European Network of
Transmission System Operators
for Electricity

CONTINGENCY PROFILE SPECIFICATION

2023-05-10

APPROVED DOCUMENT
VERSION 2.2

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NOTE CONCERNING WORDING USED IN THIS DOCUMENT

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

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

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Revision History

Version	Release	Date	Paragraph	Comments
1	0	2021-03-22		Document for SOC approval
2	0	2021-10-12		For CIM EG review. Additional information is added to exceptional contingency. The combination between assessed element and contingency is modelled.
2	0	2022-02-16		For CIM EG review. Additional information is added to exceptional contingency. The combination between assessed element and contingency is modelled. SOC approved.
2	1	2022-09-21		SOC approved
2	2	2023-05-10		ICTC approved

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1 Introduction

The contingency profile is a profile to exchange a list of contingencies.

A contingency is the identified and possible or already occurred fault of an element, including not only the transmission system elements, but also significant grid users and distribution network elements if relevant for the transmission system operational security.[1]

The contingencies are input data for security analysis.

Preventive remedial actions may be applied in the base case and consequently in each contingency case since each contingency is applied on top of the base case with the consideration of all applied preventive remedial actions. There is no explicit association between preventive remedial actions and contingencies because of the definition of preventive remedial action. Curative remedial actions may be applied to the contingencies they are associated with and these association are the ones that is included in this profile. It is required to have an explicit list of assessed elements that relate to a given contingency. Only these assessed elements will be scanned when the contingency is simulated. Therefore, the profile restricts that at least one assessed element shall be scanned for a given contingency. The profile allows that contingencies can be associated to a given region, which indicates in which region these contingencies are studied. For instance, in CSA process normally the region has the meaning of a capacity calculation region.

2 Application profile specification

2.1 Version information

The content is generated from UML model file CIM100_CGMES31v01_501-20v02_NC22v95_MM10v01.eap.

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

- Title: Contingency Vocabulary
- Keyword: CO
- Description: This vocabulary is describing the contingency profile.
- Version IRI: http://entsoe.eu/ns/CIM/Contingency-EU/2.2
- Version info: 2.2.0
- Prior version: http://entsoe.eu/ns/CIM/Contingency-EU/2.1
- 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
- Identifier: urn:uuid:8947de1c-6e53-4f1f-82c3-99ef118db9eb

2.2 Constraints naming convention

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

“{rule.Type}:{rule.Standard}:{rule.Profile}:{rule.Property}:{rule.Name}”

where

[1] [SOURCE: CACM art.2.10]

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

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

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

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

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

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

2.3 Profile constraints

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

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

- C:452:ALL:NA:datatypes

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

- R:452:ALL:NA:exchange

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

- R:452:ALL:NA:exchange1

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

- R:452:ALL:NA:exchange2

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

- R:452:ALL:NA:exchange3

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

- R:452:ALL:NA:exchange4

From the standpoint of the model import used by a data recipient, the document describes a subset of the CIM that importing software shall be able to interpret in order to import exported models. Data providers are free to exceed the minimum requirements described herein as long as their resulting data files are compliant with the CIM Schema and the conventions established in Clause 5. The document, therefore, describes additional classes and class data that, although not required, exporters will, in all likelihood, choose to include in their data files. The additional classes and data are labelled as required (cardinality 1..1) or as optional (cardinality 0..1) to distinguish them from their required counterparts. Please note, however, that data importers could potentially receive data containing instances of any and all classes described by the CIM Schema.

- R:452:ALL:NA:cardinality

The cardinality defined in the CIM model shall be followed, unless a more restrictive cardinality is explicitly defined in this document. For instance, the cardinality on the association between VoltageLevel and BaseVoltage indicates that a VoltageLevel shall be associated with one and only one BaseVoltage, but a BaseVoltage can be associated with zero to many VoltageLevels.

- R:452:ALL:NA:associations

Associations between classes referenced in this document and classes not referenced here are not required regardless of cardinality.

- R:452:ALL:IdentifiedObject.name:rule

The attribute “name” inherited by many classes from the abstract class IdentifiedObject is not required to be unique. It must be a human readable identifier without additional embedded information that would need to be parsed. The attribute is used for purposes such as User Interface and data exchange debugging. The MRID defined in the data exchange format is the only unique and persistent identifier used for this data exchange. The attribute IdentifiedObject.name is, however, always required for CoreEquipment profile and Short Circuit profile.

- R:452:ALL:IdentifiedObject.description:rule

The attribute “description” inherited by many classes from the abstract class IdentifiedObject must contain human readable text without additional embedded information that would need to be parsed.

- R:452:ALL:NA:uniqueIdentifier

All IdentifiedObject-s shall have a persistent and globally unique identifier (Master Resource Identifier - mRID).

- R:452:ALL:NA:unitMultiplier

For exchange of attributes defined using CIM Data Types (ActivePower, Susceptance, etc.) a unit multiplier of 1 is used if the UnitMultiplier specified in this document is “none”.

- C:452:ALL:IdentifiedObject.name:stringLength

The string IdentifiedObject.name has a maximum of 128 characters.

- C:452:ALL:IdentifiedObject.description:stringLength

  The string IdentifiedObject.description is maximum 256 characters.

- C:452:ALL:NA:float

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

- R:NC:ALL:Region:reference

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

- R:NC:ALL:SystemOperator:reference

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

- C:NC:CO:ContingencyEquipment.contingentStatus:allowedValues

  The allowed value for the ContingencyEquipment.contingentStatus is ContingencyEquipmentStatusKind.outOfService.

- C:NC:CO:Contingency.ContingencyElement:outOfRangeAndExceptional

  The multiplicity of the association end Contingency.ContingencyElement is restricted to 2..* for both OutOfRangeContingency and ExceptionalContingency.

2.4 Metadata

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

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

2.4.1 Constraints

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

- R:NC:ALL:wasAttributedTo:usage

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

2.4.2 Reference metadata

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

3 Detailed Profile Specification

3.1 General

This package contains contingency profile.

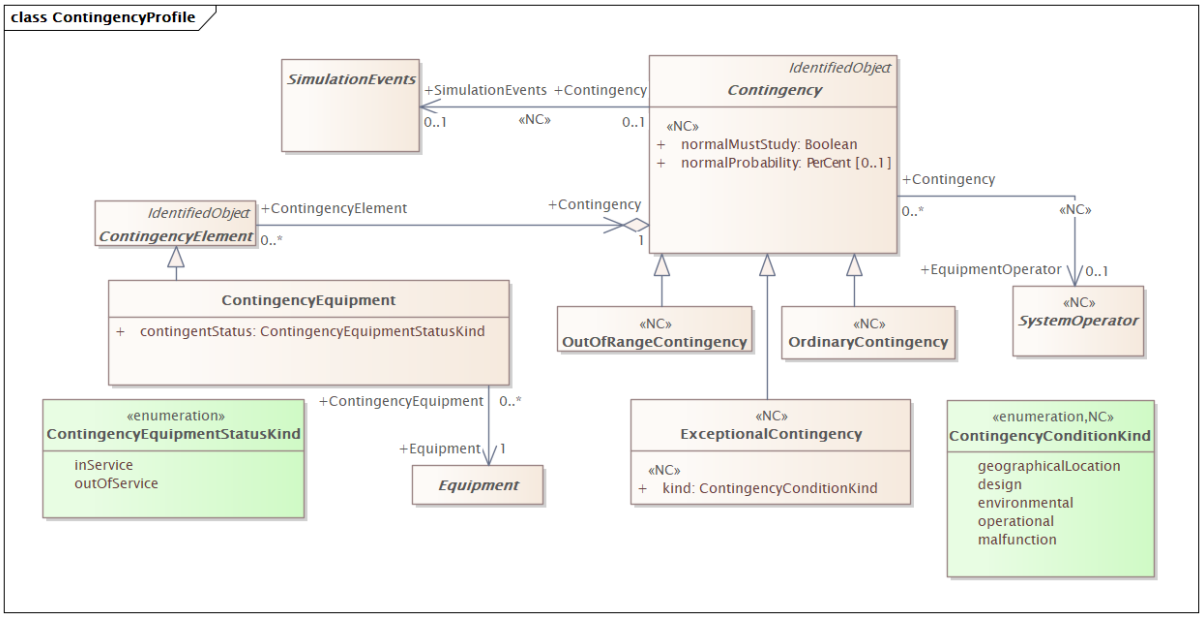

Figure 1 – Class diagram ContingencyProfile::ContingencyProfile

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

3.2 (abstract) Contingency

Inheritance path = IdentifiedObject
An event threatening system reliability, consisting of one or more contingency elements.
Table 1 shows all attributes of Contingency.

Table 1 – Attributes of ContingencyProfile::Contingency

name	mult	type	description
normalProbability	0..1	PerCent	(NC) Normal probability of the occurrence of the contingency based on normal operational condition. The value is used as the default if the probability is missing. The allowed value range is [0,100].
normalMustStudy	1..1	Boolean	(NC) Specifies the requirement of study the contingency under normal operating conditions. True means the contingency must be study in a normal scenario. False means that the contingency does not need to be included in the

name	mult	type	description
			scenario. This is the default value if mustStudy is missing.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 2 shows all association ends of Contingency with other classes.

Table 2 – Association ends of ContingencyProfile::Contingency with other classes

mult from	name	mult to	type	description
0..*	EquipmentOperator	0..1	SystemOperator	(NC) System operator that is operating the equipment that is being run a contingency on.
0..1	SimulationEvents	0..1	SimulationEvents	(NC) Simulation event for a contingency.

3.3 (abstract) ContingencyElement

Inheritance path = IdentifiedObject
An element of a system event to be studied by contingency analysis, representing a change in status of a single piece of equipment.
Table 3 shows all attributes of ContingencyElement.

Table 3 – Attributes of ContingencyProfile::ContingencyElement

name	mult	type	description
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 4 shows all association ends of ContingencyElement with other classes.

Table 4 – Association ends of ContingencyProfile::ContingencyElement with other classes

mult from	name	mult to	type	description
0..*	Contingency	1..1	Contingency	A contingency element belongs to one contingency.

3.4 ContingencyEquipment

Inheritance path = ContingencyElement : IdentifiedObject
Equipment whose in service status is to change, such as a power transformer or AC line segment.
Table 5 shows all attributes of ContingencyEquipment.

Table 5 – Attributes of ContingencyProfile::ContingencyEquipment

name	mult	type	description
contingentStatus	1..1	ContingencyEquipmentStatusKind	The status for the associated equipment when in the contingency state. This status is independent of the case to which the contingency is originally applied, but defines the

name	mult	type	description
			equipment status when the contingency is applied.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 6 shows all association ends of ContingencyEquipment with other classes.

Table 6 – Association ends of ContingencyProfile::ContingencyEquipment with other classes

mult from	name	mult to	type	description
0..*	Equipment	1..1	Equipment	The single piece of equipment to which to apply the contingency.
0..*	Contingency	1..1	Contingency	inherited from: ContingencyElement

3.5 (abstract) Equipment root class

The parts of a power system that are physical devices, electronic or mechanical.

3.6 (NC) ExceptionalContingency

Inheritance path = Contingency : IdentifiedObject

Exceptional contingency means the simultaneous occurrence of multiple contingencies with a common cause.

Table 7 shows all attributes of ExceptionalContingency.

Table 7 – Attributes of ContingencyProfile::ExceptionalContingency

name	mult	type	description
kind	1..1	ContingencyConditionKind	(NC) Defines the kind of relevance and criteria of application of the exceptional contingency.
normalProbability	0..1	PerCent	(NC) inherited from: Contingency
normalMustStudy	1..1	Boolean	(NC) inherited from: Contingency
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 8 shows all association ends of ExceptionalContingency with other classes.

Table 8 – Association ends of ContingencyProfile::ExceptionalContingency with other classes

mult from	name	mult to	type	description
0..*	EquipmentOperator	0..1	SystemOperator	(NC) inherited from: Contingency
0..1	SimulationEvents	0..1	SimulationEvents	(NC) inherited from: Contingency

3.7 (abstract) IdentifiedObject root class

This is a root class to provide common identification for all classes needing identification and naming attributes.

Table 9 shows all attributes of IdentifiedObject.

Table 9 – Attributes of ContingencyProfile::IdentifiedObject

name	mult	type	description
description	0..1	String	The description is a free human readable text describing or naming the object. It may be non unique and may not correlate to a naming hierarchy.
mRID	1..1	String	Master resource identifier issued by a model authority. The mRID is unique within an exchange context. Global uniqueness is easily achieved by using a UUID, as specified in RFC 4122, for the mRID. The use of UUID is strongly recommended. For CIMXML data files in RDF syntax conforming to IEC 61970-552, the mRID is mapped to rdf:ID or rdf:about attributes that identify CIM object elements.
name	0..1	String	The name is any free human readable and possibly non unique text naming the object.

3.8 (NC) OrdinaryContingency

Inheritance path = Contingency : IdentifiedObject
Ordinary contingency means the occurrence of a contingency of a single branch or injection.
Table 10 shows all attributes of OrdinaryContingency.

Table 10 – Attributes of ContingencyProfile::OrdinaryContingency

name	mult	type	description
normalProbability	0..1	PerCent	(NC) inherited from: Contingency
normalMustStudy	1..1	Boolean	(NC) inherited from: Contingency
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 11 shows all association ends of OrdinaryContingency with other classes.

Table 11 – Association ends of ContingencyProfile::OrdinaryContingency with other classes

mult from	name	mult to	type	description
0..*	EquipmentOperator	0..1	SystemOperator	(NC) inherited from: Contingency
0..1	SimulationEvents	0..1	SimulationEvents	(NC) inherited from: Contingency

3.9 (NC) OutOfRangeContingency

Inheritance path = Contingency : IdentifiedObject
Out of range means the simultaneous occurrence of multiple contingencies without a common cause, or a loss of power generating modules with a total loss of generation capacity exceeding the reference incident.
Table 12 shows all attributes of OutOfRangeContingency.

Table 12 – Attributes of ContingencyProfile::OutOfRangeContingency

name	mult	type	description
normalProbability	0..1	PerCent	(NC) inherited from: Contingency

name	mult	type	description
normalMustStudy	1..1	Boolean	(NC) inherited from: Contingency
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

Table 13 shows all association ends of OutOfRangeContingency with other classes.

Table 13 – Association ends of ContingencyProfile::OutOfRangeContingency with other classes

mult from	name	mult to	type	description
0..*	EquipmentOperator	0..1	SystemOperator	(NC) inherited from: Contingency
0..1	SimulationEvents	0..1	SimulationEvents	(NC) inherited from: Contingency

3.10 (abstract) SimulationEvents root class

A configuration or a set of events executed during a simulation.

3.11 (abstract,NC) SystemOperator root class

System operator.

3.12 (NC) ContingencyConditionKind enumeration

Kinds of occurrence criteria of application.
Table 14 shows all literals of ContingencyConditionKind.

Table 14 – Literals of ContingencyProfile::ContingencyConditionKind

literal	value	description
geographicalLocation		Permanent occurrence factor which is specific geographical location.
design		Permanent occurrence factor which is design condition.
environmental		Temporary occurrence factor which is weather or environmental condition (e.g. storm).
operational		Temporary occurrence factor which is operational condition.
malfunction		Temporary occurrence factor which is life time or generic malfunction affecting the risk of failure condition.

3.13 ContingencyEquipmentStatusKind enumeration

Indicates the state which the contingency equipment is to be in when the contingency is applied.
Table 15 shows all literals of ContingencyEquipmentStatusKind.

Table 15 – Literals of ContingencyProfile::ContingencyEquipmentStatusKind

literal	value	description
inService		The equipment is to be put into service.
outOfService		The equipment is to be taken out of service.

3.14 UnitMultiplier enumeration

The unit multipliers defined for the CIM. When applied to unit symbols, the unit symbol is treated as a derived unit. Regardless of the contents of the unit symbol text, the unit symbol shall be treated as if it were a single-character unit symbol. Unit symbols should not contain multipliers, and it should be left to the multiplier to define the multiple for an entire data type.
For example, if a unit symbol is "m2Pers" and the multiplier is "k", then the value is k(m**2/s), and the multiplier applies to the entire final value, not to any individual part of the value. This can be conceptualized by substituting a derived unit symbol for the unit type. If one imagines that the symbol "Þ" represents the derived unit "m2Pers", then applying the multiplier "k" can be conceptualized simply as "kÞ".
For example, the SI unit for mass is "kg" and not "g". If the unit symbol is defined as "kg", then the multiplier is applied to "kg" as a whole and does not replace the "k" in front of the "g". In this case, the multiplier of "m" would be used with the unit symbol of "kg" to represent one gram. As a text string, this violates the instructions in IEC 80000-1. However, because the unit symbol in CIM is treated as a derived unit instead of as an SI unit, it makes more sense to conceptualize the "kg" as if it were replaced by one of the proposed replacements for the SI mass symbol. If one imagines that the "kg" were replaced by a symbol "Þ", then it is easier to conceptualize the multiplier "m" as creating the proper unit "mÞ", and not the forbidden unit "mkg".
Table 16 shows all literals of UnitMultiplier.

Table 16 – Literals of ContingencyProfile::UnitMultiplier

literal	value	description
none	0	No multiplier or equivalently multiply by 1.

3.15 UnitSymbol enumeration

The derived units defined for usage in the CIM. In some cases, the derived unit is equal to an SI unit. Whenever possible, the standard derived symbol is used instead of the formula for the derived unit. For example, the unit symbol Farad is defined as "F" instead of "CPerV". In cases where a standard symbol does not exist for a derived unit, the formula for the unit is used as the unit symbol. For example, density does not have a standard symbol and so it is represented as "kgPerm3". With the exception of the "kg", which is an SI unit, the unit symbols do not contain multipliers and therefore represent the base derived unit to which a multiplier can be applied as a whole.
Every unit symbol is treated as an unparseable text as if it were a single-letter symbol. The meaning of each unit symbol is defined by the accompanying descriptive text and not by the text contents of the unit symbol.
To allow the widest possible range of serializations without requiring special character handling, several substitutions are made which deviate from the format described in IEC 80000-1. The division symbol "/" is replaced by the letters "Per". Exponents are written in plain text after the unit as "m3" instead of being formatted as "m" with a superscript of 3 or introducing a symbol as in "m^3". The degree symbol "°" is replaced with the letters "deg". Any clarification of the meaning for a substitution is included in the description for the unit symbol.
Non-SI units are included in list of unit symbols to allow sources of data to be correctly labelled with their non-SI units (for example, a GPS sensor that is reporting numbers that represent feet instead of meters). This allows software to use the unit symbol information correctly convert and scale the raw data of those sources into SI-based units.
The integer values are used for harmonization with IEC 61850.
Table 17 shows all literals of UnitSymbol.

Table 17 – Literals of ContingencyProfile::UnitSymbol

literal	value	description
none	0	Dimension less quantity, e.g. count, per unit, etc.

3.16 PerCent datatype

Percentage on a defined base. For example, specify as 100 to indicate at the defined base. Table 18 shows all attributes of PerCent.

Table 18 – Attributes of ContingencyProfile::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)

3.17 Boolean primitive

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

3.18 Float primitive

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

3.19 String primitive

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

Annex A (informative): Sample data

A.1 General

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

A.2 Sample instance data

Test data files are available in the CIM EG SharePoint.