



European Network of
Transmission System Operators
for Electricity

SECURITY ANALYSIS RESULT PROFILE SPECIFICATION

2022-02-16

SOC APPROVED
VERSION 2.0

1 Copyright notice:

2 **Copyright © ENTSO-E. All Rights Reserved.**

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

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

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

15 **This document is maintained by the ENTSO-E CIM EG. Comments or remarks are to be**
16 **provided at cim@entsoe.eu**

17 **NOTE CONCERNING WORDING USED IN THIS DOCUMENT**

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

- 20 • **SHALL:** This word, or the terms "REQUIRED" or "MUST", means that the definition is an
21 absolute requirement of the specification.
- 22 • **SHALL NOT:** This phrase, or the phrase "MUST NOT", means that the definition is an
23 absolute prohibition of the specification.
- 24 • **SHOULD:** This word, or the adjective "RECOMMENDED", means that there may exist valid
25 reasons in particular circumstances to ignore a particular item, but the full implications must
26 be understood and carefully weighed before choosing a different course.
- 27 • **SHOULD NOT:** This phrase, or the phrase "NOT RECOMMENDED", means that there may
28 exist valid reasons in particular circumstances when the particular behaviour is acceptable
29 or even useful, but the full implications should be understood and the case carefully weighed
30 before implementing any behaviour described with this label.
- 31 • **MAY:** This word, or the adjective "OPTIONAL", means that an item is truly optional.

32

33

Revision History

Version	Release	Date	Paragraph	Comments
1	0	2021-03-22		Document for SOC approval
2	0	2022-02-16		For CIM EG review. No major update. Due to modification of the extensions some elements may have different descriptions. Approved by SOC.

34	CONTENTS		
35	Copyright notice:.....		2
36	Revision History.....		3
37	CONTENTS		4
38	1 Introduction		6
39	2 Application profile specification		6
40	2.1 Version information		6
41	2.2 Constraints naming convention		6
42	2.3 Profile constraints		7
43	2.4 Metadata.....		9
44	2.4.1 Constraints		9
45	2.4.2 Reference metadata		9
46	3 Detailed Profile Specification		10
47	3.1 General.....		10
48	3.2 (abstract,NC) LimitViolation root class		11
49	3.3 (abstract) OperationalLimit root class		11
50	3.4 (abstract) Contingency root class		11
51	3.5 (abstract,NC) Region root class		11
52	3.6 PerCent datatype		11
53	3.7 Float primitive		12
54	3.8 DateTime primitive		12
55	3.9 Boolean primitive		12
56	3.10 UnitSymbol enumeration		12
57	3.11 UnitMultiplier enumeration		17
58	3.12 String primitive.....		18
59	3.13 Date primitive.....		18
60	3.14 (NC) ContingencyLimitViolation.....		18
61	3.15 (NC) BaseCaseLimitViolation		19
62	Annex A (informative): Sample data		20
63	A.1 General.....		20
64	A.2 Sample instance data.....		20
65			
66	List of figures		
67	Figure 1 – Class diagram SecurityAnalysisResultProfile::SecurityAnalysisResultProfile		10
68	Figure 2 – Class diagram		
69	SecurityAnalysisResultProfile::SecurityAnalysisResultDatatypes		10
70			
71	List of tables		
72	Table 1 – Attributes of SecurityAnalysisResultProfile::LimitViolation		11
73	Table 2 – Association ends of SecurityAnalysisResultProfile::LimitViolation with other		
74	classes		11
75	Table 3 – Attributes of SecurityAnalysisResultProfile::PerCent		12

76	Table 4 – Literals of SecurityAnalysisResultProfile::UnitSymbol	12
77	Table 5 – Literals of SecurityAnalysisResultProfile::UnitMultiplier	18
78	Table 6 – Attributes of SecurityAnalysisResultProfile::ContingencyLimitViolation	19
79	Table 7 – Association ends of SecurityAnalysisResultProfile::ContingencyLimitViolation	
80	with other classes	19
81	Table 8 – Attributes of SecurityAnalysisResultProfile::BaseCaseLimitViolation	19
82	Table 9 – Association ends of SecurityAnalysisResultProfile::BaseCaseLimitViolation	
83	with other classes	19
84		

85 1 Introduction

86 The security analysis result profile is a profile to exchange a security analysis result.

87 The security analysis result is output data for security analysis.

88 The security analysis result includes each limit violation detected for each assessed element
89 and for a given contingency. The limit violation has a direct association to operational limit and
90 contingency. The association to the operational limit provides information on the following:

- 91 - The terminal (the end of the equipment) where the limit is defined
- 92 - The equipment to which the limit is related
- 93 - The type of the limit e.g. PATL, TATL, etc including the relevant time phase and other
94 conditions

95 The association to the contingency provides information which contingency was simulated when
96 this limit violation was detected.

97 2 Application profile specification

98 2.1 Version information

99 The content is generated from UML model file CGMES30v25_501-20v01_HeaderMetaData-
100 10v08_NC20v70.eap.

101 This edition is based on the IEC 61970 UML version 'IEC61970CIM17v40', dated '2020-08-24'.

- 102 - Title: Security Analysis Result Vocabulary
- 103 - Keyword: SAR
- 104 - Description: This vocabulary is describing the security analysis result profile.
- 105 - Version IRI: <http://entsoe.eu/ns/CIM/SecurityAnalysisResult-EU/2.0>
- 106 - Version info: 2.0.0
- 107 - Prior version: <http://entsoe.eu/ns/CIM/SecurityAnalysisResult-EU/1.0>
- 108 - Conforms to: <urn:iso:std:iec:61970-600-2:ed-1>|<urn:iso:std:iec:61970-301:ed-7:amd1>|file:///iec61970cim17v40_iec61968cim13v13a_iec62325cim03v17a.eap|<urn:iso:std:iec:61970-401:draft:ed-1>|<urn:iso:std:iec:61970-501:draft:ed-2>|file:///CGMES-30v25_501-20v01.eap
- 109
- 110
- 111
- 112 - Identifier: <urn:uuid:7d53a1b2-0dcc-4556-b868-6ed099bd9ac9>

113

114 2.2 Constraints naming convention

115 The naming of the rules shall not be used for machine processing. The rule names are just a
116 string. The naming convention of the constraints is as follows.

117 "{rule.Type}:{rule.Standard}:{rule.Profile}:{rule.Property}:{rule.Name}"

118 where

119 rule.Type: C – for constraint; R – for requirement

120 rule.Standard: the number of the standard e.g. 301 for 61970-301, 456 for 61970-456, 13 for
121 61968-13. 61970-600 specific constraints refer to 600 although they are related to one or
122 combination of the 61970-450 series profiles. For NC profiles, NC is used.

123 rule.Profile: the abbreviation of the profile, e.g. TP for Topology profile. If set to "ALL" the
124 constraint is applicable to all IEC 61970-600 profiles.

125 rule.Property: for UML classes, the name of the class, for attributes and associations, the name
126 of the class and attribute or association end, e.g. EnergyConsumer, IdentifiedObject.name, etc.
127 If set to "NA" the property is not applicable to a specific UML element.

128 rule.Name: the name of the rule. It is unique for the same property.

129 Example: C:600:ALL:IdentifiedObject.name:stringLength

130 2.3 Profile constraints

131 This clause defines requirements and constraints that shall be fulfilled by applications that
132 conform to this document.

133 This document is the master for rules and constraints tagged "NC". For the sake of self-
134 containment, the list below also includes a copy of the relevant rules from IEC 61970-452,
135 tagged "452".

- 136 • C:452:ALL:NA:datatypes

137 According to 61970-501, datatypes are not exchanged in the instance data. The
138 UnitMultiplier is 1 in cases none value is specified in the profile.

- 139 • R:452:ALL:NA:exchange

140 Optional and required attributes and associations must be imported and exported if they
141 are in the model file prior to import.

- 142 • R:452:ALL:NA:exchange1

143 If an optional attribute does not exist in the imported file, it does not have to be exported
144 in case exactly the same data set is exported, i.e. the tool is not obliged to automatically
145 provide this attribute. If the export is resulting from an action by the user performed after
146 the import, e.g. data processing or model update the export can contain optional
147 attributes.

- 148 • R:452:ALL:NA:exchange2

149 In most of the profiles the selection of optional and required attributes is made so as to
150 ensure a minimum set of required attributes without which the exchange does not fulfil
151 its basic purpose. Business processes governing different exchanges can require
152 mandatory exchange of certain optional attributes or associations. Optional and required
153 attributes and associations shall therefore be supported by applications which claim
154 conformance with certain functionalities of the IEC 61970-452. This provides flexibility
155 for the business processes to adapt to different business requirements and base the
156 exchanges on IEC 61970-452 compliant applications.

- 157 • R:452:ALL:NA:exchange3

158 An exporter may, at his or her discretion, produce a serialization containing additional
159 class data described by the CIM Schema but not required by this document provided
160 these data adhere to the conventions established in Clause 5.

- 161 • R:452:ALL:NA:exchange4

- 162 From the standpoint of the model import used by a data recipient, the document
163 describes a subset of the CIM that importing software shall be able to interpret in order
164 to import exported models. Data providers are free to exceed the minimum requirements
165 described herein as long as their resulting data files are compliant with the CIM Schema
166 and the conventions established in Clause 5. The document, therefore, describes
167 additional classes and class data that, although not required, exporters will, in all
168 likelihood, choose to include in their data files. The additional classes and data are
169 labelled as required (cardinality 1..1) or as optional (cardinality 0..1) to distinguish them
170 from their required counterparts. Please note, however, that data importers could
171 potentially receive data containing instances of any and all classes described by the
172 CIM Schema.
- 173 • R:452:ALL:NA:cardinality
- 174 The cardinality defined in the CIM model shall be followed, unless a more restrictive
175 cardinality is explicitly defined in this document. For instance, the cardinality on the
176 association between VoltageLevel and BaseVoltage indicates that a VoltageLevel shall
177 be associated with one and only one BaseVoltage, but a BaseVoltage can be associated
178 with zero to many VoltageLevels.
- 179 • R:452:ALL:NA:associations
- 180 Associations between classes referenced in this document and classes not referenced
181 here are not required regardless of cardinality.
- 182 • R:452:ALL:IdentifiedObject.name:rule
- 183 The attribute “name” inherited by many classes from the abstract class IdentifiedObject
184 is not required to be unique. It must be a human readable identifier without additional
185 embedded information that would need to be parsed. The attribute is used for purposes
186 such as User Interface and data exchange debugging. The MRID defined in the data
187 exchange format is the only unique and persistent identifier used for this data exchange.
188 The attribute IdentifiedObject.name is, however, always required for CoreEquipment
189 profile and Short Circuit profile.
- 190 • R:452:ALL:IdentifiedObject.description:rule
- 191 The attribute “description” inherited by many classes from the abstract class
192 IdentifiedObject must contain human readable text without additional embedded
193 information that would need to be parsed.
- 194 • R:452:ALL:NA:uniqueIdentifier
- 195 All IdentifiedObject-s shall have a persistent and globally unique identifier (Master
196 Resource Identifier - mRID).
- 197 • R:452:ALL:NA:unitMultiplier
- 198 For exchange of attributes defined using CIM Data Types (ActivePower, Susceptance,
199 etc.) a unit multiplier of 1 is used if the UnitMultiplier specified in this document is “none”.
- 200 • C:452:ALL:IdentifiedObject.name:stringLength
- 201 The string IdentifiedObject.name has a maximum of 128 characters.
- 202 • C:452:ALL:IdentifiedObject.description:stringLength
- 203 The string IdentifiedObject.description is maximum 256 characters.

- 204 • C:452:ALL:NA:float

205 An attribute that is defined as float (e.g. has a type Float or a type which is a Datatype
206 with .value attribute of type Float) shall support ISO/IEC 60559:2020 for floating-point
207 arithmetic using single precision floating point. A single precision float supports 7
208 significant digits where the significant digits are described as an integer, or a decimal
209 number with 6 decimal digits. Two float values are equal when the significant with 7
210 digits are identical, e.g. 1234567 is equal 1.234567E6 and so are 1.2345678 and
211 1.234567E0.

- 212 • R:NC:ALL:Region:reference

213 The reference to the Region is normally a reference to the capacity calculation region,
214 which is identified by “Y” EIC code of the capacity calculation region.

- 215 • R:NC:ALL:SystemOperator:reference

216 The reference to the System Operator is normally identified by “X” EIC code of TSO.

- 217 • C:NC:SAR:LimitViolation.Contingency:multiplicity

218 if LimitViolation.inBaseCase equals false, the multiplicity of the association end
219 LimitViolation.Contingency is restricted to 1.

220 If LimitViolation.inBaseCase equals true, the association LimitViolation.Contingency
221 shall not be exchanged.

222 2.4 Metadata

223 ENTSO-E agreed to extend the header and metadata definitions by IEC 61970-552 Ed2. This
224 new header definitions rely on W3C recommendations which are used worldwide and are
225 positively recognised by the European Commission. The new definitions of the header mainly
226 use Provenance ontology (PROV-O), Time Ontology and Data Catalog Vocabulary (DCAT). The
227 global new header applicable for this profile is included in the metadata and document header
228 specification document.

229 The header vocabulary contains all attributes defined in IEC 61970-552. This is done only for
230 the purpose of having one vocabulary for header and to ensure transition for data exchanges
231 that are using IEC 61970-552:2016 header. This profile does not use IEC 61970-552:2016
232 header attributes and relies only on the extended attributes.

233 2.4.1 Constraints

234 The identification of the constraints related to the metadata follows the same convention for
235 naming of the constraints as for profile constraints.

- 236 • R:NC:ALL:wasAttributedTo:usage

237 The prov:wasAttributedTo should normally be the “X” EIC code of the actor (prov:Agent).

238

239 2.4.2 Reference metadata

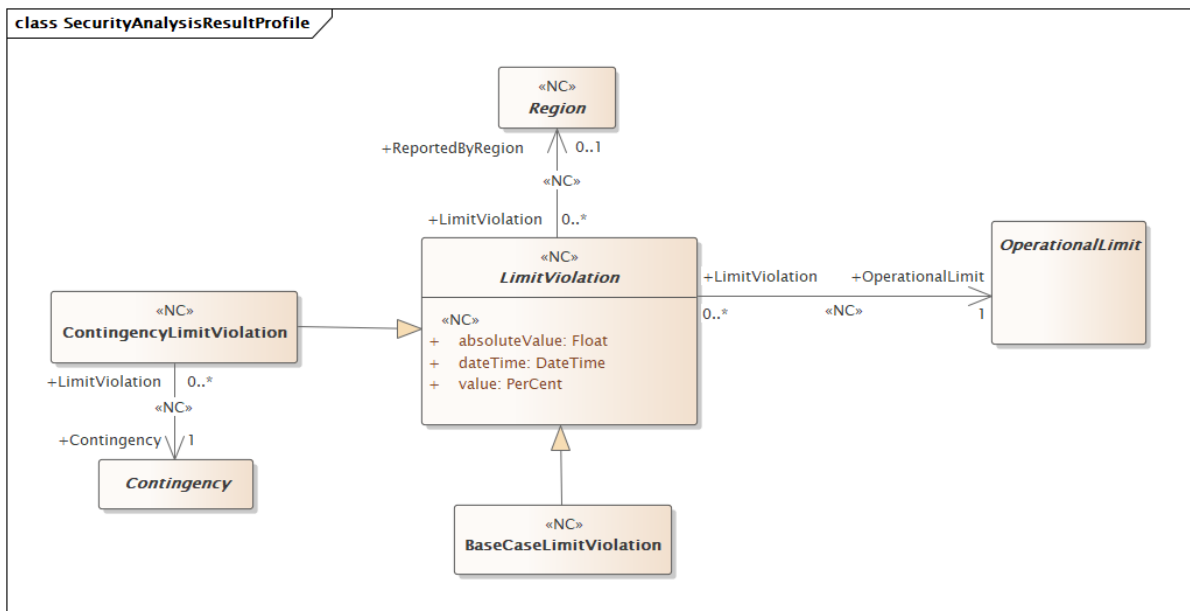
240 The header defined for this profile requires availability of a set of reference metadata. For
241 instance, the attribute prov:wasGeneratedBy requires a reference to an activity which produced
242 the model or the related process. The activities are defined as reference metadata and their
243 identifiers are referenced from the header to enable the receiving entity to retrieve the “static”
244 (reference) information that is not modified frequently. This approach imposes a requirement
245 that both the sending entity and the receiving entity have access to a unique version of the

246 reference metadata. Therefore, each business process shall define which reference metadata
247 is used and where it is located.

248 **3 Detailed Profile Specification**

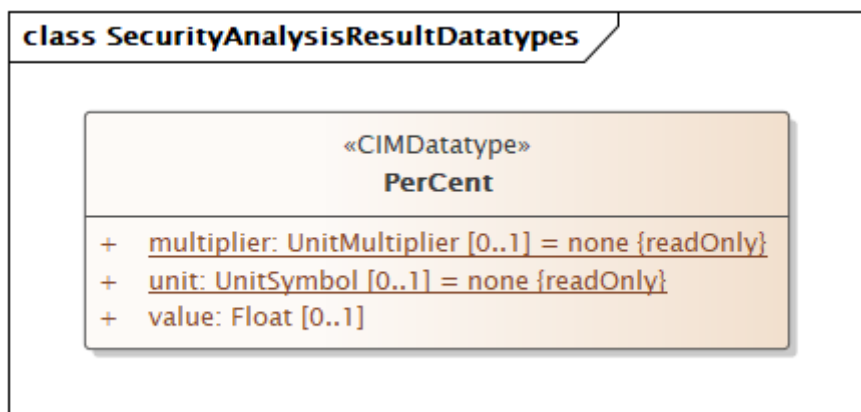
249 **3.1 General**

250 This package contains the security analysis result profile.



251
252 **Figure 1 – Class diagram SecurityAnalysisResultProfile::SecurityAnalysisResultProfile**

253 Figure 1: The diagram contains the main classes used in the profile.



254
255 **Figure 2 – Class diagram**
256 **SecurityAnalysisResultProfile::SecurityAnalysisResultDatatypes**

257 Figure 2: The diagram shows datatypes that are used by classes in the profile. Stereotypes are
258 used to describe the datatypes. The following stereotypes are defined:

- 259 <<enumeration>> A list of permissible constant values.
- 260 <<Primitive>> The most basic data types used to compose all other data types.
- 261 <<CIMDatatype>> A datatype that contains a value attribute, an optional unit of measure and
- 262 a unit multiplier. The unit and multiplier may be specified as a static variable initialized to the
- 263 allowed value.

264 <<Compound>> A composite of Primitive, enumeration, CIMDatatype or other Compound
265 classes, as long as the Compound classes do not recurse.
266 For all datatypes both positive and negative values are allowed unless stated otherwise for a
267 particular datatype.

268 3.2 (abstract,NC) LimitViolation root class

269 Limit violation.

270 Table 1 shows all attributes of LimitViolation.

271 **Table 1 – Attributes of SecurityAnalysisResultProfile::LimitViolation**

name	mult	type	description
value	1..1	PerCent	(NC) The value of the limit violation in percent related to the value of the operational limit that is violated. For instance, if the operational limit is 1000 A and the current flow is 1100 A the value is reported as 110 %.
absoluteValue	1..1	Float	(NC) Absolute value which results from a power flow calculation. For instance, if the operational limit is 1000 A and the current flow is 1100 A the absoluteValue is reported as 1100 A.
dateTime	1..1	DateTime	(NC) The date and time of the scenario time that was studied and at which the limit violation occurred.

272

273 Table 2 shows all association ends of LimitViolation with other classes.

274 **Table 2 – Association ends of SecurityAnalysisResultProfile::LimitViolation with other**
275 **classes**

mult from	name	mult to	type	description
0..*	OperationalLimit	1..1	OperationalLimit	(NC) The operational limit that has this limit violation.
0..*	ReportedByRegion	0..1	Region	(NC) The region which reports this limit violation.

276

277 3.3 (abstract) OperationalLimit root class

278 A value and normal value associated with a specific kind of limit.

279 The sub class value and normalValue attributes vary inversely to the associated
280 OperationalLimitType.acceptableDuration (acceptableDuration for short).

281 If a particular piece of equipment has multiple operational limits of the same kind (apparent
282 power, current, etc.), the limit with the greatest acceptableDuration shall have the smallest limit
283 value and the limit with the smallest acceptableDuration shall have the largest limit value. Note:
284 A large current can only be allowed to flow through a piece of equipment for a short duration
285 without causing damage, but a lesser current can be allowed to flow for a longer duration.

286 3.4 (abstract) Contingency root class

287 An event threatening system reliability, consisting of one or more contingency elements.

288 3.5 (abstract,NC) Region root class

289 A region where the system operator belongs to.

290 3.6 PerCent datatype

291 Percentage on a defined base. For example, specify as 100 to indicate at the defined base.

292 Table 3 shows all attributes of PerCent.

293

Table 3 – Attributes of SecurityAnalysisResultProfile::PerCent

name	mult	type	description
value	0..1	Float	Normally 0 to 100 on a defined base.
unit	0..1	UnitSymbol	(const=none)
multiplier	0..1	UnitMultiplier	(const=none)

294

295 3.7 Float primitive

296 A floating point number. The range is unspecified and not limited.

297 3.8 DateTime primitive

298 Date and time as "yyyy-mm-ddThh:mm:ss.sss", which conforms with ISO 8601. UTC time zone
299 is specified as "yyyy-mm-ddThh:mm:ss.sssZ". A local timezone relative UTC is specified as
300 "yyyy-mm-ddThh:mm:ss.sss-hh:mm". The second component (shown here as "ss.sss") could
301 have any number of digits in its fractional part to allow any kind of precision beyond seconds.

302 3.9 Boolean primitive

303 A type with the value space "true" and "false".

304 3.10 UnitSymbol enumeration

305 The derived units defined for usage in the CIM. In some cases, the derived unit is equal to an
306 SI unit. Whenever possible, the standard derived symbol is used instead of the formula for the
307 derived unit. For example, the unit symbol Farad is defined as "F" instead of "CPerV". In cases
308 where a standard symbol does not exist for a derived unit, the formula for the unit is used as
309 the unit symbol. For example, density does not have a standard symbol and so it is represented
310 as "kgPerm3". With the exception of the "kg", which is an SI unit, the unit symbols do not contain
311 multipliers and therefore represent the base derived unit to which a multiplier can be applied as
312 a whole.

313 Every unit symbol is treated as an unparseable text as if it were a single-letter symbol. The
314 meaning of each unit symbol is defined by the accompanying descriptive text and not by the
315 text contents of the unit symbol.

316 To allow the widest possible range of serializations without requiring special character handling,
317 several substitutions are made which deviate from the format described in IEC 80000-1. The
318 division symbol "/" is replaced by the letters "Per". Exponents are written in plain text after the
319 unit as "m3" instead of being formatted as "m" with a superscript of 3 or introducing a symbol
320 as in "m^3". The degree symbol "°" is replaced with the letters "deg". Any clarification of the
321 meaning for a substitution is included in the description for the unit symbol.

322 Non-SI units are included in list of unit symbols to allow sources of data to be correctly labelled
323 with their non-SI units (for example, a GPS sensor that is reporting numbers that represent feet
324 instead of meters). This allows software to use the unit symbol information correctly convert
325 and scale the raw data of those sources into SI-based units.

326 The integer values are used for harmonization with IEC 61850.

327 Table 4 shows all literals of UnitSymbol.

328

Table 4 – Literals of SecurityAnalysisResultProfile::UnitSymbol

literal	value	description
none	0	Dimension less quantity, e.g. count, per unit, etc.
m	2	Length in metres.
kg	3	Mass in kilograms. Note: multiplier "k" is included in this unit symbol for compatibility with IEC 61850-7-3.
s	4	Time in seconds.
A	5	Current in amperes.

literal	value	description
K	6	Temperature in kelvins.
mol	7	Amount of substance in moles.
cd	8	Luminous intensity in candelas.
deg	9	Plane angle in degrees.
rad	10	Plane angle in radians (m/m).
sr	11	Solid angle in steradians (m ² /m ²).
Gy	21	Absorbed dose in grays (J/kg).
Bq	22	Radioactivity in becquerels (1/s).
degC	23	Relative temperature in degrees Celsius. In the SI unit system the symbol is °C. Electric charge is measured in coulomb that has the unit symbol C. To distinguish degree Celsius from coulomb the symbol used in the UML is degC. The reason for not using °C is that the special character ° is difficult to manage in software.
Sv	24	Dose equivalent in sieverts (J/kg).
F	25	Electric capacitance in farads (C/V).
C	26	Electric charge in coulombs (A·s).
S	27	Conductance in siemens.
H	28	Electric inductance in henrys (Wb/A).
V	29	Electric potential in volts (W/A).
ohm	30	Electric resistance in ohms (V/A).
J	31	Energy in joules (N·m = C·V = W·s).
N	32	Force in newtons (kg·m/s ²).
Hz	33	Frequency in hertz (1/s).
lx	34	Illuminance in lux (lm/m ²).
lm	35	Luminous flux in lumens (cd·sr).
Wb	36	Magnetic flux in webers (V·s).
T	37	Magnetic flux density in teslas (Wb/m ²).
W	38	Real power in watts (J/s). Electrical power may have real and reactive components. The real portion of electrical power (I ² R or VIcos(phi)), is expressed in Watts. See also apparent power and reactive power.
Pa	39	Pressure in pascals (N/m ²). Note: the absolute or relative measurement of pressure is implied with this entry. See below for more explicit forms.
m2	41	Area in square metres (m ²).
m3	42	Volume in cubic metres (m ³).
mPers	43	Velocity in metres per second (m/s).
mPers2	44	Acceleration in metres per second squared (m/s ²).
m3Pers	45	Volumetric flow rate in cubic metres per second (m ³ /s).
mPerm3	46	Fuel efficiency in metres per cubic metres (m/m ³).

literal	value	description
kgm	47	Moment of mass in kilogram metres (kg·m) (first moment of mass). Note: multiplier “k” is included in this unit symbol for compatibility with IEC 61850-7-3.
kgPerm3	48	Density in kilogram/cubic metres (kg/m ³). Note: multiplier “k” is included in this unit symbol for compatibility with IEC 61850-7-3.
m2Pers	49	Viscosity in square metres / second (m ² /s).
WPermK	50	Thermal conductivity in watt/metres kelvin.
JPerK	51	Heat capacity in joules/kelvin.
ppm	52	Concentration in parts per million.
rotPers	53	Rotations per second (1/s). See also Hz (1/s).
radPers	54	Angular velocity in radians per second (rad/s).
WPerm2	55	Heat flux density, irradiance, watts per square metre.
JPerm2	56	Insulation energy density, joules per square metre or watt second per square metre.
SPerm	57	Conductance per length (F/m).
KPers	58	Temperature change rate in kelvins per second.
PaPers	59	Pressure change rate in pascals per second.
JPerkgK	60	Specific heat capacity, specific entropy, joules per kilogram Kelvin.
VA	61	Apparent power in volt amperes. See also real power and reactive power.
VAr	63	Reactive power in volt amperes reactive. The “reactive” or “imaginary” component of electrical power (VIsin(phi)). (See also real power and apparent power). Note: Different meter designs use different methods to arrive at their results. Some meters may compute reactive power as an arithmetic value, while others compute the value vectorially. The data consumer should determine the method in use and the suitability of the measurement for the intended purpose.
cosPhi	65	Power factor, dimensionless. Note 1: This definition of power factor only holds for balanced systems. See the alternative definition under code 153. Note 2 : Beware of differing sign conventions in use between the IEC and EEI. It is assumed that the data consumer understands the type of meter in use and the sign convention in use by the utility.
Vs	66	Volt seconds (Ws/A).
V2	67	Volt squared (W ² /A ²).
As	68	Ampere seconds (A·s).
A2	69	Amperes squared (A ²).
A2s	70	Ampere squared time in square amperes (A ² s).
VAh	71	Apparent energy in volt ampere hours.
Wh	72	Real energy in watt hours.

literal	value	description
VArh	73	Reactive energy in volt ampere reactive hours.
VPerHz	74	Magnetic flux in volt per hertz.
HzPers	75	Rate of change of frequency in hertz per second.
character	76	Number of characters.
charPers	77	Data rate (baud) in characters per second.
kgm2	78	Moment of mass in kilogram square metres (kg·m ²) (Second moment of mass, commonly called the moment of inertia). Note: multiplier "k" is included in this unit symbol for compatibility with IEC 61850-7-3.
dB	79	Sound pressure level in decibels. Note: multiplier "d" is included in this unit symbol for compatibility with IEC 61850-7-3.
WPers	81	Ramp rate in watts per second.
IPers	82	Volumetric flow rate in litres per second.
dBm	83	Power level (logarithmic ratio of signal strength , Bel-mW), normalized to 1mW. Note: multiplier "d" is included in this unit symbol for compatibility with IEC 61850-7-3.
h	84	Time in hours, hour = 60 min = 3600 s.
min	85	Time in minutes, minute = 60 s.
Q	100	Quantity power, Q.
Qh	101	Quantity energy, Qh.
ohmm	102	Resistivity, ohm metres, (rho).
APerm	103	A/m, magnetic field strength, amperes per metre.
V2h	104	Volt-squared hour, volt-squared-hours.
A2h	105	Ampere-squared hour, ampere-squared hour.
Ah	106	Ampere-hours, ampere-hours.
count	111	Amount of substance, Counter value.
ft3	119	Volume, cubic feet.
m3Perh	125	Volumetric flow rate, cubic metres per hour.
gal	128	Volume in gallons, US gallon (1 gal = 231 in ³ = 128 fl ounce).
Btu	132	Energy, British Thermal Units.
l	134	Volume in litres, litre = dm ³ = m ³ /1000.
lPerh	137	Volumetric flow rate, litres per hour.
lPerl	143	Concentration, The ratio of the volume of a solute divided by the volume of the solution. Note: Users may need use a prefix such a 'µ' to express a quantity such as 'µL/L'.
gPerg	144	Concentration, The ratio of the mass of a solute divided by the mass of the solution. Note: Users may need use a prefix such a 'µ' to express a quantity such as 'µg/g'.
molPerm3	145	Concentration, The amount of substance concentration, (c), the amount of solvent in moles divided by the volume of solution in m ³ .

literal	value	description
molPermol	146	Concentration, Molar fraction, the ratio of the molar amount of a solute divided by the molar amount of the solution.
molPerkg	147	Concentration, Molality, the amount of solute in moles and the amount of solvent in kilograms.
sPers	149	Time, Ratio of time. Note: Users may need to supply a prefix such as 'μ' to show rates such as 'μs/s'.
HzPerHz	150	Frequency, rate of frequency change. Note: Users may need to supply a prefix such as 'm' to show rates such as 'mHz/Hz'.
VPerV	151	Voltage, ratio of voltages. Note: Users may need to supply a prefix such as 'm' to show rates such as 'mV/V'.
APerA	152	Current, ratio of amperages. Note: Users may need to supply a prefix such as 'm' to show rates such as 'mA/A'.
VPerVA	153	Power factor, PF, the ratio of the active power to the apparent power. Note: The sign convention used for power factor will differ between IEC meters and EEI (ANSI) meters. It is assumed that the data consumers understand the type of meter being used and agree on the sign convention in use at any given utility.
rev	154	Amount of rotation, revolutions.
kat	158	Catalytic activity, katal = mol / s.
JPerkg	165	Specific energy, Joules / kg.
m3Uncompensated	166	Volume, cubic metres, with the value uncompensated for weather effects.
m3Compensated	167	Volume, cubic metres, with the value compensated for weather effects.
WPerW	168	Signal Strength, ratio of power. Note: Users may need to supply a prefix such as 'm' to show rates such as 'mW/W'.
therm	169	Energy, therms.
onePerm	173	Wavenumber, reciprocal metres, (1/m).
m3Perkg	174	Specific volume, cubic metres per kilogram, v.
Pas	175	Dynamic viscosity, pascal seconds.
Nm	176	Moment of force, newton metres.
NPerm	177	Surface tension, newton per metre.
radPers2	178	Angular acceleration, radians per second squared.
JPerm3	181	Energy density, joules per cubic metre.
VPerm	182	Electric field strength, volts per metre.
CPerm3	183	Electric charge density, coulombs per cubic metre.
CPerm2	184	Surface charge density, coulombs per square metre.
FPerm	185	Permittivity, farads per metre.
HPerm	186	Permeability, henrys per metre.
JPermol	187	Molar energy, joules per mole.

literal	value	description
JPermolK	188	Molar entropy, molar heat capacity, joules per mole kelvin.
CPerkg	189	Exposure (x rays), coulombs per kilogram.
GyPers	190	Absorbed dose rate, grays per second.
WPersr	191	Radiant intensity, watts per steradian.
WPerm2sr	192	Radiance, watts per square metre steradian.
katPerm3	193	Catalytic activity concentration, katals per cubic metre.
d	195	Time in days, day = 24 h = 86400 s.
anglemin	196	Plane angle, minutes.
anglesec	197	Plane angle, seconds.
ha	198	Area, hectares.
tonne	199	Mass in tons, "tonne" or "metric ton" (1000 kg = 1 Mg).
bar	214	Pressure in bars, (1 bar = 100 kPa).
mmHg	215	Pressure, millimetres of mercury (1 mmHg is approximately 133.3 Pa).
M	217	Length, nautical miles (1 M = 1852 m).
kn	219	Speed, knots (1 kn = 1852/3600) m/s.
Mx	276	Magnetic flux, maxwells (1 Mx = 10 ⁻⁸ Wb).
G	277	Magnetic flux density, gaussses (1 G = 10 ⁻⁴ T).
Oe	278	Magnetic field in oersteds, (1 Oe = (103/4p) A/m).
Vh	280	Volt-hour, Volt hours.
WPerA		Active power per current flow, watts per Ampere.
onePerHz		Reciprocal of frequency (1/Hz).
VPerVAr		Power factor, PF, the ratio of the active power to the apparent power. Note: The sign convention used for power factor will differ between IEC meters and EEI (ANSI) meters. It is assumed that the data consumers understand the type of meter being used and agree on the sign convention in use at any given utility.
ohmPerm	86	Electric resistance per length in ohms per metre ((V/A)/m).
kgPerJ		Weight per energy in kilograms per joule (kg/J). Note: multiplier "k" is included in this unit symbol for compatibility with IEC 61850-7-3.
JPers		Energy rate in joules per second (J/s).

329

330 **3.11 UnitMultiplier enumeration**

331 The unit multipliers defined for the CIM. When applied to unit symbols, the unit symbol is
332 treated as a derived unit. Regardless of the contents of the unit symbol text, the unit symbol
333 shall be treated as if it were a single-character unit symbol. Unit symbols should not contain
334 multipliers, and it should be left to the multiplier to define the multiple for an entire data type.
335 For example, if a unit symbol is "m2Pers" and the multiplier is "k", then the value is k(m**2/s),
336 and the multiplier applies to the entire final value, not to any individual part of the value. This
337 can be conceptualized by substituting a derived unit symbol for the unit type. If one imagines

338 that the symbol "P" represents the derived unit "m²Pers", then applying the multiplier "k" can
 339 be conceptualized simply as "kP".
 340 For example, the SI unit for mass is "kg" and not "g". If the unit symbol is defined as "kg", then
 341 the multiplier is applied to "kg" as a whole and does not replace the "k" in front of the "g". In
 342 this case, the multiplier of "m" would be used with the unit symbol of "kg" to represent one gram.
 343 As a text string, this violates the instructions in IEC 80000-1. However, because the unit symbol
 344 in CIM is treated as a derived unit instead of as an SI unit, it makes more sense to conceptualize
 345 the "kg" as if it were replaced by one of the proposed replacements for the SI mass symbol. If
 346 one imagines that the "kg" were replaced by a symbol "P", then it is easier to conceptualize the
 347 multiplier "m" as creating the proper unit "mP", and not the forbidden unit "mkg".
 348 Table 5 shows all literals of UnitMultiplier.

349

Table 5 – Literals of SecurityAnalysisResultProfile::UnitMultiplier

literal	value	description
y	-24	Yocto 10 ^{**} -24.
z	-21	Zepto 10 ^{**} -21.
a	-18	Atto 10 ^{**} -18.
f	-15	Femto 10 ^{**} -15.
p	-12	Pico 10 ^{**} -12.
n	-9	Nano 10 ^{**} -9.
micro	-6	Micro 10 ^{**} -6.
m	-3	Milli 10 ^{**} -3.
c	-2	Centi 10 ^{**} -2.
d	-1	Deci 10 ^{**} -1.
none	0	No multiplier or equivalently multiply by 1.
da	1	Deca 10 ^{**} 1.
h	2	Hecto 10 ^{**} 2.
k	3	Kilo 10 ^{**} 3.
M	6	Mega 10 ^{**} 6.
G	9	Giga 10 ^{**} 9.
T	12	Tera 10 ^{**} 12.
P	15	Peta 10 ^{**} 15.
E	18	Exa 10 ^{**} 18.
Z	21	Zetta 10 ^{**} 21.
Y	24	Yotta 10 ^{**} 24.

350

3.12 String primitive

351 A string consisting of a sequence of characters. The character encoding is UTF-8. The string
 352 length is unspecified and unlimited.
 353

3.13 Date primitive

354 Date as "yyyy-mm-dd", which conforms with ISO 8601. UTC time zone is specified as "yyyy-
 355 mm-ddZ". A local timezone relative UTC is specified as "yyyy-mm-dd(+/-)hh:mm".
 356

3.14 (NC) ContingencyLimitViolation

357 Inheritance path = [LimitViolation](#)

358 Limit violation for contingency.

359 Table 6 shows all attributes of ContingencyLimitViolation.
 360

361 **Table 6 – Attributes of SecurityAnalysisResultProfile::ContingencyLimitViolation**

name	mult	type	description
value	1..1	PerCent	(NC) inherited from: LimitViolation
absoluteValue	1..1	Float	(NC) inherited from: LimitViolation
dateTime	1..1	DateTime	(NC) inherited from: LimitViolation

362

363 Table 7 shows all association ends of ContingencyLimitViolation with other classes.

364 **Table 7 – Association ends of SecurityAnalysisResultProfile::ContingencyLimitViolation**
365 **with other classes**

mult from	name	mult to	type	description
0..*	Contingency	1..1	Contingency	(NC) The contingency that has this limit violation.
0..*	OperationalLimit	1..1	OperationalLimit	(NC) inherited from: LimitViolation
0..*	ReportedByRegion	0..1	Region	(NC) inherited from: LimitViolation

366

367 **3.15 (NC) BaseCaseLimitViolation**368 Inheritance path = [LimitViolation](#)

369 Limit violation for base case.

370 Table 8 shows all attributes of BaseCaseLimitViolation.

371 **Table 8 – Attributes of SecurityAnalysisResultProfile::BaseCaseLimitViolation**

name	mult	type	description
value	1..1	PerCent	(NC) inherited from: LimitViolation
absoluteValue	1..1	Float	(NC) inherited from: LimitViolation
dateTime	1..1	DateTime	(NC) inherited from: LimitViolation

372

373 Table 9 shows all association ends of BaseCaseLimitViolation with other classes.

374 **Table 9 – Association ends of SecurityAnalysisResultProfile::BaseCaseLimitViolation**
375 **with other classes**

mult from	name	mult to	type	description
0..*	OperationalLimit	1..1	OperationalLimit	(NC) inherited from: LimitViolation
0..*	ReportedByRegion	0..1	Region	(NC) inherited from: LimitViolation

376

377

378

379

Annex A (informative): Sample data

380 A.1 General

381 This Annex is designed to illustrate the profile by using fragments of sample data. It is not meant
382 to be a complete set of examples covering all possibilities of using the profile. Defining a
383 complete set of test data is considered a separate activity to be performed for the purpose of
384 setting up interoperability testing and conformity related to this profile.

385 A.2 Sample instance data

```
386 <nc:LimitViolation rdf:ID="_94feb1f0-31ee-485e-b07d-60c324cdbe9c">
387   <nc:LimitViolation.value>103.5</nc:LimitViolation.value>
388   <nc:LimitViolation.absoluteValue>1200</nc:LimitViolation.absoluteValue>
389   <nc:LimitViolation.dateTime>2021-11-25T17:00:00Z</nc:LimitViolation.dateTime>
390   <nc:LimitViolation.inBaseCase>true</nc:LimitViolation.inBaseCase>
391   <nc:LimitViolation.OperationalLimit rdf:resource="#_fe141a7a-33f9-422a-955b-52958ebf31ad" />
392   <nc:LimitViolation.ReportedByRegion rdf:resource="#urn:entsoe:10Y1001C--00059P" />
393 </nc:LimitViolation>
394
395 <nc:LimitViolation rdf:ID="_94feb1f0-31ee-485e-b07d-60c324cdbe9c">
396   <nc:LimitViolation.value>102.0</nc:LimitViolation.value>
397   <nc:LimitViolation.absoluteValue>705</nc:LimitViolation.absoluteValue>
398   <nc:LimitViolation.dateTime>2021-11-25T17:00:00Z</nc:LimitViolation.dateTime>
399   <nc:LimitViolation.inBaseCase>false</nc:LimitViolation.inBaseCase>
400   <nc:LimitViolation.Contingency rdf:resource="#_b2a2dbfa-6eac-4ca6-a31b-6295991bc08b" />
401   <nc:LimitViolation.OperationalLimit rdf:resource="#_fe141a7a-33f9-422a-955b-52958ebf31ad" />
402   <nc:LimitViolation.ReportedByRegion rdf:resource="#urn:entsoe:10Y1001C--00059P" />
403 </nc:LimitViolation>
404
```