfeedlim Level, C. Covenity, MADNING Templeter DuleMedel
4059	Ruie:	ETACLIVEPOWERINTEEULIM LEVEL: 6 Severity: WARNING TEMPIALE: RULEMOUEL
4000		Deteile
4001		Details:
4062		ine negated value of non-boundary cim:Equivalentinjection.p should be smaller
4063		than or equal to cim:EquivalentInjection.maxP and greater than or
4064		equal to cim:EquivalentInjection.minP.
4065		Note1: Negation is necessary due to the load sign convention.
4066		Note2: An instance with cim:EquivalentInjection.p = 0 is considered out of service.

Page 100 of 115





4067		
4068		Justification:
4069		Load sign convention is used for the power infeed, whereas nameplate ratings are
4070		used for the operating limits.
4071		
4072		Message:
4073		EquivalentInjection active power infeed out of range
4074		
4075	Rule	ETReactivePowerInfeedLim Level: 6 Severity: WARNING Template: RuleModel
4076	Nuic.	Encaceiverowerinneedelm Level, o Severicy, waarde tempidee, autorodei
4070		Dataile
4070		The second value of non-housdamy sime Faving lest Tripetion a should be smaller
4070		the negated value of non-boundary clm.Equivalentinjection.q should be smaller
4079		than or equal to clm:Equivalentinjection.maxy and must be greater than or
4080		equal to ccim:EquivalentInjection.minQ.
4081		Note1: Negation is necessary due to the load sign convention.
4082		
4083		Justification:
4084		Load sign convention is used for the power infeed, whereas nameplate ratings are
4085		used for the operating limits.
4086		
4087		Message:
4088		EquivalentInjection reactive nower infeed out of range
4089		
1000	Rula	ETActivePowerInfeedDiffW level: 6 Severity: WARNING Template: RuleModel
4090	Ruie.	LIACTIVEFOWERINGERUDITIW LEVEL. O Severity. WARNING TEmplate. Rulehouer
4091		
4092		
4093		For every non-boundary cim:EquivalentInjection, the value of
4094		cim:EquivalentInjection.p should not deviate more than SSH_SV_MAX_P_DIFF MW
4095		from the value of cim:SvPowerFlow.p for the associated terminal
4096		
4097		Justification:
4098		The SSH data should be based on a solved power flow (CGMM) and as a consequence,
4099		the values in SSH (input) and SV (calculation results) should not be far away.
4100		Note: cim:EquivalentInjection should not be used frequently considering its
4101		purpose.
4102		
4103		Message.
4104		Assumed non-boundary cim:EquivalentInjection injection deviates from calculated
1105		mone than SCH SV MAY D DIEE MW
4100		
4100	Dulor	EIActiveDevenInfoodDiffe Lovel, 6 Sevenity, EPBOR Template, BuleMedel
4107	Ruie.	ETACLIVEPOWERINTEEUDITTE LEVEL. 6 Severity. EKKOK Template. Kulehouel
4100		
4109		Details:
4110		The aggregated sum of the values of non-boundary cim:EquivalentInjection.p
4111		shall not deviate more than SSH_SV_TOT_P_DIFF MW from the aggregated sum of
4112		the values of cim:SvPowerFlow.p for the associated terminals
4113		
4114		Justification:
4115		The SSH data should be based on a solved power flow (CGMM) and as a consequence,
4116		the values in SSH (input) and SV (calculation results) should not be far away.
4117		Note: cim:EquivalentInjection should not be used frequently considering its
4118		purpose.
4119		
4120		Message:
4121		Assumed non-boundary cim:EquivalentInjection aggregated injection deviates from
4122		calculated more than SSH SV TOT P DIFF MW
() 66		

Page 101 of 115





4123		
4124	Rule:	EIReactivePowerInfeedDiffW Level: 6 Severity: WARNING Template: RuleModel
4125		
4126		Details:
4127		The reactive power provided to the network by a non-boundary
4128		cim:EquivalentInjection shall stay within limits regardless if it
4129		is controlling or not
4130		 cim:EquivalentInjection.q greater or equal than cim:EquivalentInjection.minQ
4131		if provided and
4132		 cim:EquivalentInjection.q less or equal than cim:EquivalentInjection.maxQ
4133		if provided
4134		
4135		Justification:
4136		The reactive power infeed at PQ nodes should be within limits
4137		
4138		Message:
4139		cim:EquivalentInjection reactive power infeed out of range
4140		
4141	Rule:	NetInterchange1 Level: 6 Severity: WARNING Template: RuleModel
4142		
4143		Details:
4144		For a cim:ControlArea of type interchange the aggregated sum of the values
4145		of cim:SvPowerFlow.p for cim:Terminals referenced by cim:TieFlow.Terminal shall
4146		not deviate from the value of cim:ControlArea.netInterchange with more than
4147		cim:ControlArea.pTolerance.
4148		Implications from other rules to consider;
4149		1) According to level 5 rule SvPowerFlowBranchInstances the cim:Terminal
4150		referenced by a cim:TieFlow.Terminal is located at a boundary
4151		cim:TopologicalNode, hence the attribute cim:TieFlow.positiveFlowIn
4152		is always true.
4153		2) According to level 5 rule SvPowerFlowBranchInstances the cim:Terminal
4154		referenced by cim: lieflow.lerminal is not required to have a cim: SvPowerFlow.
4155		3) According to level 5 rule SvPowerFlowInstances every cim:EquivalentInjection
4156		has a cim:SvPowerFlow.
4157		A concequence is that the cim:SVPOwerFlow at the cim:Equivalentinjection
4158		cim:lerminal must be used in the summation but with negated value.
4159		Ine cim:Equivalentinjection cim:Terminal is at the same boundary
4160		Cim: lopologicalNode as the cim: lerminal referced by cim: lerlow. lerminal
4101		IT piolerance is not available or greater than initric_IMBALANCE_WARNING MW,
4162		a threshold or interch_imbalance_warning mw is used.
4163		Notel: clm:ControlArea.netInterchange include AC and DC exchanges.
4104		Note2: An HVDC Boundary TopologicalNode has a clm:luencifiedobject.description
4100		actribute with leading characters HVDC .
4100		Justification
4107		JUSTITICATION:
4100		Area interchange control uses controlarea. Netinterchange as
4109		within the ControlAnce as Control Variables
4170		within the controlared as control variables.
4171		Maccago
4172		Netted Area nosition not respected more than INTEPCH IMPALANCE WARNING MW
4174		NELLER ALER POSTUTOR HOL LESPECLER HOLE CHAIL INTERCH_IMDALANCE_WARNING MW
4175	Rulo	NetInterchange? Level: 6 Severity: FRROR Template: RuleModel
4176	NULC.	Nether changez lever. O Severity. ENNON Template. Nuterouel
4177		Details
4178		For a cim:ControlArea of type interchange the aggregated sum of the values

Page 102 of 115





4179		of cim:SvPowerFlow.p for cim:Terminals referenced by cim:TieFlow.Terminal
4180		shall not deviate from the value of cim:ControlArea.netInterchange with more
4181		than INTERCH IMBALANCE ERROR MW.
4182		Implications from other rules to consider:
/183		1) According to level 5 rule SylowerElowBranchInstances the cim.Terminal
1100		notoning to rever 5 the Soviewing like located at a boundary
4104		referenced by a climination in the state of a boundary
4100		cim:TopologicalNode, hence the attribute cim:Tieriow.positiveriowin
4186		is always true.
4187		2) According to level 5 rule SvPowerFlowBranchInstances the cim:Terminal
4188		referenced by cim:TieFlow.Terminal is not required to have a cim:SvPowerFlow.
4189		3) According to level 5 rule SvPowerFlowInstances every cim:EquivalentInjection
4190		has a cim:SvPowerFlow.
4191		A concequence is that the cim:SvPowerFlow at the
4192		cim:EquivalentInjection cim:Terminal must be used in the summation
4193		but with negated value.
4194		The cim EquivalentInjection cim Terminal is at the same boundary
/105		cim: TonologicalNode as the cim: Terminal referred by cim: TieElow Terminal
4106		Noto1: cim:ControlAnoa notIntonchango include AC and DC exchanges
4190		Note:. (IM.CONTROLATED.NECINCERCHANGE INCLUDE AC and DC exchanges.
4197		Note2: An HVDC Boundary TopologicalNode has a clm; identifiedobject.description
4198		attribute with leading characters "HVDC".
4199		
4200		Justification:
4201		Area interchange control uses ControlArea.netInterchange as
4202		set point, the TieFlow terminals as State Variables and the ConformLoad
4203		within the ControlArea as Control Variables.
4204		
4205		Message:
4206		Netted Area position severely not respected for more than
4207		TNTERCH TMBALANCE ERROR MW
4208		
1200	Rula	TanDocition Level: 6 Sevenity: WARNING Template: RuleModel
4203	Nuie.	Taprosition Level. O Severity. WARNING Template. Rutenodel
4210		
4211		Details:
4212		For every instance of cim:Ratiolapinanger, cim:PhaselapinangerLinear,
4213		cim:PhaseTapChangerSymmetrical and cim:PhaseTapChangerAsymmetrical, the value of
4214		cim:TapChanger.step should not deviate more than SSH_SV_MAX_TAP_STEP_DIFF
4215		from the value of cim:SvTapStep.position
4216		
4217		Justification:
4218		Considering the Power Flow settings, the tap position shift
4219		should be minimal. The SSH data should be based on a solved power flow
4220		(CGMM) and as a consequence, the values in SSH (input) and SV (calculation
4221		results) should not be far away.
4222		resures, shourd hot be full away.
1222		Mossage
4220		Message.
4224		Assumed tap position deviates more than SSH_SV_MAX_TAP_STEP_DIFF from calculated
4220		
4226	Rule:	ShuntQ Level: 6 Severity: WARNING Template: RuleModel
4227		
4228		Details:
4229		For every instance of cim:LinearShuntCompensator, the value of cim:SvPowerFlow.q
4230		should not deviate more than SSH_SV_MAX_Q_SHUNT_DIFF MVAr from the negated.
4231		product of the value of cim:SvShuntCompensatorSections.sections, the value of
4232		cim:LinearShuntCompensator.bPerSection and the squared value of
4233		cim:SvVoltage.v at the cim:TopologicalNode, the cim:LinearShuntCompensator is
4234		connected to.

Page 103 of 115



4235		
4236		Justification:
4237		
4238		Message:
4239		power infeed deviates from calculated more than SCH SV MAX O SHUNT DIFE
4240		
4242	Rule:	SvInjectionLimit Level: 6 Severity: WARNING Template: RuleModel
4243		Dataile
4244 1215		Decalls. The absolute values of cimeSvInjection nInjection and cimeSvInjection aInjection
4245		shall be less than the SV INJECTION LIMIT MW/MVar
4247		In instance of cim:SvInjection is only needed if the limit is breached.
4248		
4249		Justification:
4250		The cim:SvInjection values gives the accuracy of the power flow solution.
4251		Large values of cim:SvInjection.pInjection and cim:SvInjection.qInjection
4252		indicates a poorly converged power flow solution.
4253 4254		Lots of cim:SvInjection instances below limit will clutter the SV file.
4255		Message:
4256		Power flow convergence mismatch not within limit, greater than
4257		SV_INJECTION_LIMIT MW/MVar
4258		
4259 4260	Rule:	VoltageProfile Level: 6 Severity: WARNING Template: RuleModel
4261		Details:
4262		Where a cim:VoltageLimit exists for an energized cim:TopologicalNode,
4263		the value of cim:SvVoltage.v
4264		should be lower than or equal to the value of cim:VoltageLimit.value
4265		associated with cim:UperationalLimit/ype.limit/ype=nignvoltage and nigner
4200		cim:OpenationalLimitType_limitType_louVeltage
4268		In case of multiple limits the most restrictive shall be used
4269		in case of maltiple limits the most restrictive shall be asea.
4270		Justification:
4271		Considering the Power Flow settings, all voltages should be
4272		within defined operational limits.
4273		See IEC TS 61970-600-2:2017 section 6.8.7.
4274		
4275		Message:
4276		Calculated voltage out of range
4277	D1	
4278	Ruie:	VoltagelargetsAtin Level: 6 Severity: WARNING Template: RuleModel
4279		Details
4281		For all cim.RegulatingControl with cim.RegulatingControl discrete=false
4282		(including its subclass cim:TapchangerControl)
4283		instances at a cim:TopologicalNode their cim:RegulatingControl.targetValues
4284		should be equal. This rule is for continuous controls.
4285		
4286		Justification:
4287		The power flow solver need a single voltage target per cim:TopologicalNode
4288		and the cim:RegulatingControl.targetValues differ the power flow will
4289		have to pick a value. It different Power Flow applications use different
4290		strategies to pick a value the voltage

Page 104 of 115





4291		solution will differ between them which is the reason to warn.
4292		
4293		Message:
4294		Voltage targets differ
4295		
4296	Rule:	VoltageTargetAndDeadbandAtTN Level: 6 Severity: WARNING Template: RuleModel
4297		
4298		Details
4200		For all cimeRegulatingControl (including its subclass cimeTanchangerControl)
4200		instances at a cim: TenelogicalNode whith one on more cim: PegulatingControls having
4300		discrete-"true" the following is valid
4301		For a DCC with sime Degulating Control discusses "true" the range is
4302		- For a KCC with Cim.RegulatingControl.ulScrete= true the range is
4303		{cim:RegulatingControl.targetValue - cim:RegulatingControl.targetDeadband/2,
4304		cim:RegulatingControl.targetValue + cim:RegulatingControl.targetDeadband/2}
4305		- The ranges for different cim:RegulatingControl instances shall be overlapping
4306		so the cim:RegulatingControl.targetValue is inside the range of all
4307		cim:RegulatingControls
4308		- For a RCC with cim:RegulatingControl.discrete="false" the
4309		cim:RegulatingControl.targetValue shall be within
4310		all the present cim:RegulatingControl ranges.
4311		This rule is for discrete controls and hence include the dead band.
4312		
4313		Justification:
4314		The power flow solver need a single dead band per cim:TopologicalNode
4315		and if the dead bands differ the power flow will have to pick a value. If different
4316		Power Flow applications use different strategies to pick a value the voltage
4317		solution will differ between them which is the reason to warn.
4318		
4319		Message:
4319 4320		Message: Voltage targets differ
4319 4320 4321		Message: Voltage targets differ
4319 4320 4321 4322	Rule:	Message: Voltage targets differ EnergizedBoundarvTN Level: 6 Severity: ERROR Template: RuleModel
4319 4320 4321 4322 4323	Rule:	Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel
4319 4320 4321 4322 4323 4324	Rule:	Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details:
4319 4320 4321 4322 4323 4324 4325	Rule:	Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: A boundary cim:TopologicalNode with a non-zero cim:EquivalentInjection n or
4319 4320 4321 4322 4323 4324 4325 4326	Rule:	Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: A boundary cim:TopologicalNode with a non-zero cim:EquivalentInjection.p or cim:EquivalentInjection a is supposed to be energized and shall have a
4319 4320 4321 4322 4323 4324 4325 4326 4326	Rule:	<pre>Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: A boundary cim:TopologicalNode with a non-zero cim:EquivalentInjection.p or cim:EquivalentInjection.q is supposed to be energized and shall have a calved voltage i a cim:SuVoltage v shall not be zero</pre>
4319 4320 4321 4322 4323 4324 4325 4326 4327 4328	Rule:	<pre>Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: 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.</pre>
4319 4320 4321 4322 4323 4324 4325 4326 4327 4328 4327	Rule:	<pre>Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: 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.</pre>
4319 4320 4321 4322 4323 4324 4325 4326 4327 4328 4329 4329	Rule:	<pre>Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: 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. Justification: All boundary cim:TopologicalNodes in a newer flow model shall have a</pre>
4319 4320 4321 4322 4323 4324 4325 4326 4327 4328 4329 4330 4330	Rule:	<pre>Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: 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. Justification: All boundary cim:TopologicalNodes in a power flow model shall have a solved voltage.</pre>
4319 4320 4321 4322 4323 4324 4325 4326 4327 4328 4329 4330 4330	Rule:	<pre>Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: 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. Justification: All boundary cim:TopologicalNodes in a power flow model shall have a solved voltage.</pre>
4319 4320 4321 4322 4323 4324 4325 4326 4327 4328 4329 4330 4331 4332	Rule:	<pre>Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: 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. Justification: All boundary cim:TopologicalNodes in a power flow model shall have a solved voltage.</pre>
4319 4320 4321 4322 4323 4324 4325 4326 4327 4328 4329 4330 4331 4332 4333	Rule:	<pre>Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: 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. Justification: All boundary cim:TopologicalNodes in a power flow model shall have a solved voltage. Message:</pre>
4319 4320 4321 4322 4323 4324 4325 4326 4327 4328 4329 4330 4331 4332 4333 4334	Rule:	<pre>Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: 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. Justification: All boundary cim:TopologicalNodes in a power flow model shall have a solved voltage. Message: Boundary cim:TopologicalNode with injecting cim:EquivalentInjection without</pre>
4319 4320 4321 4322 4323 4324 4325 4326 4327 4328 4329 4330 4331 4332 4333 4334 4335	Rule:	<pre>Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: 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. Justification: All boundary cim:TopologicalNodes in a power flow model shall have a solved voltage. Message: Boundary cim:TopologicalNode with injecting cim:EquivalentInjection without solved cim:SvVoltage.v</pre>
4319 4320 4321 4322 4323 4324 4325 4326 4327 4328 4329 4330 4331 4332 4333 4334 4335 4336	Rule:	<pre>Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: 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. Justification: All boundary cim:TopologicalNodes in a power flow model shall have a solved voltage. Message: Boundary cim:TopologicalNode with injecting cim:EquivalentInjection without solved cim:SvVoltage.v</pre>
4319 4320 4321 4322 4323 4324 4325 4326 4327 4328 4329 4330 4331 4332 4333 4334 4335 4336 4337	Rule:	<pre>Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: 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. Justification: All boundary cim:TopologicalNodes in a power flow model shall have a solved voltage. Message: Boundary cim:TopologicalNode with injecting cim:EquivalentInjection without solved cim:SvVoltage.v</pre>
4319 4320 4321 4322 4323 4324 4325 4326 4327 4328 4329 4330 4331 4332 4333 4334 4335 4336 4337 4338	Rule: Rule:	<pre>Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: 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. Justification: All boundary cim:TopologicalNodes in a power flow model shall have a solved voltage. Message: Boundary cim:TopologicalNode with injecting cim:EquivalentInjection without solved cim:SvVoltage.v</pre>
4319 4320 4321 4322 4323 4324 4325 4326 4327 4328 4329 4330 4331 4332 4333 4334 4335 4336 4337 4338 4339	Rule: Rule:	<pre>Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: 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. Justification: All boundary cim:TopologicalNodes in a power flow model shall have a solved voltage. Message: Boundary cim:TopologicalNode with injecting cim:EquivalentInjection without solved cim:SvVoltage.v</pre>
4319 4320 4321 4322 4323 4324 4325 4326 4327 4328 4329 4330 4331 4332 4333 4334 4335 4336 4337 4338 4339 4340	Rule: Rule:	<pre>Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: 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. Justification: All boundary cim:TopologicalNodes in a power flow model shall have a solved voltage. Message: Boundary cim:TopologicalNode with injecting cim:EquivalentInjection without solved cim:SvVoltage.v FakeVoltage Level: 6 Severity: WARNING Template: RuleModel Details: A cim:TopologicalNode with a solved voltage equal to the</pre>
4319 4320 4321 4322 4323 4324 4325 4326 4327 4328 4329 4330 4331 4332 4333 4334 4335 4336 4337 4338 4339 4340 4341	Rule: Rule:	<pre>Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: 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. Justification: All boundary cim:TopologicalNodes in a power flow model shall have a solved voltage. Message: Boundary cim:TopologicalNode with injecting cim:EquivalentInjection without solved cim:SvVoltage.v FakeVoltage Level: 6 Severity: WARNING Template: RuleModel Details: A cim:TopologicalNode with a solved voltage equal to the cim:BaseVoltage.nominalVoltage is suspected to copy that value rather than</pre>
4319 4320 4321 4322 4323 4324 4325 4326 4327 4328 4327 4328 4329 4330 4331 4332 4333 4334 4335 4336 4337 4338 4339 4340 4341 4342	Rule:	<pre>Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: 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. Justification: All boundary cim:TopologicalNodes in a power flow model shall have a solved voltage. Message: Boundary cim:TopologicalNode with injecting cim:EquivalentInjection without solved cim:SvVoltage.v FakeVoltage Level: 6 Severity: WARNING Template: RuleModel Details: 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.</pre>
4319 4320 4321 4322 4323 4324 4325 4326 4327 4328 4329 4330 4331 4332 4333 4334 4335 4336 4337 4338 4339 4340 4341 4342 4343	Rule:	<pre>Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: 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. Justification: All boundary cim:TopologicalNodes in a power flow model shall have a solved voltage. Message: Boundary cim:TopologicalNode with injecting cim:EquivalentInjection without solved cim:SvVoltage.v FakeVoltage Level: 6 Severity: WARNING Template: RuleModel Details: 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.</pre>
4319 4320 4321 4322 4323 4324 4325 4326 4327 4328 4329 4330 4331 4332 4333 4334 4335 4336 4337 4338 4339 4340 4341 4342 4343 4344	Rule:	<pre>Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: 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. Justification: All boundary cim:TopologicalNodes in a power flow model shall have a solved voltage. Message: Boundary cim:TopologicalNode with injecting cim:EquivalentInjection without solved cim:SvVoltage.v FakeVoltage Level: 6 Severity: WARNING Template: RuleModel Details: 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. Justification:</pre>
4319 4320 4321 4322 4323 4324 4325 4326 4327 4328 4329 4330 4331 4332 4333 4334 4335 4336 4337 4338 4339 4340 4341 4342 4343 4344 4345	Rule:	<pre>Message: Voltage targets differ EnergizedBoundaryTN Level: 6 Severity: ERROR Template: RuleModel Details: 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. Justification: All boundary cim:TopologicalNodes in a power flow model shall have a solved voltage. Message: Boundary cim:TopologicalNode with injecting cim:EquivalentInjection without solved cim:SvVoltage.v</pre> FakeVoltage Level: 6 Severity: WARNING Template: RuleModel Details: 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. Justification: This is to prevent from faking the voltage.

Page 105 of 115



4347 4348 4240		Message: Voltage at cim:TopologicalNode may be fake
4349 4350 4351	Rule:	InvalidVoltage Level: 6 Severity: ERROR Template: RuleModel
4352 4353 4354		Details: A cim:SvVoltage lower than 0.4 per unit and greater than 0 is not allowed.
4355 4356 4357		Justification: A cim:SvVoltage lower than 0.4 per unit and greater than 0 is not reasonable.
4358 4359 4360		Message: A cim:SvVoltage lower than 0.4 per unit and greater than 0 is not allowed
4361 4362	Rule:	DiscreteControl Level: 6 Severity: ERROR Template: RuleModel
4363 4364 4365 4366 4367 4368 4369 4370 4371 4372		<pre>Details: 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 no decimals are allowed for the following attributes values - cim:ShuntCompensator.sections - related cim:SvShuntCompensatorSections.sections - cim:TapChanger.step - related cim:SvTapStep.position</pre>
4373 4374 4375 4376 4377 4378		Justification: If cim:RegulatingControl.discrete is set to true it is not possible to move the control variables continuously. Message: cim:ShuntCompensator.sections or cim:TapChanger.step or
4379 4380 4381		SvShuntCompensatorSection.sections or SvTapStep.position shall be an integer value in discrete control.
4382 4383	Rule:	ContinuousControl Level: 6 Severity: WARNING Template: RuleModel
4384 4385 4386 4387 4388 4389 4390 4390		Details: For every instance of cim:RegulatingControl (SSH) for which the value of cim:RegulatingControl.discrete is false and cim:RegulatingControl.enabled is true means continuous control. For devices natively being discrete this means an imprecise modelling of the behaviour for - cim:ShuntCompensator - cim:TapChanger
4392 4393 4394 4395 4396		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.
4397 4398 4399		Message: cim:ShuntCompensator or cim:TapChanger should not be used with continuous control
4400 4401	Rule:	RequiredSvVoltage Level: 6 Severity: ERROR Template: RuleModel
4402		Details:

Page 106 of 115





4403		Instances of cim:SvVoltage is required for all cim:TopologicalNodes.
4404		If power flow didn't create a solution for a cim:TopologicalNode
4405		cim:SvVoltage angle and voltage shall be set to zero.
4406		
4407		Justification:
4408		Instances of cim:SvVoltage is required to know where power flow managed
4409		to solve.
4410		
4411		Message:
4412		cim:SvVoltage is missing for cim:TopologicalNode
4413		
4414	Rule:	RequiredSvSCSections Level: 6 Severity: ERROR Template: RuleModel
4415		
4416		Details:
4417		Instances of cim:SvShuntCompensatorSections is required for all
4418		shunt compensators.
4419		The shunt compensators are instances of subclasses to cim:ShuntCompensator.
4420		For a shunt compensator that is not used in control by power flow the
4421		value of SvShuntCompensatorSections.sections shall be the same as
4422		cim:ShuntCompensator.sections.
4423		
4424		Justification:
4425		Instances of cim:SvShuntCompensatorSections is required to tell the number
4426		of sections that was used in the solution.
4427		
4428		Message:
4429		cim:SvShuntCompensatorSections is missing for shunt compensator
4430		
4431	Rule:	RequiredSvTapStep Level: 6 Severity: ERROR Template: RuleModel
4432		
4433		Details:
4434		Instances of cim:SvTapStep is required for all tap changers.
4435		The tap changers are instances of subclasses to cim:TapChanger.
4436		For a tap changer that is not used in control by power flow the
4437		value of SvTapStep.step shall be the same as cim:TapChanger.step.
4438		
4439		Justification:
4440		Instances of cim:SvTapStep is required to tell the step number
4441		that was used in the solution.
4442		
4443		Message:
4444		cim:SvTapStep is missing for tap changer
		-

4445 9 LEVEL 7 VALIDATION: COORDINATION

4446 **9.1 INTRODUCTION**

In this category, we validate IGMs against other IGMs and against reference data. This can only be
done when neighbouring TSO issued their IGMs for the same scenarioTime and if reference data
from PEVF or CGMA is available for the same scenarioTime. The referenced MAS always applies
to IGM the referenced Power System Resources belong to.

Page 107 of 115



4451 **9.2 VALIDATION RULES**

4452	Rule:	InconsistentCurrentLimits Level: 7 Severity: WARNING Template: RuleModel
4453		
4454		Details:
4455		The value of cim:CurrentLimit.value is expected to be the same for a
4456		tie line on both sides of the boundary point.
4457		The lowest limit shall be used in studies.
4458		
4459		Justification:
4460		Tie line data is supposed to be coordinated by TSOs.
4461		
4462		Message:
4463		Current limits are inconsistent at tie line
4464		
4465	Rule:	UnpairedTieFlow Level: 7 Severity: WARNING Template: RuleModel
4466		
4467		Details:
4468		A boundary cim:TopologicalNode (AC) in a CGM may be connected to
4469		1) two branches and two cim:EquivalentInjections linking two IGMs
4470		2) one branch and one cim:EquivalentInjection terminating the IGM.
4471		In case 1) the cim:EquivalentInjections shall have p/g values
4472		equal zero (no transfer of power) or different from zero (transfer
4473		of nower). Having zero values on one side and non-zero on the other
4474		indicates different assumptions on usage of the tie line.
4475		In case 2) the cim:EquivalentInjection n and q values are injections
4476		representing the tie line power flow.
4477		Note: An HVDC Boundary Point has a cim:IdentifiedObject.description
4478		attribute with leading chracters equal to 'HVDC'
4479		
4480		Justification
4481		cim TieFlow is typically calculated at the AC Tie Line terminal.
4482		connected to the boundary point for AC Tie Lines (regardless of its
4483		position on the Tie line) and at the Point of Common Counling for HVDC
4484		links
4485		
4486		Meccage.
4487		Tie lines at the boundary have different operational status
4488		The fines at the boundary have affected operational status
4480	Rulo	ACTielineBV Level: 7 Sevenity: ERROR Template: RuleModel
4400	Ruie.	Acticities level. 7 Severity. Ennon template. Rulenouel
4400 4401		Details
1/02		Eon a cim:ControlArea of type interchange all cim:TieElow hranches
1103		not connected to an HVDC boundary point shall have a
4493		cim:BaseNeltage neminalVeltage that deviates no more than
4494		POINDARY RV MAY DIEE from the cim: Recovaltage nominal/valtage of the
4490		boundary_by_MAX_DIFF ITOm the tim.basevoitage.nominarvoitage of the
4490		Doundary point.
4497		Note: An HVDC Boundary Point has a cim; identifiedobject.description
4490		attribute equal to HVDC .
4499		Justification
4500		JUSLITICALIUN:
4501		SEE SECTION 0.10.2 OF TEC 12 013/0-000-2:201/
4002		Maggaga
4503		Message:
4004		AC THE THE HOMITHAIVOILAGES GEVIALES THOM THE DOUNGARY POINT DASE VOLTAGE


4505 4506		more than BOUNDARY_BV_MAX_DIFF
4507 4508	Rule:	ACScheduleMatch1 Level: 7 Severity: WARNING Template: RuleModel
4509		Details:
4510		For every Terminal, designated as cim:TieFlow.Terminal belonging to a
4511		cim:ControlArea of type Interchange, connected to an AC Boundary
4512		cim:TopologicalNode, the aggregated cim:SvPowerFlow.p tie flows should match
4513		the value of the external AC schedule with the same cim:ControlArea EIC 'Y'
4514		code within INTERCH_IMBALANCE_WARNING MW threshold.
4010		Note: An HVDC Boundary clm: TopologicalNode has a clm: Identifiedobject.description
4510		activitude with reading characters hope.
4518		Justification:
4519		In the Reporting Information Market Document, issued by PEVF or CGMA,
4520		the EIC 'Y' code is found in the domain.mRID, in the IGM it is the value
4521		of attribute entsoe:IdentifiedObject.EnergyIdentCodeEic for the ControlArea
4522		instance.
4523		
4524		Message:
4525		AC tie flows doesn't match the scheduled interchange value
4526		more than INTERCH_IMBALANCE_WARNING MW
4527	Dulat	ACS shadulaMatsh2 Laval, 7 Savanitur EPPOP Tamplatar BulaMadal
4520	Ruie.	ACSCHEduleMatch2 Level. / Severity. EKKok Template. RuleModel
4530		Details:
4531		For every cim:Terminal, designated as cim:TieFlow.Terminal belonging to a
4532		cim:ControlArea of type Interchange, connected to an AC Boundary
4533		cim:TopologicalNode, the aggregated cim:SvPowerFlow.p tie flows should match
4534		the value of the external AC schedule with the same cim:ControlArea
4535		EIC 'Y' code within INTERCH_IMBALANCE_ERROR MW threshold.
4536		Note: An HVDC Boundary TopologicalNode has a cim:IdentifiedObject.description
4537		attribute with leading characters "HVDC".
4539		Justification
4540		In the Reporting Information Market Document, issued by PEVE or CGMA.
4541		the EIC 'Y' code is found in the domain.mRID, in the IGM it is the value
4542		of attribute entsoe:IdentifiedObject.EnergyIdentCodeEic for the ControlArea
4543		instance.
4544		
4545		Message:
4546		AL tie flows doesn't match the scheduled interchange values
4047 4548		MORE THAN INTERCH_IMBALANCE_ERROR MW
4549		
4550	Rule:	HVDCScheduleMatch1 Level: 7 Severity: WARNING Template: RuleModel
4551		······································
4552		Details:
4553		For every cim:Terminal, designated as cim:TieFlow.Terminal belonging to a
4554		cim:ControlArea of type Interchange, connected to an HVDC Boundary
4555		cim:TopologicalNode, the cim:SvPowerFlow.p value should match the value
4556		of the external schedule for the same cim:ControlArea
4007 4559		EIC Y COUE AND WICH THE SAME CONNECTINGLINE_KEGISTEREDKESOURCE EIC I
4559		The value of cim. SvPowerFlow n is not exchanged for said cim. Terminal the
4560		negated sum of the cim:SvPowerFlow.p values associated with the same

Page 109 of 115



4561		cim:TopologicalNode is to be used instead, following Kirchhoff's Current Law.
4562		Note: An HVDC Boundary cim: TopologicalNode has a cim: IdentifiedObject.description
4563		attribute with leading characters 'HVDC'
4564		activities with leading characters invoc.
4004		
4565		JUSTIFICATION:
4566		In the Reporting Information Market Document, issued by PEVF or CGMA,
4567		the EIC 'Y' code is found in the domain.mRID, in the IGM it is the value
4568		of attribute entsoe:IdentifiedObject.EnergyIdentCodeEic for the cim:ControlArea
4569		instance. The EIC 'T' code is found in the TimeSeries in the
4570		connectingline RegisteredResource mRID in the IGM it is the value of
4670		attribute entropy Identified Direct Encogy Ident CodeFic for the Boundary
4571		activitie encode in the formation of the boundary
4572		point instance, the terminal is connected to.
4573		
4574		Message:
4575		HVDC flow doesn't match the scheduled interchange value
4576		more than INTERCH IMBALANCE WARNING MW
4577		
1578	Rula	HVDCScheduleMatch2 Level, 7 Sevenity, ERROR Template, RuleModel
4570	Ruie.	hydeschedulenatenz level. / Severity. Ekkok remplate. kulenduel
4579		
4580		Details:
4581		For every cim:Terminal, designated as cim:TieFlow.Terminal belonging to a
4582		cim:ControlArea of type Interchange, connected to an HVDC Boundary
4583		cim:TopologicalNode, the cim:SvPowerFlow.p value should match the value
4584		of the external schedule for the same cim:ControlArea
4585		ETC 'V' code and with the same connectingline RegisteredResource ETC 'T'
4505		and within INTERCI THRALANCE EDOD MULTERschald
4000		Code within interce - mbalance - error in threshold.
4587		If the value of cim:SvPowerFlow.p is not exchanged for said cim:Terminal, the
4588		negated sum of the cim:SvPowerFlow.p values associated with the same
4589		cim:TopologicalNode is to be used instead, following Kirchhoff's Current Law.
4590		Note: An HVDC Boundary cim:TopologicalNode has a cim:IdentifiedObject.description
4591		attribute with leading characters 'HVDC'.
4592		
1502		Justification
4504		In the Depending Information Manket Decument, issued by DEVE on CCMA
4094		In the Reporting information Market Document, issued by PEVF or ComA,
4595		the EIC Y code is found in the domain.mRID, in the IGM it is the value
4596		of attribute entsoe:IdentifiedObject.EnergyIdentCodeEic for the cim:ControlArea
4597		instance. The EIC 'T' code is found in the TimeSeries in the
4598		connectingLine RegisteredResource.mRID, in the IGM it is the value of
4599		attribute entsoe:IdentifiedObject.EnergyIdentCodeEic for the Boundary
4600		noint instance the terminal is connected to
1600		
4001		Magaza
4602		Message:
4603		HVDC flow doesn't match the scheduled interchange value
4604		more than INTERCH_IMBALANCE_ERROR MW
4605		
4606	Rule:	NetInterchangeMatch1 Level: 7 Severity: WARNING Template: RuleModel
4607		
4608		Details
4600		For eveny cimeControlAnce of type interchange, the value of
4640		ion every clum.concrotarea or cype incerchange, the Value OT
4010		cim:controiarea.netinterchange should
4611		not deviate more than INTERCH_IMBALANCE_WARNING MW from the sum of the
4612		netted area AC and DC positions in the aggregated netted external shedules
4613		(PEVF or CGMA) for the same scenarioTime and with the same EIC 'Y' code.
4614		If no netted area AC or DC positions or netted external schedule can be found for
4045		
4615		the control area this rule skinned
4615 4616		the control area this rule skipped.

Page 110 of 115



4617		Justification:
4618		In the Reporting Information Market Document, issued by PEVF or CGMA, the
4619		FIC 'Y' code is found in the domain.mRTD, in the TGM it is the value of
4620		attribute entspe:IdentifiedObject.EnergyIdentCodeFic for the cim:ControlArea
4621		instance.
4622		
4623		Message
4624		cim:ControlArea netInterchange deviates more than INTERCH IMBALANCE WARNING MW from
4625		netted area nosition
4020		
4020	Pulo	NotIntonchangeMatch2 Loval, 7 Sevenity, EPPOP Template, BuleModel
4021	Ruie.	Netificer changematch2 level. 7 Severity. ERROR remptate. Rutemodel
4020		Deteile
4029		Details:
4630		For every clm:ControlArea of type interchange, the value of
4631		cim:controlArea.netinterchange should
4632		not deviate more than INTERCH_IMBALANCE_ERROR MW from the sum of the netted
4633		area AC and DC positions in the aggregated netted external schedules
4634		(PEVF or CGMA) for the same scenarioTime and with the same EIC 'Y' code.
4635		If no netted area AC or DC positions or netted external schedule can be found for
4636		the control area this rule skipped.
4637		
4638		Justification:
4639		In the Reporting Information Market Document, issued by PEVF or CGMA,
4640		the EIC 'Y' code is found in the domain.mRID, in the IGM it is the value
4641		of attribute entsoe:IdentifiedObject.EnergyIdentCodeEic for the
4642		cim:ControlArea instance.
4643		
4644		Message:
4645		cim:ControlArea netInterchange deviates more than INTERCH_IMBALANCE_ERROR MW from
4646		netted area position.
4647		
4648	Rule:	<pre>InconsistentTnBaseVoltage Level: 7 Severity: WARNING Template: RuleModel</pre>
4649		
4650		Details:
4651		All equipment with own cim:BaseVoltages connected to a TN shall have a
4652		cim:BaseVoltage.nominalVoltage that deviates no more than BOUNDARY BV MAX DIFF
4653		from the cim:BaseVoltage.nominalVoltage of the boundary point.
4654		
4655		
4656		Justification:
4657		If the cim:BaseVoltage.nominalVoltage differs this may indicate a topology error.
4658		
4659		Message:
4660		cim:BaseVoltages.nominalVoltages at a cim:TopologicalNode differs
4661		more than BOUNDARY BV MAX DIFF

Page 111 of 115



10 LEVEL 8 VALIDATION: CONVERGENCE BEHAVIOUR AND CGM 4663

PLAUSIBILITY 4664

10.1 **CONVERGENCE BEHAVIOUR OF IGM** 4665

- 4666 In this section the focus is on the convergence behaviour of the Individual Grid Model, before the 4667 actual merge is initiated.
- 4668 The Individual Grid Models are expected to be based on a solved model in the local tool, which is expressed in the operating assumptions and topology derived from this solved case. 4669
- The only IGM specific rule is IGMConvergence first in section 10.3. 4670

10.2 PLAUSIBILITY OF CGM 4671

In this section the focus is on calculation results that impact credibility of the CGM solution, because 4672 the modelling assumptions for the IGMs with respect to the boundary flows do not reflect reality. 4673

10.3 VALIDATION RULES 4674

4675	Rule:	IGMConvergence Level: 8 Severity: ERROR Template: RuleModel
4676		
4677		Details:
4678		This rule appies to IGMs only.
4679		It shall be possible to solve the power flow with the following power
4680		flow settings:
4681		- Full Newton Raphson power flow algorithm.
4682		- Switched shunt adjustment must be set to enabled for shunts used for
4683		voltage regulation.
4684		- Transformer tap adjustment is set to enabled.
4685		 Q limits shall be respected for EquivalentInjection,
4686		ExternalNetworkInjection, SynchronousMachines, SVCs and
4687		SynchronousCondensers (also for slack node/swing bus).
4688		- Distributed generation slack is set to enabled
4689		(proportional to GeneratingUnit.normalPF).
4690		- Maximum mismatch is set to 0.1 MW and 0.1 MVAr per node.
4691		 Controlled node voltage error convergence tolerance = 0.0001 pu
4692		(The largest difference between actual and scheduled voltage magnitude in
4693		per unit at each node where voltage is subject to control to a set point,
4694		and for which at least one of the devices participating in the control of
4695		bus voltage to its set point is not at a reactive power limit, must be less
4696		than the controlled bus voltage error convergence tolerance)
4697		
4698		Justification:
4699		
4700		Message:
4701		Power flow could not be calculated for IGM with required settings.
4702		Check diagnostic messages
4703		
4704	Rule:	CGMConvergence Level: 8 Severity: WARNING Template: RuleModel
4705		

Page 112 of 115



4706		Details:
4707		This rule applies to CGMs only.
4708		It shall be possible to solve the power flow with the following power
4709		flow settings:
4710		- Full Newton Raphson power flow algorithm.
4711		- Switched shunt adjustment must be set to enabled for shunts used for
4712		voltage regulation.
4713		- Transformer tap adjustment is set to enabled.
4714		- O limits shall be respected for EquivalentInjection.
4715		ExternalNetworkInjection. SynchronousMachines. SVCs and
4716		SynchronousCondensers (also for slack node/swing bus)
4710 A717		- Area interchange control is set to enabled
4718		- Maximum mismatch is set to 0.1 MW and 0.1 MV/An nen node
4710		Controlled node veltage ennen convengence telenance - 0 0001 nu
4719		- controlled houe voltage enror convergence colerance = 0.0001 pu
4720		(The largest difference between actual and scheduled voltage magnitude in
4721		per unit at each node where voltage is subject to control to a set point,
4722		and for which at least one of the devices participating in the control of
4723		bus voltage to its set point is not at a reactive power limit, must be less
4/24		than the controlled bus voltage error convergence tolerance)
4725		
4726		Justification:
4727		
4728		Message:
4729		Power flow could not be calculated for CGM with required settings.
4730		Check diagnostic messages
4731		
4732	Rule:	TIConvergenceStatMissing Level: 8 Severity: WARNING Template: RuleModel
4733		
4734		
4735		Convergence status for cim: lopologicalisland is included in the
4/36		cim:IdentifiedObject.description of the cim:TopologicalIsland.
4737		The values are "diverged" or "converged".
4738		
4739		Justification:
4740		It should be possible to conclude if a cim:TopologicalIslands has diverged or
4741		converged.
4742		
4743		Message:
4744		Convergence status missing for cim:TopologicalIsland
4745		
4746	Rule:	TIConvergenceStatDiverged Level: 8 Severity: WARNING Template: RuleModel
4747		
4748		Details:
4749		Convergence status for cim:TopologicalIsland is diverged. The
4750		cim:IdentifiedObject.description of the cim:TopologicalIsland shall then
4751		contain the text "diverged".
4752		
4753		Justification
4754		It should be possible to conclude if a cime Topological Islands has diverged on
4755		converged
4756		conver geu.
4757		Massaget
4750		riessage.
4100		convergence status is aivergen for cimtioporogicalisiana
4709	D 1	COMCanyonganaa Dalayad Layala O. Canaditas EDDOD. Tamalatas D. Lawadal
4700	ките:	Comconvergenceketaxea Levet: & Severity: EKKUK Template: RuleModel
4/61		

Page 113 of 115



4762 Details: 4763 This rule applies to CGMs only. 4764 It shall be possible to solve the power flow with the following power 4765 flow settings: 4766 - Full Newton Raphson power flow algorithm. - Q limits shall be ignored (also for slack node/swing bus) meaning 4767 4768 unlimited reactive resources. 4769 - Area interchange control is set to enabled. 4770 - Maximum mismatch is set to 0.5 MW and 0.5 MVAr per node. 4771 - Controlled node voltage error convergence mismatch = 0.0001 pu 4772 (The largest difference between actual and scheduled voltage magnitude in 4773 per unit at each node where voltage is subject to control to a setpoint, 4774 and for which at least one of the devices participating in the control of 4775 bus voltage to its setpoint is not at a reactive power limit, must be less 4776 than the controlled bus voltage error convergence mismatch) 4777 Justification: 4778 4779 4780 Message: 4781 Power flow could not be calculated for CGM with relaxed Q limits. 4782 Check diagnostic messages 4783 4784 Rule: CGMVoltageProfile Level: 8 Severity: WARNING Template: RuleModel 4785 4786 Details: 4787 For every energized cim:TopologicalNode, the value of cim:SvVoltage.v 4788 should be lower than or equal to the value of cim:VoltageLimit.value 4789 associated with cim:OperationalLimitType.limitType=highVoltage and higher 4790 than or equal to the value of cim:VoltageLimit.value associated with 4791 cim:OperationalLimitType.limitType=lowVoltage 4792 4793 Justification: 4794 Considering the Power Flow settings, all voltage should be 4795 within defined operational limits. 4796 See IEC TS 61970-600-2:2017 section 6.8.7. 4797 4798 Message: 4799 VoltageLimit violation 4800 4801 Rule: CGMCongestion Level: 8 Severity: WARNING Template: RuleModel 4802 4803 Details: 4804 There should be no base case violations considering PATL limits. 4805 4806 Justification: 4807 4808 Message: 4809 Base case violation 4810 4811 Rule: CGMTieFlowImbalance Level: 8 Severity: WARNING Template: RuleModel 4812 4813 Details: 4814 The sum of the solved tie flows for each cim:ControlArea of type 4815 interchange shall equal the cim:ControlArea.netInterchange plus/minus 4816 an INTERCH IMBALANCE EMF MW. I.e. 4817 o TFS less or equal than cim:ControlArea.netInterchange +

Page 114 of 115



4818	INTERCH_IMBALANCE_EMF_MW
4819	o TFS greater or equal than cim:ControlArea.netInterchange -
4820	INTERCH_IMBALANCE_EMF_MW
4821	Where TFS, the TieFlow sum, is computed as
4822	<pre>o TFS = sum(cim:SvPowerFlow.p)</pre>
4823	cim:SvPowerFlow is not available at cim:TieFlow Terminals and must be
4824	picked up from the cim:EquivalentInjection Terminal corresponding to the
4825	tie flow Terminal.
4826	
4827	Justification:
4828	
4829	Message:
4830	The cim:TieFlow sum deviates from the cim:ControlArea interchange
4831	more than INTERCH_IMBALANCE_EMF MW
4832	
4833	

4834 **11 SUPPORTING DOCUMENTS, FOR INFORMATION ONLY**

4835 **11.1 INTRODUCTION**

4836 This section contain refrences to documents that support the rules.

4837 **11.2 CGMPROCESSCONFIGURATIONDATA**

- 4838 The CgmProcessConfigurationData document provide all enumerations and shared resources 4839 previously included in this document (QoCDCv3.2).
- 4840 It is available for download from ENTSO-E file repository together with the this (QoCDCv3.2) 4841 document.
- 4842 Note that the referenced document contain data as known at the writing of this document and is
 4843 provided for information only. The objective is to collect all configuration data from the CGM Building
 4844 Process in a master data document to be released by the CGM Programme.

4845 **11.3 RULE DESCRIPTIONS**

- In section 2.11 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 avoiding copy and pasting from the QoCDC word
 document. The xml documents are provided for information only.
- 4850 The XML documents can be found in the archive "QoDCRules 3 edition.zip" that is available for 4851 downlaod from ENTSO-E file repository together with the this (QoCDCv3.2) document.

Page 115 of 115