Long Term Development Statement (LTDS)

Grid Modelling Appendix 7: LTDS Subset of CGMES Constraints Descriptions

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This document outlines the subset of CGMES v3.0 constraints which apply to data supplied under the Grid Modelling section of the Long Term Development Statement (LTDS) Form of Statement.

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1 Introduction

This Appendix summarises set of CGMES v3.0 OCL/SHACL constraints which apply to LTDS data exchanged under the Grid Modelling section of the Long Term Development Statement (LTDS) Form of Statement. They are excerpted from the Application Profiles v3.0.1 of ENTSO-E's Conformity Assessment Scheme v3.0.11.

The ID naming convention of the constraints is as follows.
"{rule.Type}:{rule.Standard}:{rule.Profile}:{rule.Property}:{rule.Name}"
where

- rule.Type: C – for constraint; R – for requirement
- rule.Standard: the number of the standard e.g., 301 for 61970-301, 456 for 61970-456, 13 for 61968-13. 61970-600 specific constraints refer to 600 although they are related to one or combination of the 61970-450 series profiles. LTDS constraints use LTDS as the Standard.
- rule.Profile: the abbreviation of the profile
    - EQ for Equipment
    - SC for ShortCircuit
    - GL for GeographicalLocation
    - SSH for SteadyStateHypothesis
    - TP for Topology
    - SV for StateVariables
    - DL for DiagramLayout
    - SYSCAP for SystemCapacity
    - If set to "ALL" the constraint is applicable to all profiles.
- rule.Property: for UML classes, the name of the class, for attributes and associations, the name of the class and attribute or association end, e.g., EnergyConsumer, IdentifiedObject.name, etc. If set to "NA" the property is not applicable to a specific UML element.
- rule.Name: the name of the rule. It is unique for the same property.

The rule names are strings intended to assist in human understanding. They are not intended for machine processing.

[1] https://www.entsoe.eu/Documents/CIM_documents/Grid_Model_CIM/IEC61970-600-2_CGMES_3_0_1_ApplicationProfiles.zip

2 Subset of CGMES Constraints Applicable to LTDS Data Exchanges

The table below overviews the set of constraints excerpted from the Application Profiles v3.0.1 of ENTSO-E's Conformity Assessment Scheme v3.0.1 which are applicable to LTDS data exchanges.

ID	Element (class, attribute, association)	Constraint description	Constraint message
Physical (Equipment)			
C:301:EQ:ACDCTerminal.sequenceNumber:numbering	ACDCTerminal.sequenceNumber	The sequence numbering starts with 1 and additional terminals should follow in increasing order. The first terminal is the "starting point" for a two terminal branch.	There is no terminal with sequenceNumber=1 or the numbering is not unique.
C:301:EQ:ACLineSegment:baseVoltage	ACLineSegment	The BaseVoltage at the two ends of ACLineSegments in a Line shall have the same BaseVoltage.nominalVoltage. However, boundary lines may have slightly different BaseVoltage.nominalVoltages and variation is allowed. Larger voltage difference in general requires use of an equivalent branch.	The ACLineSegment has different BaseVoltage.nominalVoltage at the two end of the ACLineSegment. Voltage at end 1 is: .... Voltage at end 2 is: .....
C:452:EQ:ACLineSegment.r:valueRange	ACLineSegment.r	ACLineSegment.r shall be a positive value or zero.	The value is negative.
C:452:EQ:ACLineSegment.x:valueRange	ACLineSegment.x	The attribute shall be a positive value. As negative reactance values are not allowed for ACLineSegment-s it is recommended to model series compensators explicitly.	The value is negative or zero.
C:301:EQ:ApparentPowerLimit.normalValue:valueRange	ApparentPowerLimit.normalValue	The attribute shall be a positive value or zero.	The value is negative.
C:301:EQ:BaseVoltage.nominalVoltage:valueRange	BaseVoltage.nominalVoltage	Shall be a positive value and not zero.	The value is negative or zero.
C:301:EQ:BatteryUnit.ratedE:valueRange	BatteryUnit.ratedE	The attribute shall be a positive value.	The value is negative or zero.
C:452:EQ:BusbarSection:containment	BusbarSection	For BusbarSection the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type VoltageLevel or Bay (when a disconnector is splitting a busbar section in two).	The containment is either missing or it is not Bay or VoltageLevel.
C:301:EQ:BusbarSection:numberOfTerminals	BusbarSection	A bus bar section may have many physical terminals but for analysis is modelled with exactly one logical terminal.	The BusbarSection has more than one terminal.
C:301:EQ:ConductingEquipment:oneTerminal	ConductingEquipment	All other ConductingEquipment leaf classes (notably also including Clamp and BusbarSection) and DCConductingEquipment have a single terminal.	The ConductingEquipment does not have the required number of Terminal-s.

C:301:EQ:ConductingEquipment:twoTerminals	ConductingEquipment	The following ConductingEquipment classes have two terminals: ACLineSegment, DCLineSegment, DCSeriesDevice, DCSwitch (and its specializations), DCChopper, Switch and all its specializations (including Jumper, Fuse, Breaker, Disconnector, LoadBreakSwitch, and Cut), SeriesCompensator, and EquivalentBranch. The PowerTransformer class typically has two terminals, but may also have one or more terminals. For example a zig-zag connected grounding transformer may have one terminal. Three terminal transformers are commonly used in transmission systems and in special cases transformers may have four, five, or more terminals.	The ConductingEquipment does not have the required number of Terminal-s.
C:301:EQ:ConductingEquipment.BaseVoltage:usage	ConductingEquipment.BaseVoltage	Use only when there is no voltage level container used and only one base voltage applies. For example, not used for transformers.	The association ConductingEquipment.BaseVoltage is defined for a ConductingEquipment contained in a VoltageLevel.
C:452:EQ:ConductingEquipment.BaseVoltage:whereRequired	ConductingEquipment.BaseVoltage	The ConductingEquipment.BaseVoltage association is required for the following ConductingEquipment: ACLineSegment, EquivalentBranch and SeriesCompensator. For all other Equipment-s, not contained in a VoltageLevel, the association ConductingEquipment.BaseVoltage can be provided (as it is optional), however the association to BaseVoltage coming from the container or transformer ends takes precedence.	The association ConductingEquipment.BaseVoltage is not provided.
C:452:EQ:Conductor:containment	Conductor	For Conductor (ACLineSegment) the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Line.	The containment is either missing or it is not Line.
C:301:EQ:CurrentLimit.normalValue:valueRange	CurrentLimit.normalValue	The attribute shall be a positive value or zero.	The value is negative.
C:452:EQ:CurveData.Curve:reactive	CurveData	If CurveData.Curve is a ReactiveCapabilityCurve, the CurveData.y2value shall be greater than or equal to CurveData.y1value.It is not allowed that all CurveData.y2value values are equal to CurveData.y1value values.	Either CurveData.y2value is not >= CurveData.y1value or CurveData.y2value = CurveData.y1value for all curve points.
C:452:EQ:Disconnector:containment	Disconnector	For Disconnector the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Bay, VoltageLevel, DCConverterUnit or Line when outside substation.	The containment is either missing or it is not Bay, VoltageLevel, DCConverterUnit or Line.

C:452:EQ:EnergyConnection:containment	EnergyConnection	For EnergyConnection (EnergySource, EnergyConsumer, NonConformLoad, ConformLoad, LinearShuntCompensator, NonlinearShuntCompensator, ExternalNetworkInjection, StaticVarCompensator, SynchronousMachine, AsynchronousMachine) the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type VoltageLevel.	The containment is either missing or it is not VoltageLevel.
C:301:EQ:Equipment.aggregate:notUsed	Equipment.aggregate	The attribute is not used for EquivalentBranch, EquivalentShunt and EquivalentInjection.	Not allowed property (attribute).
C:452:EQ:Fuse:containment	Fuse	For Fuse the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Bay, VoltageLevel, DCConverterUnit or Line when outside substation.	The containment is either missing or it is not Bay, VoltageLevel, DCConverterUnit or Line.
C:301:EQ:GeneratingUnit.ratedNetMaxP:valueRange	GeneratingUnit.ratedNetMaxP	The attribute shall be a positive value.	The value is negative or zero.
C:600:EQ:GeographicalRegion:EQ__4	GeographicalRegion	Only one GeographicalRegion shall be exchanged per MAS. In case multiple Model Authority have a need to have the same GeographicalRegion (i.e. multiple TSOs in a country) the class GeographicalRegion shall be present in all Model Authority models and shall have different rdf:ID, but can have same name/description. There is no specific naming convention defined. Note that this is mainly applicable for exchanging transmission data. Additional clarifications when dealing with distribution data are not defined currently.	Muliple GeographicalRegion-s are present.
C:452:EQ:GroundDisconnector:containment	GroundDisconnector	For GroundDisconnector the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Bay, VoltageLevel, DCConverterUnit or Line when outside substation.	The containment is either missing or it is not Bay, VoltageLevel, DCConverterUnit or Line.
C:452:ALL:IdentifiedObject.description:stringLength	IdentifiedObject.description	The string IdentifiedObject.description is maximum 256 characters.	String length is greater than 256 characters.
C:452:ALL:IdentifiedObject.name:stringLength	IdentifiedObject.name	The string IdentifiedObject.name has a maximum of 128 characters.	String length is greater than 128 characters.
C:301:EQ:LimitKind.patl:numberOfLimitType	LimitKind.patl	The OperationnalLimitType.isInfiniteDuration is set to true. There shall be only one OperationalLimitType of kind PATL per OperationalLimitSet if the PATL is ApparentPowerLimit, ActivePowerLimit, or CurrentLimit for a given Terminal or Equipment.	Either there is more than one PATL defined for a given OperationalLimitSet or OperationnalLimitType.isInfinite

			Duration is not set to true for PATL type.
C:452:EQ:LinearShuntCompensator.gPerSection:valueRange	LinearShuntCompensator.gPerSection	LinearShuntCompensator.gPerSection shall be a positive value or zero.	The value is negative.
C:301:EQ:NonlinearShuntCompensatorPoint:numberOfInstances	NonlinearShuntCompensatorPoint	The number of NonlinearShuntCompenstorPoint instances associated with a NonlinearShuntCompensator shall be equal to ShuntCompensator.maximumSections.	The number of NonlinearShuntCompenstorPoint instances associated with a NonlinearShuntCompensator does not equal to ShuntCompensator.maximumSections.
C:452:EQ:NonlinearShuntCompensatorPoint.g:valueRange	NonlinearShuntCompensatorPoint.g	NonlinearShuntCompensatorPoint.g shall be a positive value or zero.	The value is negative.
C:452:EQ:PhaseTapChanger:controlModeP	PhaseTapChanger	The association TapChanger.TapChangerControl for PhaseTapChanger-s shall only point to a TapChangerControl that has the following control modes for RegulatingControl.mode: activePower or voltage.	Unallowed regulating control mode for a PhaseTapChanger.
C:301:EQ:PhaseTapChangerAsymmetrical.windingConnectionAngle:valueRange	PhaseTapChangerAsymmetrical.windingConnectionAngle	The attribute can only be multiples of 30 degrees. The allowed range is -150 degrees to 150 degrees excluding 0.	The value is not an integer, multiples of 30 degrees in the range of -150 degrees to 150 degrees excluding 0.
C:301:EQ:PowerTransformer:associationNotUsed	PowerTransformer	The inherited association ConductingEquipment.BaseVoltage should not be used. The association from TransformerEnd to BaseVoltage should be used instead.	The inherited association ConductingEquipment.BaseVoltage is used.
C:452:EQ:PowerTransformer:containment	PowerTransformer	For PowerTransformer the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Substation or DCConverterUnit. For the case of a transformer that connects two substations, the terminal of one of the PowerTransformerEnd-s can be connected to a ConnectivityNode defined in another substation.	The containment is either missing or it is not Substation or DCConverterUnit.
C:301:EQ:PowerTransformerEnd:secondWindingValues	PowerTransformerEnd	1) for a two Terminal PowerTransformer the high voltage (TransformerEnd.endNumber=1) PowerTransformerEnd has non zero values on r, r0, x, and x0 while the low voltage (TransformerEnd.endNumber=2) PowerTransformerEnd has zero values for r, r0, x, and x0. Parameters are always provided, even if the	Non-zero values for the PowerTransformerEnd with TransformerEnd.endNumber=2 for a two Terminal PowerTransformer.

		PowerTransformerEnds have the same rated voltage. In this case, the parameters are provided at the PowerTransformerEnd which has TransformerEnd.endNumber equal to 1.	
C:301:EQ:PowerTransformerEnd:terminalConsistency	PowerTransformerEnd	In all cases a PowerTransformer models a group of physical devices acting together to transform power among terminals and in one physical location.	The Terminal referenced by TransformerEnd.Terminal points to a PowerTransformer which is different than the referenced element via PowerTransformerEnd.PowerTransformer.
C:452:EQ:PowerTransformerEnd.b:valueRange	PowerTransformerEnd.b	PowerTransformerEnd.b shall be negative value or zero. Negative magnetising branch susceptance (PowerTransformerEnd.b) means inductive reactive power losses in no load.	The value is positive.
C:452:EQ:PowerTransformerEnd.g:valueRange	PowerTransformerEnd.g	PowerTransformerEnd.g shall be positive value or zero. Positive magnetising branch conductance (PowerTransformerEnd.g) means positive active power losses in no load.	The value is negative.
C:301:EQ:PowerTransformerEnd.r:valueRange	PowerTransformerEnd.r	The attribute shall be equal to or greater than zero for non-equivalent transformers.	The value is negative for a non-equivalent transformer.
C:301:EQ:PowerTransformerEnd.ratedS:valueRange	PowerTransformerEnd.ratedS	The attribute shall be a positive value.	The value is negative or zero.
C:301:EQ:PowerTransformerEnd.ratedS:valueRange2winding	PowerTransformerEnd.ratedS	For a two-winding transformer the values for the high and low voltage sides shall be identical.	The value is different for a two-winding transformer.
C:301:EQ:PowerTransformerEnd.ratedU:valueRange	PowerTransformerEnd.ratedU	A high voltage side, as given by TransformerEnd.endNumber, shall have a ratedU that is greater than or equal to ratedU for the lower voltage sides. The attribute shall be a positive value.	The PowerTransformerEnd.ratedU does not fuifil one of the following: 1) it is not a positive value; 2) the value of the high voltage side shall be greater than or equal to ratedU for the lower voltage sides.
C:452:EQ:PowerTransformerEnd.x:PowerTransformerEndX	PowerTransformerEnd.x	For cim:PowerTransformerEnds the following rules applies - two-winding transformer the high voltage end cim:PowerTransformerEnd.x shall be greater than 0.01 Ohm - two-winding transformer the low voltage end cim:PowerTransformerEnd.x = 0	One of of the following occurs: 1) The value is not >= 0.01 for a two-winding transformer. 2) The absolute value is not >=0.01 for a three-winding transformer.

		- three-winding transformer all ends abs(cim:PowerTransformerEnd.x) shall be greater than 0.01 Ohm	
C:452:EQ:PowerTransformerEnd.x:value	PowerTransformerEnd.x	Transformers with zero series reactance do not exist. PowerTransformerEnd.x of high voltage end in case of a two winding transformer shall be a positive value. In case of a three winding transformer the PowerTransformerEnd.x shall not be zero.	One of of the following occurs: 1) The value is negative or zero for wingding one of a two-winding transformer. 2) The value is zero for a three-winding transformer.
C:452:EQ:ProtectedSwitch:containment	ProtectedSwitch	For ProtectedSwitch (Breaker, DisconnectingCircuitBreaker, LoadBreakSwitch) the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type Bay, VoltageLevel or DCConverterUnit.	The containment is either missing or it is not Bay, VoltageLevel or DCConverterUnit.
C:452:EQ:RatioTapChanger:controlMode	RatioTapChanger	The association TapChanger.TapChangerControl for RatioTapChanger-s shall only point to a TapChangerControl the has the following control modes for RegulatingControl.mode: voltage, reactivePower and powerFactor.	Unallowed regulating control mode for a RatioTapChanger.
C:301:EQ:ReactiveCapabilityCurve:yvalues	ReactiveCapabilityCurve	For each active power value there is a corresponding high and low reactive power limit value. Typically there will be a separate curve for each coolant condition, such as hydrogen pressure.	CurveData associated with a ReactiveCapabilityCurve does not have both .y1value and .y2value defined.
C:600:EQ:ReactiveCapabilityCurve:units	ReactiveCapabilityCurve	For a ReactiveCapabilityCurve associated with SynchronousMachine, the Curve.xUnit shall be set to UnitSymbol.W and both Curve.y1Unit and Curve.y2Unit shall be set to UnitSymbol.VAr. As the multiplier is not included in the profile it is defined the same as the multiplier used for datatype ActivePower and ReactivePower, i.e. UnitMultiplier.M.	Not correct or not provided units of a ReactiveCapabilityCurve of a SynchronousMachine.
C:452:EQ:ReactiveCapabiltyCurve.CurveData:xvalue	ReactiveCapabiltyCurve.CurveData	All CurveData.xvalue for a given ReactiveCapabilityCurve shall be unique, e.g. it is not allowed for two or more .xvalue to have the same float value for a given ReactiveCapabilityCurve.	CurveData.xvalue for a given ReactiveCapabilityCurve are not unique.
C:452:EQ:RegulatingControl:RegulatingEquipment	RegulatingControl	A RegulatingControl that is not a TapChangerControl must have at least one regulating equipment associated through the RegulatingCondEq.RegulatingControl. That is, a RegulatingControl cannot exist without some equipment using it for regulating.	The RegulatingControl is not associated with an Equpment via RegulatingCondEq.RegulatingControl.

C:452:EQ:RegulatingControl:samePoint	RegulatingControl	A RegulatingControl will have associations to one or more instances of RegulatingCondEq and an association to a Terminal. The ConnectivityNode associated with the Terminal is the regulated point. It is common to have cases where multiple pieces of equipment regulate ConnectivityNodes that under normal network topology are associated with the same TopologicalNode. In this case, the same instance of RegulatingControl should be used by all of those regulating equipment if possible. If it is not possible, such as the case where a SynchronousMachine and a RatioTapChanger are regulating the same point using associations to instances of RegulatingControl and TapChangerControl, the number of instances of RegulatingControl and TapChangerControl should be minimized. Additionally, the target and deadband values for the same regulated point should not be contradictory. Profile restriction: If multiple instances of RegulatingControl control the same regulation point, the targetValues must not be contradictory.	Enabled RegulatingControl-s of the same type associated with the same TopologicalNode have different target values. RegulatingControl ID: {...}.
C:301:EQ:RegulatingControl:terminalConnectivityNode	RegulatingControl	The specified terminal shall be associated with the connectivity node of the controlled point. The most specific subtype of RegulatingControl shall be used in case such equipment participate in the control, e.g. TapChangerControl for tap changers.	The Terminal referenced by the RegulatingControl is not associated with a ConnectivityNode.
C:452:EQ:SeriesCompensator:containment	SeriesCompensator	For SeriesCompensator the association Equipment.EquipmentContainer is required and shall point to EquipmentContainer of type VoltageLevel when in substation, DCConverterUnit or Line when outside substation.	The containment is either missing or it is not VoltageLevel, Line or DCConverterUnit.
C:301:EQ:SeriesCompensator:numberOfTerminals	SeriesCompensator	It is a two terminal device.	The SeriesCompensator does not have two terminals.
C:452:EQ:ShuntCompensator:controlMode	ShuntCompensator	For ShuntCompensator, the association RegulatingCondEq.RequlatingControl shall only point to a RequlatingControl that has the following control modes for RegulatingControl.mode: voltage, reactivePower and powerFactor.	Unallowed regulating control mode for a ShuntCompensator.
C:301:EQ:ShuntCompensator:numberOfTerminals	ShuntCompensator	ShuntCompensator is a single terminal device.	The ShuntCompensator does not have one terminal.
C:301:EQ:ShuntCompensator.nomU:nominalVoltageDifference	ShuntCompensator.nomU	This should normally be within 10% of the voltage at which the capacitor is connected to the network.	The value differs with more than 10% of the nominal voltage

			abtained via the containment to VoltageLevel.
C:301:EQ:ShuntCompensator.normalSections:valueRangePair	ShuntCompensator.normalSections	The value shall be between zero and ShuntCompensator.maximumSections.	The value is either negative or greater than ShuntCompensator.maximumSections.
C:452:EQ:ShuntCompensator.voltageSensitivity:valueRange	ShuntCompensator.voltageSensitivity	The ShuntCompensator.voltageSensitivity attribute shall be greater than zero.	The value is negative or zero.
C:452:EQ:StaticVarCompensator:controlMode	StaticVarCompensator	For StaticVarCompensator, the association RegulatingCondEq.RequlatingControl is required and shall only point to a RequlatingControl that has the following control modes for RegulatingControl.mode: voltage and reactivePower.	Unallowed regulating control mode for a StaticVarCompensator or not allowed usage of StaticVarCompensator.sVCControlMode or StaticVarCompensator.voltageSetPoint.
C:301:EQ:StaticVarCompensator.capacitiveRating:valueRange	StaticVarCompensator.capacitiveRating	Shall always be positive.	The value is negative or zero.
C:301:EQ:StaticVarCompensator.inductiveRating:valueRange	StaticVarCompensator.inductiveRating	Shall always be negative.	The value is positive or zero.
C:301:EQ:StaticVarCompensator.slope:valueRange	StaticVarCompensator.slope	The attribute shall be a positive value or zero.	The value is negative.
C:600:EQ:Substation:count	Substation	The number of Substation-s shall reflect the design of the power system. Cases of a single Substation in a power system model or having a Substation per VoltageLevel are reported as warnings.	The model has either one Substation or a Substation per VoltageLevel. Number of Substation-s: .... Number of VoltageLevel-s: .....
C:452:EQ:Switch:connection	Switch	Switch and its subclasses shall only connect to ConnectivityNode-s that are contained in either the same VoltageLevel or in different VoltageLevel-s which have the same BaseVoltage.	Switch (or its subclasses) connects ConnectivityNode-s that are not contained in either the same VoltageLevel or in different VoltageLevel-s which have the same BaseVoltage.
C:301:EQ:Switch:numberOfTerminals	Switch	All switches are two terminal devices including grounding switches.	The Switch (or subclass) does not have two terminals.

C:301:EQ:Switch.ratedCurrent:valueRange	Switch.ratedCurrent	The attribute shall be a positive value.	The value is negative or zero.
C:452:EQ:SynchronousMachine:controlMode	SynchronousMachine	For SynchronousMachine, the association RegulatingCondEq.RequlatingControl shall only point to a RequlatingControl that has the following control modes for RegulatingControl.mode: voltage, reactivePower and powerFactor.	Unallowed regulating control mode for a SynchronousMachine.
C:452:EQ:SynchronousMachine:reactiveLimits	SynchronousMachine	ReactiveCapabilityCurve-s are not required if the reactive power limits of the SynchronousMachine do not vary with real power output. SynchronousMachine.minQ and SynchronousMachine.maxQ are required if SynchronousMachine.InitialReactiveCapabilityCurve is missing. If the association SynchronousMachine.InitialReactiveCapabilityCurve is provided it takes precedence to the information provided by the attributes SynchronousMachine.minQ and SynchronousMachine.maxQ. However, if both SynchronousMachine.minQ, SynchronousMachine.maxQ and ReactiveCapabilityCurve are present, the SynchronousMachine.minQ shall be equal to min of CurveData.y1value-s and SynchronousMachine.maxQ shall be equal to max CurveData.y2value-s.	One of the following is not fulfilled: 1)Neither SynchronousMachine.minQ, SynchronousMachine.maxQ nor SynchronousMachine.InitialReactiveCapabilityCurve are provided 2) Either SynchronousMachine.minQ is not equal to min of CurveData.y1value-s or SynchronousMachine.maxQ is not equal to max CurveData.y2value-s.
C:301:EQ:TapChanger:multipleTypes	TapChanger	Multiple tap changers can be combined within one power transformer, but to avoid interpretation issues only one phase shifting and one ratio changing tap changer shall be modelled on any given terminal.	
C:301:EQ:TapChanger.highStep:valueRangePair	TapChanger.highStep	The attribute shall be greater than lowStep.	The value of TapChanger.lowStep is greater than or equal to the value of TapChanger.highStep.
C:301:EQ:TapChanger.ltcFlag:tapChangerControl	TapChanger.ltcFlag	When TapChanger.ltcFlag=false and TapChanger.TapChangerControl is present an artificial tap changer can be used to simulate control behaviour in power flow.	An artificial tap changer is used to simulate control behaviour in power flow.
C:301:EQ:TapChanger.neutralStep:valueRangePairFrom	TapChanger.neutralStep	The attribute shall be equal to or greater than lowStep and equal or less than highStep.	The value of TapChanger.lowStep is greater than the value of TapChanger.neutralStep.
C:301:EQ:TapChanger.neutralStep:valueRangePairTo	TapChanger.neutralStep	The attribute shall be equal to or greater than lowStep and equal or less than highStep.	The value of TapChanger.neutralStep is

			greater than the value of TapChanger.highStep.
C:600:EQ:TapChanger.neutralU:ValueRangePair	TapChanger.neutralU	The TapChanger.neutralU shall be the same as PowerTransformerEnd.ratedU.	The value is not the same as the PowerTransformerEnd.ratedU.
C:301:EQ:TapChanger.neutralU:	TapChanger.neutralU	Normally neutralU of the tap changer is the same as ratedU of the PowerTransformerEnd, but it can differ in special cases such as when the tapping mechanism is separate from the winding more common on lower voltage transformers. This attribute is not relevant for PhaseTapChangerAsymmetrical, PhaseTapChangerSymmetrical and PhaseTapChangerLinear.	
C:301:EQ:TapChanger.normalStep:valueRangePairFrom	TapChanger.normalStep	The attribute shall be equal to or greater than lowStep and equal to or less than highStep.	The value of TapChanger.lowStep is greater than the value of TapChanger.normalStep.
C:301:EQ:TapChanger.normalStep:valueRangePairTo	TapChanger.normalStep	The attribute shall be equal to or greater than lowStep and equal to or less than highStep.	The value of TapChanger.normalStep is greater than the value of TapChanger.highStep.
C:452:EQ:TapChangerControl:remoteQcontrol	TapChangerControl	A power transformer cannot efficiently control reactive power flow on remote terminals. Therefore, a TapChangerControl controlling reactive power flow shall only control the flow at one of the Terminal-s associated with PowerTransformerEnd-s of the PowerTransformer where the TapChanger is located. Control of a remote Terminal not associated with the PowerTransformer that has the TapChanger is not allowed. This constraint defines that multiple TapChanger-s cannot be controlled by the same TapChangerControl.	TapChangerControl with RegulatingControl.mode equals reactivePower controls a Terminal which is not associated with PowerTransformerEnd-s of the PowerTransformer where the TapChanger is located.
C:452:EQ:Terminal:connection	Terminal	Terminal-s of the two sides of a two-terminal ConductingEquipment (or any of its subclasses) shall not be connected to the same ConnectivityNode.	Terminal-s of a two-terminal ConductingEquipment (or any of its subclasses) connect to the same ConnectivityNode.
C:600:EQ:Terminal:EXCH8ConnectivityNode	Terminal	- ConnectivityNode object instances shall be included in Core Equipment profile instance; - The association end Terminal.ConnectivityNode is optional in the Core Equipment profile instance. However, a model including topology requires Terminals to have an association to either ConnectivityNode, TopologyNode or both;	The Terminal is not associated with a ConnectivityNode.

		- The association end Terminal.TopologicalNode is required in cases where a RegulatingControl is associated with a Terminal;	
C:301:EQ:Terminal.phases:consistencyEquipment	Terminal.phases	The phase code on terminals connecting same ConnectivityNode or same TopologicalNode as well as for equipment between two terminals shall be consistent.	The phase codes for terminals of 2-terminal equipment are not consistent. Terminal 1 code:…. Terminal 2 code: ……
C:301:EQ:Terminal.phases:phaseCode	Terminal.phases	If the attribute is missing, three phases (ABC) shall be assumed, except for terminals of grounding classes (specializations of EarthFaultCompensator, GroundDisconnector, and Ground) which will be assumed to be N. Therefore, phase code ABCN is explicitly declared when needed, e.g. for star point grounding equipment.	Terminal.phases differes from PhaseCode.N for a grounding related class.
C:301:EQ:TransformerEnd.endNumber:unique	TransformerEnd.endNumber	Highest voltage winding should be 1. Each end within a power transformer should have a unique subsequent end number.	The PowerTransformer has TransformerEnd.endNumber which is not unique or the PowerTransformerEnd with endNumber 1 is not the highest voltage winding.
C:452:EQ:PowerTransformerEnd:pu		The parameters r, x, g and b are specified for each end and are not related to the overall base voltage. These values are specified in engineering units. Any PU calculations are internal to particular tools and are not part of the data exchange.	
C:452:EQ:ACLineSegment.BaseVoltage:calculations		All implementations shall use association to a BaseVoltage for the purpose of any per unit calculations and shall not rely on the voltages (neither nominal nor actual values obtained by previous or current solution) at the nodes, which the ACLineSegment connects to.	
C:452:EQ:NA:negativeImpedance		Except for series capacitors, negative branch reactance shall not represent real devices. Negative impedance is allowed for EquivalentBranch. Negative value limits the selection of load flow solution techniques and shall be avoided, if possible.	
C:452:EQ:NA:zeroImpedance		Zero impedance lines are permitted if they represent real elements in the model.	
		A RatioTapChangerTabular may be optionally associated with any RatioTapChanger and may represent a non-linear relationship	

		between tap number, tap ratio, and impedances. If associated, the tabular ratio model takes precedence.	
		Tabular representation is required in cases where it is necessary to combine both phase shifting and ratio tap changer on one terminal, as it conveys the explicit values of the resulting phases and angles.	
		Similar to PetersenCoils, it is expected that all GroundDisconnector terminals will have only phase N.	
C:600:EQ:EnergyConsumer:junction		Line containment is not allowed in cases where instances of an EnergyConsumer or any of its subclasses (NonConformLoad or ConformLoad) is connected to a ACLineSegment. In order to cover such cases a T-Junction shall be modelled and Substation classes instantiated. For instance the number of Substation-s is two plus the number of T-Junctions that need to be modelled.	
C:452:EQ:RegulatingControl:point		In cases where the controlling point is a ConnectivityNode multiple instances of RegulatingControl maybe be needed for proper modelling and connectivity of the grid.	
C:452:EQ:EquivalenInjection:instance		Using EquivalentInjection to model a distribution network equivalent is recommended practice instead of using ExternalNetworkInjection-s.	

Physical (ShortCircuit)

C:301:SC:PowerTransformerEnd.phaseAngleClock:valueRange	PowerTransformerEnd.phaseAngleClock	The valid values are 0 to 11.	The value is outside the valid range: 0-11.

Physical (GeographicalLocation)

C:600:GL:NA:position	Location	IEC 61968-13 allows both PositionPoint and mainAddress to be exchanged. CGMES requires that PositionPoint is exchanged and mainAddress is not exchanged.	Either Location.mainAddress is provided or the Location is not referenced by a PositionPoint.

Physical (DiagramLayout)

C:301:DL:DiagramObject.IdentifiedObject:internalValueType	DiagramObject.IdentifiedObject	The association end role description stated that: The domain object to which this diagram object is associated. Therefore, the association cannot point to cim:Diagram, cim:DiagramObject, cim:VisibilityLayer, cim:DiagramStyle, cim:DiagramObjectStyle or cim:TextDiagramObject.	One of the following does not conform: 1) The value type shall be IRI; 2) The value type shall not be an instance of the class: cim:Diagram, cim:DiagramObject, cim:VisibilityLayer, cim:DiagramStyle,

			cim:DiagramObjectStyle or cim:TextDiagramObject.
C:301:DL:DiagramObjectPoint.sequenceNumber:valueRange	DiagramObjectPoint.sequenceNumber	The property (attribute) shall be a positive value.	The value is negative or zero.
C:453:DL:DiagramStyle:name	DiagramStyle	The inherited IdentifiedObject.name shall have one of the following names: "node-breaker", "bus-branch", "hybrid (node-breaker and bus-branch)" or "geoschematic".	Not allowed value.
C:453:DL:IdentifiedObject.name:stringLength	IdentifiedObject.name	The string IdentifiedObject.name has a maximum of 128 characters.	String length is greater than 128 characters.
C:453:DL:Diagram:units		Coordinate units used in the exchange are mm (millimetres).	

Situation (SteadyStateHypothesis)

C:301:SSH:ApparentPowerLimit.value:valueRange	ApparentPowerLimit.value	The attribute shall be a positive value or zero.	The value is negative.
C:301:SSH:CurrentLimit.value:valueRange	CurrentLimit.value	The attribute shall be a positive value or zero.	The value is negative.
C:456:SSH:EnergyConsumer.p:ValueRange	EnergyConsumer.p	Negative active power loads shall not be exchanged. In cases where this is needed EquivalentInjection is used instead.	The value is negative.
C:456:SSH:EnergyConsumer.q:ValueRange	EnergyConsumer.q	Negative reactive power loads shall not be exchanged. In cases where this is needed EquivalentInjection is used instead.	The value is negative.
C:301:SSH:GeneratingUnit.normalPF:valueRange	GeneratingUnit.normalPF	The attribute shall be a positive value or zero.	The value is negative.
C:456:SSH:NA:singleActivePowerSlack	GeneratingUnit.normalPF	Active power slack by a single generator per ControlArea: one generator has GeneratingUnit.normalPF set to a highest value (non-zero) and all other generating units have a zero GeneratingUnit.normalPF.	Either there is no highest value among GeneratingUnit.normalPF or there are multiple maximum values which are the same.
C:301:SSH:RegulatingControl:requiredAttributes	RegulatingControl	The attribute minAllowedTargetValue and maxAllowedTargetValue are required in the following cases: - For a power generating module operated in power factor control mode to specify maximum and minimum power factor values; -	Both minAllowedTargetValue and maxAllowedTargetValue are not provided for RegulatingControl in mode powerFactor.
C:301:SSH:RegulatingControl.targetDeadband:applicability	RegulatingControl.targetDeadband	This is a deadband used with discrete control to avoid excessive update of controls like tap changers and shunt compensator banks while regulating. ...	Either RegulatingControl.targetDeadband is provided for a continuous

		If RegulatingControl.discrete is set to false, the RegulatingControl.targetDeadband is to be ignored.	control or it is not provided for a discrete control.
C:301:SSH:RegulatingControl.targetDeadband:targetDB	RegulatingControl.targetDeadband	For every instance of RegulatingControl (SSH) for which the value of cim:RegulatingControl.discrete is true and cim:RegulatingControl.enabled is true, cim:RegulatingControl.targetDeadband must be provided and must be > 0	Target deadband must be provided if the regulating control is discrete and active
C:301:SSH:RegulatingControl.targetDeadband:valueRange	RegulatingControl.targetDeadband	The attribute shall be a positive value or zero.	The value is negative.
C:452:EQ:RegulatingControl.targetValue:tapChanger	RegulatingControl.targetValue	In cases where RequlatingControl.mode is "voltage" and both TapChanger.controlEnabled and RequlatingControl.enabled are "true", o The RegulatingControl.targetValue in per unit value is calculated by RegulatingControl.targetValue/BaseVoltage.nominalVoltage. shall be within the regulating capability limits: o The tap changer upper capability limit in per unit value is calculated by 1+RatioTapChanger.stepVoltageIncrement/100*(TapChanger.highStep-TapChanger.neutralStep). o The tap changer lower capability limit in per unit value is calculated by 1- RatioTapChanger.stepVoltageIncrement/100*(TapChanger.neutralStep-TapChanger.lowStep).	The RegulatingControl.targetValue is outside the TapChanger capability.
C:456:SSH:RegulatingControl.targetValue:value	RegulatingControl.targetValue	RegulatingControl.targetValue shall be positive value in cases where the RegulatingControl.mode is set to voltage in EQ profile.	The value is negative or zero for RegulatingControl in voltage mode.
C:456:SSH:RotatingMachine:pAndQcapabilityCurve	RotatingMachine	In cases where a ReactiveCapabilityCurve is associated, the RotatingMachine.p shall be less than or equal to the maximum active power value defined by the curve and it shall be greater than or equal to the minimum active power value defined by the curve. The RotatingMachine.q shall be less than or equal to the maximum reactive power value defined by the curve and it shall be greater than or equal to the minimum reactive power value defined by the curve.	The active power is not within the limits defined by the ReactiveCapabilityCurve.

C:456:SSH:RotatingMachine:pAndQcapabilityCurve	RotatingMachine	In cases where a ReactiveCapabilityCurve is associated, the RotatingMachine.p shall be less than or equal to the maximum active power value defined by the curve and it shall be greater than or equal to the minimum active power value defined by the curve. The RotatingMachine.q shall be less than or equal to the maximum reactive power value defined by the curve and it shall be greater than or equal to the minimum reactive power value defined by the curve.	The reactive power is not within the limits defined by the ReactiveCapabilityCurve.
C:301:SSH:ShuntCompensator.sections:valueLinear	ShuntCompensator.sections	Non integer values are allowed to support continuous variables. For LinearShuntConpensator the value shall be between zero and ShuntCompensator.maximumSections. At value zero the shunt compensator conductance and admittance is zero.	The value is not between zero and ShuntCompensator.maximumSections.
C:301:SSH:ShuntCompensator.sections:valueNonLinear	ShuntCompensator.sections	For NonlinearShuntCompensator-s shall only be set to one of the NonlinearShuntCompenstorPoint.sectionNumber.	The value does not equal one of the NonlinearShuntCompenstorPoint.sectionNumber.
C:456:SSH:ShuntCompensator.sections:value	ShuntCompensator.sections	In cases where RegulatingControl.discrete is true and RegulatingControl.enabled is true, ShuntCompensator.sections shall be integer.	The value is not integer for an active discrete regulating control.
C:301:SSH:ShuntCompensator.sections:valueRange	ShuntCompensator.sections	The attribute shall be a positive value or zero.	The value is negative.
C:301:SSH:TapChanger.step:valueRangePairFrom	TapChanger.step	The attribute shall be equal to or greater than lowStep and equal to or less than highStep.	The value is greater than TapChanger.step.
C:301:SSH:TapChanger.step:valueRangePairTo	TapChanger.step	The attribute shall be equal to or greater than lowStep and equal to or less than highStep.	The value is greater than TapChanger.highStep.
C:456:SSH:TapChanger.step:value	TapChanger.step	In cases where RegulatingControl.discrete is true and RegulatingControl.enabled is true, TapChanger.step shall be integer.	The value is not integer for an active discrete regulating control.
C:301:SSH:TapChanger.step:valueType	TapChanger.step	Non integer values are allowed to support continuous tap variables.	Non-integer value for a discrete TapChangerControl.