IEC 61968-13

Edition 1.0 2008-06

INTERNATIONAL STANDARD

Application integration at electric utilities – System interfaces for distribution management –
Part 13: CIM RDF Model exchange format for distribution

IEC 61968-13:2008(E)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE XA

ICS 33.200

ISBN 2-8318-9873-0

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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**APPLICATION INTEGRATION AT ELECTRIC UTILITIES –
SYSTEM INTERFACES FOR DISTRIBUTION MANAGEMENT –**

Part 13: CIM RDF Model exchange format for distribution

FOREWORD

International Standard IEC 61968-13 has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

The text of this standard is based on the following documents:

FDIS	Report on Voting
57/930/FDIS	57/955/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

A list of all parts of the IEC 61968 series, under the general title *Application integration at electric utilities – System interfaces for distribution management*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

The IEC 61968 series of standards is intended to facilitate inter-application integration as opposed to intra-application integration. Intra-application integration is aimed at programs in the same application system, usually communicating with each other using middleware that is embedded in their underlying runtime environment, and tends to be optimized for close, real-time, synchronous connections and interactive request/reply or conversation communication models. IEC 61968, by contrast, is intended to support the inter-application integration of a utility enterprise that needs to connect disparate applications that are already built or new (legacy or purchased applications), each supported by dissimilar runtime environments. Therefore, these interface standards are relevant to loosely coupled applications with more heterogeneity in languages, operating systems, protocols and management tools. This series of standards is intended to support applications that need to exchange data every few seconds, minutes, or hours rather than waiting for a nightly batch run. This series of standards, which are intended to be implemented with middleware services that exchange messages among applications, will complement, not replace utility data warehouses, database gateways, and operational stores.

As used in IEC 61968, a DMS consists of various distributed application components for the utility to manage electrical distribution networks. These capabilities include monitoring and control of equipment for power delivery, management processes to ensure system reliability, voltage management, demand-side management, outage management, work management, automated mapping and facilities management. Standards interfaces are defined for each class of applications identified in the Interface Reference Model (IRM), which is described in IEC 61968-1.

APPLICATION INTEGRATION AT ELECTRIC UTILITIES – SYSTEM INTERFACES FOR DISTRIBUTION MANAGEMENT –

Part 13: CIM RDF Model exchange format for distribution

1 Scope

This part of IEC 61968 specifies the format and rules for exchanging modeling information based upon the CIM (Common Information Model) and related to distribution network data.

The intention of this part of IEC 61968 is to allow the exchange of instance data in bulk. Thus, the imported network model data should be sufficient to allow performing network connectivity analysis, including network tracing, outage analysis, load flow calculations, etc. This part could be used for synchronizing geographical information system databases with remote control system databases.

This part is closely linked to IEC 61970-452 Energy Management System Application Program Interface (EMS-API) CIM Network applications model exchange specification. Thus, this document has been written in order to reduce its maintenance. It describes only differences with IEC 61970-452. Nevertheless, as IEC 61970-452 is a future international standard, this part still has duplicate information with IEC 61970-452, in order to be more understandable.

It uses the CIM RDF[1] Schema presented in IEC 61970-501 as the meta-model framework for constructing XML[2] documents containing power system modeling information. The syntax of these documents is called CIM XML format. Model exchange by file transfer serves many useful purposes, specially when some applications need to have the complete network model defined. Though the format can be used for general CIM-based information exchange, in this part of IEC 61968, specific profiles (or subsets) of the CIM are identified in order to address particular exchange requirements.

Given the CIM RDF Schema described in IEC 61970-501, a DMS power system model can be converted for export as an XML document, see Figure 1. This document is referred to as a CIM XML document. All of the tags (resource descriptions) used in the CIM XML document are supplied by the CIM RDF schema. The resulting CIM XML model exchange document can be parsed and the information imported into a foreign system. This part of IEC 61968 is aligned to CIM Model version 11, CPSM 3.0 profile.

---

1) RDF: Resource Description Framework.

2) XML: eXtensible Markup Language.

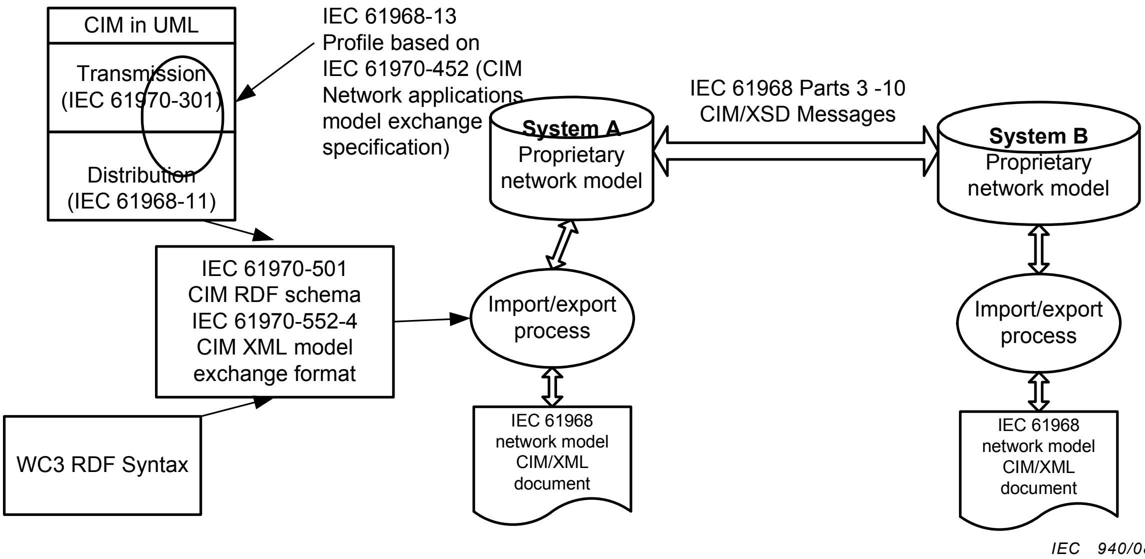


Figure 1 – XML-based DMS network data configuration

Similar to using any programming language, implementers have many choices when creating a CIM XML document. The RDF syntax itself can be used in several ways to achieve the same basic result. The way one approaches the CIM RDF Schema can yield various forms when producing a CIM XML document. The following clauses discuss the style guidelines for producing a CIM XML document. Such guideline rules are important to communicate and follow when producing these documents because they simplify and facilitate the software written to unambiguously interpret the model information.

Some comparisons have been made between CIM RDF and CIM XSD. Annexes A, B, C and D are extracted from articles and documents discussing CIM RDF and CIM XSD. A distribution management system can use only a CIM XSD message types architecture, but CIM RDF has three advantages:

- A UML model is a graph model and RDF helps to describe the graph model. XSD describes a hierarchical model which suits the message type approach.
- RDF is more readable and understandable by people working in the electrotechnical field.
- It is a basic requirement to build ontologies.

If required, tools would ensure the compatibility between CIM-RDF and, for instance, IEC 61968-4 and IEC 61968-3 message types concerning distribution network model representation.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61968-1, *Application integration at electric utilities – System interfaces for distribution management – Part 1: Interface architecture and general requirements*

IEC 61968-3, *Application integration at electric utilities – System interfaces for distribution management – Part 3: Interface for network operations*

IEC 61968-4, *Application integration at electric utilities – System interfaces for distribution management – Part 4: Interfaces for records and asset management*

IEC 61970-301, *Energy management system application program interface (EMS-API) – Part 301: Common Information Model (CIM) base*

IEC 61970-501, *Energy management system application program interface (EMS-API) – Part 501: Common Information Model Resource Description Framework (CIM RDF) schema*

3 Future standards documents related to this part

The following documents are taken into account even if they have not been published as FDIS yet.

Extensions to CIM for Distribution: IEC 61968-11.

This document is used during interoperability tests: IEC 61970-452.

IEC 61970-552-4, *EMS-API – Part 552-4: CIM XML Model Exchange Format.*

4 CIM RDF describing distribution networks

In this part of the IEC 61968 standard, the object is to describe a CIM RDF model for the Distribution networks. It has the same objective as the NERC Common Power System Model (CPSM) Profile that has been agreed to at the Transmission level (reference: http://www.w3.org/TR/2004/REC-rdf-primer-20040210 subclause 6.5, and IEC 61970-452). At the distribution level, several kinds of application exist such as Network Operation, Asset Management, Customer Information, Network Planning, Work Management, etc. Efforts on standardization of these applications are conducted at the IEC through the Technical Committee 57. For more information, refer to http://www.cimuser.org web site.

Electric utilities use power system models for a number of different purposes. For example, power system simulations are developed for planning and security analysis. An operational power system model may consist of thousands of classes of information. In addition to using these models in-house, applications inside an individual utility need to exchange system modelling information, both for planning and operational purposes (e.g. coordinating transmission and distribution networks and ensuring reliable operations). However, individual utilities use different software packages for these purposes. As a result, the system models are stored in different formats, making exchange among these models difficult. The exchange of model data is difficult and requires specific interface development for data exchange between each pair of applications. Consequently, the individual utilities recognize the need to agree on common definitions of the power system entities and relationships to facilitate the future data exchange requirements.

The CIM defines most of objects inside an electric utility as classes and attributes, as well as the relationships among them. The CIM uses these object classes, their attributes and relationships to support the integration of independently developed applications among vendor specific DMS applications. CIM represents a canonical data model to support data exchange between each part of a DMS system such as asset management, distribution planning, etc.

Based on the NERC CPSM Profile for the transmission network, this part of IEC 61968 proposes a CIM-RDF profile for modelling Distribution networks. This part of IEC 61968 defines a CDPSM profile (Common Distribution Power System Model). IEC 61968-13 will mention the differences between this part of IEC 61968 and CPSM profile when they occur.

The data intended for initial configuration of distribution network applications includes the applications such as distribution load flow calculation, dynamic network coloring, stability studies due to the impact of Distributed Energy Resources on Distribution Networks, Distribution remote control system data management, exchange of data between TSO (Transmission System Operator) and DSO (Distribution System Operator), etc.

Consequently, the proposal is mainly based on IEC 61970-301, without, at the present time, the Asset classes found in IEC 61968-11. In the future, assetType attribute of Asset class will be used instead of PsrType if CIM IEC 61968-11 is normalized and incorporated officially in the CIM. In this part of IEC 61968, class Location is defined in the IEC 61968-11 packages.

This part of IEC 61968 is valid for three-phase balanced and unbalanced distribution networks. It is described as a single phase network and may have single- or two-phase components such as single-phase laterals and transformers[3)]. However, some users may find it convenient to restrict the proposed profile to include only the subset of three-phase balanced networks and exclude support for single phase components. In the Clauses which follow, the term "partial-phase devices" is used to describe components having less than three phases.

5 Issues related to partial-phase devices modeling

5.1 General

The IEC 61970-301 standard already has support for partial phase conducting devices through the phase-code attribute which may be a combination of any or all of the letters A, B, C, and N. In general, one can think of a partial phase conducting device as being the same as a full 3-phase device with some of the phases missing.

5.2 Impedances of unbalanced and partial phase devices

IEC 61970-301 specifies impedance of conducting devices in terms of the real and reactive positive and zero sequence impedance. Unfortunately, this is only valid for perfectly symmetric three-phase networks where all 3 phases have the same value of self-impedance and the same mutual impedance value.

The impedance of unbalanced 3-phase conducting devices such as AC line segments shall be specified as a three by three complex matrix where the diagonal terms specify the self impedance of each phase and the off-diagonal terms specify the mutual impedance between each phase pair. These values can be computed using Carson's equations based on the geometric mean radius, the linear resistance and the geometric arrangement of the three phases on the pole. IEC 61970-301 provides all the parameters necessary in the Conductor and WireArrangement classes. For 2-phase devices, the impedance matrix is two by two and for single-phase devices, it is a complex scalar specifying the self impedance of the single phase conductor.

5.3 Switches

IEC 61970-301 allows only two states for a switch device, i.e. open and closed. Thus for a 3-phase switch, it suggests that all three phases of the switch always operate together and it does not support the situation where, for example, phase A of the switch is open while phases B and C are closed. Of course, a single-phase switch may be open or closed.

5.4 Partial phase continuity in radial networks

Many distribution networks are operated radially, meaning that there is only one path for power to be supplied to any conducting device. For all phases of a device in a radial network to be properly energized, all devices upstream shall have the same phases present. (For

---

3) The USA radial electric distribution system is typically unbalanced. The main distribution feeder is three-phased with single-phased tapped load. The model exchange format should support a three-phased, unbalanced model to support, as an example, unbalanced load flow calculations.

example, it is not possible to energize all the phases of a three phase device via a partial phase upstream device.)

However, this requirement is not enforced in this part of IEC 61968. Rather, it is up to the importing DMS to check if this requirement is satisfied throughout the network.

6 CIM classes used and corresponding RDF

6.1 General

There is a large variety of voltage combinations in a substation. In addition, substations may generally contain one, two or more voltage levels. The applications needing such “substation type” information will deduce the substation type from the voltage levels it contains.

In general, substations may contain one, two or more voltage levels, the substation type will be deduced by analyzing the voltage levels a substation contains. The class PSRType can be used to distinguish these different substations. Class Location can be used to define the absolute position of a Substation.

Annex E gives a complete example of a Distribution Network Data represented through CIM-RDF. It should be pointed out that this complete example has been successfully tested during CIM interoperability tests conducted by EPRI in 2004, 2005, and 2006.

From the standpoint of a data producer (exporter), the document describes a minimum subset of CIM classes and class data which must be present in an XML formatted data file to comply with CDPSM Minimum Data Requirements. From the standpoint of a data recipient (importer), the document describes a subset of the CIM that an importer could reasonably expect to receive in an XML data file designed to be compliant with the CDPSM Minimum Data Requirements (see IEC 61970-501).

6.2 BaseVoltage and VoltageLevel

For every operating voltage found in the network, a BaseVoltage is created. An ACLineSegment is associated to a BaseVoltage. A TransformerWinding is associated to a BaseVoltage. PowerTransformer should be contained in a Substation.

Every Substation is associated with one or more VoltageLevel-s, each of which is in turn associated with the corresponding BaseVoltage.

All the objects of the network, except ACLineSegment, PowerTransformer and Transformer Winding should be contained within a VoltageLevel.

```
<cim:BaseVoltage rdf:ID="BaseVoltage_1">
        <cim:BaseVoltage.nominalVoltage>63</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:BaseVoltage rdf:ID="BaseVoltage_2">
        <cim:BaseVoltage.nominalVoltage>42</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:VoltageLevel rdf:ID="VL_1">
        <cim:Naming.name>NOD10S61</cim:Naming.name>
        <cim:VoltageLevel.MemberOf_Substation rdf:resource="#Substation_1"/>
        <cim:VoltageLevel.BaseVoltage rdf:resource="#BaseVoltage_1"/>
</cim:VoltageLevel>

<cim:VoltageLevel rdf:ID="VL_2">
        <cim:Naming.name>NOD10S62</cim:Naming.name>
        <cim:VoltageLevel.MemberOf_Substation rdf:resource="#Substation_1"/>
        <cim:VoltageLevel.BaseVoltage rdf:resource="#BaseVoltage_2"/>
</cim:VoltageLevel>
```

6.3 Containment hierarchy roots

The CPSM 2.0 profile of base CIM defines HostControlArea to be at the root of containment hierarchy. In contrast, this specification defines HV/MV Substation as the root of the containment hierarchy.

6.4 HV/MV substation

The containment hierarchy begins by HV/MV Substation.

```
<cim:Substation rdf:ID="Substation_1">
        <cim:Naming.name>AIGUE_HVMV<cim:Naming.name>
        <cim:Substation.PSRType rdf:resource="#PSRType_1">
</cim:Substation>

<cim:PSRType rdf:ID="PSRType_1">
        <cim:Naming.name>HV/MV Substation</cim:Naming.name>
</cim:PSRType>

<cim:Location rdf:ID="Location_1">
        <cim:Location.PowerSystemResource rdf:resource="#Substation_1">
</cim:Location>

<cim:GmlPosition rdf:ID="CP_1" >
        <cim:GmlPosition.xPosition>910700</cim:GmlPosition.xPosition>
        <cim:GmlPosition.yPosition>66270</cim:GmlPosition.yPosition>
        <cim:Location rdf:resource="#Location_1">
</cim:GmlPosition>
```

6.5 MV/MV substation

```
<cim:Substation rdf:ID="Substation_2">
        <cim:Naming.name>AIGUE_MVMV<cim:Naming.name>
        <cim:Substation.PSRType rdf:resource="#PSRType_2">
</cim:Substation>

<cim:PSRType rdf:ID="PSRType_2">
        <cim:Naming.name>MV/MV Substation </cim:Naming.name>
</cim:PSRType>

<cim:Location rdf:ID="Location_2">

        <cim:Location.PowerSystemResource rdf:resource="#Substation_2">
</cim:Location>

<cim:GmlPosition rdf:ID="CP_1">
        <cim:GmlPosition.xPosition>910700</cim:GmlPosition.xPosition>
        <cim:GmlPosition.yPosition>66270</cim:GmlPosition.yPosition>
        <cim:Location rdf:resource="#Location_2">
</cim:GmlPosition>
```

6.6 MV/LV substation

```
<cim:Substation rdf:ID="Substation_205">
        <cim:Naming.name>AIGUE_MVLV<cim:Naming.name>
        <cim:Substation.PSRType rdf:resource=”#PSRType_3”>
</cim:Substation>

<cim:PSRType rdf:ID="PSRType_3">
        <cim:Naming.name>MV/LV Substation </cim:Naming.name>
</cim:PSRType>

<cim:Location rdf:ID="Location_3">
        <cim:Location.PowerSystemResource rdf:resource=”#Substation_3”>
</cim:Location>

<cim:GmlPosition rdf:ID=”CP_1” >
        <cim:GmlPosition.xPosition>910700</cim:GmlPosition.xPosition>
        <cim:GmlPosition.yPosition>66270</cim:GmlPosition.yPosition>
        <cim:Location rdf:resource=”#Location_3”>
</cim:GmlPosition>
```

If HV/LV Substation and LV/LV Substation have to be modeled, they will follow the same principles as above.

In IEC 61968-13, all conducting equipment shall be a member of either a substation or of a feeder. Normally, all substation equipment is housed in a physical enclosure such as a building or a fenced area. A feeder is generally outside a physical enclosure and consists of a collection, or connected set, of AC line segments, switches, transformers (which may or may not be considered as a substation), etc. See further discussion of the feeder container object under “Line” later in this document.

In addition, IEC 61968-13 shall support generalized equipment containers to group a set of connected conducting devices – for example the CompositeSwitch device of IEC 61970-301.

6.7 Junction

In the CIM, devices are connected to each other by connecting a terminal of a device to a common ConnectivityNode. A connectivity node may have any number of terminals connected to it.

In a Distribution network, most ConnectivityNodes are contained in substations. However, in some cases (e.g. a tapped distribution line), ConnectivityNodes may be located on lines which are outside of substations. IEC 61970-301 defines the Junction class to indicate such connectivity nodes. In this case, the ConnectivityNode and the Junction shall be located in a virtual Substation.

However, a typical distribution network generally has many connectivity nodes outside of substations along a feeder. Since these connectivity nodes serve no purpose other than to connect two or more devices, it is generally not necessary to also specify them as a Junction.

6.8 Switch[4)]

Switches are contained either by VoltageLevel or by Bay. If Switches are contained by VoltageLevel, Bay is not required. The abstract Switch is used only when we do not know the detailed class.

IEC 61968-13 supports the following kinds of Switch devices:

Breaker (exists in CPSM): able to interrupt fault currents greater than normal load currents.

LoadBreakSwitch (exists in CPSM): able to interrupt normal load currents only.

Disconnector (exists in CPSM): no current interrupt capability.

Fuse (does not exist in CPSM): able to interrupt fault currents.

Jumper (does not exist in CPSM).

GroundDisconnector (does not exist in CPSM).


```
<cim:BaseVoltage rdf:ID="BaseVoltage_1">
        <cim:BaseVoltage.nominalVoltage>63</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:VoltageLevel rdf:ID="VL_1">
        <cim:Naming.name>NOD10S61</cim:Naming.name>
        <cim:VoltageLevel.MemberOf_Substation rdf:resource="#Substation_1"/>
        <cim:VoltageLevel.BaseVoltage rdf:resource="#BaseVoltage_1"/>
</cim:VoltageLevel>

<cim:Substation rdf:ID="Substation_10">
        <cim:Naming.name>AIGUE_HVMV<cim:Naming.name>
        <cim:Substation.PSRType rdf:resource="#PSRType_1">
</cim: Substation >

<cimBreaker rdf:ID="Switch_1">
        <cim:Naming.name>73109J0001<cim:Naming.name>
        <cim:Switch.normalOpen>false</cim:Switch.normalOpen>
        <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#VL_1">
</cim:Breaker>

<cim:Location rdf:ID="Location_5">
        <cim:Location.PowerSystemResource rdf:resource="#Substation_1">
</cim:Location>

<cim:GmlPosition rdf:ID="CP_1">
        <cim:GmlPosition.xPosition>909255.1</cim:GmlPosition.xPosition>
        <cim:GmlPosition.yPosition>56999</cim:GmlPosition.yPosition>
        <cim:Location rdf:resource="#Location_5">
</cim:GmlPosition>
```


6.9 Bay

IEC 61970-301 supports the Bay object as a collection or container of a set of switch devices and connectivity nodes inside a substation. Generally, a substation will contain several, usually identical, bays containing connectivity nodes for incoming or outgoing lines (feeders) Outgoing and incoming feeders are distinguished by the class PSRType. (PSRType and Location are not mandatory).

4) This should be forbidden, as switch is an abstract class.

This data is not mandatory. If Switches are contained by VoltageLevel, Bay is not required.


```
<cim:BaseVoltage rdf:ID="BaseVoltage_1">
        <cim:BaseVoltage.nominalVoltage>63</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:VoltageLevel rdf:ID="VL_1">
        <cim:Naming.name>NOD10S61</cim:Naming.name>
        <cim:VoltageLevel.MemberOf_Substation rdf:resource="#Substation_1"/>
        <cim:VoltageLevel.BaseVoltage rdf:resource="#BaseVoltage_1"/>
</cim:VoltageLevel>

<cim:Substation rdf:ID="Substation_10">
        <cim:Naming.name>AIGUE_HVMV<cim:Naming.name>
        <cim:Substation.PSRType rdf:resource="#PSRType_1">
</cim: Substation >

<cim:Bay rdf:ID="Bay_1">
        <cim:Naming.name>AIGUEC0601<cim:Naming.name>
        <cim:Bay.MemberOf_Substation rdf:resource="#VL_1">
        <cim:PowerSystemResource.PSRType rdf:resource="#PSRType_5">
</cim:Bay>

<cim:PSRType rdf:ID="PSRType_5">
        <cim:Naming.name>OUTGOING FEEDER</cim:Naming.name>
</cim:PSRType>

<cim:Breaker rdf:ID="Breaker_1">
        <cim:Naming.name>AIGUEC0601<cim:Naming.name>
        <cim:Switch.normalOpen>false</cim:Switch.normalOpen>
        <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#Bay_1">
</cim:Breaker>

<cim:Location rdf:ID="Location_6">
        <cim:Location.PowerSystemResource rdf:resource="#Bay_1">
</cim:Location>

<cim:GmlPosition rdf:ID="CP_1">
        <cim:GmlPosition.xPosition>910696</cim:GmlPosition.xPosition>
        <cim:GmlPosition.yPosition>66272</cim:GmlPosition.yPosition>
        <cim:Location rdf:resource="#Location_6">
</cim:GmlPosition>
```


6.10 BusbarSection

Figure 2 describes the connectivity of a BusbarSection which has only one Terminal.

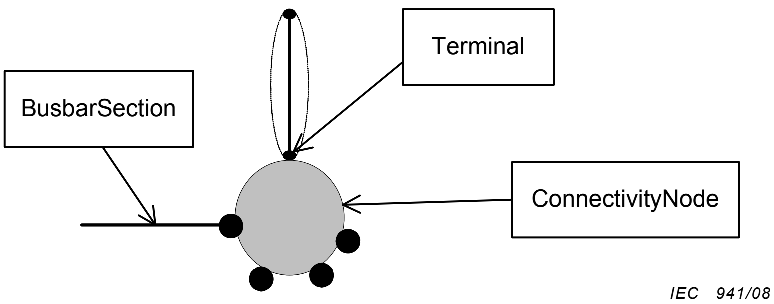


Figure 2 – Connectivity of BusbarSection

```
<cim:BaseVoltage rdf:ID="BaseVoltage_1">
            <cim:BaseVoltage.nominalVoltage>63</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:VoltageLevel rdf:ID="VL_1">
            <cim:Naming.name>NOD10S61</cim:Naming.name>
            <cim:VoltageLevel.MemberOf_Substation rdf:resource="#Substation_1"/>
            <cim:VoltageLevel.BaseVoltage rdf:resource="#BaseVoltage_1"/>
</cim:VoltageLevel>

<cim:Substation rdf:ID="Substation_10">
            <cim:Naming.name>AIGUE_HVMV<cim:Naming.name>
            <cim:Substation.PSRType rdf:resource="#PSRType_1">
</cim: Substation >
```

```
<cim:BusbarSection rdf:ID="BusbarSection_1">
            <cim:Naming.name>AIGUEB0001<cim:Naming.name>
            <cim:Equipment.MemberOf_EquipmentContainter rdf:resource="#VL_1">
</cim:BusbarSection>
<cim:Terminal rdf:ID="Terminal_1">
            <cim:Terminal.ConductingEquipment rdf:resource="#BusbarSection_1"/>
            <cim:Terminal.ConnectivityNode rdf:resource="#CN_1"/>
</cim:Terminal>

<cim:ConnectivityNode rdf:ID="CN_1">
            <cim: ConnectivityNode.MemberOf_EquipmentContainer rdf:resource="#Substation_1">
</cim:ConnectivityNode>

<cim:Location rdf:ID="Location_7">
            <cim:Location.PowerSystemResource rdf:resource="#BusbarSection_1">
</cim:Location>

<cim:GmlPosition  rdf:ID="CP_1">
            <cim:GmlPosition.xPosition>910720</cim:GmlPosition.xPosition>
            <cim:GmlPosition.yPosition>66290</cim:GmlPosition.yPosition>
            <cim:Location rdf:resource="#Location_7">
</cim:GmlPosition>
```


6.11 PowerTransformer

IEC 61968-13 supports transformer objects and their tap changers exactly as defined in IEC 61970-301.

While an Autotransformer in reality does not have two distinct windings, it is acceptable in IEC 61968-13 to model it as having two windings similar to conventional transformers in order to define the voltage ratio. However, in distribution systems, line voltage regulators are sometimes used to compensate for line voltage drop. Line voltage regulators frequently are Autotransformers which have a nominal 1:1 voltage ratio, but generally operate at slightly off-nominal taps to provide a voltage boost. There is a special problem defining the leakage impedance of such devices since at nominal tap position, the leakage impedance is essentially zero. Therefore for autotransformers with a nominal 1:1 voltage ratio, the leakage impedance shall be defined with the tap at maximum tap position.

There are dozens of distribution transformer winding configurations which cannot be simply transformed into Y-Y equivalents as is commonly done for balanced transmission modeling. Therefore, more information is needed than is provided below in order to accurately model many transformer types. However, comprehensive transformer modeling would push the size and detail of the profile beyond practical usability. Depending on the need, Kersting IEEE models could be used as a guide to an appropriate level of transformer detail to extend this profile.

The associations for PowerTransformer containment are:

Substation -> PowerTransformer -> TransformerWinding

The TransformerWinding -> BaseVoltage link should be used. The model needs only BaseVoltage instances that correspond to TransformerWinding's voltage levels.

```
<cim:BaseVoltage rdf:ID="BaseVoltage_2">
        <cim:BaseVoltage.nominalVoltage>42</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:BaseVoltage rdf:ID="BaseVoltage_3">
        <cim:BaseVoltage.nominalVoltage>20</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:PowerTransformer rdf:ID="PowerTransformer_1">
        <cim:Naming.name>AIGUEY0001<cim:Naming.name>
        <cim: PowerTransformer.MemberOf_ Substation rdf:resource="#SubStation_1">
</cim:PowerTransformer>

<cim:TransformerWinding rdf:ID="TransformerWinding_1">
        <cim:TransformerWinding.MemberOf_PowerTransformer rdf:resource="#PowerTransformer_1">
        <cim:ConductingEquipment.BaseVoltage rdf:resource="#BaseVoltage_2"/>
        <cim:TransformerWinding.windingType                    rdf:resource="http://iec.ch/TC57/2005/CIM-schema-
cim10#WindingType.primary"/>
        <cim:TransformerWinding.ratedKV>42</cim:TransformerWinding.ratedKV>
        <cim:TransformerWinding.ratedMVA>20</cim:TransformerWinding.ratedMVA>
        <cim:TransformerWinding.r>0.068</cim:TransformerWinding.r>
        <cim:TransformerWinding.x>1.89</cim:TransformerWinding.x>
        <cim:TransformerWinding.g>29</cim:TransformerWinding.g>
        <cim:TransformerWinding.shortTermMVA>22</cim:TransformerWinding.shortTermMVA >
</cim:TransformerWinding>

<cim:TransformerWinding rdf:ID="TransformerWinding_2">
        <cim:TransformerWinding.MemberOf_PowerTransformer rdf:resource="#PowerTransformer_1">
        <cim:ConductingEquipment.BaseVoltage rdf:resource="#BaseVoltage_3"/>
        <cim:TransformerWinding.windingType                    rdf:resource="http://iec.ch/TC57/2005/CIM-schema-
cim10#WindingType.secondary"/>
        <cim:TransformerWinding.ratedKV>20</cim:TransformerWinding.ratedKV>
        <cim:TransformerWinding.ratedMVA>20</cim:TransformerWinding.ratedMVA>
        <cim:TransformerWinding.r>0.08 </cim:TransformerWinding.r>
        <cim:TransformerWinding.x>1.2</cim:TransformerWinding.x>
        <cim:TransformerWinding.g>29</cim:TransformerWinding.g>
        <cim:TransformerWinding.shortTermMVA>22</cim:TransformerWinding.shortTermMVA >
</cim:TransformerWinding>

<cim:Location rdf:ID="Location_8">
        <cim:Location.PowerSystemResource rdf:resource="#PowerTransformer_1">
</cim:Location>
```

```
<cim:GmlPosition rdf:ID="CP_1">
        <cim:GmlPosition.xPosition>910720</cim:GmlPosition.xPosition>
        <cim:GmlPosition.yPosition>66290</cim:GmlPosition.yPosition>
        <cim:Location rdf:resource="#Location_8">
</cim:GmlPosition>
```

6.12 MV/MV transformer

A MV/MV transformer or auto-transformer is a PowerTransformer as described above.

6.13 Line

In IEC 61970-301, a line is a conductor connecting nodes usually in two different substations. However, IEC 61970-301 also allows for the modeling of a tapped line connecting more than two substations, but it imposes the requirement that the tap junction be contained in a "dummy" or collapsed (or fictitious) substation.

In distribution networks, it is more common to use the term "feeder" instead of the term "line". A feeder can be considered as a tapped line having, in general, several ACLineSegments, junctions or taps. In addition, a feeder may also contain switch devices, MV/LV distribution transformers, capacitors, line voltage regulators. Because of this potentially large number of junctions, it is considered impractical to insist that all such devices and junctions be contained in a substation. Instead, it is sufficient to indicate them as members of a feeder only. However, it is also acceptable to model feeder devices, such as an MV/LV transformer and related switches, to be contained in a distribution substation which, in turn, is a member of a feeder. A Substation cannot be a member of a feeder or a line. If there is a Substation, it is necessary to split the feeder or the line into two different feeders or lines.

To be consistent with CPSM, any ConnectivityNode and any equipment except ACLineSegment, PowerTransformer and TransformerWinding should be in a VoltageLevel itself in a Substation. PowerTransformer and TransformerWinding should be in a Substation.

Each Line has a list of GmlPosition. The list of GmlPositions in the file reflects a precise order using sequenceNumber attribute, if the line has to be drawn.


```
<cim:BaseVoltage rdf:ID="BaseVoltage_2">
        <cim:BaseVoltage.nominalVoltage>42</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:Line rdf:ID="Line_70">
        <cim:Naming.description>AIGUE0001</cim:Naming.description>
</cim:Line>

<cim:ACLineSegment rdf:ID="ACLine1234">
  <cim:Conductor.bch>0.0049480041</cim:Conductor.bch>
  <cim:Conductor.length>63</cim:Conductor.length>
  <cim:Conductor.r>0.0078750001</cim:Conductor.r>
  <cim:Conductor.x>0.0063</cim:Conductor.x>
  <cim:Conductor.ConductorType rdf:resource="#CT1237"/>
  <cim:ACLineSegment.MemberOf_Line rdf:resource="#Line_70"/>
  <cim:ConductingEquipment.BaseVoltage rdf:resource="#BaseVoltage_2"/>
</cim:ACLineSegment>

<cim:Location rdf:ID="Location_85">
        <cim:Location.PowerSystemResource rdf:resource=”#Line_70”>
</cim:Location>

<cim:GmlPosition rdf:ID="CP1085">
  <cim:GmlPosition.xPosition>908058.1</cim:GmlPosition.xPosition>
  <cim:GmlPosition.yPosition>64395.6</cim:GmlPosition.yPosition>
  <cim:GmlPosition.Location rdf:resource="# Location_85"/>
 <cim:GmlPosition.SequenceNumber> 1 </ cim:GmlPosition.SequenceNumber >
</cim:GmlPosition>

<cim:GmlPosition rdf:ID="CP1086">
  <cim:GmlPosition.xPosition>908574</cim:GmlPosition.xPosition>
  <cim:GmlPosition.yPosition>63368</cim:GmlPosition.yPosition>
  <cim:GmlPosition. Location rdf:resource="# Location_85"/>
  <cim:GmlPosition.SequenceNumber> 2 </ cim:GmlPosition.SequenceNumber >
</cim:GmlPosition>
```

6.14 ACLineSegment

A distinction between asset characteristics of the line segment and the operational (PowerSystemResource) characteristics of the line segment shall be made. For instance, the maximum ampacity can be modeled by the amprating attribute of WireType class (current carrying capacity, expressed in amperes, of a wire or cable under stated thermal conditions). To reflect the operational value of this attribute, a measurement can then be used with limit and LimitSet classes.

6.15 WireArrangement

The WireArrangement needs an enumeration of phase in order to make the Carson's Equations calculations for impedances. Currently, one WireArrangement is needed per phase and neutral of an ACLineSegment. Eventually, this information should be moved into the Assets package, including each phase's x,y position where ground level is assumed to be at y = 0 for reference.

For a balanced 3 or 4 wire case, an ACLineSegment instance is described as follows:

```
<cim:BaseVoltage rdf:ID="BaseVoltage_2">
        <cim:BaseVoltage.nominalVoltage>42</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:ACLineSegment rdf:ID="ACLineSegment_1">
        <cim:ACLineSegment.MemberOf_Line rdf:resource="#Line_1">
        <cim:Conductor.length>63</cim:Conductor.length>
        <cim:ACLineSegment.r>0.125000</cim:ACLineSegment.r>
        <cim:ACLineSegment.x>0.100000</cim:ACLineSegment.x>
        <cim:ACLineSegment.b0ch>250</cim:ACLineSegment.bg0ch>
        <cim:ConductingEquipment.phases>ABC</cim:ConductingEquipment.phases>
        <cim:Conductor.ConductorType rdf:resource="#ConductorType_1">
        <cim:ConductingEquipment.BaseVoltage rdf:resource="#BaseVoltage_2"/>
</cim:ACLineSegment>

<cim:WireArrangement rdf:ID="WireArrangement_1">
        <cim: WireArrangement.WireType rdf:resource="#WireType_1">
        <cim: WireArrangement.ConductorType rdf:resource="#ConductorType_1">
</cim:WireArrangement>

<cim:ConductorType rdf:ID="ConductorType_1"/>

<cim:WireType rdf:ID="WireType_1">
        <cim:WireType.ampRating>493.350006</cim:WireType.ampRating>
</cim:WireType>
```

For an unbalanced case where impedances shall be derived with Carson's Equations, the X,Y wire arrangement data shall be supplied as well as wire type impedance per unit length.

```
<cim:BaseVoltage rdf:ID="BaseVoltage_2">
        <cim:BaseVoltage.nominalVoltage>42</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:ACLineSegment rdf:ID="ACLineSegment_1">
        <cim:ACLineSegment.MemberOf_Line rdf:resource="#Line_1">
        <cim:Conductor.length>63</cim:Conductor.length>
        <cim:ConductingEquipment.phases>ABC</cim:ConductingEquipment.phases>
        <cim:Conductor.ConductorType        rdf:resource="#ConductorType_1"><cim:ConductingEquipment.BaseVoltage
rdf:resource="#BaseVoltage_2"/>
</cim:ACLineSegment>

<cim:ConductorType rdf:ID="ConductorType_1"/>

<cim:WireArrangement rdf:ID="WireArrangement_1">
        <cim: WireArrangement.WireType rdf:resource="#WireType_1">
        <cim: WireArrangement.ConductorType rdf:resource="#ConductorType_1">
        <cim: WireArrangement.mountingPointX>-1</cim:WireArrangement.mountingPointX>
        <cim: WireArrangement.mountingPointY>8</cim:WireArrangement.mountingPointY>
        <cim: WireArrangement.phase>A</cim:WireArrangement.phase>
</cim:WireArrangement>

<cim:WireType rdf:ID="WireType_1">
        <cim:WireType.ampRating>493.350006</cim:WireType.ampRating>
        <cim:WireType.resistance>.001</cim:WireType.resistance>
        <cim:WireType.gMR>.01</cim:WireType.gMR>
        <cim:WireType.radius>.01</cim:WireType.radius>
</cim:WireType>EquivalentSource
```

An EquivalentSource represents a High Voltage Source which can generally be considered as an "infinite bus" capable of supplying whatever load is connected to it.

```
<cim:BaseVoltage rdf:ID="BaseVoltage_2">
        <cim:BaseVoltage.nominalVoltage>42</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:VoltageLevel rdf:ID="VL_2">
        <cim:Naming.name>NOD10S62</cim:Naming.name>
        <cim:VoltageLevel.MemberOf_Substation rdf:resource="#Substation_1"/>
        <cim:VoltageLevel.BaseVoltage rdf:resource="#BaseVoltage_2"/>
</cim:VoltageLevel>

<cim:Substation rdf:ID="Substation_10">
        <cim:Naming.name>AIGUE_HVMV<cim:Naming.name>
        <cim:Substation.PSRType rdf:resource="#PSRType_1">
</cim: Substation >

<cim:EquivalentSource rdf:ID="EquivalentSource_1">
        <cim:Naming.name>AIGUEBHT01<cim:Naming.name>
        <cim:Equipment.MemberOf_EquipmentContainter rdf:resource="#VL_1">
        <cim:EquivalentSource.nominalVoltage>42</cim:EquivalentSource.nominalVoltage>
        <cim:EquivalentSource.r>0.068</cim:EquivalentSource.r>
        <cim:EquivalentSource.x>1.89</cim:EquivalentSource.x>
        <cim:PowerSystemResource.PSRType rdf:resource="#PSRType_11">
</cim:EquivalentSource>

<cim:PSRType rdf:ID="PSRType_11">
        <cim:Naming.name>HV Source</cim:Naming.name>
</cim:PSRType>
```

6.16 Compensator

Compensator represents either a capacitor or a reactor. They are distinguished from each other by the sign in the value of the attribute mVArPerSection. If mVArPerSection is positive, it is a capacitor. If it is negative, then it is a reactor. A Compensator can have either one or two Terminals, which means it can be either a shunt device or a series device.

```
<cim:BaseVoltage rdf:ID="BaseVoltage_2">
        <cim:BaseVoltage.nominalVoltage>42</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:VoltageLevel rdf:ID="VL_2">
        <cim:Naming.name>NOD10S62</cim:Naming.name>
        <cim:VoltageLevel.MemberOf_Substation rdf:resource="#Substation_1"/>
        <cim:VoltageLevel.BaseVoltage rdf:resource="#BaseVoltage_2"/>
</cim:VoltageLevel>

<cim:Substation rdf:ID="Substation_10">
        <cim:Naming.name>AIGUE_HVMV<cim:Naming.name>
        <cim:Substation.PSRType rdf:resource="#PSRType_1">
</cim: Substation >

<cim:Compensator rdf:ID="Compensator_1">
        <cim:Naming.name>COMP</cim:Naming.name>
        <cim:Compensator.compensatorType rdf:resource="http://iec.ch/TC57/2003/CIM-schema-
cim10#CompensatorType.shunt"/>
        <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#VL_2"/>
</cim:Compensator>
```

6.17 StaticVarCompensator

A StaticVarCompensator has only one terminal, even if it represents a coil. SVC is a always shunt device.

A StaticVarCompensator represents either a capacitor or a reactor. They are distinguished from each other by the capacitiveRating (for capacitor) and inductiveRating (for reactor).

An example of a capacitor:

```
<cim:BaseVoltage rdf:ID="BaseVoltage_2">
        <cim:BaseVoltage.nominalVoltage>42</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:VoltageLevel rdf:ID="VL_2">
        <cim:Naming.name>NOD10S62</cim:Naming.name>
        <cim:VoltageLevel.MemberOf_Substation rdf:resource="#Substation_1"/>
        <cim:VoltageLevel.BaseVoltage rdf:resource="#BaseVoltage_2"/>
</cim:VoltageLevel>

<cim:Substation rdf:ID="Substation_10">
        <cim:Naming.name>AIGUE_HVMV<cim:Naming.name>
        <cim:Substation.PSRType rdf:resource="#PSRType_1">
</cim: Substation >

<cim:StaticVarCompensator rdf:ID=" StaticVarCompensator _1">
        <cim:Naming.name>AIGUEK0680<cim:Naming.name>
        <cim:Equipment.MemberOf_EquipmentContainter rdf:resource="#VL_2">
        <cim:StaticVarCompensator.capacitiveRating> 900 </cim:StaticVarCompensator.capacitiveRating>
</cim:StaticVarCompensator>
```

An example of a reactor:


```
<cim:BaseVoltage rdf:ID="BaseVoltage_2">
        <cim:BaseVoltage.nominalVoltage>42</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:VoltageLevel rdf:ID="VL_2">
        <cim:Naming.name>NOD10S62</cim:Naming.name>
        <cim:VoltageLevel.MemberOf_Substation rdf:resource="#Substation_1"/>
        <cim:VoltageLevel.BaseVoltage rdf:resource="#BaseVoltage_2"/>
</cim:VoltageLevel>

<cim:Substation rdf:ID="Substation_10">
        <cim:Naming.name>AIGUE_HVMV<cim:Naming.name>
        <cim:Substation.PSRType rdf:resource="#PSRType_1">
</cim: Substation >

<cim:StaticVarCompensator rdf:ID=" StaticVarCompensator _1">
        <cim:Naming.name>AIGUEK0680<cim:Naming.name>
        <cim:Equipment.MemberOf_EquipmentContainter rdf:resource="#VL_2">
        <cim:StaticVarCompensator.inductiveRating> 900 </cim:StaticVarCompensator.inductiveRating>
</cim:StaticVarCompensator>
```


6.18 EquivalentLoad

According to IEC 61970-301, an EnergyConsumer is a generic user of energy – a point of consumption on the power system model. According to IEC 61968-13, a MV customer is a CustomerLoad, a LV customer is an EquivalentLoad. An EquivalentLoad has the attribute customerCount having its value greater than one to indicate the number of customers attached. The voltage level is specified by a voltage level that contains this EquivalentLoad.

The abstract EnergyConsumer is used only when we do not know the detailed class (as for Switch, it is not recommended).


```
<cim:BaseVoltage rdf:ID="BaseVoltage_4">
        <cim:BaseVoltage.nominalVoltage>0.22</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:VoltageLevel rdf:ID="VL_6">
        <cim:Naming.name>NOD10S78</cim:Naming.name>
        <cim:VoltageLevel.MemberOf_Substation rdf:resource="#Substation_205"/>
        <cim:VoltageLevel.BaseVoltage rdf:resource="#BaseVoltage_4"/>
</cim:VoltageLevel>

<cim:Substation rdf:ID="Substation_205">
        <cim:Naming.name>AIGUE_MVLV<cim:Naming.name>
        <cim:Substation.PSRType rdf:resource="#PSRType_3">
</cim: Substation >

<cim:PSRType rdf:ID="PSRType_3">
        <cim:Naming.name>MV/LV Substation </cim:Naming.name>
</cim:PSRType>

<cim:EquivalentLoad rdf:ID="EquivalentLoad_1">
        <cim:PowerSystemResource.MemberOf_EquipementContainer rdf:resource="#VL_4">
        <cim:EnergyConsumer.pfixed>16.574152</cim:EnergyConsumer.pfixed>
        <cim:EnergyConsumer.qfixed>10.574152</cim:EnergyConsumer.qfixed>
        <cim:EnergyConsumer.powerFactor>0.905024</cim:EnergyConsumer.powerFactor>
        <cim:EnergyConsumer.customerCount>22</cim:EnergyConsumer.customerCount>
</cim:EquivalentLoad>

<cim:Terminal rdf:ID="Terminal_14">
        <cim:Terminal.ConductingEquipment rdf:resource="#EnergyConsumer _1"/>
        <cim:Terminal.ConnectivityNode rdf:resource="#CN_2"/>
</cim:Terminal>

<cim:ConnectivityNode rdf:ID="CN_2">
        <cim:ConnectivityNode.MemberOf_EquipmentContainer rdf:resource="#Substation_1">
</cim:ConnectivityNode>
```

6.19 Using CustomerLoad, GeneratingUnit and SynchronousMachine to model Distributed Energy Resource

For a Distributed Energy Resource (DER), we generate CustomerLoad, SynchronousMachine and GeneratingUnit to model it. When it consumes energy, we take data from CustomerLoad. When it produces energy, we take data from SynchronousMachine and GeneratingUnit.

A DER can have two different contracts: energy consumption and energy generation. A DER can be a voltage regulator. For a DER, we need to define its rated active power and rated reactive power. When P is positive, it is consuming energy. When P is negative, it acts as producing energy.


```
<cim:BaseVoltage rdf:ID="BaseVoltage_3">
        <cim:BaseVoltage.nominalVoltage>20</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:VoltageLevel rdf:ID="VL_4">
        <cim:Naming.name>NOD10S88</cim:Naming.name>
        <cim:VoltageLevel.MemberOf_Substation rdf:resource="#Substation_205"/>
        <cim:VoltageLevel.BaseVoltage rdf:resource="#BaseVoltage_3"/>
</cim:VoltageLevel>

<cim:Substation rdf:ID="Substation_205">
        <cim:Naming.name>AIGUE_MVLV<cim:Naming.name>
        <cim:Substation.PSRType rdf:resource="#PSRType_3">
</cim: Substation >

<cim:CustomerLoad rdf:ID="CustomerLoad_1">
        <cim:PowerSystemResource.MemberOf_EquipementContainer rdf:resource="#VL_4">
        <cim:EnergyConsumer.pfixed>16.574152</cim:EnergyConsumer.pnom>
        <cim:EnergyConsumer.qfixed>10.574152</cim:EnergyConsumer.qnom>
        <cim:EnergyConsumer.powerFactor>0.905024</cim:EnergyConsumer.powerFactor>
</cim:CustomerLoad>

<cim:GeneratingUnit rdf:ID="GU_1">
        <cim:Naming.name>NOD09S61_GU</cim:Naming.name>
        <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#VL_4"/>
        <cim:GeneratingUnit.initialMW>5.5</cim:GeneratingUnit.initialMW>
</cim:GeneratingUnit>

<cim:SynchronousMachine rdf:ID="SM_1">
        <cim:Naming.name>NOD02S71_SM</cim:Naming.name>
        <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#VL_4"/>
        <cim:SynchronousMachine.baseMVAr>2.2</cim:SynchronousMachine.baseMVAr>
        <cim:SynchronousMachine.MemberOf_GeneratingUnit rdf:resource="#GU_1"/>
  </cim:SynchronousMachine>

<cim:Terminal rdf:ID="Terminal_15">
        <cim:Terminal.ConductingEquipment rdf:resource="#CustomerLoad_1"/>
        <cim:Terminal.ConnectivityNode rdf:resource="#CN_4"/>
</cim:Terminal>

<cim:Terminal rdf:ID="Terminal_16">
        <cim:Naming.name> NOD09S61_GU_T</cim:Naming.name>
        <cim:Terminal.ConductingEquipment rdf:resource="#GU_1 "/>
        <cim:Terminal.ConnectivityNode rdf:resource="#CN_4"/>
</cim:Terminal>

<cim:Terminal rdf:ID="Terminal_17">
        <cim:Naming.name>NOD02S71_SM_T</cim:Naming.name>
        <cim:Terminal.ConductingEquipment rdf:resource="#SM_1"/>
        <cim:Terminal.ConnectivityNode rdf:resource="#CN_4"/>
</cim:Terminal>

<cim:ConnectivityNode rdf:ID="CN_4">
        <cim: ConnectivityNode.MemberOf_EquipmentContainer rdf:resource="#Substation_205">
</cim:ConnectivityNode>
```

6.20 GeneratingUnit

In most distribution networks, embedded generation is not intended to supply all loads and can only operate while there is also a transmission source of supply. Thus embedded generators should be modeled as generators and not as an equivalent source. The output of an embedded generator may be specified by a curve and it may be specified as a P,Q schedule or a P,V schedule[5)].

In CPSM, these curves do not exist. There are the GrossToNetMWCurve which defines net power and gross power of the group and the MVArCapabilityCurve that defines Qmin and Qmax.

Note that in the case of a P,Q generator, it is also acceptable to model it simply as a negative load, connectivity nodes and terminals.

Connectivity nodes and terminal classes of the CIM topological model are used to describe the connectivity model. GeneratingUnit.initalMW is used to represent normal Active power (P).

```
<cim:BaseVoltage rdf:ID="BaseVoltage_1">
        <cim:BaseVoltage.nominalVoltage>63</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:VoltageLevel rdf:ID="VL_1">
        <cim:Naming.name>NOD10S61</cim:Naming.name>
        <cim:VoltageLevel.MemberOf_Substation rdf:resource="#Substation_1"/>
        <cim:VoltageLevel.BaseVoltage rdf:resource="#BaseVoltage_1"/>
</cim:VoltageLevel>

<cim:Substation rdf:ID="Substation_1">
        <cim:Naming.name>AIGUE_HVMV<cim:Naming.name>
        <cim:Substation.PSRType rdf:resource="#PSRType_1">
</cim: Substation >

<cim:GeneratingUnit rdf:ID="GU_5">
        <cim:Naming.name>NOD09S05_GU</cim:Naming.name>
        <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#VL_1"/>
        <cim:GeneratingUnit.initialMW>5.5</cim:GeneratingUnit.initialMW>
</cim:GeneratingUnit>
```

6.21 SynchronousMachine

SynchronousMachine.baseMVAr is used to represent reactive power (Q).

```
<cim:BaseVoltage rdf:ID="BaseVoltage_1">
        <cim:BaseVoltage.nominalVoltage>63</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:VoltageLevel rdf:ID="VL_1">
        <cim:Naming.name>NOD10S61</cim:Naming.name>
        <cim:VoltageLevel.MemberOf_Substation rdf:resource="#Substation_1"/>
        <cim:VoltageLevel.BaseVoltage rdf:resource="#BaseVoltage_1"/>
</cim:VoltageLevel>

<cim:Substation rdf:ID="Substation_1">
        <cim:Naming.name>AIGUE_HVMV<cim:Naming.name>
        <cim:Substation.PSRType rdf:resource="#PSRType_1">
</cim: Substation >

<cim:SynchronousMachine rdf:ID="SM_1">
        <cim:Naming.name>NOD02S71_SM</cim:Naming.name>
        <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#VL_1"/>
        <cim:SynchronousMachine.baseMVAr>2.2</cim:SynchronousMachine.baseMVAr>
        <cim:SynchronousMachine.MemberOf_GeneratingUnit rdf:resource="#GU_5"/>
</cim:SynchronousMachine>
```

5) A minimum set of data is required for an embedded generator and it is not necessary to have to support all the IEC 61970-301 data for generators.

6.22 HostControlArea

This class is not mandatory in the IEC 61968-13 (CDPSM) profile. We list it here since it is used in CPSM profile hierarchy.

```
<cim:HostControlArea rdf:ID="HCA_1">
        <cim:Naming.name>HostControlArea_1</cim:Naming.name>
</cim:HostControlArea>
```

6.23 SubControlArea

This class is not mandatory in the IEC 61968-13 (CDPSM) profile. We list it here since it is used in CPSM profile hierarchy.

```
<cim:SubControlArea rdf:ID="SCA_1">
        <cim:Naming.name>07</cim:Naming.name>
        <cim:SubControlArea.HostControlArea rdf:resource="#HCA_1 "/>
</cim:SubControlArea>
```

7 Adequation between IEC 61968-3 (CDPSM) and IEC 61968-4

In IEC 61968-4 (Records and Asset Management), NetworkDataSet Message Type is defined. In order to prove that the standard is consistent and that the semantic is shared whatever XML support used (RDF, XSD), the following table highlights differences between the CDPSM profile defined in IEC 61968-13, and Cim elements used in NetworkDataSet Message Type. A comment is given when necessary. It should be mentioned that IEC 61968-13 relies on CPSM profile, as a consequence IEC 61970-301 is used, thus PowerSytemResource is principally the base class which is used. On the other end, IEC 61968-4, and NetworkDataSet message type, relied on all CIM classes, and extensions made in CIM by wg14 , thus Asset class is also used as a base class.

The message type NetworkDataSet.xsd is based on CIM version 10 revision 7.

The message structure used by IEC 61968-3 and IEC 61968-4 standard parts are described in IEC 61968-1 part.

NOTE In order to be concise, if the same set of elements is found in the NetworkDataSet message type, a global name to is used to refer to it. For instance: TerminalSubSet.

The message is composed of two blocks described in Table 1 and Table 2:

MessageHeader
MessagePayload

Table 1 – Header of NetworkDataSet message type

CIM elements in NetworkDataSet Header	
Verb	
Noun	
Revision	
TimeDate	
Source	
SourcePathName	

Table 2 – Message Payload of NetworkDataSet message type

CIM elements in NetworkDataSet Payload Hierarchy level 0	**Comment if it exist in CDPSM**
<NetworkDataSet>	
NameSubSet	
aliasName	
description	
name	
pathname	
mrid	
EndNameSubSet	
collectionType	
collectionQuantity	
currentStatus	
statusDate	
<Equipement>	
NameSubSet	
Substation	Yes
PSRType	Yes
VoltageLevel	Yes
Measurement	Yes
Organisation	Not used in CDPSM
Location	Yes (Optional)
Structure	Not used in CDPSM
UGStructure	Not used in CDPSM
Manhole	Not used in CDPSM
Pole	Not used in CDPSM
Asset	Not used in CDPSM
<Equipement\>	
Ground	Not used in CDPSM
AssetCatalogue	Not Used in CDPSM
ConductingEquipment	Yes
PowerTransformer	Yes
EquivalentSource	Yes
EnergyConsumer	Yes
Switch	Yes
Fuse	Yes
Disconnector	Yes
LoadBreakSwitch	Yes
GroundDisconnector	Yes
Jumper	Yes
Breaker	Yes
DCLineSegment	Yes
ACLineSegment	Yes
BusbarSection	Yes
Junction	Yes
EquivalentLoad	Yes
InductionMotorLoad	No
CustomerLoad	Yes
SynchronousMachine	Yes
StaticVarCompensator	Yes
Compensator	Yes

Based on Table 2 , it can be said that IEC 61968-13 is, at the present time, a subset of IEC 61968-4, as it does not include any asset related class.

8 Adequation between CDPSM and CPSM

Annex G compares CDPSM and CPSM through some CIM-XML-RDF files examples.

Annex A
(informative)

CIM XML Document from Langdale

Electric utilities use power system models for a number of different purposes. For example, simulations of power systems are necessary for planning and security analysis. An operational power system model can consist of thousands of classes of information. In addition to using these models in-house, utilities need to exchange system modelling information, both in planning, and for operational purposes, for example, for coordinating transmission and ensuring reliable operations. However, individual utilities use different software for these purposes, and as a result the system models are stored in different formats, making the exchange of these models difficult.

In order to support the exchange of power system models, utilities needed to agree on common definitions of power system entities and relationships. To support this, the Electric Power Research Institute (EPRI) a non-profit energy research consortium, developed a Common Information Model (CIM). The CIM specifies common semantics for power system resources, their attributes, and relationships. In addition, to further support the ability to electronically exchange CIM models, the power industry has developed CIM/XML, a language for expressing CIM models in XML. CIM/XML is an RDF application, using RDF and RDF Schema to organize its XML structures. The North American Electric Reliability Council (NERC) (an industry-supported organization formed to promote the reliability of electricity delivery in North America) has adopted CIM/XML as the standard for exchanging models between power transmission system operators. The CIM/XML format is also going through an IEC international standardization process. An excellent discussion of CIM/XML can be found in http://www.w3.org/TR/2004/REC-rdf-primer-20040210/#ref-devos#ref-devos.

NOTE This power industry CIM should not be confused with the CIM developed by the Distributed Management Task Force for representing management information for distributed software, network, and enterprise environments. The DMTF CIM also has an XML representation, but does not currently use RDF, although independent research is underway in that direction.

The CIM can represent all of the major objects of an electric utility as object classes and attributes, as well as their relationships. CIM uses these object classes and attributes to support the integration of independently developed applications between vendor specific EMS systems, or between an EMS system and other systems that are concerned with different aspects of power system operations, such as generation or distribution management.

The CIM is specified as a set of class diagrams using the Unified Modeling Language (UML). The base class of the CIM is the PowerSystemResource class, with other more specialized classes such as Substation, Switch, and Breaker being defined as subclasses. CIM/XML represents the CIM as an RDF Schema vocabulary, and uses RDF/XML as the language for exchanging specific system models. Example 1 shows examples of CIM/XML class and property definitions:

Example 1: Examples of CIM/XML Class and property definitions

```
<rdfs:Class rdf:ID="PowerSystemResource">
  <rdfs:label xml:lang="en">PowerSystemResource</rdfs:label>
  <rdfs:comment>"A power system component that can be either an
    individual element such as a switch or a set of elements
    such as a substation. PowerSystemResources that are sets
    could be members of other sets. For example a Switch is a
    member of a Substation and a Substation could be a member
    of a division of a Company"</rdfs:comment>
</rdfs:Class>
```

```
<rdfs:Class rdf:ID="Breaker">
  <rdfs:label xml:lang="en">Breaker</rdfs:label>
  <rdfs:subClassOf rdf:resource="#Switch" />
  <rdfs:comment>"A mechanical switching device capable of making,
     carrying, and breaking currents under normal circuit conditions
     and also making, carrying for a specified time, and breaking
     currents under specified abnormal circuit conditions e.g. those
     of short circuit. The typeName is the type of breaker, e.g.,
     oil, air blast, vacuum, SF6."</rdfs:comment>
</rdfs:Class>

<rdf:Property rdf:ID="Breaker.ampRating">
   <rdfs:label xml:lang="en">ampRating</rdfs:label>
   <rdfs:domain rdf:resource="#Breaker" />
   <rdfs:range rdf:resource="#CurrentFlow" />
   <rdfs:comment>"Fault interrupting rating in amperes"</rdfs:comment>
</rdf:Property>
```

CIM/XML uses only a subset of the complete RDF/XML syntax, in order to simplify the expression of the models. In addition, CIM/XML implements some extensions to the RDF Schema vocabulary. These extensions support the description of inverse roles and multiplicity (cardinality) constraints describing how many instances of a given property are allowed for a given resource (allowable values for a multiplicity declaration are zero-or-one, exactly-one, zero-or-more, one-or-more). The properties in Example 2 illustrate these extensions (which are identified by a cims: QName prefix):

Example 2: Some CIM/XML extensions of RDF schema

```
<rdf:Property rdf:ID="Breaker.OperatedBy">
   <rdfs:label xml:lang="en">OperatedBy</rdfs:label>
   <rdfs:domain rdf:resource="#Breaker" />
   <rdfs:range rdf:resource="#ProtectionEquipment" />
   <cims:inverseRoleName   rdf:resource="#ProtectionEquipment.Operates"
/>
   <cims:multiplicity                     rdf:resource="http://www.cim-
logic.com/schema/990530#M:0..n" />
   <rdfs:comment>"Circuit breakers may be operated by
       protection relays."</rdfs:comment>
</rdf:Property>

<rdf:Property rdf:ID="ProtectionEquipment.Operates">
   <rdfs:label xml:lang="en">Operates</rdfs:label>
   <rdfs:domain rdf:resource="#ProtectionEquipment" />
   <rdfs:range rdf:resource="#Breaker" />
   <cims:inverseRoleName rdf:resource="#Breaker.OperatedBy" />
   <cims:multiplicity                     rdf:resource="http://www.cim-
logic.com/schema/990530#M:0..n" />
   <rdfs:comment>"Circuit breakers may be operated by
       protection relays."</rdfs:comment>
</rdf:Property>
```

EPRI has conducted successful interoperability tests using CIM/XML to exchange real-life, large-scale models (involving, in the case of one test, data describing over 2 000 substations) between a variety of vendor products, and validating that these models would be correctly interpreted by typical utility applications. Although the CIM was originally intended for EMS systems, it is also being extended to support power distribution as well as other applications.

The Object Management Group has adopted an object interface standard to access CIM power system models called the Data Access Facility. Like the CIM/XML language, the DAF is based on the RDF model and shares the same CIM schema. However, while CIM/XML enables a model to be exchanged as a document, DAF enables an application to access the model as a set of objects.

CIM/XML illustrates the useful role RDF can play in supporting XML-based exchange of information that is naturally expressed as entity-relationship or object-oriented classes, attributes, and relationships (even when that information will not necessarily be Web-accessible). In these cases, RDF provides a basic structure for the XML in support of identifying objects, and using them in structured relationships. This connection is illustrated by a number of applications using RDF/XML for information interchange, as well as a number of projects investigating linkages between RDF (or ontology languages such as OWL) and UML (and its XML representations). CIM/XML's need to extend RDF Schema to support cardinality constraints and inverse relationships also illustrates the kinds of requirements that have led to the development of more powerful RDF-based schema/ontology languages such as DAML+OIL and OWL. Such languages may be appropriate in supporting many similar modelling applications in the future.

Finally, CIM/XML also illustrates an important fact for those looking for additional examples of "RDF in the Field": sometimes languages are described as "XML" languages, or systems are described as using "XML", and the "XML" they are actually using is RDF/XML, i.e., they are RDF applications. Sometimes it is necessary to go fairly far into the description of the language or system in order to find this out (in some examples that have been found, RDF is never explicitly mentioned at all, but sample data clearly shows it is RDF/XML). Moreover, in applications such as CIM/XML, the RDF that is created will not be readily found on the Web, since it is intended for information exchange between software components rather than for general access (although future scenarios could be imagined in which more of this type of RDF would become Web-accessible).

Annex B
(informative)

Comparison between CIM RDF and CIM XSD (ISO ITC Working Group Architecture)

Categories	CIM/RDF	CIM/XSD
Technologies	RDF, RDF(S), XSD and XML	XSD and XML
Semantics	A semantic model for CIM modelled by RDF(S) and namespace extension "cims". It is a schema for describing the CIM semantics.	It is a schema for describing format and structure of the model for defining messages. It is an XSD representation of CIM with embedded semantic information.
Data types and instances	String	Wide range of data types
Format and structure	Additional specification needs to be provided on top of RDF. One document IEC 61970-501 that specifies how to use RDF Schema for power system model transfers has been produced.	XSD structure
Technology development status	RDF(S) is a W3C recommendation but cim namespace is a WG13 extension	XML Schema is a W3C recommendation
Technology acceptance and support	Continues to be modified and developed Requires time for wider acceptance Limited supporting tools Has evolved Should be replaced with OWL	Wide acceptance Ease of use Many supporting and companion standards such as XSLT Many supporting tools
Base file	RDF representation of CIM UML model.	XSD representation of CIM UML model.
CIM classes	Represented as an element with the CIM class name and identified by rdf:ID Defined by complexType with an identifier.	Defined by complexType with mrid attribute as a unique identifier.
CIM attributes	Represented as an element with the CIM attribute name.	Defined as local elements.
CIM relationships	Represented as an element with a reference pointing to the related instance.	Flexible structure. Can use: Containment Reference Reference with key/keyref

Categories	CIM/RDF	CIM/XSD
Message schema generation	Not available for a direct XML representation of RDF schema. Manually identify classes and attributes for the message schema.	Messages are modelled using UML and then message schemas are automatically generated based on user selected message configuration options.
Message schema structure	Fixed and flat structure without conforming schemas. Once the message schema is defined, there is no programmatic connection between the message and CIM/RDF base file. The message schema is defined using CIM but can not be validated afterwards. Changes made to the schema that deviate from CIM will not make it invalid. Certain CIM definitions are not carried into the schema, and definitions are repeated in every schema.	Options are provided for message structure. Individual message schemas are based on the base file and therefore always conform to CIM semantics, and they can easily be made backward compatible.
Schema level validation	A specialized CIM Validator is provided, but is designed for Network Model Data exchange. Data type checking is not included. The referenced relationship cannot be validated through XSD validation either.	The message schema provides the schema level validation. Relationships can be checked either by the containment or the key/keyref.
Required element validation	Validation is by convention. By selecting the class and attribute profile to be included in the schema (examples are CPSM and this part of IEC 61968). Schema will need to change as new attributes for the schema are needed even from existing CIM classes.	All CIM attributes are included in the schema design as optional elements. Required elements are checked by using XSLT.
Business rule validation	Not available.	Business rules can be defined using XSLT.

Annex C
(informative)

Key discussion points on CIM RDF and CIM XSD (ISO ITC Working Group Architecture)

Key discussion points on CIM RDF and CIM XSD:

a) RDF was chosen when XSD was immature and not yet a standard. RDF proved to be the correct choice for electric network model exchange because:
   1) Electric network models are very complex and require a flexible and object oriented way to represent network connectivity.
   2) The “flat” nature of CIM/RDF XML instance data helps reduce the amount of data to represent and process large electric network models.
   3) Several application vendors have adopted CIM/RDF for network model exchange.
   4) CIM/RDF for Full Network Model that includes both the physical and dynamic (market) components of a network model is a natural extension of CIM/RDF.
b) RDF may prove useful for messages very similar in nature to network models (large and complex and requiring very efficient structure to minimize message size etc.), such as used for inter-application data exchange in a homogeneous operating environment, but RDF is not the right choice for a vast majority of loosely-coupled business messages such as Bids, Interchange Schedules, Outages, and Work, etc., that are exchanged between systems or enterprises. XSD, on the other hand, is designed for a well-structured representation of business data in general, which is why most other industry standards for common data exchange use XSD, not RDF.
c) RDF was designed primarily for semantic representation, not data exchange, but industry standards have continued to evolve beyond RDF. OWL Web Ontology Language provides a more robust structure for representing complex and object-oriented data. OWL builds upon RDF specification and will be the language of choice for representing semantics. OWL was only recently adopted as a standard and there are not many implementations as of yet.
d) XSD is used for message definition because of the following advantages.
   1) Attributes of all classes are now represented in messages (previous messages used XML QName pointers to classes not included in the message).
   2) CIM classes are logically represented in XML Schema as they are defined in UML.
   3) CIM associations are represented using functionality provided by XML Schema.
   4) Data integrity is assured within a message instance to ensure content is meaningful to both sender and receiver.
   5) Strong typing is provided to XML data types whenever possible to ensure that content is represented as intended by the CIM.
   6) Reliance on programmatic logic in message adaptors to determine the meaning of a message, i.e., discovering class associations, is reduced.
   7) The mapping of messages to business vocabularies is simplified.
   8) Messages adhere to generally applied XML Schema design methodologies.

Annex D
(informative)

Conclusions and recommendations (ISO ITC Working Group Architecture)

This part of IEC 61968 defines an approach and includes the necessary guidelines for leveraging the CIM/CME to produce XSD representations.

The following recommendations are being proposed:

a) When defining infrastructures, creating interfaces and performing integrations, the CIM/CME should be leveraged as a standard ontology model. It provides the basis for reducing dissonance and defining data unambiguously. It provides mechanisms for extensions and is an adequate platform independent model for the utilities domain.

b) Apply model-based principles by using the CIM and a consistent approach for forward engineering to XSD or RDF depending on the data requirements. This will improve interoperability, reliability and reduce the cost of integration.

c) As CIM extensions become necessary, submit them to the standards body for adoption and ratification. It is also recommended that the ISO/RTO share the extensions (prior to submission) as they are defined to reduce overlaps and improve consistency of the CIM/CME.

d) Both RDF and XSD based formats should be used when implementing CIM based architectures – RDF should be utilized for network model exchanges and XSD for all other use-cases.

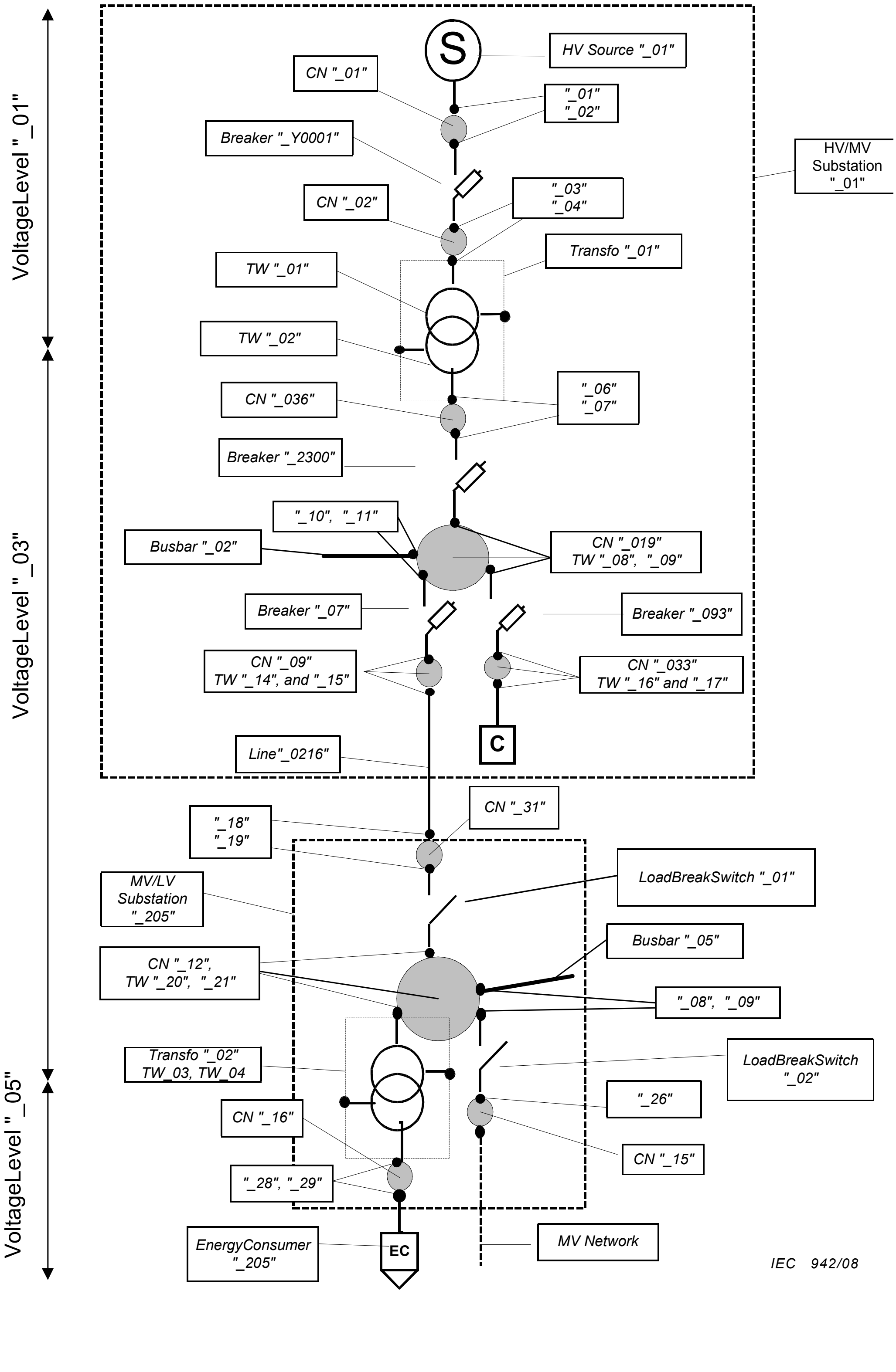
e) Closely follow emerging standards (i.e. OWL).

Annex E
(informative)

Example of a European distribution network described through CIM RDF

E.1 Distribution network

An example of a MV European distribution network is presented as in Figure E.1.



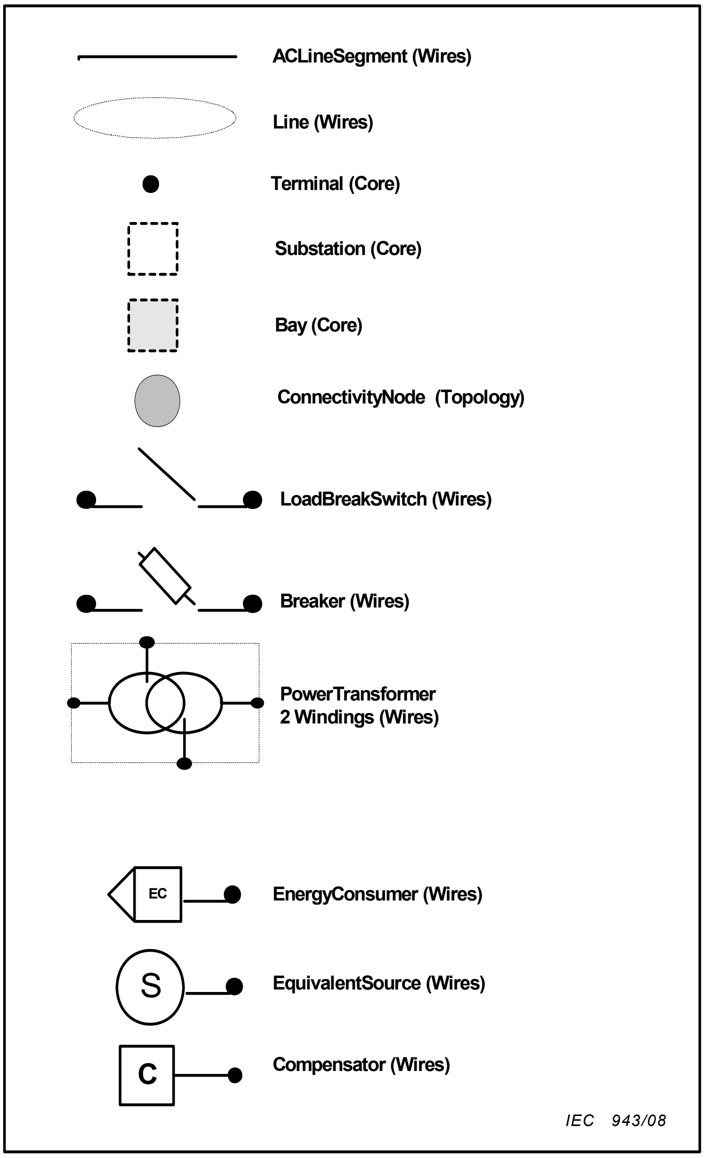


Figure E.1 – European distribution network example

E.2 Corresponding CIM RDF


```
<cim:BaseVoltage rdf:ID="BaseVoltage_01">
	<cim:BaseVoltage.nominalVoltage>42</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:VoltageLevel rdf:ID="VL_01">
	<cim:Naming.name>VL_42_1</cim:Naming.name>
	<cim:VoltageLevel.MemberOf_Substation rdf:resource="#Substation_01"/>
	<cim:VoltageLevel.BaseVoltage rdf:resource="#BaseVoltage_01"/>
</cim:VoltageLevel>

<cim:VoltageLevel rdf:ID="VL_02">
	<cim:Naming.name>VL_42_2</cim:Naming.name>
	<cim:VoltageLevel.MemberOf_Substation rdf:resource="#Substation_01"/>
	<cim:VoltageLevel.BaseVoltage rdf:resource="#BaseVoltage_01"/>
</cim:VoltageLevel>

<cim:BaseVoltage rdf:ID="BaseVoltage_02">
	<cim:BaseVoltage.nominalVoltage>20</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:VoltageLevel rdf:ID="VL_03">
	<cim:Naming.name>VL_20_1</cim:Naming.name>
	<cim:VoltageLevel.MemberOf_Substation rdf:resource="#Substation_01"/>
	<cim:VoltageLevel.BaseVoltage rdf:resource="#BaseVoltage_02"/>
</cim:VoltageLevel>
```

```
<cim:VoltageLevel rdf:ID="VL_04">
        <cim:Naming.name>VL_20_2</cim:Naming.name>
        <cim:VoltageLevel.MemberOf_Substation rdf:resource="#Substation_01"/>
        <cim:VoltageLevel.BaseVoltage rdf:resource="#BaseVoltage_02"/>
</cim:VoltageLevel>

<cim:BaseVoltage rdf:ID="BaseVoltage_03">
        <cim:BaseVoltage.nominalVoltage>0.22</cim:BaseVoltage.nominalVoltage>
</cim:BaseVoltage>

<cim:VoltageLevel rdf:ID="VL_05">
        <cim:Naming.name>VL_0.22_1</cim:Naming.name>
        <cim:VoltageLevel.MemberOf_Substation rdf:resource="#Substation_01"/>
        <cim:VoltageLevel.BaseVoltage rdf:resource="#BaseVoltage_02"/>
</cim:VoltageLevel>

<cim:VoltageLevel rdf:ID="VL_06">
        <cim:Naming.name>VL_0.22_2</cim:Naming.name>
        <cim:VoltageLevel.MemberOf_Substation rdf:resource="#Substation_205"/>
        <cim:VoltageLevel.BaseVoltage rdf:resource="#BaseVoltage_03"/>
</cim:VoltageLevel>

<cim:Substation rdf:ID="Substation_01">
        <cim:Naming.name>AIGUE_HVMV<cim:Naming.name>
        <cim:PowerSystemResource.PSRType rdf:resource="#PSRType_1">
</cim:Substation>

<cim:PSRType rdf:ID="PSRType_1">
        <cim:Naming.name>HV/MV Substation</cim:Naming.name>
</cim:PSRType>

<cim:Location rdf:ID="Location_1"/>
        <cim:Location.PowerSystemResource rdf:resource="#Substation_01”>
</cim:Location>

<cim: GmlPosition rdf:ID="CP1001”>
        <cim:GmlPosition.xPosition>763593</cim:GmlPosition.xPosition>
        <cim:GmlPosition.yPosition>172693</cim:GmlPosition.yPosition>
        <cim:GmlPosition.Location rdf:resource="#Location_1"/>
</cim:GmlPosition >

<cim:EquivalentSource rdf:ID="EquivalentSource_01">
        <cim:Naming.name>AIGUEBHT01<cim:Naming.name>
        <cim:Equipment.MemberOf_EquipmentContainter rdf:resource="#VL_01">
        <cim:PowerSystemResource.PSRType rdf:resource="#PSRType_11">
        <cim:EquivalentSource.nominalVoltage>90</cim:EquivalentSource.nominalVoltage>
        <cim:EquivalentSource.x>17.052631</cim:EquivalentSource.x>
        <cim:EquivalentSource.r>0</cim:EquivalentSource.r>
</cim:EquivalentSource>

<cim:PSRType rdf:ID="PSRType_11">
        <cim:Naming.name>HV Source</cim:Naming.name>
</cim:PSRType>

<cim:Location rdf:ID="Location_12"/>
        <cim:Location.PowerSystemResource rdf:resource="#EquivalentSource_01">
</cim:Location>

<cim:GmlPosition rdf:ID="CP1002">
        <cim:GmlPosition.xPosition>763603</cim:GmlPosition.xPosition>
        <cim:GmlPosition.yPosition>172703</cim:GmlPosition.yPosition>
        <cim:GmlPosition.Location rdf:resource="#Location_12"/>
</cim:GmlPosition>

<cim:Terminal rdf:ID="Terminal_01">
        <cim:Terminal.ConductingEquipment rdf:resource="#EquivalentSource_01"/>
        <cim:Terminal.ConnectivityNode rdf:resource="#CN_01"/>
</cim:Terminal>

<cim:ConnectivityNode rdf:ID=”CN_01”>
        <cim:ConnectivityNode.MemberOf_EquipmentContainer rdf:resource=”#VL_01”>
</cim:ConnectivityNode>

<cim:Terminal rdf:ID="Terminal_02">
        <cim:Terminal.ConductingEquipment rdf:resource="#Breaker_Y0001"/>
        <cim:Terminal.ConnectivityNode rdf:resource="#CN_01"/>
</cim:Terminal>

<cim:Breaker rdf:ID="Breaker_Y0001">
        <cim:Naming.name>AIGUEY0001_Breaker<cim:Naming.name>
        <cim:Switch.normalOpen>false</cim:Switch.normalOpen>
        <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#VL_01">
</cim:Breaker>

<cim:Terminal rdf:ID="Terminal_03">
        <cim:Terminal.ConductingEquipment rdf:resource="#Breaker_Y0001"/>
        <cim:Terminal.ConnectivityNode rdf:resource="#CN_02"/>
</cim:Terminal>
```

```
<cim:ConnectivityNode rdf:ID=”CN_02”>
            <cim:ConnectivityNode.MemberOf_EquipmentContainer rdf:resource=”#VL_01”>
</cim:ConnectivityNode>

<cim:Terminal rdf:ID="Terminal_04">
            <cim:Terminal.ConductingEquipment rdf:resource="#TW_01"/>
            <cim:Terminal.ConnectivityNode rdf:resource="#CN_02"/>
</cim:Terminal>

<cim:PowerTransformer rdf:ID="Transfo_01">
            <cim:Naming.name>AIGUEY0001<cim:Naming.name>
            <cim:Equipment.MemberOf_EquipmentContainter rdf:resource="#Substation_01">
</cim:PowerTransformer>

<cim:Location rdf:ID="Location_7">
            <cim:Location.PowerSystemResource rdf:resource="#Transfo_01">
</cim:Location>

<cim:GmlPosition rdf:ID=”CP1003”>
            <cim:GmlPosition.xPosition>763763</cim:GmlPosition.xPosition>
            <cim:GmlPosition.yPosition>172863</cim:GmlPosition.yPosition>
            <cim:GmlPosition.Location rdf:resource="#Location_7"/>
</cim:GmlPosition>

<cim:TransformerWinding rdf:ID="TW_01">
            <cim:Naming.name>AIGUEY0001_TW1</cim:Naming.name>
            <cim:TransformerWinding.g>30.413794</cim:TransformerWinding.g>
            <cim:TransformerWinding.r>0</cim:TransformerWinding.r>
            <cim:TransformerWinding.ratedKV>42</cim:TransformerWinding.ratedKV>
            <cim:TransformerWinding.ratedMVA>20</cim:TransformerWinding.ratedMVA>
            <cim:TransformerWinding.shortTermMVA>22</cim:TransformerWinding.shortTermMVA>
            <cim:TransformerWinding.windingType                    rdf:resource="http://iec.ch/TC57/2003/CIM-schema-
cim10#WindingType.primary"/>
            <cim:TransformerWinding.x>0</cim:TransformerWinding.x>
            <cim:TransformerWinding.MemberOf_PowerTransformer rdf:resource="#Transfo_01"/>
            <cim:ConductingEquipment.BaseVoltage rdf:resource="#VL_01"/>
</cim:TransformerWinding>

<cim:TransformerWinding rdf:ID="TW_02">
            <cim:Naming.name>AIGUEY0001_TW2</cim:Naming.name>
            <cim:TransformerWinding.g>6.8965516</cim:TransformerWinding.g>
            <cim:TransformerWinding.r>0</cim:TransformerWinding.r>
            <cim:TransformerWinding.ratedKV>20</cim:TransformerWinding.ratedKV>
            <cim:TransformerWinding.ratedMVA>20</cim:TransformerWinding.ratedMVA>
            <cim:TransformerWinding.shortTermMVA>22</cim:TransformerWinding.shortTermMVA>
            <cim:TransformerWinding.windingType                    rdf:resource="http://iec.ch/TC57/2003/CIM-schema-
cim10#WindingType.secondary"/>
            <cim:TransformerWinding.x>0</cim:TransformerWinding.x>
            <cim:TransformerWinding.MemberOf_PowerTransformer rdf:resource="#Transfo_01"/>
            <cim:ConductingEquipment.BaseVoltage rdf:resource="#VL_02"/>
</cim:TransformerWinding>

<cim:Terminal rdf:ID="Terminal_06">
            <cim:Terminal.ConductingEquipment rdf:resource="#Tw_02"/>
            <cim:Terminal.ConnectivityNode rdf:resource="#CN_036"/>
</cim:Terminal>

<cim:ConnectivityNode rdf:ID=”CN_036”>
            <cim: ConnectivityNode.MemberOf_EquipmentContainer rdf:resource=”#VL_03”>
</cim:ConnectivityNode>

<cim:Terminal rdf:ID="Terminal_07">
            <cim:Terminal.ConductingEquipment rdf:resource="#Breaker_2300"/>
            <cim:Terminal.ConnectivityNode rdf:resource="#CN_036"/>
</cim:Terminal>

<cim:Breaker rdf:ID="Breaker_2300">
            <cim:Naming.name>AIGUEC2300_Breaker<cim:Naming.name>
            <cim:Switch.normalOpen>false</cim:Switch.normalOpen>
            <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#VL_03">
</cim:Breaker>

<cim:Location rdf:ID="Location_5">
            <cim:Location.PowerSystemResource rdf:resource="#Breaker_2300">
</cim:Location>

<cim:GmlPosition rdf:ID=”CP1004”>
            <cim:GmlPosition.xPosition>763693</cim:GmlPosition.xPosition>
            <cim:GmlPosition.yPosition>172793</cim:GmlPosition.yPosition>
            <cim:GmlPosition.Location rdf:resource="#Location_5"/>
</cim:GmlPosition>

<cim:Terminal rdf:ID="Terminal_08">
            <cim:Terminal.ConductingEquipment rdf:resource="#Breaker_2300"/>
            <cim:Terminal.ConnectivityNode rdf:resource="#CN_019"/>
</cim:Terminal>
```

```
<cim:ConnectivityNode rdf:ID="CN_019">
	<cim: ConnectivityNode.MemberOf_EquipmentContainer rdf:resource="#VL_03">
</cim:ConnectivityNode>

<cim:Terminal rdf:ID="Terminal_09">
	<cim:Terminal.ConductingEquipment rdf:resource="#Breaker_093"/>
	<cim:Terminal.ConnectivityNode rdf:resource="#CN_019"/>
</cim:Terminal>

<cim:Terminal rdf:ID="Terminal_10">
	<cim:Terminal.ConductingEquipment rdf:resource="#Busbar_02"/>
	<cim:Terminal.ConnectivityNode rdf:resource="#CN_019"/>
</cim:Terminal>

<cim:BusbarSection rdf:ID="Busbar_02">
	<cim:Naming.name>AIGUEB0002 <cim:Naming.name>
	<cim:Equipment.MemberOf_EquipmentContainter rdf:resource="#VL_03">
</cim:BusbarSection>

<cim:Location rdf:ID="Location_6">
	<cim:Location.PowerSystemResource rdf:resource="#Busbar_02">
</cim:Location>

<cim:GmlPosition rdf:ID="CP1005">
	<cim:GmlPosition.xPosition>763623</cim:GmlPosition.xPosition>
	<cim:GmlPosition.yPosition>172723</cim:GmlPosition.yPosition>
	<cim:GmlPosition.Location rdf:resource="#Location_6"/>
</cim:GmlPosition>

<cim:Breaker rdf:ID="Breaker_093">
	<cim:Naming.name>AIGUEC0093_Breaker<cim:Naming.name>
	<cim:Switch.normalOpen>false</cim:Switch.normalOpen>
	<cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#VL_3">
</cim:Breaker>

<cim:Terminal rdf:ID="Terminal_16">
	<cim:Terminal.ConductingEquipment rdf:resource="#Breaker_093"/>
	<cim:Terminal.ConnectivityNode rdf:resource="#CN_033"/>
</cim:Terminal>

<cim:ConnectivityNode rdf:ID="CN_033">
	<cim: ConnectivityNode.MemberOf_EquipmentContainer rdf:resource="#VL_3">
</cim:ConnectivityNode>

<cim:Terminal rdf:ID="Terminal_17">
	<cim:Terminal.ConductingEquipment rdf:resource="#SVC_2000"/>
	<cim:Terminal.ConnectivityNode rdf:resource="#CN_033"/>
</cim:Terminal>

<cim:Compensator rdf:ID="Comp_2000">
	<cim:Naming.name>AIGUEK2000<cim:Naming.name>
	<cim:Equipment.MemeberOf_EquipmentContainter rdf:resource="#VL_3">
	<cim:PowerSystemResource.Location rdf:resource="#Location_42">
</cim:Compensator>

<cim:Location rdf:ID="Location_42">
	<cim:Location.PowerSystemResource rdf:resource="#Comp_2000">
</cim:Location>

<cim:GmlPosition rdf:ID="CP1006">
	<cim:GmlPosition.xPosition>763753</cim:GmlPosition.xPosition>
	<cim:GmlPosition.yPosition>172853</cim:GmlPosition.yPosition>
	<cim:GmlPosition.Location rdf:resource="#Location_42"/>
</cim:GmlPosition>

<cim:Breaker rdf:ID="Breaker_07">
	<cim:Naming.name>AIGUEC0093_Breaker<cim:Naming.name>
	<cim:Switch.normalOpen>false</cim:Switch.normalOpen>
	<cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#VL_3">
	<cim:PowerSystemResource.PSRType rdf:resource="#PSRType_5">
</cim:Breaker>

<cim:Terminal rdf:ID="Terminal_11">
	<cim:Terminal.ConductingEquipment rdf:resource="#Breaker_07"/>
	<cim:Terminal.ConnectivityNode rdf:resource="#CN_019"/>
</cim:Terminal>

<cim:Location rdf:ID="Location_93">
	<cim:Location.PowerSystemResource rdf:resource="#Breaker_07">
</cim:Location>

<cim:GmlPosition rdf:ID="CP1007">
	<cim:GmlPosition.xPosition>763590</cim:GmlPosition.xPosition>
	<cim:GmlPosition.yPosition>172691.8</cim:GmlPosition.yPosition>
	<cim:GmlPosition.Location rdf:resource="#Location_93"/>
</cim:GmlPosition>

<cim:PSRType rdf:ID="PSRType_5">
```

```
            <cim:Naming.name>OUTGOING FEEDER</cim:Naming.name>
</cim:PSRType>

<cim:Terminal rdf:ID="Terminal_14">
            <cim:Terminal.ConductingEquipment rdf:resource="#Breaker_07"/>
            <cim:Terminal.ConnectivityNode rdf:resource="#CN_09"/>
</cim:Terminal>

<cim:ConnectivityNode rdf:ID=”CN_09”>
            <cim: ConnectivityNode.MemberOf_EquipmentContainer rdf:resource=”#VL_3”>
</cim:ConnectivityNode>

<cim:Terminal rdf:ID="Terminal_15">
            <cim:Terminal.ConductingEquipment rdf:resource="#ACLS_0216_1"/>
            <cim:Terminal.ConnectivityNode rdf:resource="#CN_09"/>
</cim:Terminal>

<cim:Line rdf:ID="Line_0216">
            <cim:Naming.description>AIGUE0216</cim:Naming.description>
            <cim:PowerSystemResource.Location rdf:resource="#Location_85">
</cim:Line>

<cim:Location rdf:ID="Location_85">
            <cim:Location.PowerSystemResource rdf:resource="#Line_0216">
</cim:Location>

<cim:GmlPosition rdf:ID=”CP2000>
            <cim:GmlPosition.xPosition>763577.7</cim:GmlPosition.xPosition>
            <cim:GmlPosition.yPosition>172692.7</cim:GmlPosition.yPosition>
            <cim:GmlPosition.Location rdf:resource="#Location_85"/>
</cim:GmlPosition>

<cim:GmlPosition rdf:ID=”CP1008”>
            <cim:GmlPosition.xPosition>763542.3</cim:GmlPosition.xPosition>
            <cim:GmlPosition.yPosition>172718.7</cim:GmlPosition.yPosition>
            <cim:GmlPosition.Location rdf:resource="#Location_85"/>
</cim:GmlPosition>

<cim:GmlPosition rdf:ID=”CP1009”>
            <cim:GmlPosition.xPosition>763608.4</cim:GmlPosition.xPosition>
            <cim:GmlPosition.yPosition>172802.7</cim:GmlPosition.yPosition>
            <cim:GmlPosition.Location rdf:resource="#Location_85"/>
</cim:GmlPosition>

<cim:ACLineSegment rdf:ID="ACLS_0216_1">
            <cim:ACLineSegment.MemberOf_Line rdf:resource="#Line_0216"/>
            <cim:ConductingEquipment.BaseVoltage rdf:resource="#BaseVoltage02”/>
            <cim:Conductor.length>566</cim:Conductor.length>
            <cim:ConductorType rdf:resource=”ConductorType_1”>
            <cim:ACLineSegment.r>0.2</cim:ACLineSegment.r>
            <cim:ACLineSegment.x>0.1</cim:ACLineSegment.x>
            <cim:ACLineSegment.b0ch>449</cim:ACLineSegment.g0ch>
</cim:ACLineSegment>

<cim:ConductorType rdf:ID=”ConductorType_1”/>

<cim:WireArrangement rdf:ID=”WireArrangement_1”>
            <cim: WireArrangement.WireType rdf:resource=”#WireType_1”>
            <cim: WireArrangement.ConductorType rdf:resource=”#ConductorType_1”>
</cim:WireArrangement>

<cim:WireType rdf:ID=”WireType_1”>
            <cim:WireType.ampRating>258.225006</cim:WireType.ampRating>
</cim:WireType>

<cim:Substation rdf:ID="Substation_205">
            <cim:Naming.name>30189P0205<cim:Naming.name>
            <cim:PowerSystemResource.Location rdf:resource="#Location_2">
            <cim:PowerSystemResource.PSRType rdf:resource="#PSRType_2">
</cim:Substation>

<cim:PSRType rdf:ID="PSRType_2">
            <cim:Naming.name>MV/LV Substation</cim:Naming.name>
</cim:PSRType>

<cim:Location rdf:ID="Location_2">
            <cim:Location.PowerSystemResource rdf:resource="#Substation_205">
</cim:Location>

<cim:GmlPosition rdf:ID=”CP1010”>
            <cim:GmlPosition.xPosition>763682.7</cim:GmlPosition.xPosition>
            <cim:GmlPosition.yPosition>173102</cim:GmlPosition.yPosition>
            <cim:GmlPosition.Location rdf:resource="#Location_2"/>
</cim:GmlPosition>

<cim:Terminal rdf:ID="Terminal_18">
            <cim:Terminal.ConductingEquipment rdf:resource="#ACLS_0216_1"/>
            <cim:Terminal.ConnectivityNode rdf:resource="#CN_031"/>
```

```
</cim:Terminal>

<cim:ConnectivityNode rdf:ID=”CN_031”>
        <cim: ConnectivityNode.MemberOf_EquipmentContainer rdf:resource=”#VL_05”>
</cim:ConnectivityNode>

<cim:Terminal rdf:ID="Terminal_19">
        <cim:Terminal.ConductingEquipment rdf:resource="#LoadBreakSwitch_01"/>
        <cim:Terminal.ConnectivityNode rdf:resource="#CN_031"/>
</cim:Terminal>

<cim:LoadBreakSwitch rdf:ID="LoadBreakSwitch_01">
        <cim:Naming.name>30189P0205_LBS1<cim:Naming.name>
        <cim:Switch.normalOpen>false</cim:Switch.normalOpen>
        <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#VL_05">
</cim:LoadBreakSwitch>

<cim:ConnectivityNode rdf:ID=”CN_012”>
        <cim: ConnectivityNode.MemberOf_EquipmentContainer rdf:resource=”#VL_05”>
</cim:ConnectivityNode>

<cim:Terminal rdf:ID="Terminal_20">
        <cim:Terminal.ConductingEquipment rdf:resource="#LoadBreakSwitch_01"/>
        <cim:Terminal.ConnectivityNode rdf:resource="#CN_012"/>
</cim:Terminal>

<cim:Terminal rdf:ID="Terminal_21">
        <cim:Terminal.ConductingEquipment rdf:resource="#TW_03"/>
        <cim:Terminal.ConnectivityNode rdf:resource="#CN_012"/>
</cim:Terminal>

<cim:Terminal rdf:ID="Terminal_31">
        <cim:Terminal.ConductingEquipment rdf:resource="#BusbarSection_05"/>
        <cim:Terminal.ConnectivityNode rdf:resource="#CN_012"/>
</cim:Terminal>

<cim:Terminal rdf:ID="Terminal_32">
        <cim:Terminal.ConductingEquipment rdf:resource="#LoadBreakSwitch_02"/>
        <cim:Terminal.ConnectivityNode rdf:resource="#CN_012"/>
</cim:Terminal>

<cim:BusbarSection rdf:ID="Busbar_05">
        <cim:Naming.name>30189P0205_Busbar_01<cim:Naming.name>
        <cim:Equipment.MemberOf_EquipmentContainter rdf:resource="#VL_05">
</cim:BusbarSection>

<cim:PowerTransformer rdf:ID="Transfo_02">
        <cim:Naming.name>30189P0205_Transfo_01<cim:Naming.name>
        <cim:Equipment.MemberOf_EquipmentContainter rdf:resource="#Substation_205">
</cim:PowerTransformer>

<cim:TransformerWinding rdf:ID="TW_03">
        <cim:TransformerWinding.MemberOf_PowerTransformer rdf:resource="#Transfo_02">
        <cim:TransformerWinding.ratedKV>20</cim:TransformerWinding.ratedKV>
        <cim:ConductingEquipment.BaseVoltage rdf:resource="#BaseVoltage_02"/>
</cim:TransformerWinding>

<cim:TransformerWinding rdf:ID="TW_04">
        <cim:TransformerWinding.MemberOf_PowerTransformer rdf:resource="#Transfo_02">
        <cim:ConductingEquipment.BaseVoltage rdf:resource="#BaseVoltage_03"/>
        <cim:TransformerWinding.ratedKV>0.22</cim:TransformerWinding.ratedKV>
</cim:TransformerWinding>

<cim:Terminal rdf:ID="Terminal_28">
        <cim:Terminal.ConductingEquipment rdf:resource="#TW_04"/>
        <cim:Terminal.ConnectivityNode rdf:resource="#CN_016"/>
</cim:Terminal>

<cim:ConnectivityNode rdf:ID=”CN_016”>
        <cim: ConnectivityNode.MemberOf_EquipmentContainer rdf:resource=”#VL_05”>
</cim:ConnectivityNode>

<cim:Terminal rdf:ID="Terminal_29">
        <cim:Terminal.ConductingEquipment rdf:resource="#EC_205"/>
        <cim:Terminal.ConnectivityNode rdf:resource="#CN_016"/>
</cim:Terminal>

<cim:EquivalentLoad rdf:ID="EC_205">
        <cim:PowerSystemResource.MemberOf_EquipementContainer rdf:resource="#VL_05">
        <cim:EnergyConsumer.pnom>0.081</cim:EnergyConsumer.pnom>
        <cim:EnergyConsumer.qnom>0,002693</cim:EnergyConsumer.qnom>
        <cim:EnergyConsumer.powerFactor>0.967823</cim:EnergyConsumer.powerFactor>
        <cim:EnergyConsumer.customerCount>173</cim:EnergyConsumer.customerCount>
</cim:EquivalentLoad >

<cim:LoadBreakSwitch rdf:ID="LoadBreakSwitch_2">
        <cim:Naming.name>30189P0205_LBS2<cim:Naming.name>
```

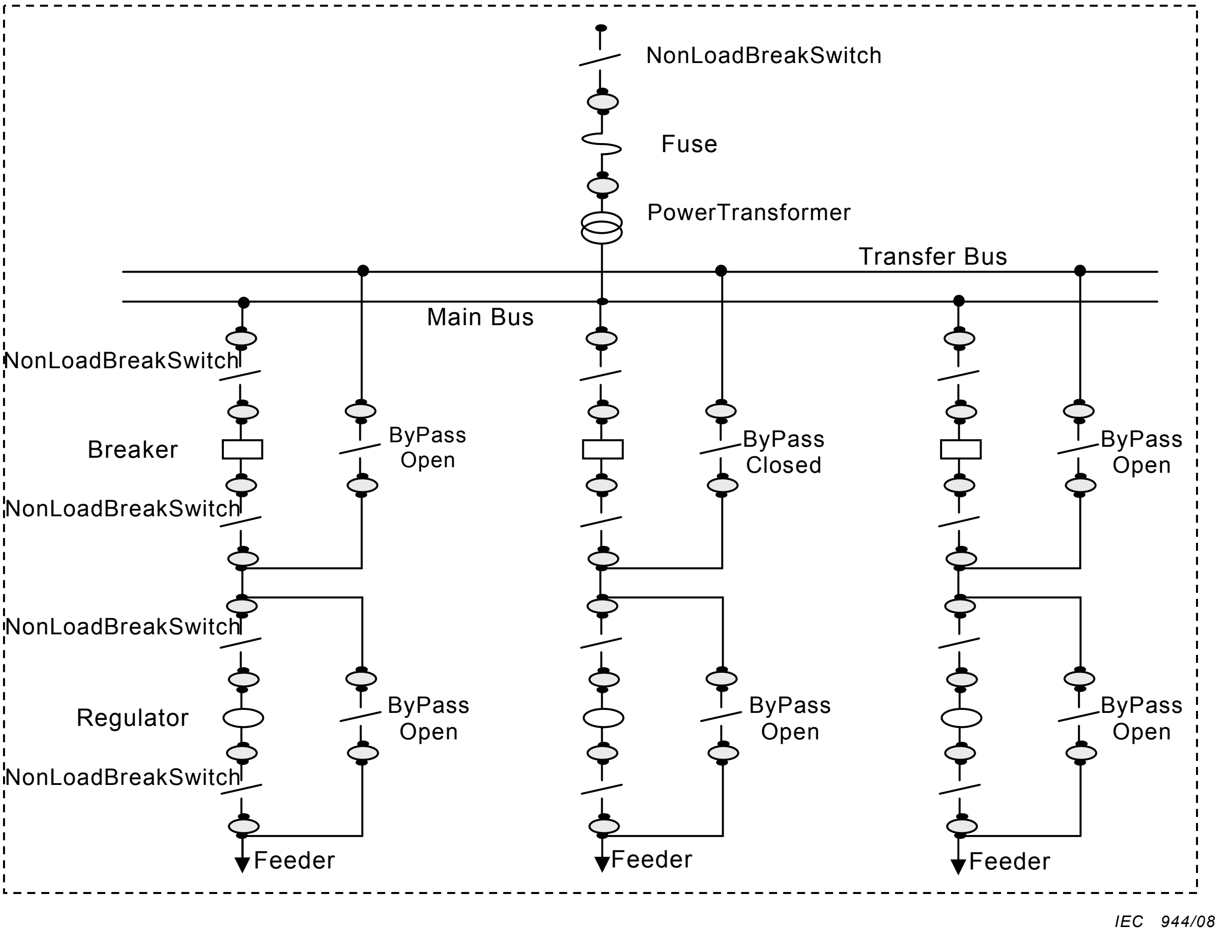
```
        <cim:Switch.normalOpen>false</cim:Switch.normalOpen>
        <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#VL_05">
</cim:LoadBreakSwitch>

<cim:Terminal rdf:ID="Terminal_26">
        <cim:Terminal.ConductingEquipment rdf:resource="#LoadBreakSwitch_2"/>
        <cim:Terminal.ConnectivityNode rdf:resource="#CN_15"/>
</cim:Terminal>

<cim:ConnectivityNode rdf:ID="CN_15">
        <cim: ConnectivityNode.MemberOf_EquipmentContainer rdf:resource="#VL_05">
</cim:ConnectivityNode>
```

Annex F
(informative)

Example of a North American distribution network

A graphical example of a US HV/LV Substation is presented as in Figure F.1.

This figure represents a graphical representation of a North American substation, not a graphical CIM representation (Transfer bus and Main Bus are busbar which in CIM has only one terminal).



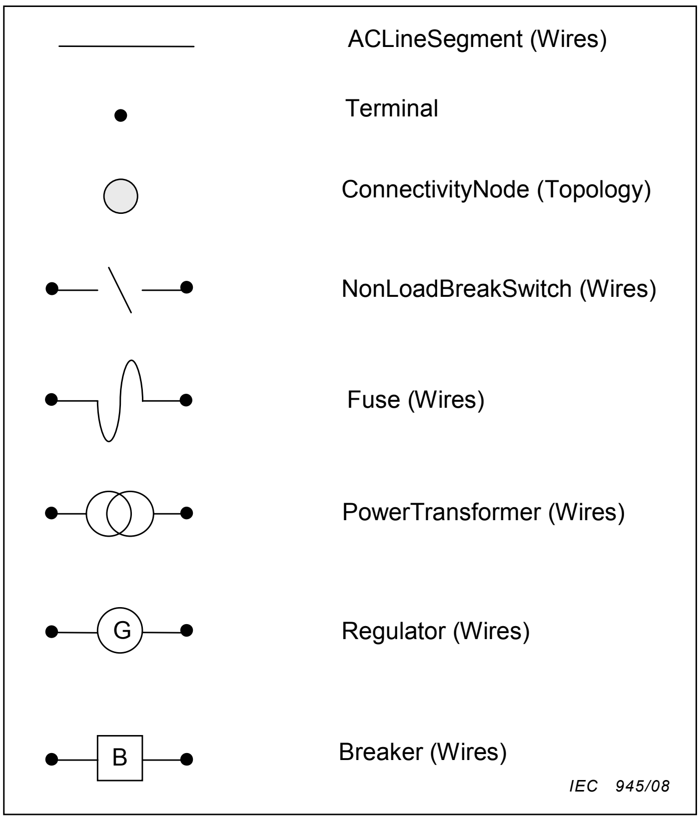


Figure F.1 – North American distribution network example

Annex G
(informative)

Comparison between CDPSM and CPSM

CIM CLASS	CDPSM
Substation	<cim:Substation rdf:ID="SUB102"> <cim:Naming.description>LAC</cim:Naming.description> <cim:Naming.name>73002P0013</cim:Naming.name> <cim:PowerSystemResource.PSRType rdf:resource="#PSR5"/> <cim:PowerSystemResource.Location rdf:resource="#LOC103"/> <cim:EquipmentContainer.ConnectivityNodes rdf:resource="#CN105"/> </cim:Substation>
ConnectivityNode	<cim:ConnectivityNode rdf:ID="CN1008"> <cim:Naming.name>73237J0003_CN1</cim:Naming.name> <cim:ConnectivityNode.MemberOf_EquipmentContainer rdf:resource="#EC1005"/> </cim:ConnectivityNode>
EquivalentSource	<cim:EquivalentSource rdf:ID="EquivalentSource_1"> <cim:Naming.name>AIGUEBHT01<cim:Naming.name> <cim:Equipment.MemberOf_EquipmentContainter rdf:resource="#VL_1"> <cim:EquivalentSource.nominalVoltage>42</cim:EquivalentSource.nominalVoltage> <cim:EquivalentSource.r>0.068</cim:EquivalentSource.r> <cim:EquivalentSource.x>1.89</cim:EquivalentSource.x> <cim:PowerSystemResource.PSRType rdf:resource="#PSRType_11"> </cim:EquivalentSource>

CIM CLASS	CDPSM
Compensator	<cim:Compensator rdf:ID="Compensator_1"> <cim:Naming.name>COMP</cim:Naming.name> <cim:Compensator.compensatorType rdf:resource="http://iec.ch/TC57/2003/CIM-schema-cim1/> <cim:Compensator.maximumSections>1</cim:Compensator.maximumSections> <cim:Compensator.mVArPerSection>5</cim:Compensator.mVArPerSection> <cim:Compensator.nominalkV>33</cim:Compensator.nominalkV> <cim:Compensator.normalSections>1</cim:Compensator.normalSections> <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#VL_2"/> </cim:Compensator>
StaticVarCompensator	<cim:StaticVarCompensator rdf:ID="SVC1214"> <cim:Naming.name>AIGUEK0680_SVC</cim:Naming.name> <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#SUB1210"/> <cim:StaticVarCompensator.inductiveRating>0</cim:StaticVarCompensator.inductiveRating> <cim:StaticVarCompensator.sVCControlMode>Voltage</cim:StaticVarCompensator.sVCControlMode> <cim:ConductingEquipment.Terminals rdf:resource="#TER1216"/> <cim:StaticVarCompensator.capacitiveRating>900000</cim:StaticVarCompensator.capacitiveRating> </cim:StaticVarCompensator>

CIM CLASS	CDPSM
EnergyConsumer	<cim:EnergyConsumer rdf:ID="EC100"> <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#SUB96"/> <cim:ConductingEquipment.Terminals rdf:resource="#TER101"/> <cim:EnergyConsumer.customerCount>120</cim:EnergyConsumer.customerCount> <cim:EnergyConsumer.pfixed>0.093000032</cim:EnergyConsumer.pnom> <cim:EnergyConsumer.powerFactor>0.90502399</cim:EnergyConsumer.powerFactor> <cim:EnergyConsumer.conformingLoadFlag>0</cim:EnergyConsumer.conformingLoadFlag> <cim:EnergyConsumer.qfixed>0.043709937</cim:EnergyConsumer.qnom> </cim:EnergyConsumer>
GeneratingUnit	<cim:GeneratingUnit rdf:ID="GU_5"> <cim:Naming.name>NOD09S05_GU</cim:Naming.name> <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#VL_1"/> <cim:GeneratingUnit.initialMW>5.5</cim:GeneratingUnit.initialMW> <cim:GeneratingUnit.ratedNetMaxMW>4648</cim:GeneratingUnit.ratedNetMaxMW> <cim:GeneratingUnit.genControlSource>offAGC</cim:GeneratingUnit.genControlSource> </cim:GeneratingUnit>
SynchronousMachine	<cim:SynchronousMachine rdf:ID="SM_1"> <cim:Naming.name>NOD02S71_SM</cim:Naming.name> <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#VL_1"/> <cim:SynchronousMachine.baseMVAr>2.2</cim:SynchronousMachine.baseMVAr> <cim:SynchronousMachine.MemberOf_GeneratingUnit rdf:resource="#GU_5"/> </cim:SynchronousMachine>

CIM CLASS	CDPSM
ACLineSegment	<cim:ACLineSegment rdf:ID="ACLine1234"> <cim:ConductingEquipment.Terminals rdf:resource="#TER1238"/> <cim:ConductingEquipment.Terminals rdf:resource="#TER1239"/> <cim:Conductor.bch>0.0049480041</cim:Conductor.bch> <cim:Conductor.length>63</cim:Conductor.length> <cim:Conductor.r>0.0078750001</cim:Conductor.r> <cim:Conductor.x>0.0063</cim:Conductor.x> <cim:Conductor.ConductorType rdf:resource="#CT1237"/> <cim:ACLineSegment.MemberOf_Line rdf:resource="#LIN1226"/> </cim:ACLineSegment>
Breaker	<cim:Breaker rdf:ID="BRK1228"> <cim:Naming.name>AIGUEC0602_SW</cim:Naming.name> <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#Bay1175"/> <cim:ConductingEquipment.Terminals rdf:resource="#TER1229"/> <cim:ConductingEquipment.Terminals rdf:resource="#TER1230"/> <cim:Switch.normalOpen>false</cim:Switch.normalOpen> </cim:Breaker>
BusbarSection	<cim:BusbarSection rdf:ID="BUS1154"> <cim:Naming.name>AIGUEB0001</cim:Naming.name> <cim:PowerSystemResource.Location rdf:resource="#LOC1155"/> <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#SUB6"/> <cim:ConductingEquipment.Terminals rdf:resource="#TER1158"/> <cim:ConductingEquipment.Terminals rdf:resource="#TER2635"/> <cim:ConductingEquipment.Terminals rdf:resource="#TER2648"/> <cim:ConductingEquipment.Terminals rdf:resource="#TER2661"/> <cim:ConductingEquipment.Terminals rdf:resource="#TER2674"/> <cim:ConductingEquipment.Terminals rdf:resource="#TER2687"/> </cim:BusbarSection>

CIM CLASS	CDPSM
Bay	<cim:Bay rdf:ID="Bay1170"> <cim:Naming.description>AIGUEB</cim:Naming.description> <cim:Naming.name>AIGUEC0601</cim:Naming.name> <cim:PowerSystemResource.PSRType rdf:resource="#PSRType1"/> <cim:PowerSystemResource.Location rdf:resource="#LOC1171"/> <cim:EquipmentContainer.ConnectivityNodes rdf:resource="#CN1173"/> <cim:EquipmentContainer.ConnectivityNodes rdf:resource="#CN1174"/> <cim:EquipmentContainer.Contains_Equipments rdf:resource="#BRK2692"/> <cim:Bay.MemberOf_Substation rdf:resource="#SUB6"/> </cim:Bay>
LoadBreakSwitch	<cim:LoadBreakSwitch rdf:ID="LBS1231"> <cim:Naming.name>73002J0501_SW</cim:Naming.name> <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#EC36"/> <cim:ConductingEquipment.Terminals rdf:resource="#TER1232"/> <cim:ConductingEquipment.Terminals rdf:resource="#TER1233"/> <cim:Switch.normalOpen>false</cim:Switch.normalOpen> </cim:LoadBreakSwitch>
Line	<cim:Line rdf:ID="LIN1226"> <cim:Naming.name>AIGUE0001</cim:Naming.name> <cim:PowerSystemResource.Location rdf:resource="#LOC1227"/> </cim:Line>
Terminal	<cim:Terminal rdf:ID="TER101"> <cim:Terminal.ConductingEquipment rdf:resource="#EC100"/> <cim:Terminal.ConnectivityNode rdf:resource="#CN99"/> </cim:Terminal>

CIM CLASS	CDPSM
PowerTransformer	<cim:PowerTransformer rdf:ID="PT1217"> <cim:Naming.name>AIGUEY0001</cim:Naming.name> <cim:PowerSystemResource.Location rdf:resource="#LOC1218"/> <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#SUB6"/> <cim:PowerTransformer.Contains_TransformerWindings rdf:resource="#TW1220"/> <cim:PowerTransformer.Contains_TransformerWindings rdf:resource="#TW1221"/> <cim:PowerTransformer.transformerType rdf:resource="http://iec.ch/TC57/2005/CIM-schema-cim10#TransformerType.fix"/> </cim:PowerTransformer>
TransformerWinding	<cim:TransformerWinding rdf:ID="TW1220"> <cim:Naming.name>AIGUEY0001_TW1</cim:Naming.name> <cim:ConductingEquipment.BaseVoltage rdf:resource="#_BV1"/> <cim:TransformerWinding.b>0</cim:TransformerWinding.b> <cim:ConductingEquipment.Terminals rdf:resource="#TER1224"/> <cim:TransformerWinding.g>30.413794</cim:TransformerWinding.g> <cim:TransformerWinding.r>0</cim:TransformerWinding.r> <cim:TransformerWinding.ratedKV>24.248711</cim:TransformerWinding.ratedKV> <cim:TransformerWinding.ratedMVA>20</cim:TransformerWinding.ratedMVA> <cim:TransformerWinding.shortTermMVA>22</cim:TransformerWinding.shortTermMVA> <cim:TransformerWinding.windingType rdf:resource="http://iec.ch/TC57/2003/CIM-schema-cim10#WindingType.primary"/> <cim:TransformerWinding.x>0</cim:TransformerWinding.x> <cim:TransformerWinding.MemberOf_PowerTransformer rdf:resource="#PT1217"/> </cim:TransformerWinding>
VoltageLevel	<cim:VoltageLevel rdf:ID="VL_1"> <cim:Naming.name>NOD10S61</cim:Naming.name> <cim:VoltageLevel.MemberOf_Substation rdf:resource="#Substation_1"/> <cim:VoltageLevel.BaseVoltage rdf:resource="#BaseVoltage_1"/> <cim:VoltageLevel.highVoltageLimit>23</cim:VoltageLevel.highVoltageLimit> <cim:VoltageLevel.lowVoltageLimit>17</cim:VoltageLevel.lowVoltageLimit> </cim:VoltageLevel>

CIM CLASS	CDPSM
BaseVoltage	<cim:BaseVoltage rdf:ID="BaseVoltage_2"> <cim:BaseVoltage.nominalVoltage>42</cim:BaseVoltage.nominalVoltage> </cim:BaseVoltage>
HostControlArea	<cim:HostControlArea rdf:ID="HCA_1"> <cim:Naming.name>HostControlArea_1</cim:Naming.name> </cim:HostControlArea>
SubControlArea	<cim:SubControlArea rdf:ID="SCA_1"> <cim:Naming.name>07</cim:Naming.name> <cim:SubControlArea.HostControlArea rdf:resource="#HCA_1 "/> </cim:SubControlArea>
Substation	<cim:Substation rdf:ID="CO-NEPOOLDV-EASTST-HEARN" > <cim:Naming.name>HEARN</cim:Naming.name> <cim:Substation.MemberOf_SubControlArea rdf:resource="#AREA-EASTDV-EASTAREA-EAST"/> </cim:Substation> >

CIM CLASS	CDPSM
ConnectivityNode	<cim:ConnectivityNode rdf:ID="CO-ECARDV-ECARST-MARTDALEKV-345ND-169" > <cim:Naming.name>169</cim:Naming.name> <cim:ConnectivityNode.MemberOf_EquipmentContainer rdf:resource="#CO-ECARDV-ECARST-MARTDALEKV-345"/> </cim:ConnectivityNode> >
EquivalentSource	not in CPSM
Compensator	<cim:Compensator rdf:ID="_3542900133514a94a4ecb8a3860db26"> <cim:Naming.name>ME 1S35_CP</cim:Naming.name> <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#_285126666c44a8abfd5497d411d4b14"/> <cim:Compensator.maximumSections>1</cim:Compensator.maximumSections> <cim:Compensator.mVArPerSection>5</cim:Compensator.mVArPerSection> <cim:Compensator.nominalkV>33</cim:Compensator.nominalkV> <cim:Compensator.normalSections>1</cim:Compensator.normalSections> <cim:Compensator.compensatorType rdf:resource="http://iec.ch/TC57/2005/CIM-schema-cim10#CompensatorType.shunt"/> </cim:Compensator>

CIM CLASS	CDPSM
StaticVarCompensator	<cim:StaticVarCompensator rdf:ID="_50DE873E88E2421383DCC3945A1F8A4D"> <cim:Naming.name>SVC NTHSD</cim:Naming.name> <cim:StaticVarCompensator.capacitiveRating>500</cim:StaticVarCompensator.capacitiveRating> <cim:StaticVarCompensator.inductiveRating>500</cim:StaticVarCompensator.inductiveRating> <cim:StaticVarCompensator.sVCControlMode>Voltage</cim:StaticVarCompensator.sVCControlMode> <cim:StaticVarCompensator.slope>0.00001</cim:StaticVarCompensator.slope> <cim:StaticVarCompensator.voltageSetPoint>229.55</cim:StaticVarCompensator.voltageSetPoint> <cim:RegulatingCondEq.Measurement rdf:resource="#_114304E1EB1A4C5B9244BDBCA33F5C9B"/> <cim:RegulatingCondEq.RegulationSchedule rdf:resource="#_A2F043D541D04116A9DBB18A6B061546"/> <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#_EB84E6A15E9D4DF18CE33ADB8CBE4648"/> </cim:StaticVarCompensator>
EnergyConsumer	<cim:EnergyConsumer rdf:ID="_491034bf555d46f59c1e2ad4c3e17d12"> <cim:Naming.name>NOD04S71</cim:Naming.name> <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#_3d6d614d5beb4fa189e422e6cac5cfa8"/> <cim:EnergyConsumer.conformingLoadFlag>0</cim:EnergyConsumer.conformingLoadFlag> <cim:EnergyConsumer.pfixed>956</cim:EnergyConsumer.pfixed> <cim:EnergyConsumer.qfixed>-78</cim:EnergyConsumer.qfixed> </cim:EnergyConsumer>
GeneratingUnit	<cim:GeneratingUnit rdf:ID="_f1c0c969644343e8b88ae41537dd5b"> <cim:Naming.name>NOD01S71_GU</cim:Naming.name> <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#_23333cd4619840f88ea8431dc1915fe"/> <cim:GeneratingUnit.initialMW>5112.7998</cim:GeneratingUnit.initialMW> <cim:GeneratingUnit.ratedNetMaxMW>4648</cim:GeneratingUnit.ratedNetMaxMW> <cim:GeneratingUnit.SubControlArea rdf:resource="#_b198466d24a64f25942195cbab26b384"/> </cim:GeneratingUnit>

CIM CLASS	CDPSM
SynchronousMachine	<cim:SynchronousMachine rdf:ID="_1983f84c3db84f75b46c5559b793d19f"> <cim:Naming.name>NOD06S61_SM</cim:Naming.name> <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#_d0191bb2b8643419b74f1a77d8e4e9"/> <cim:RegulatingCondEq.Measurement rdf:resource="#_10dac0e32bfe40e1878585de7ae0e66b"/> <cim:RegulatingCondEq.RegulationSchedule rdf:resource="#_9ba849f8593e4092882897a593d8f281"/> <cim:SynchronousMachine.baseMVAr>287.42599</cim:SynchronousMachine.baseMVAr> <cim:SynchronousMachine.maximumMVAr>99999</cim:SynchronousMachine.maximumMVAr> <cim:SynchronousMachine.minimumMVAr>-99999</cim:SynchronousMachine.minimumMVAr> <cim:SynchronousMachine.operatingMode rdf:resource="http://iec.ch/TC57/2005/CIM-schema-cim10#SynchronousMachineOperatingMode.condenser"/> <cim:SynchronousMachine.type rdf:resource="http://iec.ch/TC57/2005/CIM-schema-cim10#SynchronousMachineType.condenser"/> <cim:SynchronousMachine.MemberOf_GeneratingUnit rdf:resource="#_faf74f1d45e444a4b4341c276c143f60"/> </cim:SynchronousMachine>
ACLineSegment	<cim:ACLineSegment rdf:ID="_211296fa3ff9498d8833a8a8df9bc1b0"> <cim:Naming.name>NOD02S71-NOD05S71-1</cim:Naming.name> <cim:ConductingEquipment.BaseVoltage rdf:resource="#_358210899d3742a59e6d74bbf2d3dce0"/> <cim:Conductor.bch>0.000479223</cim:Conductor.bch> <cim:Conductor.r>4.1110682</cim:Conductor.r> <cim:Conductor.x>12.552692</cim:Conductor.x> <cim:ACLineSegment.MemberOf_Line rdf:resource="#_fe63c77941904924994487b4cd4be77"/> </cim:ACLineSegment>

CIM CLASS	CDPSM
Breaker	<cim:Breaker rdf:ID="_214c2c7829284edd91d3b90e4e2d32"> <cim:Naming.name>NOD04S71-NOD05S71-1_B2</cim:Naming.name> <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#_d0908bce97ad46c38f8fba427ed873a1"/> <cim:Switch.normalOpen>0</cim:Switch.normalOpen> </cim:Breaker>
BusbarSection	<cim:BusbarSection rdf:ID="_26D828C78EDC46C18C6AE57C543E8924"> <cim:Naming.name>O-IN1150</cim:Naming.name> <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#_DE7397F17ED140F38EFCA1B395DAE4D6"/> </cim:BusbarSection>
Bay	<cim:Bay rdf:ID="_557717BD05A548EB86619BBEC636856D"> <cim:Naming.name>115SW1</cim:Naming.name> <cim:Bay.MemberOf_VoltageLevel rdf:resource="#_DE7397F17ED140F38EFCA1B395DAE4D6"/> </cim:Bay>

CIM CLASS	CDPSM
LoadBreakSwitch	<cim:LoadBreakSwitch rdf:ID="_4150C8ADD03545DA9B8F99E491422E9A"> <cim:Naming.name>LBS</cim:Naming.name> <cim:Switch.normalOpen>false</cim:Switch.normalOpen> <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#_1434840A084340DBA5C16C18638C3BC1"/> </cim:LoadBreakSwitch>
Line	<cim:Line rdf:ID="_d2a592391c45e0aacc2eae2e702e"> <cim:Naming.name>NOD01S71-NOD02S71-1</cim:Naming.name> </cim:Line>
Terminal	<cim:Terminal rdf:ID="_d2b23dccdeae451abaf3625fc60498"> <cim:Naming.name>NOD06S61-NOD11S61-1_TS2</cim:Naming.name> <cim:Terminal.ConductingEquipment rdf:resource="#_f74cf8358ad44ef866d93fea3ba17b"/> <cim:Terminal.ConnectivityNode rdf:resource="#_91b1acae5635424094f4c490ac8acfa"/> </cim:Terminal>
PowerTransformer	<cim:PowerTransformer rdf:ID="_e058a062f2ce4c519cd460e97069561f"> <cim:Naming.name>NOD09S61-NOD07S71-1</cim:Naming.name> <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#_dcd2272019834930bf50c0af8cfbc093"/> <cim:PowerTransformer.transformerType rdf:resource="http://iec.ch/TC57/2005/CIM-schema-cim10#TransformerType.fix"/> </cim:PowerTransformer>

CIM CLASS	CDPSM
TransformerWinding	<cim:TransformerWinding rdf:ID="_7924abe41c94b7b89d257d2a7f242"> <cim:Naming.name>NOD02S71-NOD04S71-1_TW2</cim:Naming.name> <cim:ConductingEquipment.BaseVoltage rdf:resource="#_358210899d3742a59e6d74bbf2d3dce0"/> <cim:TransformerWinding.b>0</cim:TransformerWinding.b> <cim:TransformerWinding.g>0</cim:TransformerWinding.g> <cim:TransformerWinding.r>2.0978055</cim:TransformerWinding.r> <cim:TransformerWinding.ratedKV>380</cim:TransformerWinding.ratedKV> <cim:TransformerWinding.ratedMVA>6581.1001</cim:TransformerWinding.ratedMVA> <cim:TransformerWinding.windingType rdf:resource="http://iec.ch/TC57/2005/CIM-schema-cim10#WindingType.secondary"/> <cim:TransformerWinding.x>6.3652906</cim:TransformerWinding.x> <cim:TransformerWinding.MemberOf_PowerTransformer rdf:resource="#_6bb7dc437e7416ca1adcd5e46ce42d7"/> </cim:TransformerWinding>
VoltageLevel	<cim:VoltageLevel rdf:ID="_83441496d74aa7b9e1e3d9996e8f1"> <cim:Naming.name>NOD09S61</cim:Naming.name> <cim:VoltageLevel.highVoltageLimit>253</cim:VoltageLevel.highVoltageLimit> <cim:VoltageLevel.lowVoltageLimit>187</cim:VoltageLevel.lowVoltageLimit> <cim:VoltageLevel.MemberOf_Substation rdf:resource="#_dcd2272019834930bf50c0af8cfbc093"/> <cim:VoltageLevel.BaseVoltage rdf:resource="#_144aef9f8d44b1496dc347efc75786"/> </cim:VoltageLevel>
BaseVoltage	<cim:BaseVoltage rdf:ID="BV-345" > <cim:BaseVoltage.nominalVoltage>345</cim:BaseVoltage.nominalVoltage> </cim:BaseVoltage>

CIM CLASS	CDPSM
HostControlArea	<cim:HostControlArea rdf:ID="CO-NEPOOLHCA-DV-EAST" > <cim:Naming.name>NEPOOL</cim:Naming.name> <cim:HostControlArea.Controls rdf:resource="#CO-NEPOOLDV-EAST"/> </cim:HostControlArea>
SubControlArea	<cim:SubControlArea rdf:ID="AREA-EASTDV-EASTAREA-EAST" > <cim:Naming.name>EAST</cim:Naming.name> <cim:SubControlArea.HostControlArea rdf:resource="#CO-NEPOOLHCA-DV-EAST"/> <cim:PowerSystemResource.OperatedBy_Companies rdf:resource="#CO-NEPOOL"/> </cim:SubControlArea>

Classes used in CPSM, and not mandatory in CDPSM	DayType LimitSet LoadArea MeasurementType RegulationSchedule Season TapChanger Unit AreaLoadCurve Company ControlAreaOperator CurveSchedData Limit
Classes used in CDPSM, and not mandatory in CPSM	WireArrangement WireType EquivalentLoad PSRType Location GmlPosition ConductorType EquipmentContainer

Bibliography

IEC 61968-11, *System Interfaces for Distribution Management – Interface Reference Model* [6)]

IEC 61970-452, *EMS-API – Part 452: CIM Model Exchange Specification* [6)]

IEC 61970-552-4, *EMS-API – Part 552-4: CIM XML Model Exchange Format* [6)]

6) Under consideration.

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