1 Description of the Use Case

1.1 Name of Use Case

Use Case Identification		
ID	**Domain(s)**	**Name of Use Case**
	Transmission Electrical and Asset Model	Calculate and Maintain Ratings in the Substation

1.2 Version Management

Version Management						
Changes / Version	**Date**	**Name Author(s) or Committee**	**Domain Expert**	**Area of Expertise / Domain / Role**	**Title**	**Approval Status** *draft, for comments, for voting, final*
1	9/15/2020	WG-13	Chuck DuBose	Power System Engineer	Principal Engineer	draft for discussion

1.3 Scope and Objectives of Use Case

Scope and Objectives of Use Case	
Related business case	N/A
Scope	This case only covers the asset and electrical model for the buswork and equipment risers inside the substation.
Objective	Model sections of buswork in the electrical model. Model connections between buswork and equipment in the electrical model. Add asset and electrical model details to support ratings calculations. Describe steps to perform ratings calculations.

1.4 Narrative of Use Case

Narrative of Use Case

Short description *– max 3 sentences*

There is a need to calculate and maintain ratings for subsegments, conductors and bus work inside substations. These subsegments include sections of buswork between different connection points.
This includes rigid and flexible connections between the buswork sections and series devices such as switching devices, lines, transformers, and other substation equipment. This does not include connections to shunt devices such as potential devices or lightening arresters. The primary tasks to perform this use case is: 1) Add info to Calculate ratings in AMS, 2) Add Risers and Bus Segments into the Network Model; 3) Map the bus segments and risers to the wireinfo and rigidbus info of the CIM model; and, 4) Calculate the operational limits from the ratings data.

Complete description

Problem Description:
The calculations cannot be performed because the current CIM model does not support the ability to calculate and maintain ratings for subsegments conductors and bus work inside the substations. The issues for the model are as follows and these modelling issues must be corrected to complete this use case:

1. No way to model different types of rigid conductors for buswork.
2. No way to associate conductors to anything representing a bus.
3. No way to define sections of bus work between connections points of breaker strings.
4. Connections from breakers to bus need to be considered without adding more to the electrical network.

NERC is requiring audit trails for all ratings and electrical parameters. The raw values are derived from the physical values of the conductors and equipment. The Asset model is the source for all the physical devices in the CIM. The Asset model has a line model which included conductor specifications. But this only includes cylindrical stranded bare or insulated conductors. This does not include any of the extruded shapes found inside the substation fence. The dimensions of these conductors do not fit in the existing WireInfo model.

Currently the electrical model for the transmission and distribution provide a detailed model to support most all power flow needs. But it is missing the necessary artifacts to include the ratings for the very short conductors which connects devices to one another. These conductors are considered in the determination

of the thermal ratings of the devices they are attached to. These are lengths of conductor which are not considered in the power flow solution. They have very small impedances and should not be considered by power flow applications.

In addition, in the electrical model, log sections of buswork are modelled as a single point in the electrical model. In fact, these are sections of stranded wire or solid aluminium or copper conductor. This buswork may be several hundred feet long and built in stages as the substation evolves. The conductor may not be consistent for the entire length. Based on the configuration of the bus, flows may concentrate on different sections of bus more than others. With the “single point” bus model in CIM, there is nothing in the model specify subsections of buswork between connection points. For instance, in the case of a three-string breaker and a half scheme. Figure 1 is a diagram of such a scheme.

Model Solution to Achieve Use Case Problem:
To solve the above modelling problem, this use case includes a change to the Line Asset Info Model and the Auxiliary Equipment package as well as a change to support modelling the buswork as a series element. Each of these additions and modifications are described in the paragraphs below.

The modification to the Line Asset Info model includes a new class for the Rigid Bus Information. The rigid bus requires resistance attributes just as the wire conductors do. The rigid conductors have different dimensions than the wire conductors require. Instead of using the existing conductor dimension attributes, it will be better to create a new class, inheriting from the WireInfo class, to use for the rigid conductor. This new class is proposed to be titled RigidBusInfo. The RigidBusInfo class will need attributes to describe the type of rigid conductor and the dimensions. Proposed are two attributes to describe the dimensions of the rigid conductor. They are aDimension and bDimension. The dimension attributes are multi-use depending on the shape of the rigid conductor. Figure 2 is the UML of the proposed model

The rigidBusType specifies the cross-section shale of the rigid conductor. Figure 5 shows these types of bus conductor.

- Pipe Type - Cylindrical tube where the thickness and diameter are based around NPS Schedule types
- Tube - Cylindrical tube where the thickness and diameter are independently specified.
- Rectangular Bar - Flat solid bar of consistent thickness and width.
- Integral Web - I beam type of conductor with the outer edges. turned into each other.
- Angle - rigid conductor shaped in a L in the cross section.

The pipeType attribute is used to designate whether the dimensions are based on Schedule 40 or Schedule 80 APC specifications.

The aDimension is a multi use dimension based on the shape of the rigid conductor.

- Pipe Type - Outside diameter of the Cylindrical conductor
- Tube - Outside diameter of the Cylindrical conductor
- Rectangular Bar - Cross section thickness of the flat conductor
- Integral Web - Cross section height of the conductor
- Angle - Cross section height of the conductor

The bDimension is a multi use dimension based on the shape of the rigid conductor.

- Pipe Type - Cross section thickness of the wall of the Cylindrical conductor
- Tube - Cross section thickness of the wall of the Cylindrical conductor
- Rectangular Bar - Cross section width of the flat conductor
- Integral Web - Cross section width of the conductor
- Angle - Cross section width of the conductor

Creating a new class for the rigid conductor will require that the AC resistance and ratedCurrent attributes be inherited from WireInfo. For purposes of profiling, only the AC resistance and ratedCurrent attributes will be used from the inherited WireInfo. All other associations and attributes inherited from other classes will be used. Figure 2 is the UML of the proposed model.

The change to the AuxiliaryEquipment package includes the addition of a new Riser class which utilizes the existing associated to the Terminal. The new Riser associated with a terminal will reference the location of the riser conductor. The Riser inherits from PowerSystemResource which allows the WireAssetInfo package to be associated to the risers thus designating the parameters of the Conductor used. The Riser Inherits from Equipment which allows use of the OperationalLimits to store the actual limits user for the Riser. Figure 3 is the UML of the proposed model.

The change to support modelling buswork in more of a series element allows multiple connection points to be modelled. Using the concept of retaining a switch for network analysis processing, the new class should be able to be collapsed for network analysis or even retained to include in network analysis. Figure 1 displays this concept. The Use Case requires the designation of conductors for sections of bus between the connection points. These connection points may be for attaching other sections of buswork or tap points for switching equipment. A new class BusSegment is added which is inherited from the Conductor class. This makes the new class a ConductingEquipment which has Terminals. The BusSegment class will not have any impedance attribute and we be treated as a zero-impedance device. Since having many zero impedance series impedance elements in the model cause solution problems for the simultaneous equations of power flow, the BusSegment will have a retained flag as does the switch class. If the retained flag is set False, then the BusSegment can be collapsed to a single node by the network analysis. In the model, since the BusSegment is a ConductingEquipment, Operational Limits can be used for limits. Also,

ConductingEquipment inherits from PowerSystemResource which allows AssetInfo to be associated to define the Conductor used. Figure 3 is the UML of the proposed model.

1.5 General Remarks

General Remarks
N/A

2 Diagrams of Use Case

Diagram of Use Case
N/A

3 Technical Details

3.1 Actors: People, Systems, Applications, Databases, the Power System, and Other Stakeholders

Actors		
Grouping (Community)		**Group Description**
Actor Name *see Actor List*	**Actor Type** *see Actor List*	**Actor Description** *see Actor List*
Asset Management System (AMS)	Application/Engineer	Application used for entering data into Asset Management System. Engineer uses the application to enter data.
Network Applications	Software	Power flow, state estimator, contingency analysis, market system, Fault Analysis software.
Network Modelling	Application	Application used for entering data in the electrical model. Engineer uses the application to enter data.
Network Modeller	Engineer	The Engineer that uses the Network Modelling Application to support data entry.
Ratings Calculations	Application/Engineer	Software / Engineer calculating operational limits for lines and transformers using raw ratings data from the model and placing the results in the model.

3.2 References / Issues

References						
No.	**References Type**	**Reference**	**Status**	**Impact on Use Case**	**Originator / Organisation**	**Link**
1	IEC Standard 61970-452	Standard	CD	Basis for the additions proposed	TC57 WG13	None
2	CIM 100 UML			The CIM 100 UML provides the foundation of the conical model where the new model artifacts will be added.	TC57 WG13/WG14/ WG19	None

3.4 Further Information to the Use Case for Classification / Mapping

Classification Information
Relation to Other Use Cases
N/A
Level of Depth
N/A
Prioritisation
obligatory / mandatory
Generic, Regional or National Relation
NERC FAC8 requirements

View
Technical
Further Keywords for Classification
Limits, Ratings, Conductor, Bus,

4 Scenario: Calculate and Maintain Ratings in the Substation

Scenario						
Scenario Name:						
Step No.	*Event*	*Name of Process/ Activity*	*Description of Process/ Activity*	*Information Provider (Actor)*	*Information Consumer (Actor)*	*Information Exchanged*
1	Update Asset Management System with new ratings and wire information	Add info to Calculate ratings by adding data to the AMS	Add specific class WireInfo or RigidBusInfo and populate data into the AMS to describe the new instances of conductors.	Asset Management System	Ratings Calculation Engine	Conductor Characteristics
2	Update the Network Model by adding Risers for all conducting Equipment at their terminals	Add info to calculate ratings by adding data to the NMM	Add Risers to ConductingEquipment in Substations where necessary.	Network Modelling	Ratings Calculation	Placement of the Risers in the Electric Model
3	Update the Network Model by adding BusSegments for all segments where ratings are required.	Add info to calculate ratings by adding data to the NMM	Add BusSegments to Substations where necessary. BusSegments should be added for all sections of bus between connection points where ratings must be managed.	Network Modelling	Ratings Calculation	Placement of the BusSegments in the Electric Model and Ratings Calculation
4	Update the Network Model by setting the retained status on necessary BusSegments	Add info to be used in the Network applications by adding data to the NMM	For those BusSegments needed for analysis in Network applications, set the BusSegment.retain flag to True.	Network Modelling	Network Applications	Which BusSegments will be used in the Network Applications for computations
5	Update Asset Management System with setting association from the Asset Infor to the PowerSystemResource in the AMS	Add info to Calculate ratings by adding data to the AMS	Map WireInfo or RigidBusInfo Assets to Riser using association to PowerSystemResource of Riser or BusSegment.	Asset Modeling	Ratings Calculations	Connections of the source data in the Asset model to the placement of the equipment in the Electric Model.
6	Export Network model including Risers and BusSegments from NMM and import into Ratings Calculations	Export information from NMM to calculate ratings and import into Ratings Calculations	Export the entire Network model and import into Ratings Calculation.	Network Modeling	Ratings Calculation	Riser List and location of Riser along with BusSegments in the Electric Model
7	Export WireInfo or RigidBusInfo mapped to Risers and BusSegments from NMM and import into Ratings Calculations	Export information from AMS to calculate ratings and import into Ratings Calculations	Export the WireInfo or RigidBusInfo, including mapping to the PowerSystemResource from the Asset Info, into Ratings Calculation.	Asset Modeling	Ratings Calculation	Electrical parameters needed for ratings calculations
10	Run Calculations to produce Operational	Execute calculations in	Execute calculations to use Asset data mapped	Internal	Internal	None

	Limits for Conducting Equipment	Ratings Calculations application	to Risers and BusSegments to produce the Operational limits for the Conducting Equipment.			
11	Export OperationalLimits from Ratings Calculations and import into NMM	Export information from the Rating Calculations Engine to be used in the NMM	Post the Calculated Limits from the Ratings Calculator to the Operational Limits and export so they may be imported into the NMM.	Ratings Calculation	Network Modeling	Operational Limits

5 Information Exchanged

Information Exchanged	
Name of Information Exchanged	***Description of Information Exchanged***
Riser	Location of the conductor connecting conducting equipment to a connectivity node. This is associated to the AssetInfo class describing the specific conductor type.
BusSegment	The conductor between connection points to substation conducting equipment on a substation bus. This is associated to the AssetInfo class describing the specific conductor type.
RigidBusInfo	Asset model for rigid bus conductors. It defines the type and dimensions of specific conductors.
OperationalRatings	Limit data for conducting equipment in the Electrical Model.

6 Common Terms and Definitions

Common Terms and Definitions	
Term	**Definition**
Bus	A length of conductor in a substation providing connection points where Transformers and lines are attached. Due to the size of the equipment connected these buses may be hundreds of feet long.
Riser	A length of conductor which connects a switching device, line, transformer or a section of bus to each other. A riser may be 5 – 50 feet long.
Rigid Conductor	Aluminium or copper shaped conductor made of solid material. Conductor may be tubular, angle, rectangular bar or Integral/I-beam. Examples of these are shown below in Figure 5.
Flexible Conductor	Aluminium or copper conductor made of stranded conductors.
Electric Model	Arrangement of equipment along with their electrical parameters necessary for use by the Network Applications.
AMS	Asset Management System
NMM	Network Model Manager

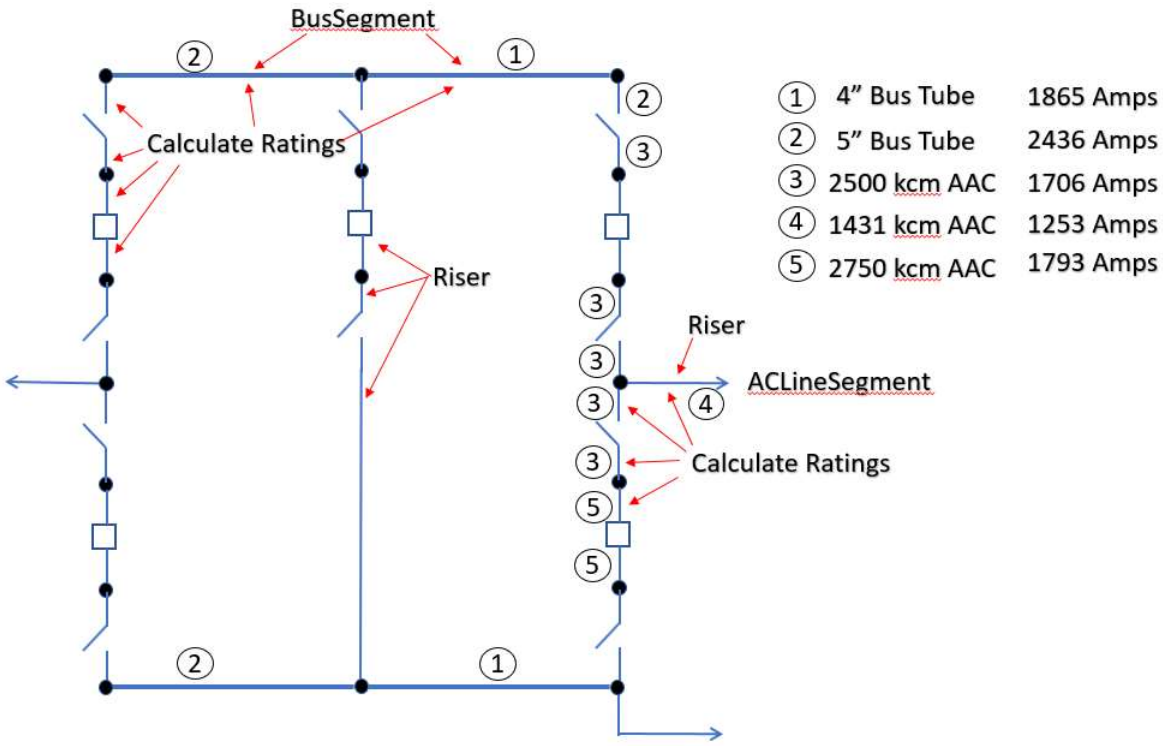


Figure 1 – Three String Breaker and a Half Scheme

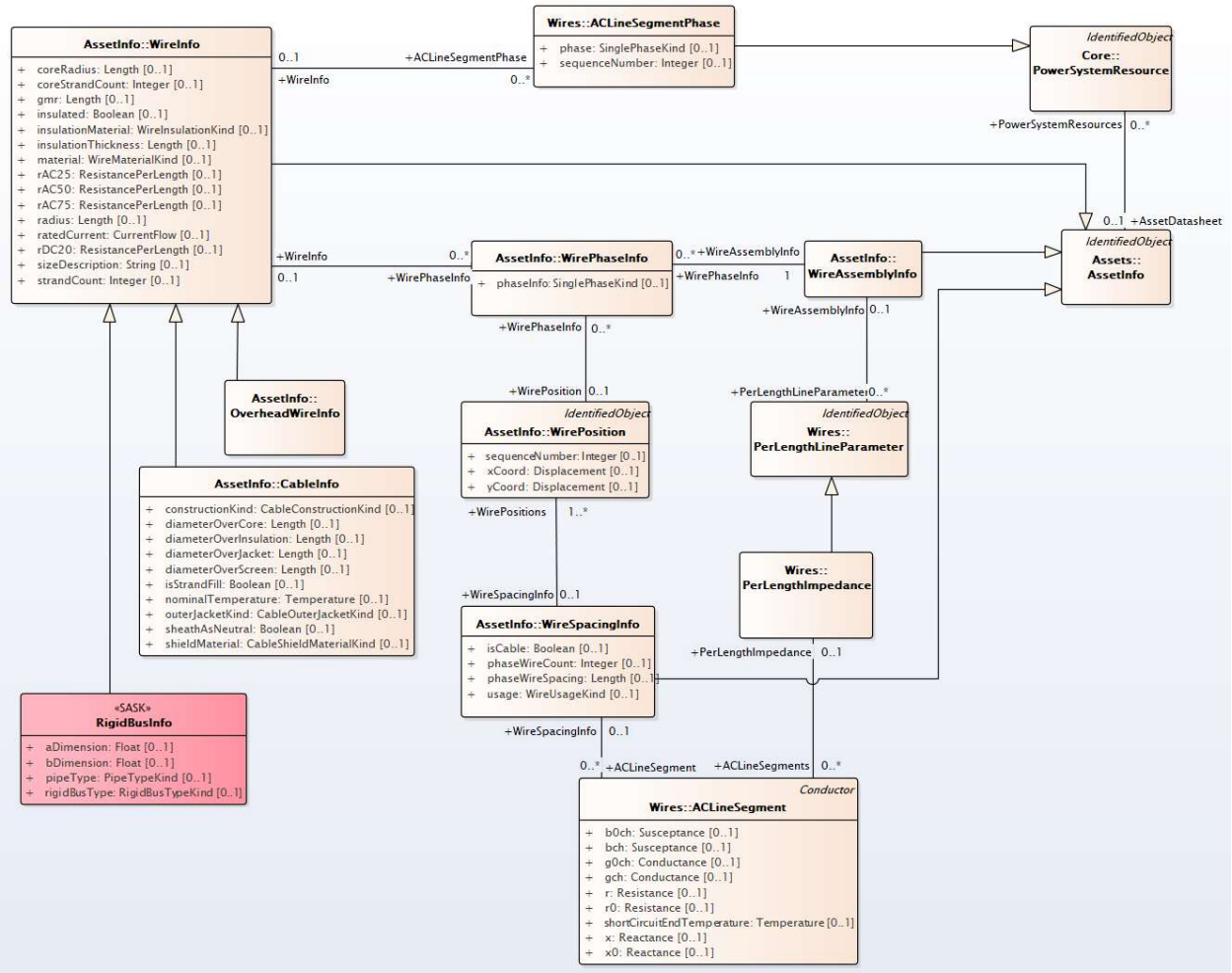


Figure 2 – Wires Asset Info

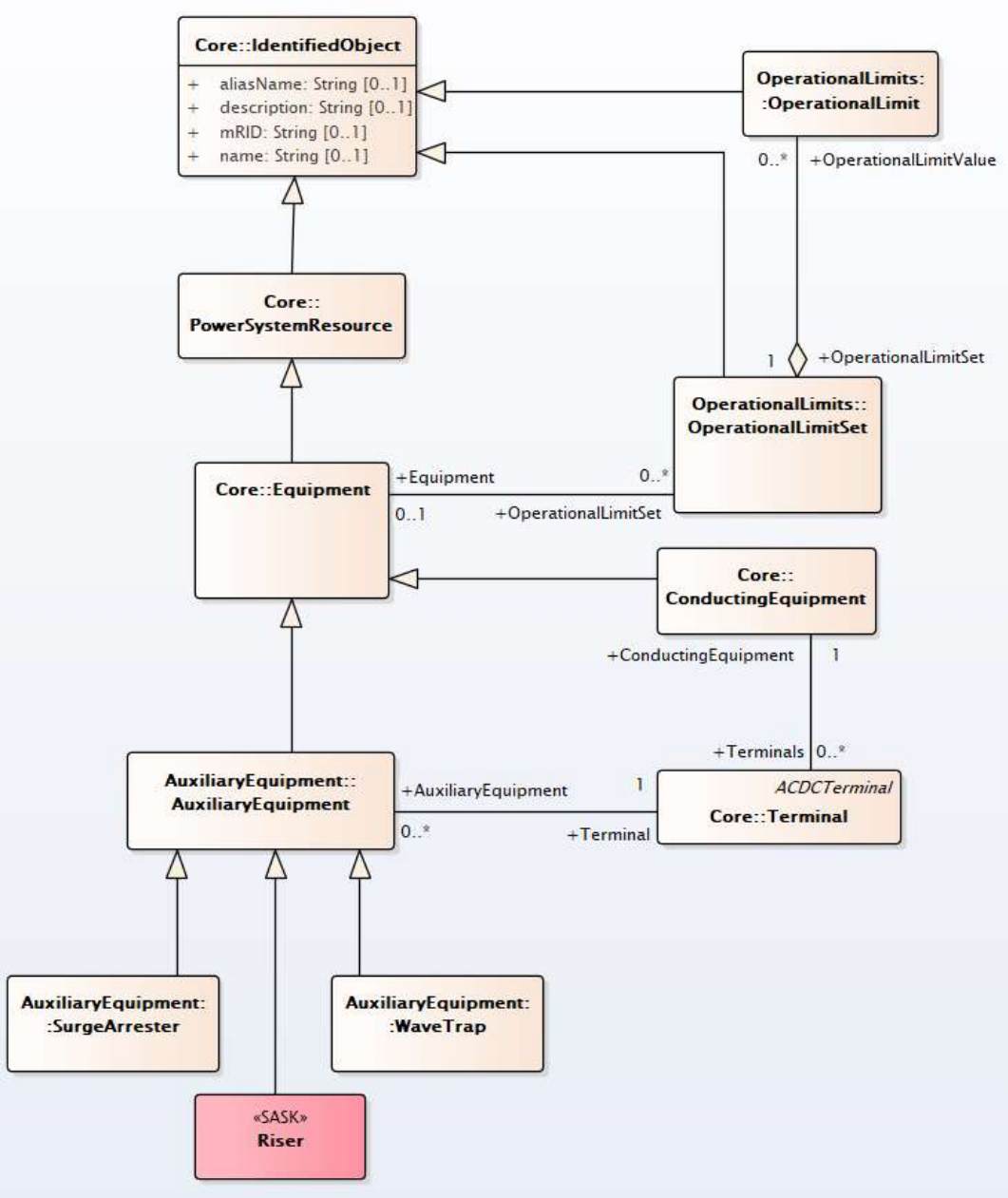


Figure 3 – Riser

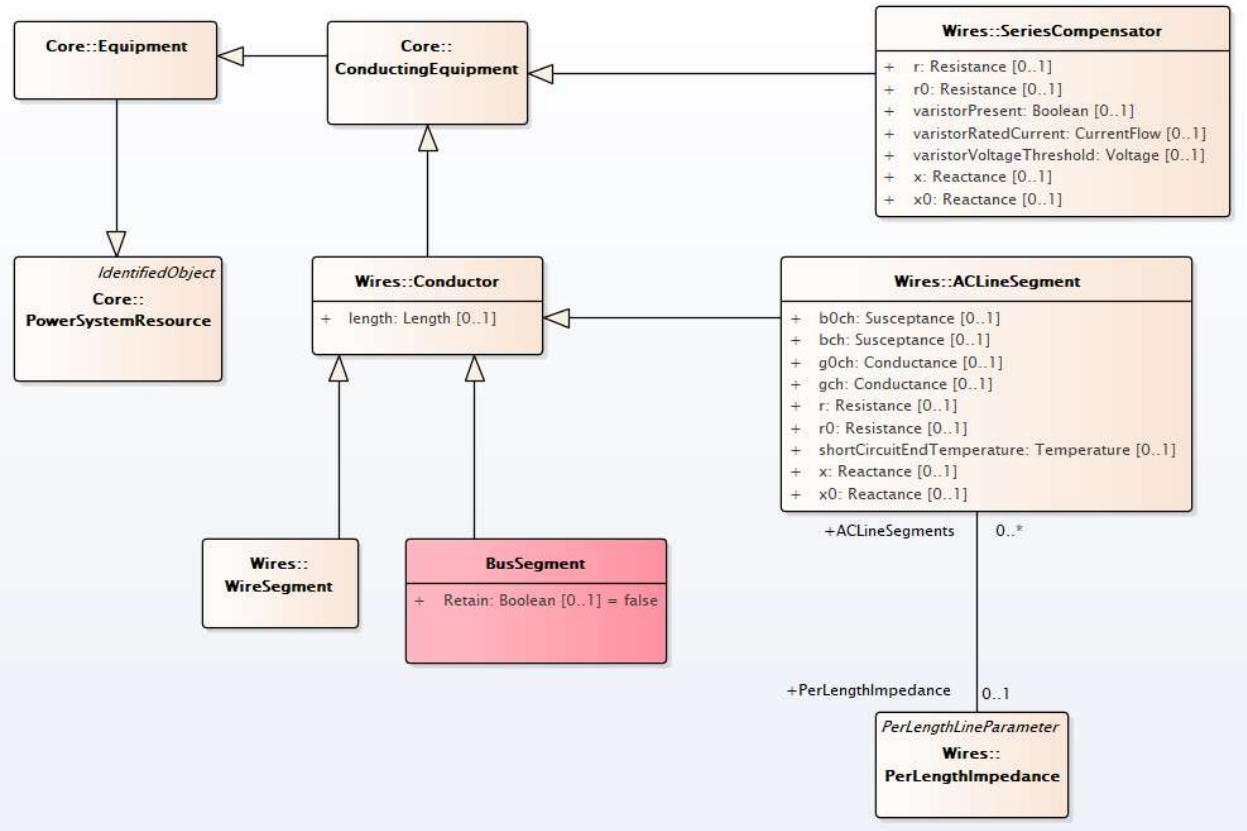
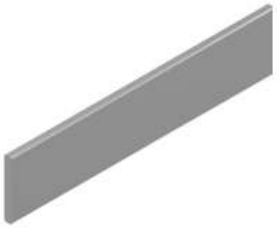


Figure 4 – BusSegment

Pipe or Tube



Rectangular Bar

Integral Web

Angle

Figure 5 – Types of Rigid Conductor

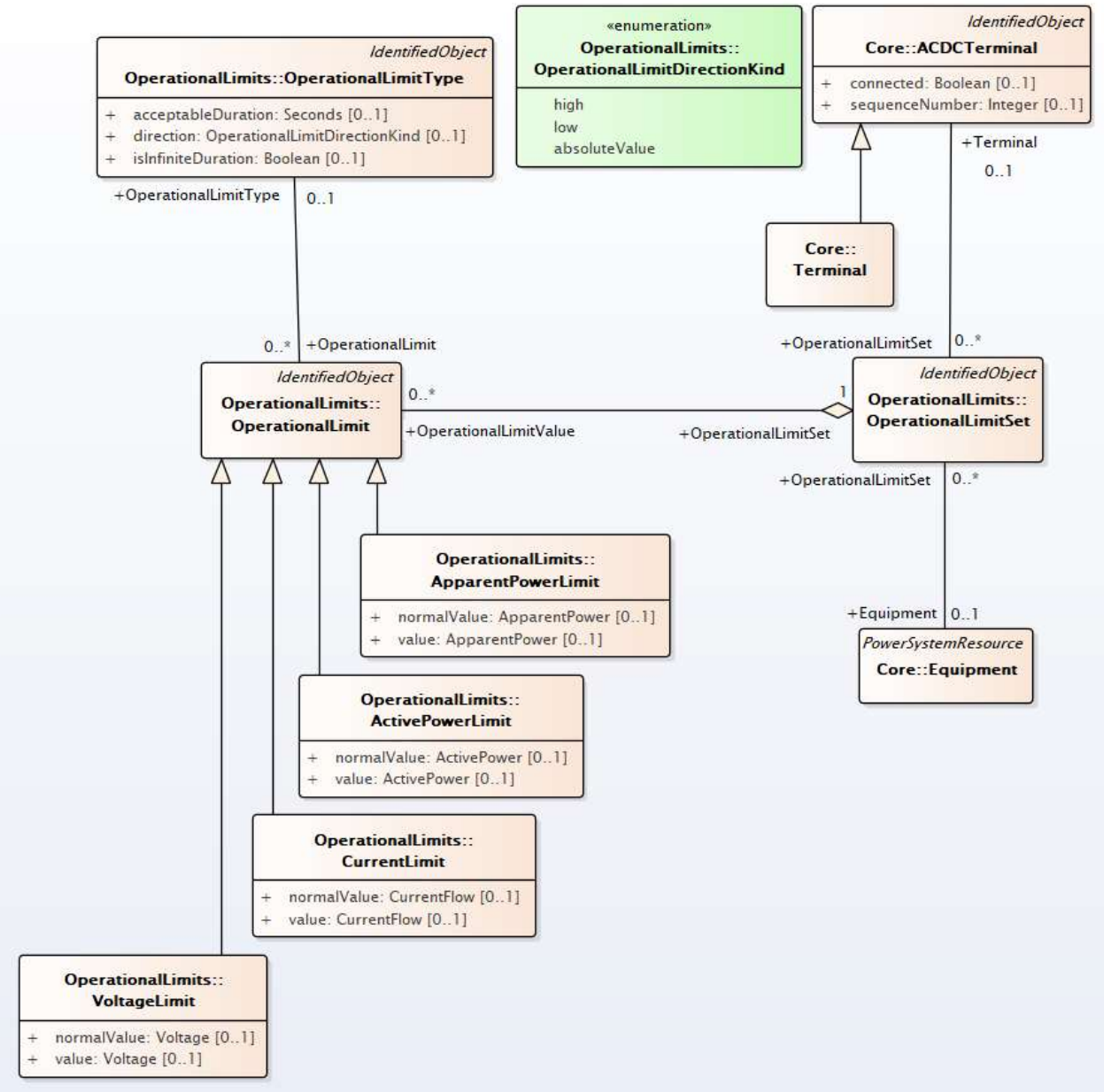


Figure 6 – Operational Limits associates to Equipment

Rigid Bus Conductor

Flexible Bus Conductor

Flexible Riser