

© Copyright SEK. Reproduction in any form without permission is prohibited.

Gränssnitt för EMS (EMS-API) – Del 301: Grund för gemensam informationsmodell (CIM)

*Energy management system application program interface (EMS-API) –
Part 301: Common information model (CIM) base*

Som svensk standard gäller europastandarden EN 61970-301:2013. Den svenska standarden innehåller den officiella engelska språkversionen av EN 61970-301:2013.

Nationellt förord

Europastandarden EN 61970-301:2013

består av:

- **europastandardens ikraftsättningsdokument**, utarbetat inom CENELEC
- **IEC 61970-301, Fourth edition, 2013 - Energy management system application program interface (EMS-API) - Part 301: Common information model (CIM) base**

utarbetad inom International Electrotechnical Commission, IEC.

Tidigare fastställd svensk standard SS-EN 61970-301, utgåva 2, 2012, gäller ej fr o m 2016-06-27.

ICS 33.200.00

Denna standard är fastställd av SEK Svensk Elstandard, som också kan lämna upplysningar om **sakinnehållet** i standarden.
Postadress: SEK, Box 1284, 164 29 KISTA
Telefon: 08 - 444 14 00. Telefax: 08 - 444 14 30
E-post: sek@elstandard.se. Internet: www.elstandard.se

Standarder underlättar utvecklingen och höjer elsäkerheten

Det finns många fördelar med att ha gemensamma tekniska regler för bl a säkerhet, prestanda, dokumentation, utförande och skötsel av elprodukter, elanläggningar och metoder. Genom att utforma sådana standarder blir säkerhetskraven tydliga och utvecklingskostnaderna rimliga samtidigt som marknadens acceptans för produkten eller tjänsten ökar.

Många standarder inom elområdet beskriver tekniska lösningar och metoder som åstadkommer den elsäkerhet som föreskrivs av svenska myndigheter och av EU.

SEK är Sveriges röst i standardiseringsarbetet inom elområdet

SEK Svensk Elstandard svarar för standardiseringen inom elområdet i Sverige och samordnar svensk medverkan i internationell och europeisk standardisering. SEK är en ideell organisation med frivilligt deltagande från svenska myndigheter, företag och organisationer som vill medverka till och påverka utformningen av tekniska regler inom elektrotekniken.

SEK samordnar svenska intressenters medverkan i SEKs tekniska kommittéer och stödjer svenska experters medverkan i internationella och europeiska projekt.

Stora delar av arbetet sker internationellt

Utformningen av standarder sker i allt väsentligt i internationellt och europeiskt samarbete. SEK är svensk nationalkommitté av International Electrotechnical Commission (IEC) och Comité Européen de Normalisation Electrotechnique (CENELEC).

Standardiseringsarbetet inom SEK är organiserat i referensgrupper bestående av ett antal tekniska kommittéer som speglar hur arbetet inom IEC och CENELEC är organiserat.

Arbetet i de tekniska kommittéerna är öppet för alla svenska organisationer, företag, institutioner, myndigheter och statliga verk. Den årliga avgiften för deltagandet och intäkter från försäljning finansierar SEKs standardiseringsverksamhet och medlemsavgift till IEC och CENELEC.

Var med och påverka!

Den som deltar i SEKs tekniska kommittéarbete har möjlighet att påverka framtida standarder och får tidig tillgång till information och dokumentation om utvecklingen inom sitt teknikområde. Arbetet och kontakterna med kollegor, kunder och konkurrenter kan gynnsamt påverka enskilda företags affärsutveckling och bidrar till deltagarnas egen kompetensutveckling.

Du som vill dra nytta av dessa möjligheter är välkommen att kontakta SEKs kansli för mer information.

SEK Svensk Elstandard

Box 1284
164 29 Kista
Tel 08-444 14 00
www.elstandard.se

English version

**Energy management system application program interface (EMS-API) -
Part 301: Common information model (CIM) base
(IEC 61970-301:2013)**

Interface de programmation d'application
pour système de gestion d'énergie
(EMS-API) -
Part 301: Base de modèle d'information
commun (CIM)
(CEI 61970-301:2013)

Schnittstelle für Anwendungsprogramme
für Netzführungssysteme (EMS-API) -
Teil 301: Allgemeines Informationsmodell
(CIM), Basismodell
(IEC 61970-301:2013)

This European Standard was approved by CENELEC on 2013-06-27. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B - 1000 Brussels

Foreword

The text of document 57/1331/FDIS, future edition 4 of IEC 61970-301, prepared by IEC TC 57 "Power systems management and associated information exchange" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61970-301:2013.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2014-04-04
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2016-06-27

This document supersedes EN 61970-301:2011.

EN 61970-301:2013 includes the following significant technical changes with respect to EN 61970-301:2011:

- extensions have been added to support UCTE exchange;
- several classes have been moved from EN 61970 to the Assets package in EN 61968;
- the transformer regulation model has been modified and expanded to support phase shifting transformer models needed by ENTSO-E;
- zero and negative sequence impedance terms have been added where missing;
- new StateVariables package has been added to support exchange of network model solutions from power flow, state estimation, etc.;
- additional classes that have been added included:
 - PhaseTapChanger
 - RatioTapChanger
 - ImpedanceVariationCurve
 - RatioVariationCurve
 - TapSchedule
 - SwitchSchedule
 - PhaseVariationCurve
 - EquivalentInjection added to the Equivalent package
 - WindGeneratingUnit and NuclearGeneratingUnit added as subtypes of GeneratingUnit
- classes that were removed included:
 - Company
 - HeatExchanger
 - MeasurementType class removed and replaced with attribute Measurement.measurementType.
 - Datatypes ShortLength and LongLength were removed and replaced with Length.
 - Load, CustomerLoad, and InductionMotorLoad.
 - Subtypes of ConformLoad and NonConFormLoad

- various editorial changes to cleanup the UML model.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association.

Endorsement notice

The text of the International Standard IEC 61970-301:2013 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 61850 series	NOTE	Harmonised in EN 61850 series.
IEC 61850-7-3	NOTE	Harmonised as EN 61850-7-3.
IEC 61968 series	NOTE	Harmonised in EN 61968 series.
IEC 61968-11:2010	NOTE	Harmonised as EN 61968-11:2010 (not modified).
IEC 61970-501	NOTE	Harmonised as EN 61970-501.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61850-7-4	-	Communication networks and systems for power utility automation - Part 7-4: Basic communication structure - Compatible logical node classes and data object classes	EN 61850-7-4	-
IEC/TS 61970-2	-	Energy management system application program interface (EMS-API) - Part 2: Glossary	CLC/TS 61970-2	-
ISO 8601	-	Data elements and interchange formats - Information interchange - Representation of dates and times	-	-

CONTENTS

INTRODUCTION	20
1 Scope.....	22
2 Normative references.....	22
3 Terms and definitions.....	23
4 CIM specification.....	23
4.1 CIM modeling notation.....	23
4.2 CIM packages.....	23
4.3 CIM classes and relationships	25
4.3.1 Classes.....	25
4.3.2 Generalization	26
4.3.3 Simple association	27
4.3.4 Aggregation.....	28
4.4 CIM model concepts and examples.....	28
4.4.1 Concepts.....	28
4.4.2 Containment, equipment hierarchies and naming.....	28
4.4.3 Connectivity model.....	31
4.4.4 Inheritance hierarchy.....	34
4.4.5 Transformer model	36
4.4.6 Regulating transformer modeling	37
4.4.7 Measurements and controls	40
4.4.8 Regulating control models.....	44
4.5 Modeling guidelines.....	44
4.5.1 Modeling for change	44
4.5.2 Process for amendments to the CIM.....	45
4.5.3 Changes to the CIM UML model	45
4.5.4 Changes to the CIM standards documents.....	45
4.5.5 CIM profiles.....	45
4.6 Modeling tools	46
4.7 User implementation conventions	46
4.8 CIM modeling examples.....	46
5 Detailed model	47
5.1 Overview.....	47
5.2 Context	47
6 Package architecture	49
6.1 Top package IEC61970	49
6.1.1 General.....	49
6.1.2 IEC61970CIMVersion root class	49
6.1.3 Package Domain.....	50
6.1.4 Package Core.....	69
6.1.5 Package OperationalLimits.....	96
6.1.6 Package Topology.....	103
6.1.7 Package Wires.....	110
6.1.8 Package Generation	174
6.1.9 Package LoadModel	238
6.1.10 Package Outage	251

6.1.11 Package Protection	256
6.1.12 Package Equivalents	262
6.1.13 Package Meas	267
6.1.14 Package SCADA	291
6.1.15 Package ControlArea	296
6.1.16 Package Contingency	302
6.1.17 Package StateVariables	305
Bibliography	310
Figure 1 – CIM IEC 61970-301 package diagram	25
Figure 2 – Example of generalization	27
Figure 3 – Example of simple association	28
Figure 4 – Example of aggregation	28
Figure 5 – Equipment containers	30
Figure 6 – Connectivity model	31
Figure 7 – Simple network example	33
Figure 8 – Simple network connectivity modeled with CIM Topology	33
Figure 9 – Equipment inheritance hierarchy	35
Figure 10 – Transformer model	37
Figure 11 – Symmetrical Phase Shifter	38
Figure 12 – Asymmetrical Phase Shifter	39
Figure 13 – Navigating from PSR to MeasurementValue	41
Figure 14 – Measurement placement	43
Figure 15 – Regulating control models	44
Figure 16 – CIM top level packages	47
Figure 17 – Logical diagram IEC61970::Main	49
Figure 18 – Logical diagram Domain::CombinedDatatypes	50
Figure 19 – Logical diagram Domain::BasicDatatypes	51
Figure 20 – Logical diagram Domain::ElectricityDatatypes	51
Figure 21 – Logical diagram Domain::EnumeratedUnitDatatypes	52
Figure 22 – Logical diagram Domain::GeneralDatatypes	53
Figure 23 – Logical diagram Domain::MonetaryDatatypes	54
Figure 24 – Logical diagram Domain::TimeDatatypes	54
Figure 25 – Logical diagram Core::Reporting	69
Figure 26 – Logical diagram Core::Main	70
Figure 27 – Logical diagram Core::CurveSchedule	71
Figure 28 – Logical diagram Core::Datatypes	71
Figure 29 – Logical diagram Core::DocumentationExampleAggregation	72
Figure 30 – Logical diagram Core::DocumentationExampleAssociation	72
Figure 31 – Logical diagram Core::Ownership	73
Figure 32 – Logical diagram OperationalLimits::OperationalLimits	96
Figure 33 – Logical diagram OperationalLimits::BranchGroup	97
Figure 34 – Logical diagram Topology::TopologicalNodeTerminal	104
Figure 35 – Logical diagram Topology::Topology	105

Figure 36 – Logical diagram Topology::TopologyMeasRelations	106
Figure 37 – Logical diagram Topology::TopologyReporting	107
Figure 38 – Logical diagram Topology::Main	108
Figure 39 – Logical diagram Wires::DocumentationExampleInheritance	111
Figure 40 – Logical diagram Wires::MutualCoupling	112
Figure 41 – Logical diagram Wires::Schedules	113
Figure 42 – Logical diagram Wires::Datatypes	114
Figure 43 – Logical diagram Wires::InheritanceHierarchy.....	115
Figure 44 – Logical diagram Wires::LineModel.....	116
Figure 45 – Logical diagram Wires::NamingHierarchyPart1	117
Figure 46 – Logical diagram Wires::NamingHierarchyPart2.....	118
Figure 47 – Logical diagram Wires::RegulatingEquipment.....	119
Figure 48 – Logical diagram Wires::TransformerModel	120
Figure 49 – Logical diagram Wires::VoltageControl	121
Figure 50 – Logical diagram Generation::Main.....	175
Figure 51 – Logical diagram GenerationDynamics::Main.....	175
Figure 52 – Logical diagram GenerationDynamics::Datatypes	176
Figure 53 – Logical diagram Production::Nuclear	192
Figure 54 – Logical diagram Production::Main	193
Figure 55 – Logical diagram Production::Datatypes.....	194
Figure 56 – Logical diagram Production::Hydro.....	195
Figure 57 – Logical diagram Production::Thermal	196
Figure 58 – Logical diagram LoadModel::Main.....	238
Figure 59 – Logical diagram LoadModel::Datatypes	239
Figure 60 – Logical diagram Outage::Datatypes.....	251
Figure 61 – Logical diagram Outage::Main	252
Figure 62 – Logical diagram Protection::Main	256
Figure 63 – Logical diagram Equivalents::Main	262
Figure 64 – Logical diagram Meas::Datatypes	268
Figure 65 – Logical diagram Meas::Meas	268
Figure 66 – Logical diagram Meas::Control	269
Figure 67 – Logical diagram Meas::InheritanceStructure.....	270
Figure 68 – Logical diagram Meas::Measurement with limits	271
Figure 69 – Logical diagram Meas::Quality.....	272
Figure 70 – Logical diagram SCADA::Datatypes	292
Figure 71 – Logical diagram SCADA::Main.....	292
Figure 72 – Logical diagram ControlArea::ControlArea	297
Figure 73 – Logical diagram ControlArea::ControlAreaInheritance	298
Figure 74 – Logical diagram ControlArea::Datatypes.....	298
Figure 75 – Logical diagram Contingency::Contingency.....	302
Figure 76 – Logical diagram StateVariables::StateVariables	305
Table 1 – MeasurementType naming conventions.....	42

Table 2 – MeasurementValueSource naming conventions.....	43
Table 3 – Attributes	47
Table 4 – Association ends.....	48
Table 5 – Enums	48
Table 6 – Attributes of IEC61970::IEC61970CIMVersion.....	50
Table 7 – Attributes of Domain::AbsoluteDate.....	54
Table 8 – Attributes of Domain::AbsoluteDateTime	55
Table 9 – Attributes of Domain::ActivePower	55
Table 10 – Attributes of Domain::ActivePowerChangeRate	55
Table 11 – Attributes of Domain::Admittance	56
Table 12 – Attributes of Domain::AngleDegrees.....	56
Table 13 – Attributes of Domain::AngleRadians	56
Table 14 – Attributes of Domain::ApparentPower	56
Table 15 – Attributes of Domain::Capacitance	57
Table 16 – Attributes of Domain::Conductance	57
Table 17 – Attributes of Domain::CostPerEnergyUnit.....	57
Table 18 – Attributes of Domain::CostRate.....	58
Table 19 – Literals of Domain::Currency	58
Table 20 – Attributes of Domain::CurrentFlow.....	58
Table 21 – Attributes of Domain::Damping	59
Table 22 – Attributes of Domain::FloatQuantity.....	59
Table 23 – Attributes of Domain::Frequency.....	59
Table 24 – Attributes of Domain::Hours.....	60
Table 25 – Attributes of Domain::Impedance	60
Table 26 – Attributes of Domain::Inductance	60
Table 27 – Attributes of Domain::IntegerQuantity	60
Table 28 – Attributes of Domain::KWActivePower	61
Table 29 – Attributes of Domain::Length	61
Table 30 – Attributes of Domain::Minutes.....	61
Table 31 – Literals of Domain::MonetaryAmountPerEnergyUnit	62
Table 32 – Literals of Domain::MonetaryAmountPerHeatUnit	62
Table 33 – Literals of Domain::MonetaryAmountRate	62
Table 34 – Attributes of Domain::Money.....	62
Table 35 – Attributes of Domain::PerCent	63
Table 36 – Attributes of Domain::Pressure	63
Table 37 – Attributes of Domain::PU.....	63
Table 38 – Attributes of Domain::Reactance.....	63
Table 39 – Attributes of Domain::ReactivePower	64
Table 40 – Attributes of Domain::RealEnergy	64
Table 41 – Attributes of Domain::Resistance	64
Table 42 – Attributes of Domain::RotationSpeed.....	65
Table 43 – Attributes of Domain::Seconds.....	65
Table 44 – Attributes of Domain::StringQuantity.....	65

Table 45 – Attributes of Domain::Susceptance.....	66
Table 46 – Attributes of Domain::Temperature.....	66
Table 47 – Literals of Domain::UnitMultiplier	66
Table 48 – Literals of Domain::UnitSymbol.....	67
Table 49 – Attributes of Domain::Voltage	68
Table 50 – Attributes of Domain::VoltagePerReactivePower.....	68
Table 51 – Attributes of Domain::Volume	68
Table 52 – Attributes of Domain::WaterLevel.....	68
Table 53 – Attributes of Domain::Weight	69
Table 54 – Attributes of Core::ReportingGroup	73
Table 55 – Association ends of Core::ReportingGroup with other classes.....	74
Table 56 – Attributes of Core::ReportingSuperGroup.....	74
Table 57 – Association ends of Core::ReportingSuperGroup with other classes	74
Table 58 – Attributes of Core::BasePower.....	74
Table 59 – Attributes of Core::BaseVoltage	75
Table 60 – Association ends of Core::BaseVoltage with other classes.....	75
Table 61 – Attributes of Core::BasicIntervalSchedule	76
Table 62 – Attributes of Core::Bay.....	76
Table 63 – Association ends of Core::Bay with other classes	77
Table 64 – Literals of Core::BreakerConfiguration.....	77
Table 65 – Literals of Core::BusbarConfiguration.....	77
Table 66 – Literals of Core::CompanyType.....	78
Table 67 – Attributes of Core::ConductingEquipment.....	78
Table 68 – Association ends of Core::ConductingEquipment with other classes	78
Table 69 – Attributes of Core::ConnectivityNode.....	79
Table 70 – Association ends of Core::ConnectivityNode with other classes	79
Table 71 – Attributes of Core::ConnectivityNodeContainer.....	80
Table 72 – Association ends of Core::ConnectivityNodeContainer with other classes.....	80
Table 73 – Attributes of Core::Curve.....	80
Table 74 – Association ends of Core::Curve with other classes	81
Table 75 – Attributes of Core::CurveData.....	81
Table 76 – Association ends of Core::CurveData with other classes	81
Table 77 – Literals of Core::CurveStyle.....	82
Table 78 – Attributes of Core::Equipment.....	82
Table 79 – Association ends of Core::Equipment with other classes	82
Table 80 – Attributes of Core::EquipmentContainer.....	83
Table 81 – Association ends of Core::EquipmentContainer with other classes	83
Table 82 – Attributes of Core::GeographicalRegion.....	84
Table 83 – Association ends of Core::GeographicalRegion with other classes	84
Table 84 – Attributes of Core::IdentifiedObject	84
Table 85 – Attributes of Core::IrregularIntervalSchedule	85
Table 86 – Association ends of Core::IrregularIntervalSchedule with other classes	85
Table 87 – Attributes of Core::IrregularTimePoint	86

Table 88 – Association ends of Core::IrregularTimePoint with other classes	86
Table 89 – Attributes of Core::OperatingParticipant.....	86
Table 90 – Association ends of Core::OperatingParticipant with other classes	86
Table 91 – Attributes of Core::OperatingShare	87
Table 92 – Association ends of Core::OperatingShare with other classes	87
Table 93 – Literals of Core::PhaseCode.....	87
Table 94 – Attributes of Core::PowerSystemResource.....	88
Table 95 – Association ends of Core::PowerSystemResource with other classes	88
Table 96 – Attributes of Core::PsrList	89
Table 97 – Association ends of Core::PsrList with other classes.....	89
Table 98 – Attributes of Core::PSRType.....	89
Table 99 – Association ends of Core::PSRType with other classes	89
Table 100 – Attributes of Core::RegularIntervalSchedule	90
Table 101 – Association ends of Core::RegularIntervalSchedule with other classes.....	90
Table 102 – Attributes of Core::RegularTimePoint.....	91
Table 103 – Association ends of Core::RegularTimePoint with other classes	91
Table 104 – Attributes of Core::SubGeographicalRegion	91
Table 105 – Association ends of Core::SubGeographicalRegion with other classes	91
Table 106 – Attributes of Core::Substation	92
Table 107 – Association ends of Core::Substation with other classes.....	92
Table 108 – Attributes of Core::Terminal.....	93
Table 109 – Association ends of Core::Terminal with other classes	93
Table 110 – Attributes of Core::Unit.....	94
Table 111 – Association ends of Core::Unit with other classes	95
Table 112 – Attributes of Core::VoltageLevel.....	95
Table 113 – Association ends of Core::VoltageLevel with other classes	95
Table 114 – Literals of OperationalLimits::OperationalLimitDirectionKind	97
Table 115 – Attributes of OperationalLimits::OperationalLimitType	98
Table 116 – Association ends of OperationalLimits::OperationalLimitType with other classes.....	98
Table 117 – Attributes of OperationalLimits::ActivePowerLimit	98
Table 118 – Association ends of OperationalLimits::ActivePowerLimit with other classes.....	99
Table 119 – Attributes of OperationalLimits::ApparentPowerLimit	99
Table 120 – Association ends of OperationalLimits::ApparentPowerLimit with other classes.....	99
Table 121 – Attributes of OperationalLimits::BranchGroup	100
Table 122 – Association ends of OperationalLimits::BranchGroup with other classes.....	100
Table 123 – Attributes of OperationalLimits::BranchGroupTerminal.....	100
Table 124 – Association ends of OperationalLimits::BranchGroupTerminal with other classes.....	100
Table 125 – Attributes of OperationalLimits::CurrentLimit	101
Table 126 – Association ends of OperationalLimits::CurrentLimit with other classes	101
Table 127 – Attributes of OperationalLimits::OperationalLimit	101

Table 128 – Association ends of OperationalLimits::OperationalLimit with other classes	102
Table 129 – Attributes of OperationalLimits::OperationalLimitSet.....	102
Table 130 – Association ends of OperationalLimits::OperationalLimitSet with other classes.....	102
Table 131 – Attributes of OperationalLimits::VoltageLimit	103
Table 132 – Association ends of OperationalLimits::VoltageLimit with other classes	103
Table 133 – Attributes of Topology::BusNameMarker	109
Table 134 – Association ends of Topology::BusNameMarker with other classes.....	109
Table 135 – Attributes of Topology::TopologicalNode	109
Table 136 – Association ends of Topology::TopologicalNode with other classes.....	110
Table 137 – Attributes of Wires::ImpedanceVariationCurve	121
Table 138 – Association ends of Wires::ImpedanceVariationCurve with other classes.....	122
Table 139 – Attributes of Wires::PhaseVariationCurve.....	122
Table 140 – Association ends of Wires::PhaseVariationCurve with other classes	123
Table 141 – Attributes of Wires::RatioVariationCurve	123
Table 142 – Association ends of Wires::RatioVariationCurve with other classes.....	123
Table 143 – Literals of Wires::RegulatingControlModeKind	124
Table 144 – Attributes of Wires::SwitchSchedule	124
Table 145 – Association ends of Wires::SwitchSchedule with other classes.....	125
Table 146 – Attributes of Wires::ACLineSegment.....	125
Table 147 – Association ends of Wires::ACLineSegment with other classes	126
Table 148 – Attributes of Wires::Breaker.....	126
Table 149 – Association ends of Wires::Breaker with other classes	127
Table 150 – Attributes of Wires::BusbarSection	127
Table 151 – Association ends of Wires::BusbarSection with other classes.....	128
Table 152 – Attributes of Wires::CompositeSwitch	129
Table 153 – Association ends of Wires::CompositeSwitch with other classes.....	129
Table 154 – Attributes of Wires::CompositeSwitchType	129
Table 155 – Attributes of Wires::Conductor	130
Table 156 – Association ends of Wires::Conductor with other classes.....	130
Table 157 – Attributes of Wires::Connector	131
Table 158 – Association ends of Wires::Connector with other classes.....	131
Table 159 – Literals of Wires::CoolantType	132
Table 160 – Attributes of Wires::DCLineSegment.....	132
Table 161 – Association ends of Wires::DCLineSegment with other classes	132
Table 162 – Attributes of Wires::Disconnecter	133
Table 163 – Association ends of Wires::Disconnecter with other classes.....	133
Table 164 – Attributes of Wires::EnergyConsumer	134
Table 165 – Association ends of Wires::EnergyConsumer with other classes.....	135
Table 166 – Attributes of Wires::EnergySource.....	135
Table 167 – Association ends of Wires::EnergySource with other classes	136
Table 168 – Attributes of Wires::FrequencyConverter.....	136
Table 169 – Association ends of Wires::FrequencyConverter with other classes	137

Table 170 – Attributes of Wires::Fuse	138
Table 171 – Association ends of Wires::Fuse with other classes.....	138
Table 172 – Attributes of Wires::Ground	139
Table 173 – Association ends of Wires::Ground with other classes	139
Table 174 – Attributes of Wires::GroundDisconnecter.....	140
Table 175 – Association ends of Wires::GroundDisconnecter with other classes	140
Table 176 – Attributes of Wires::HeatExchanger	141
Table 177 – Association ends of Wires::HeatExchanger with other classes.....	141
Table 178 – Attributes of Wires::Jumper	141
Table 179 – Association ends of Wires::Jumper with other classes	142
Table 180 – Attributes of Wires::Junction.....	143
Table 181 – Association ends of Wires::Junction with other classes.....	143
Table 182 – Attributes of Wires::Line	144
Table 183 – Association ends of Wires::Line with other classes.....	144
Table 184 – Attributes of Wires::LoadBreakSwitch	144
Table 185 – Association ends of Wires::LoadBreakSwitch with other classes.....	145
Table 186 – Attributes of Wires::MutualCoupling.....	146
Table 187 – Association ends of Wires::MutualCoupling with other classes	146
Table 188 – Attributes of Wires::OperatingMode	147
Table 189 – Attributes of Wires::PhaseTapChanger	147
Table 190 – Association ends of Wires::PhaseTapChanger with other classes	148
Table 191 – Literals of Wires::PhaseTapChangerKind	149
Table 192 – Attributes of Wires::Plant.....	149
Table 193 – Association ends of Wires::Plant with other classes	149
Table 194 – Attributes of Wires::PowerTransformer	150
Table 195 – Association ends of Wires::PowerTransformer with other classes	150
Table 196 – Attributes of Wires::ProtectedSwitch.....	151
Table 197 – Association ends of Wires::ProtectedSwitch with other classes	151
Table 198 – Attributes of Wires::RatioTapChanger.....	152
Table 199 – Association ends of Wires::RatioTapChanger with other classes	152
Table 200 – Attributes of Wires::ReactiveCapabilityCurve.....	153
Table 201 – Association ends of Wires::ReactiveCapabilityCurve with other classes	154
Table 202 – Attributes of Wires::RectifierInverter	154
Table 203 – Association ends of Wires::RectifierInverter with other classes.....	155
Table 204 – Attributes of Wires::RegulatingCondEq	155
Table 205 – Association ends of Wires::RegulatingCondEq with other classes.....	156
Table 206 – Attributes of Wires::RegulatingControl	156
Table 207 – Association ends of Wires::RegulatingControl with other classes.....	157
Table 208 – Attributes of Wires::RegulationSchedule	157
Table 209 – Association ends of Wires::RegulationSchedule with other classes	158
Table 210 – Attributes of Wires::Resistor	158
Table 211 – Association ends of Wires::Resistor with other classes.....	159
Table 212 – Attributes of Wires::SeriesCompensator.....	159

Table 213 – Association ends of Wires::SeriesCompensator with other classes	160
Table 214 – Attributes of Wires::ShuntCompensator	160
Table 215 – Association ends of Wires::ShuntCompensator with other classes	161
Table 216 – Attributes of Wires::StaticVarCompensator.....	162
Table 217 – Association ends of Wires::StaticVarCompensator with other classes	163
Table 218 – Literals of Wires::SVCControlMode	163
Table 219 – Attributes of Wires::Switch.....	164
Table 220 – Association ends of Wires::Switch with other classes	164
Table 221 – Attributes of Wires::SynchronousMachine	165
Table 222 – Association ends of Wires::SynchronousMachine with other classes	166
Table 223 – Literals of Wires::SynchronousMachineOperatingMode	167
Table 224 – Literals of Wires::SynchronousMachineType	167
Table 225 – Attributes of Wires::TapChanger	168
Table 226 – Association ends of Wires::TapChanger with other classes	168
Table 227 – Literals of Wires::TapChangerKind	169
Table 228 – Attributes of Wires::TapSchedule	169
Table 229 – Association ends of Wires::TapSchedule with other classes.....	170
Table 230 – Literals of Wires::TransformerControlMode	170
Table 231 – Attributes of Wires::TransformerWinding	170
Table 232 – Association ends of Wires::TransformerWinding with other classes.....	171
Table 233 – Attributes of Wires::VoltageControlZone	172
Table 234 – Association ends of Wires::VoltageControlZone with other classes	172
Table 235 – Literals of Wires::WindingConnection	173
Table 236 – Attributes of Wires::WindingTest	173
Table 237 – Association ends of Wires::WindingTest with other classes.....	174
Table 238 – Literals of Wires::WindingType.....	174
Table 239 – Literals of GenerationDynamics::BoilerControlMode.....	176
Table 240 – Attributes of GenerationDynamics::BWRSteamSupply	176
Table 241 – Association ends of GenerationDynamics::BWRSteamSupply with other classes.....	177
Table 242 – Attributes of GenerationDynamics::CombustionTurbine	178
Table 243 – Association ends of GenerationDynamics::CombustionTurbine with other classes.....	178
Table 244 – Attributes of GenerationDynamics::CTTempActivePowerCurve.....	179
Table 245 – Association ends of GenerationDynamics::CTTempActivePowerCurve with other classes	179
Table 246 – Attributes of GenerationDynamics::DrumBoiler	180
Table 247 – Association ends of GenerationDynamics::DrumBoiler with other classes.....	181
Table 248 – Attributes of GenerationDynamics::FossilSteamSupply.....	181
Table 249 – Association ends of GenerationDynamics::FossilSteamSupply with other classes.....	182
Table 250 – Attributes of GenerationDynamics::HeatRecoveryBoiler.....	182
Table 251 – Association ends of GenerationDynamics::HeatRecoveryBoiler with other classes.....	183
Table 252 – Attributes of GenerationDynamics::HydroTurbine.....	184

Table 253 – Association ends of GenerationDynamics::HydroTurbine with other classes.....	184
Table 254 – Attributes of GenerationDynamics::PrimeMover	185
Table 255 – Association ends of GenerationDynamics::PrimeMover with other classes.....	185
Table 256 – Attributes of GenerationDynamics::PWRSteamSupply	185
Table 257 – Association ends of GenerationDynamics::PWRSteamSupply with other classes.....	186
Table 258 – Attributes of GenerationDynamics::SteamSupply	187
Table 259 – Association ends of GenerationDynamics::SteamSupply with other classes....	187
Table 260 – Attributes of GenerationDynamics::SteamTurbine	187
Table 261 – Association ends of GenerationDynamics::SteamTurbine with other classes.....	188
Table 262 – Attributes of GenerationDynamics::Subcritical	188
Table 263 – Association ends of GenerationDynamics::Subcritical with other classes.....	189
Table 264 – Attributes of GenerationDynamics::Supercritical	190
Table 265 – Association ends of GenerationDynamics::Supercritical with other classes	191
Table 266 – Literals of GenerationDynamics::TurbineType.....	191
Table 267 – Literals of Production::HydroEnergyConversionKind.....	196
Table 268 – Attributes of Production::NuclearGeneratingUnit	197
Table 269 – Association ends of Production::NuclearGeneratingUnit with other classes.....	198
Table 270 – Attributes of Production::WindGeneratingUnit.....	199
Table 271 – Association ends of Production::WindGeneratingUnit with other classes	200
Table 272 – Attributes of Production::AirCompressor	201
Table 273 – Association ends of Production::AirCompressor with other classes	201
Table 274 – Attributes of Production::CAESPlant.....	201
Table 275 – Association ends of Production::CAESPlant with other classes	202
Table 276 – Attributes of Production::Classification.....	202
Table 277 – Attributes of Production::CogenerationPlant	202
Table 278 – Association ends of Production::CogenerationPlant with other classes.....	203
Table 279 – Attributes of Production::CombinedCyclePlant.....	203
Table 280 – Association ends of Production::CombinedCyclePlant with other classes	204
Table 281 – Attributes of Production::CostPerHeatUnit.....	204
Table 282 – Attributes of Production::Emission.....	204
Table 283 – Attributes of Production::EmissionAccount	205
Table 284 – Association ends of Production::EmissionAccount with other classes.....	205
Table 285 – Attributes of Production::EmissionCurve	205
Table 286 – Association ends of Production::EmissionCurve with other classes.....	206
Table 287 – Literals of Production::EmissionType.....	206
Table 288 – Literals of Production::EmissionValueSource.....	207
Table 289 – Attributes of Production::FossilFuel	207
Table 290 – Association ends of Production::FossilFuel with other classes.....	208
Table 291 – Attributes of Production::FuelAllocationSchedule	208
Table 292 – Association ends of Production::FuelAllocationSchedule with other classes....	209
Table 293 – Literals of Production::FuelType.....	209

Table 294 – Attributes of Production::GeneratingUnit	209
Table 295 – Association ends of Production::GeneratingUnit with other classes.....	211
Table 296 – Literals of Production::GeneratorControlMode	212
Table 297 – Literals of Production::GeneratorControlSource	212
Table 298 – Literals of Production::GeneratorOperatingMode	213
Table 299 – Attributes of Production::GenUnitOpCostCurve.....	213
Table 300 – Association ends of Production::GenUnitOpCostCurve with other classes	214
Table 301 – Attributes of Production::GenUnitOpSchedule	214
Table 302 – Association ends of Production::GenUnitOpSchedule with other classes.....	214
Table 303 – Attributes of Production::GrossToNetActivePowerCurve	215
Table 304 – Association ends of Production::GrossToNetActivePowerCurve with other classes.....	215
Table 305 – Attributes of Production::HeatInputCurve	216
Table 306 – Association ends of Production::HeatInputCurve with other classes.....	216
Table 307 – Attributes of Production::HeatRate	217
Table 308 – Attributes of Production::HeatRateCurve.....	217
Table 309 – Association ends of Production::HeatRateCurve with other classes	217
Table 310 – Attributes of Production::HydroGeneratingEfficiencyCurve	218
Table 311 – Association ends of Production::HydroGeneratingEfficiencyCurve with other classes	218
Table 312 – Attributes of Production::HydroGeneratingUnit.....	219
Table 313 – Association ends of Production::HydroGeneratingUnit with other classes	220
Table 314 – Literals of Production::HydroPlantType	221
Table 315 – Attributes of Production::HydroPowerPlant.....	221
Table 316 – Association ends of Production::HydroPowerPlant with other classes	222
Table 317 – Attributes of Production::HydroPump	222
Table 318 – Association ends of Production::HydroPump with other classes.....	223
Table 319 – Attributes of Production::HydroPumpOpSchedule	223
Table 320 – Association ends of Production::HydroPumpOpSchedule with other classes.....	224
Table 321 – Attributes of Production::IncrementalHeatRateCurve	224
Table 322 – Association ends of Production::IncrementalHeatRateCurve with other classes.....	225
Table 323 – Attributes of Production::InflowForecast.....	225
Table 324 – Association ends of Production::InflowForecast with other classes	225
Table 325 – Attributes of Production::LevelVsVolumeCurve	226
Table 326 – Association ends of Production::LevelVsVolumeCurve with other classes.....	226
Table 327 – Attributes of Production::PenstockLossCurve	226
Table 328 – Association ends of Production::PenstockLossCurve with other classes	227
Table 329 – Attributes of Production::Reservoir	227
Table 330 – Association ends of Production::Reservoir with other classes.....	228
Table 331 – Attributes of Production::ShutdownCurve	229
Table 332 – Association ends of Production::ShutdownCurve with other classes.....	229
Table 333 – Attributes of Production::StartIgnFuelCurve.....	230

Table 334 – Association ends of Production::StartIgnFuelCurve with other classes	230
Table 335 – Attributes of Production::StartMainFuelCurve	230
Table 336 – Association ends of Production::StartMainFuelCurve with other classes	231
Table 337 – Attributes of Production::StartRampCurve	231
Table 338 – Association ends of Production::StartRampCurve with other classes	232
Table 339 – Attributes of Production::StartupModel	232
Table 340 – Association ends of Production::StartupModel with other classes	233
Table 341 – Attributes of Production::SteamSendoutSchedule	233
Table 342 – Association ends of Production::SteamSendoutSchedule with other classes	233
Table 343 – Attributes of Production::TailbayLossCurve	234
Table 344 – Association ends of Production::TailbayLossCurve with other classes	234
Table 345 – Attributes of Production::TargetLevelSchedule	234
Table 346 – Association ends of Production::TargetLevelSchedule with other classes	235
Table 347 – Attributes of Production::ThermalGeneratingUnit	235
Table 348 – Association ends of Production::ThermalGeneratingUnit with other classes	237
Table 349 – Attributes of LoadModel::ConformLoad	239
Table 350 – Association ends of LoadModel::ConformLoad with other classes	239
Table 351 – Attributes of LoadModel::ConformLoadGroup	240
Table 352 – Association ends of LoadModel::ConformLoadGroup with other classes	240
Table 353 – Attributes of LoadModel::ConformLoadSchedule	241
Table 354 – Association ends of LoadModel::ConformLoadSchedule with other classes	241
Table 355 – Attributes of LoadModel::DayType	241
Table 356 – Association ends of LoadModel::DayType with other classes	242
Table 357 – Attributes of LoadModel::EnergyArea	242
Table 358 – Association ends of LoadModel::EnergyArea with other classes	242
Table 359 – Attributes of LoadModel::LoadArea	242
Table 360 – Association ends of LoadModel::LoadArea with other classes	243
Table 361 – Attributes of LoadModel::LoadGroup	243
Table 362 – Association ends of LoadModel::LoadGroup with other classes	243
Table 363 – Attributes of LoadModel::LoadResponseCharacteristic	244
Table 364 – Association ends of LoadModel::LoadResponseCharacteristic with other classes	244
Table 365 – Attributes of LoadModel::NonConformLoad	245
Table 366 – Association ends of LoadModel::NonConformLoad with other classes	245
Table 367 – Attributes of LoadModel::NonConformLoadGroup	246
Table 368 – Association ends of LoadModel::NonConformLoadGroup with other classes	246
Table 369 – Attributes of LoadModel::NonConformLoadSchedule	246
Table 370 – Association ends of LoadModel::NonConformLoadSchedule with other classes	247
Table 371 – Attributes of LoadModel::PowerCutZone	247
Table 372 – Association ends of LoadModel::PowerCutZone with other classes	247
Table 373 – Attributes of LoadModel::Season	248

Table 374 – Association ends of LoadModel::Season with other classes	248
Table 375 – Attributes of LoadModel::SeasonDayTypeSchedule.....	248
Table 376 – Association ends of LoadModel::SeasonDayTypeSchedule with other classes.....	249
Table 377 – Literals of LoadModel::SeasonName	249
Table 378 – Attributes of LoadModel::StationSupply.....	249
Table 379 – Association ends of LoadModel::StationSupply with other classes	250
Table 380 – Attributes of LoadModel::SubLoadArea	250
Table 381 – Association ends of LoadModel::SubLoadArea with other classes.....	251
Table 382 – Attributes of Outage::ClearanceTag.....	253
Table 383 – Association ends of Outage::ClearanceTag with other classes	253
Table 384 – Attributes of Outage::ClearanceTagType.....	254
Table 385 – Association ends of Outage::ClearanceTagType with other classes	254
Table 386 – Attributes of Outage::OutageSchedule	254
Table 387 – Association ends of Outage::OutageSchedule with other classes.....	255
Table 388 – Attributes of Outage::SwitchingOperation.....	255
Table 389 – Association ends of Outage::SwitchingOperation with other classes	255
Table 390 – Literals of Outage::SwitchState	256
Table 391 – Attributes of Protection::CurrentRelay.....	256
Table 392 – Association ends of Protection::CurrentRelay with other classes	257
Table 393 – Attributes of Protection::FaultIndicator	258
Table 394 – Association ends of Protection::FaultIndicator with other classes.....	258
Table 395 – Attributes of Protection::ProtectionEquipment.....	258
Table 396 – Association ends of Protection::ProtectionEquipment with other classes	259
Table 397 – Attributes of Protection::RecloseSequence.....	259
Table 398 – Association ends of Protection::RecloseSequence with other classes	260
Table 399 – Attributes of Protection::SurgeProtector	260
Table 400 – Association ends of Protection::SurgeProtector with other classes.....	260
Table 401 – Attributes of Protection::SynchrocheckRelay	261
Table 402 – Association ends of Protection::SynchrocheckRelay with other classes	261
Table 403 – Attributes of Equivalents::EquivalentInjection	263
Table 404 – Association ends of Equivalents::EquivalentInjection with other classes	263
Table 405 – Attributes of Equivalents::EquivalentBranch	264
Table 406 – Association ends of Equivalents::EquivalentBranch with other classes	264
Table 407 – Attributes of Equivalents::EquivalentEquipment	265
Table 408 – Association ends of Equivalents::EquivalentEquipment with other classes.....	265
Table 409 – Attributes of Equivalents::EquivalentNetwork.....	266
Table 410 – Association ends of Equivalents::EquivalentNetwork with other classes	266
Table 411 – Attributes of Equivalents::EquivalentShunt	266
Table 412 – Association ends of Equivalents::EquivalentShunt with other classes.....	267
Table 413 – Attributes of Meas::Accumulator.....	272
Table 414 – Association ends of Meas::Accumulator with other classes	273
Table 415 – Attributes of Meas::AccumulatorLimit.....	273

Table 416 – Association ends of Meas::AccumulatorLimit with other classes	273
Table 417 – Attributes of Meas::AccumulatorLimitSet	274
Table 418 – Association ends of Meas::AccumulatorLimitSet with other classes.....	274
Table 419 – Attributes of Meas::AccumulatorValue	274
Table 420 – Association ends of Meas::AccumulatorValue with other classes	275
Table 421 – Attributes of Meas::Analog	275
Table 422 – Association ends of Meas::Analog with other classes	275
Table 423 – Attributes of Meas::AnalogLimit.....	276
Table 424 – Association ends of Meas::AnalogLimit with other classes	276
Table 425 – Attributes of Meas::AnalogLimitSet.....	276
Table 426 – Association ends of Meas::AnalogLimitSet with other classes	277
Table 427 – Attributes of Meas::AnalogValue	277
Table 428 – Association ends of Meas::AnalogValue with other classes	277
Table 429 – Attributes of Meas::Command	278
Table 430 – Association ends of Meas::Command with other classes.....	278
Table 431 – Attributes of Meas::Control	278
Table 432 – Association ends of Meas::Control with other classes.....	279
Table 433 – Attributes of Meas::ControlType	279
Table 434 – Association ends of Meas::ControlType with other classes.....	279
Table 435 – Attributes of Meas::CurrentTransformer	280
Table 436 – Association ends of Meas::CurrentTransformer with other classes.....	280
Table 437 – Attributes of Meas::Discrete.....	281
Table 438 – Association ends of Meas::Discrete with other classes	281
Table 439 – Attributes of Meas::DiscreteValue	281
Table 440 – Association ends of Meas::DiscreteValue with other classes	282
Table 441 – Attributes of Meas::Limit.....	282
Table 442 – Attributes of Meas::LimitSet.....	283
Table 443 – Attributes of Meas::Measurement	283
Table 444 – Association ends of Meas::Measurement with other classes.....	284
Table 445 – Attributes of Meas::MeasurementValue.....	284
Table 446 – Association ends of Meas::MeasurementValue with other classes	284
Table 447 – Attributes of Meas::MeasurementValueQuality.....	285
Table 448 – Association ends of Meas::MeasurementValueQuality with other classes	285
Table 449 – Attributes of Meas::MeasurementValueSource.....	285
Table 450 – Association ends of Meas::MeasurementValueSource with other classes	286
Table 451 – Attributes of Meas::PotentialTransformer	286
Table 452 – Association ends of Meas::PotentialTransformer with other classes.....	286
Table 453 – Attributes of Meas::Quality61850.....	287
Table 454 – Attributes of Meas::SetPoint	288
Table 455 – Association ends of Meas::SetPoint with other classes.....	288
Table 456 – Attributes of Meas::StringMeasurement.....	289
Table 457 – Association ends of Meas::StringMeasurement with other classes	289
Table 458 – Attributes of Meas::StringMeasurementValue	289

Table 459 – Association ends of Meas::StringMeasurementValue with other classes	290
Table 460 – Literals of Meas::Validity	290
Table 461 – Attributes of Meas::ValueAliasSet	290
Table 462 – Association ends of Meas::ValueAliasSet with other classes	291
Table 463 – Attributes of Meas::ValueToAlias.....	291
Table 464 – Association ends of Meas::ValueToAlias with other classes	291
Table 465 – Attributes of SCADA::CommunicationLink	293
Table 466 – Association ends of SCADA::CommunicationLink with other classes	293
Table 467 – Attributes of SCADA::RemoteControl.....	293
Table 468 – Association ends of SCADA::RemoteControl with other classes	294
Table 469 – Attributes of SCADA::RemotePoint.....	294
Table 470 – Association ends of SCADA::RemotePoint with other classes.....	294
Table 471 – Attributes of SCADA::RemoteSource	294
Table 472 – Association ends of SCADA::RemoteSource with other classes.....	295
Table 473 – Attributes of SCADA::RemoteUnit	295
Table 474 – Association ends of SCADA::RemoteUnit with other classes	295
Table 475 – Literals of SCADA::RemoteUnitType.....	296
Table 476 – Literals of SCADA::Source	296
Table 477 – Attributes of ControlArea::AltGeneratingUnitMeas.....	299
Table 478 – Association ends of ControlArea::AltGeneratingUnitMeas with other classes.....	299
Table 479 – Attributes of ControlArea::AltTieMeas	299
Table 480 – Association ends of ControlArea::AltTieMeas with other classes.....	299
Table 481 – Attributes of ControlArea::ControlArea.....	300
Table 482 – Association ends of ControlArea::ControlArea with other classes	300
Table 483 – Association ends of ControlArea::ControlAreaGeneratingUnit with other classes.....	301
Table 484 – Literals of ControlArea::ControlAreaTypeKind.....	301
Table 485 – Attributes of ControlArea::TieFlow.....	301
Table 486 – Association ends of ControlArea::TieFlow with other classes	301
Table 487 – Attributes of Contingency::ContingencyEquipment	303
Table 488 – Association ends of Contingency::ContingencyEquipment with other classes.....	303
Table 489 – Literals of Contingency::ContingencyEquipmentStatusKind.....	303
Table 490 – Attributes of Contingency::Contingency.....	304
Table 491 – Association ends of Contingency::Contingency with other classes	304
Table 492 – Attributes of Contingency::ContingencyElement.....	304
Table 493 – Association ends of Contingency::ContingencyElement with other classes	304
Table 494 – Attributes of StateVariables::SvShortCircuit.....	306
Table 495 – Association ends of StateVariables::SvShortCircuit with other classes	306
Table 496 – Attributes of StateVariables::SvInjection	306
Table 497 – Association ends of StateVariables::SvInjection with other classes	306
Table 498 – Attributes of StateVariables::SvPowerFlow.....	307
Table 499 – Association ends of StateVariables::SvPowerFlow with other classes	307

Table 500 – Attributes of StateVariables::SvShuntCompensatorSections.....	307
Table 501 – Association ends of StateVariables::SvShuntCompensatorSections with other classes	307
Table 502 – Attributes of StateVariables::SvStatus	308
Table 503 – Association ends of StateVariables::SvStatus with other classes	308
Table 504 – Attributes of StateVariables::SvTapStep	308
Table 505 – Association ends of StateVariables::SvTapStep with other classes	308
Table 506 – Attributes of StateVariables::SvVoltage.....	308
Table 507 – Association ends of StateVariables::SvVoltage with other classes	309
Table 508 – Attributes of StateVariables::TopologicalIsland	309
Table 509 – Association ends of StateVariables::TopologicalIsland with other classes.....	309

INTRODUCTION

This standard is one of several parts of the IEC 61970 series which define an application program interface (API) for an energy management system (EMS). This part of IEC 61970 was originally based upon the work of the EPRI control center API (CCAPI) research project (RP-3654-1). The principle objectives of the EPRI CCAPI project were to

- reduce the cost and time needed to add new applications to an EMS;
- protect the investment of existing applications or systems that are working effectively with an EMS.

The principal objective of the IEC 61970 series of standards is to produce standards which facilitate the integration of EMS applications developed independently by different vendors, between entire EMS systems developed independently, or between an EMS system and other systems concerned with different aspects of power system operations, such as generation or distribution management systems (DMS). This is accomplished by defining application program interfaces to enable these applications or systems access to public data and exchange information independent of how such information is represented internally.

The common information model (CIM) specifies the semantics for this API. The component interface specifications (CIS), which are contained in other parts of the IEC 61970 standards, specify the content of the messages exchanged.

The CIM is an abstract model that represents all the major objects in an electric utility enterprise typically needed to model the operational aspects of a utility. This model includes public classes and attributes for these objects, as well as the relationships between them.

The objects represented in the CIM are abstract in nature and may be used in a wide variety of applications. The use of the CIM goes far beyond its application in an EMS. This standard should be understood as a tool to enable integration in any domain where a common power system model is needed to facilitate interoperability and plug compatibility between applications and systems independent of any particular implementation.

This standard defines the CIM Base set of packages which provide a logical view of the functional aspects of an Energy Management System including SCADA. Other functional areas are standardized in separate IEC documents that augment and reference this base CIM standard. For example, IEC 61968-11 addresses distribution models and references this base CIM standard. While there are multiple IEC standards dealing with different parts of the CIM, there is a single, unified information model comprising the CIM behind all these individual standards documents.

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning a computer-based implementation of an object-oriented power system model in a relational database. As such, it does not conflict with the development of any logical power system model including the Common Information Model (CIM), where implementation of the model is not defined.

The IEC takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has assured the IEC that he/she is willing to negotiate licences either free of charge or under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with IEC. Information may be obtained from:

ICL
Wenlock Way
West Gorton
Manchester
M12 5DR
United Kingdom (U.K.)

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights other than those identified above. IEC shall not be held responsible for identifying any or all such patent rights.

ISO (www.iso.org/patents) and IEC (http://www.iec.ch/tctools/patent_decl.htm) maintain on-line data bases of patents relevant to their standards. Users are encouraged to consult the data bases for the most up to date information concerning patents.

ENERGY MANAGEMENT SYSTEM APPLICATION PROGRAM INTERFACE (EMS-API) –

Part 301: Common information model (CIM) base

1 Scope

This part of IEC 61970 deals with the common information model (CIM), an abstract model that represents all the major objects in an electric utility enterprise typically involved in utility operations.

The object classes represented in the CIM are abstract in nature and may be used in a wide variety of applications. The use of the CIM goes far beyond its application in an EMS. This standard should be understood as a tool to enable integration in any domain where a common power system model is needed to facilitate interoperability and plug compatibility between applications and systems independent of any particular implementation.

By providing a standard way of representing power system resources as object classes and attributes, along with their relationships, the CIM facilitates the integration of Energy Management System (EMS) applications developed independently by different vendors, between entire EMS systems developed independently, or between an EMS system and other systems concerned with different aspects of power system operations, such as generation or distribution management. SCADA (supervisory control and data acquisition) is modeled to the extent necessary to support power system simulation and inter-control center communication. The CIM facilitates integration by defining a common language (i.e. semantics) based on the CIM to enable these applications or systems to access public data and exchange information independent of how such information is represented internally.

Due to the size of the complete CIM, the object classes contained in the CIM are grouped into a number of logical Packages, each of which represents a certain part of the overall power system being modeled. Collections of these Packages are progressed as separate International Standards. This particular International Standard specifies a Base set of packages which provide a logical view of the functional aspects of Energy Management System (EMS) information within the electric utility enterprise that is shared between all applications. Other standards specify more specific parts of the model that are needed by only certain applications. Subclause 4.2 below provides the current grouping of packages into standards documents.

2 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 61850-7-4, *Communication networks and systems for power utility automation – Part 7-4: Basic communication structure – Compatible logical node classes and data object classes*

IEC 61970-2, *Energy management system application program interface (EMS-API) – Part 2: Glossary*

ISO 8601, *Data elements and interchange formats – Information interchange – Representation of dates and times*