NMMS:

ERCOT Modeling Guidelines

Version 0.06

Document Revisions			
Date	Version	Description	Author(s)
1/13/09	0.01	Initial draft	Terry Nielsen
1/29/09	0.02	Updated rules, edited to support for draft release to NDWSG.	Terry Nielsen
2/17/09	0.03	Updated with section changes based upon NDSWG input and NMMS team input. Also updated to add draft completed section for switch.	Terry Nielsen, Keith Smith
4/9/09	0.04	Updated with sections for: SVC Substations Breakers Disconnectors Shunt Compensators Series Compensators Lines and ACLinesegements SCADA and ICCP data Transformers Modeling Objects	Terry Nielsen Including sections from ERCOT NMMS Team
4/16/09	0.05	Incorporate comments from internal review by MMS and EMS team.	Terry Nielsen Including updates from ERCOT NMMS Team
5/6/2009	0.06	Updates to loads, substations section. Incorporating comments from Market participants.	Kalidindi Raju Joel Koepke Nitika Mago Mario De La Garza Kimberly Boatright Kashia Thuerwaechter Neelima Bezwada Vamsi Madam Keith Smith Rochie Guiyab

Table of Contents

FIGURES

1 OVERVIEW

This document provides guidelines for the creation of Network Model changes that are to be submitted to ERCOT. The Network Model changes may be either created using the Information Model Management (IMM) editor component of the Network Model Management System (NMMS) or by submitting a file that is in Common Information Model (CIM) XML format.

1.1 DOCUMENT ORGANIZATION

The document explains how to use the attributes, associations and classes defined in the ERCOT data dictionary. The classes are organized into two sections. Classes that can be modified by TDSP's and classes that can be modeled by ERCOT only. Also there are appendices showing the validation rules and the list of classes that are not allowed.

1.1.1 Major Sections

The document is broken down into major sections that map to a single CIM package or a subsection of a package. This breaks down the document into logical subsections that cover areas such as generation, loads, etc.

The major sections are divided into two groups, those that are anticipated to be submitted by TSPs and those that are maintained by ERCOT, but would appear in any ERCOT model files.

Introductory sections describing how to perform general modeling tasks are covered first before the detailed modeling approach subsections.

1.1.2 Modeling Approach Subsection

These are documented, either class by class or as logical group in subsections titled "Modeling approach for <X>". The modeling approach section will describe the approach a user should take for modeling this object type. It covers what associations and attributes are needed and how they should be defined. For more complex modeling concepts, it may include flowcharts or other diagrams necessary to explain the modeling approach.

1.1.3 Attribute

All the attributes for each of the classes are listed in the Attributes subsection with the required attributes in Bold.

1.1.4 Linkage

Linkage subsection lists all the required associations or links from the class that is being described, to other classes.

1.1.5 Appendix A - Validation Rules for Required Fields

Appendix A lists all of the validation rules for attributes that must be defined for a specific class. It also lists any validation for attributes that must be within a specific value range.

1.1.6 Appendix B - Validation Rules for Required Associations

Appendix B lists all of the validation rules for associations (links) that must be defined for a specific class.

1.1.7 Appendix C – Complex Validation Rules

Appendix C lists all the validation rules that beyond the required attributes and links and could apply to more than one class at a time. It also list all the validation rules that are more complex than required fields and range checks. These include validation rules that are conditional based upon certain conditions, involve associations with other attributes, and those that describe specific data relationships. The validation rule is explained descriptively and not in a formal language.

1.1.8 Appendix D - Classes Not Allowed Subsection

If a particular CIM class is not used in the ERCOT systems and would potentially break the ERCOT model, the class will be listed in the subsection titled "Classes Not Allowed". The complete lists of classes that are not used are listed in Appendix D.

The appendix of this document contains the complete listing of validation rules that run against each NMMS NOMCR submission. If any of these rules do not pass, the NOMCR will not be allowed to be submitted and the user must make the necessary corrections. These rules document any minimally required attributes, valid data ranges. The validation also ensures that the submission meets the cardinality defined in the latest ERCOT data dictionary.

1.1.9 Automatic Validation Performed by NMMS Based Upon Data Dictionary

The list of validation rules does not include the validation that is automatically performed by NMMS for links between objects. These links are validated based upon the data dictionary definition of the cardinality between the associated objects. There are two cardinality definitions that are validated, the first is the CardinalityRoleA and the second CardinalityRoleB. CardinalityRoleA defines the number of objects of the first Class that may exist related to the second Class.

For instance, in the data dictionary, the link between ThermalGeneratingUnit to CombinedCyclePlant CardinalityRoleA has a value of "0..n". This means that there may be anything between 0 and n ThermalGeneratingUnits associated with a CombinedCyclePlant. The same association has a CardinalityRoleB of "0..1" which means that there may be between 0 and 1 CombinedCyclePlants associated with a ThermalGeneratingUnit.

This validation performed by NMMS follows the inheritance tree and the same validation is done for all objects that inherit from the object which has the cardinality definition.

For instance, in the data dictionary, a GeneratingUnit has a link to a ResourceNode that has a CardinalityRoleA defined as 1..n. This means that validation would be performed checking that there are one or more GeneratingUnits associated with a ResourceNode. It also means that validation would be performed for HydroGeneratingUnit, ThermalGeneratingUnit, WindGeneratingUnit and NuclearGeneratingUnit because these classes inherit from GeneratingUnit. Note: that the cardinality is not defined explicitly for each inherited class.

1.1.10 Further Clarification on Interpreting Data Dictionary and How Data is used in NMMS IMM

The rules used when dealing with associations/links may help with understanding these relationships. In general, the direction is defined in the data dictionary by the A and B (e.g. Class A and Class B, A --> B). The key, however, is that while the IMM UI uses the direction of the link to determine which side to display the links, the CIM/RDF export standard uses the cardinality to determine which side to export links.

Sample association definition:

Class A	Cardinality A	Class B	Cardinality B	NMMS Label
GeneratingUnit	0..1	DCTie	1..1	PartOfDCTie

The NMMS IMM UI displays links in the direction A --> B.

By default the IMM UI instance editor will show links to instances of Class B on the Class A side. This means you will see links in the direction of A --> B. In the definition above, the IMM UI will show the link to DCTie on the "link tab" of the GeneratingUnit. If the user wishes to see the links in the opposite direction, they can do so by pressing the [Options] button and choosing the appropriate setting.

The NMMS RDF Export lists the links to the Class having lower cardinality under the Class having higher cardinality.

The CIM/RDF standard recommends that the side with the lower cardinality be exported under the side having higher cardinality. In case the cardinalities are equal, NMMS is implemented so that it export the links to Class B under the Class A instance.

This explains why the user sees an inconsistency between IMM UI and RDF export with the GeneratingUnit to DCTie relationship. IMM UI shows the links to DCTie (Class B) under the GeneratingUnit (Class A). However, RDF Export lists the links pointing to GeneratingUnit (cardinality 0-1) under the DCTie (cardinality 1-1).

The cardinality order is shown in the following table:

Cardinality Order (Least to Greatest)
0..1
1..1
0..n
1..n

Below is another example:

Class A	Cardinality A	Class B	Cardinality B	NMMS Label

ConductingEquipment	0..n	BaseVoltage	0..1	BaseVoltage
SynchronousMachine	0..1	GeneratingUnit	0..1	GeneratingUnit
Reservoir	0..1	HydroPowerPlant	0..n	Provides Water To(HydroPowerPlants)

The links to **BaseVoltage** (lower cardinality) will be exported under **ConductingEquipment** (higher cardinality). Likewise, IMM UI will list the links to **BaseVoltage** (Class B) under the **ConductingEquipment** (Class A).

The links to **GeneratingUnit** (cardinality 0..1) will be exported under the **SynchronousMachine** (cardinality 0..1). Likewise, IMM UI will list the links to **GeneratingUnit** (Class B) under the **SynchronousMachine** (Class A). The links to **Reservoir** (lower cardinality) will be exported under **HydroPowerPlant** (higher cardinality). However, IMM UI will list the links to **HydroPowerPlant** (Class B) under the **Reservoir** (Class A).

1.1.11 Relevant reference documents:

- ERCOT Data Dictionary.
- ERCOT Processes and Procedures.
- ERCOT Training documents.

2 PROJECT TRACKER AND COORDINATOR

The Project Tracker and Coordinator (PTC) is the single entry point for Operations Model changes. Modeling data and change requests are initially received in the PTC, where each submission is tracked through any corrections, resubmission, validation, testing and review.

Upon login to the PTC, the user will see that Project Summary screen shown below in Figure 1. The Project Summary screen is the base display for the PTC and provides the user the ability to view, edit, and create both change requests and projects.

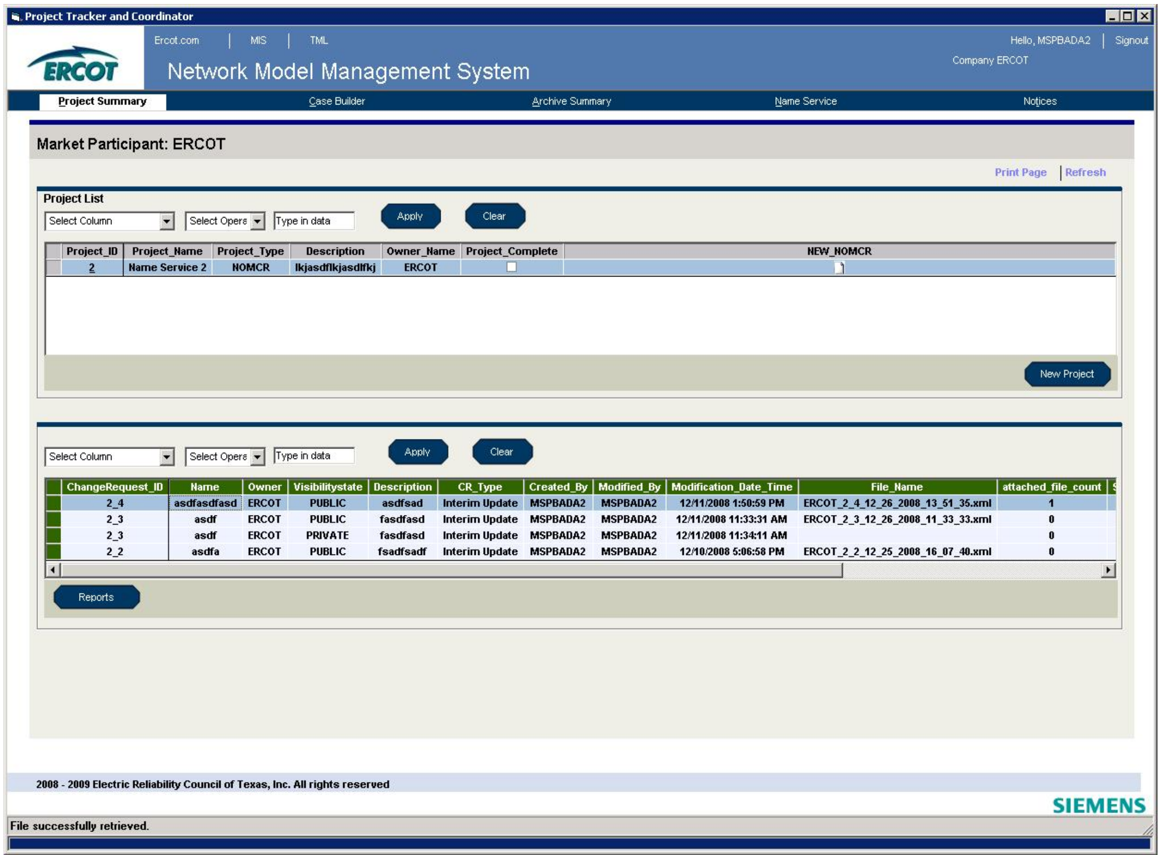


Figure 1 - Project Summary Display

2.1 PTC PROJECT

A PTC project is a container that is used to group similar change requests. It is a requirement that every change request belong to a project, even if it is the only change request in the project. To create a new project the user will click the New Project button on the Project Summary Display screen. The Create New Project screen shown below in Figure 2 will appear. The user must designate the project as a NOMCR (Network Operations Model Change Request) project or a SAMR (Special Action Model Request) project. Required fields are marked with an asterisk. For modeling purposes, we will only cover a NOMCR project. After the required fields are populated, the project can be saved.

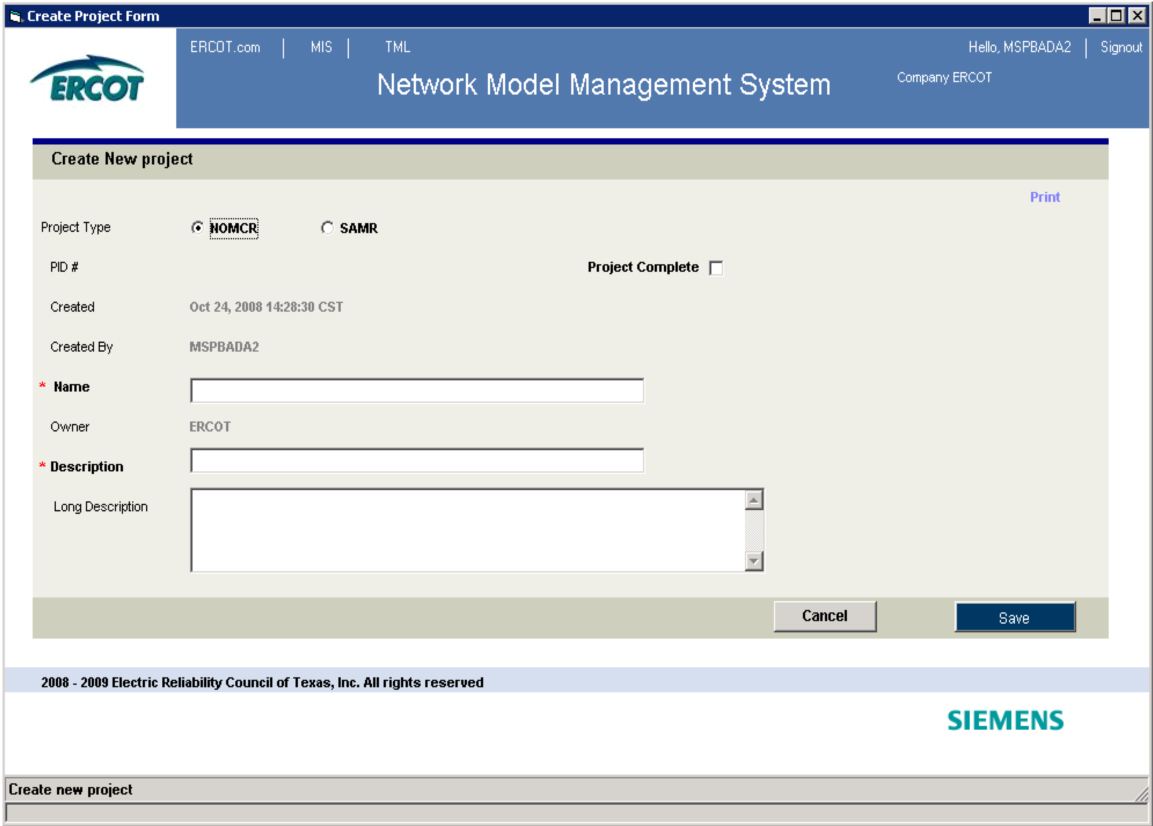


Figure 2 - Create New Project Display

Once a project is created, the Edit Project screen can be opened by clicking on the Project ID on the Project Summary Screen. The Edit Project screen is shown below in Figure 3. Here the user can make changes to the project, create a new change request, or edit an existing change request.

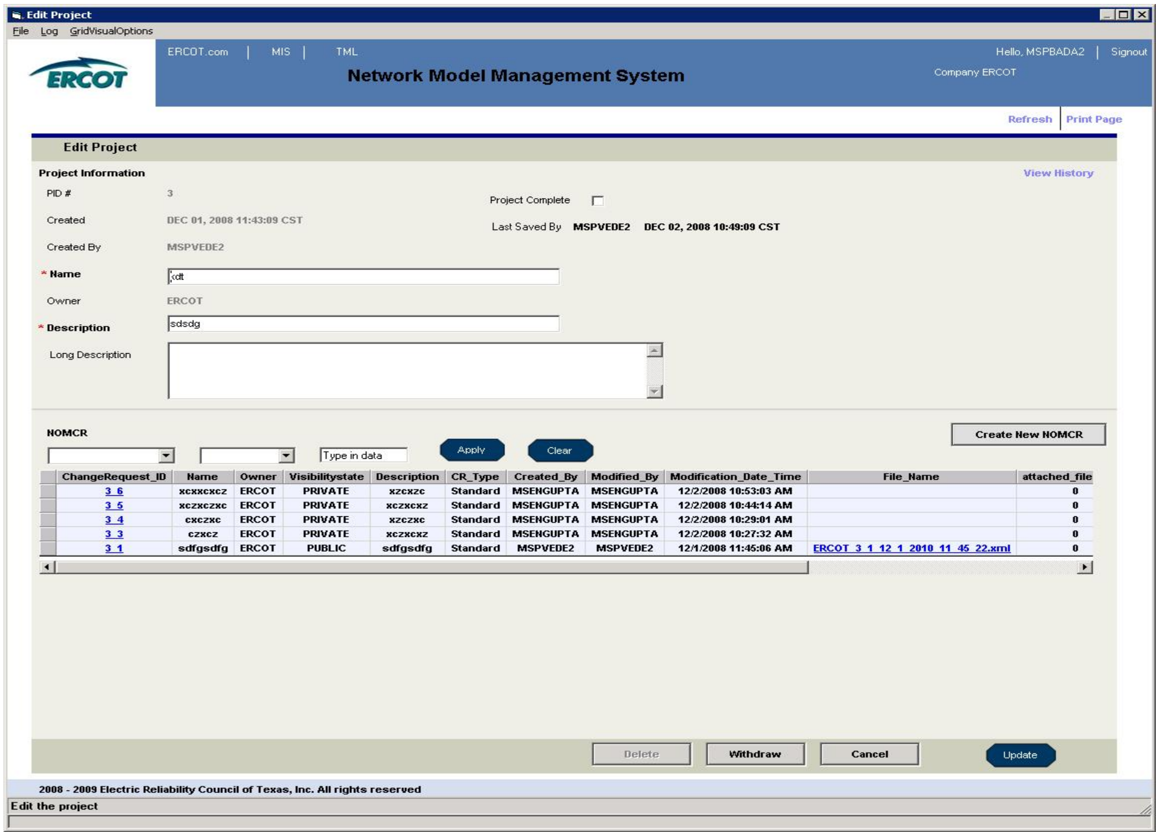


Figure 3 - Edit Project Display

2.2 NETWORK OPERATIONS MODEL CHANGE REQUEST

Transmission Service Providers (TSPs) will submit all types of modeling changes using a Network Operations Model Change Request (NOMCR). These changes include topological changes, limit/rating changes, telemetry mapping, and telemetry definitions. The NOMCR process is defined in the Nodal Protocols and outlines submission deadlines, formats, and procedures.

A new NOMCR can be created from the Project Summary Screen, the Create New Project Screen, or the Edit Project Screen. Once a NOMCR is created, the Edit NOMCR screen shown in Figure 4 will appear. All NOMCR information can be added/edited from this screen.

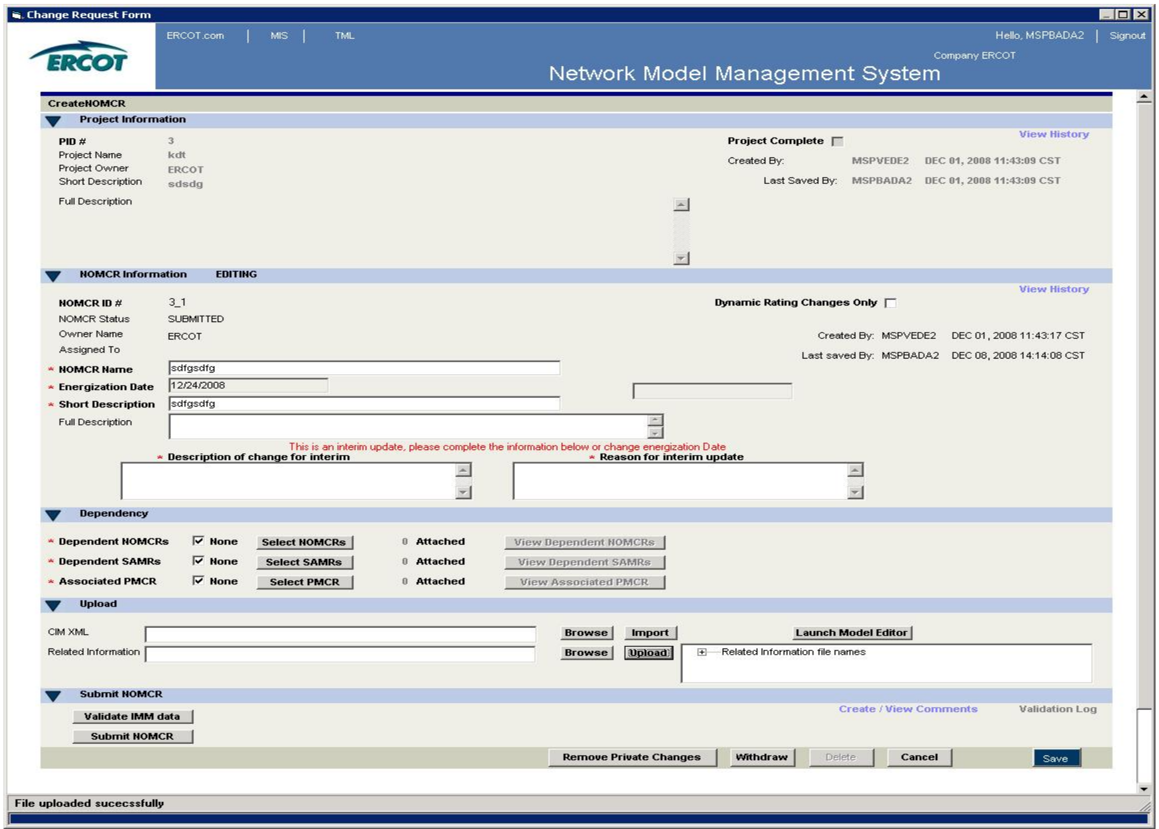


Figure 4 - Edit NOMCR Display

Once data is entered into the required fields in the Edit NOMCR screen, the user can make changes to the model. The most common method for making changes to the model is by clicking the Launch Model Editor button on the Edit NOMCR screen, which will open the Information Model Manager (IMM). Once model changes have been made in the IMM, the NOMCR must be validated and submitted for the model changes to be applied to the Network Operations Model. Validation is performed by clicking the Validate IMM Data button. If the model changes pass validation, the NOMCR can be submitted by clicking the Submit NOMCR. If the model changes fail validation, an error message will appear in the bottom left corner of the screen on the status bar. The validation errors can be viewed by clicking on the Validation Log button. These errors must be corrected before the NOMCR can be submitted.

Another option for making changes to the model is importing a CIM XML file. This can be done by clicking the Browse button next to the CIM XML data field in the Upload section of the Edit NOMCR screen. Once a CIM XML file is selected, the file is imported by clicking the Import button next to the Browse button. After the file is imported successfully, the NOMCR can be validated and submitted.

3 INFORMATION MODEL MANAGER

The Information Model Manager (IMM) is the user interface used to add and modify data in the Network Operations Model database. The IMM can be accessed by clicking the "Launch Model Editor" button on the Edit NOMCR screen seen in Figure 4. The IMM, as shown below in Figure 5 will appear.

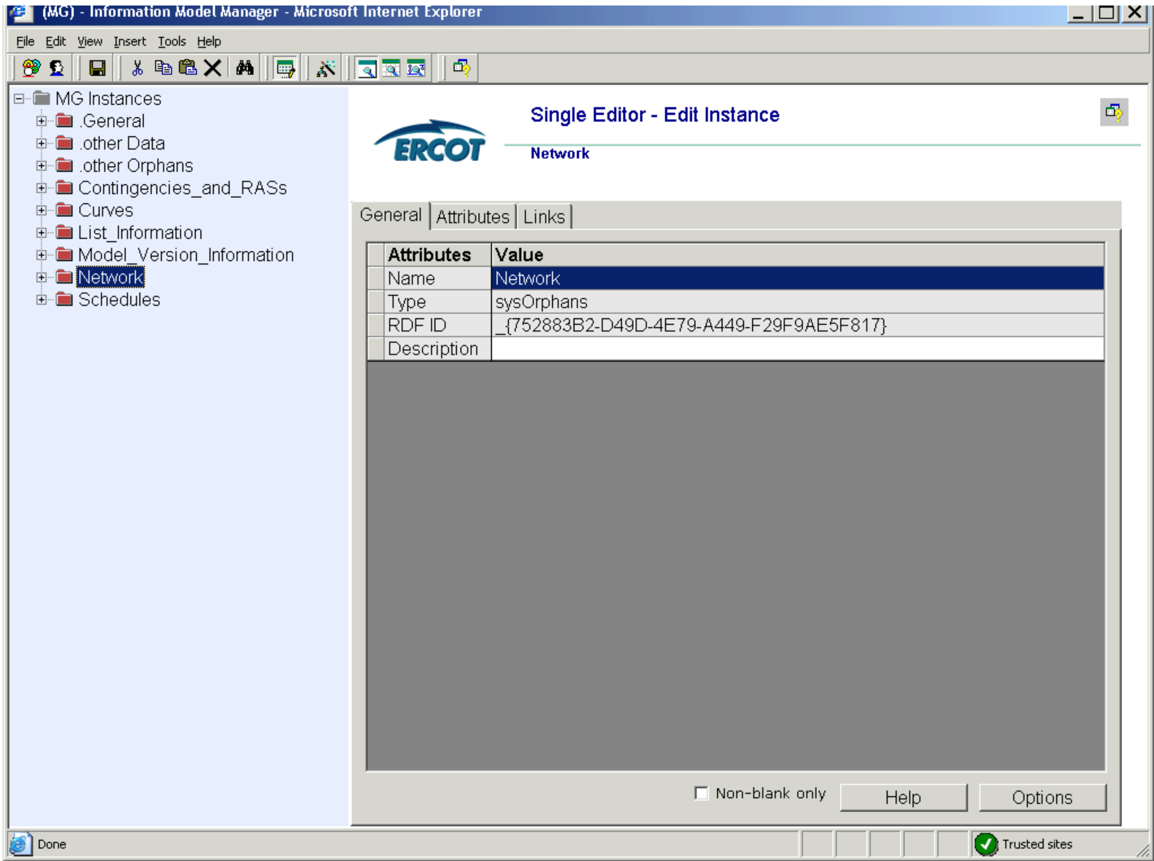


Figure 5 - IMM Main Screen

Market Participants will be responsible for maintaining only a small number of the instances that are seen in the IMM. A majority of these instances will be in the IMM under the path Network/Ercot Texas Network. Figure 6 shows the IMM model expanded to show the full ERCOT Texas Network. The ERCOT Texas Network includes substations, AC lines, and series compensators, all of which will be modeled by the Market Participants.

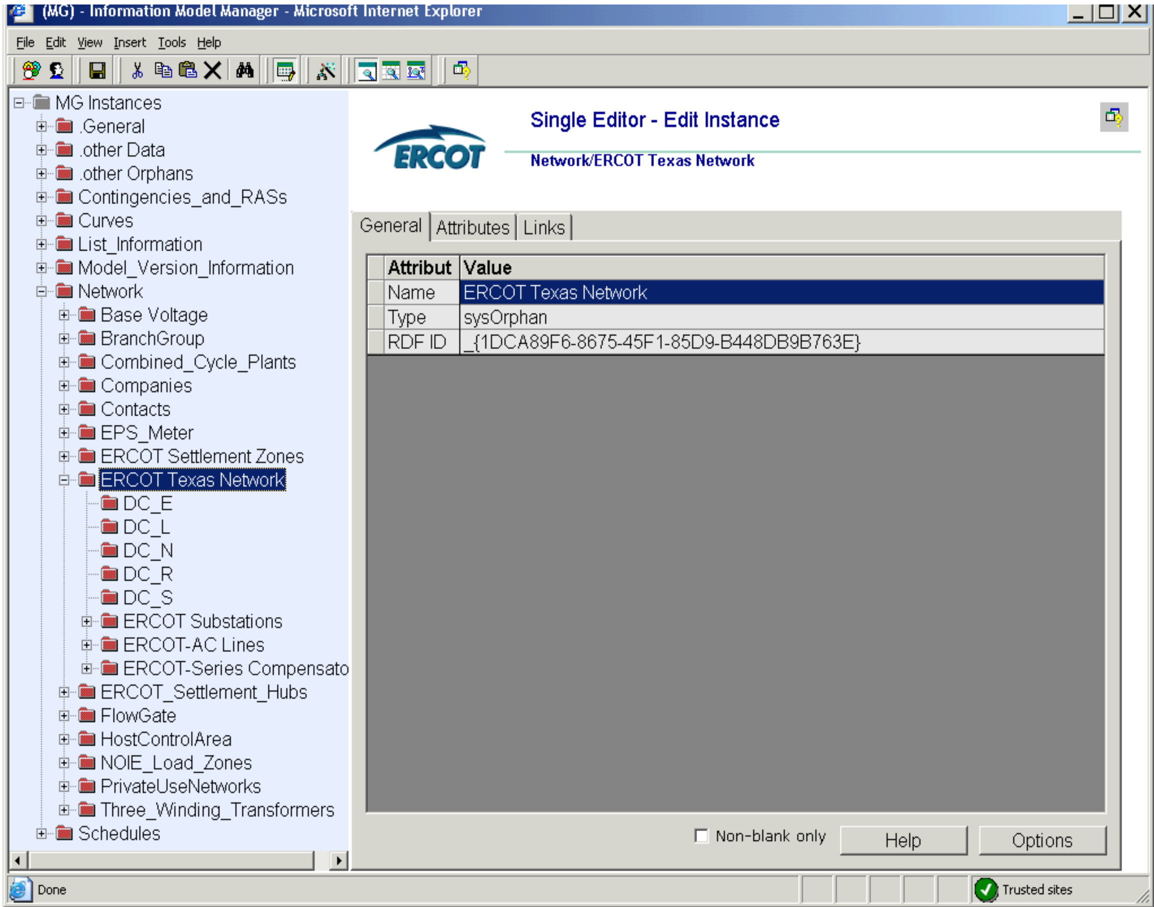


Figure 6 - ERCOT Texas Network

This section will cover the process of making model changes in the IMM by creating and editing a generic device. For simplicity purposes we will use a substation as an example at this time. The modeling of more complex scenarios and devices will be covered later in the document.

3.1 CREATE NEW INSTANCE

In order to find where in the model hierarchy a device is modeled it is best to look at the section on Substations. Here we see that a *Substation* is modeled under a WeatherZone. To create a new substation right-click on weather zone and select New, as seen below in Figure 7.

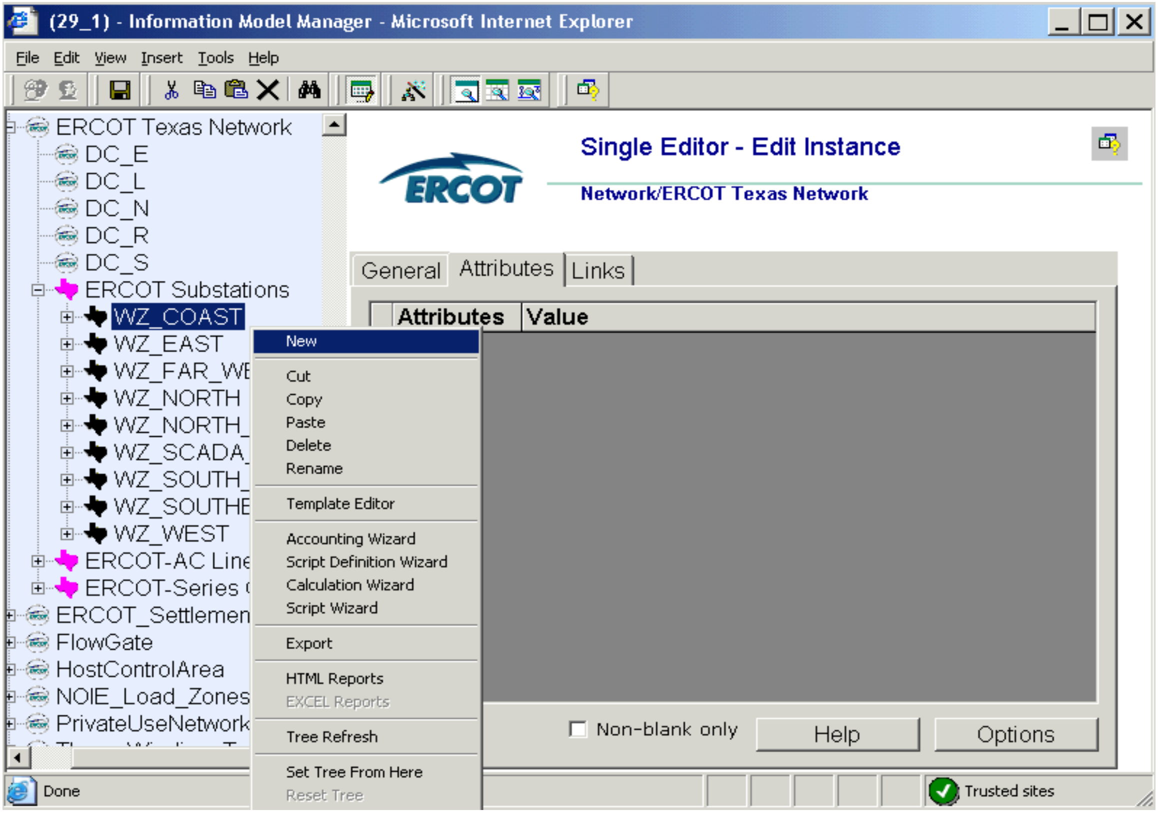


Figure 7 - Create New Instance

The screen seen in Figure 8 will appear in the IMM prompting the user to select an instance type. Select substation and click the Create Instance button.

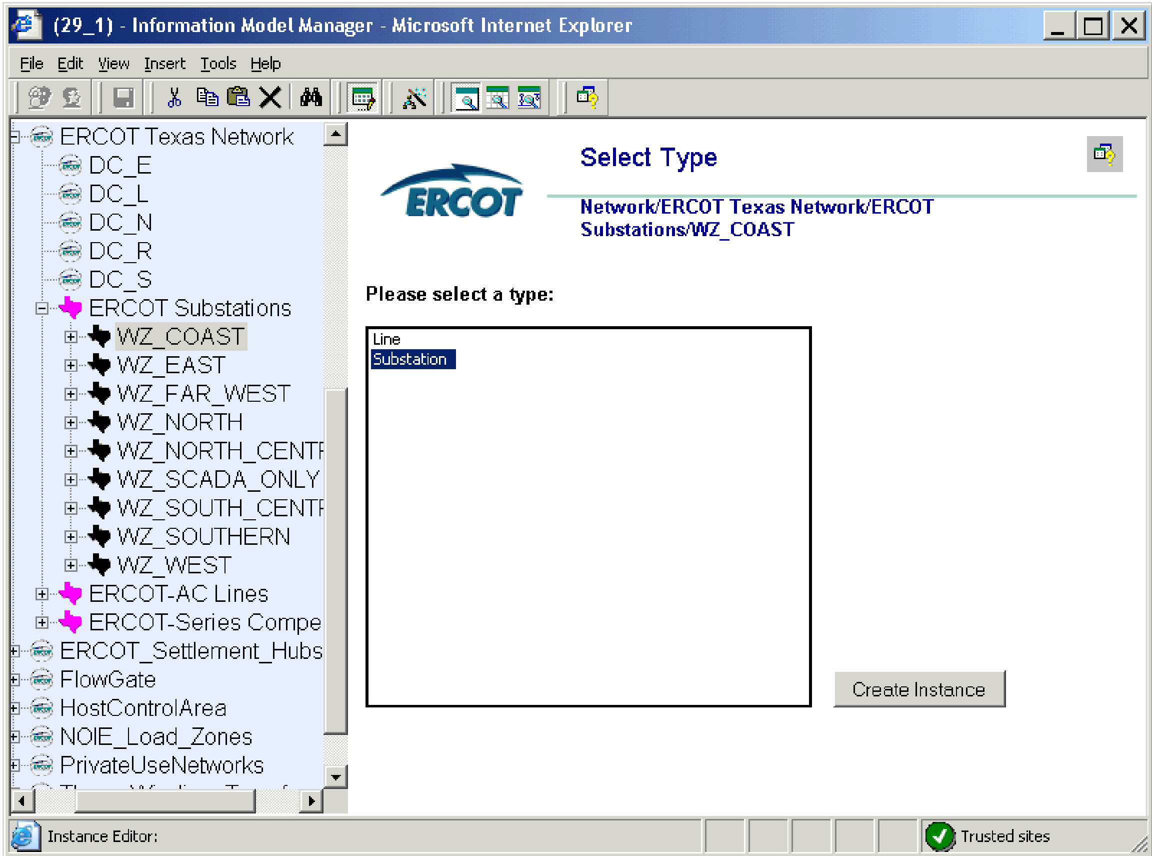


Figure 8 - Create New Substation

Once the substation is created the General Edit Instance screen shown below in Figure 9 will appear. A name must be entered for the instance before the instance can be saved in the model. Upon saving the new instance, the substation will appear in the model hierarchy.

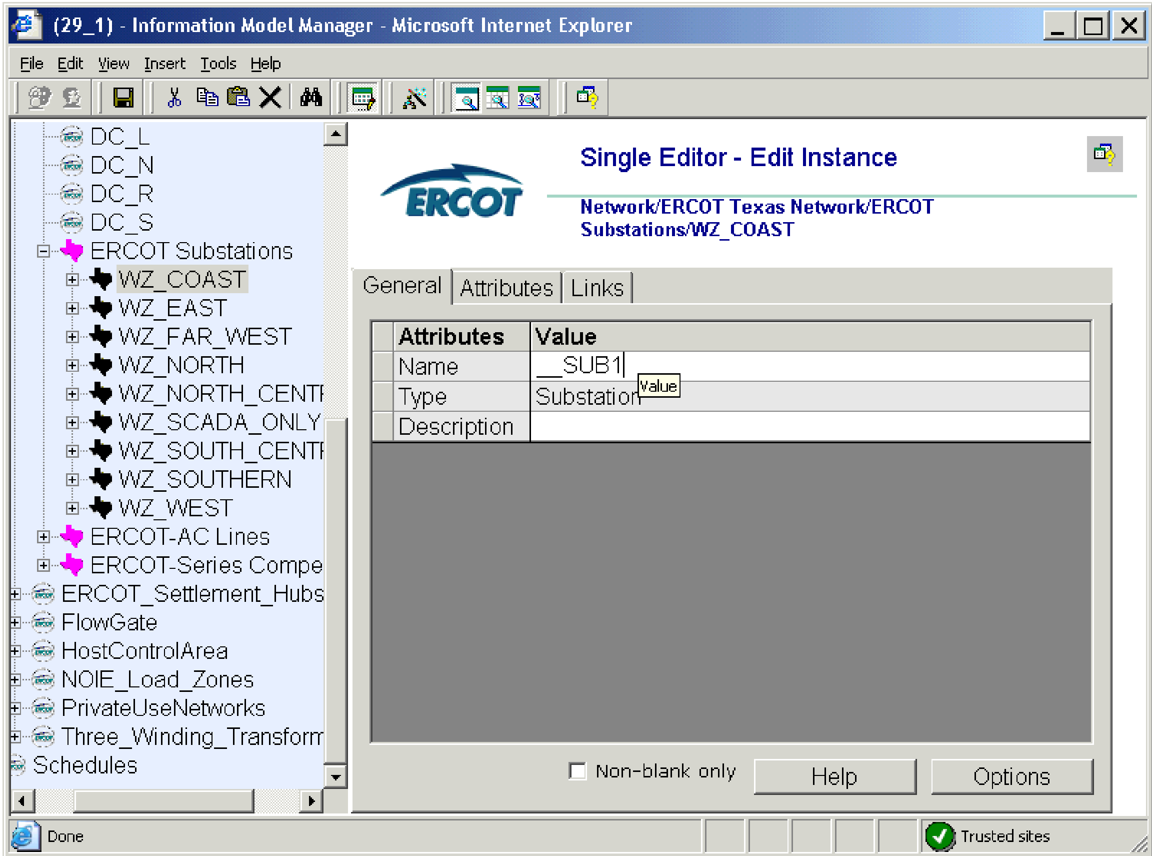


Figure 9 - General Edit Instance Screen

The updated model hierarchy with new substation __SUB1 is shown below in Figure 10.

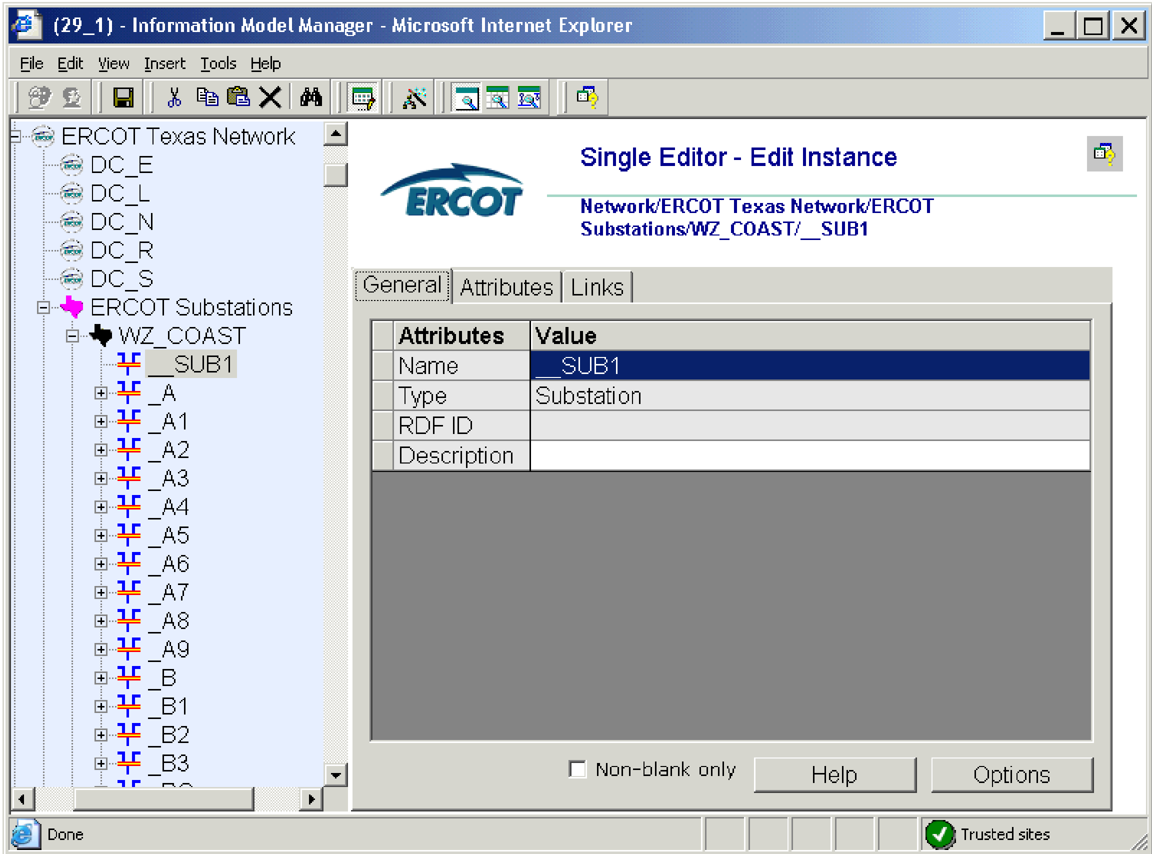


Figure 10 - __SUB1 in Model Hierarchy

3.2 ADD ATTRIBUTES

Once the substation has been created and saved, attributes for the substation must be entered into the required attribute fields. Required attributes for each device can be found in a table in the device section. Looking at the section on Substations, it is found that the required attributes for a substation are forNetwork and forScada. These fields must be populated for the model changes to pass IMM validation.

Many of the attribute fields are auto-populated by the IMM. Figure 11 shows the attributes screen for a newly created substation. The auto-populated fields are populated in this figure. The IMM will prevent data that is not of the correct data type or size from being saved in the model.

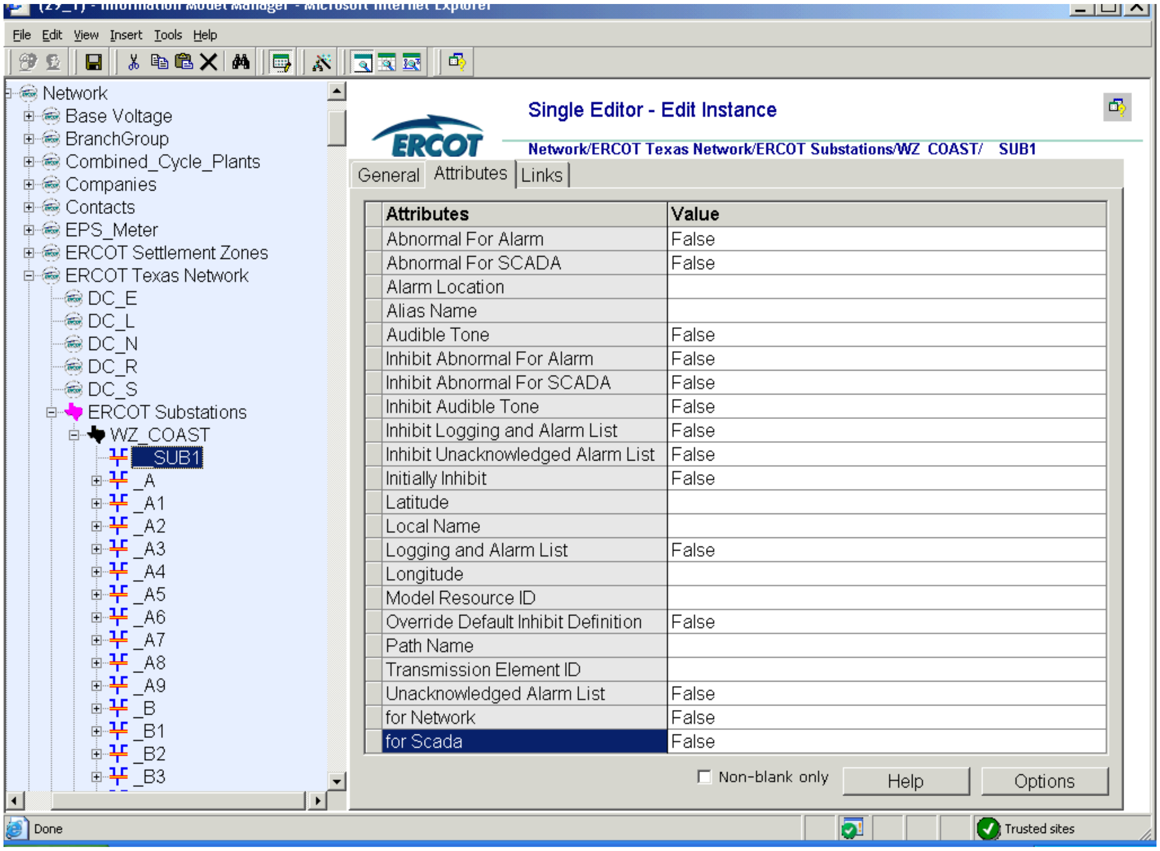


Figure 11 - Substation Attributes

3.3 ADD LINKS

As with attributes, for every device there are required link fields that must be populated for the model changes to pass the IMM validation. The required links for a substation can be found in the table named required links in the substation section of this document. Looking at this table, it is found that the required links for a substation are *Ownership*, *Operatorship*, and *PermissionArea*. Figure 12 shows the links screen for a newly created *Substation*.

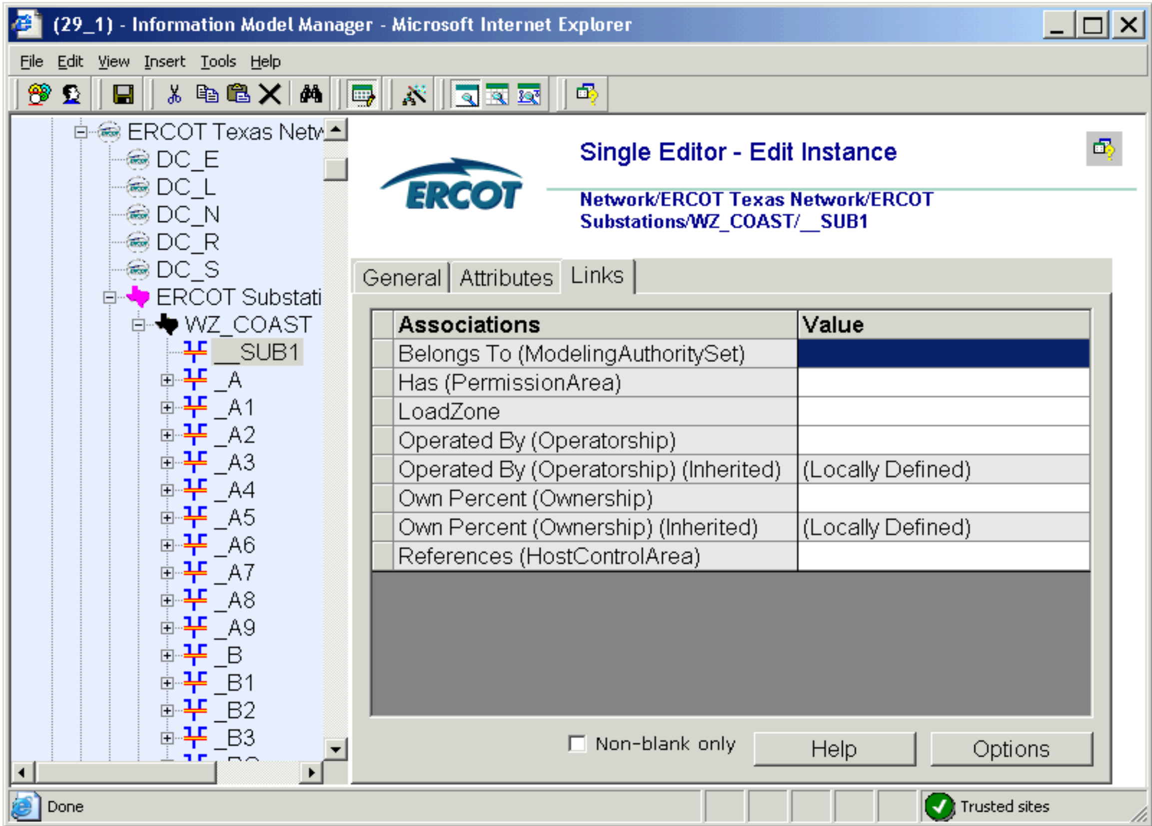


Figure 12 - Substation Links

Links cannot be manually entered into the value column. All of the links must be added using the drag and drop method or the copy/paste method. The path for all of the required links can be found in the Required Links table. With the links screen shown in Figure 12 up in the IMM, navigate to the desired link in the IMM and left-click on the link holding down the mouse button. Drag the selected link into the desired field and release the mouse button. The value field will be populated with the link. Save the change and move forward populating all of the required links in a similar manner. The screen shot in Figure 13 shows the ERCOT_Operator and ERCOT_Owner links in the __SUB1 Operatorship and Ownership fields.

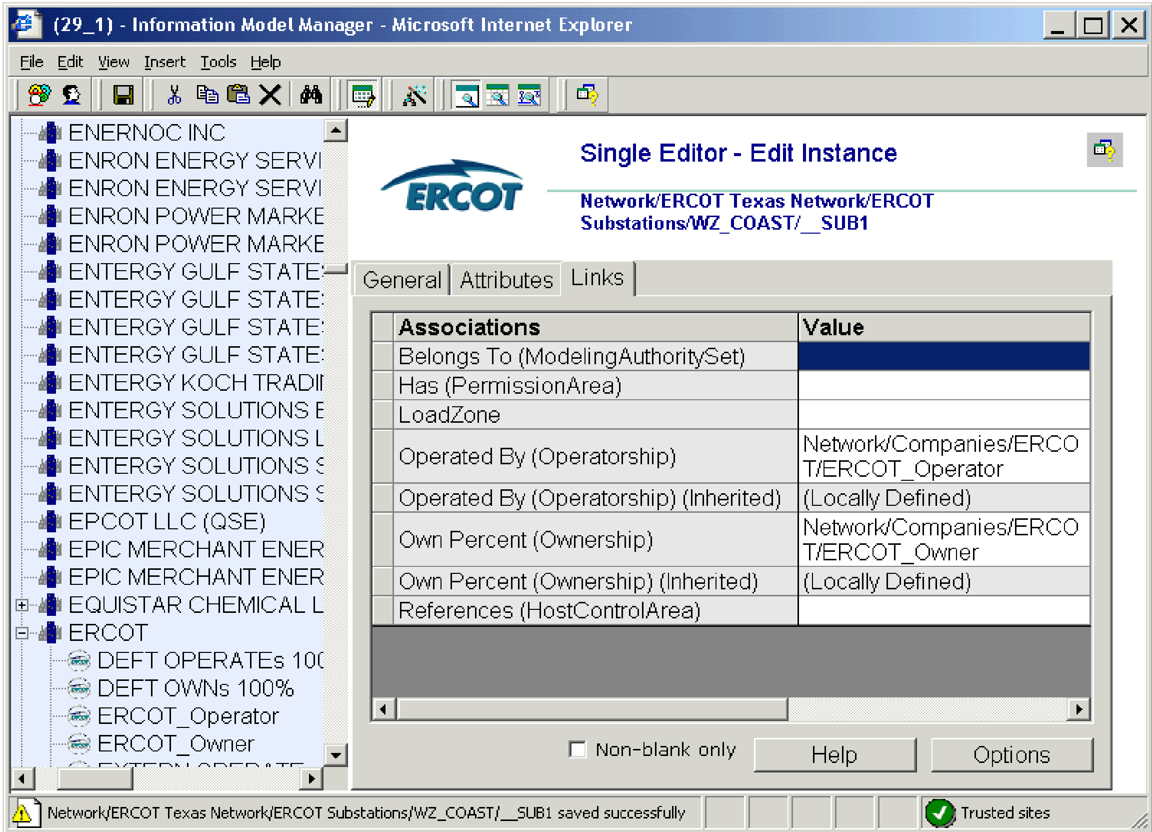


Figure 13 - __SUB1 Links Populated

3.4 RENAME INSTANCE

To rename an instance right-click on the instance and selecting Rename. A popup screen will appear prompting the user to enter a new instance name. This popup screen is shown in Figure 14. After the name is entered and the user selects the OK button, the instance name will be updated in the model hierarchy.

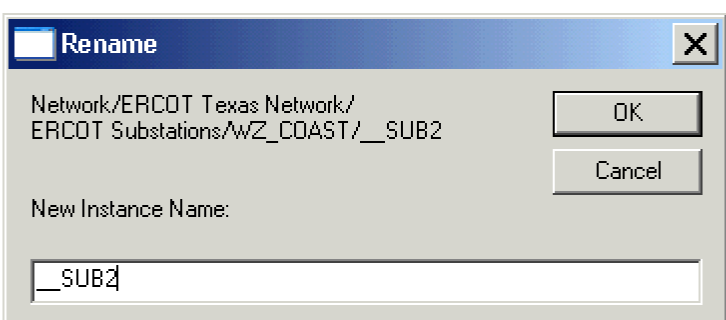


Figure 14 - Rename Substation

3.5 DELETE INSTANCE

To delete an instance right-click on the instance and select Delete. The warning message shown in Figure 15 will appear. If the instance or children of the instance are modified in a later job, the user will not be able to delete the instance.

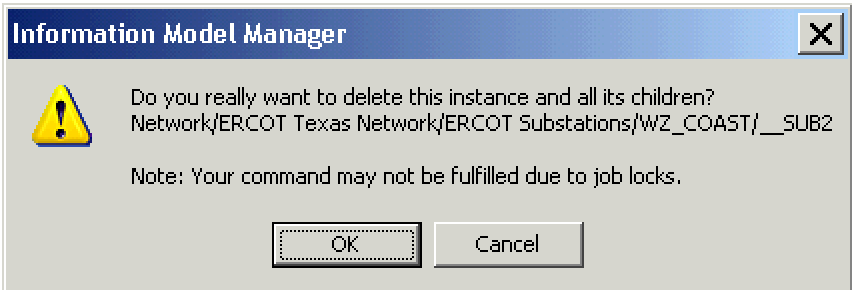


Figure 15 - Delete Substation

4 IMM TOOLS

4.1 TEMPLATES

4.2 AUTO LAYOUT

5 MODELING BREAKERS

5.1 MODELING APPROACH

The ERCOT CIM model defines a *Breaker* as 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.

A *Breaker* is modeled under a *VoltageLevel* in a *Substation*. Two *Terminals* are modeled under the *Breaker* as connection points to the circuit. SCADA values modeled under the *Terminals* provide the Open/Close status of the *Breakers* to the model. Figure below shows a *Breaker* modeled in the IMM model hierarchy with parent/child associations labeled. For more information on modeling SCADA values, refer to the section on 'Modeling SCADA'.

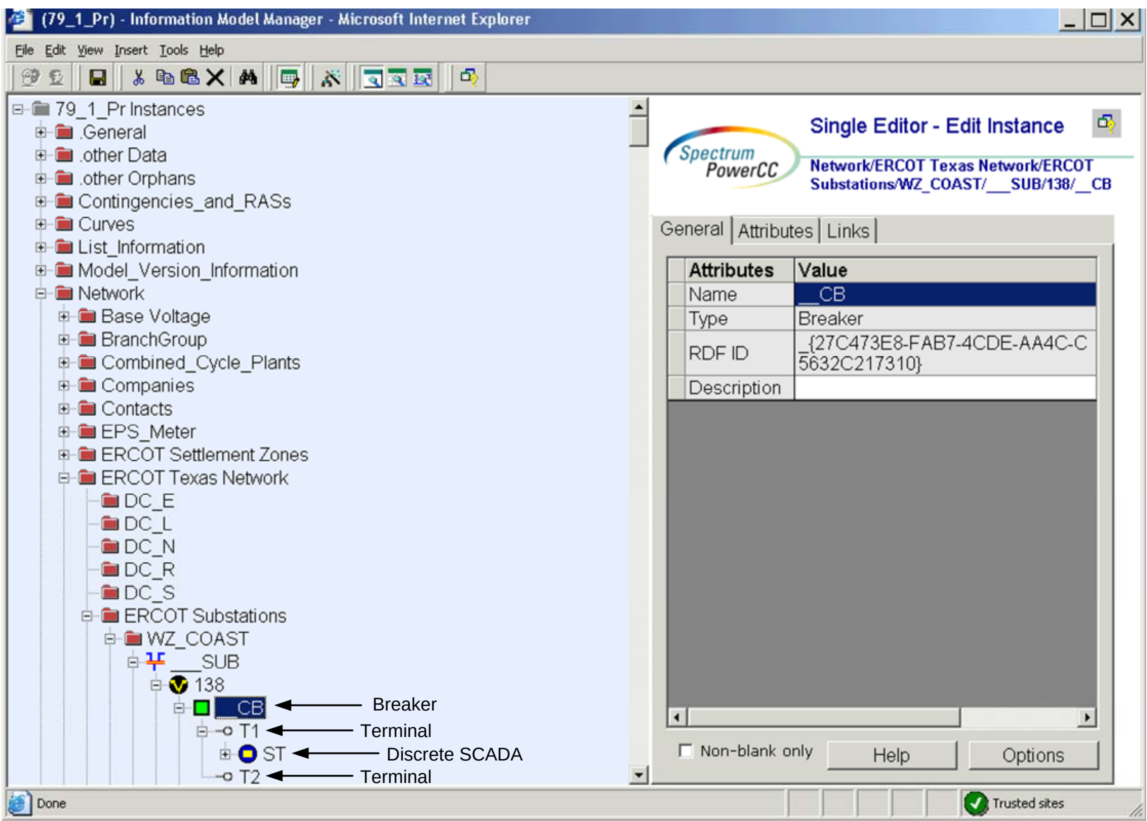


Figure 16 - Breaker

5.2 ATTRIBUTES

The attributes for a *Breaker* are shown in the table below.

Attribute	Description	Data Type	Default Value	Sample Data
TEID	Transmission Element ID	Integer	Auto-	

			populated	
normalOpen	The attribute is used in cases when no Measurement for the status value is present.	Boolean	False	
initiallyOpen	T = The initial breaker state for the online switching device model is open.	Boolean	False	
inTransitTime	**The transition time from open to close, in seconds.**	**Float**	**0**	
Alias Name	Free text name of the object or instance.	String	None	
Current Flow	Fault interrupting rating in amperes.	Float	None	
DAM Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	False	
DAM Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	True	
Enable Manual Switching	T = Enables manual switching capability for the device.	Boolean	True	
Latitude	Latiitude coordinates.	Float	None	
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the	String	None	

	uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.			
Longitude	Longitude coordinates.	Float	None	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	None	
Normal Open	The attribute is used in cases when no Measurement for the status value is present. If the Switch has a status measurment the Measurement.normalValue is expected to match with the Switch.normalOpen.	Boolean	False	
OUS Priority	An Outage Scheduler priority is included in all ConductingEquipment classes except BusbarSection and TransformerWinding.	Integer	None	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	
Phases	Describes the phases carried by a conducting equipment. Possible values { ABCN , ABC, ABN, ACN, BCN, AB, AC, BC, AN, BN, CN, A, B, C, N }.	PhaseCode	None	
PSS®E ID	Attribute will give IMM modelers control over the PSS®E ID that the Topology Processor uses to properly name units, loads, branches, and transformers	String	None	

Remove	The equipment is removed from the network.	Boolean	False	
Remove Enable	The equipment can be removed from the network.	Boolean	False	
RUC Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	False	
RUC Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	True	
Switch On Count	The switch on count since the switch was last reset or initialized.	Integer	None	
Switch On Date	The date and time when the switch was last switched on.	Date/Time	None	
Switch Operation Over	Over Limit Violation Switch Operation (Open/Close).	Boolean	None	
Switch Operation Under	Under Limit Violation Switch Operation (Open/Close).	Boolean	None	
Switched By Schedule	T = The switch will follow a switching schedule to change state in the network applications.	Boolean	False	
Trigger Network	T = The switch will trigger the real?time network application sequence when the	Boolean	False	

Sequence	switch changes state in SCADA.			
Trip Lockout	Lockout after trip.	Boolean	None	
Zero Impedance Branch?	Mark Switching devices that should be converted to Zero Impedance Branches in Connectivity Node to Bus Processing Option 1.	Boolean	False	

5.3 LINKAGE

The required links for a *Breaker* are defined below.

Link Name	Description	Path Name
Operatorship	The Operatorship link is used for permission rights. The Operator of equipment has the right to edit the equipment. An operator can only be assigned by the creator or owner of the equipment.	Network/Companies
Ownership	The Ownership link is used for permission rights. The owner of equipment has editing and administrative rights. An owner can only be assigned by the creator of the equipment.	Network/Companies

6 MODELING DISCONNECTORS

6.1 MODELING APPROACH

The ERCOT CIM model defines a *Disconnector* as manually operated or motor operated mechanical switching device used for changing the connections in a circuit, or for isolating a circuit or equipment from a source of power. It is required to open or close circuits when negligible current is broken or made.

A *Disconnector* is modeled under a *VoltageLevel* in a *Substation*. Two T*erminals* are modeled under the *Disconnector* as connection points to the circuit. SCADA values modeled under the *Terminals* provide the Open/Close status of the *Breakers* to the model. Figure below shows a *Disconnector* modeled in the IMM model hierarchy with parent/child associations labeled. For more information on modeling SCADA values, refer to the section on SCADA.

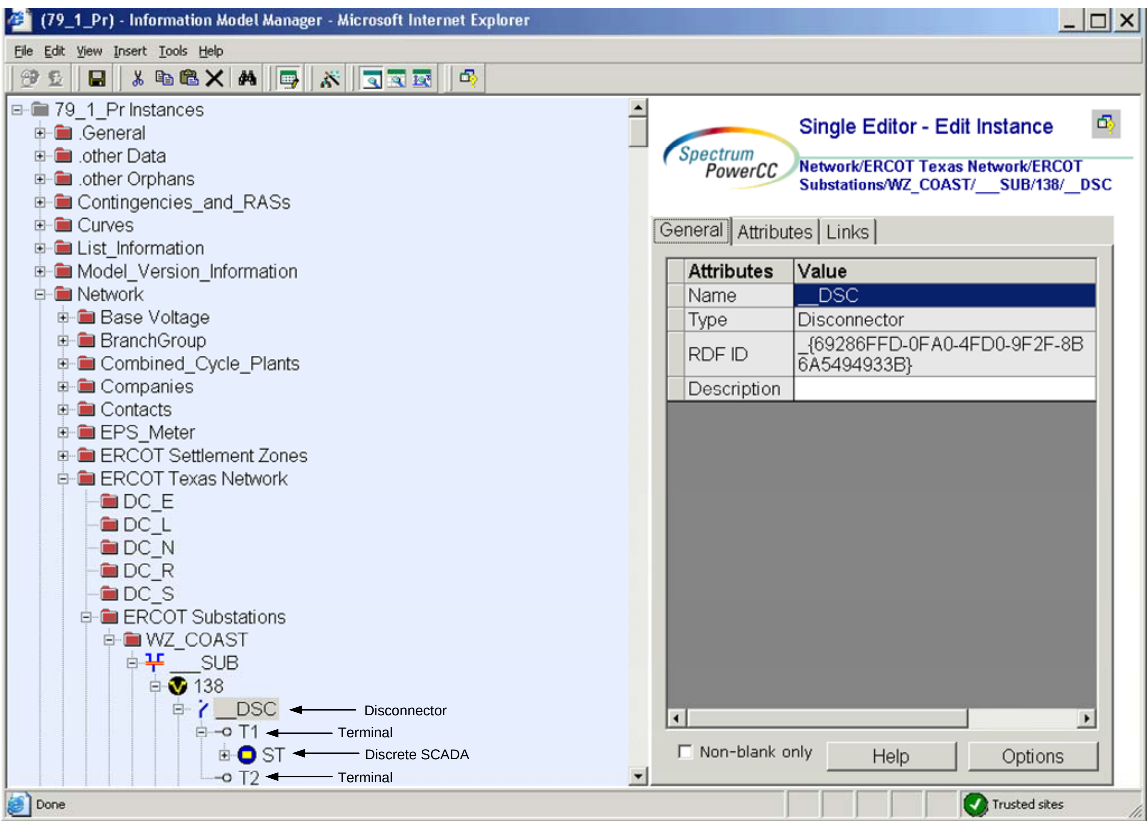


Figure 17 - Disconnector

6.2 ATTRIBUTES

The attributes for a *Disconnector* are shown in the table below.

Attribute	Description	Data Type	Default Value	Sample Data
normalOpen	The attribute is used in cases	Boolean	False	

	when no Measurement for the status value is present.			
initiallyOpen	T = The initial breaker state for the online switching device model is open.	Boolean	False	
Alias Name	Free text name of the object or instance.	String	None	
DAM Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	False	
DAM Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	True	
Enable Manual Switching	T = Enables manual switching capability for the device.	Boolean	True	
Latitude	Latiitude coordinates.	Float	None	
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	

Longitude	Longitude coordinates.	Float	None	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	Auto-populated	
Normal Open	The attribute is used in cases when no Measurement for the status value is present. If the Switch has a status measurment the Measurement.normalValue is expected to match with the Switch.normalOpen.	Boolean	False	
OUS Priority	An Outage Scheduler priority is included in all ConductingEquipment classes except BusbarSection and TransformerWinding.	Integer	None	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	
Phases	Describes the phases carried by a conducting equipment. Possible values { ABCN , ABC, ABN, ACN, BCN, AB, AC, BC, AN, BN, CN, A, B, C, N }.	PhaseCode	None	
PSS®E ID	Attribute will give IMM modelers control over the PSS®E ID that the Topology	String	None	

	Processor uses to properly name units, loads, branches, and transformers			
Remove	The equipment is removed from the network.	Boolean	False	
Remove Enable	The equipment can be removed from the network.	Boolean	False	
RUC Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	False	
RUC Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	True	
Switch On Count	The switch on count since the switch was last reset or initialized.	Integer	None	
Switch On Date	The date and time when the switch was last switched on.	Date/Time	None	
Switched By Schedule	T = The switch will follow a switching schedule to change state in the network applications.	Boolean	False	
Trigger Network Sequence	T = The switch will trigger the real?time network application sequence when the switch	Boolean	False	

	changes state in SCADA.			
Zero Impedance Branch?	Mark Switching devices that should be converted to Zero Impedance Branches in Connectivity Node to Bus Processing Option 1.	Boolean	False	

6.3 LINKAGE

The required links for a *Disconnector* are defined in the table below.

Link Name	Description	Path Name
Operatorship	The Operatorship link is used for permission rights. The Operator of equipment has the right to edit the equipment. An operator can only be assigned by the creator or owner of the equipment.	Network/Companies
Ownership	The Ownership link is used for permission rights. The owner of equipment has editing and administrative rights. An owner can only be assigned by the creator of the equipment.	Network/Companies

7 MODELING SHUNT COMPENSATORS

7.1 MODELING APPROACH

In the ERCOT CIM model, a *ShuntCompensator* is defined as a shunt capacitor or reactor or switchable bank of shunt capacitors or reactors. A section of a *Shunt Compensator* is an individual capacitor or reactor. Negative values for mVArPerSection and nominalMVAr indicate that the compensator is a reactor.

A *Shunt Compensator* is modeled under a *VoltageLevel* in a *Substation*. One *Terminal* is modeled under the *Shunt Compensator* as a connection point to the circuit. Figure below shows a *Shunt Compensator* modeled in the IMM model hierarchy with parent/child associations labeled. For more information on modeling SCADA values, refer to the SCADA section of this document.

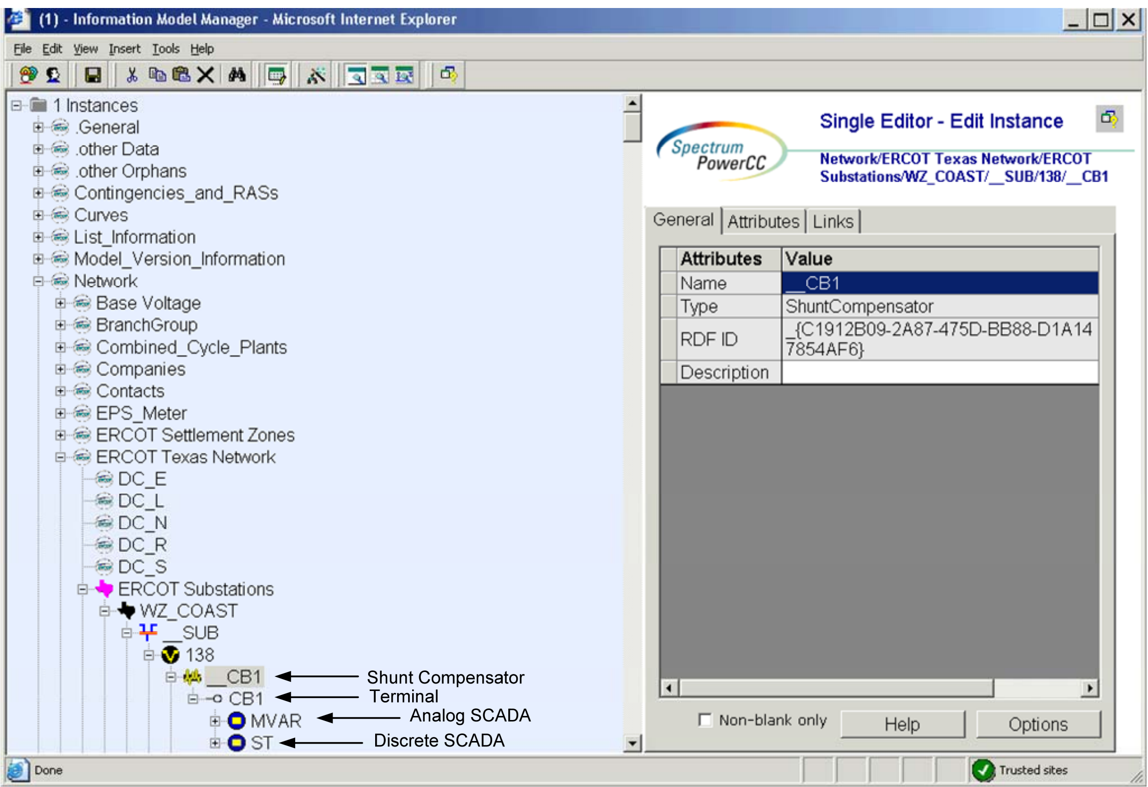


Figure 18 - Shunt Compensator

7.2 ATTRIBUTES

The attributes for a *Shunt Compensator* are shown in the table below.

Attribute	Description	Data Type	Default Value	Sampl e Data

Switching Priority	**Switching priority number.**	**Integer**		**12345**
Alias Name	Free text name of the object or instance.	String	None	
Automatic Voltage Regulation Delay	**Time delay in seconds required for the device to be connected or disconnected by automatic voltage regulation (AVR).**	**Seconds**	**None**	
Automatic Voltage Regulation Enabled	T = Automatic voltage regulation enabled.	Boolean		
DAM Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	False	
DAM Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	True	
Impedance	The positive sequence impedance of the capacitor.	Impeadance	None	
Latitude	Latiitude coordinates.	Float	None	
Load Based Regulation Enabled	T = Load based voltage regulation enabled.	Boolean		
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are	String	None	

	unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.			
Longitude	Longitude coordinates.	Float	None	
Maximum Sections	For a capacitor bank, the maximum number of sections that may be switched in.	Counter	None	
Maximum kV	**The maximum voltage at which the capacitor bank should operate.**	**Voltage**	**None**	
Minimum kV	**The minimum voltage at which the capacitor bank should operate.**	**Voltage**	**None**	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	Auto-populated	
Nominal MVAr	**Nominal MVAr output of the capacitor bank at the nominal kV. This number should be positive.**	**Reactive Power**	**None**	
Nominal kV	**The nominal voltage at which the nominal MVAr was measured. This should normally be within 10% of the voltage at which the capacitor is connected to the network.**	**Voltage**	**None**	
Normal Sections	For a capacitor bank, the normal number of sections switched in. This number should correspond to the Nominal MVAr.	Counter	None	
OUS Priority	An Outage Scheduler priority is included in all ConductingEquipment classes except	Integer	None	

	BusbarSection and TransformerWinding.			
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	
Phases	Describes the phases carried by a conducting equipment. Possible values { ABCN , ABC, ABN, ACN, BCN, AB, AC, BC, AN, BN, CN, A, B, C, N }.	PhaseCode	None	
PSS®E ID	Attribute will give IMM modelers control over the PSS®E ID that the Topology Processor uses to properly name units, loads, branches, and transformers	String	None	
Remove	The equipment is removed from the network.	Boolean	False	
Remove Enable	The equipment can be removed from the network.	Boolean	False	
RUC Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	False	
RUC Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	True	
Switch On Count	The switch on count since the capacitor count was last reset or initialized.	Counter	None	

Switch On Date	The date and time when the capacitor bank was last switched on.	Absolute Date/Time	None	
Voltage Sensitivity	**Voltage sensitivity required for the device to regulate the bus voltage, in per unit voltage/MVAr.**	**PU kV per MVAr**	**None**	
Y Per Section	For a capacitor bank, the admittance of each switchable section. Calculated using the MVAr per section and corrected for network voltage.	Admittance	None	
mVAr Per Section	For a capacitor bank, the size in MVAr of each switchable section at the Nominal kV.	Reactive Power	None	

7.3 LINKAGE

The required links for a *Shunt Compensator* are defined in Table below.

Link Name	Description	Path Name
Operated By (Operatorship)	The Operatorship link is used for permission rights. The Operator of equipment has the right to edit the equipment. An operator can only be assigned by the creator or owner of the equipment.	Network/Companies
Owned By (Ownership)	The Ownership link is used for permission rights. The owner of equipment has editing and administrative rights. An owner can only be assigned by the creator of the equipment.	Network/Companies

8 MODELING SERIES COMPENSATORS

8.1 MODELING APPROACH

In the ERCOT CIM model a *SeriesCompensator* is defined as a series capacitor, reactor, or AC transmission line without charging susceptance.

Although *Series Compensators* are contained within a *Substation* in the ERCOT model, they are not modeled under a *Substation* in the ERCOT model. *Series compensators* are modeled in the container named *ERCOT-Series Compensator* under ERCOT Texas Network, where they are grouped by voltage level.

Figure below shows a *Series Compensator* in the IMM model hierarchy. *Series Compensators* must be modeled under a line and have two *Terminals* that serve as connection points to the circuit. Analog SCADA values that provide limits and ratings for the *Series Compensator* are modeled under the *Terminals*. These SCADA values can be modeled using multiple configurations. More information on modeling SCADA values can be found in the SCADA section of this document.

Seriescompensator cannot go between different voltage levels and should be contained within one substation.

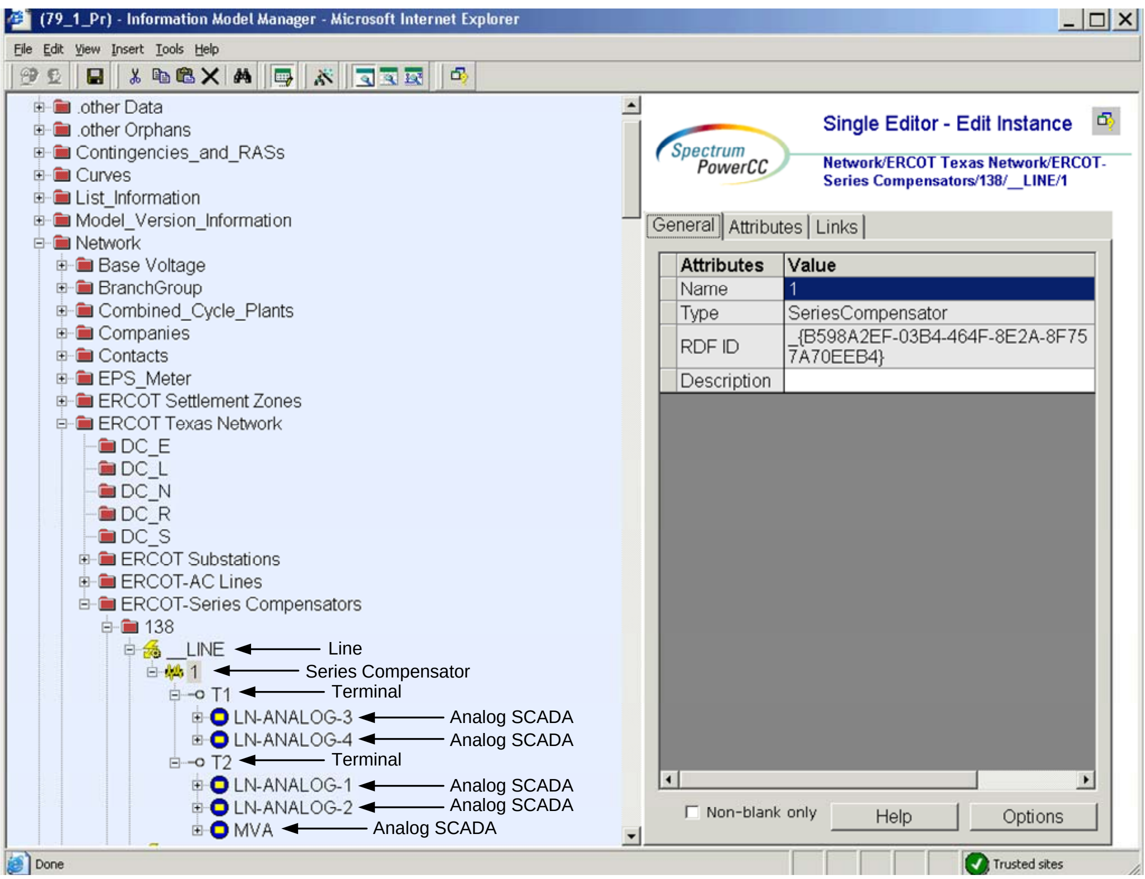


Figure 19 - Series Compensator

8.2 ATTRIBUTES

The attributes for a *Series Compensator* are shown in the table below

Attribute	Description	Data Type	Default Value	Sample Data
Alias Name	Free text name of the object or instance.	String	None	
DAM Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	False	
DAM Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	True	
Emergency Max Shadow Price	States the Emergency Max Shadow price for a SeriesCompensator.	DoubleFloat	99999	
Latitude	Latiitude coordinates.	Float	None	
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	
Longitude	Longitude coordinates.	Float	None	

Max Shadow Price	States the Max Shadow price	DoubleFloat	99999	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	Auto-populated	
OUS Priority	An Outage Scheduler priority is included in all ConductingEquipment classes except BusbarSection and TransformerWinding.	Integer	None	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	
Phases	Describes the phases carried by a conducting equipment. Possible values { ABCN , ABC, ABN, ACN, BCN, AB, AC, BC, AN, BN, CN, A, B, C, N }.	PhaseCode	None	
PSS®E ID	Attribute will give IMM modelers control over the PSS®E ID that the Topology Processor uses to properly name units, loads, branches, and transformers	String	None	
Reactance	**Positive sequence reactance**	**Float**	**None**	
Remove	The equipment is removed from the network.	Boolean	False	
Remove Enable	The equipment can be removed from the network.	Boolean	False	

Resistance	**Positive sequence resistance**	**Float**	**None**	
RUC Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	False	
RUC Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	True	

8.3 LINKAGE

The required links for a *Series Compensator* are defined in Table below.

Link Name	Description	Path Name
Operatorship	The Operatorship link is used for permission rights. The Operator of equipment has the right to edit the equipment. An operator can only be assigned by the creator or owner of the equipment.	Network/Companies
Ownership	The Ownership link is used for permission rights. The owner of equipment has editing and administrative rights. An owner can only be assigned by the creator of the equipment.	Network/Companies

9 MODELING LINES

9.1 MODELING APPROACH

This section describes the modeling of the *Line* container class as well as the *ACLineSegment* (transmission lines that connect two *Substations*) and *SeriesCompensators* (transmission lines that are fully contained within a substation) classes.

The *Line* class is modeled underneath a *Geographical* and *Sub Geographical Region*. The *Geographical Region* in which the line will be created differs depending on what type of sub-classes the line will contain. If the line is to contain an *ACLineSegment*, then the line must be in a *Sub Geographical Region* (named after the base voltage of the line) which is underneath the "ERCOT – AC Lines". Likewise, if the line will contain a *SeriesCompensator*, it must be created underneath both the "ERCOT – Series Compensators" geographical region and the sub geographical region corresponding to the line's base voltage.

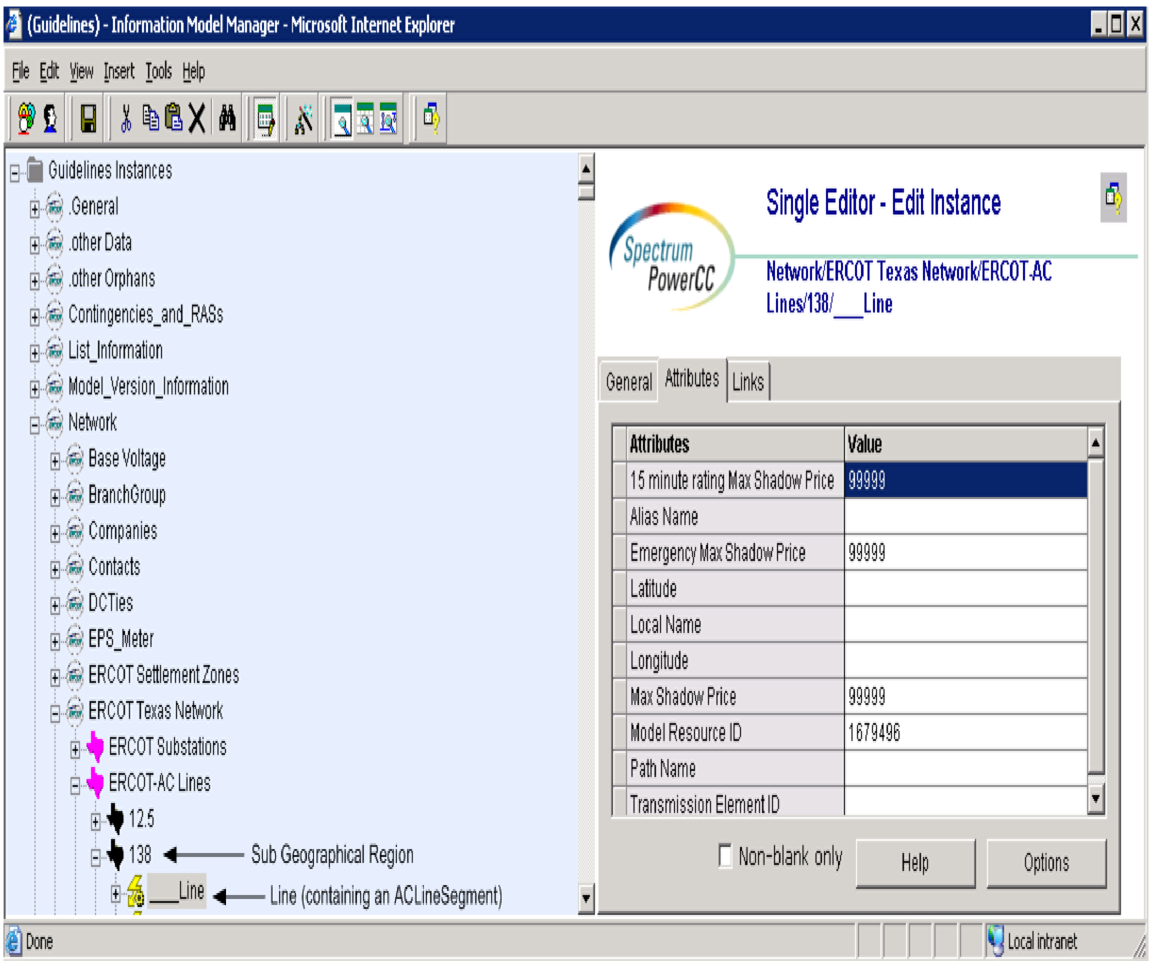


Figure 20 - Location of Lines containing ACLineSegments

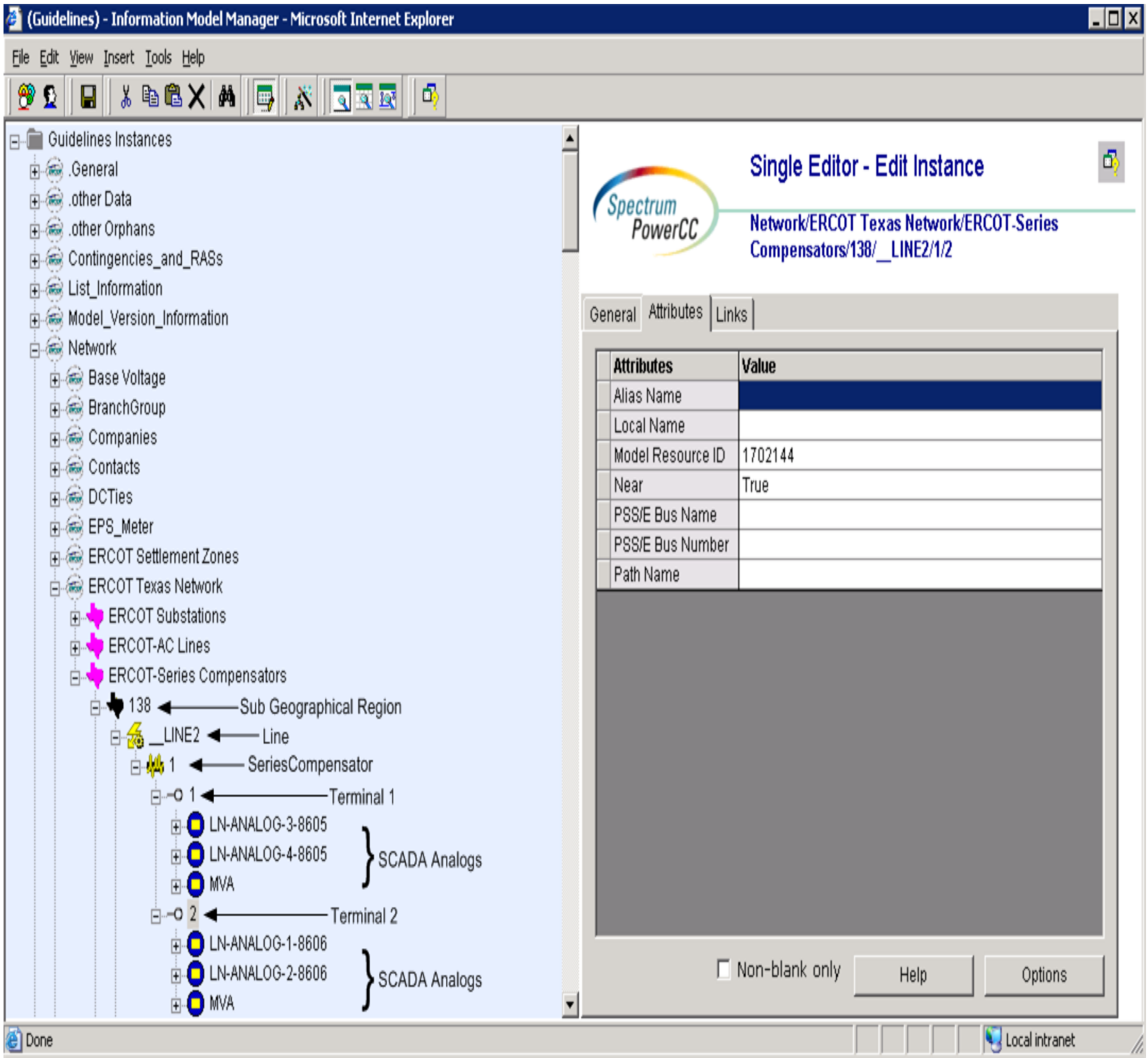


Figure 21 - Location of Lines containing SeriesCompensators

9.2 ATTRIBUTES

The attributes for a *Line* are shown in the table below.

Attribute	Description	Data Type	Default Value	Sample Data
TEID	Transmission Element ID	Integer	Auto-populated	
15 minute rating Max Shadow Price	15 minute rating Max Shadow price	DoubleFloat		

Alias Name	Free text name of the object or instance.	String	None
Emergency Max Shadow Price	Emergency Max Shadow price	DoubleFloat	
Latitude	Latiitude coordinates.	Float	None
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None
Longitude	Longitude coordinates.	Float	None
Max Shadow Price	Max shadow price	DoubleFloat	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	None
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.		

9.3 LINKAGE

There are no required links.

10 MODELING ACLINESEGMENT

10.1 MODELING APPROACH

The *ACLineSegment* class represents an AC transmission line that connects two different *Substations*. An *ACLineSegment* cannot be contained within a single *Substation*. Additionally, an *ACLineSegment* must be underneath a *Line* instance and must have two *Terminals*.

ACLinesegment cannot go between different voltage levels.

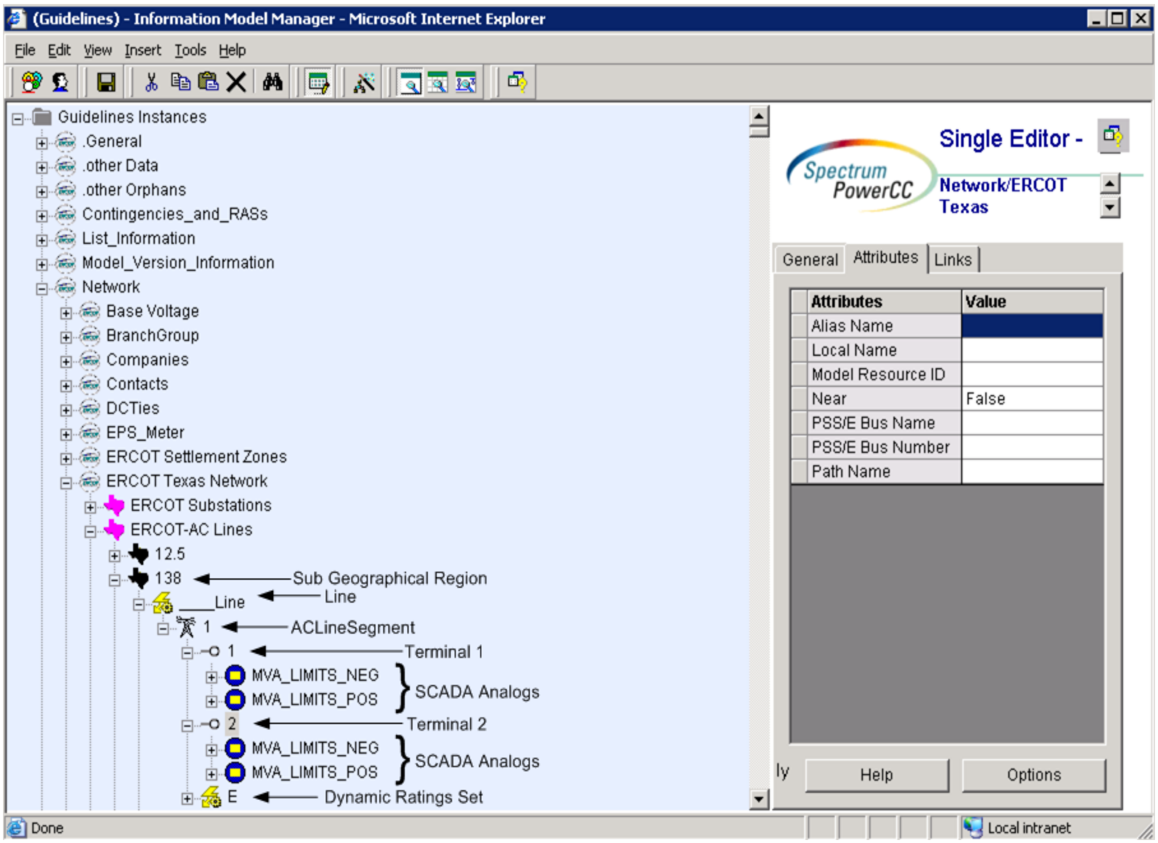


Figure 22 - ACLineSegment

10.2 ATTRIBUTES

Attribute	Description	Data Type	Default Value	Sample Data
15 minute rating Max Shadow Price	15 minute rating Max Shadow price	Double Float		
Alias Name	Free text name of the object or instance.	String	None	

b0ch	Zero sequence shunt (charging) susceptance, uniformly distributed, of the entire line section.	Double Float	
bch	Positive sequence shunt (charging) susceptance, uniformly distributed, of the entire line section.	Double Float	
DAM Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Bool	
DAM Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Bool	
Emergency Max Shadow Price	Emergency Max Shadow price	Double Float	
g0ch	Zero sequence shunt (charging) conductance, uniformly distributed, of the entire line section.	Double Float	
gch	Positive sequence shunt (charging) conductance, uniformly distributed, of the entire line section.	Double Float	
Latitude	Latiitude coordinates.	Float	None
length	Segment length for calculating line section capabilities (long length units).	Float	
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None
Longitude	Longitude coordinates.	Float	None
Max Shadow Price	Max shadow price	Double Float	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this	String	

	id is part of the mRID, then the mRID is globally unique.		
OUS Priority	An Outage Scheduler priority is included in all ConductingEquipment classes except BusbarSection and TransformerWinding.	Long Int	None
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	
Phases	Describes the phases carried by a conducting equipment. Possible values { ABCN , ABC, ABN, ACN, BCN, AB, AC, BC, AN, BN, CN, A, B, C, N }.	String	
PSS®E	Attribute will give IMM modelers control over the PSS®E ID that the Topology Processor uses to properly name units, loads, branches, and transformers.	String	
r	**Positive sequence series resistance of the entire line section.**	**Double Float**	
R0	Zero sequence series resistance of the entire line section.	Double Float	
Remove	The equipment is removed from the network.	Bool	
Remove Enable	The equipment can be removed from the network in the EMS.	Bool	
RUC Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Bool	
RUC Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Bool	
Transmission Element ID	Transmission Element ID	Integer	Auto-populated
x	**Positive sequence series reactance of the entire line section.**	**Double Float**	
X0	Zero sequence series reactance of the entire line section.	Double Float	

10.3 LINKAGE

The required links for a *ACLineSegment* are defined in Table below.

Link Name	Description	Path Name
BaseVoltage	A link to a BaseVoltage is only necessary when there is no VoltageLevel container used. If a VoltageLevel container is used the disconnector will inherit a BaseVoltage from the VoltageLevel.	Network/Base Voltage
Operatorship	The Operatorship link is used for permission rights. The Operator of equipment has the right to edit the equipment. An operator can only be assigned by the creator or owner of the equipment.	Network/Companies
Ownership	The Ownership link is used for permission rights. The owner of equipment has editing and administrative rights. An owner can only be assigned by the creator of the equipment.	Network/Companies

11 MODELING SUBSTATION

11.1 MODELING APPROACH

The ERCOT CIM model defines a *Substation* as collection of equipment for purposes other than generation or utilization, through which electric energy in bulk is passed for the purposes of switching or modifying its characteristics.

A *Substation* is modeled under a *SubGeographicalRegion*. *VoltageLevels*, *Transformers* and Device types are modeled under the *Substation* along with generic equipment. The *Substation* serves as a container for these instances. Figure below shows a *Substation* modeled in the IMM model hierarchy with parent/child associations labeled. For more information on modeling *VoltageLevels*, Device Types, and *PowerTransformers* please see relevant sections.

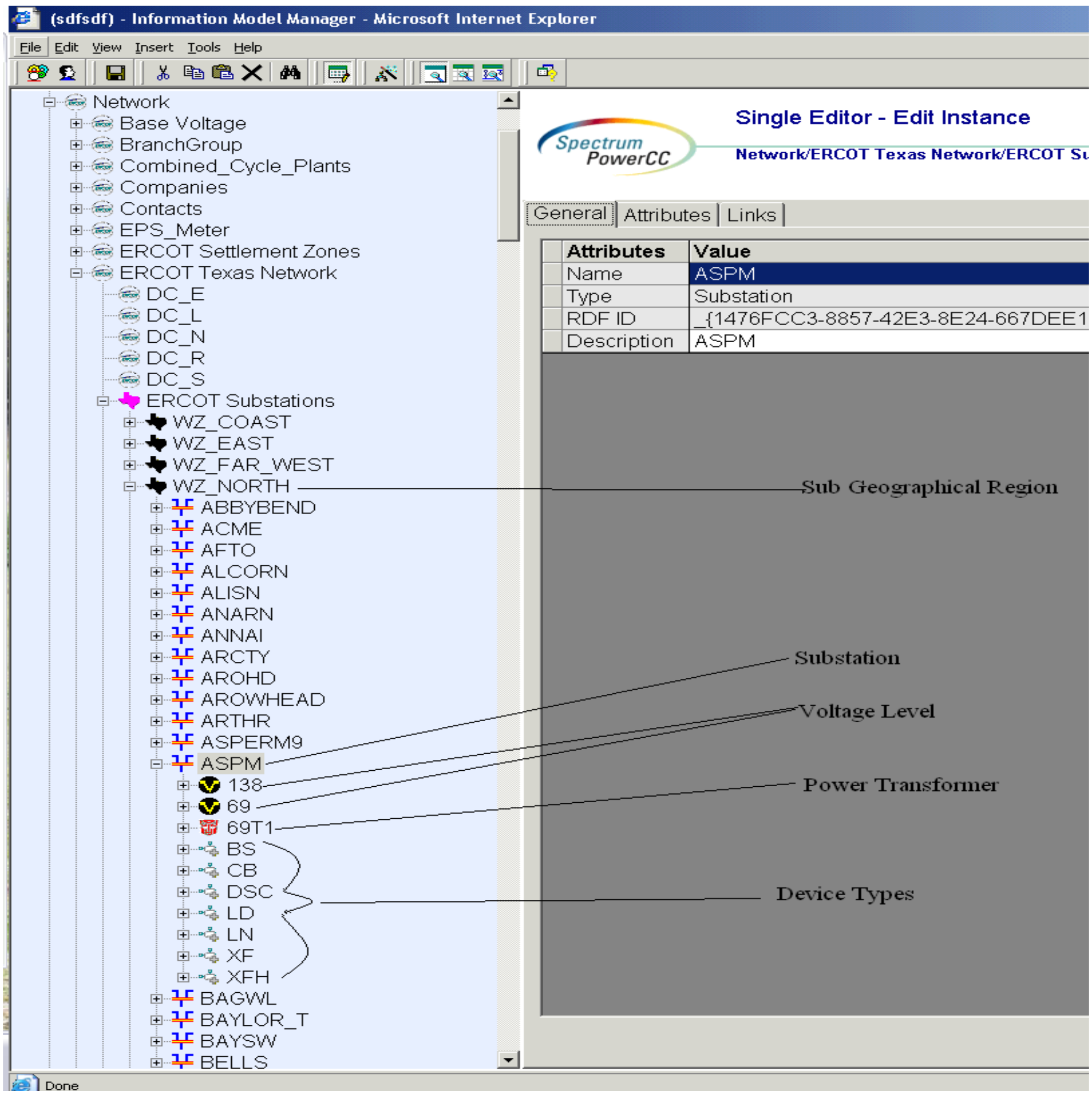


Figure 23 - Substation

11.2 ATTRIBUTES

The attributes for a *Substation* are shown in the table below.

Attribute	Description	Data Type	Default value	Sample data
Transmission Element ID	Transmission Element ID	Integer		
abnormalForAlarm	This flag is used to cause alarm messages for abnormals to have their date/time displayed in black in the Alarm displays instead of red (assuming the HABITAT FG element set).	Boolean	FALSE	
abnormalForSCADA	Setting this flag to true does not affect Alarm displays, but forces the record to appear Normal on SCADA displays.	Boolean	FALSE	
alarmLocation	Alarm location, must match LOC.ID_LOC in the Alarm database.	String8		
audibleTone	A flag indicating that notifications of alarm conditions via audible tones and horns will be suppressed.	Boolean	FALSE	
forNetwork	**This flag is used to indicate this substation is used by Network application.**	**Boolean**	**FALSE**	
forScada	**This flag is used to indicate this substation is used by SCADA application.**	**Boolean**	**FALSE**	
inhibitAbnormalForAlarm	Permanently Inhibit the flag of abnormalForAlarm .	Boolean	FALSE	
inhibitAbnormalForSCADA	Permanently Inhibit the flag of abnormalForSCADA.	Boolean	FALSE	
inhibitAudibleTone	Permanently Inhibit the flag of audibleTone.	Boolean	FALSE	

©2009 Electric Reliability Council of Texas, Inc.

inhibitLoggingAndAlarmList	Permanently Inhibit the flag of loggingAndAlarmList.	Boolean	FALSE
inhibitUnackAlarmList	Permanently Inhibit the flag of unacknowledgedAlarmList.	Boolean	FALSE
initiallyInhibit	A flag indicating that when the system first comes online, alarm indications for this SCADA entiry will initially be inhibited.	Boolean	FALSE
loggingAndAlarmList	A flag indicating that SCADA will issue neither an alarm nor an event. Therefore, entries will appear in the neither the alarm list nor the event logs.	Boolean	FALSE
overrideDefaultInhibitDef	A flag indicating that that the Operator Inhibit Definition overrides the Global Default Inhibit.	Boolean	FALSE
unacknowledgedAlarmList	A flag ndicating that SCADA will issue an event to the event log, but will not issue unacknowledged alarm indications to the alarm list.	Boolean	FALSE
Alias Name	Free text name of the object or instance.	String100	
Latitude	Latiitude coordinates.	Float	
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has seve	String30	
Longitude	Longitude coordinates.	Float	

Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String100
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String500

11.3 LINKAGE

Below are the required links for a Substation.

Link Name	Description	Path Name
Operated By (Operatorship)		Network/Companies
Own Percent (Ownership)		Network/Companies

12 MODELING BAY

12.1 MODELING APPROACH

The ERCOT CIM model defines a *Bay* as a collection of *Breakers* and *Disconnectors* within a given *VoltageLevel*. A *Bay* is modeled under a *VoltageLevel.* Only *Breakers* and *Disconnectors* can be modeled under a *Bay*. All the *Breakers* and *Disconnectors* defined under a *Bay* should also populate the Switch.voltageLevel association to indicate the *VoltageLevel* to which these devices belong to.

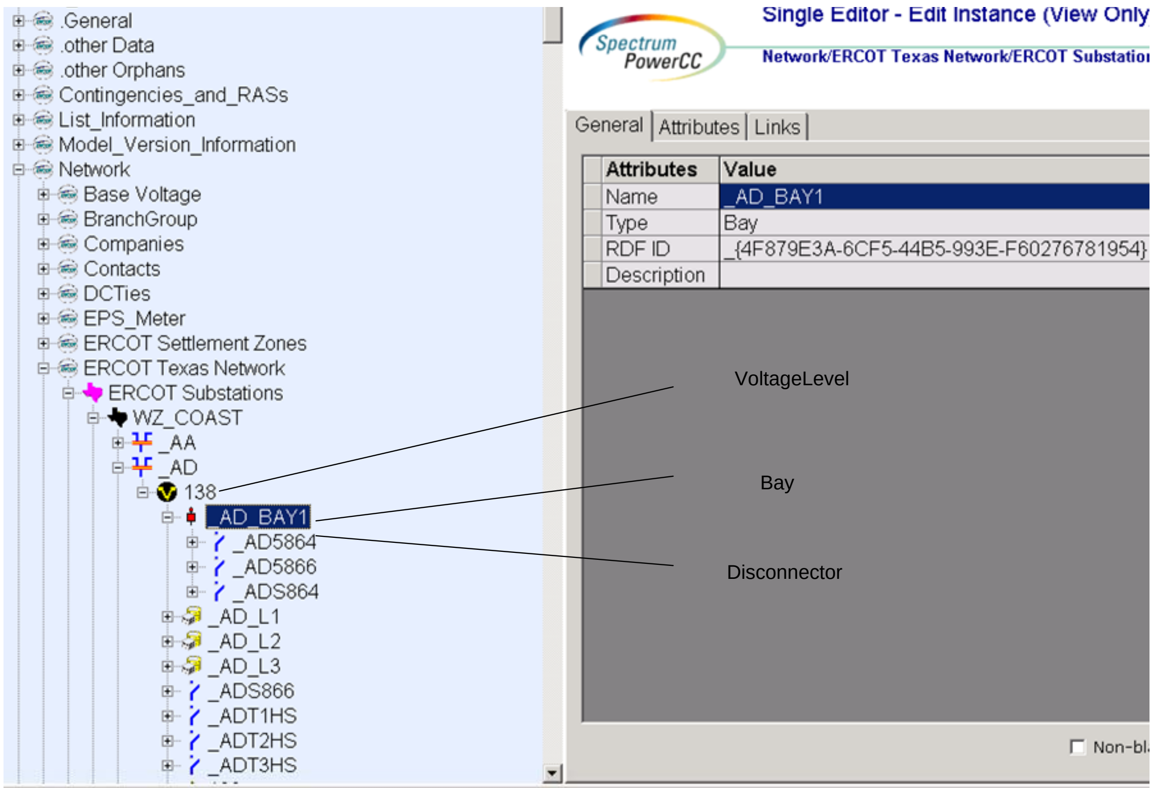


Figure 24 - Bay

12.2 ATTRIBUTES

The attributes for a *Bay* are shown in the table below.

Attribute	Description	Data Type	Default value	Sample data
Alias Name	Free text name of the object or instance.	String		

bay Energy Measurement Flag	Indicates the presence/absence of kWh/kvarh measurements.	Boolean	False
bay Power Measurement Flag	Indicates the presence/absence of MW/MVAr measurements.	Boolean	False
Breaker Configuration	Breaker configuration.	Breakerconfiguration	
Busbar Configuration	Busbar configuration.	BusbarConfiguration	
Description	Description of the object or instance.	String	
Latitude	Latiitude coordinates.	Integer	
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	
Longitude	Longitude coordinates.	Integer	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority	String	

	has a unique id and this id is part of the mRID, then the mRID is globally unique.	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String
Transmission Element ID	Transmission Element ID.	Integer

12.3 LINKAGE

The required links for a *Bay* are defined below.

Link Name	Description	Path Name
Operatorship	The Operatorship link is used for permission rights. The Operator of equipment has the right to edit the equipment. An operator can only be assigned by the creator or owner of the equipment.	Network/Companies
Ownership	The Ownership link is used for permission rights. The owner of equipment has editing and administrative rights. An owner can only be assigned by the creator of the equipment.	Network/Companies

13 MODELING SCADA

13.1 MODELING APPROACH FOR SCADA

This section describes the approach for modeling SCADA in the ERCOT CIM model. SCADA stands for Supervisory Control and Data Acquisition. It refers to the centralized systems which monitor and control entire sites, or complexes of systems spread over large areas. The control actions are performed automatically by the remote terminal units or by programming logic controllers.

In the ERCOT CIM model *Analog* and *Discrete* measurements are created under equipment's *Terminal*. A *Terminal* association ascertains the *ConnectivityNode* in the network model that closely represents location of the physical measuring device in the field. In addition to *ConnectivityNode*, it is useful to know equipment in the network model, this measurement data is being supplied for. In case of most measurements this equipment is usually the parent of identified terminal.

Knowledge of the medium being utilized to transfer the measured data to ERCOT is equally essential. Most of the measurements in the CIM model use ICCP, SCADA RTUs or Calculation as the media for data transfer. The CIM model identifies the transfer medium for a measurement as its *MeasurementValueSource*. The subtle differences in modeling Analog and Discrete measurements from each of these *MeasurementValueSource*s are outlined in this section.

The CIM classes, *MeasurementLocation*, *MeasurementGroup*, *Analog*, *Discrete*, *AnalogValue* and *DiscreteValue* are mainly utilized for defining the SCADA measurement components in the network model. Figure below shows the modeling of MVAR telemetry for a load as modeled in the IMM hierarchy. As can be seen in figure, an *Analog* named MVAR is modeled under the Load's *Terminal*. An *AnalogValue* MVAR_SValue is modeled under the MVAR Analog. Both the *Analog* and *AnalogValue* instances are together used to define various SCADA specific features of the MVAR measurement. A *MeasurementLocation* is visible be modeled under the load, indicating the presence of measurements at the load. A *MeasurementGroup*, MGRP is modeled under the *MeasurementLocation*. The following sections describe the modeling of each of these classes in detail.

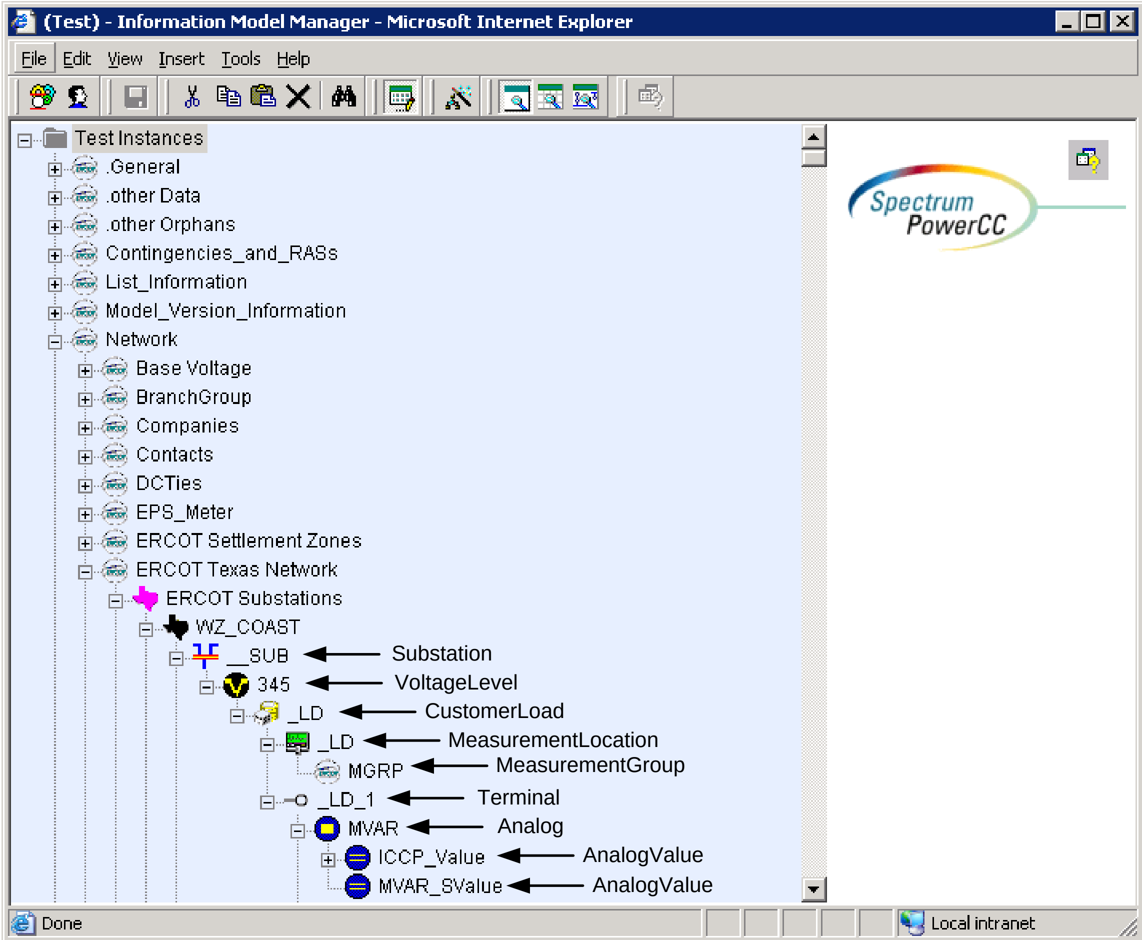


Figure 25 - IMM hierarchical view for SCADA measurement.

13.1.1 Modeling Approach for MeasurementLocation

A *MeasurementLocation* is used to identify equipment in the network model which is being monitored using *Analog* and *Discrete* measurements. This monitored equipment can be of type *Breaker, Busbarsection, Synchronousmachine, Transfomerwinding* etc.

In the figure above a *MeasurementLocation* is created under the load at which the MVAR flow measurements are being monitored. A *MeasurementLocation* must have the exact same name as that of its parent device. In the ERCOT CIM model, a *MeasurementLocation* also holds the SCADA device-type for its parent device. With the exception of *Lines* and *PowerTransformers*, any equipment in the ERCOT network model must have only one child *MeasurementLocation* of a specific device-type. In case of *Lines*/*PowerTransformers* a maximum of two MeasurementLocation children may be present, one each of each end/winding of the *Line/Transformer*.

13.1.1.1 Linkage

The required links for a *MeasurementLocation* are defined in the table below.

Link Name	Description	Path Name
HasTypeofDeviceType	Identifies the device type at which the measurement is being defined	Other Orphans/DeviceTypeName
HasAPermissionArea	Identifies the permission area	List_Information/Permission Areas/ERCOT

13.1.2 Modeling Approach for a MeasurementGroup

The ERCOT data dictionary defines a *MeasurementGroup* as a group of related *Analog* or *Discrete* measurements. In the ERCOT CIM model, *MeasurementGroups* are created under *MeasurementLocations*. *Analog* and *Discrete* measurements that are sourced from SCADA RTU's and/or ICCP are collected together by associations to *MeasurementGroup*. *MeasurementGroups* that are under the same parent *MeasurementLocation* must have unique names, no longer than 4 characters. An example of a *MeasurementGroup* MGRP as visible in the IMM hierarchy view is shown in the below figure. Also the *AnalogValues*, MVAR_SValue and MW_SValue that are sourced from ICCP, both reference the MGRP.

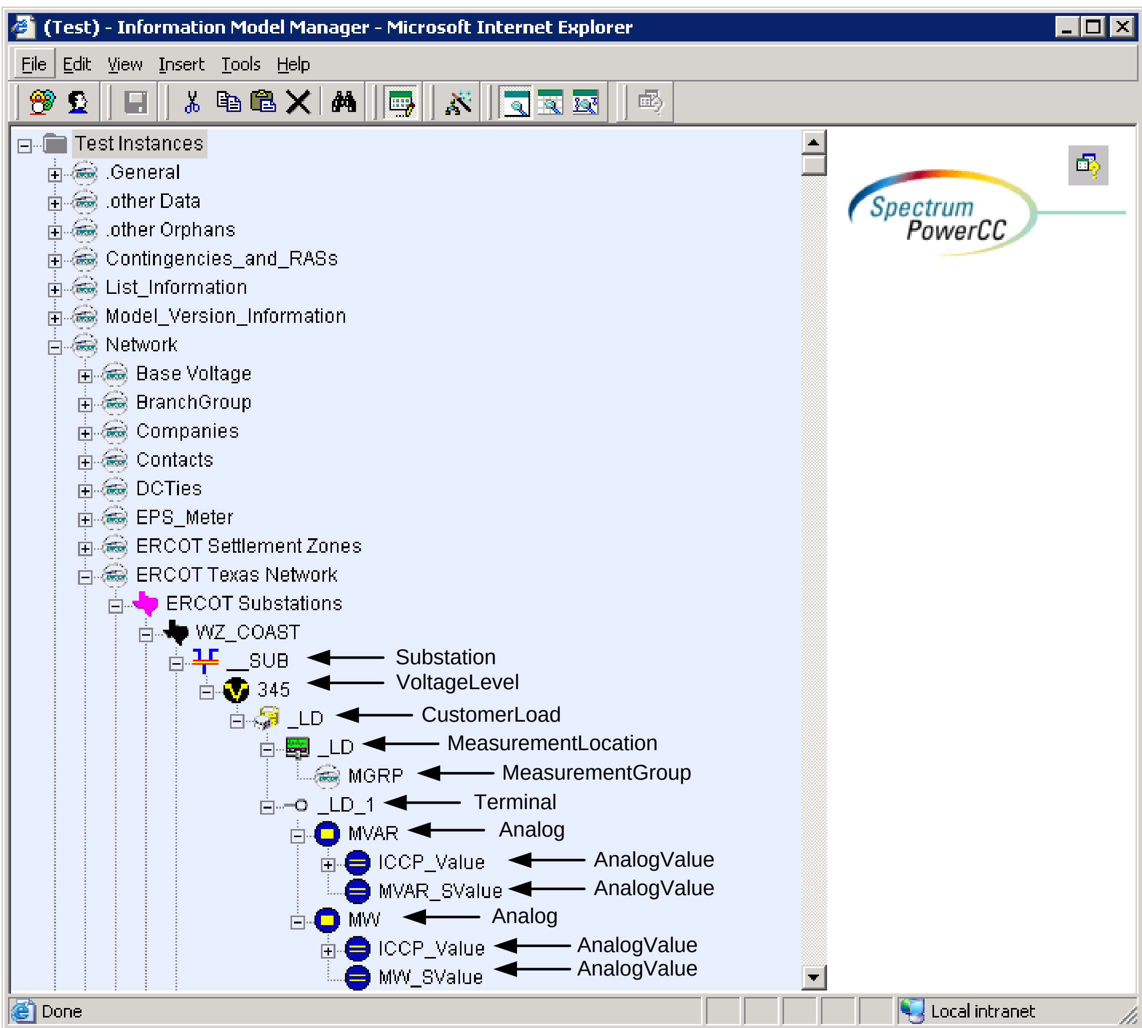


Figure 26 - IMM hierarchical view of a load with multiple SCADA measurements.

13.1.2.1 Attributes

The attributes for a *MeasurementGroup* are shown in the table below.

Attribute	Description	Data Type	DefaultValue	Sample Data
Zonal Attribute	**Temp Attribute to support dual SCADA feeds.**	**Boolean**	**False**	**False**
Alias Name	Free text name of the object or instance.	String	None	XYZ
buffer Period	Number of seconds to wait for a cluster of exceptions to be reported.	Short Integer	None	3
Description	Description of the object or instance.	String	None	XYZ
grace Period	Number of seconds to wait before declaring an expected scan "late".	Short Integer	None	5
integrity Period	Number of seconds between integrity scans.	Short Integer	None	3
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	XYZ
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	None	323
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	XYZ
scan Period	Number of seconds between scans.	Short Integer	None	4

©2009 Electric Reliability Council of Texas, Inc.

13.1.3 Modeling Approach for a Calculation

A *Calculation* is a type of *MeasurementValueSource* for *Analog* and *Discrete* measurements in the network model. *Calculations* are usually defined when a physical quantity desired to be monitored at a particular equipment isn't directly measured but can be computed using one or more direct/derived measurements.

In the ERCOT CIM model, a *Calculation* is modeled under a *MeasurementLocation* using one or many *MeasurementArguments* and/or *ConstantArguments*. An example of a *Calculation* CALC is visible in the hierarchy view in the figure. Note that, all *Calculations* under the same parent *MeasurementLocation* should have unique names, no longer than 4 characters as well.

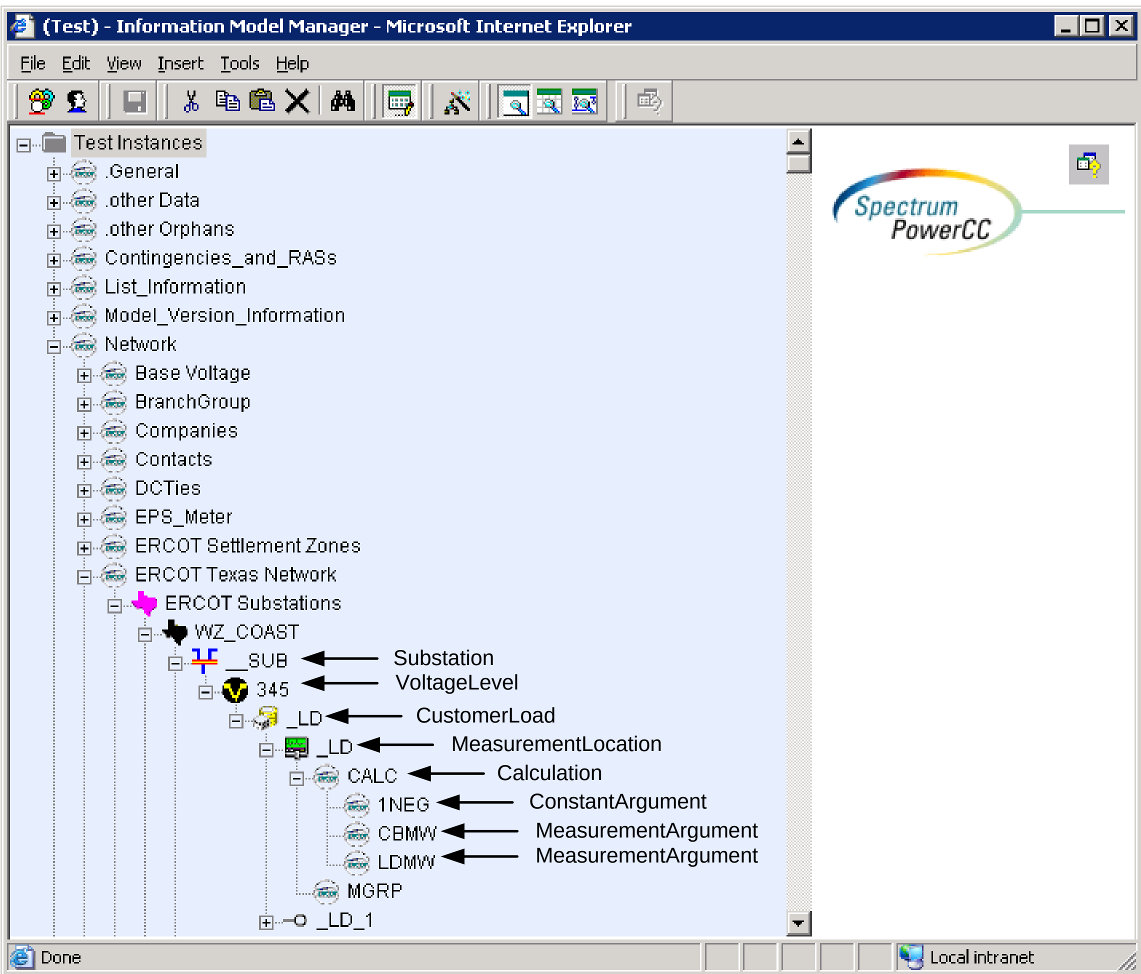


Figure 27 - IMM hierarchical view of a calculation definition.

13.1.3.1 Attributes

The attributes for a *Calculation* are shown in the table below.

Attribute	Description	Data Type	Default	Sample

				Data
Zonal Attribute	Temp Attribute to support dual SCADA feeds.	Boolean	False	False
Alias Name	Free text name of the object or instance.	String	None	XYZ
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	XYZ
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	None	232
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	XYZ
Type	Type	String	None	XYZ

13.1.3.2 Linkage

The required links for a *Calculation* are defined in the table below.

Link Name	Description	Path Name
CalculationTriggeredByCalculationTriggerTimer	Identifies Timer to be used to trigger re-computations when the inputs change.	List_Information/Calculation Trigger Timers
CalculationUsesFunction	Identifies the function used to do the Calculation	List_Information/Functions

13.1.4 Modeling Approach for MeasurementArgument

When creating *Calculations* in the ERCOT CIM model, input/output parameters that involve *Analog* and *Discrete* measurements are defined using instances of type *MeasurementArgument*. Each *MeasurementArgument* must be associated to a single SCADA *AnalogValue* and/or

SCADA *DiscreteValue* in the model. Note that the output parameter of a *Calculation* should always be *MeasurementArgument* whereas not all input parameters of a *Calculation* need be of type *MeasurementArgument*.

As mentioned in earlier sections, *MeasurementArguments* are created under a *Calculation*. The *Calculation* CALC shown in the hierarchical view in figure has two *MeasurementArguments*, namely CBMW and LDMW as its input/output parameters.

13.1.4.1 Attributes

The attributes for a *MeasurementArgument* are shown in the table below.

Attribute	Description	Data Type	Default	Sample Data
referenceflag	True when the Measurement is an input and False when the Measurement is an output.	Boolean	False	False
triggerFlag	True if a change in the value of the associated MeasurementValue triggers a recalculation of the output	Boolean	False	False
Zonal Attribute	Temporary attribute to support dual SCADA feeds.	Boolean	False	False
Alias Name	Free text name of the object or instance.	String	None	XYZ
Description	Description of the object or instance.	String	None	XYZ
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	None	343
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	XYZ
Reference Name	If this is a Reference, name for the reference.	String	None	XYZ

13.1.4.2 Linkage

The required links for a *MeasurementArgument* are defined in the table below.

Link Name	Description	Path Name

AssignedTo(FunctionArgument)	Identifies to which function argument of the function it belongs to.	List_Informatio n/Functions/
MappedTo(MeasurementValue)	Identifies a MeasurementValue that is acting as an input/output feed to/for this MeasurementArgument.	

13.1.5 Modeling Approach for ConstantArgument

In addition to *MeasurementArguments*, the ERCOT data dictionary allows scalar inputs parameters to be defined for a *Calculation* using instances of type *ConstantArguments*. Similar to *MeasurementArgument* modeling, *ConstantArguments* are modeled under a *Calculation* as well. *ConstantArguments* can only serve as input parameters of a *Calculation*. The IMM hierarchical view for the *Calculation* CALC in figure shows one such *CalculationArgument*, namely 1NEG as its input.

13.1.5.1 Attributes

The attributes for a *ConstantArgument* are shown in the table below.

Attribute	Description	Data Type	Default	Sample Data
referenceflag	True when the Measurement is an input and False when the Measurement is an output.	Boolean	False	False
Zonal Attribute	Temporary attribute to support dual SCADA feeds.	Boolean	False	False
Alias Name	Free text name of the object or instance.	String	None	XYZ
LocalName	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	XYZ
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	None	232
Path Name	The pathname is a system unique name	String	None	XYZ

	composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.			
Reference Name	If this is a Reference, name for the reference.	String	None	XYZ

13.1.5.2 Linkage

The required links for a *ConstantArgument* are defined in the table below.

Link Name	Description	Path Name
AssignedTo(FunctionArgument)	Identifies to which function argument of the function it belongs to.	List_Information/Function/ FuctionArgument
MappedTo(ConstantValue)	Identifies a ConstantValue that is acting as an input/output feed to/for this ConstantArgument.	

13.1.6 Modeling Function and FunctionArguments

In the ERCOT CIM model *Functions* are utilized to define commonly use mathematical computations pertaining to SCADA measurements. *Functions* get referenced when defining *Calculations* in the model. Some of the function definitions available for re-use in the ERCOT CIM model include absolute value (ABS), addition (ADD3), average (AVG1), bestOf (BEST), division (DIV), multiplication (MULT) and MVA-computation (MVA1). A list of all available Functions in the model can be viewed in the IMM hierarchy at the path List_Information/Functions.

The CIM model uses *FunctionArguments* to define the characteristic features of the input and output parameters of a function. The attributes ReadFlag and WriteFlag for a *FunctionArgument* are of special importance. As the names suggests ReadFlag and WriteFlag help define the I/O nature of the parameter, i.e. the parameter will be considered as an input to the function when it's ReadFlag = True and WriteFlag = False. Similarly the variant will be considered as an output to the Function when it's ReadFlag = True and WriteFlag = False. In the CIM model *FunctionArguments* get referenced when defining *MeasurementArguments* and/or *ConstantArguments* for a *Calculation*.

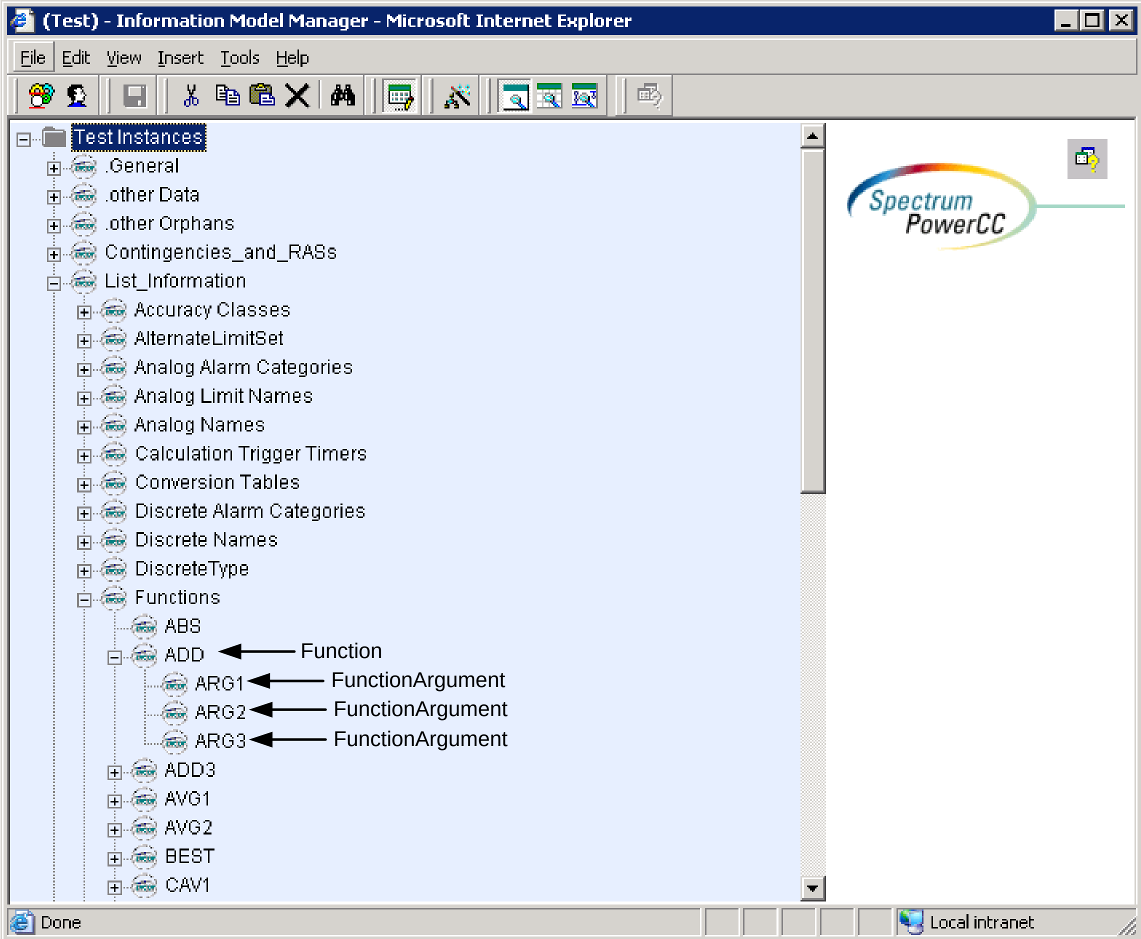


Figure 28 - IMM hierarchical view of a Function definition in the ERCOT model.

An example of the function ADD is visible in the figure. This function has three *FunctionArguments* under it namely, ARG1, ARG2 and ARG3. When defining Calculations in the model the total number of input/output parameters (*MeasurementArguments* and/or *ConstantArguments*) is limited by the total number of *FunctionArguments* defined in the referenced Function. Thus if a *calculation* is to be modeled by referencing the *Function* ADD, it must have 3 input/output parameters (*MeasurementArguments* and/or *ConstantArguments*) modeled as its children.

13.1.7 Modeling Approach for Analog and Discrete Measurement

The ERCOT data dictionary defines *Analog* and/or *Discrete* measurement as any measured, calculated or non-measured quantity. Any piece of equipment in the model can have measurements, e.g. a substation may have temperature measurements and door open indications, a transformer may have oil temperature and tank pressure measurements, a bay may contain a number of power flow measurements and a breaker may contain a switch status measurement.

As mentioned earlier, in the ERCOT model *Analog* and *Discrete* measurements are created under a terminal. The choice of a measurement is dependent on the nature of the physical quantity being measured. For example, MW/MVAR/MVA measurements will be identified as Analog measurement in the ERCOT model, whereas Status-like binary-logic based measurements will be classified as Discrete measurements in the ERCOT model.

13.1.7.1 Attributes

The attributes for *Analog* and *Discrete* measurements are shown in the table below.

Attribute	Description	Data Type	Default	Sample Data	Analog	Discrete
ForNetwork	In the case of SCADA measurement this boolean needs to be set to False.	Boolean	False	False	X	
Zonal Attribute	Temp Attribute to support dual SCADA feeds.	Boolean	False	False	X	X
Transmission Element ID	Transmission Element ID.	Long Integer	Auto Populated	343	X	X
Alias Name	Free text name of the object or instance.	String	None	XYZ	X	X
Description	Description of the object or instance.	String	None	XYZ	X	X
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	XYZ	X	X
Maximum Value	Normal value range maximum for any of the MeasurementValue.values. Used for scaling, e.g. in bar graphs or of telemetered raw values.	Float	None	23	X	X

Minimum Value	Normal value range minimum for any of the MeasurementValue.values. Used for scaling, e.g. in bar graphs or of telemetered raw values.	Float	None	34	X	X
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	String	234	X	X
Normal Value	Normal measurement value, e.g., used for percentage calculations.	Float	None	34	X	X
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	XYZ	X	X
Positive Flow In	If true then this measurement is a MW, MVAR or AMPS with the convention that a positive value measured at the Terminal means power is flowing into the related PowerSystemResource.	Boolean	False	False	X	

13.1.7.2 Linkage

The required links for *Analog* and *Discrete* measurements are defined in the table below

Link Name	Description	Path Name	Analog	Discrete
Measurement UsesAMeasur ementType	Specify the type of measurement ex. threephasepower, threephasereactivepower, threephaseactivepower, linecurrent, etc.	List_Information/Me asurementType	X	X
Measurement UsesAUnit	Dimension of the telemetered value. Ex. MVA, MW, MVAr, A, etc.	List_Information/Unit s	X	X
Measurement MemberOfPo	The device identified in this association is exactly same as the parent device of	Network/ERCOTTex asNetwork/ERCOTS	X	X

werSystemResource	the associated terminal.	ubstations/WeatherZone/Substation/VoltageLevel/Device		
Measurement OwnedByOwnership	The operator of equipment has the right to edit the equipment. An operator can only be assigned by the creator or owner of the equipment.	Network/Companies	X	X
Measurement OwnedByOperatorship	The owner of equipment has editing and administrative rights. An owner can only be assigned by the creator of the equipment.	Network/Companies	X	X

13.1.8 Modeling Approach for SCADA AnalogValue and DiscreteValue

The ERCOT data dictionary utilizes AnalogValues and/or DiscreteValues to define current state for the Analog and/or Discrete measurement. A state value is an instance of a measurement from a specific source. Analog and/or Discrete measurements can be associated with many state values, each representing a different source for the measurement.

In the ERCOT CIM model AnalogValues and/or DiscreteValues are used to define inputs for the EMS SCADA database or the ICCP database by variations in the linkages of AnalogValue and/or DiscreteValue. For simplicity the prior type of AnalogValue and/or DiscreteValue is referred as SCADA measurementvalue and the later is referred as ICCP measurementvalue this section onwards. The current section will describe the modeling subtleties of SCADA measurementvalues whereas the ICCP measurementvalues will be covered in the following sections.

All Analog and/or Discrete measurements irrespective of their *MeasurementValueSource* should have a SCADA *MeasurementValue* of appropriate type created under it. The hierarchical view in the figure shows the AnalogValue MVAR_SValue created under the Analog MVAR.

13.1.8.1 Attributes

The attributes for a SCADA *AnalogValues* and *DiscreteValues* are shown in the table below.

Attribute	Description	Data Type	Default Value	Sample Data	Analog	Discrete
Abnormal Alarm Delay Time	The number of seconds for the alarm to remain on the persistence alarm list before toning/alarming because it remained in the violated state.	Long Integer	None	23	X	X
Abnormal For Alarm	This flag is used to cause alarm messages for abnormals to have their date/time displayed in	Boolean	False	False	X	X

	black in the Alarm displays instead of red (assuming the HABITAT FG element set).					
Abnormal For SCADA	Setting this flag to true does not affect Alarm displays, but forces the record to appear Normal on SCADA displays.	Boolean	False	False	X	X
Audible Tone	A flag indicating that notifications of alarm conditions via audible tones and horns will be suppressed.	Boolean	False	False	X	X
Auto Acknowledge	When set to true, this flag specifies that alarms will be automatically acknowledged on return to normal. This will only occur if the Alarm Return to Violations flag is not set on the Limit Names table.	Boolean	False	False	X	X
Auto Ack and Delete Alarms	Automatically acknowledge and delete alarms if the Analog is manually entered or successfully controlled by the operator to a normal state.	Boolean	False	False	X	X
Block via Primary Site	Block Value and Quality update via Primary Site: Do not allow update from the primary site.	Boolean	False	False	X	X
Block via Secondary Site	Block Value and Quality update via Secondary Site: Do not allow update from the secondary site.	Boolean	False	False	X	X
byPass	When set to true, this flag specifies allowing bypass entry of Suspect values if telemetered from a remote site or SCADA Front End.	Boolean	False	False	X	X
Control Demand Scan	True = Issues a demand scan request to the RTU at a configurable number of seconds after any successful control	Boolean	False	False	X	X

	requests are issued. This feature is primarily used by measurements with a slow scan rate to provide more timely feedback on the success or failure of the control operation.					
Initially Inhibit	A flag indicating that when the system first comes online, alarm indications for this SCADA entry will initially be inhibited.	Boolean	False	False	X	X
Inhibit Abnormal For Alarm	Permanently Inhibit the flag of abnormalForAlarm.	Boolean	False	False	X	X
Inhibit Abnormal For SCADA	Permanently Inhibit the flag of abnormalForSCADA.	Boolean	False	False	X	X
Inhibit Audible Tone	Permanently Inhibit the flag of audibleTone.	Boolean	False	False	X	X
Inhibit Logging and Alarm List	Permanently Inhibit the flag of loggingAndAlarmList	Boolean	False	False	X	X
Inhibit Unacknowledged Alarm List	Permanently Inhibit the flag of unacknowledgedAlarmList.	Boolean	False	False	X	X
Logging and Alarm List	Permanently Inhibit the flag of loggingAndAlarmList.	Boolean	False	False	X	X
Not In Service	flag indicating not in service.	Boolean	False	False	X	X
Override Default Inhibit Definition	A flag indicating that that the Operator Inhibit Definition overrides the Global Default Inhibit.	Boolean	False	False	X	X
Record Historical Data	When set to true, this flag specifies that state changes on the Analog are recorded in the historical data review file.	Boolean	False	False	X	X
Return to Normal Alarm Delay Time	The number of seconds for the alarm to remain on the persistence alarm list before toning/alarming because it remained in the	Boolean	False	False	X	X

	normal state.					
Time Delay	The number of seconds after the control request is successfully issued before sending a demand scan request to the associated RTU.	Boolean	False	False	X	X
Unacknowledged Alarm List	Permanently Inhibit the flag of unacknowledgedAlarmList.	Boolean	False	False	X	X
XEnable Auto SE Replacement	TRUE = Allow automatic State Estimator replacement. Automatically substitute the display value with a good quality state estimated value if the quality of the telemetered Analog becomes SUSPECT.	Boolean	False	False	X	
Invert Analog Via Secondary Site	TRUE = Negate the Analog value when received from the secondary site.	Boolean	False	False	X	
Invert Sign	When set to true, this flag specifies that the Analog value, as received by SCADA, is inverted before using in other applications.	Boolean	False	False	X	
Negative Uni-Polar Clamping	True = positive values will be forced (clamped) to zero before updating into the database.	Boolean	False	False	X	
Peak Data	When set to true, this flag specifies that the Peak Data Processing task will sample this Analog.	Boolean	False	False	X	
Positive Uni-Polar Clamping	TRUE = negative values will be forced (clamped) to zero before updating into the database.	Boolean	False	False	X	
SE Deadband	Display values of good quality which are different than a good quality state-estimated value by more than this amount are	Boolean	False	False	X	

	considered anomalous, and automatically substituted with the state-estimated value, if the global Automatic State-Estimator Replacement function is enabled.					
Zero Clamping Deadband	If value is greater than zero, then any value between zero and the entered value will be forced (clamped) to zero for update into the database.	Boolean	False	False	X	
Invert Status	True = The status point value, as received by SCADA, is inverted before using in other applications.	Boolean	False	False		X
Invert Extended Status via ISD	True = The extended status bit (XIS) will be inverted when received from the primary site.	Boolean	False	False		X
Invert Extended Status Via Sec Site	True = The extended status bit (XIS) will be inverted when received from the secondary site.	Boolean	False	False		X
Invert Status Bit Received Via ISD	True = The status bit (SIS) will be inverted when received from the primary site.	Boolean	False	False		X
Invert Status Bit Received Via Sec Site	True = The status bit (SIS) will be inverted when received from the secondary site.	Boolean	False	False		X
Momentary Change Detection	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Boolean	False	False		X
No ISD Download	True = Even though the Point is associated with a remote site, the Point will not be included in the Intersite Data download request for status values to the remote site. The	Boolean	False	False		X

	remote site is only used for determining which site to send Supervisory Controls to.					
No Warning if Hanging	Don't issue warning message if a lone Topology Node is defined, which is not defined on any other record within the Substation.	Boolean	False	False		X
status Bit Live Indication	T = S bit true indicates LIVE, false indicates DEAD; F = S bit true indicates DEAD, false indicates LIVE.	Boolean	False	False		X
Tap Changer Timeout	The timeout between steps of a multiple raise/lower supervisory control sequence for a tap changer.	Boolean	False	False		X
Three State	True = A three-state point is modeled.	Boolean	False	False		X
Alias Name	Free text name of the object or instance.	String	None	XYZ	X	X
Allow SELECT Step	TRUE = a separate SELECT action is allowed (but not required) prior to the supervisory control action.	Boolean	False	False	X	X
Component Status	True when value represents status of communication path component.	Boolean	False	False	X	X
Description	Description of the object or instance.	String	None	XYZ	X	X
from Calculation	When set to true, this flag specifies the source of the data is from Calculation, set to false otherwise.	Boolean	False	False	X	X
From External Program	When set to true, this flag specifies the source of the data is an external program, set to false otherwise.	Boolean	False	False	X	X

from Manual Entry	When set to true, this flag specifies the source of the data is from Manual Entry, set to false otherwise.	Boolean	False	False	X	X
from Remote	When set to true, this flag specifies the source of the data is ICCP, set to false otherwise.	Boolean	False	False	X	X
HABC Name	Connection ID of value using HABConnect.	String	None	False	X	X
ISD Name	Dollar-separacted SCADA Composite ID.	String	None	False	X	X
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	XYZ	X	X
Mapped In OAG	T = This data-point is also represented in the OAG model as a data item (designated member of a data packet).	Boolean	False	False	X	X
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	None	XYZ	X	X
Path Name	The pathname is a system unique name composed	String	None	XYZ	X	X

	from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.					
Require EXECUTE Step	True = a supervisory control action is not initiated when a control action is received, and must wait for an additional EXECUTE action.	Boolean	False	False	X	X
Require SELECT Step	TRUE = a separate SELECT action is required before a supervisory control action.	Boolean	False	False	X	X
Sensor Accuracy	The limit, expressed as a percentage of the sensor maximum, that errors will not exceed when the sensor is used under reference conditions.	Double Float	None	45	X	X
Tabular Display Priority	Priority of tabular display.	Long Integer	0	3	X	X
Time Stamp	The time when the value was last updated.	Date Time	None	3/4/2009	X	X
Value	Value of measurement.	Float	None	4	X	X
VMD Scope	True when value has VMD scope.	Boolean	False	False	X	X
Zonal Attribute	Temp Attribute to support dual SCADA feeds.	Boolean	False	False	X	X
Control MMI Sequence	true = override any default settings.	Boolean	False	False	X	
From State Estimator	When set to true, this flag specifies the source of the data is state estimator; otherwise it is usually set to False.	Boolean	False	False	X	
Historical Recording Deadband	Threshold (percentage currently recorded Analog data) above which additional data points should not be retained.	Double Float	0	45.6	X	
Negate Value	When set to true, this flag	Boolean	False	False	X	

Received from ISD	specifies that the polarity of the Analog value received via ISD will be switched.					
Skip Limit Checking	When set to true, this flag specifies disable reasonability limit checking for this Analog.	Boolean	False	False	X	
Zero Clamping Deadband	If value is greater than zero, then any value between zero and the entered value will be forced (clamped) to zero for update into the database.	Float	None	4.5	X	
Allow Control from Foreign Sites	True = Another site may issue a control on this point.	Boolean	False	False		X
Allow Multiple Raise or Lower	True = Multiple Tap Raise and Lower commands may be issued consecutively without re-selecting the...	Boolean	False	False		X
Feedback Analog	True = The Analog Name which is configured to provide feedback of the associated Analog value for control completion checks of Raise/Lower supervisory controls. The chosen Analog must be modeled under the same Device as the controlling Point record. This field is optional.	String	None	XYZ		X
Log for Control Issued	True = Controls issued on this point will be logged in the system activity log.	Boolean	False	False		X

13.1.8.2 Linkage

The required links for SCADA *AnalogValues* and *DiscreteValues* are defined in the table below.

Link Name	Description	Path Name	Analog	Discrete

BelongTo(Site)	Identifies a SCADA Site that is used to transfer data measured by this measurement. W.r.t. to Nodal model, sites, QSE1-QSE3 and TSP1-TSP3are usually used with certain exceptions.	List_Information/Site	X	X
HasSecondary(Site)	Identifies a backup SCADA Site that may be used to transfer data measured by this measurement. W.r.t. to Nodal model, sites, QSE4-QSE7 and TSP4-TSP7 are usually used with certain exceptions.	List_Information/Site	X	X
CalculatedBy(Calculation)	Identifies the Calculation to which this measurement belongs.		X	X
GroupedBy(MeasurementGroup)	Identifies the measurement group to which this measurement belongs.	Points to the Measurement Group created under a Measurement Location	X	X
BelongTo (Analog Alarm Category)	Identifies whether an Analog Value belongs to Analog Alarm Category	List_Information/Analog Alarm Categories	X	
HasNameof(AnalogName)	The name of the Analog value	List_Information/Analog Names	X	
HasA(Accuracy Class)	Identifies if the Analog value has an accuracy class	List_Information/Accuracy Classes	X	
BelongTo (Discrete Alarm Category)	Identifies whether a Discrete Value belongs to Discrete Alarm Category	List_Information/Discrete Alarm Categories		X
HasNameof(DiscreteName)	The name of the Discrete value	List_Information/Discrete Names		X
Has(ConversionTable)	Identifies whether a Discrete value has a Conversion Table	List_Information/Conversion Tables		X
HasTypeof(DiscreteType)	Identifies whether a Discrete Value has type of Discrete type.	List_Information/Discrete		X

		Type		

13.1.9 Modeling Approach for Auxiliary SCADA Lists

This subsection briefly describes the various auxiliary SCADA lists in the ERCOT CIM model that are utilized when creating SCADA *Analog* and/or *Discrete measurementvalues*.

- Sites: The Sites table is used to define valid SCADA sites, including the local site. Each Point, Analog, and Count Record in the model must be associated with a SCADA Site record in this table. Only data retrieved via intersite data will be associated with any site other than the local site name. In the ERCOT model, DE is the designated local site. The various other sites currently defined and used in the ERCOT model are, QSE1, QSE2, QSE3, QSE4, QSE5, QSE6, QSE7, SI, TSP1, TSP2, TSP3, TSP4, TSP5, TSP6, TSP7, etc..

- Analog Alarm Category: This reference table is used to define Analog alarm category information for the SCADA subsystem. The Analog alarm categories currently defined and used in the ERCOT model are: AL and BB.

- Discrete Alarm Category: This reference table is used to model SCADA Discrete Alarm Category information. The Discrete alarm categories currently defined and used in the ERCOT model are, AL, BB, AL, AV, B1, B2, B3, B4, and SS.

- Analog Name: This reference table is used to define various types of Analog measurements that can be defined in the ERCOT CIM model. Some of the Analog Names currently defined and used in the ERCOT model are, AMP, MW, MVA, MVAR, HZ etc.

- Discrete Name: This reference table is used to define various types of Discrete measurements that can be defined in the ERCOT CIM model. Some of the Discrete Names currently defined and used in the ERCOT model are, ST, AVR, RBST, etc.

- Permission Areas: This reference table is used to define valid areas of responsibility for SCADA measurements. The Permission areas currently defined and used in the ERCOT CIM model are, AL, COMMS, EAST, ECAR, ERCOT, GEN, NORT, SOUT, and SYSTEM.

- Conversion Tables: This reference table is used to specify a method of data conversion to be utilized for measurements. The only conversion table used in the ERCOT model is the OAG (Open Access Gateway).

- Accuracy Class: This reference table holds accuracy information for measurement, generation and load schedules. The accuracy classes that are currently defined and used in the ERCOT CIM model are, DCLN, KCL, KV, LD, LDHR, LDHW, LDLR, LDLW, LDMR, LDMW, etc..

- Analog Limit Names: This reference table is used to define valid Limit names and parameters to be used when defining Limit. The Analog Limit names currently defined and used in the ERCOT model are: 15MN, DA15, DAEM, DANR, DM15, DMEM, DMNR, EMGY, etc..

- Discrete Type: This reference table is used to define parameters for switching devices, such as breakers or disconnects, in the SCADA topology model. The various Discrete Types defined currently defined and used in the ERCOT model are, CA_M, COO, HU_T, IN_T, MNB, MOB, MOO, N_A, N_T, O_C, O_C1, etc.

- DeviceTypeName: This reference table is used to define the SCADA device type names The various Discrete Types defined currently defined and used in the ERCOT model are, BKR, BS, BUS, CAP, CB, LD, GEN etc.. More DeviceTypeNames can be found by navigating to .other Orphans/DeviceTypeName

14 MODELING ICCP

14.1 MODELING APPROACH FOR ICCP

This section describes the approach for modeling ICCP (Inter Control Center Protocol). It is used to provide data exchange between control centers, utilities, power pools, regional control centers and Non-Utility Generators. The data that is sent can be periodic system data, block data transfer, information messages, device control requests etc. Figure below shows the modeling of MVAR telemetry that is sourced from ICCP for a load as modeled in the IMM hierarchy.

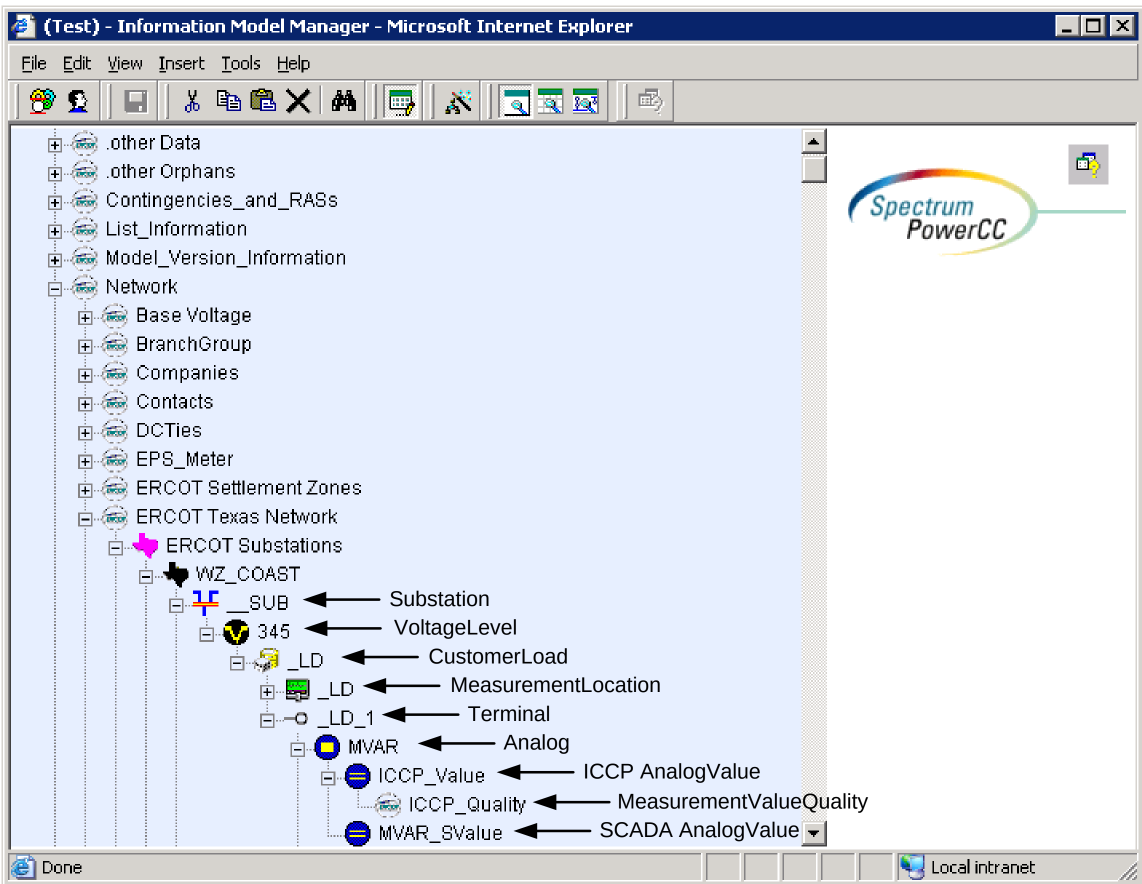


Figure 29 - IMM hierarchical view of ICCP-sourced measurements in the ERCOT model.

As mentioned earlier the ERCOT CIM model allows multiple *AnalogValues* and/or *DiscreteValues* to be associated with the same *Analog* and/or *Discrete* measurement parent. This feature is exploited when modeling Analog and/or Discrete measurements that are sourced from ICCP in the ERCOT model. In practice the ERCOT CIM model allows a maximum of three *AnalogValue* and/or *DisceteValues* to reside under the same *Analog* and/or *Discrete* parent. As mentioned in the earlier section on SCADA one amongst these three *AnalogValues* and/or *DiscreteValues* is the SCADA *measurementvalue* that holds information necessary to define the instance in the EMS SCADA database and the other two may be utilized to provide information relevant to the ICCP source. An *Analog* and/or *Discrete* measurement may contain two ICCP *measurementvalues* in the scenarios when the telemetered ICCP value is desired to be visible in both ERCOT TSP and ERCOT QSE ICCP database. The modeling of ICCP will be described in the sections to follow.

14.2 MODELING APPROACH FOR ICCP ANALOGVALUE AND DISCRETEVALUE

The ERCOT CIM model utilizes *AnalogValue* and *DiscreteValues* to model ICCP related data. The current section will identify the modeling subtleties of ICCP measurementvalues. As mentioned earlier the ICCP *AnalogValue* and/or *DiscreteValue* is created under an *Analog* and/or *Discrete* measurement in the IMM hierarchy. In the figure below the *AnalogValue*, ICCP_Value is the ICCP *AnalogValue* that holds information relevant to the ICCP source of the MVAR Analog measurement. It is imperative for a SCADA *AnalogValue*/*DiscreteValue* to be defined under the same Analog parent utilizing the modeling approach described in the previous sections.

14.2.1 Attributes

The attributes for ICCP *AnalogValues* and *DiscreteValues* are shown in the table below.

Attribute	Description	Data Type	Default Value	Sample Data	Analog	Discrete
Remote Site Normally Calculated.	Remote site normally calculated. True for ICCP, false otherwise.	Boolean	False	False	X	X
Remote Site Normally Estimated	Remote site normally estimated. True for ICCP, false otherwise.	Boolean	False	False	X	X
Remote Site Normally Manually Entered	Remote site normally manually entered. True for ICCP, false otherwise.	Boolean	False	False	X	X
Remote Site Normally Telemetered	Remote site normally telemetered. True for ICCP, false otherwise.	Boolean	False	False	X	X
ICCP Data Set Period	ICCP data set period used for the measurement.	Long Integer	None	3	X	X

14.2.2 Linkage

The required links for ICCP *AnalogValues* and *DiscreteValues* are defined in the table below.

Link Name	Description	Path Name	Analog	Discrete
MeasurementValue Source	MeasurementValueSource describes the alternative sources updating a MeasurementValue.	Network/Companies / MeasurementValueSource	X	X

14.3 MODELING APPROACH FOR MEASUREMENTVALUEQUALITY

MeasurementValueQuality codes are flags which are utilized to know the quality of the data that is received or sent by or to ERCOT. There are various quality codes that are used by ERCOT and the MarketParticipant to communicate about the quality of data. In the ERCOT model a *MeasurementValueQuality* must be modeled under the ICCP *AnalogValue* or *DiscreteValue*. The following figure shows this hierarchical association between *AnalogValue*/*DisceretValue* and a *MeasurementValueQuality* the *MeasurementValueQuality*, ICCP_Quality modeled under the ICCP *AnalogValue* ICCP_Value.

14.3.1 Attributes

The attributes for ICCP *MeasurementValueQuality* are shown in the table below

Attribute	Description	Data Type	Default Value	Sample Data	Analog	Discrete
hasCOV	Whether or not ICCP item has Change of Value modifier.	Boolean	False	False	X	X
hasquality	Whether or not ICCP item has Quality modifier.	Boolean	False	False	X	X
hasTimeStamp	Whether or not ICCP item has Timestamp modifier.	Boolean	False	False	X	X
ZonalAttribute	Temporary attribute to support dual SCADA feeds.	Boolean	False	False	X	X
Alias Name	Free text name of the object or instance.	String	None	XYZ	X	X
Bad Reference	Measurement value may be incorrect due to a reference being out of calibration.	Boolean	False	False	X	X
Description	Description of the object or instance.	String	None	XYZ	X	X
Estimator Replaced	Value has been replaced by State Estimator. estimatorReplaced is not an IEC61850 quality bit but has been put in this class for convenience.	Boolean	False	False	X	X

Failure	This identifier indicates that a supervision function has detected an internal or external failure, e.g. communication failure.	Boolean	False	False	X	X
LocalName	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	XYZ	X	X
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	None	XYZ	X	X
Old Data	Measurement value is old and possibly invalid, as it has not been successfully updated during a specified time interval.	Boolean	False	False	X	X

Operator Blocked	Measurement value is blocked and hence unavailable for transmission.	Boolean	False	False	X	X
Oscillatory	To prevent some overload of the communication it is sensible to detect and suppress oscillating (fast changing) binary inputs. If a signal changes in a defined time (tosc) twice in the same direction (from 0 to 1 or from 1 to 0) then oscillation is detected and the detail quality identifier 'oscillatory' is set. If it is detected a configured numbers of transient changes could be passed by. In this time the validity status 'questionable' is set. If after this defined numbers of changes the signal is still in the oscillating state the value shall be set either to the opposite state of the previous stable value or to a defined default value. In this case the validity status 'questionable' is reset and 'invalid' is set as long as the signal is oscillating. If it is configured such that no transient changes should be passed by then the validity status 'invalid' is set immediately in addition to the detail quality identifier 'oscillatory' (used for status information only).	Boolean	False	False	X	X

Out of Range	Measurement value is beyond a predefined range of value.	Boolean	False	False	X	X
Over Flow	Measurement value is beyond the capability of being represented properly. For example, a counter value overflows from maximum count back to a value of zero.	Boolean	False	False	X	X
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	XYZ	X	X
Source	Source gives information related to the origin of a value. The value may be acquired from the process, defaulted or substituted.	Enumeration	PROCESS	PROCESS	X	X
Suspect	A correlation function has detected that the value is not consitent with other values. Typically set by a network State Estimator.	Boolean	False	False	X	X
Test	Measurement value is transmitted for test purposes.	Boolean	False	False	X	X
Validity	Validity may be good, questionable or invalid. Refer to the Validity enumeration for more details.	Enumeration	GOOD	GOOD	X	X

14.3.2 Linkage

The required links for ICCP *MeasurementValueQuality* are defined in the table below.

Link Name	Description	Path Name	Analog	Discrete
MeasurementValueQualityMemberOfMeasurementValue	A MeasurementValue has a MeasurementValueQuality associated with it.		X	X

©2009 Electric Reliability Council of Texas, Inc.

15 MODELING RATINGS

15.1.1 Modeling Approach for Ratings

In the network model static ratings are required to be defined for different equipment types (eg. lines, transformers, etc.). In addition to defining operational thresholds for devices, these ratings help define the reasonable boundary conditions for analogs measurements telemetered on the devices as well.

The ERCOT CIM model utilizes instances of type *AnalogLimitSets* and *AnalogLimits* to model both, operational static limits of a device and SCADA limits of individual analog measurements. In the model both the Rating *AnalogLimitSets* and SCADA *AnalogLimitSets* are defined under an *Analog*. The attribute forNetwork on the parent Analog measurement is used to distinguish analogs containing Rating AnalogLimitSets (forNetwork = True) from analogs containing SCADA AnalogLimitsSets (forNetwork = False). The following sections describe the other subtle differences in modeling Rating AnalogLimitsSets and SCADA AnalogLimitSets.

15.1.2 Modeling Approach for SCADA AnalogLimitSet

SCADA *AnalogLimitSets* (AnalogLimitSet.forNetwork = False) define a group of Limits that are help set the bounds of SCADA Analog telemetry. In the current ERCOT model SCADA *AnalogLimitSets* are modeled for *Transfomers* and *Lines* only. Figure below shows the modeling of SCADA *AnalogLimitSets* for a line as modeled in the IMM hierarchy. In the figure below the SCADA AnalogLimitSet, ALS is modeled under the Analog measurement named, MVA. Note that every Analog can contain only one SCADA *AnalogLimitSet* definition.

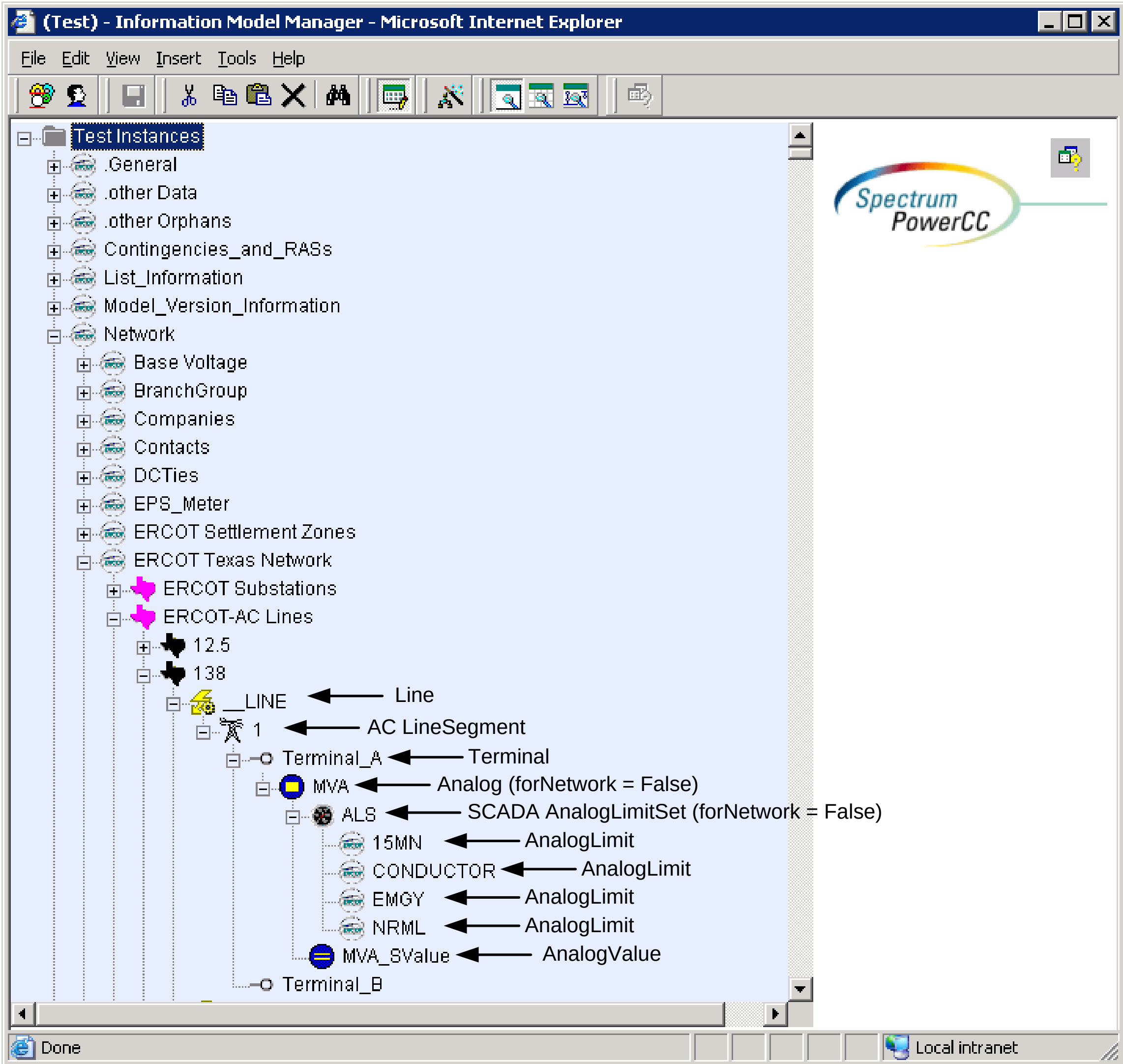


Figure 30 - IMM hierarchical view of SCADA limits in the ERCOT model.

15.1.2.1 Attributes

The attributes for *AnalogLimitSet* are shown in the table below.

Attribute	Description	Data Type	Default	Sample Data
ForNetwork	In the case of SCADA limits this boolean should be set to False.	Boolean	False	False
IsPercentageLimits	Tells if the limit values are in percentage of normalValue or the specified Unit for	Boolean	False	False

	Measurements and Controls.			
ZonalAttribute	Temp Attribute to support dual SCADA feeds.	Boolean	False	False
Alias Name	Free text name of the object or instance.	String	None	XYZ
Description	Description of the object or instance.	String	None	XYZ
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	XYZ
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	None	123
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	XYZ
Type	This value should be set to Limits when ForNetwork is False.	Enumerator	None	limits

15.1.2.2 Linkage

The required links for *AnalogLimitSet* are defined in the table below.

©2009 Electric Reliability Council of Texas, Inc.

Link Name	Description	Path Name
Belongs To (ModelingAuthoritySet)	An IdentifiedObject belongs to a Modeling Authority Set for purposes of defining a group of data maintained by the same Modeling Authority.	
Has A (Season)	Defines season associated to the rating.	

15.1.3 Modeling Approach for SCADA AnalogLimit

The ERCOT data dictionary utilizes the *AnalogLimits* to specify the limit values for the *Analog* measurement. *AnalogLimits* are modeled under the *AnalogLimitSet*. The attribute limittype is utilized to classify the type of the AnalogLimit being modeled. The commonly utilized types are fifteen minute rating, two hour rating, normal rating and conductor rating. In the ERCOT CIM model every *AnalogLimitSet* can have a maximum of four distinctly typed *AnalogLimits* as its children. In the figure below, four AnalogLimits, namely 15MN, CONDUCTOR, EMGY and NRML are modeled as under of the AnalogLimitSet, ALS.

15.1.3.1 Attributes

The attributes for *AnalogLimit* are shown in the table below.

Attribute	Description	Data Type	Default	Sample Data
LowerThreshhold	**The value below which the Analog is considered in violation of the limit. When the Upper Threshold is null, only the Lower Threshold is checked for violation.**	**Float**	**None**	**-24**
UpperThreshhold	**The value above which the Analog is considered in violation of the limit. When the low limit is null, only the high limit is checked for violation. This value must be greater than the Lower Threshold.**	**Float**	**None**	**24**
Deadband	**Amount, expressed as a percentage of the range between upper and lower threshold, used in the limit comparison to eliminate extraneous alarms generated when an Analog value oscillates around a limit. When either threshold is null, the percentage is that of the non-null limit.**	**Double Float**	**None**	**5**

LimitType	Type of limit.	Enumeration	None	Normal Rating
ForbiddenRegion	T = The Analog is in violation if it is smaller than the Upper Threshold and larger than the Lower Threshold.	Boolean	False	False
IgnoreLimitChecking	T = The limit should be ignored when checking the Analog for limit violations.	Boolean	False	False
UsePercentage	T = The value displayed in the deadband field (below) is the percentage deadband. Otherwise, the value displayed is the numeric deadband.	Boolean	False	False
Value	The value to supervise against. Should be Null for SCADA AnalogLimit.	Double Float	None	Null
Zonal Attribute	Temp Attribute to support dual SCADA feeds.	Boolean	False	False
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	XYZ
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	None	123
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	XYZ

Alias Name	Free text name of the object or instance.	String	None	XYZ

15.1.3.2 Linkage

The required links for *AnalogLimit* are defined in the table below.

Link Name	Description	Path Name
AnalogLimitBelongstoLimitAlarmCategory	Describes the type of alarm to be raised when the limit is violated. This association should be populated for SCADA AnalogLimits.	List_Information/LimitAlarmCategory
AnalogLimitHasNameofAnalogLimitName	Describes the type of AnalogLimit. This association should be populated for SCADA AnalogLimits.	List_Information/AnalogLimitNames

15.1.4 Modeling Approach for Ratings AnalogLimitSet

Ratings *AnalogLimitSets* (AnalogLimitSet.forNetwork = True) define the static ratings of a device in the model. In the current ERCOT model Rating *AnalogLimitSets* are modeled for *Transfomers* and *Lines* only. When modeling Rating *AnalogLimitSets*, modeling flexibility is available to model different sets of ratings when direction of current flow through the device changes. This flexibility can be executed by utilizing the positiveFlowIn attribute on the parent Analog.

The figure below shows the modeling of Rating *AnalogLimitSets* for a line as modeled in the IMM hierarchy. In the figure the *AnalogLimitSet* Pos_Rating_ALS contains operational ratings of the line when current is flowing into the ERCOT grid whereas the *AanlogLimitSet* Neg_Rating_ALS contains operational ratings of the line when current is flowing out of the ERCOT grid. Note that every rating Analog (Analog.forNetwork = True) can contain only one rating *AnalogLimitSet* definition and no SCADA or ICCP AnalogValue children.

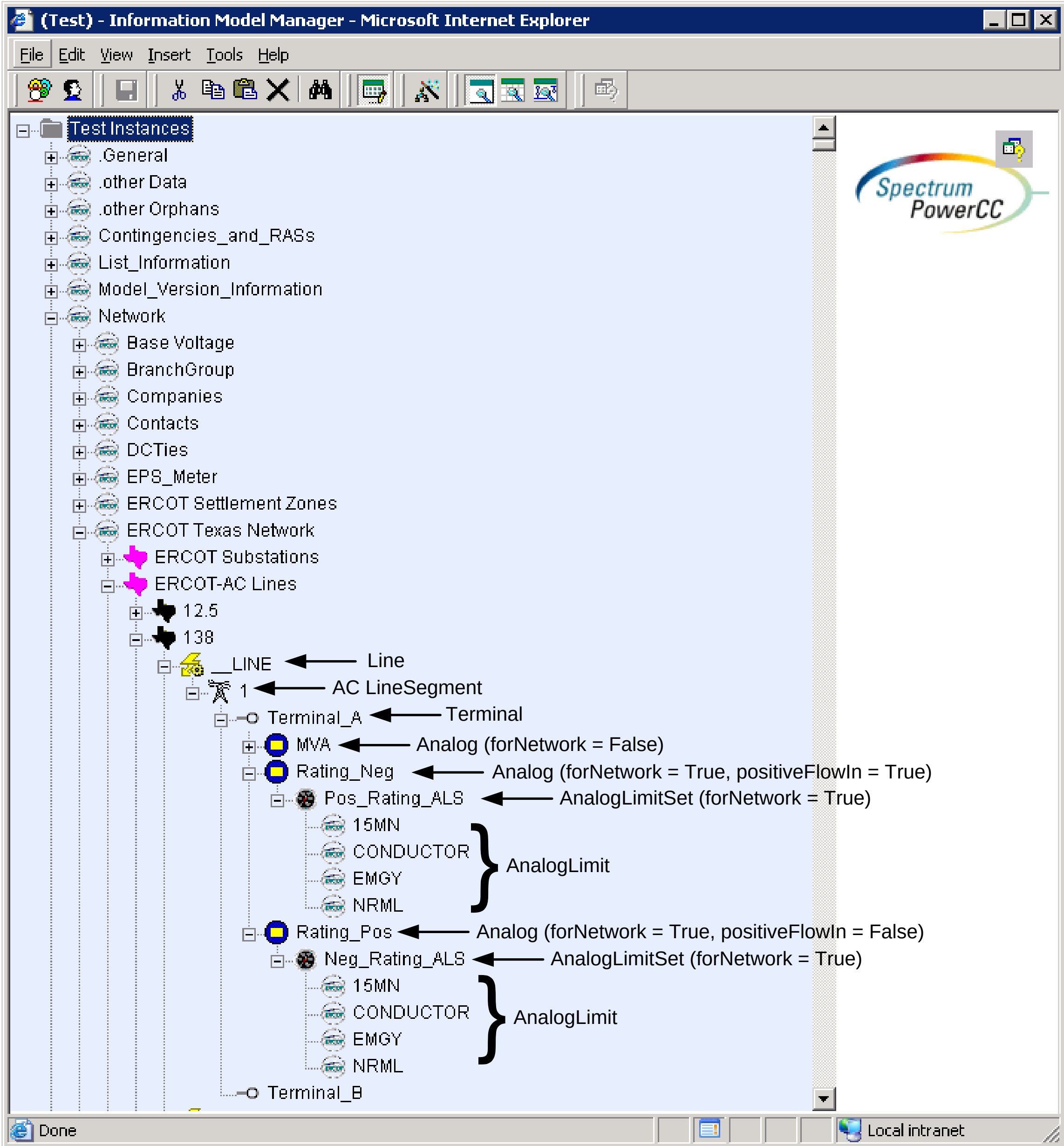


Figure 31 - IMM hierarchical view of static ratings of a device in the ERCOT model.

15.1.4.1 Attributes

The attributes for *AnalogLimitSet* are shown in the table below.

Attribute	Description	Data Type	Default	Sample Data
ForNetwork	In the case of SCADA limits this boolean should be set to False.	Boolean	False	False

IsPercentageLimits	Tells if the limit values are in percentage of normalValue or the specified Unit for Measurements and Controls.	Boolean	False	False
ZonalAttribute	Temp Attribute to support dual SCADA feeds.	Boolean	False	False
Alias Name	Free text name of the object or instance.	String	None	XYZ
Description	Description of the object or instance.	String	None	XYZ
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	XYZ
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	None	123
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	XYZ
Type	This value should be set to Limits when ForNetwork is False.	Enumerator	None	rating

15.1.4.2 Linkage

The required links for *AnalogLimitSet* are defined in the table below.

Link Name	Description	Path Name
Belongs To (ModelingAuthoritySet)	An IdentifiedObject belongs to a Modeling Authority Set for purposes of defining a group of data maintained by the same Modeling Authority.	
Has A (Season)	Defines season associated to the rating.	

15.1.5 Modeling Approach for Ratings AnalogLimit

The ERCOT data dictionary utilizes the *AnalogLimits* to specify the limit values for the Analog measurement. *AnalogLimits* are modeled under the *AnalogLimitSet*. The attribute limittype is utilized to classify the type of the AnalogLimit being modeled. The commonly utilized types are fifteen minute rating, two hour rating, normal rating and conductor rating. In the ERCOT CIM model every *AnalogLimitSet* can have a maximum of four distinctly typed *AnalogLimits* as its children. In the figure, four *AnalogLimits*, namely 15MN, CONDUCTOR, EMGY and NRML are modeled as under of the *AnalogLimitSet*, ALS.

15.1.5.1 Attributes

The attributes for *AnalogLimit* are shown in the table below.

Attribute	Description	Data Type	Default	Sample Data
Value	**The value to supervise against. Should be Null for SCADA AnalogLimit.**	**Double Float**	**None**	**Null**
Deadband	**Amount, expressed as a percentage of the range between upper and lower threshold, used in the limit comparison to eliminate extraneous alarms generated when an Analog value oscillates around a limit. When either threshold is null, the percentage is that of the non-null limit.**	**Double Float**	**None**	**5**
LimitType	**Type of limit.**	**Enumeration**	**None**	**Normal Rating**
LowerThreshhold	The value below which the Analog is considered in violation of the limit. When the Upper Threshold is	Float	None	-24

	null, only the Lower Threshold is checked for violation.			
UpperThreshhold	The value above which the Analog is considered in violation of the limit. When the low limit is null, only the high limit is checked for violation. This value must be greater than the Lower Threshold.	Float	None	24
ForbiddenRegion	T = The Analog is in violation if it is smaller than the Upper Threshold and larger than the Lower Threshold.	Boolean	False	False
IgnoreLimitChecking	T = The limit should be ignored when checking the Analog for limit violations.	Boolean	False	False
UsePercentage	T = The value displayed in the deadband field (below) is the percentage deadband. Otherwise, the value displayed is the numeric deadband.	Boolean	False	False
Zonal Attribute	Temp Attribute to support dual SCADA feeds.	Boolean	False	False
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	XYZ
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	None	123
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a	String	None	XYZ

	standard naming hierarchy path from the object to the root.			
Alias Name	Free text name of the object or instance.	String	None	XYZ

15.1.5.2 Linkage

The required links for *AnalogLimit* are defined in the table below.

Link Name	Description	Path Name
AnalogLimitBelongstoLimitAlarmCategory	Describes the type of alarm to be raised when the limit is violated. This association should be not populated for ratings AnalogLimits.	List_Information/LimitAlarmCategory
AnalogLimitHasNameofAnalogLimitName	Describes the type of AnalogLimit. This association should not be populated for ratings AnalogLimits.	List_Information/AnalogLimitNames

16 MODELING TRANSFORMERS

16.1 MODELING APPROACH

A *Transformer* is defined as an energy transformation device that transforms alternating current or voltage at one level to alternating current or voltage at another level depending on the application of the device. The two most common usages of Power Transformers are as a voltage Step-Up Transformer from generation level to transmission level and as a Step-Down Transformer from transmission level to load end users.

Transformers are modeled under a *Substation* in the ERCOT Model. The three types of transformers currently modeled are Two-winding, Three-winding and phase shifting transformers. Three-winding transformers are modeled as three two-winding transformers with a common tie at 1Kv and are associated to a *TransformerKluge*. A Power Transformer is required to have a *PowerTransformer* class, 2 *TransformerWinding* being the Primary and Secondary, Terminal for each end and a unique *TapChanger* for a *TransformerWinding* specifying if it is a Load Tap Changer or a Fixed Tap.

The following subsections shows the hierarchical association on modeling *PowerTransformer*, *TransformerWinding*,*TapChanger* and *TransformerKluge*.

16.2 MODELING APPROACH FOR POWERTRANSFORMER

PowerTransformer is modeled under *Substation* as a child instance. Transformer Type should be defined in this class depending on its operational use. The transformer types are voltageControl(regulates voltage), phaseControl(phase shifters), voltageAndPhaseControl and fix.

Figure below shows the parent/child hierarchy of a PowerTransformer in IMM.

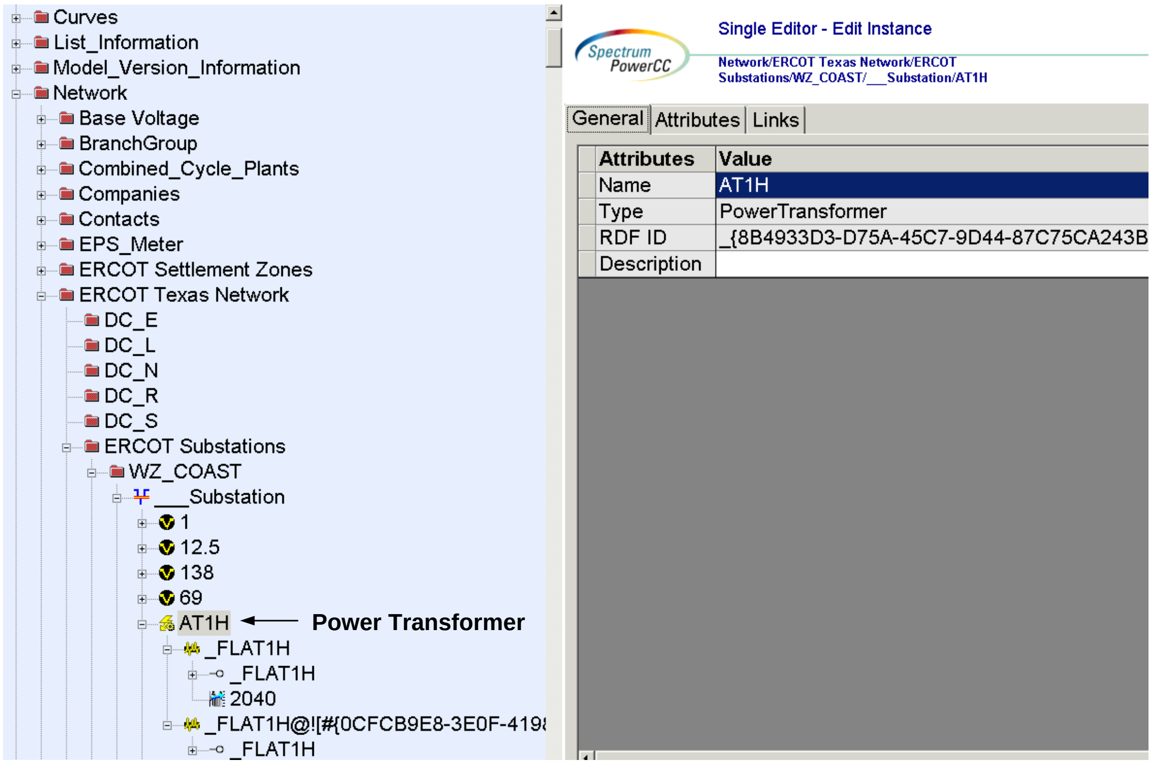


Figure 32 - Hierarchy for PowerTransformer

16.2.1 Attributes

The attributes for a *PowerTransformer* are shown in the table below.

Attribute	Description	Data Type	Default Value	Sample Data
15 minute rating Max Shadow Price	States the 15 minute rating Max Shadow price for a Transformer.	DoubleFloat	99999	
Alias Name	Free text name of the object or instance	String	None	
DAM Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	FALSE	

DAM Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	TRUE	
Emergency Max Shadow Price	States the Emergency Max Shadow price for a Transformer	DoubleFloat	99999	
Latitude	Latiitude coordinates.	DoubleFloat	None	
Local Name	The local Name is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, Voltage Level, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	
Longitude	Longitude coordinates.	String	None	
Magnetizing Saturation Flux	Core magnetizing saturation curve knee flux level.	PerCent	None	
Magnetizing Saturation Voltage	The reference voltage at which the magnetizing saturation measurements were made.	Voltage	None	
Magnetizing Susceptance Saturation	**Core shunt magnetizing susceptance in the saturation region, in per cent.**	**PerCent**	**None**	
Max Shadow Price	States the Max Shadow price for a Power Transformer.	DoubleFloat	99999	

Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	None	
OUS Priority	An Outage Scheduler priority is included in all ConductingEquipment classes except BusbarSection and TransformerWinding.	Integer	None	
PSS®E ID	**Attribute will give IMM modelers control over the PSS®E ID that the Topology Processor uses to properly name units, loads, branches, and transformers.**	**Integer**	**None**	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	
Phases	Describes the phases carried by a power transformer. Possible values { ABCN , ABC, ABN, ACN, BCN, AB, AC, BC, AN, BN, CN, A, B, C, N }.	PhaseCode	None	
RUC Monitored	he Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	FALSE	
RUC Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	TRUE	

Transformer Cooling Type	Type of transformer cooling.	EnumTransformerCoolingType	FALSE	
Transformer Type	**Transformer Type.**	**EnumTransformerType**	**None**	**voltageControl, phaseControl, fix**
Transmission Element ID	Transmission Element ID.	Integer	None	
Voltage Sensitivity	**SENSITIVITY OF VOLTAGE TO THE TRANSFORMER tap ratio.**	**PerCent**	**None**	

16.2.2 Linkage

The required links for a *PowerTransformer* are defined in table below.

Link Name	Description	Path Name
Operated By (Operatorship)	The Operatorship link is used for permission rights. The Operator of equipment has the right to edit the equipment. An operator can only be assigned by the creator or owner of the equipment.	Network/Companies
Own Percent (Ownership)	The Ownership link is used for permission rights. The owner of equipment has editing and administrative rights. An owner can only be assigned by the creator of the equipment.	Network/Companies

16.3 MODELING APPROACH FOR TRANSFORMERWINDING

TransformerWinding is modeled under *PowerTransformer* as a child instance. This is where the Impedance, Transformer Winding Ratings, Connection Type (Wye or Delta) and Winding Type (Primary and Secondary) are defined.

Figure below shows the parent/child hierarchy of a *TransformerWinding* in IMM.

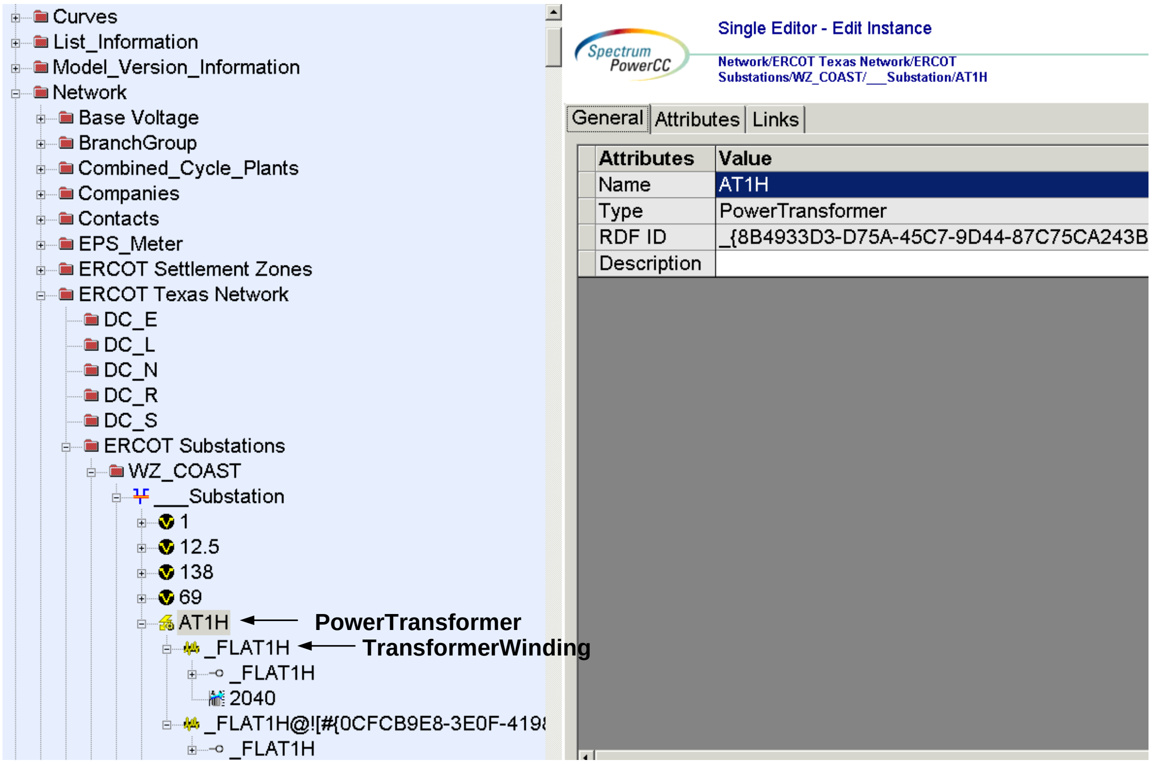


Figure 33 - Hierarchy for TransformerWinding

16.3.1 Attributes

The attributes for a *TransformerWinding* are shown in the table below.

Attribute	Description	Data Type	Default Value	Sample Data
Alias Name	Free text name of the object or instance	String	None	
Connection Type	**The type of connection of the winding (e.g. Delta, Wye, zigzag).**	**EnumWinding Connection**	**1**	

DAM Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	FALSE	
DAM Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	TRUE	
Emergency Rating	**The MVA that the winding can carry under emergency conditions.**	**ApparentPowe r**	**99999**	
Grounded	**Set if the winding is grounded.**	**Boolean**	**TRUE**	
Insulation kV	Basic insulation level voltage rating.	Voltage	None	
Latitude	Latiitude coordinates.	DoubleFloat	None	
Local Name	The local Name is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, Voltage Level, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	

Longitude	Longitude coordinates.	String	None	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	None	
Normal Rating	**The normal rating, in MVA, for the winding.**	**ApparentPower**	**99999**	
OUS Priority	An Outage Scheduler priority is included in all ConductingEquipment classes except BusbarSection and TransformerWinding.	Integer	None	
PSS®E ID	**Attribute will give IMM modelers control over the PSS®E ID that the Topology Processor uses to properly name units, loads, branches, and transformers.**	**Integer**	**None**	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	
Phases	Describes the phases carried by a power transformer. Possible values { ABCN , ABC, ABN, ACN, BCN, AB, AC, BC, AN, BN, CN, A, B, C, N }.	PhaseCode	None	
RUC Monitored	he Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	FALSE	

RUC Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	TRUE	
Rated KV	**The rated voltage (phase-to-ground) of the winding, usually the same as the neutral voltage.**	**Voltage**	**None**	
Remove	The equipment is removed from the network.	Boolean	FALSE	
Remove Enable	**The equipment can be removed from the network.**	**Boolean**	**FALSE**	
Short Term Rating	**MVA that the winding can carry for a short period of time.**	**ApparentPower**	**99999**	
Transmission Element ID	Transmission Element ID.	Integer	None	
Winding Type	**The type of winding, i.e., Primary, Secondary, Tertiary, Quaternary.**	**EnumWinding Type**	**None**	
b	**Magnetizing branch susceptance (B mag).**	**Susceptance**	**None**	
bmag Sat	Shunt magnetizing susceptance in saturation region.	Susceptance	None	
g	**Magnetizing branch conductance (G mag).**	**Conductance**	**None**	

©2009 Electric Reliability Council of Texas, Inc.

gmag Sat	Shunt magnetizing conductance in saturation region.	Conductance	None	
knee Sat	Magnetization curve saturation knee flux level (pu volts/pu hz)	Float	None	
r	**Positive sequence series resistance of the winding.**	**Resistance**	**None**	
r0	**Zero sequence series resistance of the winding.**	**Resistance**	**None**	
rground	**Ground resistance path through connected grounding transformer.**	**Resistance**	**0**	
x	**Positive sequence series reactance of the winding.**	**Reactance**	**None**	
x ground	Ground reactance path through connected grounding transformer.	Reactance	None	
x0	**Zero sequence series reactance of the winding.**	**Reactance**	**None**	

16.3.2 Linkage

The required links for a TransformerWinding are defined in table below.

Link Name	Description	Path Name
Operated By (Operatorship)	The Operatorship link is used for permission rights. The Operator of equipment has the right to edit the equipment. An operator can only be assigned by the creator or owner of the equipment.	Network/Companies

Own Percent (Ownership)	The Ownership link is used for permission rights. The owner of equipment has editing and administrative rights. An owner can only be assigned by the creator of the equipment.	Network/Companies

16.4 MODELING TAPCHANGER

TapChanger is modeled under *TransformerWinding* as a child instance. Tap Changers can be a Load Tap Changer or a Fixed tap(LTC Control Mode is set to "off"). If the Transformer is a Phase Shifting Transformer, a *PhaseShifterImpedanceCurve* should be associated with the *TapChanger*. All the properties of a *TapChanger* such as Step Size, Step Voltage Increment, Step Phase Increment, etc. are defined in this class.

Figure below shows the parent/child hierarchy of a TapChanger in IMM.

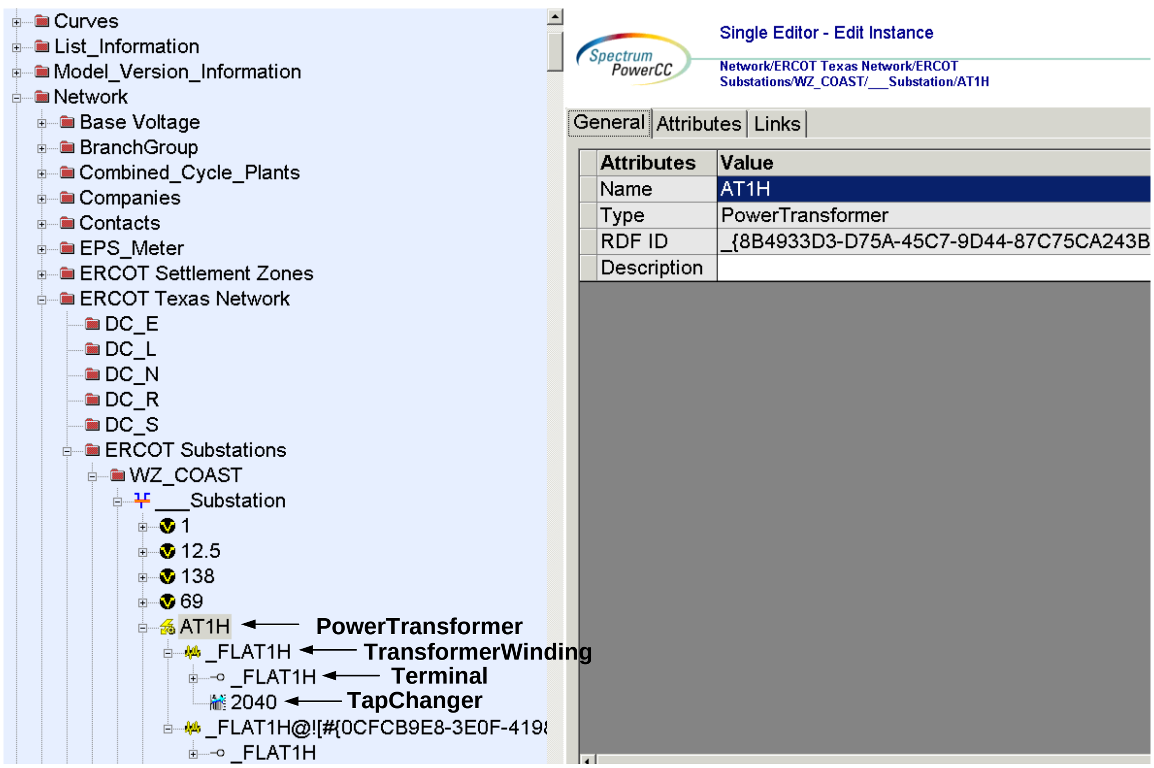


Figure 34 - Hierarchy for TapChanger

16.4.1 Attributes

The attributes for a *TapChanger* are shown in the table below.

Attribute	Description	Data Type	Default Value	Sample Data
AVR Enabled	**T =Automatic Voltage Regulation is enabled**	**Boolean**	**FALSE**	
AWR Enabled	**T = automatic MW control is enabled**	**Boolean**	**FALSE**	
Alias Name	Free text name of the object or instance	String	None	
Coupled To Transformer	T = indicates that the phase shifter is coupled to a transformer winding	Boolean	FALSE	
Flow Sensitivity	The sensitivity of the regulated MW flow to angle changes, in MW per degree	Float	None	
High Step	**Highest possible tap step position, advance from neutral**	**TapStep**	**0**	
Initial Delay	**For an LTC, the delay for initial tap changer operation (first step change).**	**Seconds**	**10**	
LTC Control Mode	**For an LTC, the tap changer control mode, e.g.: Off, Local, Volt, MVAr**	**EnumTransformerControlMode**	**None**	**volt**
Latitude	Latitude coordinates.	DoubleFloat	None	
Load-Based Regulation Enabled	T = Load-Based Voltage Regulation is enabled	Boolean	FALSE	

Figure below shows the parent/child hierarchy of a Power transformer in IMM. Figure below shows the parent/child hierarchy of a TransformerWinding in IMM. Local Name	The local Name is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, Voltage Level, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	
Longitude	Longitude coordinates.	String	None	
Low Step	**Lowest possible tap step position, retard from neutral**	**TapStep**	**0**	
Maximum kV	**The maximum voltage regulation for TapChangers. Note that this is a fixed parameter which is not a function of time (i.e., not a regulation schedule).**	**Voltage**	**None**	
Minimum kV	**The minimum voltage regulation for TapChangers. Note that this is a fixed parameter which is not a function of time (i.e., not a regulation schedule).**	**Voltage**	**None**	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	None	

©2009 Electric Reliability Council of Texas, Inc.

Neutral Angle	**The CIM currently has no way of defining the angle associated with the neutral position of a TapChanger belonging to a phase shifter. Thus a neutralAngle attribute (measured in degrees) has been added to the TapChanger class. This attribute only appears in XML when the parent PowerTransformer is a phase shifter, i.e., when PowerTransformer.transformerType = "phaseControl" or "voltageAndPhaseControl".**	**AngleDegrees**	**None**	
Neutral KV	**Voltage at which the winding operates at the neutral tap setting.**	**Voltage**	**None**	
Neutral Step	**The neutral tap step position for this winding.**	**TapStep**	**0**	
Normal Step	**The tap step position used in 'normal' network operation for this winding. For a 'Fixed' tap changer indicates the current physical tap setting.**	**TapStep**	**0**	
PAR Maximum MW	PAR maximum MW value (MW).	ActivePower	None	
PAR Minimum MW	PAR minimum MW value (MW).	ActivePower	None	
PAR Optimization	PAR optimization flag.	Boolean	FALSE	
PAR Ramp Rate	PAR optimiation ramp rate (MW per minute).	ActivePower	None	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	

Step Phase Shift Increment	Phase shift, in degrees, per step position. A positive value indicates a positive phase shift from the winding where the tap is located to the other winding (for a two-winding transformer), or to the "T" point (for a three-winding transformer).	AngleDegrees	None	
Step Voltage Increment	**Tap step increment, in per cent of nominal voltage, per step position.**	**PerCent**	**None**	
Subsequent Delay	**For an LTC, the delay for subsequent tap changer operation (second and later step changes).**	**Seconds**	**5**	
Transmission Element ID	Transmission Element ID.	Integer	None	

16.4.2 Linkage

The required links for a TapChanger are entered in **BOLD** in table below. The path name shows where the links can be found in the model. Definitions for all of the links can be found by clicking on the help button at the bottom of the links screen.

The required Links for a TapChanger varies depending on the operational use of the Transformer. Important points to consider are as follows:

- If the Transformer is a Phase Shifting Transformer, a Phase Shifter Impedance Curve should be associated through the “Has A (PhaseShifterImpedanceCurve)” linkage.
- If the Transformer is equipped with a Tap Ratio Curve, a Tap Ratio Curve should be associated through the “Has A (TapRatioCurve)” linkage.
- If the Transformer’s are operated in a Parallel configuration. A Master and a Follower should be identified amongst the Transformer’s in Parallel. Hence if the Transformer is a Follower, the “Has A Master (TapChanger)” should be associated indicating the Master Transformer.
- “Regulated By (LoadBasedRegulationCurve)” may be filled if the TapChanger is the LTC side.
- “Regulates (Measurement)” maybe filled if the TapChanger is the LTC side depending if Voltage or MW Flow Regulation is desired.
- “Regulates (Terminal)” should be filled if the TapChanger is the LTC side with the linkage shown in the table below.

Link Name	Description	Path Name
Has A (PhaseShifterImpedanceCurve)		Curves/Phase Shifter Impedance Curves
Has A (TapRatioCurve)		Curves/Tap Ratio Curve
Has A Master (TapChanger)		Network/ERCOT Texas Network/ERCOT Substations/Sub Geographical Region/Substation/PowerTransformer/TransformerWinding/Tap Changer
Regulated By (LoadBasedRegulationCurve)		Schedules/Regulation Schedule
Regulates (Measurement)	An LTC may regulate a specific measurement from the network, typically voltage. A phase shifter would typically be used to regulate a real power (MW) flow measurement. An LTC with significant phase shift characteristics could be used to regulate MW flow instead of voltage.	
Regulates (Terminal)		Network/ERCOT Texas Network/ERCOT Substations/Sub Geographical Region/Substation/PowerTransformer/TransformerWinding/Terminal
RegulationSchedule	An LTC may have a regulation schedule.	Schedules/Regulation Schedules/Schedule
Operated By (Operatorship)	The Operatorship link is used for permission rights. The Operator of equipment has the right to edit the equipment. An operator can only be assigned by the creator or owner of the equipment.	Network/Companies
Own Percent (Ownership)	The Ownership link is used for permission rights. The owner of equipment has editing and administrative rights. An owner can only be assigned by the creator of the equipment.	Network/Companies

16.5 MODELING APPROACH FOR TRANSFORMERKLUGE

This class is used for Three Winding Transformers. In ERCOT CIM Model, Three winding transformers are modeled as a three 2-winding transformers with a common tie at 1KV. TransformerKluge is modeled under sysOrphan as a child instance. The 2-winding transformers that comprises the Three Winding Transformer are linked together in this class through the "Has A (PowerTransformer)" links tab.

Figure below shows the parent/child hierarchy of a *TransformerKluge* in IMM.

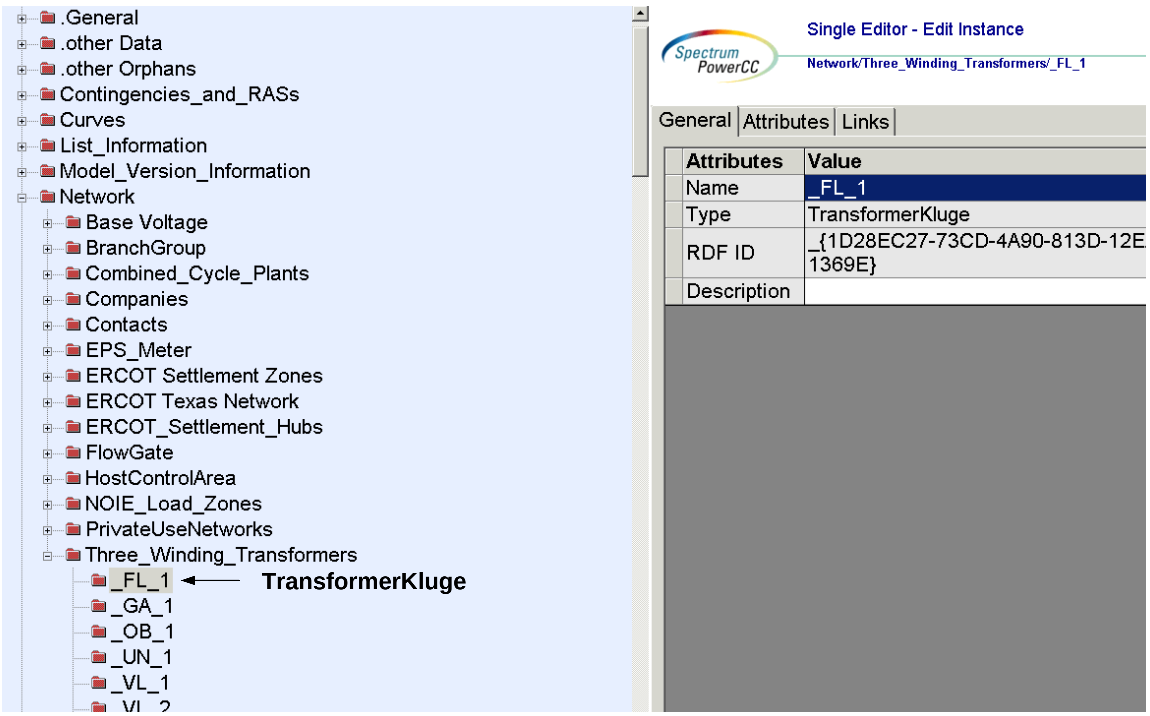


Figure 35 - Hierarchy for TransformerKluge

16.5.1 Attributes

The attributes for a *TransformerKluge* are shown in the table below.

Attribute	Description	Data Type	Default Value	Sample Data
Alias Name	Free text name of the object or instance	String	None	
Description	Description of the object or instance.	Boolean	FALSE	

Model Resource ID	**A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.**	**String**	**None**	
PSS/E 3 Winding ID	**Attribute will be used to store the three winding transformer ID and Mark which transformers are to be grouped as three winding Transformers.**	**String2**	**None**	
PSS/E 3 Winding Name	**Attribute will be used to store the three winding transformer name.**	**String12**	**None**	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	

16.5.2 Linkage

The required links for a *TransformerKluge* are defined in table below

Link Name	Description	Path Name
Has A (PowerTransformer)	Indicates the Power Transformers associated to a Three Winding Transformer	Network/ERCOT Texas Network/ERCOT Substations/Sub Geographical Region/Substation/PowerTransformer

17 MODELING LOAD

17.1 MODELING APPROACH

In the ERCOT CIM model, Loads are any classes that inherit from the class: *EnergyConsumer*. EnergyConsumer is an abstract class and should not be used for real loads.

CustomerLoad inherits from *ConformLoad* and is used in the ERCOT model. *StationSupply* also inherits from *EnergyConsumer* and is used in the ERCOT model. Loads of type *StationSupply* and *CustomerLoad* should be modeled under a *VoltageLevel* in a *Substation*.

17.2 MODELING APPROACH FOR CUSTOMERLOAD

Conforming loads can be modeled as an instance of the *CustomerLoad* class. The instance needs to be contained in an equipmentContainer of the class *VoltageLevel*. The *VoltageLevel* needs to be contained in a *Substation*.

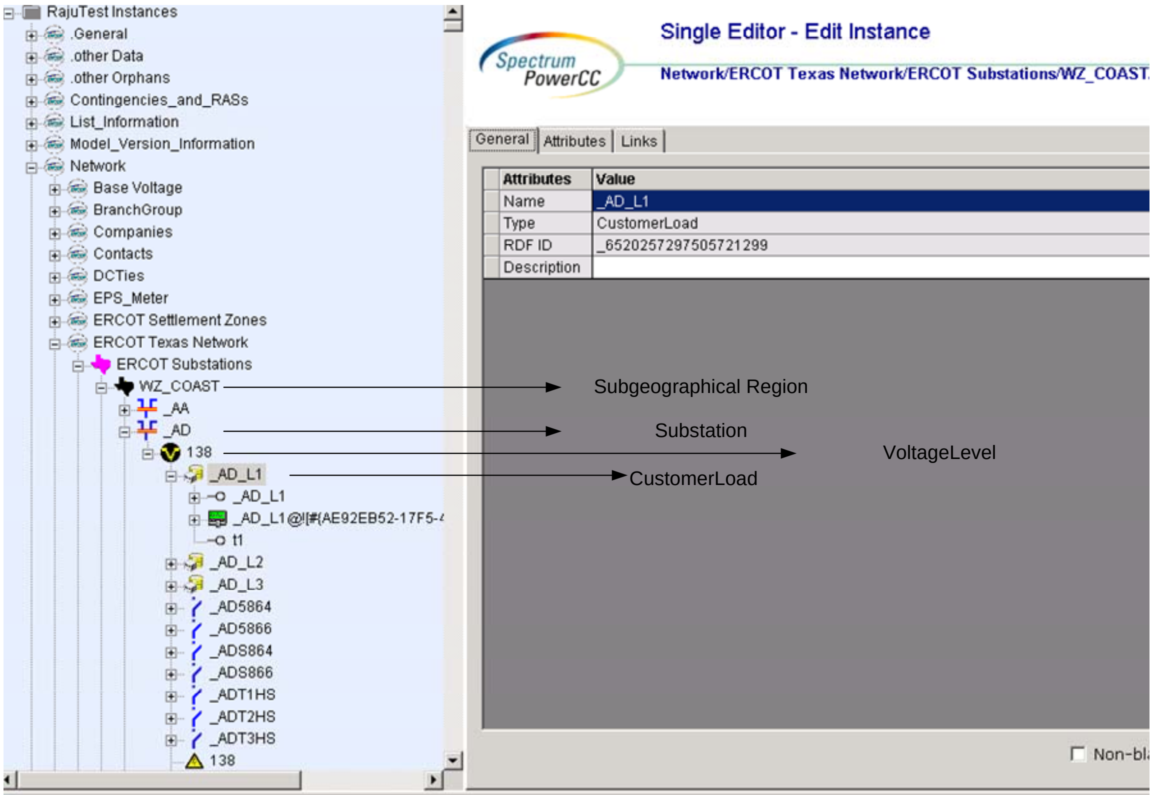
The *CustomerLoad* class is used to model the location in which power is being removed from the transmission grid. Each *CustomerLoad* class represents a single transformer in the field. The amount of power consumed by the *CustomerLoad* is dictated by an associated hourly schedule.

Each CustomerLoad instance should be associated with one instance of SettlementNOIELoadZone, or one instance of DCTie, or its parent Substation should be associated with one instance of SettlementLoadZone.

If a Load is assigned to a NOIE load zone, then its electrical bus can ONLY have loads that are assigned to the same NOIE load zone, i.e. cannot have other loads at the same electrical bus assigned to different load zone

In other words, all loads that connect to the same EB must belong to the same load zone. All those loads must either be associated to the same NOIE load zone, or none of them has this association.

CustomerLoad and Load instances cannot have association to PrivateAreaNetwork of type ERCOTPANTYPE.PrivateUseNetwork or SelfServe or BLT_Normally_out.



17.2.1 Attributes

The attributes for a *CustomerLoad* are shown in the table below.

Attribute	Description	Data Type	Default	Sample Data
Alias Name	Free text name of the object or instance.	String		
Conforming Load Flag	Flag is set to YES if the load is conforming, i.e., tracks the area load to which the energy consumer belongs.	Boolean	True	
Customer Count	Number of individual customers represented by this Demand.	Counter		123
DAM Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	False	
DAM Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which	Boolean	True	

	process the devices is secured.			
Description	Description of the object or instance.	String		
Fixed Reactive Power	**Reactive component of the load that is a fixed quantity, MVAr.**	**ReactivePower**		
Fixed Reactive Power Percent	Fixed MVAr as per cent of load area fixed MVAr.	Percent		
Fixed Real Power	Real component of the load that is a fixed quantity, MW.	ActivePower		
Fixed Real Power Percent	**Fixed MW as per cent of load area fixed MW.**	**Percent**		**45.1856**
height	height	Integer		
label height	label height	Integer		
label width	label width	Integer		
label x co-ordinate	label x co-ordinate	Integer		
label y co-ordinate	label y co-ordinate	Integer		
Latitude	Latiitude coordinates.	Float		
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String		
Longitude	Longitude coordinates.	Float		
Maximum	Maximum Reactive POWER	Float		80

MVAR	LOAD.			
Maximum MW	Maximum REAL POWER LOAD.	Float		80
Minimum MVAR	MINIMUM Reative POWER LOAD.	Float		-80
Minimum MW	MINIMUM REAL POWER LOAD.	Float		0
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String		470542
Nominal Reactive Power	Nominal value for reactive power, MVAr.	ReativePower		5
Nominal Reactive Power Percent	**Nominal MVAr as per cent of load group nominal MVAr.**	**Percent**		
Nominal Real Power	Nominal value for real power, MW. Nominal real power is adjusted according to the load profile selected for the consumer. It equates to one per unit in the load profile.	ActivePower		95
Nominal Real Power Percent	**Nominal MW as per cent of load group nominal MW.**	**Percent**		
OUS Priority	An Outage Scheduler priority is included in all ConductingEquipment classes except BusbarSection and TransformerWinding.	Integer		
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String		
Phases	Describes the phases carried by a conducting equipment. Possible values { ABCN , ABC, ABN, ACN, BCN, AB, AC, BC, AN, BN, CN, A, B, C, N }.	PhaseCode		

©2009 Electric Reliability Council of Texas, Inc.

Power Factor	**Power factor for nominal portion of load. Defined as MW/MVA.**	**PowerFactor**		**0.999991**
PSS®E ID	Attribute will give IMM modelers control over the PSS®E ID that the Topology Processor uses to properly name units, loads, branches, and transformers.	String		1
Reactive Power Frequency Exponent	Exponent of per unit frequency effecting reactive power	Exponent		
Reactive Power Voltage Exponent	Exponent of per unit voltage effecting reactive power.	Exponent		
Real Power Frequency Exponent	Exponent of per unit frequency effecting real power.	Exponent		
Real Power Voltage Exponent	Exponent of per unit voltage effecting real power.	Exponent		
Remove	The equipment is removed from the network.	Boolean	False	
Remove Enable	The equipment can be removed from the network.	Boolean	False	
RUC Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	False	
RUC Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	True	
Transmission Element ID	Transmission Element ID.	Integer		
width	width	Integer		
x co-ordinate	x co-ordinate	Integer		
y co-ordinate	y co-ordinate	Integer		

17.2.2 Linkage

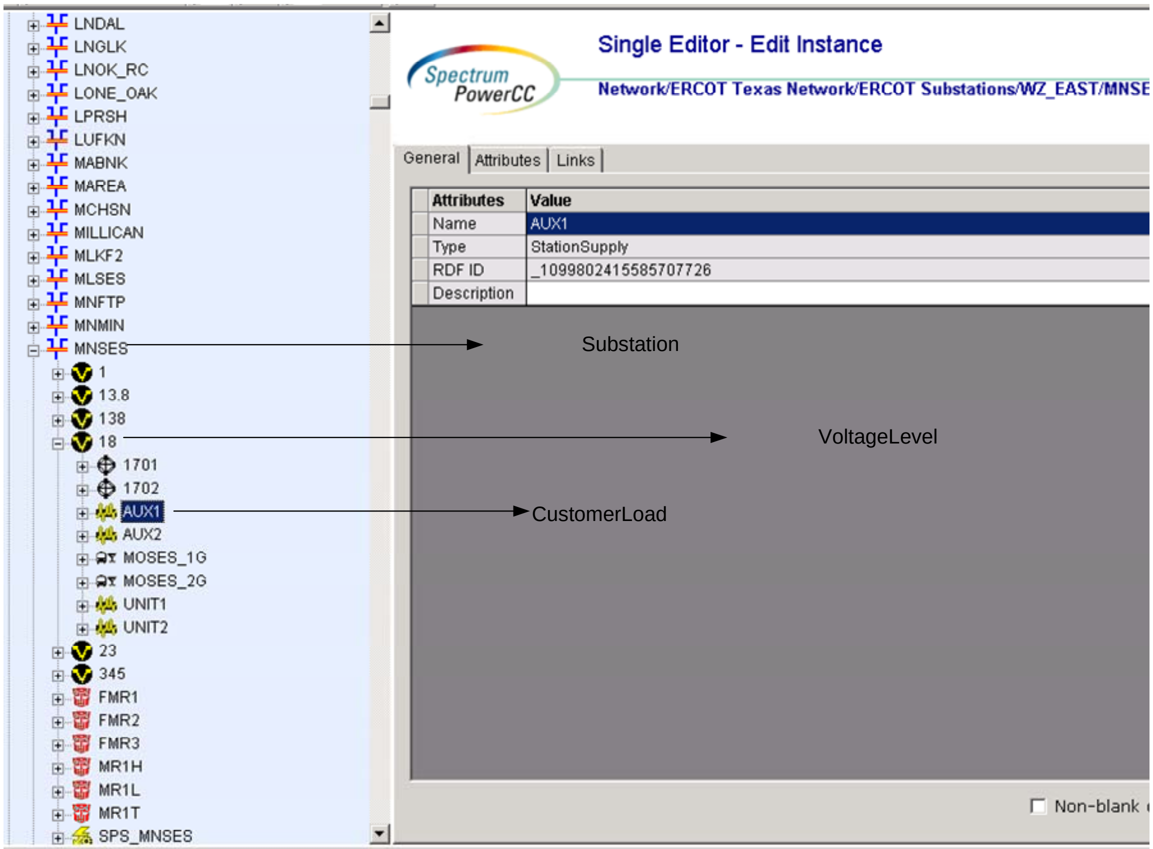
The required links for a *CustomerLoad* are shown in the table below.

Link Name	Description	Path
Assigned To (ConformLoadGroup)	Consumers may be assigned to a load area.	Schedules/Load Area Schedules/ERCOT/SubLoadArea
Operated By (Operatorship)	The Operatorship link is used for permission rights. The Operator of equipment has the right to edit the equipment. An operator can only be assigned by the creator or owner of the equipment.	Network/Companies
Own Percent (Ownership)	The Ownership link is used for permission rights. The owner of equipment has editing and administrative rights. An owner can only be assigned by the creator of the equipment.	Network/Companies

17.3 MODELING APPROACH FOR STATIONSUPPLY

Loads that are not customer load can be modeled as an instance of the *StationSupply* class. A *StationSupply* load may be either conforming or non-conforming. The instance needs to be contained in an equipmentContainer of the class *VoltageLevel*. The *VoltageLevel* needs to be contained in a *Substation*.

The *StationSupply* class is used to model the power necessary to support the generation of power (i.e. feed water pumps, condenser pumps, etc.). The amount of power consumed by the station supply will be dependent on the output of an associated generator.



17.3.1 Attributes

The required attributes for a *StationSupply* are shown in the table below.

Attribute	Description	Data Type	Default	Sample Data
Alias Name	Free text name of the object or instance.	String		
Conforming Load Flag	Flag is set to YES if the load is conforming, i.e., tracks the area load to which the energy consumer belongs.	Boolean	True	
Customer Count	Number of individual customers represented by this Demand.	Counter		123
DAM Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	False	
DAM Secured	The Boolean flags to indicate	Boolean	True	

	which process(s) monitor the branch devices and by which process the devices is secured.			
Description	Description of the object or instance.	String		
Fixed Reactive Power	**Reactive component of the load that is a fixed quantity, MVAr.**	**ReactivePower**		
Fixed Reactive Power Percent	Fixed MVAr as per cent of load area fixed MVAr.	Percent		
Fixed Real Power	Real component of the load that is a fixed quantity, MW.	ActivePower		
Fixed Real Power Percent	**Fixed MW as per cent of load area fixed MW.**	**Percent**		**45.1856**
height	height	Integer		
label height	label height	Integer		
label width	label width	Integer		
label x co-ordinate	label x co-ordinate	Integer		
label y co-ordinate	label y co-ordinate	Integer		
Latitude	Latiitude coordinates.	Float		
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String		

Longitude	Longitude coordinates.	Float		
Maximum MVAR	Maximum Reactive POWER LOAD.	Float		80
Maximum MW	Maximum REAL POWER LOAD.	Float		80
Minimum MVAR	MINIMUM Reative POWER LOAD.	Float		-80
Minimum MW	MINIMUM REAL POWER LOAD.	Float		0
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String		470542
Nominal Reactive Power	Nominal value for reactive power, MVAr.	ReativePower		5
Nominal Reactive Power Percent	**Nominal MVAr as per cent of load group nominal MVAr.**	**Percent**		
Nominal Real Power	Nominal value for real power, MW. Nominal real power is adjusted according to the load profile selected for the consumer. It equates to one per unit in the load profile.	ActivePower		95
Nominal Real Power Percent	**Nominal MW as per cent of load group nominal MW.**	**Percent**		
OUS Priority	An Outage Scheduler priority is included in all ConductingEquipment classes except BusbarSection and TransformerWinding.	Integer		
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String		
Phases	Describes the phases carried by a conducting equipment.	PhaseCode		

©2009 Electric Reliability Council of Texas, Inc.

	Possible values { ABCN , ABC, ABN, ACN, BCN, AB, AC, BC, AN, BN, CN, A, B, C, N }.			
Power Factor	**Power factor for nominal portion of load. Defined as MW/MVA.**	**PowerFactor**		**0.999991**
PSS®E ID	Attribute will give IMM modelers control over the PSS®E ID that the Topology Processor uses to properly name units, loads, branches, and transformers.	String		1
Reactive Power Frequency Exponent	Exponent of per unit frequency effecting reactive power	Exponent		
Reactive Power Voltage Exponent	Exponent of per unit voltage effecting reactive power.	Exponent		
Real Power Frequency Exponent	Exponent of per unit frequency effecting real power.	Exponent		
Real Power Voltage Exponent	Exponent of per unit voltage effecting real power.	Exponent		
Remove	The equipment is removed from the network.	Boolean	False	
Remove Enable	The equipment can be removed from the network.	Boolean	False	
RUC Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	False	
RUC Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	True	
Step	**Schedule is step function.**	**Boolean**	**False**	
Transmission Element ID	Transmission Element ID.	Integer		
width	width	Integer		

©2009 Electric Reliability Council of Texas, Inc.

x co-ordinate	x co-ordinate	Integer		
y co-ordinate	y co-ordinate	Integer		

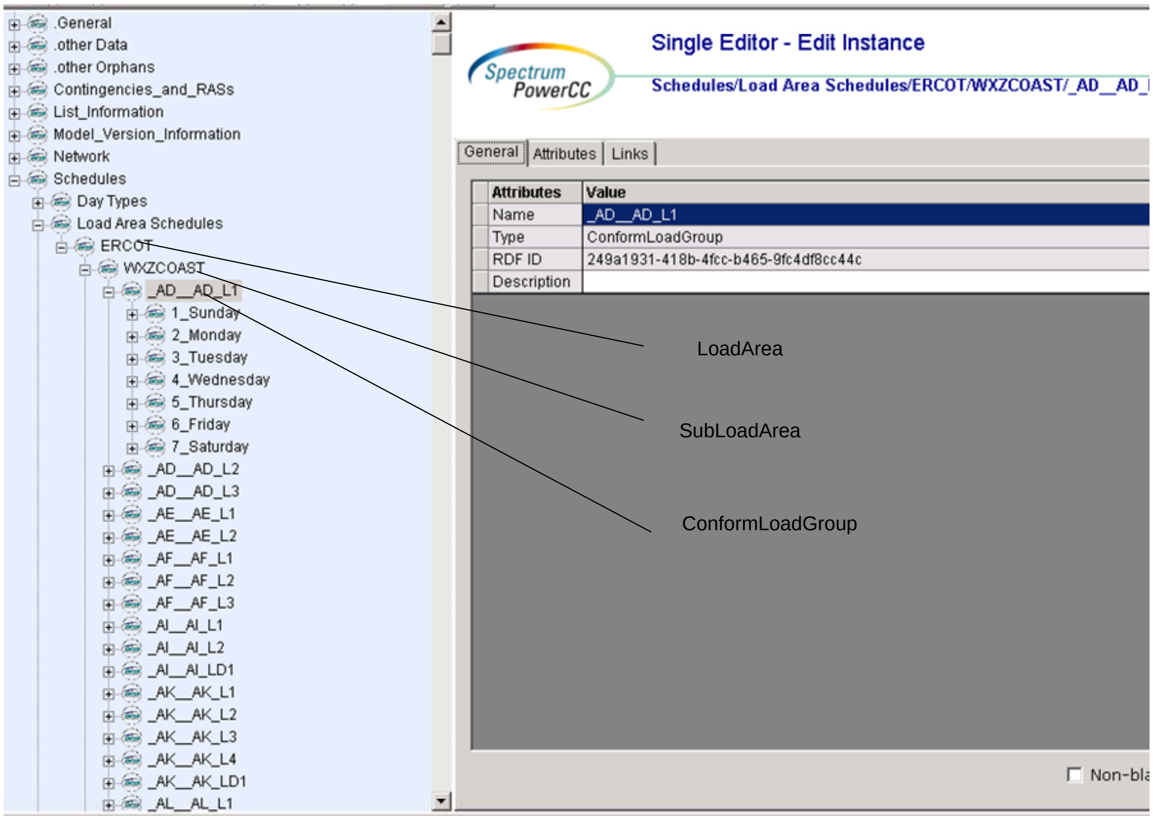
17.3.2 Linkage

The required associations for a *StationsSupply* are shown in the table below.

Link Name	Description	Path
Operated By (Operatorship)	The Operatorship link is used for permission rights. The Operator of equipment has the right to edit the equipment. An operator can only be assigned by the creator or owner of the equipment.	Network/Companies
Own Percent (Ownership)	The Ownership link is used for permission rights. The owner of equipment has editing and administrative rights. An owner can only be assigned by the creator of the equipment.	Network/Companies

17.4 MODELING APPROACH FOR CONFORMLOADGROUP

All the ConformingLoads should be assigned to *ConformLoadGroup*. These are the Loads that follows a daily and seasonal load variation pattern. ConformLoadGroup should be created under a LoadArea/SubLoadArea under ‘Schedules/Load Area Schedules’.



17.4.1 Attributes

The required attributes for a *ConformLoadGroup* are shown in the table below.

Attribute	Description	Data Type	Default	Sample Data
Alias Name	Free text name of the object or instance.	String		
Description	Description of the object or instance.	String		
Forecast Enabled	Forecast enabled.	Boolean	False	
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation,	String		

	VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.			
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String		
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String		

17.4.2 Linkage

There are no required associations for a *ConformLoadGroup*.

17.5 MODELING APPROACH FOR CONFORMLOADSCHEDULE

A curve of load versus time (X-axis) showing the active power values (Y1-axis) and reactive power (Y2-axis) for each unit of the period covered. This curve represents a typical pattern of load over the time period for a given day type and season.

ConformLoadSchedule should be created under a LoadArea/SubLoadArea/ConformLoadGroup under 'Schedules/Load Area Schedules'.

17.5.1 Attributes

Attribute	Description	Data Type	Default
Alias Name	Free text name of the object or instance.	String	
Description	Description of the object or instance.	String	
End Time	**End Time.**	**Time**	**01:00:00AM**
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has	String	

	several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.		
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	
Start Time	**Start Time.**	**Time**	**12:00:00AM**
Time Step	Time Step	Seconds	
Value 1 Unit	**Value 1 Unit. Valid values: MW, MVAr, kV (Source: 61970-452, Normative String Table).**	**String**	**MW**
Value 2 Unit	**Value 2 Unit. Valid values: MW, MVAr, kV (Source: 61970-452, Normative String Table).**	**String**	**MVAR**

17.5.2 Linkage

There are no required links for *ConformLoadSchedule*.

18 MODELING CURVES

This section will cover modeling of Curves which include *LoadBseRegulationCurve, MVArCapabilityCurve, PhaseShifterImpedanceCurve, RampRateCurves, StationSupplyWRCurve, and TransformerImpedanceCurve*.

18.1 MODELING APPROACH

The ERCOT CIM data dictionary defines a *Curve* as relationship between an independent variable (X-axis) and one or two dependent variables (Y1-axis and Y2-axis), which can also serve as schedules. There are six types of curves which are *LoadBseRegulationCurve, MVArCapabilityCurve, PhaseShifterImpedanceCurve*, *RampRateCurves*, *StationSupplyWRCurve*, and *TransformerImpedanceCurves.* Figure below shows a RampRateCurve as modeled in IMM, with parent/child associations labeled, the screenshot should look similar for the other five types of curves with the exception of the Parent instance of the curve.

The number of CurveData associated with the MVArCapabilityCurves and RampRateCurve should not exceed 10.

All x_axisdata data points in a MVArCapabilityCurve should be unique. Only one y1_axisdata point in a MVArCapabilityCurve can be 0. Only one y2_axisdata point in a MVArCapabilityCurve can be 0.

Number of CurveScheduleData under PhaseShifterImpedanceCurve and TransformerImpedanceCurve are the same as Number of TapChanger step within PowerTransformer where the curve is asscociated to.

©2009 Electric Reliability Council of Texas, Inc.

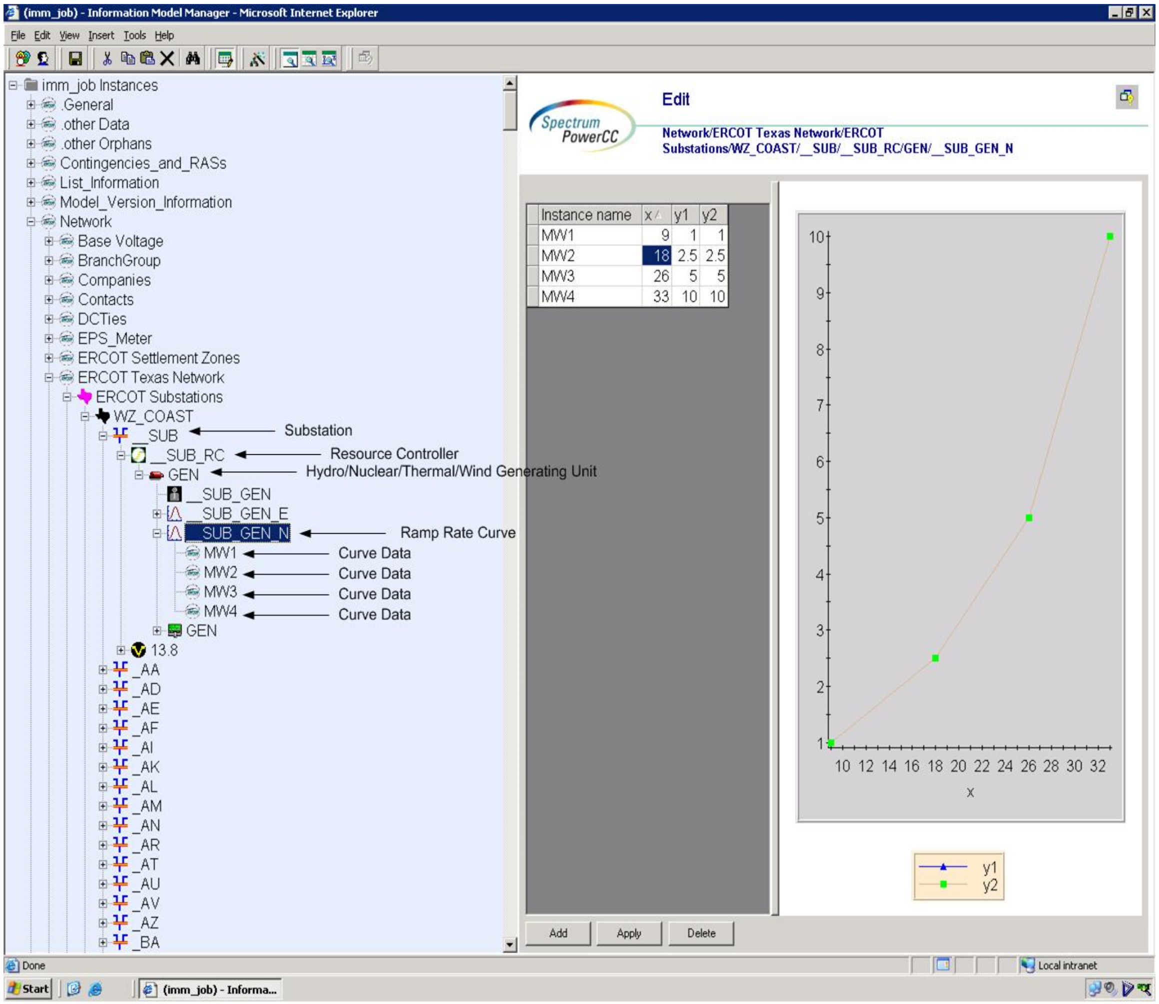


Figure 36 - Modeled RampRateCurves with parent/child associations labeled.

18.2 ATTRIBUTES CURVES

The attributes for a Curve are shown in the Table 1 below. There is an additional four columns representing each type of *GeneratingUnit* by which it will specified if an attribute is used within that type. The labels of these columns are *LoadBseRegulationCurve* as LBRC, *MVArCapabilityCurve as MVArCC, PhaseShifterImpedanceCurve* as PSIC, *RampRateCurves* as RRC, *StationSupplyWRCurve* as SSWRC, and *TransformerImpedanceCurve* as TIC.

Attribute	Description	Data Type	Default Value	Sample Data	LBRC	MVArCC	PSIC	RRC	SSWRC	TIC
curveStyle	**The style or shape of the curve.**	**EnumCurveStyle**	**None**		**X**	**X**	**X**	**X**	**X**	**X**
xUnit	**The X-axis units of**	**String20**	**None**		**X**	**X**	**X**	**X**	**X**	**X**

	measure. Valid values: MW, MVAr, kV (Source: 61970-452, Normative String Table).									
y1Unit	**The Y1-axis units of measure. Valid values: MW, MVAr, kV (Source: 61970-452, Normative String Table).**	**String20**	**None**		**X**	**X**	**X**	**X**	**X**	**X**
rampRateCurveId	**Ramp Rate Curve ID.**	**String5**	**None**					**X**		
y2Unit	The Y2-axis units of measure. Valid values: MW, MVAr, kV (Source: 61970-452, Normative String Table).	String20	None		X	X	X	X	X	X
coolantTemperature	The machine's coolant temperature in degrees Celsius (e.g., ambient air or stator circulating water).	Temperature	None			X				
hydrogenPressure	The hydrogen coolant pressure.	Pressure	None			X				
Emergency	Denote the type of ramp rate.	Boolean	None					X		

In table below, it specifies what are the curveStyle, xUnit, y1Unit, and y2Unit of each type of curve.

Curve Style and Unit Table

Curve Name	Curve Style	X Unit	Y1 Unit	Y2 Unit
LoadBseRegulationCurve	straightLineYValues	MW	KV	KV
MVArCapabilityCurve	straightLineYValues	MW	MVAr	MVAr
PhaseShifterImpedanceCurve	straightLineYValues	Degrees	Ratio	None
RampRateCurves	straightLineYValues	MW	MW/Min	MW/Min
StationSupplyWRCurve	straightLineYValues	MW	MW	MVAr
TransformerImpedanceCurve	straightLineYValues	Impedance	Tap	None

©2009 Electric Reliability Council of Texas, Inc.

18.3 LINKAGE CURVES

The required links for all *Curves* types are defined in Table below.

Linkage Table for Curves

Link Name	Description	Path Name	LBRC	MVarC C	PSI C	RR C	SS W RC	T I C
SynchronousMachine				X				
Configuration						X		
Member Of (EnergyConsumerResource)						X		
Member Of (GeneratingUnit)						X		
StationSupply							X	

©2009 Electric Reliability Council of Texas, Inc.

19 MODELING CURVEDATA

19.1 MODELING APPROACH

CureveData instances can be created both by ERCOT and Market Participants. Curve Data contains data point values for defining a curve or schedule. *CurveData* should be created as a child of one of allowed instances of Curve namely *TransformerImpedanceCurve, StationSupplyWRCurve or PhaseShifterImpedanceCurve.*

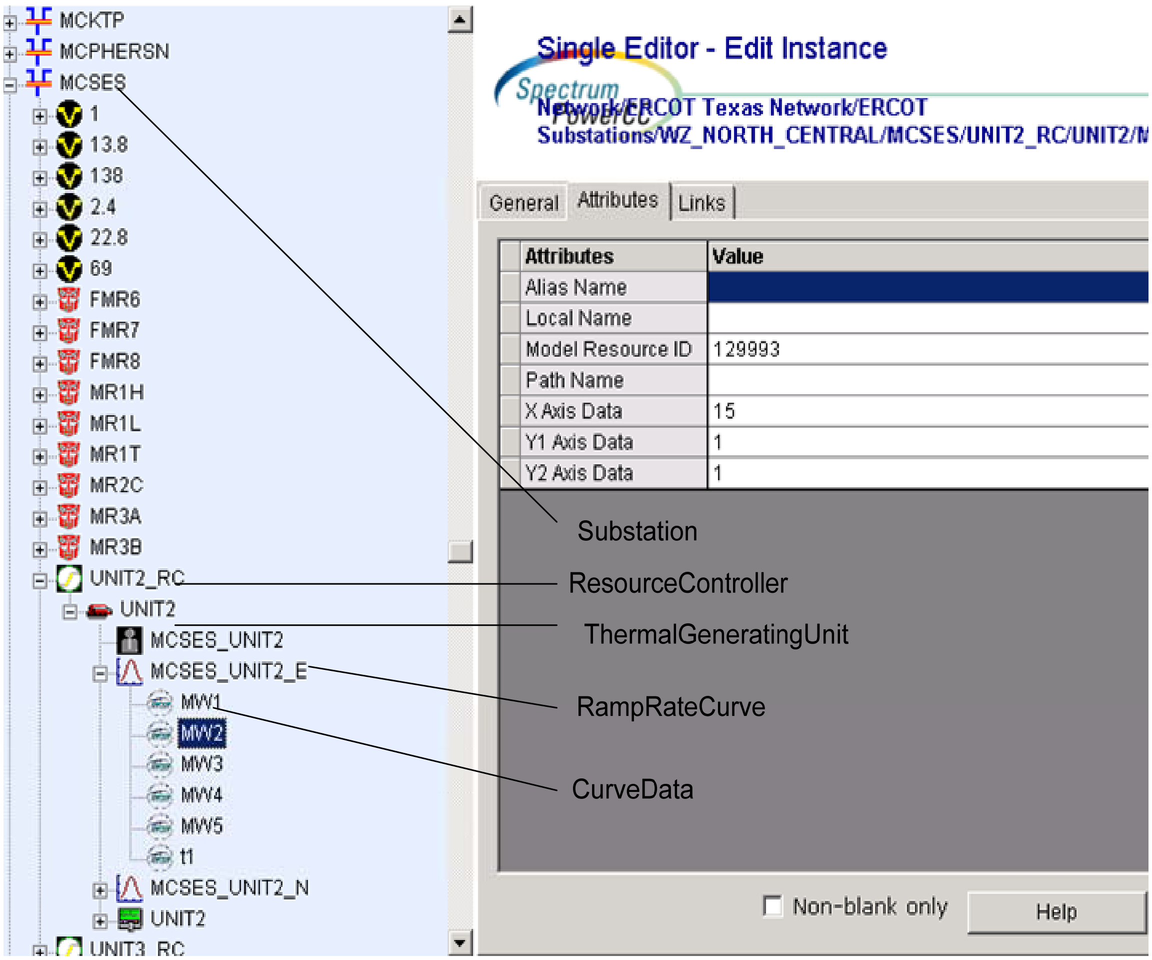


Figure 37 - CurveData

19.2 ATTRIBUTES

The following table shows all the attributes that are available for a CurveData.

Attribute	Description	Data Type	Default Value	Sample Data
Alias Name	Free text name of the object or instance	String	None	
Local Name	The localName is a human readable name of the object	String	None	
Model Resource ID	A Model Authority issues mRIDs	String	None	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.			
X Axis Data	**The data value of the X-axis variable, depending on the X-axis units**		**Double Float**	**15**
Y1 Axis Data	**The data value of the first Y-axis variable, depending on the Y-axis units**		**Double Float**	**1**
Y2 Axis Data	**The data value of the second Y-axis variable (if present), depending on the Y-axis unit.**		**Double Float**	**1**

19.3 LINKAGE

There are no required links to the CurveData.

20 MODELING REGULARTIMEPOINT

20.1 MODELING APPROACH

Instances of *RegularTimePoint* can be created both by Market Participants and ERCOT. *RegularTimePoint* represents Time Points for a schedule where the time between the points is constant.

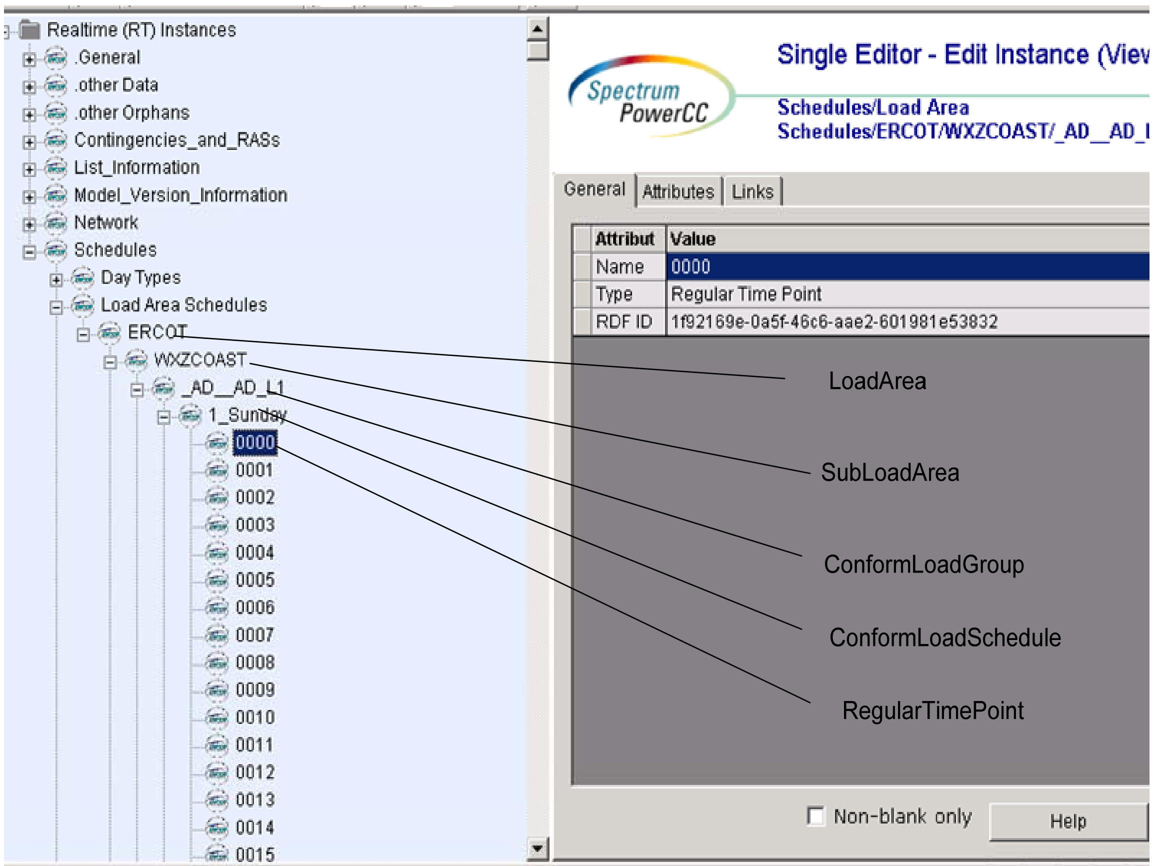


Figure 38 - RegularTimePoint

20.2 ATTRIBUTES

The following table shows all the attributes that are available for a *RegularTimePoint*.

Attribute	Description	Data Type	Default Value	Sample Data
RT Name	Equivalent of IdentifiedObject.name.	String	None	SUN_0
Sequence Number	Sequence Number.	Number	None	1

Value 1	Value 1.	Float	None	9.99
Value 2	Value 2.	Float	None	0.1

20.3 LINKAGE

There are no required links to the RegularTimePoint.

21 MODELING TERMINAL

21.1 MODELING APPROACH

Terminal's can be created by TDSP's. *Terminal* is an electrical connection point to a piece of conducting equipment. Terminals are connected at physical connection points called 'connectivity nodes'. A terminal should always be connected to conducting Equipment.

Terminals connected an Equipment can not be connected to the same connectivitynode.

Terminal associated to an equipment should have unique names.

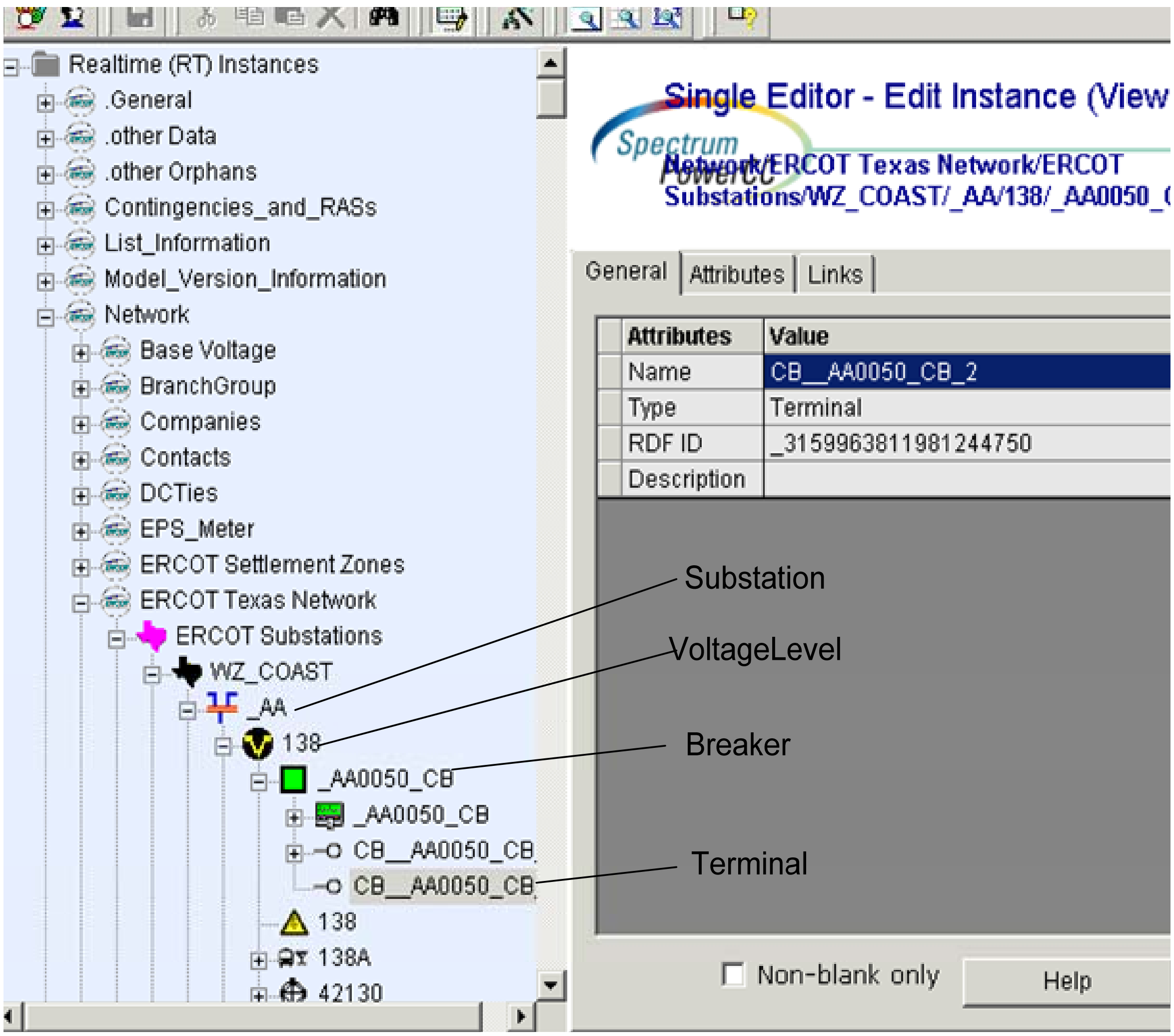


Figure 39 - Terminal

21.2 ATTRIBUTES

The following table shows all the attributes that are available for a Terminal.

Attribute	Description	Data Type	Default Value	Sample Data
Alias Name	Free text name of the object or instance.	String		
Description	Description of the object or instance.	String		
Edge Val	edgeVal is a concatenation of all edge coordinates.	String		
From X offset	From X offset	Number		
From X perm	From X perm	Number		
From Y offset	From Y offset	Number		
From Y perm	From Y perm	Number		
Height	height	Number		
label height	label height	Number		
label width	label width	Number		
label x co-ordinate	label x co-ordinate	Number		
label y co-ordinate	label y co-ordinate	Number		
Local Name	The localName is a human readable name of the object.	String		
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String		
Near	Flag indicating whether the terminal is a near terminal of a branch.	Boolean		
Path Name	The pathname is a system unique name composed from all	String		

	IdentifiedObject.names in a standard naming hierarchy path from the object to the root.			
PSS/E Bus Name	Store the PSS¿E bus name that will be associated with the grouping of Connectivity Nodes in Option 2.	String		
PSS/E Bus Number	Attribute will be used to store the PSS¿E bus number that will be associated with the grouping of Connectivity Nodes in Option 2.	Number		
To X offset	To X offset	Number		
To X perm	To X perm	Number		
To Y offset	To Y offset	Number		
To Y perm	To Y perm	Number		
width	width	Number		
x co-ordinate	x co-ordinate	Number		
y co-ordinate	y co-ordinate	Number		

21.3 LINKAGE

There are no required links to a Terminal.

22 MODELING CONNECTIVITYNODE

22.1 MODELING APPROACH

Connectivity nodes are points where terminals of conducting equipment are connected together with zero impedance. A *ConnectivityNode* is created under a *ConnectivityNodeGroup* in IMM. *ConnectivityNodeGroup's* are created under a *VoltageLevel*.

Connectivity nodes must be associated to atleast 2 terminals.

The ConnectivityNodes in a ConnectivityNodeGroup must be in the same substation i.e. ConnectivityNodes in a given ConnectivityNodeGroup cannot span multiple Stations.

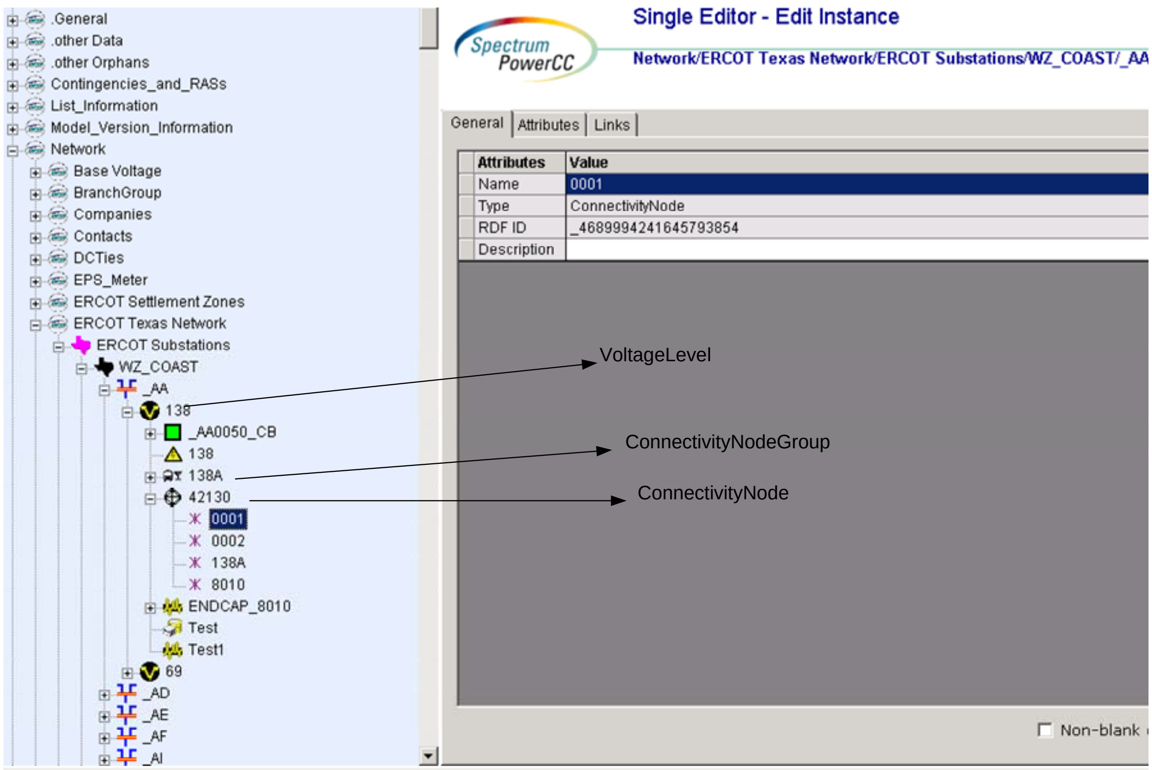


Figure 40 - ConnectivityNode

22.2 ATTRIBUTES

The following table shows all the attributes that are available for a ConnectivityNode.

Attribute	Description	Data Type	Default Value	Sample Data
Alias Name	Free text name of the object or instance.	String		
Description	Description of the object or	String		

	instance.			
height	height	Integer		
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String		
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String		
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String		
PSS/E Bus Name	Store the PSS¿E bus name that will be associated with the most favored Connectivity Node in Connectivity Node to Bus Processing Option 1.	String		
PSS/E Bus Number	The PSS/E bus number associated with this point in the network. This attribute should only be used to model ficticious PSS/E busbars that are	Integer		

	not associated with physical busbar sections.			
Slack Bus Priority	Swing Bus Definition.	Integer		
Transmission Element ID	Transmission Element ID.	String		
width	width	Integer		
x co-ordinate	x co-ordinate	Integer		
y co-ordinate	y co-ordinate	Integer		

22.3 LINKAGE

The required links for a *ConnectivityNode* are defined below.

Link Name	Description	Path Name
EquipmentContainer	ConnectivityNodeMemberOfEquipmentContainer	

©2009 Electric Reliability Council of Texas, Inc.

23 MODELING ELECTRICALBUS

23.1 MODELING APPROACH

This section describes the approach for modeling an *ElectricalBus*. *ElectricalBuses* are modeled by the Market Participants.

ElectricalBus needs to be always contained in an instance of the class *ConnectivityNode*, which in turn is contained in an instance of the class *ConnectivityNodeGroup*. As per modeling approach for a *HUBBus* an electrical bus can become a part of the *HUBBus* definition by being contained under a *ConnectivityNodeGroup* which is associated to a *HUBBus*.

Every *ElectricalBus* should be within a *LoadZone* or a *NOIELoadZone*. All the loads connected to *ElectricalBus* should be in the same *LoadZone* or *NOIELoadZone*. If an *ElectricalBus* is connected to a *DCTie* Psuedo Load, then it cannot be connected to other loads.

The name of the electrical bus class is somewhat misleading. It should be noted that instances of this class do not represent actual buswork in the field (see: BusbarSection). Rather, the Electrical Bus class represents a settlement point.

Definition

An abstract Market construct used to denote connectivity nodes of interest. LMP prices will be determined at these nodes. Electrical buses are maintained by both TDSPs and ERCOT.

There are specific rules for where electrical buses must be located in the model. An electrical bus must be associated with a connectivity node when:

- A load is attached to the node.
- A unit is attached to the node.
- Three or more switches are attached to the node and the node has a voltage reading.
- A resource node is associated with the node.
- An EPS meter is associated with the node.

Additionally, hub buses (as defined in the protocols) are required to contain at least one electrical bus. If none of the above criteria is met for the nodes contained within a hub bus, an electrical bus must be added to the model and associated to one of the associated nodes.

Electrical buses are created and maintained by both TDSPs and ERCOT. TDSPs will be responsible for maintaining electrical buses relating to their connectivity nodes (i.e. for loads, >3 switches, and hub buses). ERCOT will maintain, on behalf of the resource entity, the electrical buses related to resource nodes and EPS meters.

In general, TDPSs will be responsible for electrical buses contained within their substations. However, since EPS meters and resource nodes can be located in a TDSP’s substation, their will be certain cases where ERCOT will be responsible for electrical buses contained within a TDSP’s substation.

©2009 Electric Reliability Council of Texas, Inc.

Example #1: A TDSP is creating a NOMCR to reflect the future addition of a load transformer. In addition to adding the load and associated switches, the TDSP must create an electrical bus and associate it to the same connectivity node in which the load is attached.

Example #2: An RE informs ERCOT of a future EPS meter configuration change. ERCOT will create a NOMCR changing the associated connectivity node of the EPS meter. Additionally, ERCOT will move the EPS meter-related electrical bus to the new connectivity node.

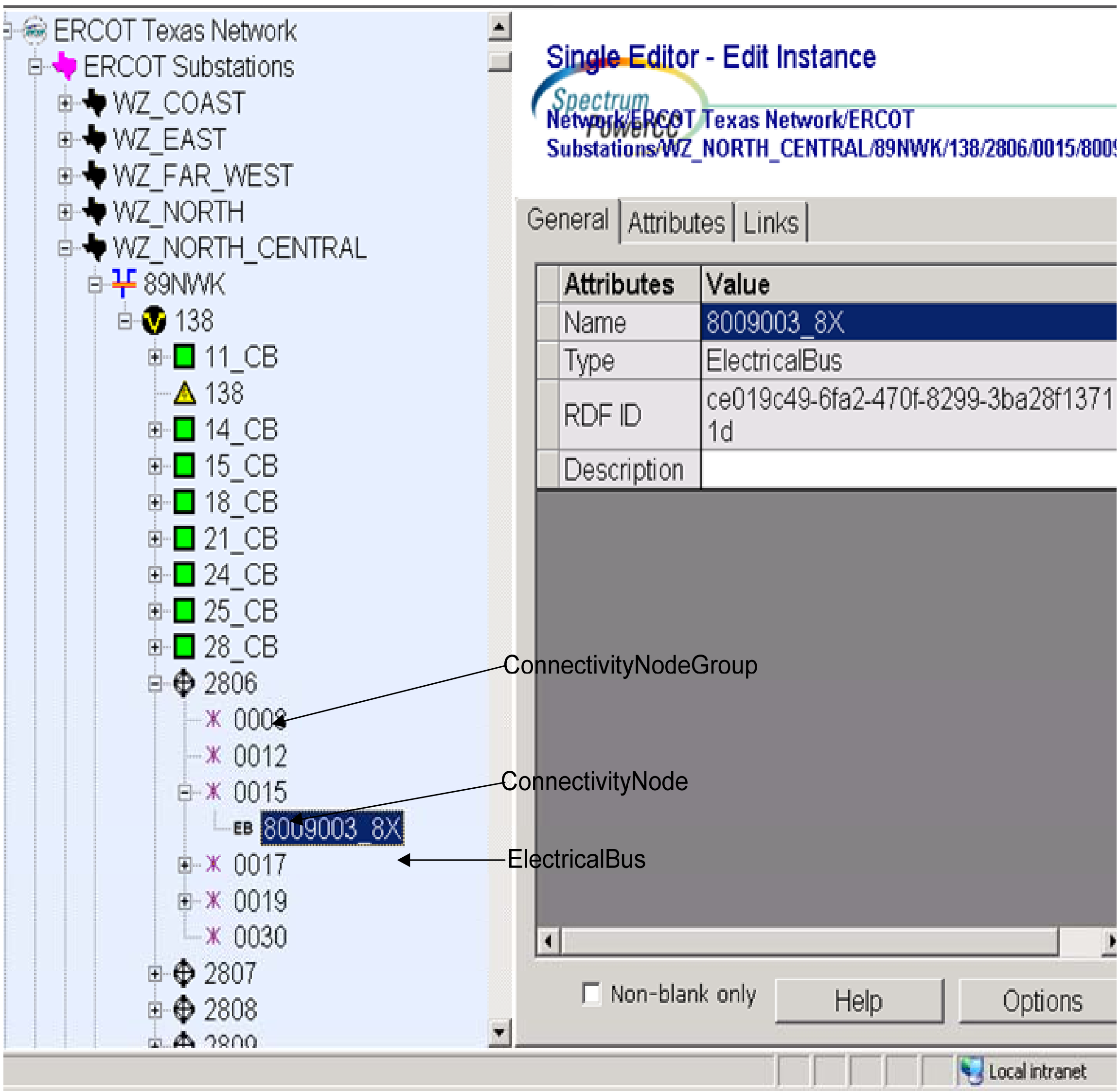


Figure 41 - ElectricalBus

23.2 ATTRIBUTES

Following are the attributes for *ElectricalBus*.

Attribute	Description	Data Type	Default
Alias Name	Free text name of the object or instance.		
Description	Description of the object or instance.		
Display LMP	Display LMP?	Boolean	True
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.		
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.		
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.		

23.3 LINKAGES

AssociationName	Class	Description

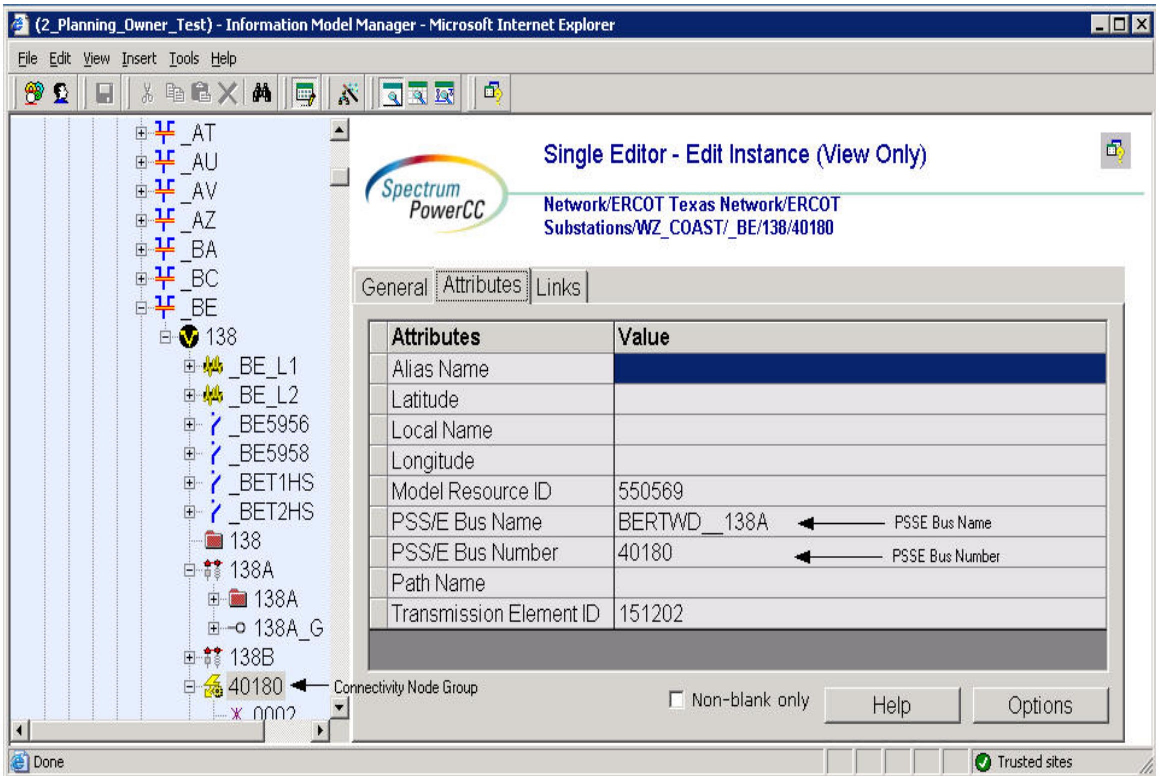
ElectricalBus.ConnectivityNode	ConnectivityNode	ElectricalBusMemberOfConnectivityNode is a Required Linkage. ElectricalBus needs to be always contained in an instance of the class ConnectivityNode.

©2009 Electric Reliability Council of Texas, Inc.

24 MODELING CONNECTIVITYNODEGROUP

24.1 MODELING APPROACH

The ERCOT CIM model defines a connectivity node group as a grouping of connectivity nodes. The Transmission operation (TO)'s planners will need to identify the PSS/E Bus name and PSS/E Bus number for each connectivity node group. The PSS/E Bus name and PSS/E bus Number must be unique within the IMM. These values cannot be duplicated. See figure below as an example.



24.2 ATTRIBUTES

Attribute	Description	Data Type	Default Value	Sample Data
Alias Name	Free text name of the object or instance.	String	None	
Description	Description of the object or instance	String	None	
Latitude	Latitude coordinates	Float	None	

Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	
Longitude	Longitude coordinates.	Float	None	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	Auto-populated	
PSSEBusName	**The bus name which is used by planners to idendify the bus** **Stores the PSS™E bus name that will be associated with the grouping of Connectivity Nodes in Option 2.**	**String12**	**None**	
PSSEBusNumber	**The bus number which is used by planners to idendify the bus** **Attribute will be used to store the PSS™E bus number that will be associated with the grouping of Connectivity Nodes in Option 2.**	**Integer**	**None**	
	The pathname is a system	String	None	

Path Name	unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.			
TEID	Transmission Element ID	Integer	Auto-populated	

24.3 LINKAGE

The required links for a Connectivity Node Group are defined in the table below.

Link Name	Description	Path Name
Operatorship	The Operatorship link is used for permission rights. The Operator of equipment has the right to edit the equipment. An operator can only be assigned by the creator or owner of the equipment.	Network/Companies
Ownership	The Ownership link is used for permission rights. The owner of equipment has editing and administrative rights. An owner can only be assigned by the creator of the equipment.	Network/Companies
PlanningArea	Attribute will give IMM modelers control over the PSS®E ID that the Topology Processor uses to properly number areas.	Network/Companies
Planning Zone	Attribute will give IMM modelers control over the PSS®E ID that the Topology Processor uses to properly number zones.	Network/Companies

25 MODELING OPERATORSHIP

25.1 MODELING APPROACH

In the ERCOT CIM model an operator is assigned to each piece of equipment. The operator of the equipment is given the right to edit the equipment and add instances under the equipment. An operator must be created under a company and used as a link to equipment.

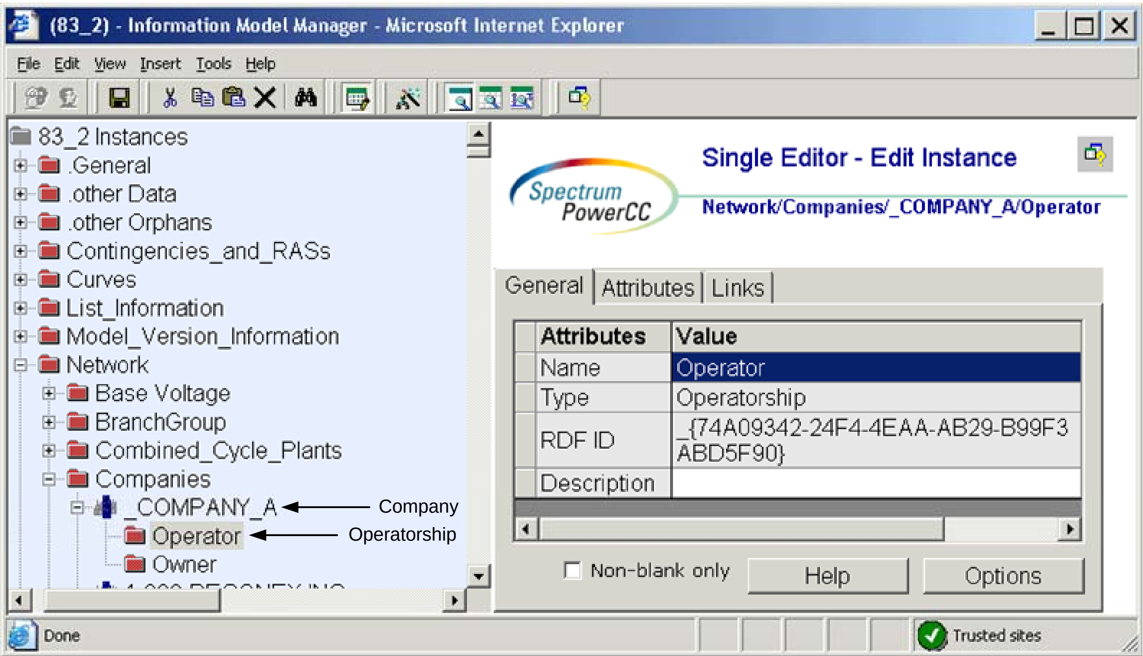


Figure 42 - Operatorship

25.2 ATTRIBUTES

The attributes for *Operatorship* are shown in the table below.

Attribute	Description	Data Type	Default Value	Sample Data
Alias Name	Free text name of the object or instance.	String	None	
Description	Description of the object or instance	String	None	
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the	String	None	

	root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.			
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	Auto-populated	
Operate Percent	Operator share percentage	Float	None	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	

25.3 LINKAGE

None

26 MODELING OWNERSHARERATING

26.1 MODELING APPROACH

OwnerShareRating can be utilized on Power Equipments that can be co-rated by different companies defined as an owner of the equipments. In ERCOT CIM Model, only transmission lines have the functionality to be dynamically rated and co-rated so only transmission lines will have *OwnerShareRating* class. *OwnerShareRating* is modeled under *ACLineSegment* or *TransformerWinding* as a child instance. As mentioned above, since only transmission lines have this capability in the ERCOT Model, only the lines will have an *OwnerShareRating* instance.

When defining an *OwnerShareRating*, the "Owned By (Dynamic Element)" , "Rated by (Ownership)" , "Reference (WeatherStation)" , and if possible "Reference (WeatherStationAlt)" should be properly linked according to their Path Name(see Linkage OwnerShareRating below).

Figure below shows the parent/child hierarchy of a *OwnerShareRating* in IMM.

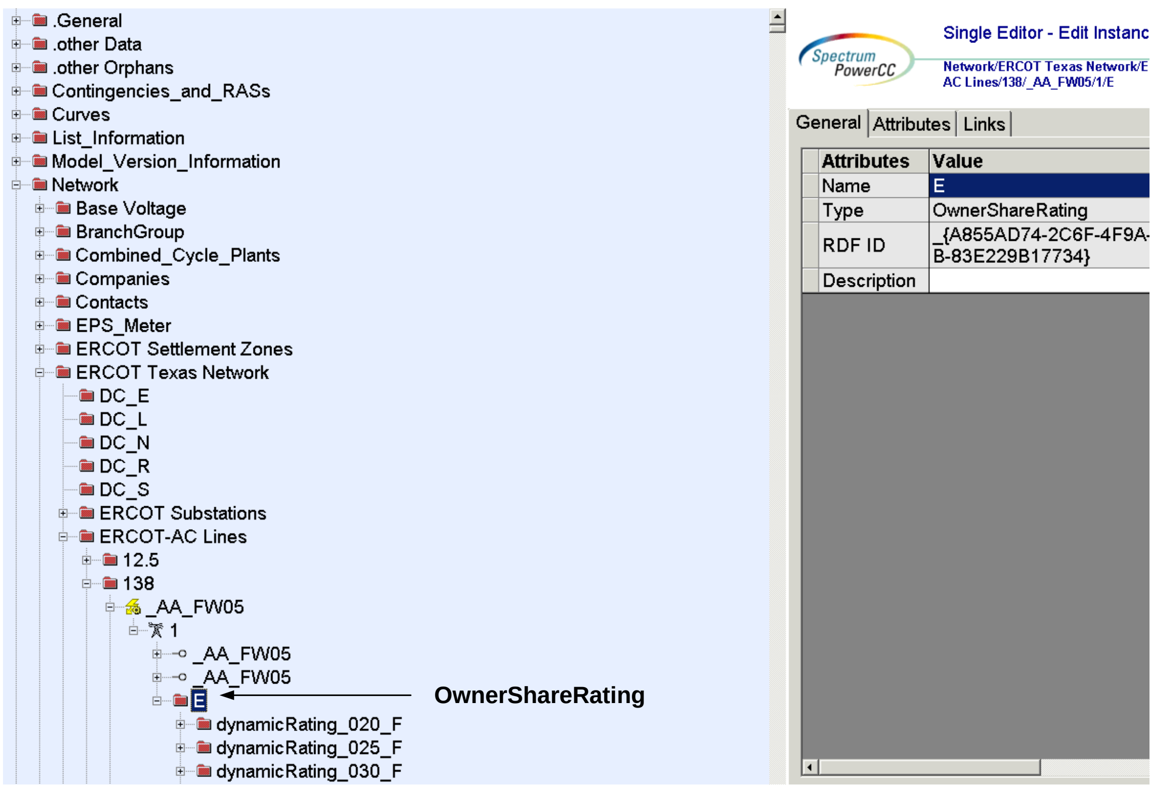


Figure 43 - Hierarchy for OwnerShareRating

26.2 ATTRIBUTES

The attributes for a OwnerShareRating are shown in the table below.

Attribute	Description	Data Type	Default Value	Sample Data

Alias Name	Free text name of the object or instance.	String	None	
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.			
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	

26.3 LINKAGE

The required links for a OwnerShareRating are defined in table below.

Link Name	Description	Path Name
Owned By (DynamicElement)	The Equipment name that is to be rated.	.other Orphans/DynamicElement/Line
Rated By (Ownership)	Registered Owner of the Equipment	Network/Companies/Company/Owner ship
Reference (WeatherStation)	Weather Station the Equipment is assigned to.	.other Orphans/WeatherStation/Weather Stations
Reference (WeatherStationAlt)	Alternate Weather Station that the owner intends to assign to the Equipment.	.other Orphans/WeatherStation/Weather Stations

CLASSES ONLY MODELED BY ERCOT

Modeling guidelines for the classes described beyond this point are classes that will only be allowed to be submitted by ERCOT. These classes will appear in models posted by ERCOT.

©2009 Electric Reliability Council of Texas, Inc.

27 MODELING BASEVOLTAGE

27.1 MODELING APPROACH

BaseVoltage's are created by ERCOT. These are a collection of Base Voltages which are used to verify that the *BusbarSection*, *BaseVoltage* and other voltage attributes in the CIM are given a value existing in the collection.

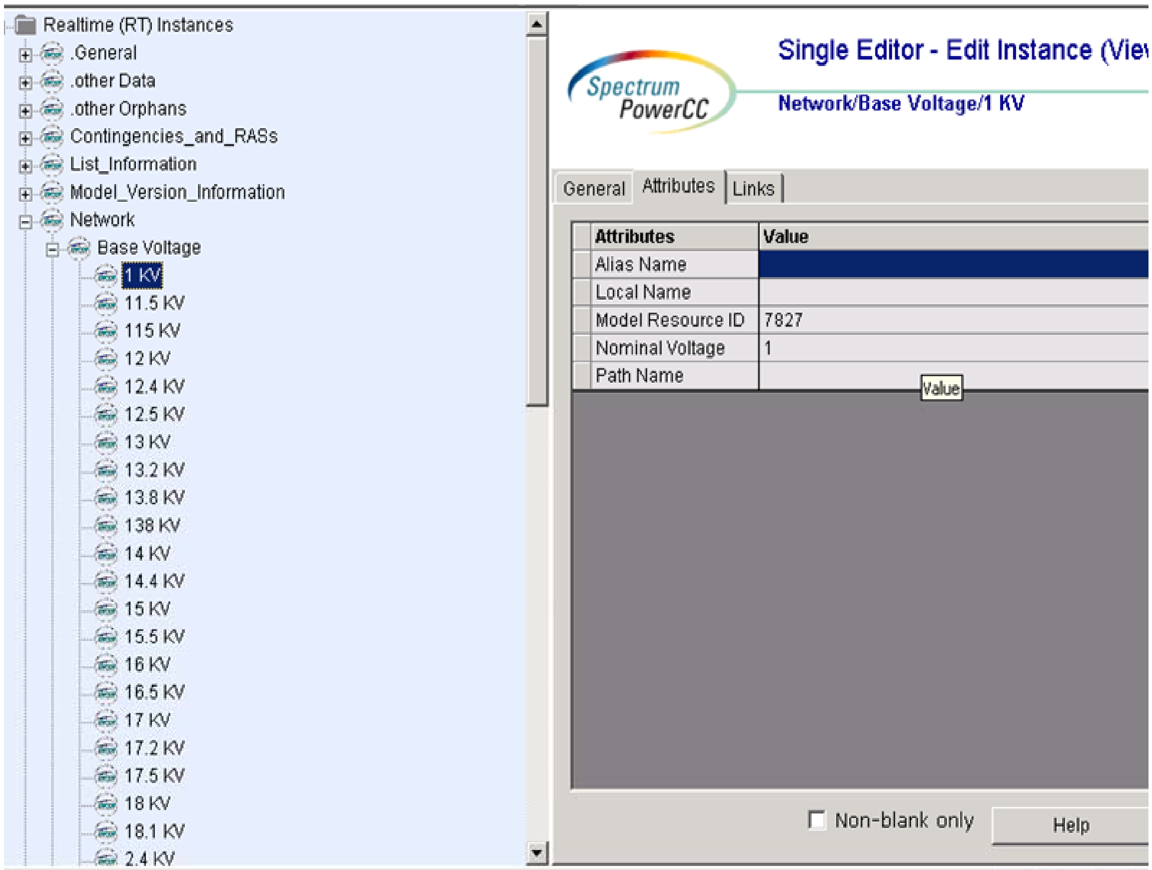


Figure 44 - BaseVoltage

27.2 ATTRIBUTES

The following table shows all the attributes that are available for a *BaseVoltage*.

Attribute	Description	Data Type	Default	Sample Data
Alias Name	Free text name of the object or instance	String	None	

Local Name	The localName is a human readable name of the object	String	None	
Model Resource ID	A Model Authority issues mRIDs	String	None	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.			
Nominal Voltage	The PowerSystemResource's base voltage			69kv

27.3 LINKAGE

There are no required linkages to the *BaseVoltage*.

28 MODELING COMPANY

28.1 MODELING APPROACH

Instances of this class are created by ERCOT based on the Registration Information. A *Company* is a legal entity that owns and operates power system resources and is a party to interchange and transmission contracts.

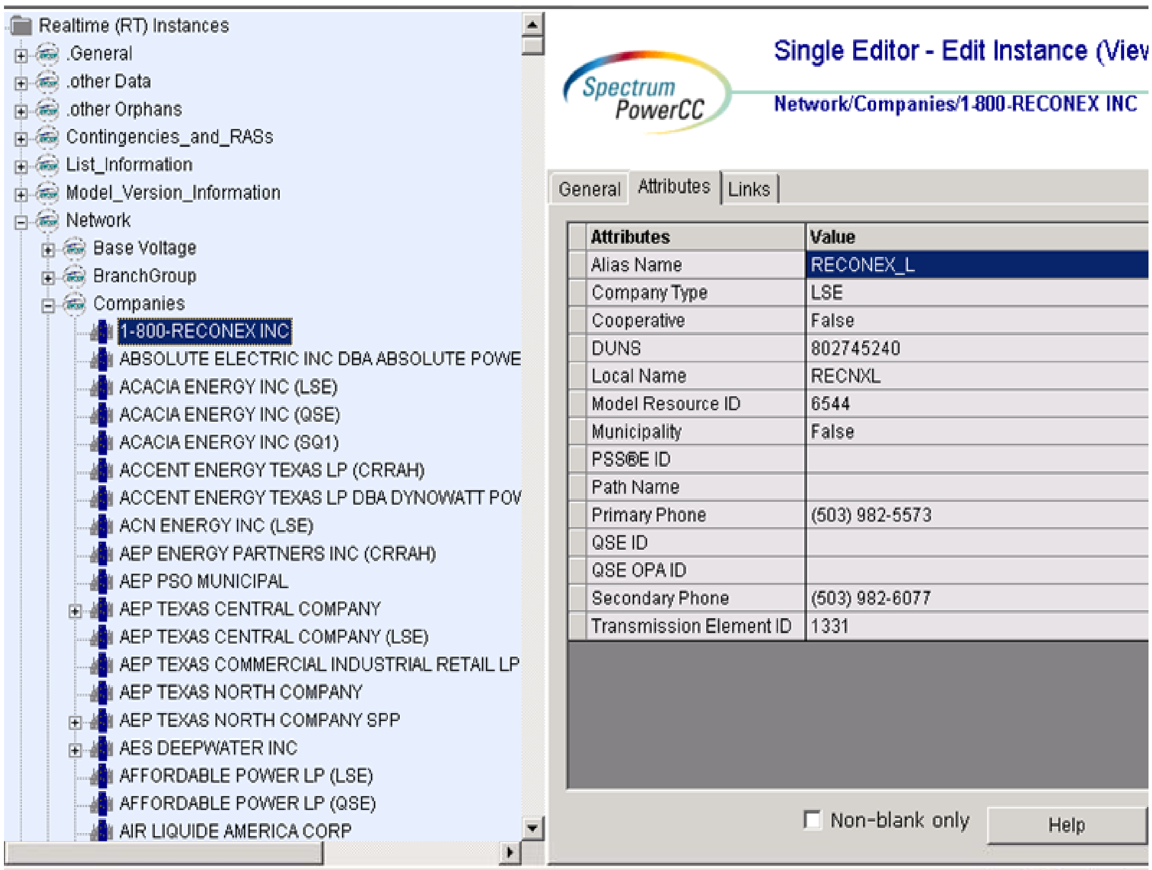


Figure 45 - Company

28.2 ATTRIBUTES

The following table shows all the attributes that are available for a *Company*.

Attribute	Description	Data Type	Default Value	Sample Data
Alias Name	Free text name of the object or instance.	String	None	RECONEX_L
Company	The type of company,	String	None	LSE

Type	e.g.: pool, municipal, private.			
Cooperative	Cooperative boolean.	Boolean	None	False
Description	Description of the object or instance.	String		
DUNS	DUNS Number	String		802745240
Local Name	The localName is a human readable name of the object.	String		RECNXL
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String		6544
Municipality	Municipality boolean.	Boolean		False
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.			
Primary Phone	Primary Phone number for contact.			
PSS®E ID	Attribute will give IMM modelers control over the PSS®E ID that the Topology Processor uses to properly number owners.	Number		
QSE ID	A 14 character QSE ID used for ERCOT LFC.	String		
QSE OPA ID	A 6 character QSE OPA ID for the QSE operating in the QSE Simulator.			
Secondary Phone	Secondary Phone number for contact.			
Transmission Element ID	Transmission Element ID.	Number		1331

©2009 Electric Reliability Council of Texas, Inc.

28.3 LINKAGE

There are no required linkages to the *Company*.

29 MODELING SUBGEOGRAPHICALREGION

29.1 MODELING APPROACH

SubgeographicalRegion's can be created only by ERCOT. It is a subset of a geographical region of a power system network model.

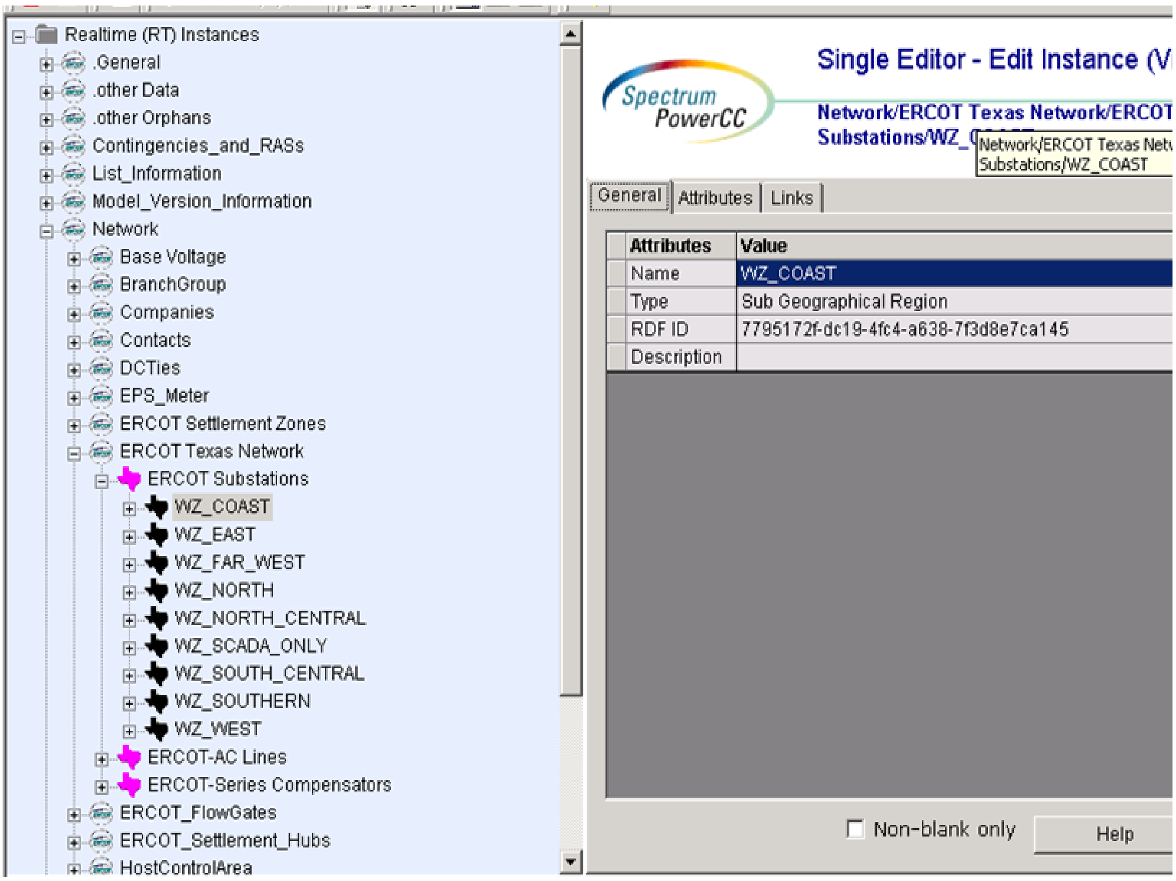


Figure 46 - SubGeographicalRegion

29.2 ATTRIBUTES

The following table shows all the attributes that are available for a *SubGeographical* Region.

Attribute	Description	Data Type	Default Value	Sample Data
Alias Name	Free text name of the object or instance.	String		

Description	Description of the object or instance.	String		
is WeatherZone	Indicates whether a SubGeographicalRegion is a Weather Zone.	Boolean	False	
Local Name	The localName is a human readable name of the object.	String		
Model Resource ID	A Model Authority issues mRIDs.			
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.			
PSS®E ID	**Attribute will give IMM modelers control over the PSS®E ID that the Topology Processor uses to properly number Alternate Areas and Zones.**			

29.3 LINKAGE

There are no required links to the *SubgeographicalRegion*.

30 MODELING GEOGRAPHICAL REGION

30.1 MODELING APPROACH

Geograpraphical Regions are created by ERCOT. A geographical region represents a region of a power system network model.

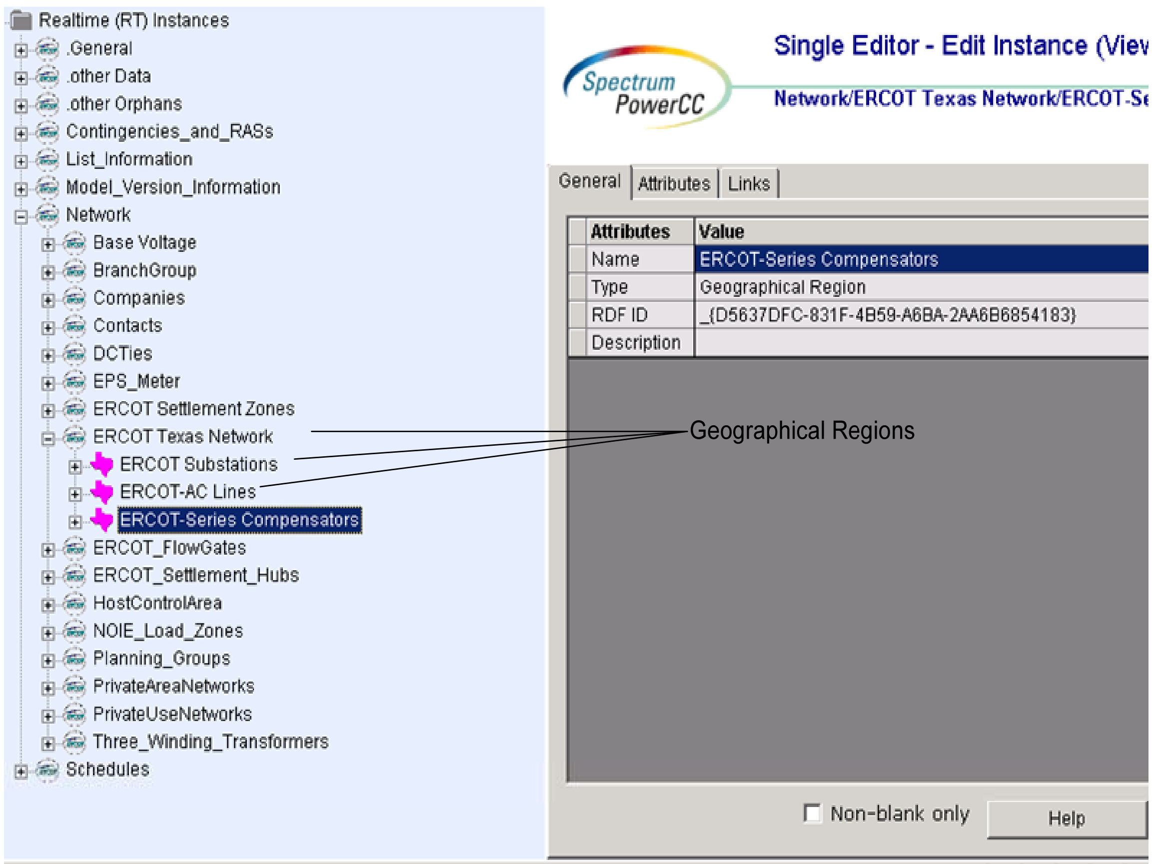


Figure 47 - GeographicalRegion

30.2 ATTRIBUTES

The following table shows all the attributes that are available for a *Geographical Region*.

Attribute	Description	Data Type	Default Value	Sample Data
Alias Name	Free text name of the object or instance	String	None	

Local Name	The localName is a human readable name of the object	String	None	
Model Resource ID	A Model Authority issues mRIDs	String	None	

30.3 LINKAGE

There are no required links to the Geographical Region

31 MODELING MARKET OBJECTS

Market Objects include classes of the type:

- SettlementHUB
- AggregateHUB
- HUBBus
- PricingVector
- ResourceNode
- EPSMeter
- SettlementLoadZone
- SettlementNOIELoadZone

31.1 MODELING APPROACH FOR SETTLEMENTHUB

This section describes the approach for modeling a *SettlementHUB*. *SettlementHUB's* are modeled by ERCOT. A *SettlementHUB* is a designated Settlement Point for an ERCOT HUB.The SettlementHUB should only be contained within an instance of class sysOrphan, named "ERCOT_Settlement_Hubs". There are four SettlementHUBs currently defined in ERCOT Model

- HB_HOUSTON
- HB_NORTH
- HB_SOUTH
- HB_WEST

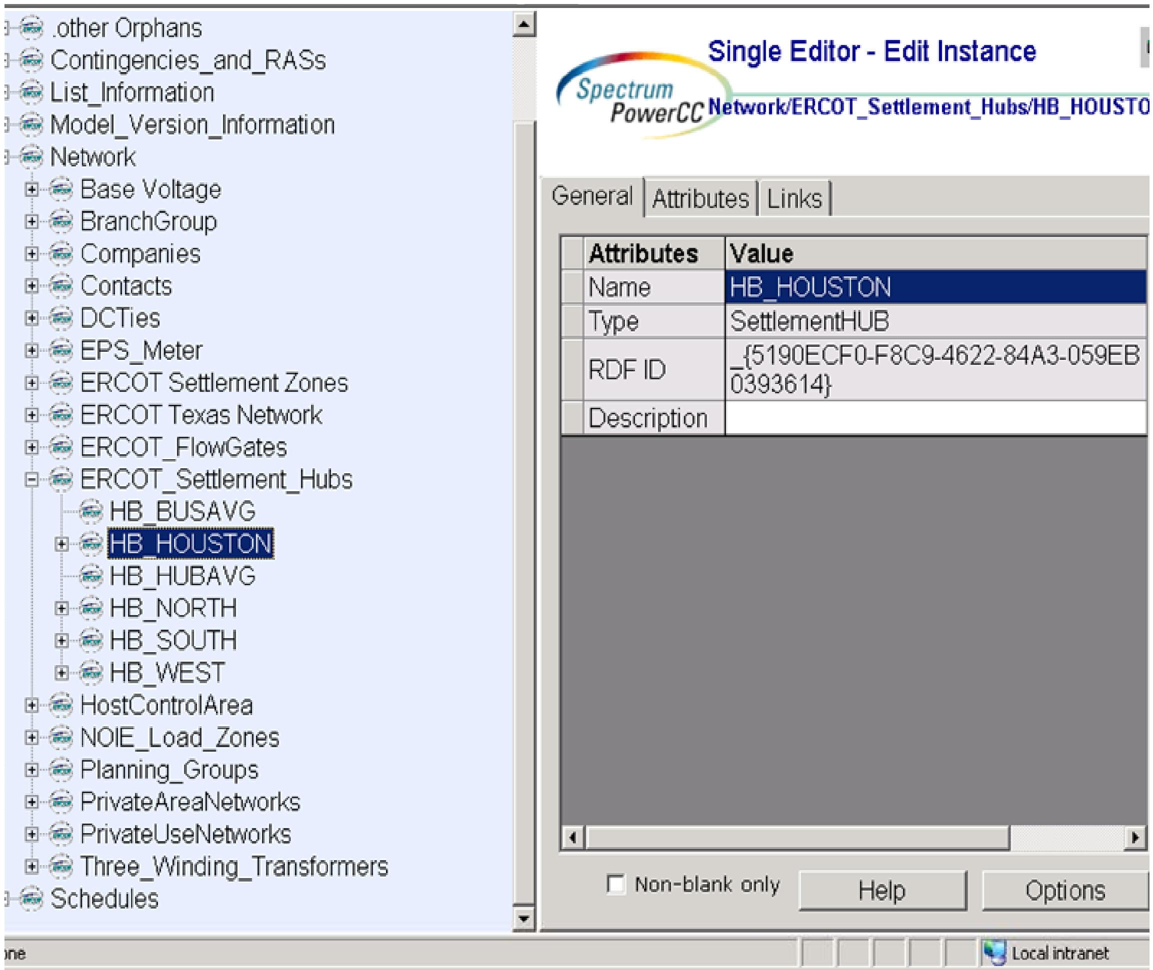


Figure 48 - SettlementHub

31.1.1 Attributes

The following table shows all the attributes that are available for a Settlement Hub. There are no required attributes for a SettlementHub.

Attribute	Description	Data Type	Default Value	Sample Data
Alias Name	Free text name of the object or instance	String	None	
Local Name	The localName is a human readable name of the object	String	None	
Model Resource ID	A Model Authority issues mRIDs	String	None	

31.1.2 Linkage

The following is a required linkage.

AssociationName	Class	Description
Domain.MemberOfSysOrphan	SysOrphan	SettlementHUB needs to be contained only within the instance of class sysorphan.

31.2 MODELING APPROACH FOR AGGREGATEHUB

This section describes the approach for modeling an *AggregateHUB*. *AggregateHUB's* are modeled by ERCOT. There are two AggregateHubs "HB_HUBAVG" and "HB_BUSAVG" defined in the ERCOT model based on the HUB Calculation Methods.

31.2.1 HB_HUBAVG

The HB_HUBAVG for both Day-Ahead and Real-Time is the simple average of four prices from the applicable time period: the North 345 kV Hub price, the South 345 kV Hub price, the Houston 345 kV Hub price, and the West 345 kV Hub price.

Like *SettlementHUB's*, this *AggregateHUB* should only be contained within an instance of class sysorphan named "ERCOT_Settlement_Hubs".

31.2.1.1 Attributes

Following are the attributes.

Attribute	Description	Data Type	Default
AggregateHub.hubCalculationMethod	HubCalculationMethod should be set to ERCOT_HUBS	Enumeration	None.

31.2.1.2 Linkage

Below are the required linkages to AggregateHub.

AssociationName	Class	Description
Domain.MemberOfSysOrphan	SysOrphan	AggregateHUB should only be contained within an instance of the class sysOrphan.
AggregateHub.SettlementHUB	SettlementHUB	"AggregateHub.SettlementHUB" is a Required Linkage. In this particular case all the SettlementHubs that are defined under

		“ERCOT_Settlement_Hubs” must be associated to “ERCOT_HUB_AVG”.

31.2.2 HB_BUSAVG

The HB_BUSAVG is the simple average of the Hub Bus prices for each hour of the Settlement Interval of the DAM in the Day-Ahead and is the simple average of the time weighted Hub Bus prices for each 15-minute Settlement Interval in Real-Time, for each Hub Bus included in this Hub.

Like SettlementHUB’s, this AggregateHUB should only be contained within an instance of class sysorphan named “ERCOT_Settlement_Hubs”.

31.2.2.1 Attributes

Attribute	Description	Data Type	Default
AggregateHub.hubCalculationMethod	HubCalculationMethod should be set to ALL_ERCOT_345KV_HUBBUSES	Enumeration	None.

31.2.2.2 Linkage

AssociationName	Class	Description
Domain.MemberOfSysOrphan	SysOrphan	AggregateHUB should only be contained within an instance of the class sysOrphan.
AggregateHub.SettlementHUB	SettlementHUB	“AggregateHub.SettlementHUB” is a Required Linkage. In this particular case all the SettlementHubs that are defined under “ERCOT_Settlement_Hubs” must be associated to “ERCOT_345KV_HUBBUSES_AVG”.

31.3 MODELING APPROACH FOR HUBBUS

This section describes the approach for modeling a *HUBBus*. *HUBBus’* are modeled by ERCOT. A *HUBBus* by definition is an energized Electrical Bus or group of energized Electrical Buses defined as a single element in the Hub definition.

HUBBus needs to be contained within an instance of the class *SettlementHUB*.

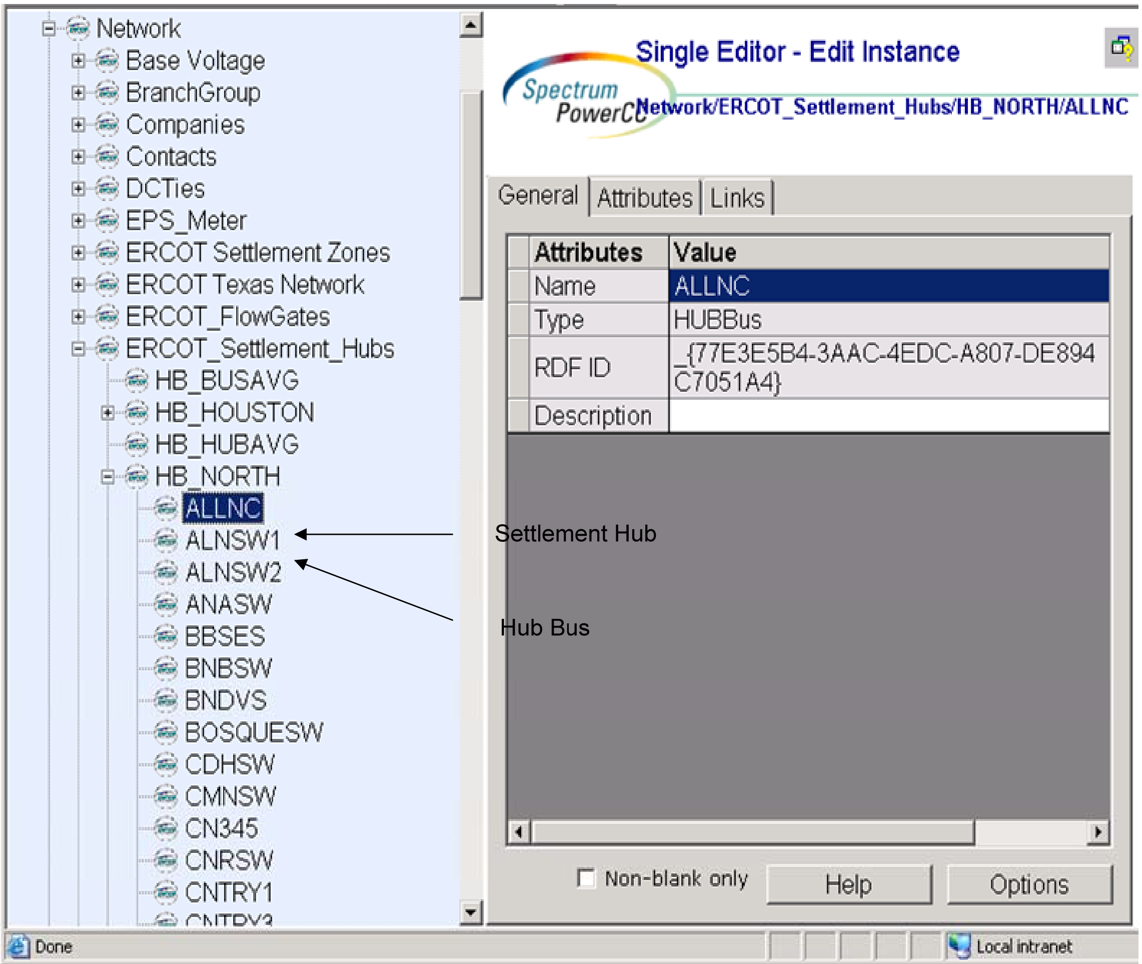


Figure 49 - HubBus

31.3.1.1 Attributes

Attribute	Description	Data Type	Default
None			

31.3.1.2 Linkages

AssociationName	Class	Description
HUBBus.SettlementHub	SettlementHUB	"HUBBus.SettlementHub" is a Required Linkage. HUBBus needs to be contained in an instance of the class SettlementHUB
ConnectivityNodeGroup.HasAHUBBus	ConnectivityNode	"ConnectivityNodeGroup.HasAHUBBus" is a Required Linkage. HUBBus must be associated to a

		ConnectivityNodeGroup that has at least one ElectricalBus under it. If a HUBBus is associated to more than one ConnectivityNodeGroups then all the associated ConnectivityNodeGroups must belong to the same station.

31.4 MODELING APPROACH FOR PRICINGVECTOR

This section describes the approach for modeling a PricingVector. PricingVector's are modeled by ERCOT. PricingVector is the location where the metered price is calculated. PricingVector needs to be always contained with in an instance of the class ElectricalBus.

PricingVector's name should be unique with in the model. PricingVector's can not be connected to BusbarSection or EndCap.

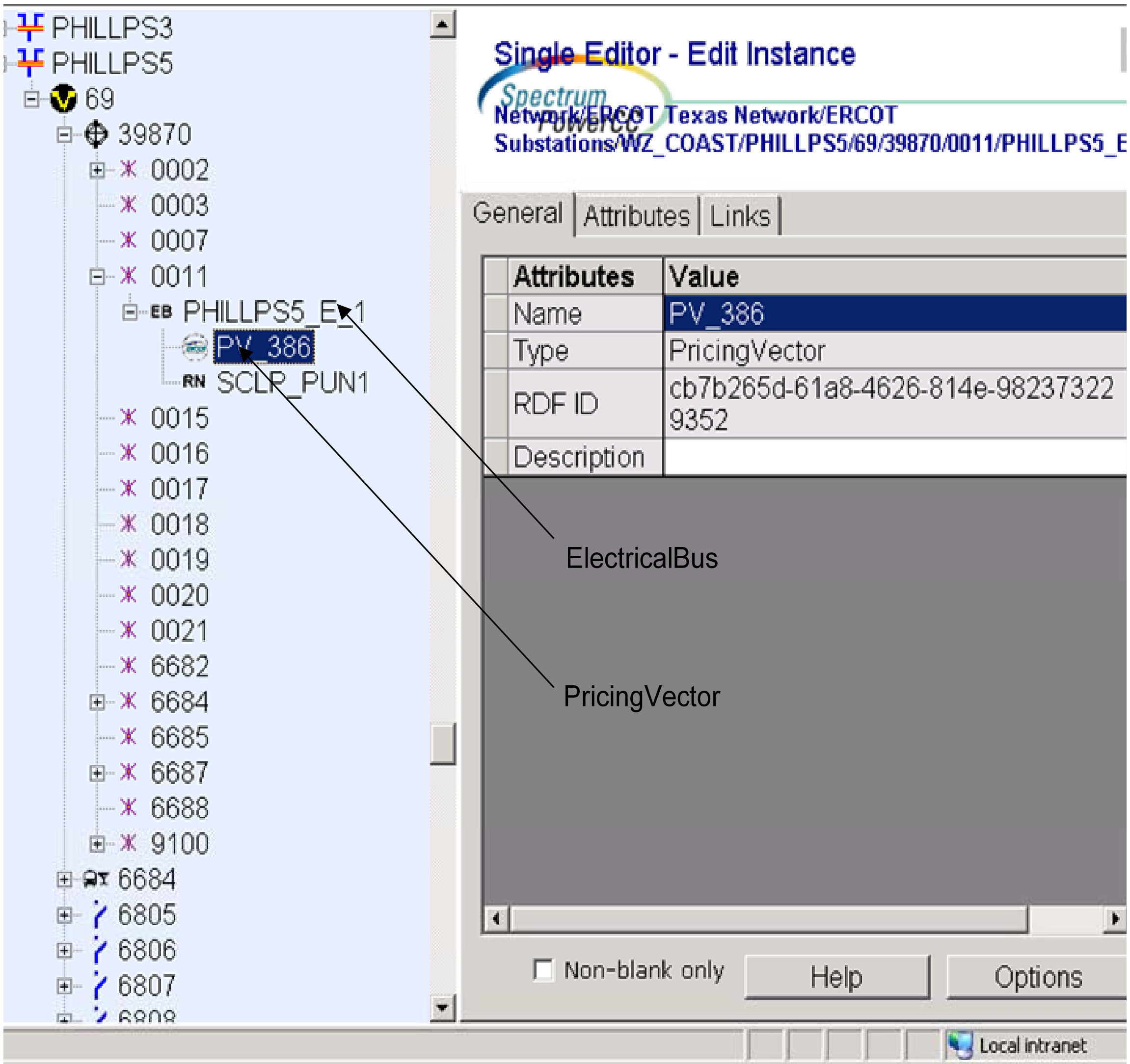


Figure 50 - PricingVector

31.4.1 Attributes

Attribute	Description	Data Type	Default
teid	Transmission Element ID	Integer	Autopopulated

31.4.2 Linkages

AssociationName	Class	Description
PricingVector.ElectricalBus	ElectricalBus	PricingVectorMemberOfElectricalBus is a Required Linkage. PricingVector needs to be always

		contained in an instance of the class ElectricalBus.
PricingVector.Terminal	Terminal	PricingVectorHasATerminal is a Required Linkage. PricingVector must be associated to a terminal where the price is calculated.

31.5 MODELING APPROACH FOR EPSMETER

This section describes the approach for modeling a *EPSMeter*. *EPSMeters* are modeled by ERCOT. *EPSMeter* is a meter polled directly by ERCOT for use in the financial settlement of the market. *EPSMeter* needs to be contained only with in the instance of class sysorphan with EPS_Meter as its name.

31.5.1 Attributes

Following are the attributes for EPSMeters.

Attribute	Description	Data Type	Default
AcceptedStatus	EPS meter location has been accepted by settlements.	Boolean	false
RID	Resource number for EPS meter Identifier	String	Autopopulated
teid	Transmission Element ID	Integer	Autopopulated

31.5.2 Linkages

AssociationName	Class	Description
Domain.MemberOfSysOrphan	SysOrphan	DomainMemberOfsysOrphan is a Required Linkage. This implies that an EPSMeter needs to be contained only in the instance of class sysorphan.
PricingVector.EPSMeter_HasA	PricingVector	PricingVector should be associated to a EPSMeter.

31.6 MODELING APPROACH FOR RESOURCENODE

This section describes the approach for modeling a *ResourceNode*. *ResourceNode's* are modeled by ERCOT. *ResourceNode* is either a logical construct that creates a virtual pricing point required to model a Combined-Cycle Configuration or an Electrical Bus defined in the Network Operations Model, at which a Settlement Point Price is calculated and used in Settlement. *ResourceNode* needs to be always contained within an instance of the class ElectricalBus.

ResourceNode's should not be associated to a *LoadResource* or a *ControllableLoadResource*. *ResourceNode's* that are associated to a *PrivateUseNetwork*, should not be connected to a Physical *GeneratingUnit*. Every *GeneratingUnit* should be associated to *ResourceNode* unless the GeneratingUnit is part of a DCTie or Non-Modeled-Generation or Block Load Transfer or Retired or Mothballed.

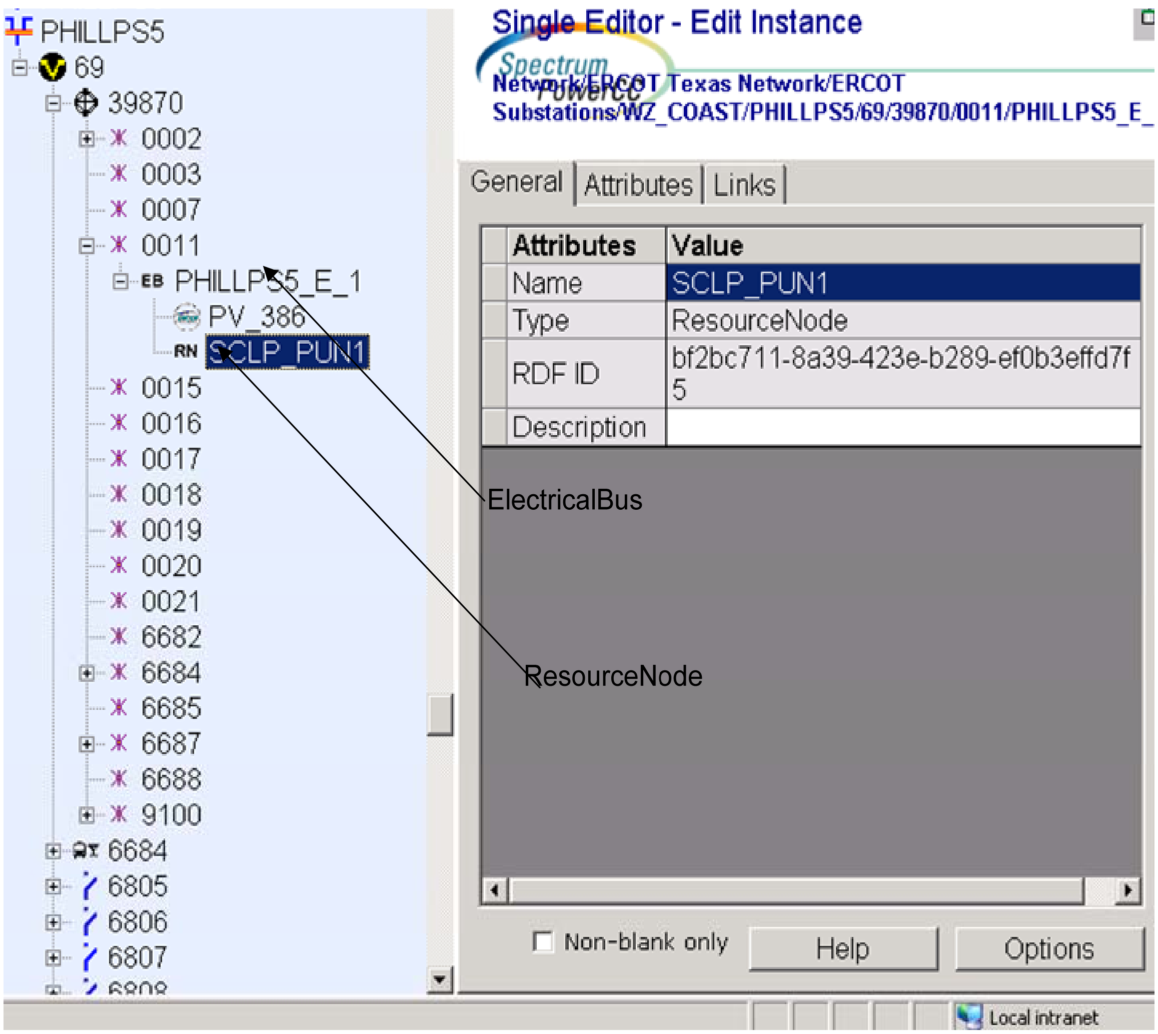


Figure 51 - ResourceNode

31.6.1 Attributes

Attribute	Description	Data Type	Default
None			

31.6.2 Linkages

AssociationName	Class	Description
ResourceNode.ElectricalBus	ElectricalBus	ResourceNode needs to be always contained in an instance of the class ElectricalBus.

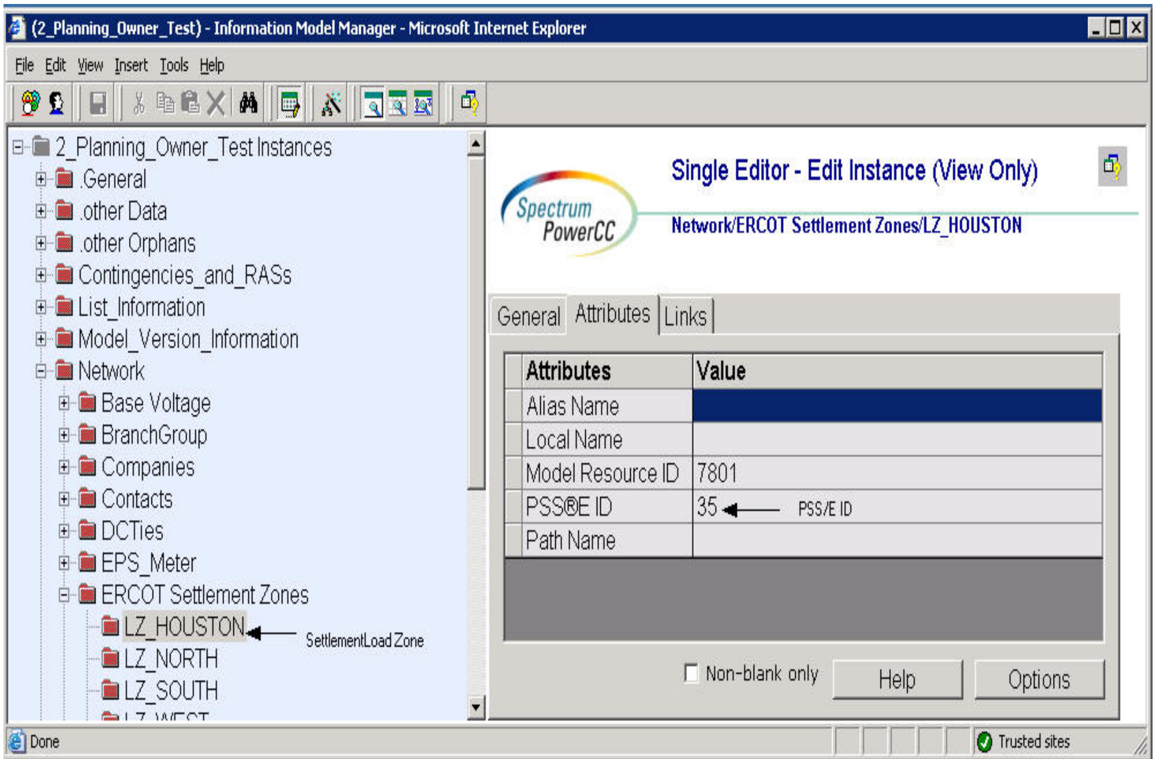
31.7 MODELING APPROACH FOR SETTLEMENTLOADZONE

The ERCOT CIM model defines a *SettlementLoadZone* as Settlement Point for ERCOT Load Zones. ERCOT will designate Settlement Load Zones to specific zones allowing for additional subdivision of the network to facilitate analyses and documentation.

SettlementLoadZone needs to be contained only with in the instance of class sysorphan with “ERCOT Settlement Zones” as its name.

The settlement load zones will be pre-populated and maintained by ERCOT in the IMM. This data may change with future settlement load zones additions.

The each Settlement load zone name and PSS/E ID must be unique within the IMM. These values cannot be duplicated. See figure below as an example.



31.7.1 Attributes

Attribute	Description	Data Type	Default Value	Sample Data
Alias Name	Free text name of the object or instance.	String	None	
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	

Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	Auto-populated	
PSS®E ID	Attribute will give IMM modelers control over the PSS®E ID that the Topology Processor uses to properly name units, loads, branches, and transformers	String	None	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	

31.7.2 Linkage

AssociationName	Class	Description
Substation.SettlementLoadZone	Substation	SettlementLoadZoneContainsSubstation is a Required Linkage. All the Substations with Loads must be associated to at least one SettlementLoadZone

31.8 MODELING APPROACH FOR SETTLEMENTNOIELOADZONE

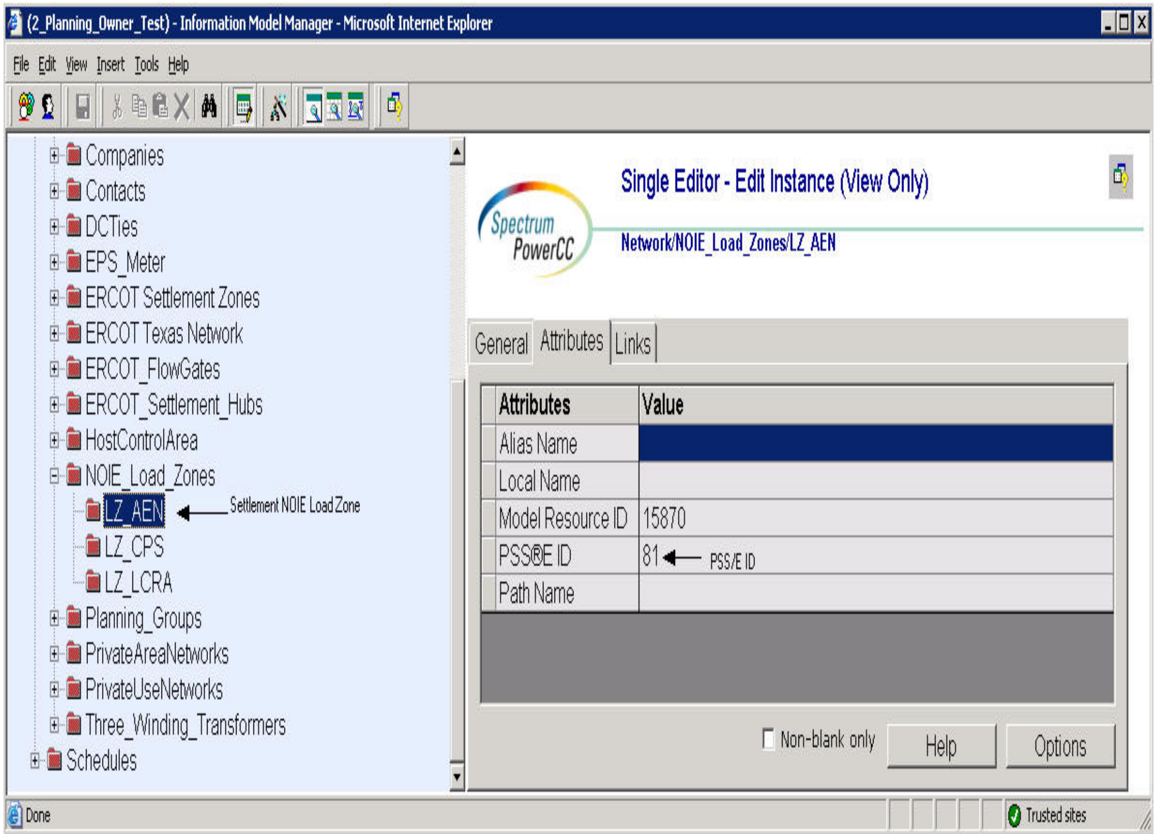
The ERCOT CIM model defines a *SettlementNoieLoadZone* as Settlement Point for ERCOT NOIE Load Zones.

ERCOT will designate Settlement Noie Load Zones to specific zones allowing for additional subdivision of the network to facilitate analyses and documentation.

The Settlement Load Zones will be pre-populated and maintained by ERCOT in the IMM. This data may change with future settlement load zones additions.

The each Settlement load zone name and PSS/E ID must be unique within the IMM. These values cannot be duplicated. See figure below as an example.

SettlementNOIELoadZone needs to be contained only with in the instance of class sysorphan with “NOIE_Load_Zones” as its name.



31.8.1 Attributes

Attribute	Description	Data Type	Default Value
Alias Name	Free text name of the object or instance.	String	None
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None

Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	Auto-populated
PSS®E ID	Attribute will give IMM modelers control over the PSS®E ID that the Topology Processor uses to properly name units, loads, branches, and transformers	String	None
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None

31.8.2 Linkages

There are no required links.

32 MODELING GENERATION

This section will cover modeling of *GeneratingUnits*, *CombinedCyclePlants*, *ControllableLoadResources* and *LoadResources*.

32.1 MODELING GENERATING UNIT

GeneratingUnit is modeled using a *ResourceController*, *GeneratingUnit*, and *SynchronousMachine*. Figure 52 below shows a Generating Unit as modeled in IMM, with parent/child associations labeled. In this figure a Resource Controller named GEN_RC is modeled under a *Substation*. A Generating Unit, GEN is located under the Resource Controller, GEN_RC. Within the same substation, under Voltage Level, 13.8 a Synchronous Machine is modeled.

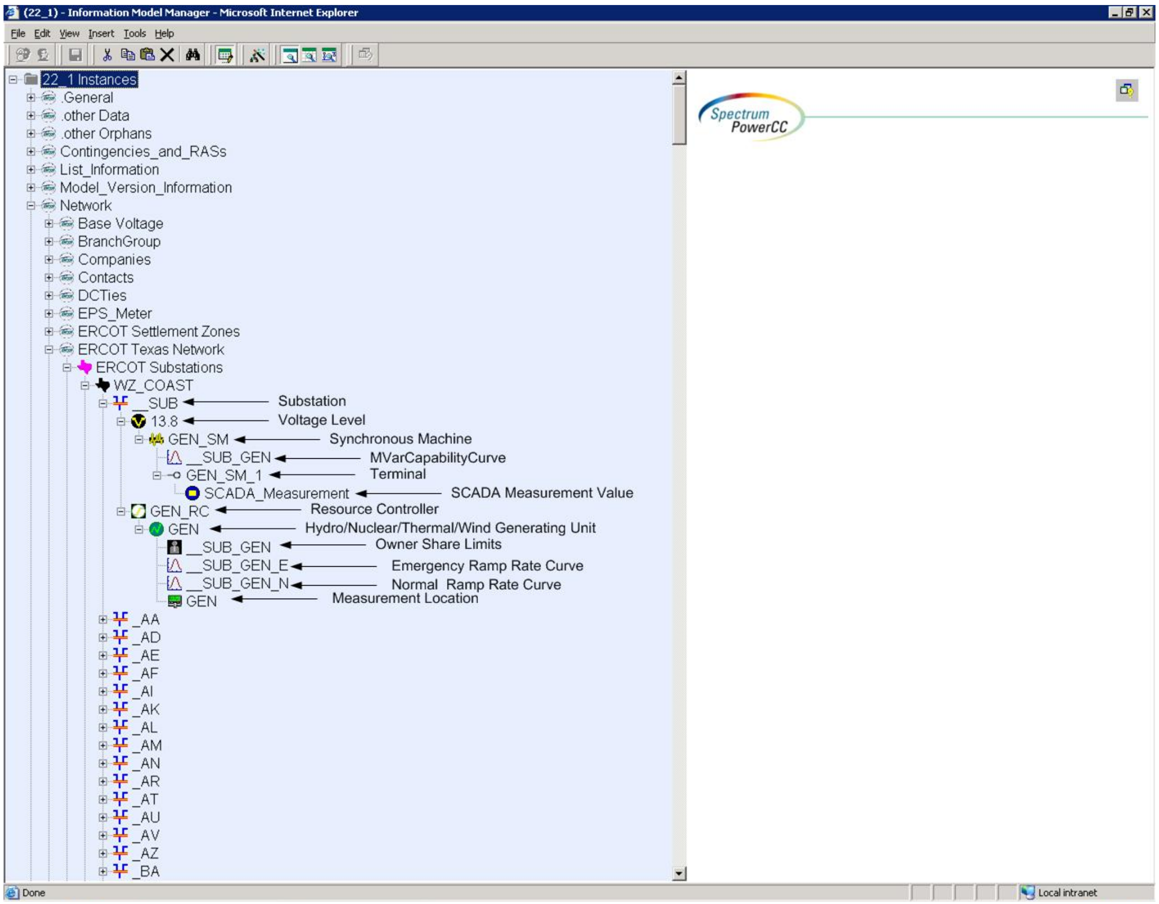


Figure 52 – Modeled Generating Unit with parent/child associations labeled.

32.1.1 Modeling Approach for Resource Controller

The ERCOT CIM data dictionary defines a *ResourceController* as a plant controller. A *ResourceController* is modeled under a Substation. Figure below shows a Resource Controller in IMM, with parent/child associations labeled. Every *GeneratingUnit* in the network model must be contained within a *ResourceController*. Only in case of *CombinedCyclePlants*, multiple *GeneratingUnits* may be present within the same ResourceController.

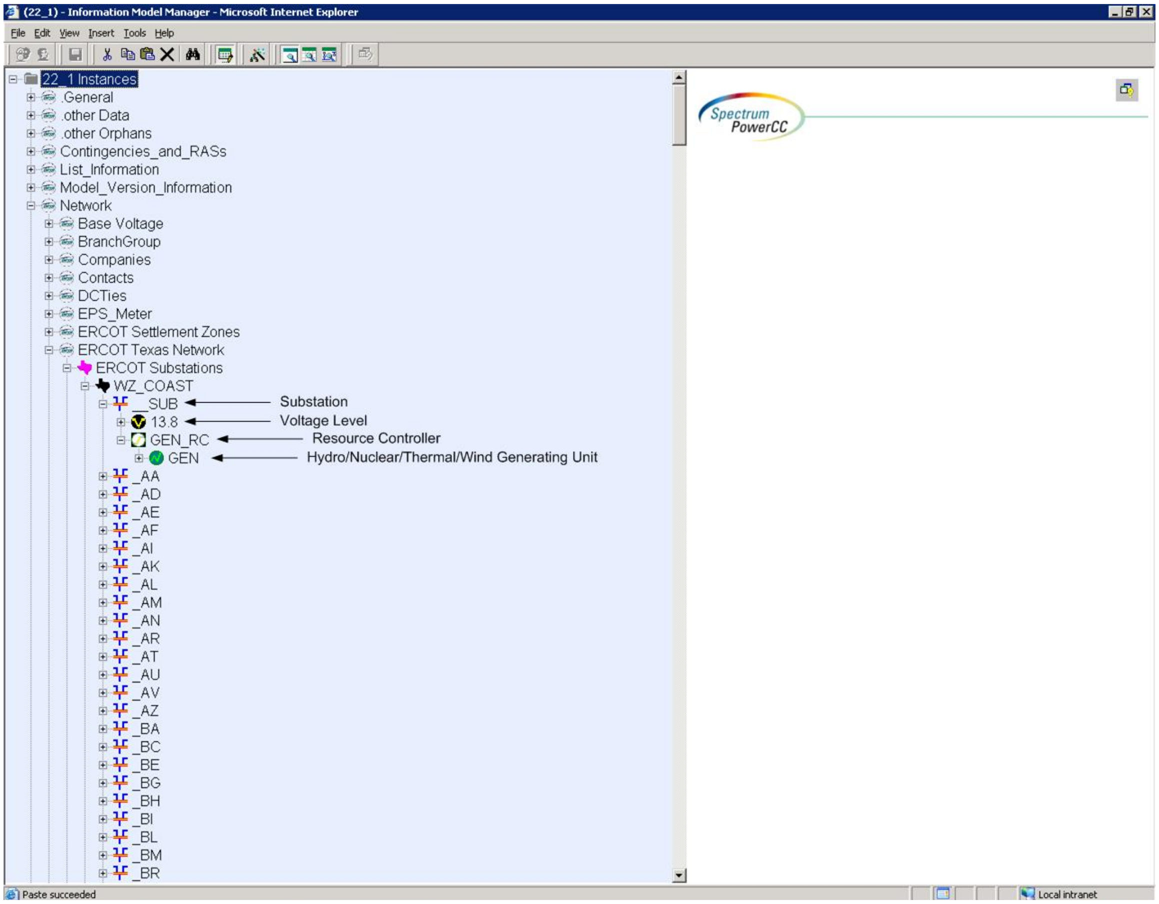


Figure 53 – Modeled Resource Controller with parent/child association.

32.1.1.1 Attributes

The attributes for a *ResourceController* are shown in the table below.

Attribute Table for Resource Controllers

Attribute	Description	Data Type	Default Value	Sample Data
TEID	**Transmission Element ID**	**Integer**	**Auto-populated**	
externalJointUnit		**Boolean**	**False**	
frequencyBias		**Float**	**None**	
gross		**Boolean**	**False**	
jointUnit		**Boolean**	**False**	
physical		**Boolean**	**False**	

Alias Name	Free text name of the object or instance.	String	None	
Latitude	Latiitude coordinates.	Float	None	
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	
Longitude	Longitude coordinates.	Float	None	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	None	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.			

32.1.1.2 Linkage

The required links for a ResourceController are defined in defined in the table.

Linkage Table for Resource Controllers

Link Name	Description	Path Name
Substation	The Substation link is used in order to identify the location of the device	Network/ERCOT Substations/Weather_Zone
Operatorship	The Operatorship link is used for permission rights. The Operator of equipment has the right to edit the equipment. An operator can only be assigned by the creator or owner of the equipment.	Network/Companies

©2009 Electric Reliability Council of Texas, Inc.

Ownership	The Ownership link is used for permission rights. The owner of equipment has editing and administrative rights. An owner can only be assigned by the creator of the equipment.	Network/Companies

32.1.2 Modeling Approach for Generating Unit

The ERCOT CIM model defines a *GeneratingUnit* as a single or set of *SynchronousMachines* for converting mechanical power into alternating-current power. A *GeneratingUnit* is modeled under a *ResourceController*. An emergency and a normal rampratecurve must be modeled under every market participating *GeneratingUnit*. Modeling of curves in is covered in detail in Section ___.

In the ERCOT CIM model a GeneratingUnit can be of four different types: *HydroGeneratingUnit*, *NuclearGeneratingUnit*, *ThermalGeneratingUnit*, and *WindGeneratingUnit*. Below figure below shows a *GeneratingUnit* in IMM, with parent/child associations labeled.

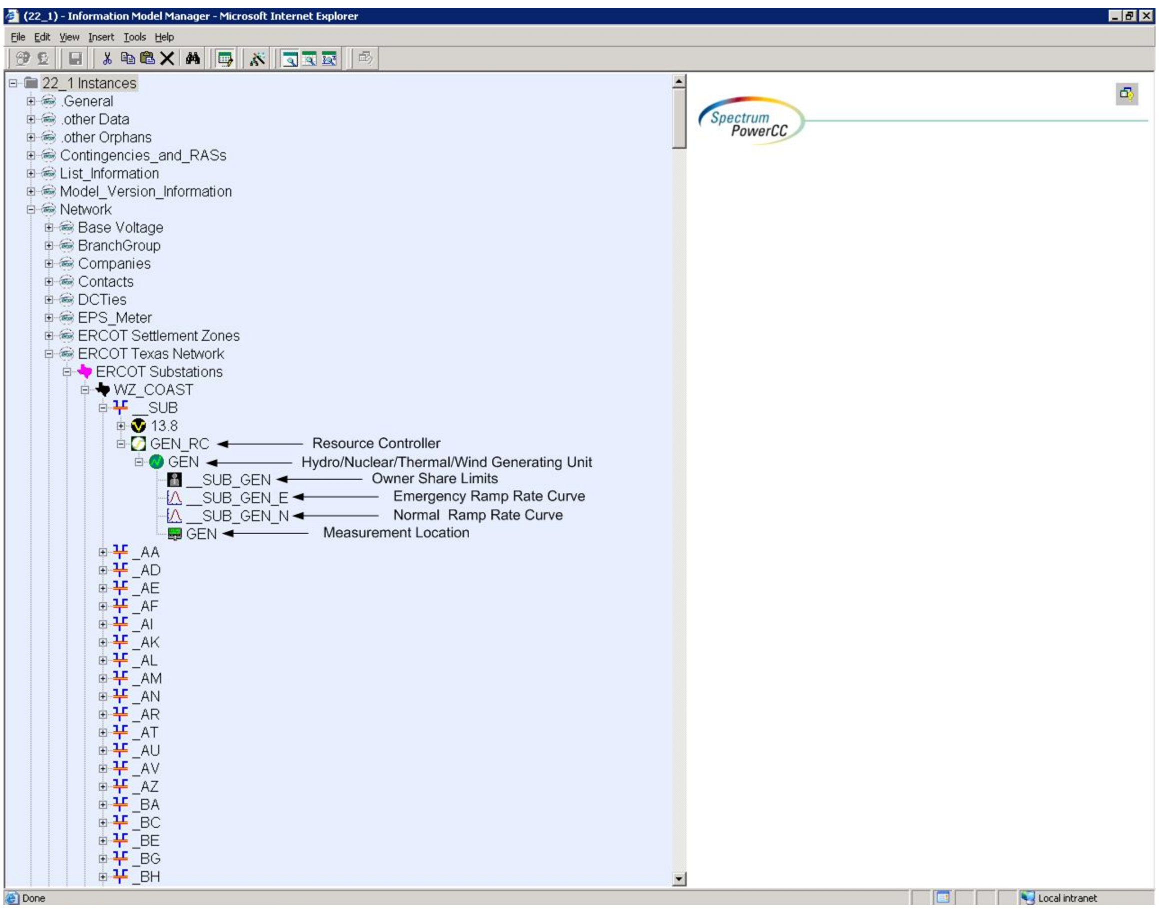


Figure 54 – Modeled Generating Unit with parent/child association.

©2009 Electric Reliability Council of Texas, Inc.

32.1.2.1 Attributes

The attributes for all four types of *GeneratingUnit* are shown in the table below. There is an additional four columns representing each type of *GeneratingUnit* by which it will specified if an attribute is used within that type. The labels of these columns are H for *HydroGeneratingUnits*, N for *NuclearGeneratingUnits*, T for *ThermalGeneratingUnits* and W for *WindGeneratingUnits*. Required attributes are listed at the top of the table in bold text. Most of the Boolean values will have default values upon creation. These values are listed in the table along with sample data for the field.

Attribute Table for Generating Units

Attribute	Description	Data Type	Default Value	Sample Data	H	N	T	W
TEID	**Transmission Element ID**	**Integer**	**Auto-populated**		**X**	**X**	**X**	**X**
coldStartTime	**coldStartTime**	**Float**	**False**		**X**	**X**	**X**	**X**
commercialOperationsDate	**Commericial operations date.**	**Date**	**None**		**X**	**X**	**X**	**X**
controlPulseHigh	**Pulse high limit which is the largest control pulse that the unit can respond to.**	**Seconds**	**0.5**		**X**	**X**	**X**	**X**
controlPulseLow	**Pulse low limit which is the smallest control pulse that the unit can respond to.**	**Seconds**	**0.5**		**X**	**X**	**X**	**X**
controlResponseRate	**MW change for a control pulse of one second in the most responsive loading level of the unit.**	**PowerROCPerSec**	**2**		**X**	**X**	**X**	**X**
efficiency	**The efficiency of the unit in converting mechanical energy, from the prime mover, into electrical energy.**	**PU**	**1**		**X**	**X**	**X**	**X**

freqBias	**Unit Regulating Frequency Bias as MW per 0.1 Hz.**	**Float**	**None**		**X**	**X**	**X**	**X**
freqDevDeadband	**Frequency deviation deadband for Feed-Forward correction.**	**Float**	**None**		**X**	**X**	**X**	**X**
genOperatingMode	**Operating mode for secondary control, e.g.: Off, Manual, Fixed, LFC, AGC, EDC, RPN, MRN, or REG.**	**EnumGeneratorOperatingMode**	**0**		**X**	**X**	**X**	**X**
governorMPL	**Governor motor position limit.**	**PU**	**1**		**X**	**X**	**X**	**X**
governorSCD	**Governor Speed Changer Droop.**	**PerCent**	**5**		**X**	**X**	**X**	**X**
highReasonabilityLimit	**High reasonability limit.**	**ActivePower**	**None**		**X**	**X**	**X**	**X**
hotintTime	**Hot-to-intermediate time (Seasonal).**	**Float**	**None**		**X**	**X**	**X**	**X**
hotStartTime	**Hot start time.**	**Float**	**None**		**X**	**X**	**X**	**X**
intColdTime	**Intermediate-to-cold time (Seasonal).**	**Float**	**None**		**X**	**X**	**X**	**X**
lowReasonabilityLimit	**Low reasonability limit.**	**ActivePower**	**None**		**X**	**X**	**X**	**X**
lowReasonabilityRampRateLimit	**Low reasonability ramp rate limit.**	**ActivePower**	**None**		**X**	**X**	**X**	**X**
maxDailyStarts	**Maximum daily starts (seasonal parameter).**	**Float**	**None**		**X**	**X**	**X**	**X**

maximumOperatingMW	**This is the maximum operating MW limit the dispatcher can enter for this unit.**	**ActivePower**	**None**		**X**	**X**	**X**	**X**
maxONTime	**Maximum On-Line time.**	**Float**	**None**		**X**	**X**	**X**	**X**
maxWeeklyEnergy	**Maximum weekly energy (seasonal parameter).**	**Float**	**None**		**X**	**X**	**X**	**X**
maxWeeklyStarts	**Maximum weekly starts (seasonal parameter).**	**Float**	**None**		**X**	**X**	**X**	**X**
minimumOperatingMW	**This is the minimum operating MW limit the dispatcher can enter for this unit.**	**ActivePower**	**0**		**X**	**X**	**X**	**X**
minOFFTime	**Minimum Off-Line time.**	**Float**	**None**		**X**	**X**	**X**	**X**
minONTime	**Minimum On-Line time.**	**Float**	**None**		**X**	**X**	**X**	**X**
modelDetail	**Detail level of the generator model data.**	**Classification**	**3**		**X**	**X**	**X**	**X**
penaltyFactor	**The unit's penalty factor as calculated by the Network Sensitivity function.**	**PenaltyFactor**	**1**		**X**	**X**	**X**	**X**
PrimaryFuelType	**Primary fuel type.**	**EnumERCOTFuelType**	**None**		**X**	**X**	**X**	**X**
qualificationStatus	**Qualification status.**	**Boolean**	**FALSE**		**X**	**X**	**X**	**X**

seasonalMaxSustainableRating	**Seasonal maximum sustainable rating.**	**ActivePower**	**None**		**X**	**X**	**X**	**X**
seasonalMinEmergencyRating	**Seasonal minimum emergency rating.**	**ActivePower**	**None**		**X**	**X**	**X**	**X**
seasonalMinSustainableRating	**Seasonal minimum sustainable rating.**	**ActivePower**	**None**		**X**	**X**	**X**	**X**
SecondaryFuelType	**Secondary fuel type.**	**EnumERCOTFuelType**	**None**		**X**	**X**	**X**	**X**
stepChange	**Unit allowable step change which specifies the maximum stored energy in the boiler.**	**ActivePower**	**5**		**X**	**X**	**X**	**X**
Alias Name	Free text name of the object or instance.	String	None		**X**	**X**	**X**	**X**
allocSpinResMW	The planned unused capacity (spinning reserve) which can be used to support emergency load.	ActivePower	None		**X**	**X**	**X**	**X**
autoCntrlMarginMW	The planned unused capacity which can be used to support automatic control overruns, in MW.	ActivePower	None		**X**	**X**	**X**	**X**
baseMW	For dispatchable units, this value represents the economic MW basepoint, for units that are not dispatchable, this value represents the fixed generation value.	ActivePower	None		**X**	**X**	**X**	**X**

	The value must be between the operating low and high limits.							
blackStart	Determines if a unit is qualified to black start.	Bool	FALSE		X	X	X	X
blockLoadTransfer	Block load transfer.	Boolean	FALSE		X	X	X	X
controlDeadband	Unit control error deadband. When a unit's desired MW change is less than this deadband, then no control pulses will be sent to the unit.	ActivePower	None		X	X	X	X
DAM_Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	FALSE		X	X	X	X
DAM_Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	FALSE		X	X	X	X
description	Description of the object or instance.	String1000	None		X	X	X	X
dispReserveFlag	Display Reserve Flag	Boolean	FALSE		X	X	X	X
energyMinMW	Energy Minimum MW.	HeatPerHour	None		X	X	X	X
fastStartFlag	Fast Start Flag.	Boolean	FALSE		X	X	X	X
frequencyDeadBa	Allowable	Float	None		X	X	X	X

ndHz	deviation of the unit frequency.							
fuelPriority	Fuel Priority.	Priority	None		X	X	X	X
genControlMode	Select the unit control mode as Setpoint (S) or Pulse (P).	EnumGeneratorControlMode	None		X	X	X	X
genControlSource	The source of controls for a generating unit, i.e., Unavailable, Off-AGC, On-AGC, Plant Control.	EnumGeneratorControlSource	None		X	X	X	X
highControlLimit	High limit for secondary (AGC) control.	ActivePower	None		X	X	X	X
highReasonabilityRampRateLimit	High reasonability ramp rate limit.	ActivePower	None		X	X	X	X
initialMW	Default generation for use when the operating type is fixed. An entry is required because the unit may later be placed in a fixed operating type mode even though that may not be the initial selection.	ActivePower	None		X	X	X	X
intStartTime	Intermediate start time.	Float	None		X	X	X	X
Latitude	Latiitude coordinates.	Float	None		X	X	X	X
localName	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming	String	None		X	X	X	X

	hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.							
Longitude	Longitude coordinates.	Float	None		X	X	X	X
longPF	Additional information is not available.	ParticipationFactor	None		X	X	X	X
lowControlLimit	Low limit for secondary (AGC) control.	ActivePower	None		X	X	X	X
lowerRampRate	Lower Ramp Rate.	PowerROCPerMin	None		X	X	X	X
maxCapacityLimit	Maximum possible capacity.	Integer	None		X	X	X	X
maxDownRampRate	Default maximum ramp rate in down direction.	Float	None		X	X	X	X
maximumAllowableSpinngReserve	Maximum allowable spinning reserve. Spinning reserve will never be considered greater than this value regardless	ActivePower	None		X	X	X	X

	of the current operating point.							
maximumCurrentCapacity	(MW) Default current max capacity. Operator Enterable.	Float	None		X	X	X	X
maximumCurrentCapacityRef	(MW) Reference value for Advisory ECO maximum. Entered in modeling.	Float	None		X	X	X	X
maximumEconomicMW	Maximum high economic MW limit that should not exceed the maximum operating MW limit.	ActivePower	None		X	X	X	X
maximumEconomicMWRef	Maximum economic dispatch reference value.	Float	None		X	X	X	X
maxResponseReserveLimit	Maximum responsive reserve limit MW.	Float	None		X	X	X	X
maxSpinReserveContribution	Maximum Spinning Reserve Contribution.	Float	None		X	X	X	X
maxUpRampRate	Default maximum ramp rate in up direction.	Float	None		X	X	X	X
minCapacityLimit	The Lowest continuous economical capacity limit.	Integer	None		X	X	X	X
minimumEconomicMW	Low economic MW limit that must be greater than or equal to the minimum operating MW limit.	ActivePower	0		X	X	X	X
minimumOffTime	Minimum time	Seconds	None		X	X	X	X

	interval between unit shutdown and startup.							
minResponseReserveLimit	Minimum responsive reserve limit MW.	Float	None		X	X	X	X
mRID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String100			X	X	X	X
normalPF	Economic participation factor based on the slope of the unit incremental cost curve at the current operating point of the unit.	ParticipationFactor	1		X	X	X	X
onlineThresholdDeadbandPercent	Unit online threshold deadband percentage.	Float	None		X	X	X	X
OUSPriority	An Outage Scheduler priority is included in all ConductingEquipment classes except BusbarSection and TransformerWinding.	Integer	None		X	X	X	X
pathName	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String500	None		X	X	X	X
psseid	Attribute will give	String2	None		X	X	X	X

	IMM modelers control over the PSS®E ID that the Topology Processor uses to properly name units, loads, branches, and transformers							
raiseRampRate	Raise Ramp Rate	PowerROCPerMin	None		X	X	X	X
ratedGrossMaxMW	The unit's gross rated maximum capacity (Book Value).	ActivePower	None		X	X	X	X
ratedGrossMinMW	The gross rated minimum generation level which the unit can safely operate at while delivering power to the transmission grid.	ActivePower	None		X	X	X	X
ratedNetMaxMW	The net rated maximum capacity determined by subtracting the auxiliary power used to operate the internal plant machinery from the rated gross maximum capacity.	ActivePower	None		X	X	X	X
reliabilityMustRun	TRUE - Unit is qualified to reliability must run.	Boolean	FALSE		X	X	X	X
reserveDiscountFactor	Reserve Discount Factor.	Float	None		X	X	X	X
resourceCategory	Type of resource.	String50	None		X	X	X	X
RUC_Monitored	The Boolean flags to indicate which process(s) monitor the	Boolean	FALSE		X	X	X	X

	branch devices and by which process the devices is secured.							
RUC_Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	TRUE		X	X	X	X
shortPF	Short Participation Factor	ParticipationFactor	None		X	X	X	X
spinningReserveMax	Max spinning reserve from this unit. Usuallly derived from response rate. Applicable only to non-peakers.	Float	None		X	X	X	X
spinReserveRamp	Spin Reserve Ramp	PowerROCPerMin	None		X	X	X	X
startupTime	Time it takes to get the unit on-line, from the time that the prime mover mechanical power is applied.	Seconds	None		X	X	X	X
synCondenserCapable	Flag indicating whether the Resource is Synchronous Condenser capable.	Boolean	FALSE		X	X	X	X
tieLinePF	Unit frequency and tie-line regulation participation factor.	ParticipationFactor	1		X	X	X	X
wfrmcr	wfrmcr.	Boolean	FALSE		X	X	X	X
hydroUnitWaterCo	The equivalent	Float	None		X			

st	cost of water that drives the hydro turbine, expressed as (dollars/cubic meter).							
boilerEfficiency	(%) Boiler efficiency factor. The heat rate curve will be divided by this factor to account for a dirty boiler or any other cause for loos of efficiency of the heat cycle.	Float	None				X	
boilerColdStartEnergy	Boiler cold start engergy (MBTU).	Float	None				X	
oMCost	Operating and maintenance cost for the thermal unit.	CostPerHeatUnit	None				X	
turbineColdStartEnergy	Turbine cold start energy MBTU (used by UC only).	Float	None				X	

32.1.2.2 Linkage

The required links for all *GeneratingUnit* types are defined in the table below.

Linkage Table for Generating Units

Link Name	Description	Path Name
DCTie	Should be populated only when the unit is part of a DC Tie.	Netowrk/DCTies
GenerationType		List_Information/GenerationType
PrivateAreaNetwork	Should be populated only when the unit is	Network/PrivateAreaNetworks

	part of a PUN or if the unit is retired, mothballed or blockloadtransfer.	
ProtectedSwitch	??	??
ResourceNode	All market participating gen units should have this populated	Network/ERCOT Texas Network/ERCOT Substations/Weather_Zone/Substation/Voltage_Level/ConnectivityNodeGrou/ConnectivityNode/ElectricalBus/
SubLoadArea	All units should be part of a subloadarea	Schedules/Load Area Schedules

32.1.3 Modeling Approach for Synchronous Machine

The ERCOT CIM data dictionary defines a *SynchronousMachine* as an electromechanical device that operates synchronously with the network. It is a single machine operating either as a generator or synchronous condenser or pump. In the ERCOT CIM model a *SynchronousMachine* is modeled under a Voltage Level. Every SynchronousMachine may have a MVArCapabilityCurve defined as a child under the SynchronousMachine. Modeling of MVar Capability is described in Section ____ of this document. A single terminal must be modeled under a *SynchronousMachine*. One or many SCADA measurement/s may be modeled under the terminal. Figure 55 – Modeled Synchronous Machine with parent/child association. below shows a *SynchronousMachine* in IMM model hierarchy, with parent/child associations labeled.

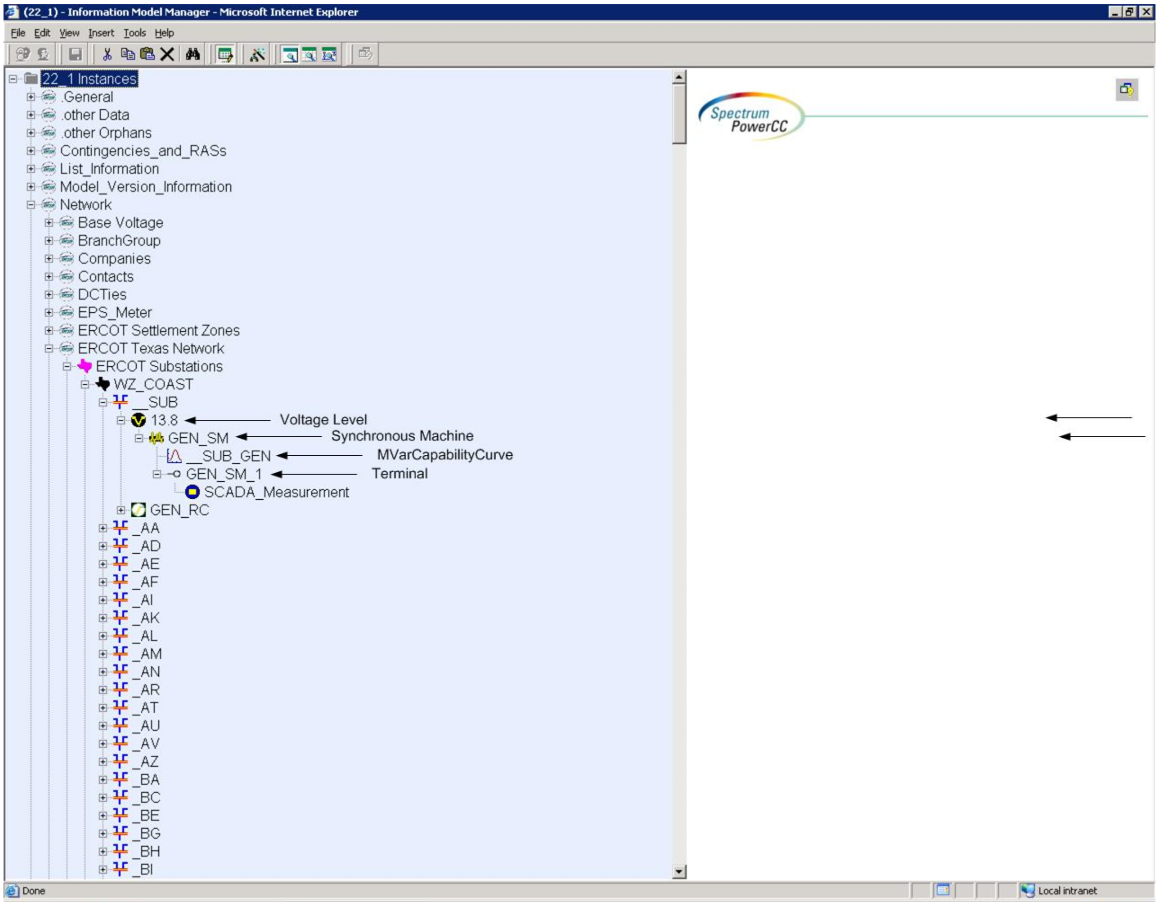


Figure 55 – Modeled Synchronous Machine with parent/child association.

32.1.3.1 Attributes

The attributes for a *SynchronousMachine* are shown in the table below.

Attribute Table for Synchronous Machine

Attribute	Description	Data Type	Default Value	Sample Data
TEID	**Transmission Element ID**	**Integer**	**Auto-populated**	
inertia	**The energy stored in the rotor when operating at rated speed. This value is used in the accelerating power reference frame for operator training simulator solutions.**	**Inertia**	**5**	
xSubtrans	**Subtransient reactance, also known as X".**	**Reactance**	**None**	
xTrans	**Transient reactance, also**	**Resitance**	**False**	

	known as X".			
Alias Name	Free text name of the object or instance.	String	None	
avrEnabled				
aVRToManualLag	Time delay, in seconds, required when switching from AVR to manual for a lagging MVAr violation.	Seconds	None	
aVRToManualLead	Time delay, in seconds, required when switching from Automatic Voltage Regulation to Manual for a leading MVAr violation.	Seconds	None	
baseMVAr	Default base MVAr value. This value represents the initial MVAr that can be used by any application function.	ReactivePower	None	
condenserMW	Condensor MW	ActivePower	None	
coolantCondition	Temperature or pressure of coolant medium.	Float	None	
coolantType	Method of cooling the machine, e.g., air, hydrogen gas, water.	EnumCoolantType	None	
DAM_Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	FALSE	
DAM_Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	FALSE	
damping	Damping torque coefficient, a proportionality constant that, when multiplied by the angular velocity of the rotor poles with respect to the magnetic field (frequency), results in the damping torque.	Damping	None	
description	Description of the object or instance.	String1000	None	

Latitude	Latiitude coordinates.	Float	None	
loadBasedRegulationEnabled	T = Load based voltage regulation enabled.	Boolean	False	
localName	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	
Longitude	Longitude coordinates.	Float	None	
manualToAVR	Time delay, in seconds, required when switching from Manual to Automatic Voltage Regulation. This value is used in the accelerating power reference frame for powerflow solutions.	Seconds	None	
maximumKV	Maximum kV limit for the unit.	Voltage	None	
maximumMVAr	Maximum MVAr limit. This is the maximum (nameplate) limit for the unit.	ReactivePower	None	
minimumKV	Minimum kV limit for the unit.	Voltage	None	
minimumMVAr	Minimum MVAr limit for the unit.	ReactivePower	None	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	None	
operatingMode	Current mode of operation, i.e., generator or condenser.	EnumSynchronousMachineOpera	None	

		tingMode		
OUSPriority	An Outage Scheduler priority is included in all ConductingEquipment classes except BusbarSection and TransformerWinding.	Integer	None	
pathName	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String500	None	
phases	Describes the phases carried by a conducting equipment. Possible values { ABCN , ABC, ABN, ACN, BCN, AB, AC, BC, AN, BN, CN, A, B, C, N }.	PhaseCode	None	
psseid	Attribute will give IMM modelers control over the PSS®E ID that the Topology Processor uses to properly name units, loads, branches, and transformers	String2	None	
r	Positive sequence resistance of the synchronous machine.	Resistance	None	
r0	Zero sequence resistance of the synchronous machine.	Resistance	None	
ratedMVA	Nameplate MVA rating for the unit.	ApparentPower	None	
Reduce	Attribute will be used to mark generators on low voltage systems that should be reduced and attached directly to the Transmission Level.	Boolean	FALSE	
referencePriority	Priority of unit for reference bus selection. 0 = don t care (default) 1 = highest priority. 2 is less than 1 and so on.	Integer	None	
remove	The equipment is removed from the network.	Boolean	FALSE	
removeEnable	The equipment can be removed from the network.	Boolean	FALSE	
RUC_Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which	Boolean	None	

	process the devices is secured.			
RUC_Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	None	
type	Modes that this synchronous machine can operate in, i.e., as a generator, condenser, or both.	EnumSynchronousMachineType	None	
varManual	Manually entered MVAR overrides capability curve.	Boolean	False	
x	Positive sequence reactance of the synchronous machine.	Reactance	0.12	
x0	Zero sequence reactance of the synchronous machine.	Reactance	0.05	
xDirectSubtrans	Direct-axis subtransient reactance, also known as X'd.	Reactance	None	
xDirectSync	Direct-axis synchronous reactance. The quotient of a sustained value of that AC component of armature voltage that is produced by the total direct-axis flux due to direct-axis armature current and the value of the AC component of this current, the machine running at rated speed. (Xd)	Reactance	None	
xDirectTrans	Direct-axis transient reactance, also known as X'd.	Reactance	None	
xQuadSubtrans	Quadrature-axis subtransient reactance, also known as X'q.	Reactance	None	
xQuadSync	Quadrature-axis synchronous reactance (Xq) , the ratio of the component of reactive armature voltage, due to the quadrature-axis component of armature current, to this component of current, under steady state conditions and at rated frequency.	Reactance	None	
xQuadTrans	Quadrature-axis transient reactance, also known as X'q.	Reactance	None	

32.1.3.2 Linkage

The required links for a *SynchronousMachine* are defined in the table**Error! Reference source not found.** below.

Linkage Table for Synchronous Machines

Link Name	Description	Path Name
BaseVoltage	A link to a BaseVoltage is only necessary when there is no VoltageLevel container used. If a VoltageLevel container is used the disconnector will inherit a BaseVoltage from the VoltageLevel.	Network/Base Voltage
MemberOf_GeneratingUnit	A synchronous machine may operate as a generator and such becomes a member of a generating unit	Network/Weather_Zone/Substation/Resource_Controller
AccuracyClass		
LoadBasedRegulationCurve		
Terminal		
Operatorship	The Operatorship link is used for permission rights. The Operator of equipment has the right to edit the equipment. An operator can only be assigned by the creator or owner of the equipment.	Network/Companies
Ownership	The Ownership link is used for permission rights. The owner of equipment has editing and administrative rights. An owner can only be assigned by the creator of the equipment.	Network/Companies
InitiallyUsesMVArCapabilityCurve	This link defines the default MVArCapabilityCurve for use by a SynchronousMachine. The instance of the MVArCapabilityCurve should be created by the user.	Network/Weather_Zone/Substation/Voltage_Level/Synchronous_Machine

32.2 MODELING COMBINED CYCLE PLANT

This section concentrates on the modeling of combined cycle plants in the ERCOT CIM model, Instances of type *CombinedCyclePlant*, *LogicalConfiguration*, *Configuration*, *TransState* and *ConfigurationMember* are utilized when modeling a *CombinedCyclePlant*. Figure 56 –Combined Cycle with parent/child associations labeled. below shows a complete *CombinedCyclePlant* as modeled in IMM hierarchy, with parent/child associations labeled. As can be seen in figure a *CombinedCyclePlant* named __SUB_CC is modeled under the *ResourceController*, RC. All *GeneratingUnits* that are part of __SUB_CC are modeled within the *ResourceController* RC as well. The following sections will describe the modeling of each of these classes in detail.

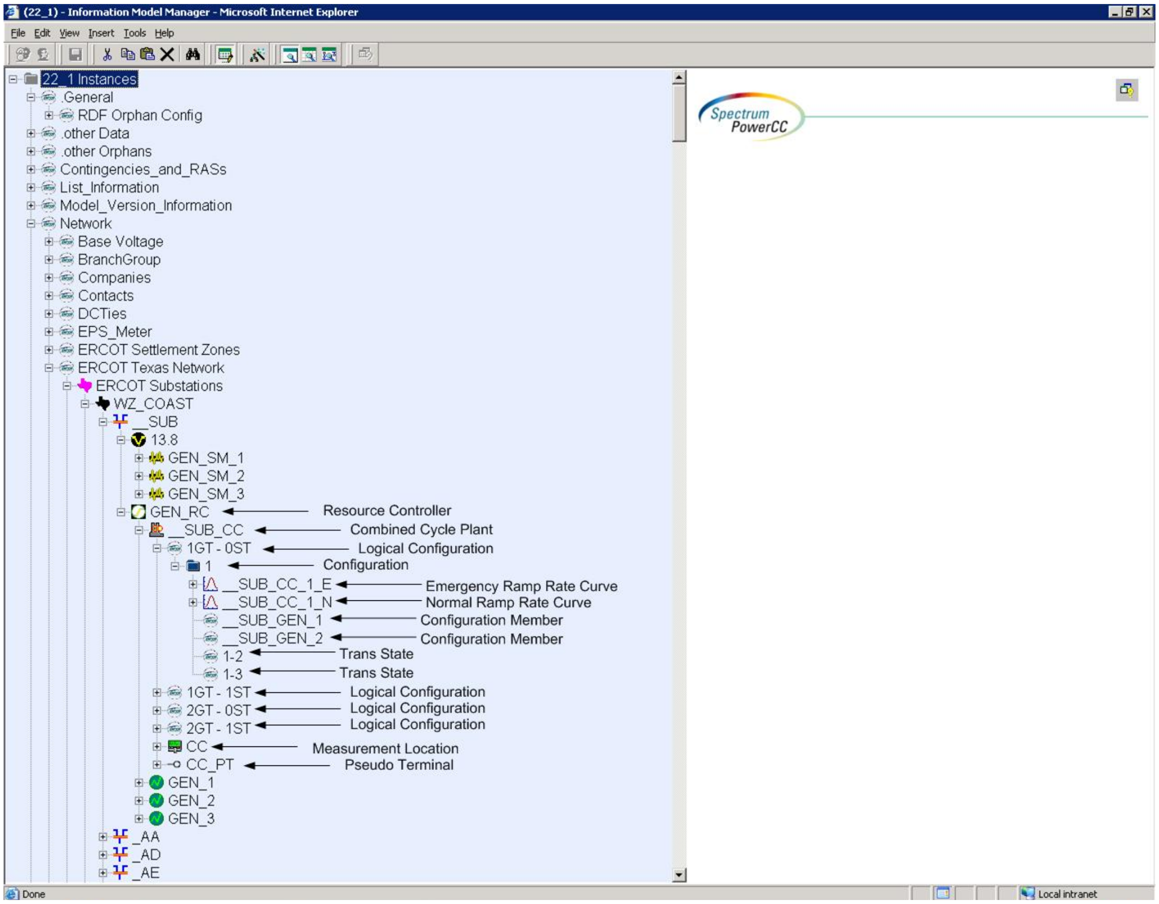


Figure 56 –Combined Cycle with parent/child associations labeled.

32.2.1 Modeling Approach for Combined Cycle Plant

The ERCOT CIM data dictionary defines a *CombinedCyclePlant* as a set of combustion turbines and steam turbines where the exhaust heat from the combustion turbines is recovered to make steam for the steam turbines, resulting in greater overall plant efficiency. Figure 57 – Modeled Combined Cycle Plant with parent/child association labeled. above shows a Combined Cycle Plant modeled in IMM, with parent/child associations labeled. Notice the presence of a Pseudoterminal under the *CombinedCyclePlant*, SUB_CC. This psuedoterminal does not connect to into the network topology and is solely utilized for the purpose of readily displaying SCADA/ICCP telemetry being provided for the *CombinedCycplePlant*. Modeling of *Pseudoterminals* is described in detail in that section.

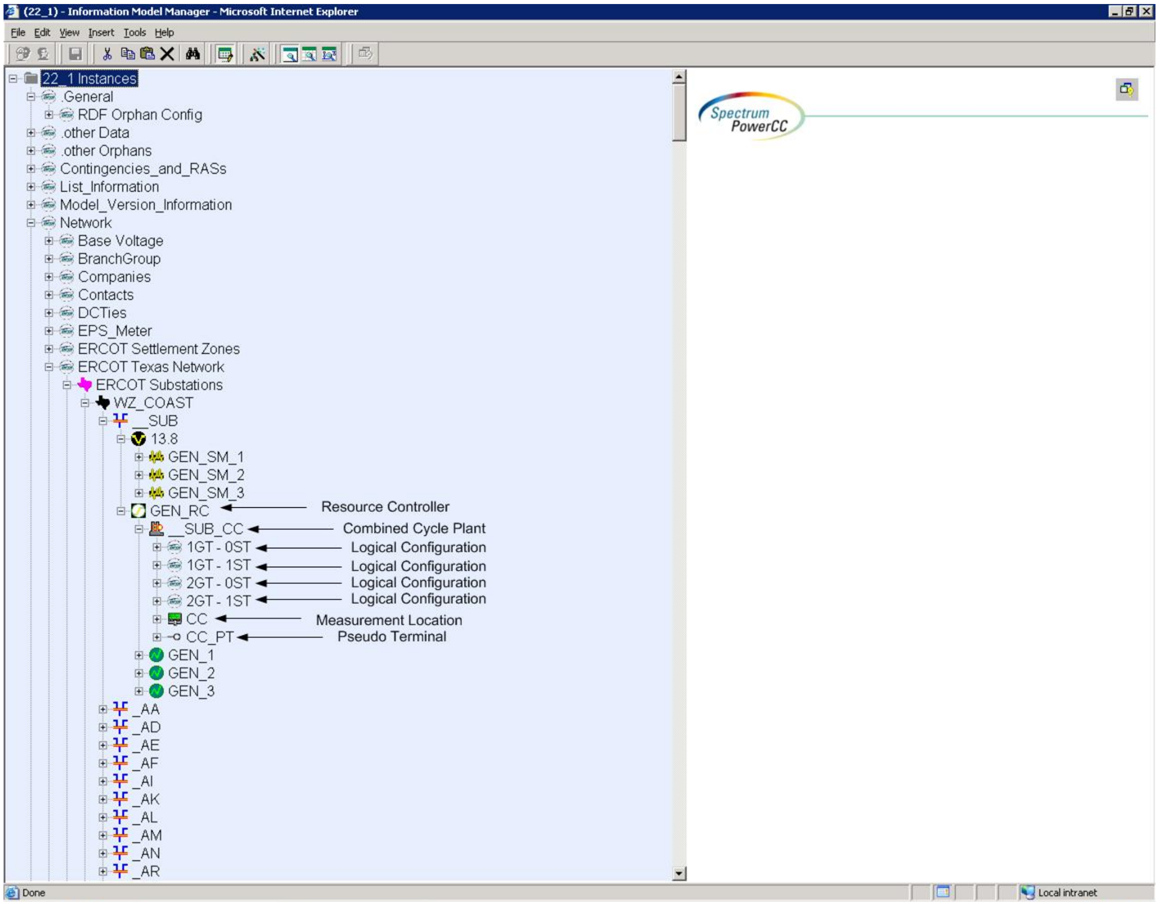


Figure 57 – Modeled Combined Cycle Plant with parent/child association labeled.

32.2.1.1 Attributes

The attributes for a *CombinedCyclePlant* are shown in the table below.

Attribute Table for Combined Cycle Plants

Attribute	Description	Data Type	Default Value	Sample Data
TEID	Transmission Element ID	Integer	Auto-populated	
commercialOperationsDate	**Date commercial operations started.**	**Date**	**None**	
LogicalResourceNodeName	**Logical resource node name.**	**String12**	**None**	
blockLoadTransfer	Block load transfer.	Boolean	FALSE	
combCyclePlantRating	The combined cycle plant's	ActivePower	None	

	output rating, in MW			
GstTpspiMax	GstTpspiMax	Float	None	
GstTpspiMin	GstTpspiMin	Float	None	
GtMax	GtMax	Float	None	
GtMin	GtMin	Float	None	
Latitude	Latiitude coordinates.	Float	None	
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	
Longitude	Longitude coordinates.	Float	None	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	None	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.			

qualificationStatus	Qualification status.	Boolean	FALSE	
resourceCategory	Type of resource.	String50	None	
wfrmcr	wfrmcr.	Boolean	FALSE	

32.2.1.2 Linkage

The required links for a *CombinedCyclePlant* are defined in the table.

Linkage Table for Combined Cycle Plants

Link Name	Description	Path Name
Resource Controller	The Resource Controller link is used in order to associate a Combined Cycle Plant with its respective Resource Controller	Network/ERCOT Substations/Weather_Zone/Substation
Operatorship	The Operatorship link is used for permission rights. The Operator of equipment has the right to edit the equipment. An operator can only be assigned by the creator or owner of the equipment.	Network/Companies
Ownership	The Ownership link is used for permission rights. The owner of equipment has editing and administrative rights. An owner can only be assigned by the creator of the equipment.	Network/Companies

32.2.2 Modeling Approach for Logical Configuration

The ERCOT CIM model utilizes an *LogicalConfiguration* as a collection of all configurations in a combined cycle plant that operate with the same number of primary combustion turbines and primary steam turbines. As mentioned earlier one or many *LogicalConfiguration/s* can be present within a *CombinedCyclePlant*. - Figure 58 below shows one such *CombinedCyclePlant* as modeled in IMM hierarchy with 2/3 *logicalConfigurations*, with parent/child associations labeled.

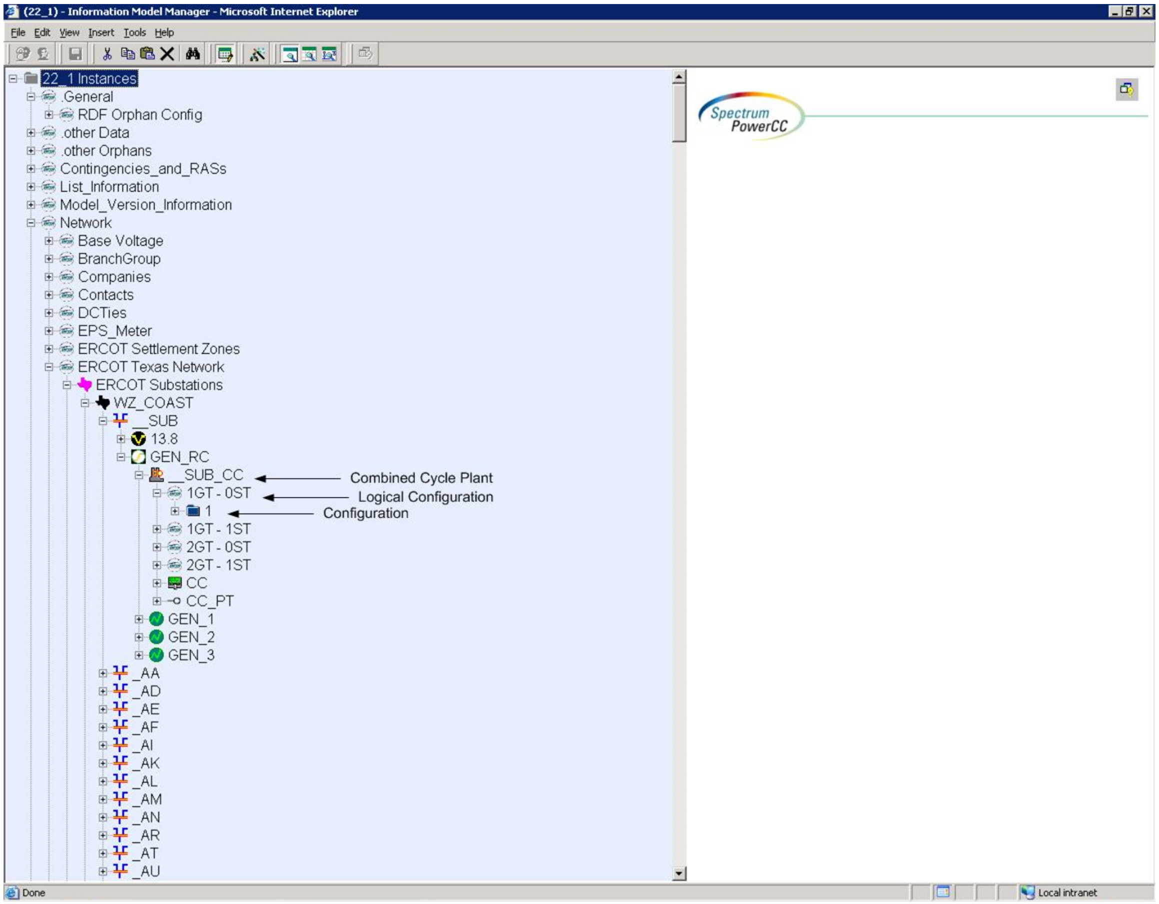


Figure 58 – Modeled Logical Configuration with parent/child association.

32.2.2.1 Attributes

The attributes for a *LogicalConfiguration* are shown in the table below. Required attributes are listed at the top of the table in bold text. Most of the Boolean values will have default values upon creation. These values are listed in the table along with sample data for the field.

Attribute Table for Logical Configurations

Attribute	Description	Data Type	Default Value	Sample Data
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	None	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.			

32.2.2.2 Linkage

The required links for a *LogicalConfiguration* are defined in the **Error! Reference source not found.** below. The path name shows where the links can be found in the model. Definitions for all of the links can be found by clicking on the help button at the bottom of the links screen.

Linkage Table for Logical Configurations

Link Name	Description	Path Name
Combined Cycle Plant	The Combined Cycle Plant link is used in order to associate Logical Configuration a with its respective Combined Cycle Plant	Network/ERCOT Substations/Weather_Zone/Substation/Resource_Controller

32.2.3 Modeling Approach for Configuration

The ERCOT CIM model utilizes instances of type *Configuration* to define the constituents and operational characteristics of the various combinations of combustion turbines and steam turbines a *CombinedCyclePlant* can operate with. IN the ERCOT model as mentioned in the earlier sections, a configuration can be created under a *LogicalConfigurtion* only. Every configuration must contain two (emergency & normal) *RampRateCurves*, and one/many *ConfigurationMembers*. Modeling of *RampRateCurves* is covered in detail in Section ___. Within a single *CombinedCyclePlant*, every configuration must be able to startup., shut down or transition to/from other configuration in the same CCP. Figure 59 below shows a Combined Cycle Plant modeled in IMM, with parent/child associations labeled.

©2009 Electric Reliability Council of Texas, Inc.

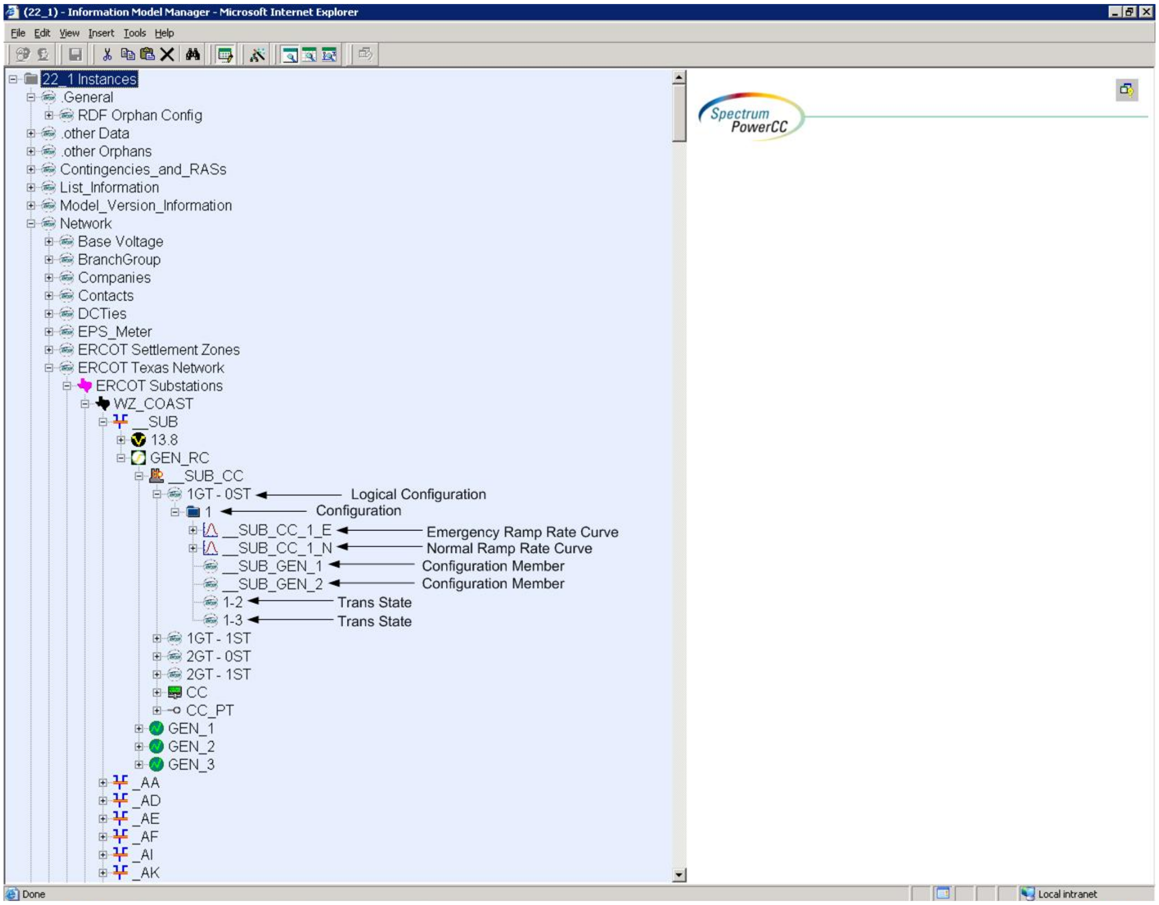


Figure 59 -- Modeled Configuration with parent/child associations labeled.

32.2.3.1 Attributes

The attributes for a *Configuration* are shown in the below.

Attribute Table for Configurations

Attribute	Description	Data Type	Default Value	Sample Data
highReasonabilityLimit	High reasonability limit.	ActivePower	None	
highReasonabilityRampRateLimit	High reasonability ramp rate limit.	ActivePower	None	
hotintTime	Hot-to-intermediate time (Seasonal).	Float	None	
hotStartTime	Hot start time.	Float	None	
intColdTime	Intermediate-to-cold time (Seasonal).	Float	None	

intStartTime	Intermediate start time.	Float	None	
lowReasonabilityLimit	Low reasonability limit.	ActivePower	None	
lowReasonabilityRampRateLimit	Low reasonability ramp rate limit.	ActivePower	None	
maxDailyStarts	Maximum daily starts (seasonal parameter).	Float	None	
maxONTime	Maximum On-Line time.	Float	None	
maxWeeklyEnergy	Maximum weekly energy (seasonal parameter).	Float	None	
maxWeeklyStarts	Maximum weekly starts (seasonal parameter).	Float	None	
minOFFTime	Minimum Off-Line time.	Float	None	
minONTime	Minimum On-Line time.	Float	None	
primaryConfiguration	Primary configuration?	Boolean	FALSE	
qualificationStatus	Qualification status.	Boolean	FALSE	
seasonalMaxEmergencyRating	Seasonal maximum emergency rating.	ActivePower	None	
seasonalMaxSustainableRating	Seasonal maximum sustainable rating.	ActivePower	None	
seasonalMinEmergencyRating	Seasonal minimum emergency rating.	ActivePower	None	
seasonalMinSustainableRating	Seasonal minimum sustainable rating.	ActivePower	None	
coldStartTime	Cold Start Time	Float	None	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globaly unique.	Integer	None	
Path Name	The pathname is a system unique name			

	composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.			
ShutdownFlag	Determines whether a Combined Cycle Plant can be shut-down in this Logical Configuration	Boolean	False	
StartupFlag	Determines Whether a Combined Cycle Plant can be started in this Logical Configuration	Boolean	Flase	

32.2.3.2 Linkage

The required links for a Configuration are defined in the table below

Linkage Table for Configurations

Link Name	Description	Path Name
Logical Configuration	The Combined Cycle Plant link is used in order to associate Configuration a with its respective Logical Configuration	Network/ERCOT Substations/Weather_Zone/Substation/Resource_Controller/Combined_Cycle_Plant/

32.2.4 Modeling Approach for Trans State

The ERCOT CIM data dictionary uses instances of type *TransState* to define the available transitions between the various configurations of a Combine Cycle Configurations. One/many TransStates may be defined for every configuration within a *CombinedCyclePlant*. Every transstate is defined as an uptransition when the total number of primary members in the To-configuration are greater tha or equal to the same in the from configuration. Figure 60 below shows a Trans State modeled in IMM, with parent/child associations labeled.

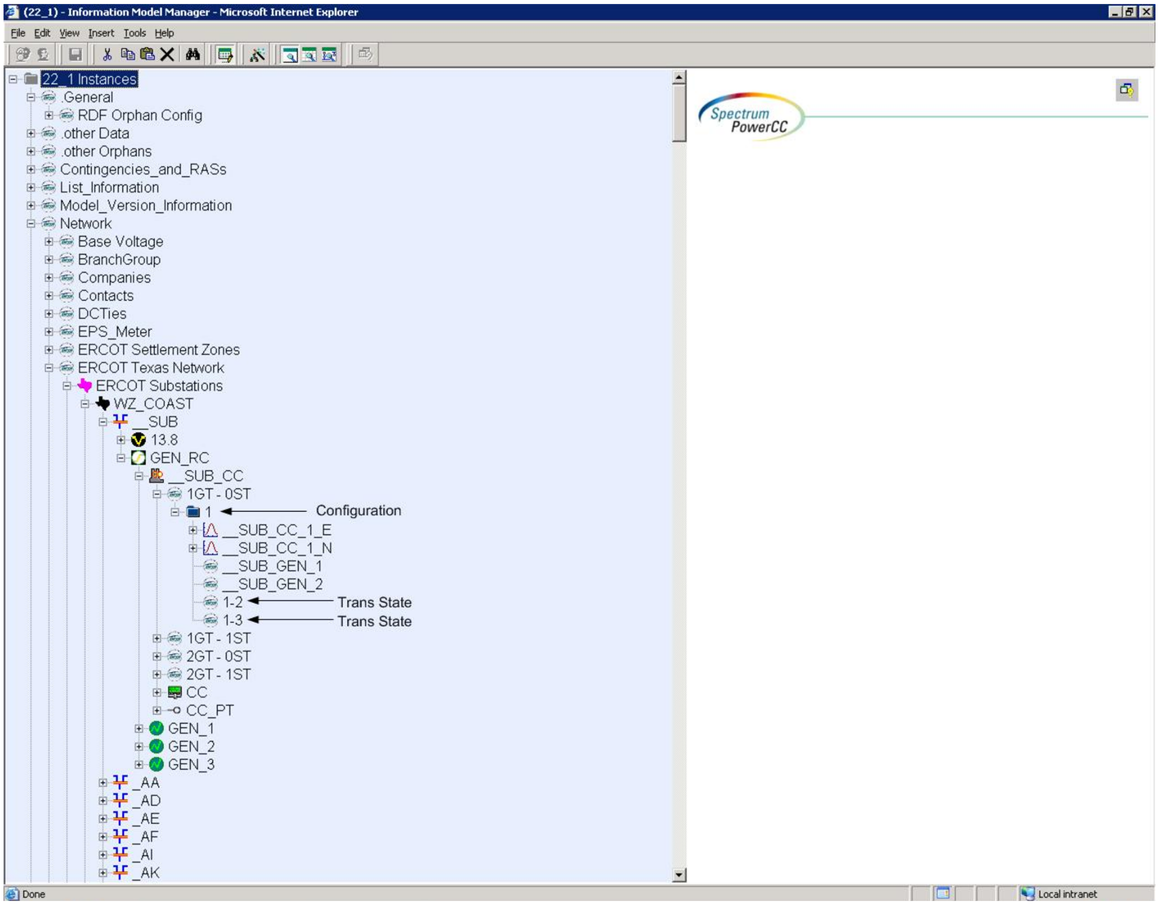


Figure 60 -- Modeled Trans State with parent/child associations labeled.

32.2.4.1 Attributes

The attributes for a *TransState* are shown in the table below.

Attribute Table for Trans State

Attribute	Description	Data Type	Default Value	Sample Data
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	None	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.			
upTransition	Up Transition	Boolean	False	

32.2.4.2 Linkage

The required links for a *TransState* are defined in the table below.

Linkage Table for Trans States

Link Name	Description	Path Name
ToConfig_Configuration	The next Configuration that this configuration can traverse into.	Network/ERCOT Substations/Weather_Zone/Substation/Resource_Controller/Combined_Cycle_Plant/Logic_Configyration
FromConfig_Configuration	The current Configuration in which this Trans State is under.	

32.2.5 Modeling Approach for Configuration Member

The ERCOT CIM data dictionary utilizes instances of type *ConfigurationMember* to identify the *ThermalGeneratingUnits* that are a member of CCP Configuration instance along with their operational nature (Steam/Gas Turbine) and primary/alternate status of the associated resource. in the ERCOT CIM model, one/many configurationmembers can be defined within a configuration. Figure 61 below shows a *ConfigurationMember* modeled in IMM, with parent/child associations labeled.

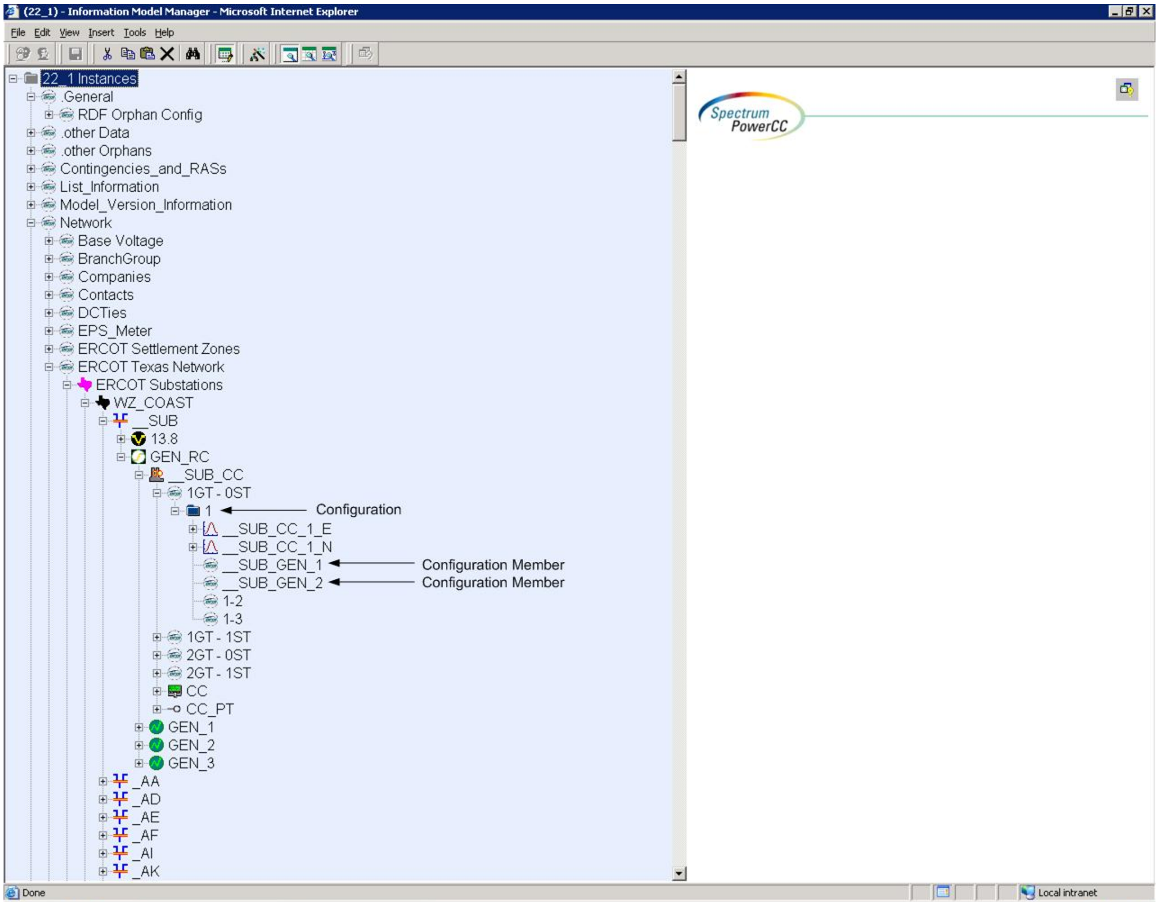


Figure 61 -- Modeled Configuration Member with parent/child associations labeled.

32.2.5.1 Attributes

The attributes for a *ConfigurationMember* are shown in the table below.

Attribute Table for Configuration Members

Attribute	Description	Data Type	Default Value	Sample Data
primary	Determines if this is the primary unit in the Configuration that it falls under.	Boolean	FALSE	
steam	Determines if this is a steam generating unit.	Boolean	FALSE	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	None	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to			

	the root.			

32.2.5.2 Linkage

The required links for a *ConfigurationMember* are defined in the table below.

Linkage Table for Configuration Member

Link Name	Description	Path Name
ThermalGeneratingUnit	The link determines which Unit is the Configuration Member.	Network/ERCOT Substations/Weather_Zone/Substation/Resource_Controller/Thermal_Generating_unit
Configuration	The link determines under which Confifguration this Configuration Member falls into.	Network/ERCOT Substations/Weather_Zone/Substation/Resource_Controller/Combined_Cycle_Plant

33 MODELING CONTROLLABLE LOAD RESOURCES AND LOAD RESOURCES

33.1 MODELING APPROACH

The ERCOT CIM model defines a *LoadResource* as a load that is capable of providing Ancillary Service to the ERCOT System. A *ControllableLoadResource* is a *LoadResource* capable of controllably reducing or increasing consumption under dispatch control (similar to AGC) and that immediately responds proportionally to frequency changes (similar to generator governor action). Figure 62 and Figure 63 below show a Controllable Load Resource and Load resource respectively in IMM, with parent/child associations labeled.

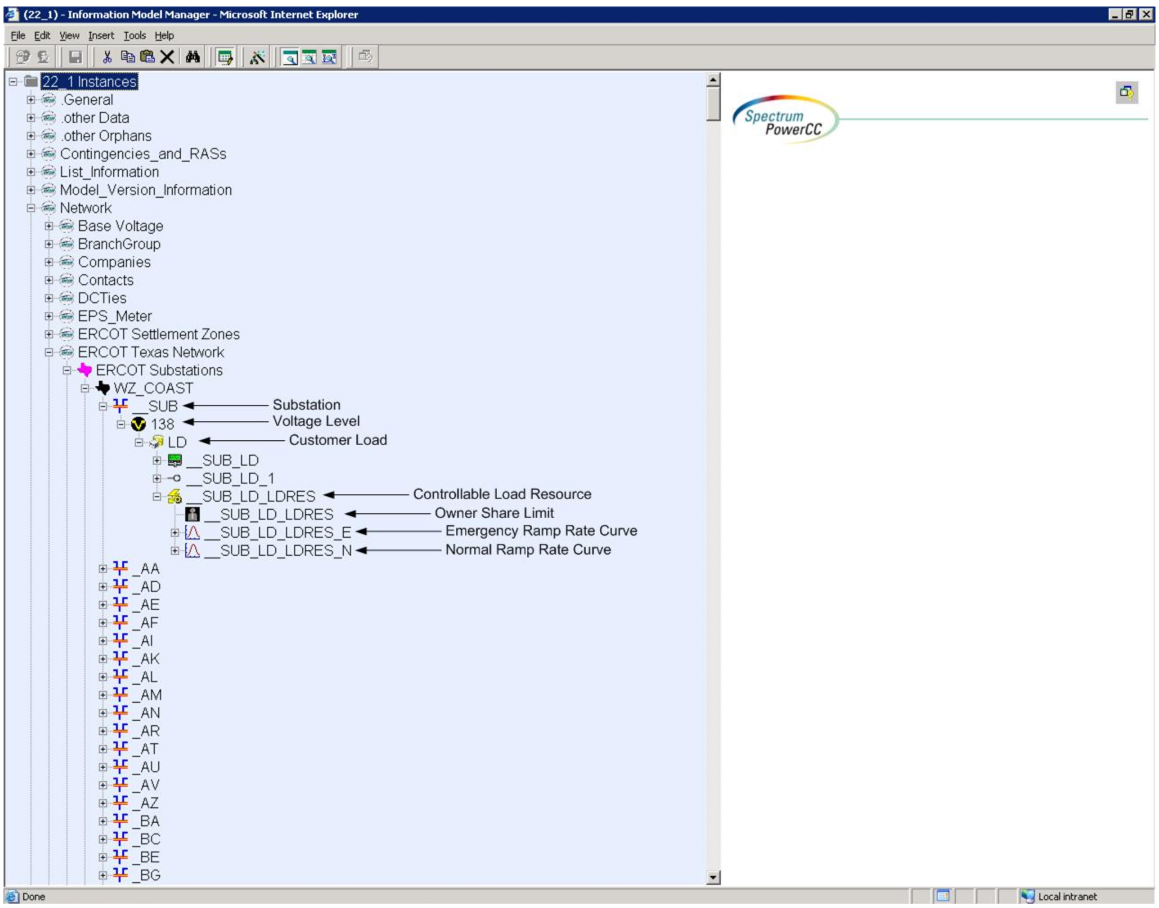


Figure 62 – Modeled Controllable Load Resource with parent/child associations labeled.

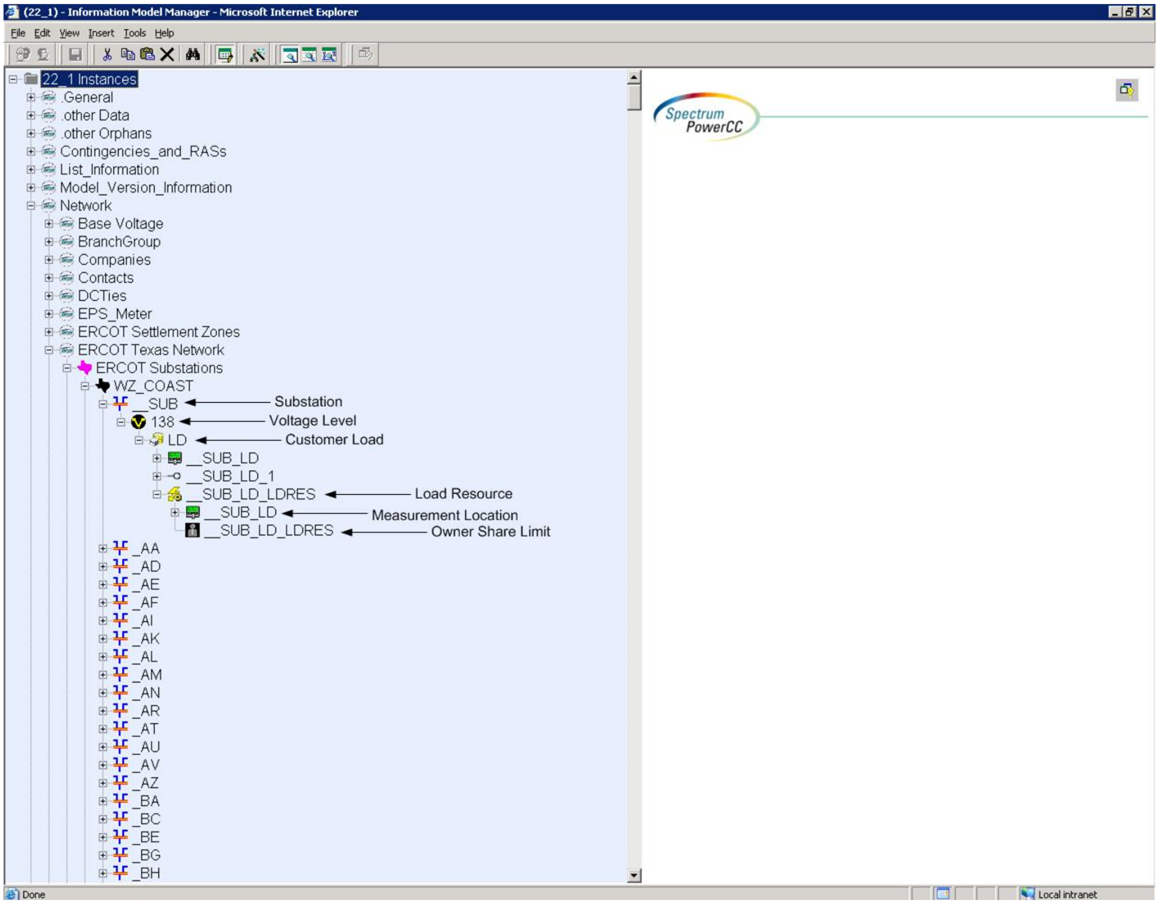


Figure 63 – Modeled Load Resource with parent/child associations labeled.

33.2 ATTRIBUTES

The attributes for both *ControllableLoadResources* and *LoadResources* are shown in the table below.

Attribute Table for Controllable Load Resources and Load Resources

Attribute	Description	Data Type	Default Value	Sample Data	CLR	LR
TEID	Transmission Element ID	Integer	Auto-populated		**X**	**X**
maxDeploymentTime	Maximum deployment time.	Float	None		**X**	
maxWeeklyEnergy	Maximum weekly energy.	Float	None		**X**	**X**
minNoticeTime	Minimum notice time (seconds).	Float	None		**X**	**X**
rampRateSlopeD	Reasonability Limit	Float	None		**X**	

ownLimit	for Down Ramp Rate.					
rampRateSlopeUpLimit	Reasonability Limit for UP Ramp Rate.	Float	None		**X**	
Alias Name	Free text name of the object or instance.	String	None		**X**	**X**
blockLoadTransfer	Determines if the device is a block load transfer.	Boolean	False		**X**	**X**
commercialOperationsDate	Date commercial operations started.	Date	None		**X**	**X**
DAM_Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	FALSE		**X**	**X**
DAM_Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	FALSE		**X**	**X**
height					**X**	**X**
idth					**X**	**X**
label_height					**X**	**X**
label_width					**X**	**X**
label_xval					**X**	**X**
label_yval					**X**	**X**
Latitude	Latiitude coordinates.	Float	None		**X**	**X**
loadFreqBias	Regulating Frequency Bias as MW per 0.1 Hz.	Float	None		**X**	**X**
loadFreqDevDeadband	Frequency deviation deadband for Feed-Forward correction (in Hz).	Float	None		**X**	**X**

loadId	A 14 character load ID used in ERCOT LFC.	String14	None		X	X
loadSubStationId	ID of load's substation.	String18	None		X	X
localName	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None		X	X
Longitude	Longitude coordinates.	Float	None		X	X
maxDailyDeployment	Maximum daily deployments.	Float	None		X	X
maxInterruptionTime	Maximum interruption time.	Float	None		X	X
MaxPowerConsumption	Maximum power consumption for resource.	Float	None		X	X
maxWeeklyDeployment	Maximum weekly deployments.	Float	None		X	X
minInterruptionTim	Minimum	Float	None		X	X

e	interruption time.					
MinPowerConsumption	Minimum power consumption for resource.	Float	None		X	X
minRestorationTime	Minimum restoration time.	Float	None		X	X
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	None		X	X
OUSPriority	An Outage Scheduler priority is included in all ConductingEquipment classes except BusbarSection and TransformerWinding.	Integer	None		X	X
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.				X	X
psseid	Attribute will give IMM modelers control over the PSS®E ID that the Topology Processor uses to properly name units, loads, branches, and transformers	String2	None		X	X
qualificationStatus	Qualification status.	Boolean	False		X	X
RelayType	Type of relay.	EnumRelayType	None		X	X
resourceCategory	Type of resource.	String50	None		X	X
RUC_Monitored	The Boolean flags to indicate which process(s) monitor the branch devices	Boolean	False		X	X

	and by which process the devices is secured.					
RUC_Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	True		**X**	**X**
wfrmcr	wfrmcr.	Boolean	FALSE		**X**	**X**

Table 1

33.3 LINKAGE

The required links for both *ControllableLoadResources* and *LoadResources* are defined in table below.

Linkage Table for Controllable Load Resources and Load Resources

Link Name	Description	Path Name	CLR	LR
HasA_EnergyConsumer			**X**	**X**
HostControlArea				**X**

©2009 Electric Reliability Council of Texas, Inc.

34 MODELING OWNER SHARE LIMITS

34.1.1 Modeling Approach

Owner Share Limits are used for *GeneratingUnits*, *ControllableLoadResource* or *LoadResource*. OwnerShareLimit (OSL) is mainly used for modeling Jointly Owned Units (Split Generation Units). A OwnerShareLimit is created for each Owner. If there are 3 owners for a unit then 3 OwnerShareLimits are created for that unit. Each OSL is associated to an Ownership record which points to each of the owners.

At least one Ownersharelimit instance should be associated with every LoadResource, ControllableLoadResource, ThermalGeneratingUnit, HydroGeneratingUnit, WindGeneratingUnit, and NuclearGeneratingUnit.

34.1.2 Attributes

The attributes for an *OwnerShareLimit* are shown in the table below.

Attribute Table for Owner Share Limits

Attribute	Description	Data Type	Default Value	Sample Data
TEID	Transmission Element ID	Integer	Auto-populated	
highReasonabilityLimit	**highReasonabilityLimit split based on the ownership percentage.**	**ActivePower**	**None**	
lowReasonabilityLimit	**lowReasonabilityLimit split based on the ownership percentage.**	**ActivePower**	**None**	
Alias Name	Free text name of the object or instance.	String	None	
Latitude	Latiitude coordinates.	Float	None	
localName	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met	String	None	

	IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.			
Longitude	Longitude coordinates.	Float	None	
maxWeeklyEnergy	Maximum weekly energy (seasonal parameter) split based on the ownership percentage.	Float	None	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	None	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.			

34.1.3 Linkage

The required links for a *OwnerShareLimits* are defined in the table below.

Linkage Table for Owner Share Limits

Link Name	Description	Path Name
GeneratingUnit	Determines which Generating Unit this owner share limit represents.	Network/ERCOT Substations/Weather_Zone/Substation
EnergyConsumerResource	Determines which Controllable Load Resource or Load Resource this owner share limit represents	Network/ERCOT Substations/Weather_Zone/Substation/Voltage_Level/Customer_Load
Operatorship	The Operatorship link is used for permission rights. The Operator of equipment has the right to edit the equipment. An operator can only be assigned by the creator or owner of the equipment.	Network/Companies
Ownership	The Ownership link is used for permission rights. The owner of equipment has editing and	Network/Companies

	administrative rights. An owner can only be assigned by the creator of the equipment.	

35 MODELING FLOWGATE GROUP

35.1 MODELING APPROACH

In the ERCOT CIM model a *FlowgateGroup* is a grouping of flowgate elements. Flowgate groups are modeled under the path Network/Flowgate in the model hierarchy. Figure below shows a flowgate group in the model.

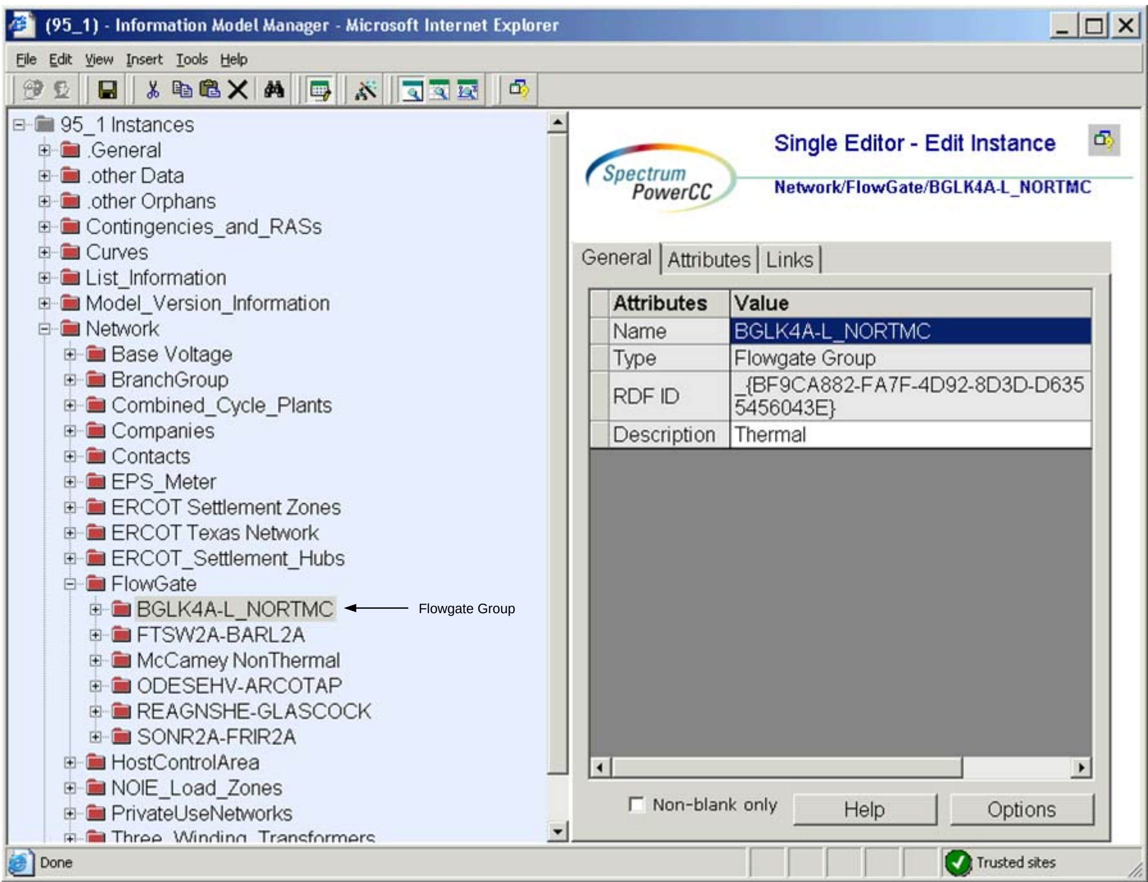


Figure 64 - FlowgateGroup

35.2 ATTRIBUTES

The attributes for a *FlowgateGroup* are shown in the table below

Attribute	Description	Data Type	Default Value	Sample Data
infB	**Impact Normalization Factor for Base Case**	**Float**	**None**	
infC	**Impact Normalization Factor for Contingency**	**Float**	**None**	
Alias Name	Free text name of the object or instance.	String	None	
Default Limit	Default Limit	DoubleFloat	None	
Description	Description of the object or instance	String	None	
Eligible	Eligible	Boolean		
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	
Max Shadow Price	States the Max Shadow price	DoubleFloat	99999	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	Auto-populated	

Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	
Rating	Flowgate Group Rating	Float	None	
Thermal Limit	Thermal limit	Boolean	False	
TEID	Transmission Element ID	Integer	Auto-populated	

35.3 LINKAGE

The required links for a series *FlowgateGroup* are defined in the table below.

Link Name	Description	Path Name
Monitored Group		List_Information/Monitored Groups

36 MODELING FLOWGATE ELEMENT

36.1 MODELING APPROACH

In the ERCOT CIM model a *FlowgateElement* is a market based element defining a region for energy production. *FlowgateElements* are modeled under a flowgate group in the model hierarchy. Figure below shows a flowgate element in the model.

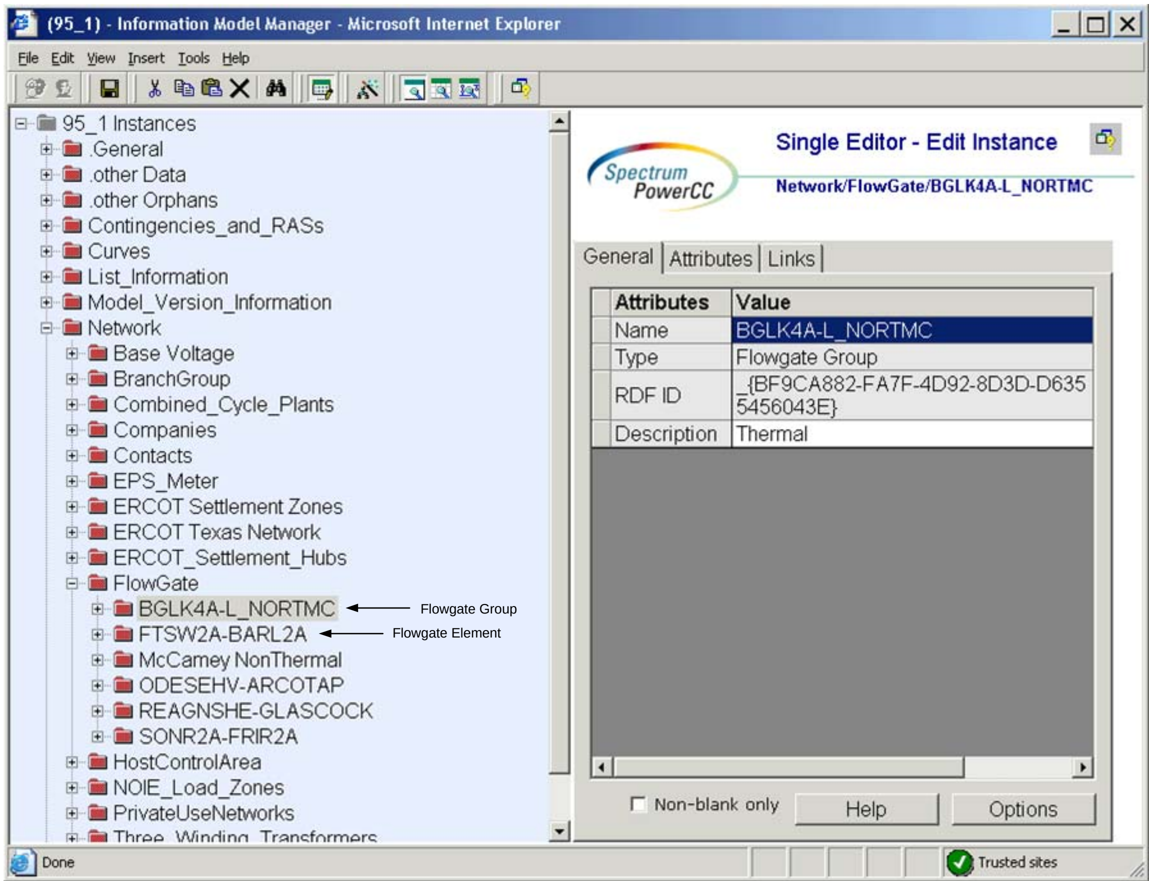


Figure 65 - FlowgateElement

36.2 ATTRIBUTES

The attributes for a flowgate element are shown in the table below.

Attribute	Description	Data Type	Default Value	Sample Data
Biddable	**Biddable**	**Boolean**	**False**	

endDate	**End Date**	**Date**	**None**	
monitored	**Monitored**	**Boolean**	**False**	
rating	**Rating**	**DoubleFloat**	**None**	
startDate	**Start Date**	**Date**	**None**	
Alias Name	Free text name of the object or instance.	String	None	
Description	Description of the object or instance	String	None	
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	
Max Shadow Price	States the Max Shadow price	DoubleFloat	None	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	Auto-populated	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	
Positive Flow In	Determines metered direction of EPS meter	Boolean	True	

©2009 Electric Reliability Council of Texas, Inc.

Principle Element	Principle Element	Boolean	False	

36.3 LINKAGE

None

37 MODELING OWNERSHIP

37.1 MODELING APPROACH

In the ERCOT CIM model an owner is assigned to each piece of equipment. The owner of the equipment is given the right to edit the equipment, add instances under the equipment, and add other owners or operators for the equipment. It is possible to have multiple owners for a single piece of equipment. An owner must be created under a company and used as a link to a piece of equipment.

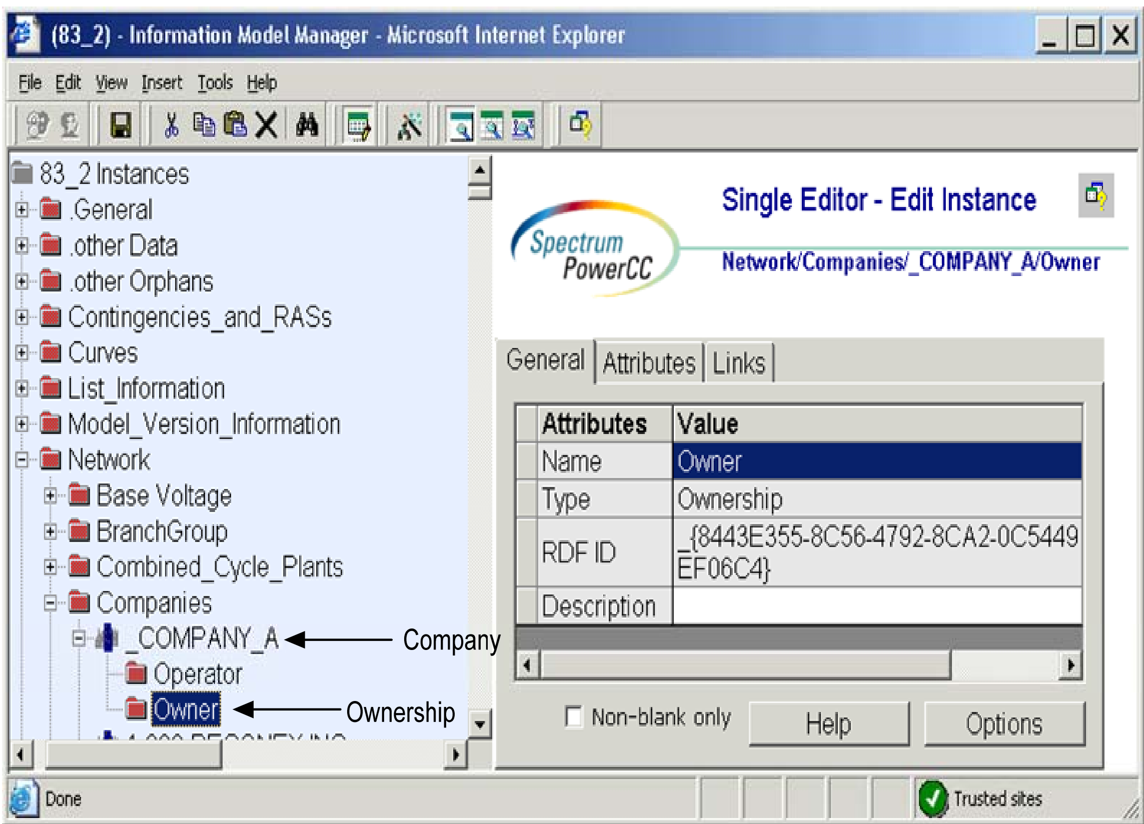


Figure 66 - Ownership

37.2 ATTRIBUTES

The attributes for ownership are shown in the table below.

Attribute	Description	Data Type	Default Value	Sample Data
Own Percent	**Owner share percentage**	**Float**	**None**	

Alias Name	Free text name of the object or instance.	String	None	
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	Auto-populated	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	
Penalty Factor	Determines metered direction of EPS meter	Float	None	

37.3 LINKAGE

None

38 MODELING DC TIES

DC Tie is defined as a non-synchronous transmission interconnection between ERCOT and non-ERCOT electric power systems. A DC Tie includes a DC Tie Load -- A Load used to represent the withdrawal of power from the ERCOT System to a DC Tie and a DC Tie Resource-- A Resource used to represent the injection of power into the ERCOT System from a DC Tie.

38.1 MODELING APPROACH

This section describes the approach for modeling a DCTie. This is one of the instances that is modeled by ERCOT.

A DCTie needs to be contained only in the instance of class sysorphan (ERCOT Texas Network)
An example of a DC Tie DC_E is visible in the hierarchy view in the figure below.
The attribute DC Tie Zone name for DC tie should always match the name field

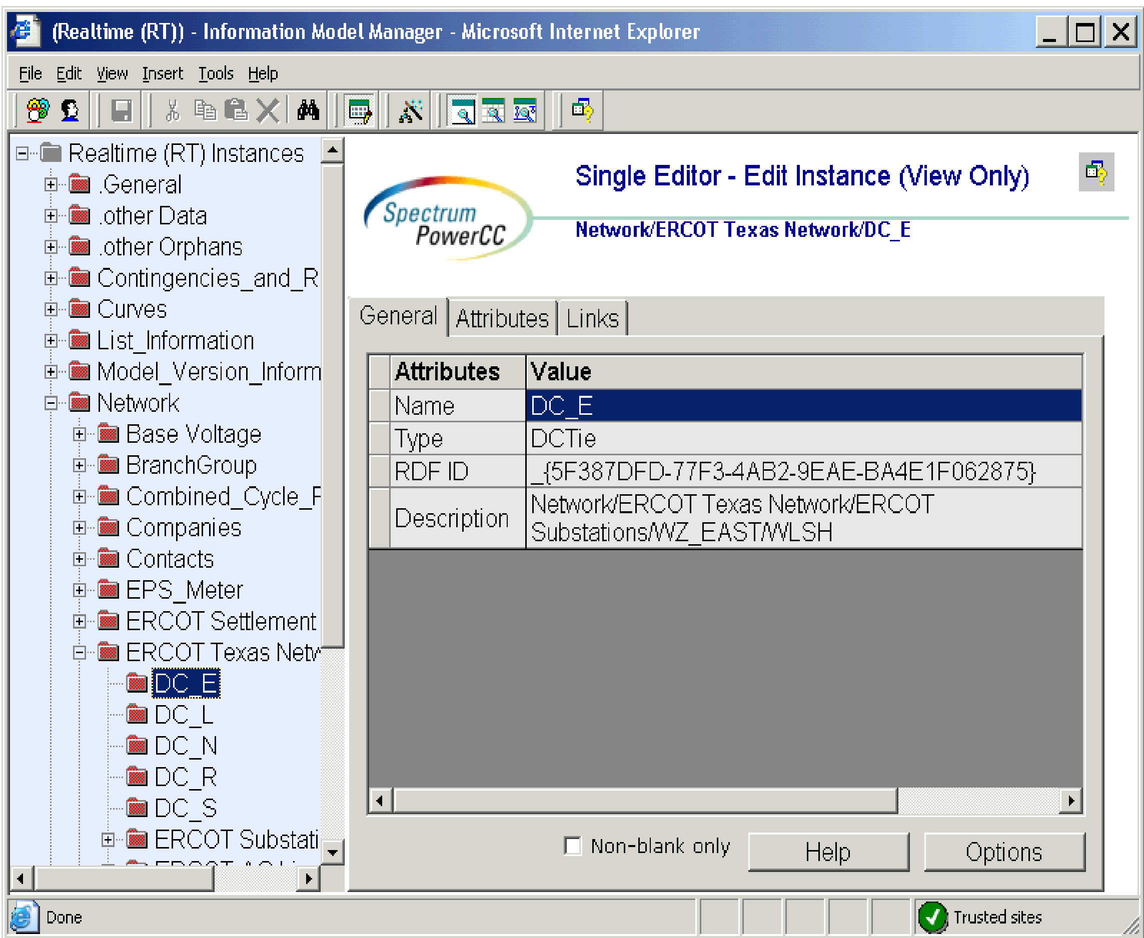


Figure 67 - DcTie

38.2 ATTRIBUTES

The attributes for a DC Tie are shown in the table below.

Attribute	Description	Data Type	Default
DC Tie Zone name for DC tie	**DC Tie Zone name for DC tie.**	**String**	
Alias Name	Free text name of the object or instance.		
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.		
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.		
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.		

38.3 LINKAGE

The required links for a DC Tie are defined in the table below.

Link Name	Description	Path Name
IdentifiedObjectBelongsToModelingAuthoritySet	An IdentifiedObject belongs to a Modeling Authority Set for purposes of defining a group of data maintained by the same Modeling Authority.	
TieCorridorPartOfDCTie	A Tie Corridor should be a Part of the DC tie to identify the lines that are part of the DC tie. This is a required association	

GeneratingUnitPartOfDCTie is a required reverse association. The Pseudo Generating Unit created for the DC Tie must be associated a DCTie.

EnergyConsumerPartOfDCTie is a required reverse association. The Pseudo Load created for the DC Tie must be associated a DCTie.

39 MODELING CONTINGENCIES

Contingencies are modeled to study the “What-if” situations. They are defined on *Line*s, *PowerTransformer*s and generating units which are likely to affect the system reliability incase of a forced outage. Network Security Analysis application is used to gauge its impact before they occur and alert the operators to any potential overloads or serious voltage violations.

The initial load of base contingencies will be responsibility of ERCOT. These contingencies make up a set of base contingencies. Changes to the list of base contingencies will be submitted by Market Participants using SAMRs. ERCOT will approve or reject the SAMRs and notify the Market Participant. The approved changes are added by ERCOT Staff to the Network Operations Model via NOMCRs. The Information Model Manager (IMM) provides basic validation of the equipment names/ID’s as the contingency is defined.

39.1 MODELING APPROACH FOR CONTINGENCY

In ERCOT CIM model, *Contingency* is defined as “An event threatening system reliability, consisting of one or more *Contingency Element*s”.

The location of contingencies in the Network model is shown in the figure below. A new *Contingency* can be added under the object called “*Contingencies*” by right mouse clicking on it and selecting ‘New’. Note that duplicate names are not allowed in the model while creating an instance. Complete the required attributes and links for the instance created. The attributes and links for *Contingencies* are described in the following sections.

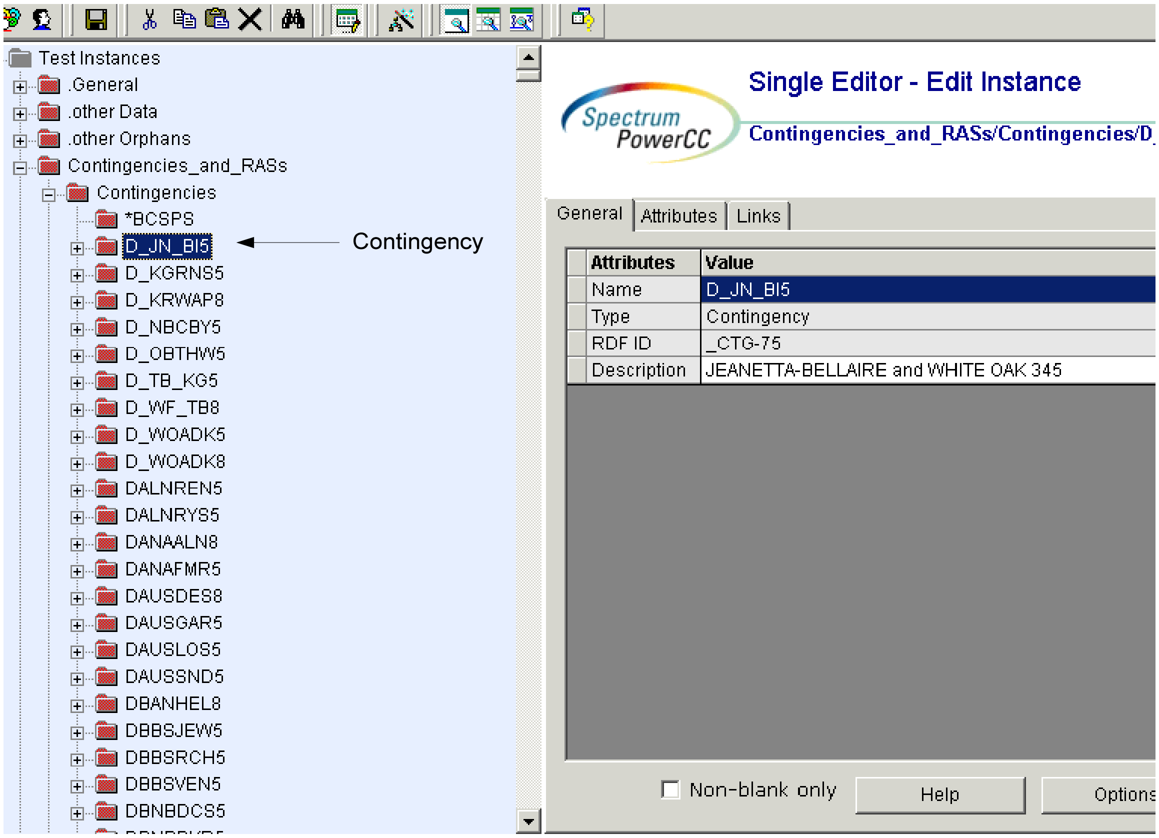


Figure 68 - Hierarchy of Contingencies

39.1.1 Attributes

The following table shows the attributes and their descriptions for Contingencies.

Attribute	Description	Data Type	Default Value	Sample Data
Device Name	Device Name.	String100		Contingency name
Device Type	Device Type.	String100		Station_A XFMR 138/69
Action Type	Action Type.	String100		
Active Mode	Contingency active mode.	Enumeration		Default

Alias Name	Free text name of the object or instance.	String		_CB
Enable Cascading	TRUE if Cascading contigency analysis needs to performed, default is FALSE.	Boolean		FALSE
Enable Redefinition	T=enable F=disable dynamic redefinition.	Boolean	FALSE	FALSE
Enable SPS	T=enable F=disable SPS functions.	Boolean	FALSE	FALSE
End Date	Final Date this Contingency is in use.	Absolute Date Time	1/1/2100	1/1/2100
Generation Loss	The amount (in MW) of generation you expect the contingency to lose.	Float		9999
Generator Participation Factor	Short/Long.	Enumeration		normal
Load Loss	The amount (in MW) of load you expect the contingency to lose.	Float		9999
Local Name	The local Name is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, Voltage Level, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String		Station_A 138/69 transformer XFMR1
Max Shadow Price	States the Max Shadow price for a Contingency.	Double Float	99999	99999
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String		1785236
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String		
Probability Of	A number between 0 and 1. Contingencies with a probability less than 0.5 are considered	Float		1

Occurrence	'low probability' contingencies.			
Process Type	Contingency process type.	Enumeration		Use Wide
Refractor	Set to TRUE to force a partial refactorization method when updating the matrices for the contingency solution. The default is FALSE, in this case the software will automatically determine whether a factor update or partial refactorization is more efficient for the contingency being processed, and use the most efficient method.	Boolean		FALSE
Response Time	The time frame of response in seconds for the components associated with this contingency.	Long Integer		1
RunFlag	Run Flag.	Boolean	TRUE	TRUE
Start Date	Starting Date this Contingency is expected to be in use.	Date Time	1/1/2001	1/1/2001

Table: Attributes for contingencies

39.1.2 Linkage

The following table shows the links for Contingencies.

Linkage Name	Description	Path Name
IdentifiedObjectBelongsToModelingAuthoritySet	An Identified Object belongs to a Modeling Authority Set for purposes of defining a group of data maintained by the same Modeling Authority.	

Contingency Links

39.2 MODELING APPROACH FOR CONTINGENCY ELEMENT

The ERCOT CIM model defines a *ContingencyElement* as an element of a system event to be studied by contingency analysis, representing a change in status of a single piece of equipment.

Contingency element is modeled under the object type ‘Contingency’ as a child instance. Duplicate names are not allowed for contingency elements. The location of the contingency elements in the model tree is shown below.

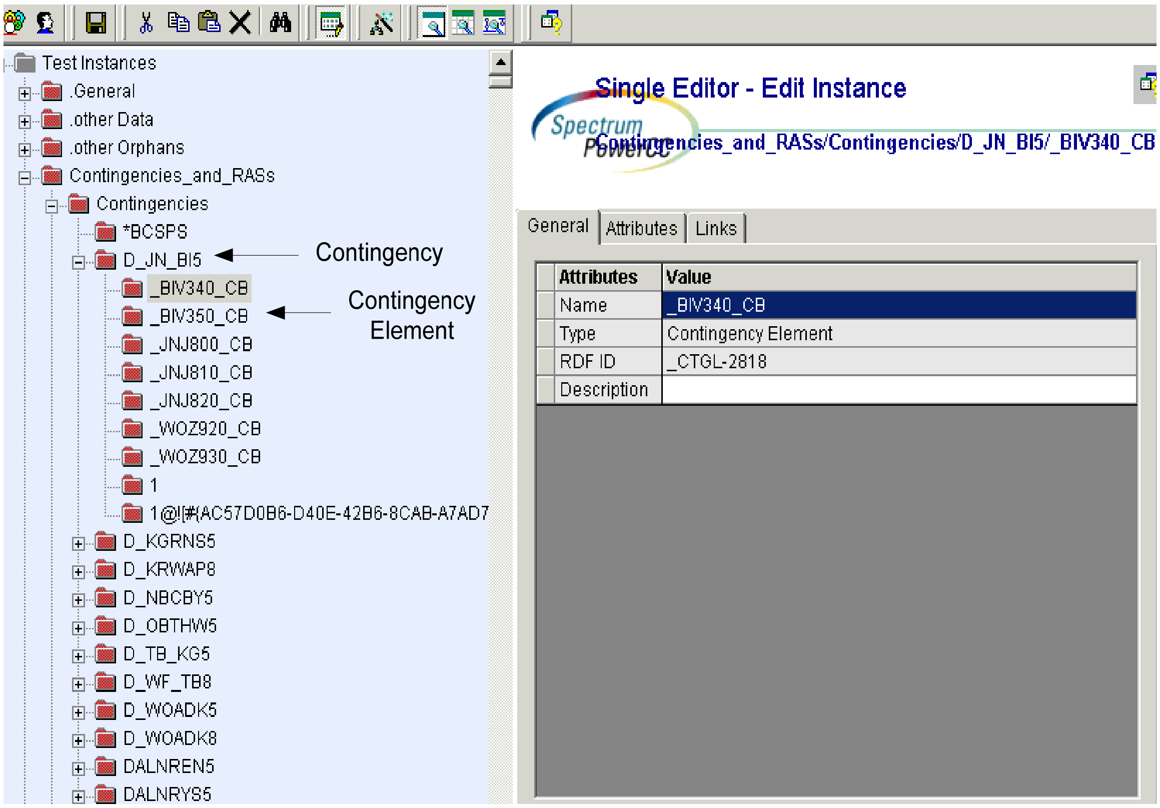


Figure 69 - Hierarchy for Contingency Elements

39.2.1 Attributes

The following table shows the attributes and their descriptions for *ContingencyElement*.

Attribute	Description	Data Type	Default Value	Sample Data
Alias Name	Free text name of the object or instance.	String		
CB Fault	Indicates TRUE if this CB is included in post contingency and related to CB fault due to the dynamic redefinition logic.	Boolean		TRUE
Local Name	The local Name is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy	String		

	has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, Voltage Level, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.			
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String		1785236
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String		
Status	The status of contingency element, i.e. Open/Close for Switch, Removed or not for other conducting equipment. Status = TRUE for an OPEN Switch or Removed conducting equipment.	Boolean	TRUE	TRUE

Contingency Element Attributes

39.2.2 Linkage

The following table shows the links for *Contingency Element*.

Linkage Name	Description	Path Name
IdentifiedObjectBelongsToModelingAuthoritySet	An Identified Object belongs to a Modeling Authority Set for purposes of defining a group of data maintained by the same Modeling Authority.	
ContingencyElementHasAEquipment	The equipment to be studied	Network/ERCOT Texas Network

Contingency Element Links

39.3 MODELING APPROACH FOR CONTINGENCY GROUPS

ContingencyGroup is used for activation of groups of contingencies. Contingencies can belong to multiple groups.

The following figure shows the location of the *ContingencyGroup*s in the network model tree. A new contingency group can be created under the object called “Contingency Groups” by right mouse clicking on it and selecting ‘New’.

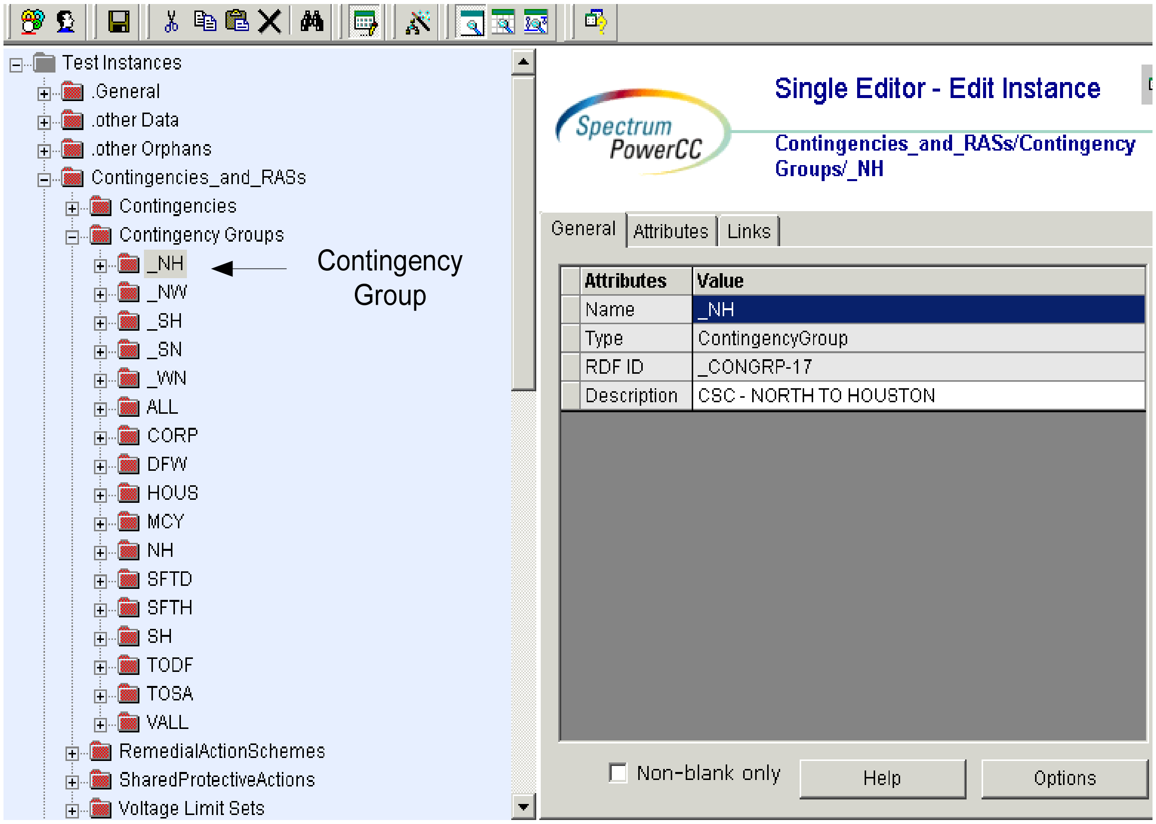


Figure 70 - Hierarchy for Contingency Groups

39.3.1 Attributes

The following table shows the attributes and their descriptions for *Contingency Groups*.

Attribute	Description	Data Type	Default Value	Sample Data
Alias Name	Free text name of the object or instance.	String		
Local Name	The local Name is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, Voltage Level, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use	String		

	IdentifiedObject.name instead.			
Maintain Sub Systems	This field sets whether the subsystems for the contingencies in this CTGGroup are maintained even though the group is inactive. When Maintain Subsystems set ON, and Study is set OFF, CA maintains the contingency local subsystems for base case changes. If Maintain Subsystems is set OFF and Study is set OFF, the subsystems are deleted.	Boolean	TRUE	TRUE
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String		178523 6
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String		
Study	T=activate the contigencies in the group.	Boolean	TRUE	TRUE

Table: Contingency Group Attributes

39.3.2 Linkage

The following table shows the links for contingency groups.

Linkage Name	Description	Path Name
IdentifiedObjectBelongsTo ModelingAuthoritySet	An Identified Object belongs to a Modeling Authority Set for purposes of defining a group of data maintained by the same Modeling Authority.	

Contingency Group Links

39.4 MODELING APPROACH FOR CONTINGENCY GROUP MEMBERS

*ContingencyGroupMember*s are used to create many to many relationship between *Contingency* and *Contingency Group*. These are the contingencies that are studied as a group.

The following figure shows the location of the *Contingency Group Member* in the network model tree. A new contingency group member can be created under the object called “Contingency Groups” by right mouse clicking on it and selecting ‘New’.

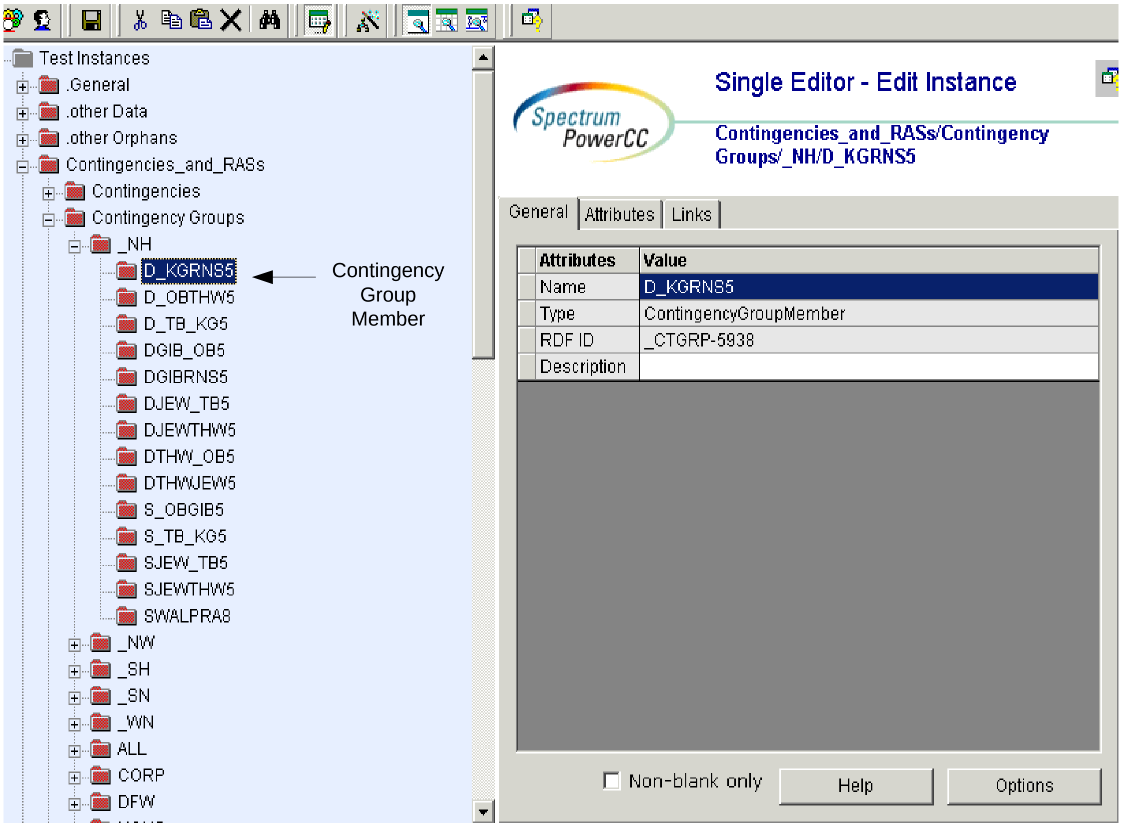


Figure 71 - Hierarchy for Contingency Group Member

39.4.1 Attributes

The following table shows the attributes and their descriptions for Contingency Group Members.

Attribute	Description	Data Type	Default Value	Sample Data
Alias Name	Free text name of the object or instance.	String		
Local Name	The local Name is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, Voltage Level, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String		

Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String		178523 6
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String		
Study	T=activate the contigencies in the group.	Boolean	TRUE	TRUE

Contingency Group Member Attributes

39.4.2 Linkage

The following table shows the links for *ContingencyGroups*.

Linkage Name	Description	Path Name
ContingencyGroupMemberHasAContingency	Conteingency which is a member of this group	Contingencies_and_RASs /Contingencies
IdentifiedObjectBelongsToModelingAuthoritySet	An Identified Object belongs to a Modeling Authority Set for purposes of defining a group of data maintained by the same Modeling Authority.	

Contingency Group Member Links

40 MODELING REMEDIAL ACTION SCHEMES (RAS)

40.1 MODELING APPROACH

Remedial Action Schemes encompass Remedial Action Plans (RAP), Special Protection Schemes (SPS), Remedial Action Plans Conditional (RAPC), and Mitigation Plans. All RASs are in response to a specific Contingency.

Special Protection Schemes are automatic, relay controlled actions taken to relieve an overload condition on one or more transmission elements. RAPs are manual corrective actions agreed upon between ERCOT and Market Participants to be taken to relieve an overload condition on one or more transmission elements. RAPCs are different from RAPs in that the corrective actions only relieve the overload under a specific system condition. For example, if Line A is out of service AND contingency X occurs, and then the RAPC is put into affect. If Line A is in-service AND contingency X occurs, then the RAPC is not followed. Mitigation Plans are similar to RAPs, except that Mitigation Plans can involve shedding of load.

40.2 MODELING APPROACH RAS

Changes to the base Remedial Action Schemes will be submitted by Market Participants through PTC using a SAMR. ERCOT will approve or reject the SAMRs and notify the Market Participant. The SAMR types for RAS include RAP, SPS, RAPC, and Mitigation Plans. The approved changes are added by ERCOT Staff to the Network Operations Model using the NOMCR process. The Information Model Manager (IMM) provides a basic level of validation.

Figure below shows the IMM hierarchy for an example RASs. An RAS has a Stage, the state of a remedial action scheme, and a Trigger Condition, which is the set of gates that would logically trigger the RAS.

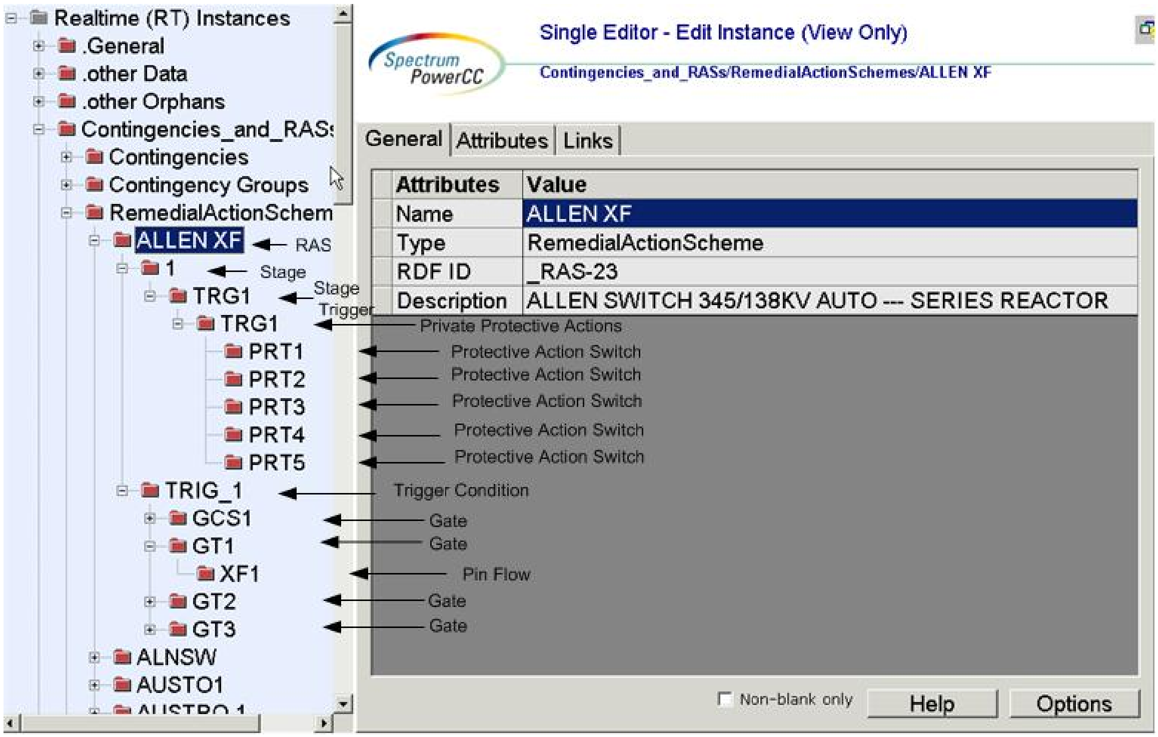


Figure 72 - RAS

Under the Stage is a Stage Trigger, or condition that is triggered within a stage. Under the Stage Trigger is the Private Protective Actions, which are specific to a RAS trigger condition. Under the Private Protective Actions, the individual Private Actions are housed and can include any of the actions listed in the table below.

Protective Action	Description
ProtActACLineSegment	Protective action to put an ACLineSegment in-service/out-of-service.
ProtActAnalog	Base class for protective actions that are non-switching.
ProtActEnergyConsumer	RAS protective action associated with a load instance.
ProtActSeriesCompensator	Protective action to put a series compensator in-service/out-of-service.
ProtActStationReduction	Protective action to reduce station generation.
ProtActSwitch	Protective action to move a switch.
ProtActSynchronousMachine	Protective action to change output of a synchronous machine.
ProtActTransformerWinding	Protective action to put a TransformerWinding in-service/out-of-

	service.
ProtectiveAction	Base class for a protective action for RAS.
ProtectiveActionShared	Protective actions that can be shared among triggers.

The collection of RAS logical Gates are housed under the Trigger Condition. Each Gate can have various Pin inputs listed in the table below.

PinType	Description
GateInputPin	Input pin for a special protection scheme gate.
PinBranchGroup	Branch flow summation input pin for RAS.
PinFlow	Network solution flow input pin for RAS.
PinGate	Input pin that maps to a Gate for RAS.
PinSwitch	Input pin that maps to network solution switch status for RAS.
PinTriggerCondition	Input pin that maps to a TriggerCondition for RAS.
PinVoltage	Input pin that maps to a network voltage for RAS.

40.2.1 Attributes

Class Attributes and Linkage tables have been combined wherever possible and when the classes are close in proximity to each other within the Network Model hierarchy. The table below lists the attributes for Remedial Action Schemes. The default values populated will be used unless changed by user. The required attributes are shown bolded.

Attribute	Description	Data Type	Default Value	Sample Data
Active	User specified active	Boolean	False	
isRAP	This is a remedial action plan (RAP)	Boolean	False	
isRAS	This is a remedial action scheme (RAS)	Boolean	False	
AliasName	Free text name of the object or instance.	String	None	RAS_12
LocalName	The Local Name is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The	String	None	RAS_ab

	simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.			
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Float	None	123456
PathName	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	

40.2.2 Linkage

The following table shows the required links for Remedial Action Schemes.

Linkage Name	Description	Path Name
Belongs To (Contingency)	Links to specific Contingency.	Contengencies_and_ RASs/ Contengencies/Cont_ Name

40.3 MODELING APPROACH RAS-STAGE, STAGE TRIGGER, PRIVATE PROTECTIVE ACTIONS

A Remedial Action Schemes' Stage, Trigger Condition, or set of gates that would logically trigger the RAS, and Private Protective Actions, which are specific to a Trigger Condition share the same attributes. Their attributes table has been combined but their Linkage tables remain separate.

40.3.1 Attributes

The table below lists the attributes for RAS-Stage, Stage Trigger, and Private Protective Actions. The default values populated will be used unless changed by user. The required attributes are shown bolded.

Attribute	Description	Data Type	Default Value	Sample Data
AliasName	Free text name of the object or instance.	String	None	STAGE_

				12
LocalName	The Local Name is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	STAGE_ab
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Float	None	123456
PathName	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	

40.3.2 Linkage for RAS-Stage

The following table shows the required links for a Stage.

Linkage Name	Description	Path Name
BelongsTo (ModelAuthoritySet)	An Identified Object belongs to a Modeling Authority Set for purposes of defining a group of data maintained by the same Modeling Authority.	

40.3.3 Linkage for RAS-Stage Trigger

The following table shows the required links for Stage Trigger.

Linkage Name	Description	Path Name
TriggeredBy	Trigger Condition	Contingencies_and_R

		ASs/RemedialActionSchemes/RAS_1/TRIG

40.3.4 Linkage for RAS- Private Protective Actions

The following table shows the required links for Private Protective Actions.

Linkage Name	Description	Path Name
BelongsTo (ModelAuthoritySet)	An Identified Object belongs to a Modeling Authority Set for purposes of defining a group of data maintained by the same Modeling Authority.	

40.4 MODELING APPROACH RAS-PROTECTIVE ACTION ACLINE SEGMENT, SERIES COMPENSATOR, SWITCH, AND TRANSFORMER WINDING

Four types of Private Protective Actions do not directly include SCADA measurements include those for ACLine Segments, Series Compensators, Switches, and Transformer Windings and share the same attributes. Both their Attributes and Linkage tables are combined. For a description of these classes, see section Modeling Approach RAS above.

40.4.1 Attributes

The table below lists the attributes for Protective Action ACLine Segment, Series Compensator, Switch, and Transformer Winding. The default values populated will be used unless changed by user. The required attributes are shown bolded.

Attribute	Description	Data Type	Default Value	Sample Data
inService	Element put in service	Boolean	False	
enableArming		Boolean	False	
AliasName	Free text name of the object or instance.	String	None	PPA_12
LocalName	The Local Name is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met	String	None	PPA_ab

	IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.			
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Float	None	123456
PathName	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	

40.4.2 Linkage

The following table shows the required links for Protective Action ACLine Segment, Series Compensator, Switch, and Transformer Winding.

Linkage Name	Description	Path Name
References (Transmission Device), where Transmission Device is either a Switch, ACLine Segment, ect…	References device that performs Protective Action.	Network/ERCOT Texas Network/ERCOT Substations/WZ_NORTH_CENTRAL/Sub/138/SWITCH_123

40.5 MODELING APPROACH RAS-PROTECTIVE ACTION ANALOG, ENERGY CONSUMER, STATION REDUCTION, AND SYNCHRONOUS MACHINE

Four types of Private Protective Actions could include SCADA measurements include those for Analogs, Energy Consumers, Station Reductions, and Synchronous Machines and share the same attributes. Both their Attributes and Linkage tables are combined. For a description of these classes, see section Modeling Approach RAS above.

40.5.1 Attributes

The table below lists the attributes for Protective Action Analog, Energy Consumer, Station Reduction, and Synchronous Machine. The default values populated will be used unless changed by user. The required attributes are shown bolded.

Attribute	Description	Data Type	Default Value	Sample Data
Action Value	If no SCADA value, then is the value to reduce by	Float	None	
Action Value from SCADA	True, the action value is obtained from SCADA otherwise from actionValue	Boolean	False	

	attribute			
Is Reduced To	If true, action is a 'reduce to' otherwise it is a 'reduce by'.	Boolean	False	
inService	Element put in service	Boolean	False	
enableArming		Boolean	False	
AliasName	Free text name of the object or instance.	String	None	PPA_12
LocalName	The Local Name is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	PPA_ab
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Float	None	123456
PathName	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	

40.5.2 Linkage

The following table shows the required links for Protective Action ACLine Segment, Series Compensator, Switch, and Transformer Winding.

Linkage Name	Description	Path Name
References (Element), where Element is either AnalogValue,EnergyConsumer, Substation, or SynchronousMachine	References element that performs Protective Action.	Network/ERCOT Texas Network/ERCOT Substations/WZ_NORTH_CENTRAL/Sub

40.6 MODELING APPROACH RAS-PROTECTIVE ACTION AND PROTECTIVE ACTION SHARED

The Protective Action class is the base class for the Remedial Action Scheme. Protective Action Shared can be shared among triggers. These classes' Attributes tables are combined.

40.6.1 Attributes

The table below lists the attributes for Protective Action. The default values populated will be used unless changed by user. The required attributes are shown bolded.

Attribute	Description	Data Type	Default Value	Sample Data
enableArming		Boolean	False	
AliasName	Free text name of the object or instance.	String	None	PPA_12
LocalName	The Local Name is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	PPA_ab
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Float	None	123456
PathName	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	

40.6.2 Linkage for RAS- Protective Action

The following table shows the required links for Protective Action.

Linkage Name	Description	Path Name
Armed By(DiscreteValue)	Discrete Value	

40.6.3 Linkage for RAS- Protective Action Shared

The following table shows the required links for Protective Action Shared.

Linkage Name	Description	Path Name
Armed By(DiscreteValue)	Discrete Value	
Has (SharedProtectiveActions)		

40.7 MODELING APPROACH RAS- TRIGGER CONDITION

A Trigger Condition is the set of gates that would logically trigger the RAS. The Gate class is mentioned in the following section.

40.7.1 Attributes

The table below lists the attributes for a Trigger Condition. The default values populated will be used unless changed by user. The required attributes are shown bolded.

Attribute	Description	Data Type	Default Value	Sample Data
LocalName	The Local Name is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of	String	None	PPA_ab

	the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.			
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Float	None	123456
PathName	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	

40.7.2 Linkage

The following table shows the required links for a Trigger Condition.

Linkage Name	Description	Path Name
Has Resulting (Gate)	Gate	Contingencies_and_RASs/RemedialActionSchemes/RAS/TRG/GT

40.8 MODELING APPROACH RAS- GATE

The Gate class is a Special Protection Scheme gate which evaluates to Boolean. The types of inputs available to the gate class are mentioned in the section that follows.

40.8.1 Attributes

The table below lists the attributes for a Gate. The default values populated will be used unless changed by user. The required attributes are shown bolded.

Attribute	Description	Data Type	Default Value	Sample Data
thresholdValue	Threshold value for gate type of (GE,GT,LE,LT,NE,EQ) with single gate input	Float		

Change Threshold	Use change limit for voltages.	Boolean	False	
Emergency Threshold	Use the branch emergency limit as threshold.	Boolean	False	
gatetype	Gate Type.	Enum GateType		
level	Level of the gate.	Integer	0	
limitPercentage	Percentage of the limit. 90% should enter 90.	Float		
Loadshed Threshold	Use the branch loadshed limit as threshold.	Boolean	False	
lowerThreshold	Use lower limit (for FlowSummation and voltage).	Boolean	False	
normalThreshold	Use the branch normal limit as threshold.	Boolean	False	
upperThreshold	Use upper limit (for FlowSummation and voltage).	Boolean	False	
useLimit Threshold	Use the branch limit as threashold value, otherwise use Gate::thresholdValue.	Boolean	False	
LocalName	The Local Name is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	PPA_ab
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Float	None	123456
PathName	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	

40.8.2 Linkage

The following table shows the required links for a Gate.

Linkage Name	Description	Path Name
Belong To(ModelAuthoritySet)	An IdentifiedObject belongs to a Modeling Authority Set for purposes of defining a group of data maintained by the same Modeling Authority.	

40.9 MODELING APPROACH RAS- GATE INPUT PIN, PIN BRANCH GROUP, PIN BRANCH GROUP, PIN GATE, PIN SWITCH, PIN TRIGGER CONDITION, AND PIN VOLTAGE

Each Gate can have various Pin inputs including Gate Input Pin, Pin Branch Group, Pin Branch Group, Pin Gate, Pin Switch, Pin Trigger Condition, and Pin Voltage. Their Attributes tables are combined, but their Linkage tables are listed separately. Pin Flow is discussed in the following section. For a description of these classes, see section 22.1.1 Modeling Approach RAS above.

40.9.1 Attributes

The table below lists the attributes for Gate Input Pin, Pin Branch Group, Pin Branch Group, Pin Gate, Pin Switch, Pin Trigger Condition, and Pin Voltage. The default values populated will be used unless changed by user. The required attributes are shown bolded.

Attribute	Description	Data Type	Default Value	Sample Data
Flow MVA	If true the input is a MVA.	Boolean	False	
Flow MVAR	If true the input is a MVAR.	Boolean	False	
Flow MW	If true, the input is a MW.	Boolean	False	
Negate	If true, input is negated first and then input to the gate. Only applicable to logical gates.	Boolean	False	
Use Absolute Value	Use absolute value of input (only applies to analog inputs).	Boolean	False	
LocalName	The Local Name is a human readable name of the object. It is only used with	String	None	PPA_ab

	objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.			
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Float	None	123456
PathName	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	

40.9.2 Linkage for RAS- Gate Input Pin

The following table shows the required links for Gate Input Pin.

Linkage Name	Description	Path Name
BelongsTo (ModelAuthoritySet)	An IdentifiedObject belongs to a Modeling Authority Set for purposes of defining a group of data maintained by the same Modeling Authority.	Contengencies_and_ RASs/

40.9.3 Links for RAS- Pin Branch Group

The following table shows the required links for Pin Branch Group. The path name shows where the links can be found in the model. Definitions for all of the links can be found by clicking on the help button at the bottom of the links screen.

Linkage Name	Description	Path Name
BelongsTo(BranchGroup)	Branch Group	Network/BranchGroup /N_TO_W

40.9.4 Links for RAS- Pin Gate

The following table shows the required links for Pin Gate.

Linkage Name	Description	Path Name
Has A (Gate)	Gate	Contingencies_and_RASs/RemedialActionSchemes/_a/TC1/Gate

40.9.5 Linkage for RAS- Pin Switch

The following table shows the required links for Pin Switch. The path name shows where the links can be found in the model. Definitions for all of the links can be found by clicking on the help button at the bottom of the links screen.

Linkage Name	Description	Path Name
Has A (Switch)	Switch	Network/ERCOT Texas Network/ERCOT Substations/WZ_COAST/SUB/138/DCS1

40.9.6 Linkage for RAS- Pin Trigger Condition

The following table shows the required links for Pin Trigger Condition.

Linkage Name	Description	Path Name
Has A (Trigger Condition)	Trigger Condition	Contingencies_and_RASs/RemedialActionSchemes/RAS/TrigCon

40.9.7 Linkage for RAS- Pin Voltage

The following table shows the required links for Pin Voltage. The path name shows where the links can be found in the model. Definitions for all of the links can be found by clicking on the help button at the bottom of the links screen.

©2009 Electric Reliability Council of Texas, Inc.

Linkage Name	Description	Path Name
Has A (ConnectivityNode)	Connectivity Node	Network/ERCOT Texas Network/ERCOT Substations/WZ_COAST/SUB/138/CN

40.10 MODELING APPROACH FOR RAS-PIN FLOW

Each Gate can have various Pin inputs including Pin Flow. The other Pin classes, Gate Input Pin, Pin Branch Group, Pin Branch Group, Pin Gate, Pin Switch, Pin Trigger Condition, and Pin Voltage, are discussed in the section above. For a description of these classes, see section 22.1.1 Modeling Approach RAS above.

40.10.1 Attributes

The table below lists the attributes for Pin Flow. The default values populated will be used unless changed by user. The required attributes are shown bolded.

Attribute	Description	Data Type	Default Value	Sample Data
Either End	True if doing status input on a branch and want to check if either end is out.	Boolean	False	
Flow MVA	If true the input is a MVA.	Boolean	False	
Flow MVAR	If true the input is a MVAR.	Boolean	False	
Flow MW	If true, the input is a MW.	Boolean	False	
Input Is Flow	If true, the input is a flow, otherwise it is branch status.	Boolean	False	
Into Bus	Flow into the bus is positive.	Boolean	False	
Negate	If true, input is negated first and then input to the gate. Only applicable to logical gates.	Boolean	False	
Out Of Bus	Flow out of the bus is positive.	Boolean	False	
Use Absolute Value	Use absolute value of input (only applies to analog inputs).	Boolean	False	

LocalName	The Local Name is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	PPA_ab
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Float	None	123456
PathName	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	

40.10.2 Linkage

The following table shows the required links for Pin Flow.

Linkage Name	Description	Path Name
Has A (Terminal)	Terminal	Network/ERCOT Texas Network/ERCOT Substations/WZ_COAST/SUB/138/Device/Terminal

41 MODELING PRIVATEAREANETWORKS

41.1 MODELING APPROACH

In the ERCOT CIM model instance of type *PrivateAreaNetwork* are utilized for identifying individual *GeneratingUnits* that are Retired, Mothballed or Non-MarketParticipating (Non-Modeled Generation), pseudo Generation/Loads that are modeled to represent BlockLoadTransfers, loads that are part of a Self Serving Entity and to identify Load and/or GeneratingUnits that form a Private Use network. This modeling distinction is defined by the enumerated attribute networkType (labeled as "Type of Private Use Network" in IMM).

Figure below shows a PrivateAreaNetwork named _PrivteAreaNetwrk_A in the IMM hierarchical view. Also visible are the various types of Private Use Networks that can be defined.

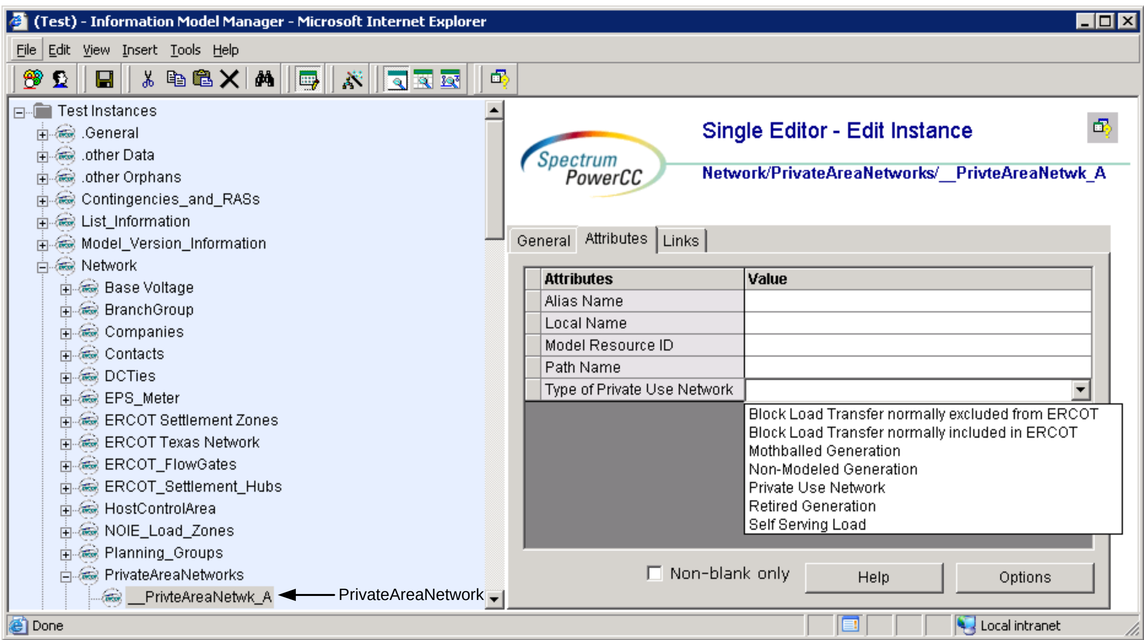


Figure 73 - IMM hierarchical view of a PrivateAreaNetwork as modeled in the ERCOT model.

41.2 ATTRIBUTES

The attributes for *PrivateAreaNetwork* are shown in the table below.

Attribute	Description	Data Type	Default	Sample Data
Type of Private Use Network	Describes the Type of Private Use Network	Enumeration	None	Retired Generation
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The	String	None	XYZ

	simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.			
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	None	123
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	XYZ
Alias Name	Free text name of the object or instance.	String	None	XYZ

41.3 LINKAGE

The required links for PrivateAreaNetworks are defined in the table below.

Link Name	Description	Path Name
Belongs To (ModelingAuthoritySet)	An IdentifiedObject belongs to a Modeling Authority Set for purposes of defining a group of data maintained by the same Modeling Authority.	

42 MODELING BRANCH GROUP

42.1 MODELING APPROACH

BranchGroup is defined as Directed Sum of terminal Flows. These groups are defined by operations for monitoring secure MW flows between different transfer areas.

This section describes the approach for modeling a *BranchGroup*. This is one of the instances that is modeled by ERCOT.A *BranchGroup* needs to be contained only in the instance of class sysorphan (*BranchGroup*)

An example of a *BranchGroup* N_TO_H is visible in the hierarchy view in the figure.

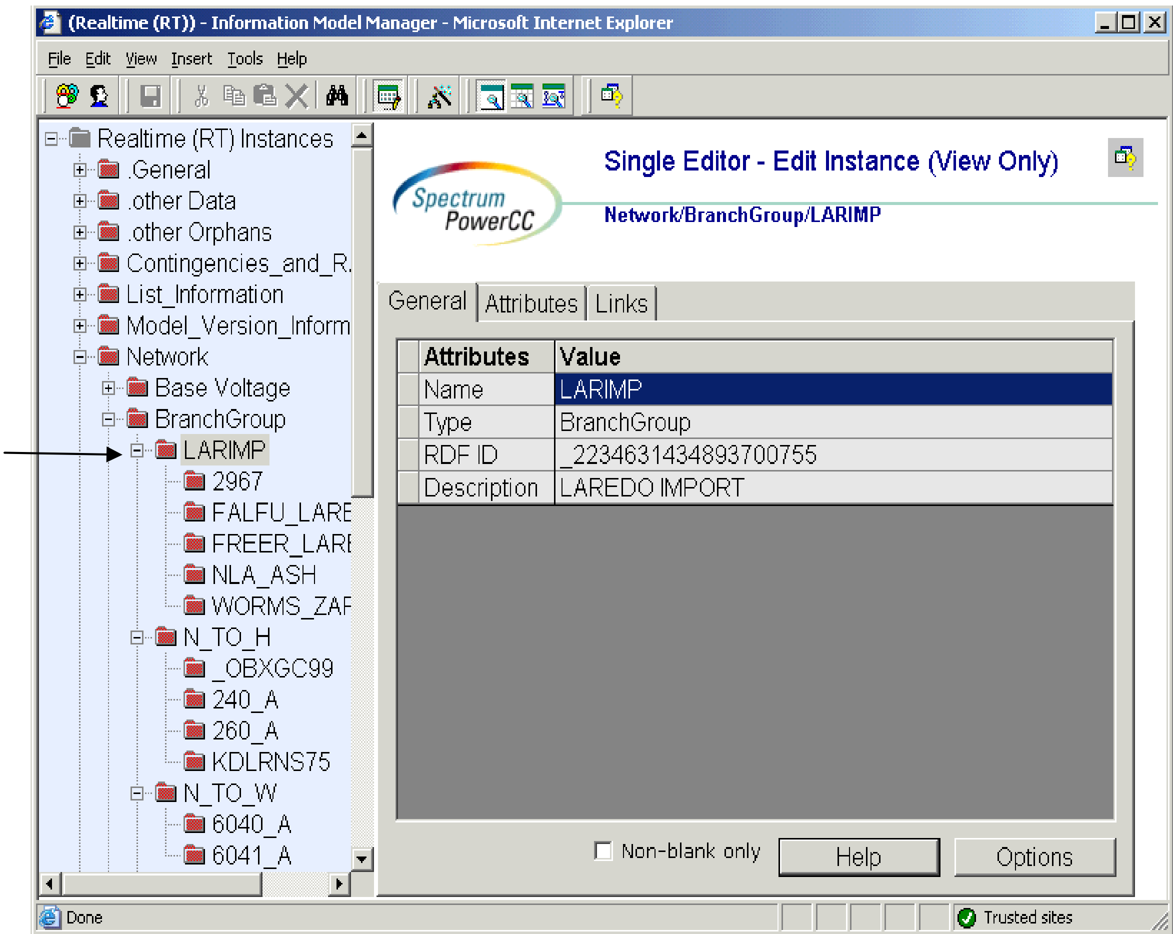


Figure 74 - BranchGroup

42.2 ATTRIBUTES

The attributes for a *BranchGroup* are shown in the table below.

Attribute	Description	Data Type	Default

©2009 Electric Reliability Council of Texas, Inc.

Description	Description of the object or instance	String	
Monitor Active Power	Monitor active power. (True or False)	Boolean	True
Monitor Reactive Power	Monitor Reactive power. (True or False)	Boolean	False
Alias Name	Free text name of the object or instance.	String	
Eligible	Eligible Flag	Boolean	False
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	
Max Shadow Price	States the Max Shadow price for a BranchGroup.	Double Float	99999
Maximum Active Power	Maximum Active Power	Double Float	0
Maximum MVAR	Maximum MVAR	Double Float	
Maximum MW	Maximum MW	Double Float	0
Maximum Reactive Power	Maximum Reactive Power	Double Float	0
Minimum Active Power	Minimum Active Power	Double Float	0
Minimum MVAR	Minimum MVAR	Double Float	
Minimum MW	Minimum MW	Double Float	0
Minimum Reactive Power	Minimum Reactive Power	Double Float	0

Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	
Transmission Element ID	Transmission Element ID	Integer	

42.3 LINKAGE

The required links for a BranchGroup are defined in the table below.

Link Name	Description	Path Name
IdentifiedObjectBelongsToModelingAuthoritySet	An IdentifiedObject belongs to a Modeling Authority Set for purposes of defining a group of data maintained by the same Modeling Authority.	
MonitoredMemberOfMonitoredGroup	Branch Group Member of MonitoredGroup	List_Information/Monitored Groups/ISO
BranchGroupReferencesTerminal	BranchGroupReferencesTerminal	
BranchGroupReferencesInverseTerminal	BranchGroupReferencesInverseTerminal	

43 MODELING BRANCH GROUP TERMINAL

43.1 MODELING APPROACH

BranchGroupTerminal is defined as Directed terminal flow to add into *BranchGroup*. This is one of the instances that is modeled by ERCOT.A *BranchGroupTerminal* needs to be contained only in the instance of class *BranchGroup.*

An example of a *BranchGroupTerminal* 2967 is visible in the hierarchy view in the below figure.

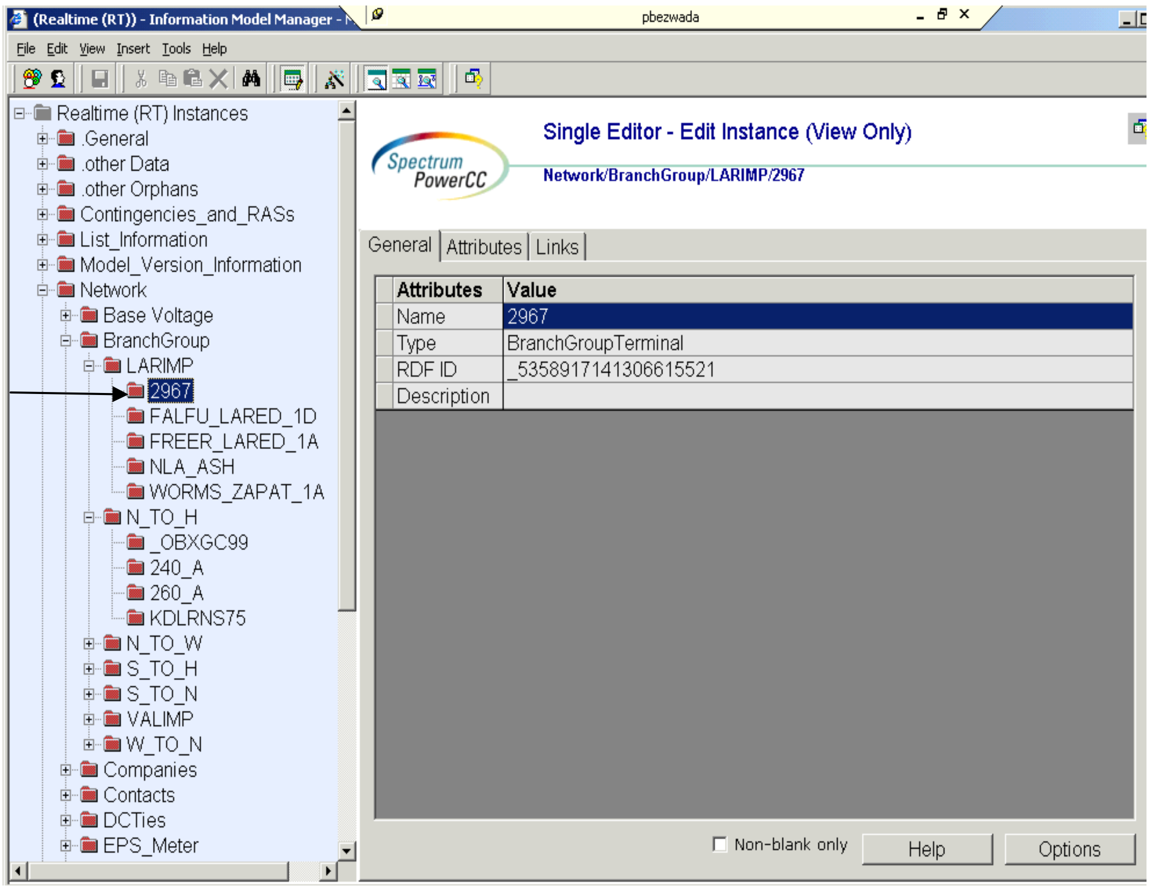


Figure 75 - BranchGroupTerminal

43.2 ATTRIBUTES

The attributes for a BranchGroupTerminal are shown in the table below.

Attribute	Description	Data Type	Default
Description	Description of the object or instance	String	
Alias Name	Free text name of the object or instance.	String	

Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	
Positive Flow In	Positive Flow In	Boolean	

43.3 LINKAGE

The required links for a BranchGroupTerminal are defined in the table below.

Link Name	Description	Path Name
IdentifiedObjectBelongsToModelingAuthoritySet	An IdentifiedObject belongs to a Modeling Authority Set for purposes of defining a group of data maintained by the same Modeling Authority.	
BranchGroupTerminalReferencesTerminal	BranchGroupTerminalReferencesTerminal	Network/ERCOT Texas Network/ERCOT-AC Lines/138/2967/1/2967_B

©2009 Electric Reliability Council of Texas, Inc.

44 MODELING ENDCAP

44.1 MODELING APPROACH

EndCap is defined as a cap to terminate the line or device

An example of an ENDCAP_8010 is visible in the hierarchy view in the figure.

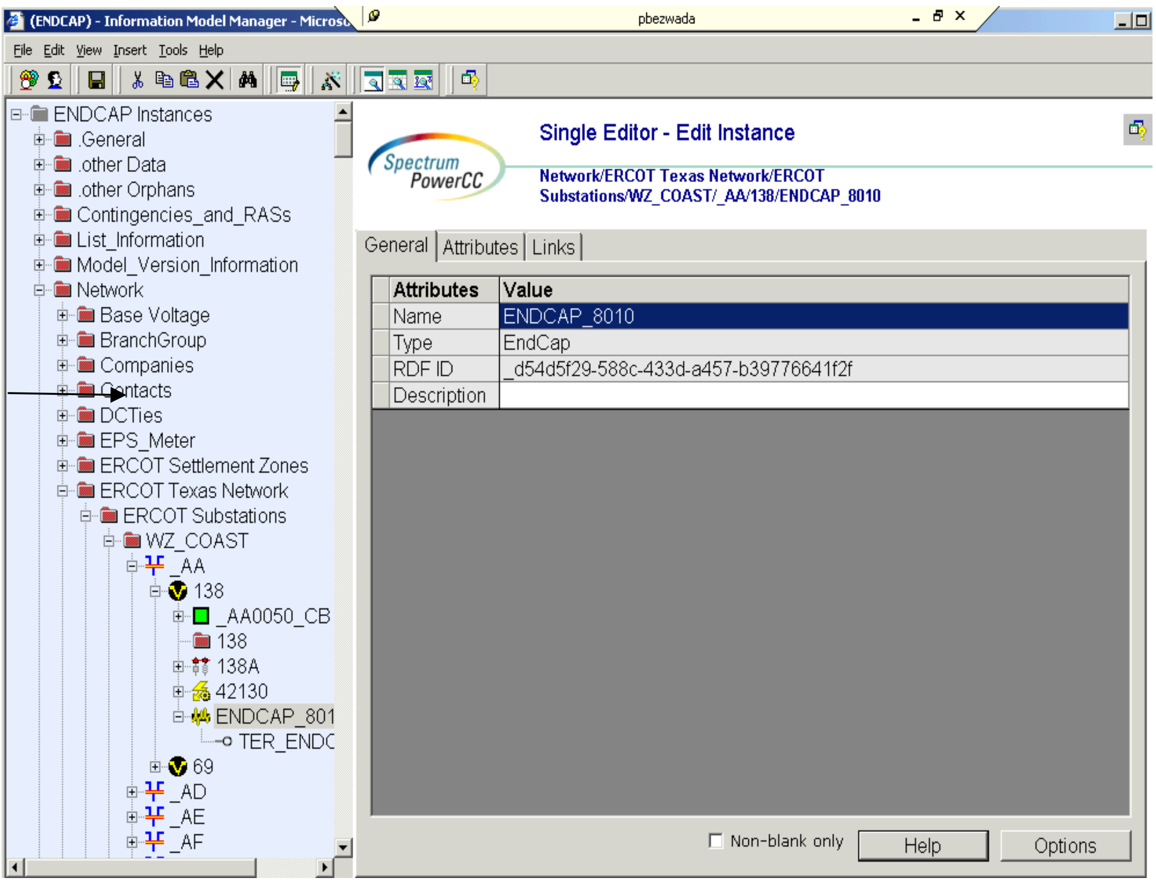


Figure 76 - EndCap

44.2 ATTRIBUTES

The attributes for an *EndCap* are shown in the table below.

Attribute	Description	Data Type	Default
Description	Description of the object or instance	String	
Alias Name	Free text name of the object or instance.	String	
DAM Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is	Boolean	

	secured.		
DAM secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured	Boolean	
Latitude	Latiitude coordinates	Float	
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	
Longitude	Longitude coordinates	Float	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	
OUS Priority	An Outage Scheduler priority is included in all ConductingEquipment classes except BusbarSection and TransformerWinding.	Long Int	
PSSE ID	Attribute will give IMM modelers control over the PSS®E ID that the Topology Processor uses to properly name units, loads, branches, and transformers.	String	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	
Phases	Describes the phases carried by a conducting equipment. Possible values { ABCN , ABC, ABN, ACN, BCN, AB, AC, BC, AN, BN, CN, A, B, C, N }.	String	
RUC Monitored	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured.	Boolean	
RUC Secured	The Boolean flags to indicate which process(s) monitor the branch devices and by which process the devices is secured	Boolean	
Remove	The equipment is removed from the network	Boolean	
Remove Enable	The equipment can be removed from the network in the EMS	Boolean	

Transmission Element ID	Transmission Element ID	Integer	

44.3 LINKAGE

The Required links for an EndCap are defined in the table below.

Link Name	Description	Path Name
BaseVoltage	A link to a BaseVoltage is only necessary when there is no VoltageLevel container used. If a VoltageLevel container is used the disconnector will inherit a BaseVoltage from the VoltageLevel.	Network/Base Voltage
Operatorship	The Operatorship link is used for permission rights. The Operator of equipment has the right to edit the equipment. An operator can only be assigned by the creator or owner of the equipment.	Network/Companies
Ownership	The Ownership link is used for permission rights. The owner of equipment has editing and administrative rights. An owner can only be assigned by the creator of the equipment.	Network/Companies

45 MODELING TIECORRIDOR

45.1 MODELING APPROACH

TieCorridor is defined under a *SubLoadArea* and is linked to a *TieLine*

An example of a *TieCorridor* 10_A is visible in the hierarchy view in the figure.

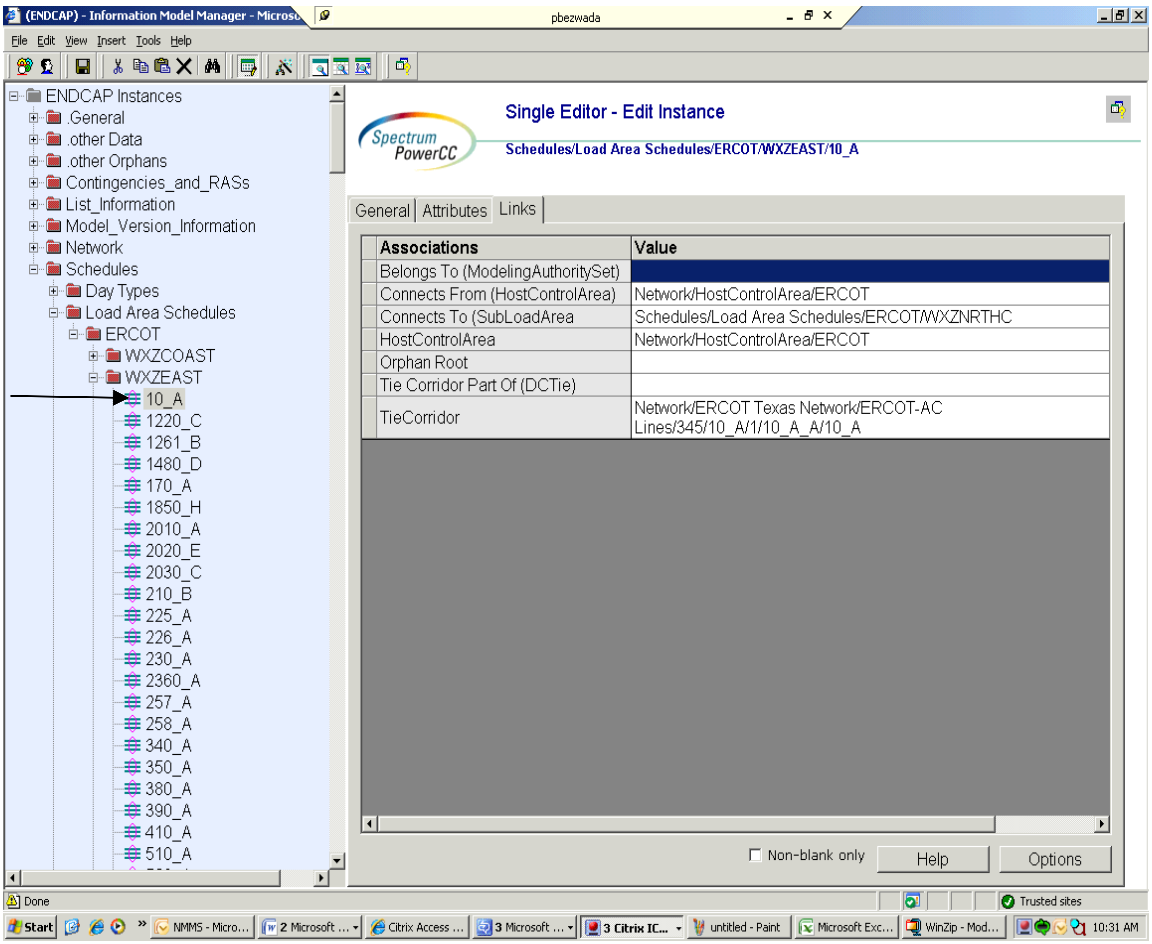


Figure 77 - TieCorridor

45.2 ATTRIBUTES

The attributes for a *TieCorridor* are shown in the table below. Required attributes are listed at the top of the table in bold text.

Attribute	Description	Data Type	Default
Description	Description of the object or instance	String	

Alias Name	Free text name of the object or instance.	String	
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	
Maximum MW Inflow Alarm Limit	Maximum MW Inflow Alarm Limit	Float	
Maximum MW Outflow Alarm Limit	Maximum MW Outflow Alarm Limit	Float	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	
Tie ID	Tie ID	Integer	
Tie is Internal	Tie is Internal ?	Boolean	
Transmission Element ID	Transmission Element ID	Integer	

45.3 LINKAGE

The Required links for a TieCorridor are defined in the table below. The path name shows where the links can be found in the model. Definitions for all of the links can be found by clicking on the help button at the bottom of the links screen.

Link Name	Description	Path Name
TieCorridorConnectsFromHostControlArea	To side of the Tie Corridor	Network/HostControlArea/ERCOT
TieCorridorConnectsToSubLoadArea	SubLoad Area the Tie corridor connects to	Schedules/Load Area Schedules/ERCOT/WXZNRTH

		C
TieCorridorConnectsToaHostControlArea	From Side of the Tie Corridor	Network/HostControlArea/ERCOT

46 MODELING PERMISSIONAREA

46.1 MODELING APPROACH

PermissionArea is modeled under sysOrphan "Permission Areas" as a child instance. *PermissionArea* is used to define valid areas of responsibility for SCADA measurements. The Permission Areas currently defined and used in the ERCOT CIM model are, AL, COMMS, EAST, ECAR, ERCOT, GEN, NORT, SOUT, and SYSTEM.

Figure below shows the parent/child hierarchy of a *PermissionArea* in IMM.

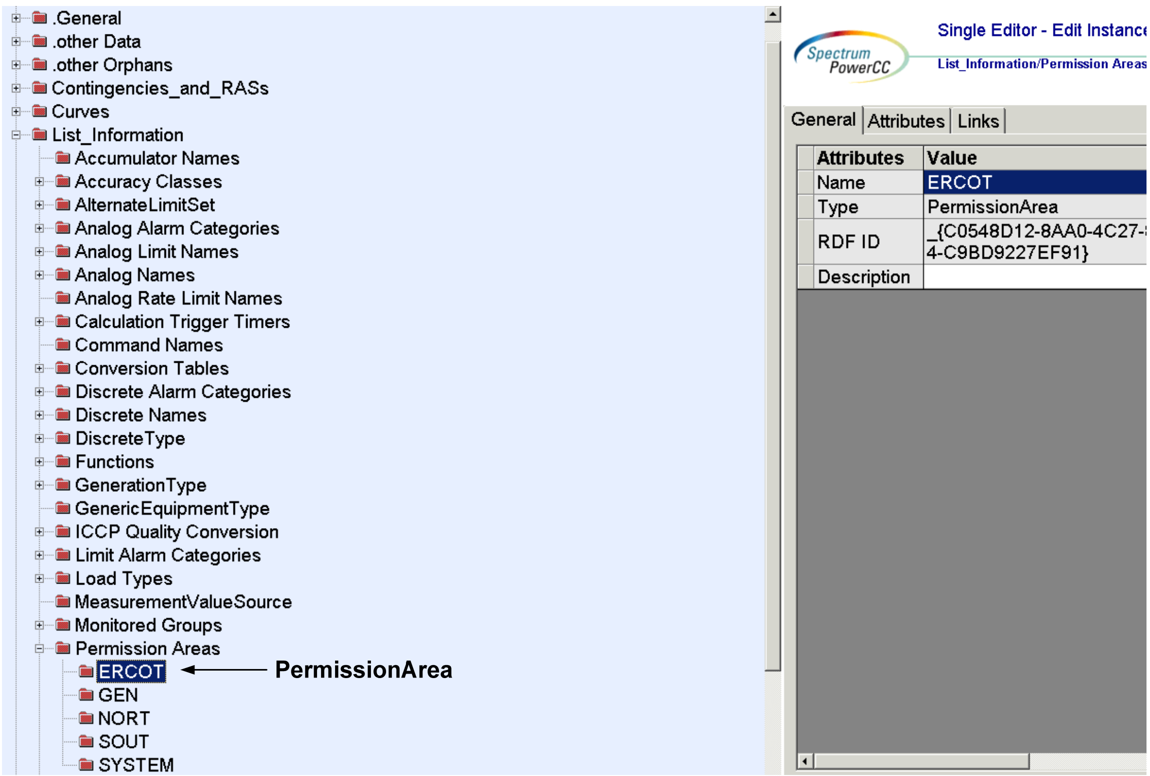


Figure 78 - Hierarchy for PermissionArea

46.2 ATTRIBUTES

The attributes for a PermissionArea are shown in the table below.

Attribute	Description	Data Type	Default Value	Sample Data
Alias Name	Free text name of the object or instance.	String	None	

Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.			
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	

46.3 LINKAGE

None.

47 MODELING APPROACH FOR DAYTYPE

47.1 MODELING APPROACH

Group of similar days, e.g., Mon/Tue/Wed, Thu/Fri, Sat/Sun, Holiday1, Holiday2.

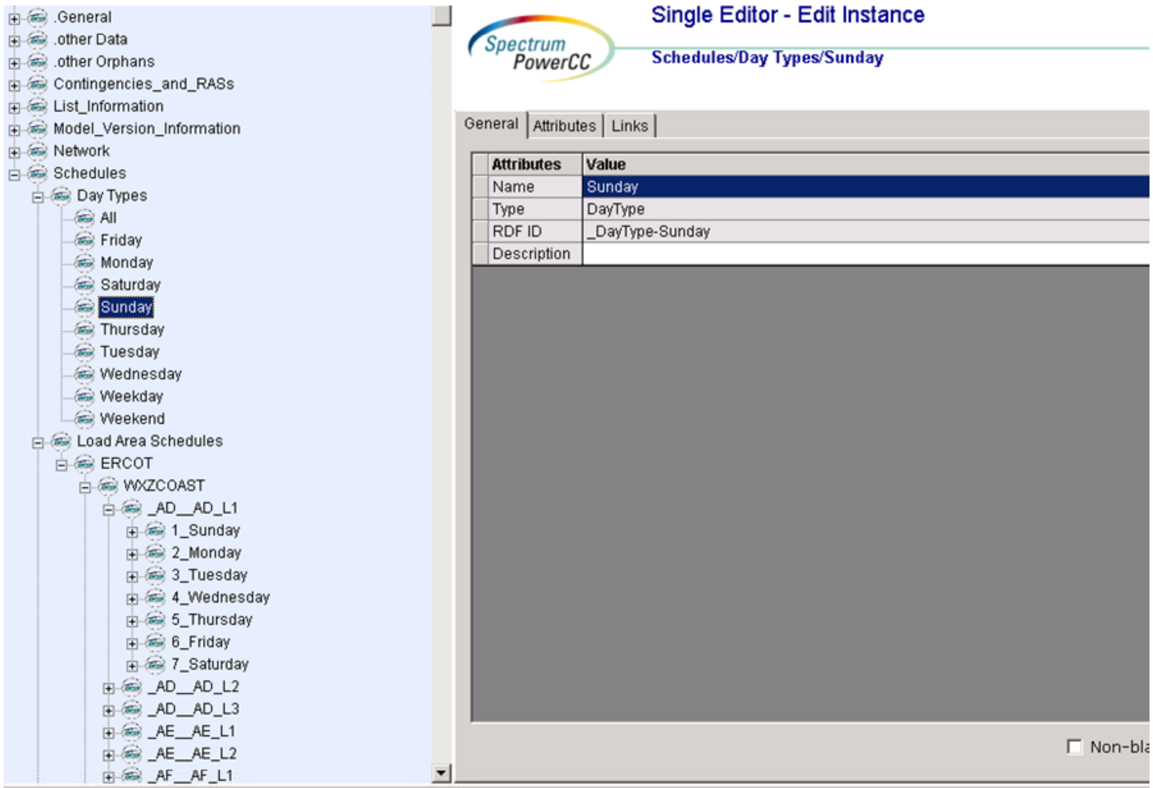


Figure 79 - DayType

47.2 ATTRIBUTES

Attribute	Description	Data Type	Default
Alias Name	Free text name of the object or instance.	String	
Description	Description of the object or instance.	String	
End Time	Time daytype ends	Time	
Fri Flag	Indicates whether Friday is included in this Day Type.	Boolean	
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation,	String	

	VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.		
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	
Mon Flag	Indicates whether Monday is included in this Day Type.	Boolean	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	
Sat Flag	Indicates whether Saturday is included in this Day Type.	Boolean	
Start Time	Time daytype starts		
Sun Flag	Indicates whether Sunday is included in this Day Type.	Boolean	
Thurs Flag	Indicates whether Thursday is included in this Day Type.	Boolean	
Tues Flag	Indicates whether Tuesday is included in this Day Type.	Boolean	
Wed Flag	Indicates whether Wednesday is included in this Day Type.	Boolean	

47.3 LINKAGE

There are no required links.

48 MODELING APPROACH FOR LOADTYPE

48.1 MODELING APPROACH

Container for shared attributes for loads of the same type.

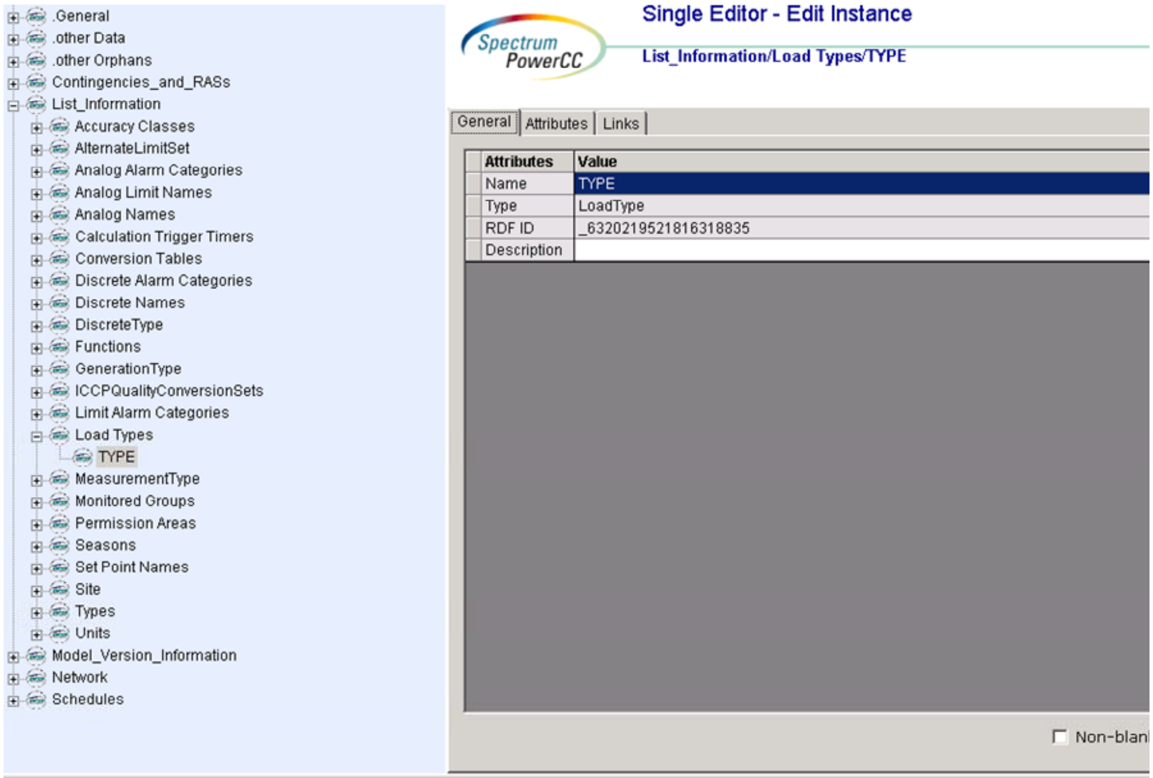


Figure 80 - LoadType

48.2 ATTRIBUTES

Attribute	Description	Data Type	Default
Alias Name	Free text name of the object or instance.		
Description	Description of the object or instance.		
exp P Frequency	Load watts are proportional to (V**WVEXP)*(F**WFEXP).		
exp P Voltage	Exp P Voltage.		
exp Q Frequency	Load vars are proportional to (V**RVEXP)*(F**RFEXP).		

exp Q Voltage	Exp Q Voltage.		
Initial Time	The initial time on the cooling characteristic in seconds.		
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.		
Maximum Scaling	The maximum value that the load could be scaled by upon its reconection.		
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.		
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.		

48.3 LINKAGE

There are no required links.

49 MODELING APPROACH FOR SUBLOADAREA

The class is the second level in a hierarchical structure for grouping of loads for the purpose of load flow load scaling.

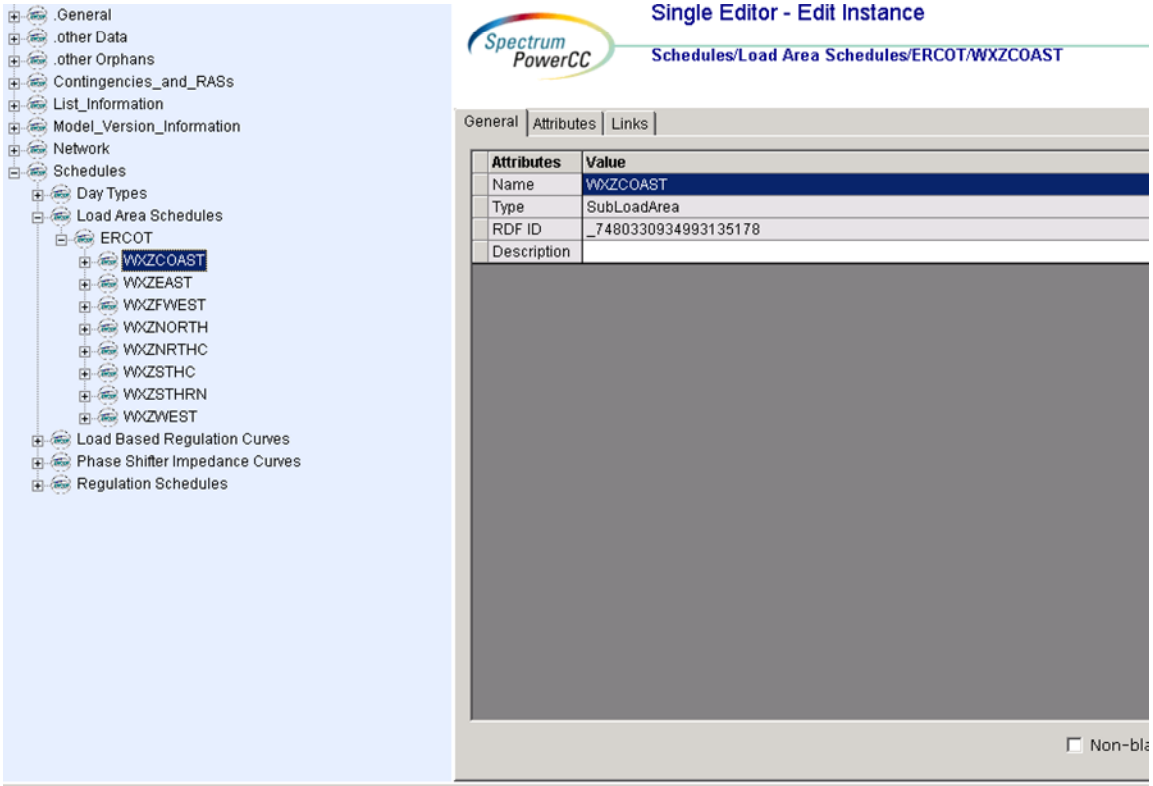


Figure 81 - SubLoadArea

49.1 ATTRIBUTES

Attribute	Description	Data Type	Default
Alias Name	Free text name of the object or instance.		
Description	Description of the object or instance.		
Forecast Enabled	Forecast enabled.		
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the		

	uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.		
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.		
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.		

49.2 LINKAGE

There are no required links.

50 MODELING APPROACH FOR SEASON

50.1 MODELING APPROACH

A specified time period of the year, e.g., Spring, Summer, Fall, Winter. Season Types may be defined with starting and ending month and day. All defined season types must make up one year.

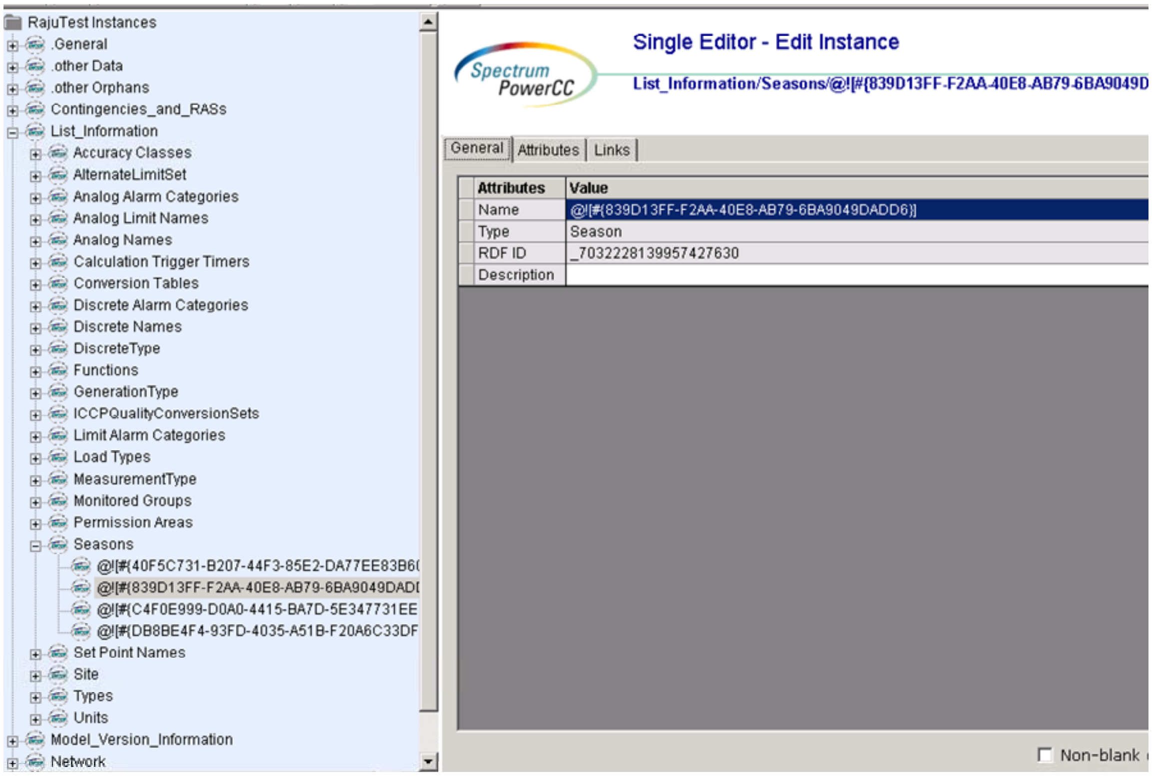


Figure 82 - Season

50.2 ATTRIBUTES

Attribute	Description	Data Type	Default
Alias Name	Free text name of the object or instance.	String	
Description	Description of the object or instance.	String	
End Date	Date season ends.	Time	
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent	String	

	have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.		
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	String	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	
Season Name	Name of the Season.	String	Winter
Start Date	Date season starts.	Time	

50.3 LINKAGE

There are no required links.

©2009 Electric Reliability Council of Texas, Inc.

51 MODELING PSEUDOTERMINAL

51.1 MODELING APPROACH

The pseudo terminal is defined to provide UI support. The psuedoterminal does not connect to into the network topology and is solely utilized for the purpose of readily displaying SCADA/ICCP telemetry being provided for the equipment.

PsuedoTerminal shoud not be Associated to a connectivityNode.

Psuedoterminal should not be associated to a RegulatingconductingEquipment.

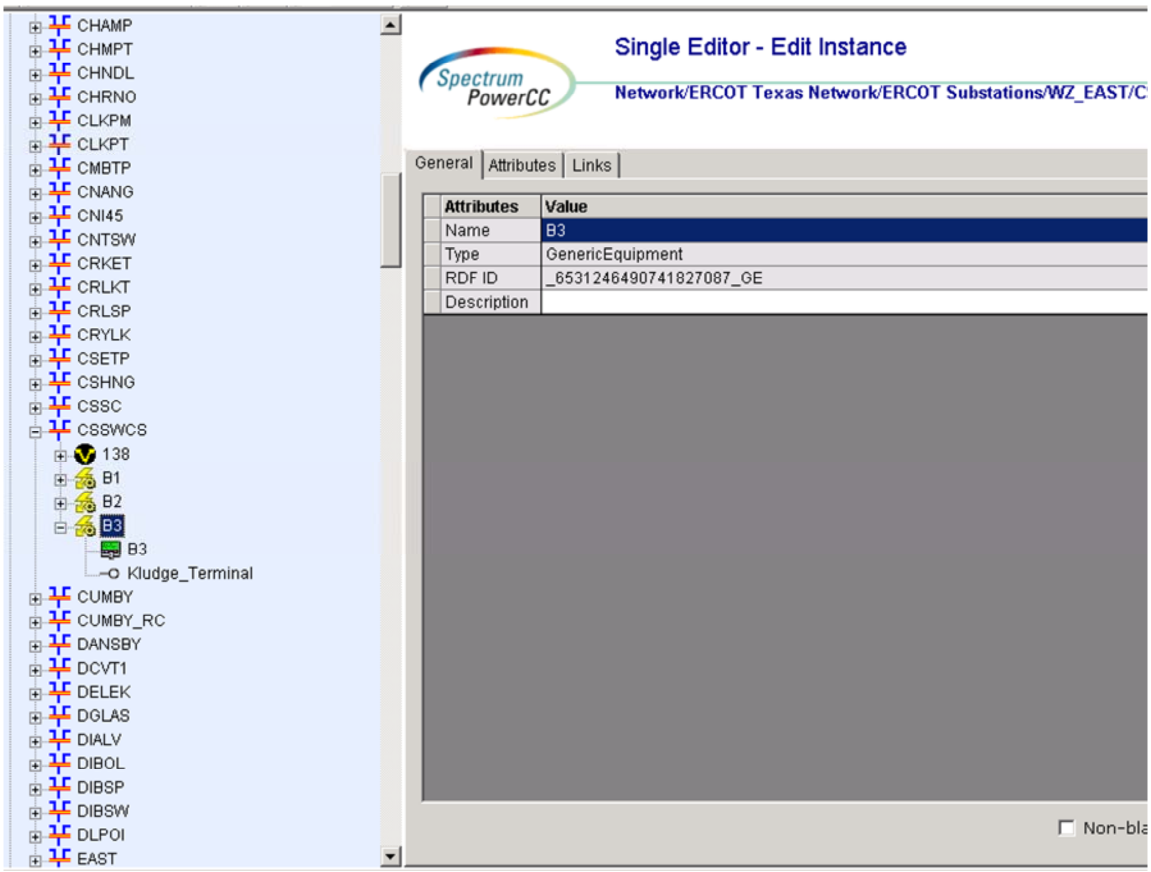


Figure 83 - PseudoTerminal

51.2 ATTRIBUTES

The attributes for a *PseudoTerminal* are shown in the table below.

Attribute	Description	Data Type	Default Value	Sample Data

Alias Name	Free text name of the object or instance.			
Description	Description of the object or instance.			
Edge Val	edgeVal is a concatenation of all edge coordinates.			
From X offset	From X offset			
From X perm	From X perm			
From Y offset	From Y offset			
From Y perm	From Y perm			
height	height			
label height	label height			
label width	label width			
label x co-ordinate	label x co-ordinate			
label y co-ordinate	label y co-ordinate			
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.			
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.			
Near	Flag indicating whether the terminal is a near terminal of a branch.			
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.			

PSS/E Bus Name	Store the PSS¿E bus name that will be associated with the grouping of Connectivity Nodes in Option 2.			
PSS/E Bus Number	Attribute will be used to store the PSS¿E bus number that will be associated with the grouping of Connectivity Nodes in Option 2.			
To X offset	To X offset			
To X perm	To X perm			
To Y offset	To Y offset			
To Y perm	To Y perm			
width	width			
x co-ordinate	x co-ordinate			
y co-ordinate	y co-ordinate			

51.3 LINKAGE

There are no required links for a *PseudoTerminal.*

52 MODELING PLANNING OBJECTS

52.1 MODELING APPROACH FOR PLANNING AREA

The ERCOT CIM model defines a planning area as planning areas.

Planning areas are commonly used to designate sections of the network which represent control areas between which there are scheduled flows. Planning areas will be pre-populated and maintained by ERCOT in the IMM. This data may change with future planning area additions.

The each planning area name and PSS/E ID must be unique within the IMM. These values cannot be duplicated. See figure below as an example.

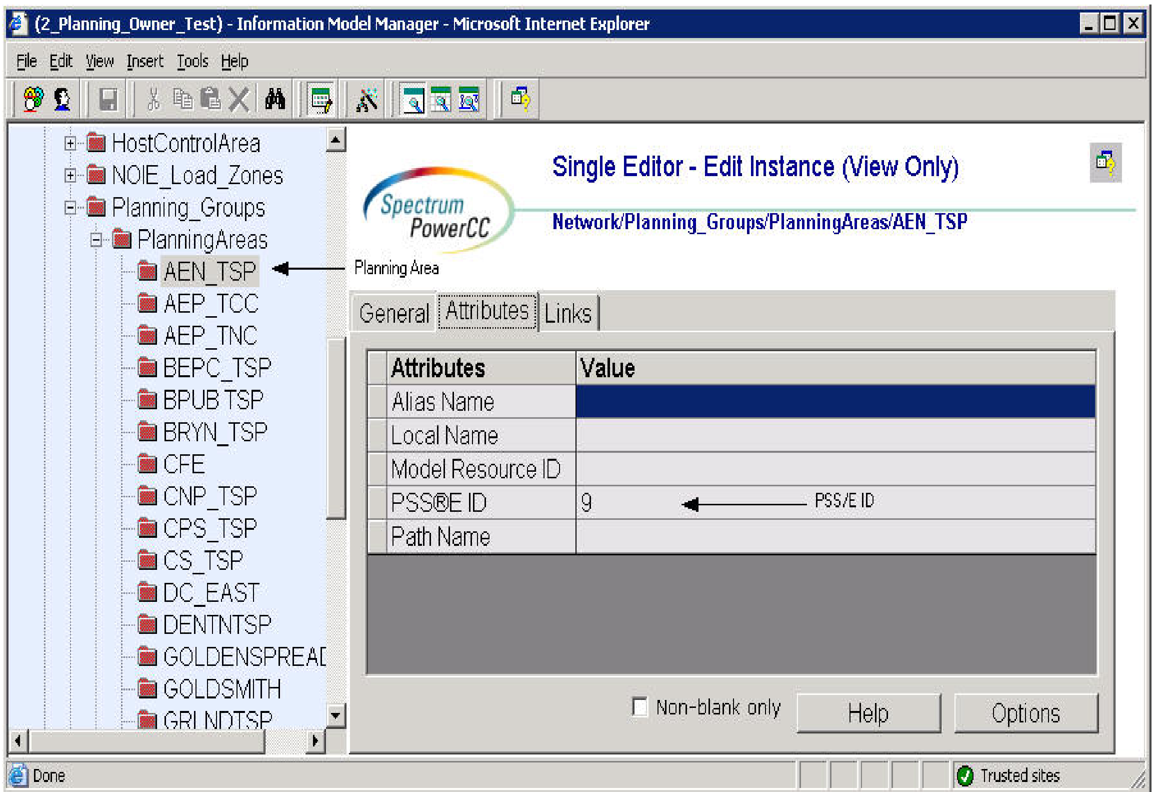


Figure 84 - PlanningArea

52.1.1 Attributes

Attribute	Description	Data Type	Default Value	Sample Data
Alias Name	Free text name of the object or instance.	String	None	

Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.	String	None	
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	Auto-populated	
PSS®E ID	Attribute will give IMM modelers control over the PSS®E ID that the Topology Processor uses to properly name units, loads, branches, and transformers	String	None	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	

52.1.2 Linkage

There are no required links for Planning Area.

52.2 MODELING APPROACH FOR PLANNING ZONES

The ERCOT CIM model defines planning zones as planning zones.

Planners designate buses to specific zones allowing for additional subdivision of the network to facilitate analyses and documentation.

The Planning zones will be pre-populated and maintained by ERCOT in the IMM. This data may change with future planning zones additions.

Each planning zone name and PSS/E ID must be unique within the IMM. These values cannot be duplicated. See figure below as an example.

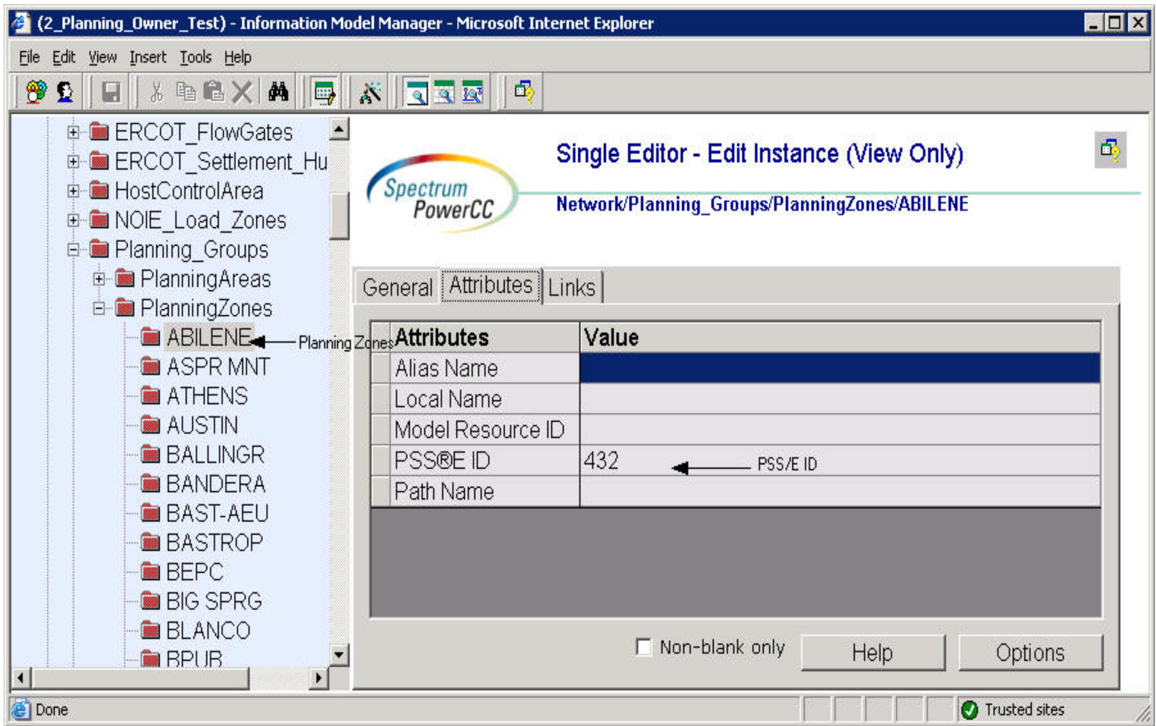


Figure 85 - PlanningZone

52.2.1 Attributes

Attribute	Description	Data Type	Default Value	Sample Data
Alias Name	Free text name of the object or instance.	String	None	
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness	String	None	

	requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.			
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	Auto-populated	
PSS®E ID	Attribute will give IMM modelers control over the PSS®E ID that the Topology Processor uses to properly name units, loads, branches, and transformers	String	None	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	

52.2.2 Linkage

There are no required links for PlanningZones.

52.3 MODELING APPROACH FOR SUBCONTROLAREA

The ERCOT CIM model defines a SubcontrolArea as an area defined for the purpose of tracking interchange with surrounding areas via tie points; may or may not serve as a control area. Right now, the Load area schedules are the same field as subcontrol area. The subcontrol area is a future area for data.

The subcontrol areas will be pre-populated and maintained by ERCOT in the IMM. This data may change with future subcontrol areas additions.

The each Subcontrol area name and PSS/E ID must be unique within the IMM. These values cannot be duplicated. See figure below as an example.

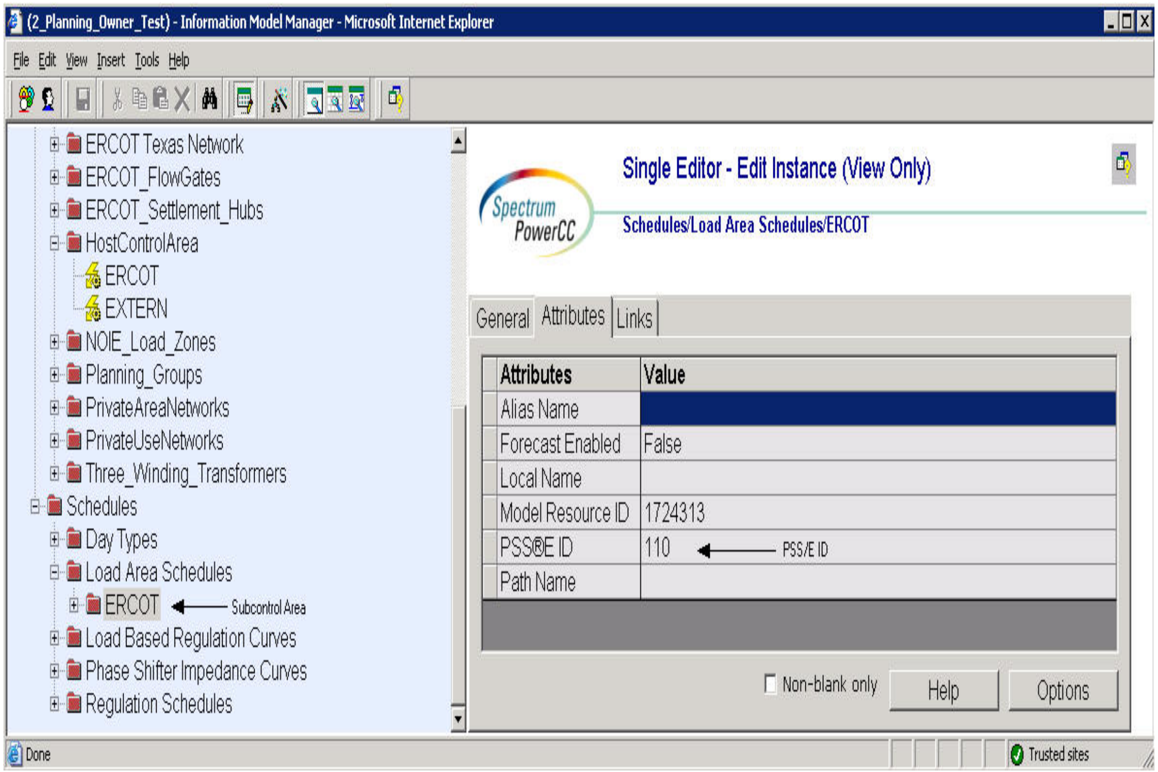


Figure 86 - SubcontrolArea

52.3.1 Attributes

Attribute	Description	Data Type	Default Value	Sample Data
Alias Name	Free text name of the object or instance.	String	None	
Local Name	The localName is a human readable name of the object. It is only used with objects organized in a naming hierarchy. The simplest naming hierarchy has just one parent (the root) giving a flat naming hierarchy. However, the naming hierarchy usually has several levels, e.g. Substation, VoltageLevel, Equipment etc. Children of the same parent have names that are unique among them. If the uniqueness	String	None	

	requirement cannot be met IdentifiedObject.localName shall not be used, use IdentifiedObject.name instead.			
Model Resource ID	A Model Authority issues mRIDs. Given that each Model Authority has a unique id and this id is part of the mRID, then the mRID is globally unique.	Integer	Auto-populated	
PSS®E ID	Attribute will give IMM modelers control over the PSS®E ID that the Topology Processor uses to properly name units, loads, branches, and transformers	String	None	
Path Name	The pathname is a system unique name composed from all IdentifiedObject.names in a standard naming hierarchy path from the object to the root.	String	None	

52.3.2 Linkage

There are no required links to SubcontrolArea.

APPENDIX A - VALIDATION RULES – REQUIRED FIELDS

This appendix lists all of the validation rules for attributes that must be defined for a specific class. It also lists any validation for attributes that must be within a specific value range.

ClassName	Attributes	Required	Range
AccumulatorLimit	value	x	>=0
AccumulatorValue	cstatus	x	
ACLineSegment	r	x	>= -500 and <= 500
ACLineSegment	x	x	>= -1000 and <= 1000
ACLineSegment	teid	x	>=0 and <= 999999999
Address	City	x	
Address	PostalCode	x	
Address	State	x	
Address	Street1	x	
AggregateHub	hubCalculationMethod	x	
AirCompressor	teid	x	>=0 and <= 999999999
AlternateLimit	highLimit	x	
AlternateLimit	lowLimit	x	
Analog	teid	x	>=0 and <= 999999999
AnalogValue	cstatus	x	
AreaReserveSpec	lowerRegMarginReqt	x	>= 0
AreaReserveSpec	opReserveReqt	x	>= 0
AreaReserveSpec	primaryReserveReqt	x	>= 0
AreaReserveSpec	raiseRegMarginReqt	x	>= 0
AreaReserveSpec	spinningReserveReqt	x	>= 0
BasePower	basePower	x	
BaseVoltage	nominalVoltage	x	>=0 and <= 1100
BasicIntervalSchedule	startTime	x	

©2009 Electric Reliability Council of Texas, Inc.

BasicIntervalSchedule	value1Unit	x	
BasicIntervalSchedule	value2Unit	x	
Bay	teid	x	>=0 and <= 999999999
BranchGroup	maximumActivePower	x	
BranchGroup	maximumReactivePower	x	
BranchGroup	minimumReactivePower	x	
BranchGroup	monitorActivePower	x	
BranchGroup	teid	x	>=0 and <= 999999999
BranchGroupTerminal	positiveFlowIn	x	
Breaker	InTransitTime	x	
Breaker	teid	x	>=0 and <= 999999999
BusbarSection	teid	x	>=0 and <= 999999999
BWRSteamSupply	teid	x	>=0 and <= 999999999
CAESPlant	teid	x	>=0 and <= 999999999
CogenerationPlant	teid	x	>=0 and <= 999999999
CombinedCyclePlant	LogicalResourceNodeName	x	
CombinedCyclePlant	teid	x	>=0 and <= 999999999
CombinedCyclePlant	aliasName	x	
CombustionTurbine	teid	x	>=0 and <= 999999999
CommunicationLink	teid	x	>=0 and <= 999999999
Company	companyType	x	
Company	DUNS	x	
Company	PrimaryPhone	x	
Company	teid	x	>=0 and <= 999999999
Company	aliasName	x	
CompositeSwitch	teid	x	>=0 and <= 999999999
ConductingEquipment	teid	x	>=0 and <= 999999999

Conductor	teid	x	>=0 and <= 999999999
Configuration	highReasonabilityLimit	x	>= lowReasonabilityLimit
Configuration	highReasonabilityRamp RateLimit	x	>= lowReasonabilityRampRateLimit
Configuration	hotintTime	x	
Configuration	hotStartTime	x	<= intStartTime
Configuration	intColdTime	x	
Configuration	intStartTime	x	<= coldStartTime
Configuration	lowReasonabilityLimit	x	>= 0
Configuration	lowReasonabilityRampRateLimit	x	
Configuration	maxDailyStarts	x	
Configuration	maxONTime	x	
Configuration	maxWeeklyEnergy	x	
Configuration	maxWeeklyStarts	x	>= maxDailyStarts
Configuration	minOFFTime	x	
Configuration	minONTime	x	<= maxONTime
Configuration	primaryConfiguration	x	
Configuration	qualificationStatus	x	
Configuration	seasonalMaxEmergencyRating	x	>= seasonalMinEmergencyRating
Configuration	seasonalMaxSustainableRating	x	>= seasonalMinSustainableRating
Configuration	seasonalMinEmergencyRating	x	
Configuration	seasonalMinSustainableRating	x	
ConformLoad	conformingLoadFlag	x	
ConformLoad	pfixedPct	x	
ConformLoad	pnomPct	x	
ConformLoad	powerFactor	x	

ConformLoad	qfixed	x	
ConformLoad	qnomPct	x	
ConformLoad	teid	x	>=0 and <= 999999999
ConformLoadSchedule	startTime	x	
ConformLoadSchedule	value1Unit	x	
ConformLoadSchedule	value2Unit	x	
ConformLoadSchedule	aliasName	x	
ConnectivityNode	teid	x	>=0 and <= 999999999
ConnectivityNodeGroup	PSSEBusNumber	x	can not be between 9400-9999 and 94000-99999
ConnectivityNodeGroup	teid	x	>=0 and <= 999999999
Connector	teid	x	>=0 and <= 999999999
Contact	EmailAddress	x	
Contact	FirstName	x	
Contact	LastName	x	
Contact	PrimaryPhone	x	
Contact	City	x	
Contact	PostalCode	x	
Contact	State	x	
Contact	Street1	x	
Contingency	DeviceName	x	
Contingency	DeviceType	x	
ControlHouseEquipment	teid	x	>=0 and <= 999999999
ControllableLoadResource	maxDeploymentTime	x	
ControllableLoadResource	maxWeeklyEnergy	x	
ControllableLoadResource	minNoticeTime	x	
ControllableLoadResource	rampRateSlopeDownLimit	x	

ControllableLoadResource	rampRateSlopeUpLimit	x	
ControllableLoadResource	maxDailyDeployment	x	
ControllableLoadResource	maxInterruptionTime	x	>= minInterruptionTime
ControllableLoadResource	maxWeeklyDeployment	x	>= maxDailyDeployment
ControllableLoadResource	minInterruptionTime	x	
ControllableLoadResource	minRestorationTime	x	
ControllableLoadResource	teid	x	>=0 and <= 999999999
ControllableLoadResource	aliasName	x	
CurrentRelay	teid	x	>=0 and <= 999999999
Curve	curveStyle	x	
Curve	xUnit	x	
Curve	y1Unit	x	
Curve	y2Unit	x	
CurveData	xvalue	x	
CurveData	y1value	x	
CurveData	y2value	x	
CustomerLoad	conformingLoadFlag	x	
CustomerLoad	pfixedPct	x	
CustomerLoad	pnomPct	x	
CustomerLoad	qfixed	x	
CustomerLoad	qnomPct	x	
CustomerLoad	teid	x	>=0 and <= 999999999
DayType	FriFlag	x	
DayType	MonFlag	x	
DayType	SatFlag	x	
DayType	SunFlag	x	
DayType	ThursFlag	x	

DayType	TuesFlag	x	
DayType	WedFlag	x	
DCLineSegment	r	x	
DCLineSegment	teid	x	>=0 and <= 999999999
DCTie	DCTieLZName	x	
Disconnector	initiallyOpen	x	
Disconnector	normalOpen	x	
Disconnector	teid	x	>=0 and <= 999999999
Discrete	teid	x	>=0 and <= 999999999
DiscreteValue	cstatus	x	
DrumBoiler	teid	x	>=0 and <= 999999999
EndCap	teid	x	>=0 and <= 999999999
EnergyConsumer	conformingLoadFlag	x	
EnergyConsumer	pfixedPct	x	
EnergyConsumer	pnomPct	x	
EnergyConsumer	qfixed	x	
EnergyConsumer	qnomPct	x	
EnergyConsumer	teid	x	>=0 and <= 999999999
EnergyConsumer AltConnection	percentTransfer	x	
EnergyConsumerResource	maxDailyDeployment	x	
EnergyConsumerResource	maxInterruptionTime	x	<= minInterruptionTime
EnergyConsumerResource	maxWeeklyDeployment	x	>= maxDailyDeployment
EnergyConsumerResource	minInterruptionTime	x	
EnergyConsumerResource	minRestorationTime	x	
EnergyConsumerResource	teid	x	>=0 and <= 999999999
EPSMeter	AcceptedStatus	x	
EPSMeter	RID	x	

©2009 Electric Reliability Council of Texas, Inc.

EPSMeter	teid	x	>=0 and <= 999999999
Equipment	teid	x	>=0 and <= 999999999
EquipmentContainer	teid	x	>=0 and <= 999999999
EquivalentSource	teid	x	>=0 and <= 999999999
ERCOTVersion	ContactEmail	x	
ERCOTVersion	ContactPhoneNumber	x	
ERCOTVersion	date	x	
ERCOTVersion	ModelAdmin	x	
ERCOTVersion	version	x	
Feeder	teid	x	>=0 and <= 999999999
FlowgateElement	biddable	x	
FlowgateElement	endDate	x	
FlowgateElement	monitored	x	
FlowgateElement	rating	x	
FlowgateElement	startDate	x	
FlowgateGroup	infB	x	
FlowgateGroup	infC	x	
FlowgateGroup	teid	x	>=0 and <= 999999999
FossilSteamSupply	teid	x	>=0 and <= 999999999
FrequencyConverter	teid	x	>=0 and <= 999999999
FrequencyRelay	teid	x	>=0 and <= 999999999
Fuse	initiallyOpen	x	
Fuse	normalOpen	x	
Fuse	teid	x	>=0 and <= 999999999
Gate	thresholdValue	x	
GeneratingUnit	coldStartTime	x	
GeneratingUnit	controlPulseHigh	x	

GeneratingUnit	controlPulseLow	x	
GeneratingUnit	controlResponseRate	x	
GeneratingUnit	efficiency	x	>= 0.001 and <= 2
GeneratingUnit	freqBias	x	
GeneratingUnit	freqDevDeadband	x	
GeneratingUnit	governorMPL	x	
GeneratingUnit	governorSCD	x	
GeneratingUnit	highReasonabilityLimit	x	>= lowReasonabilityLimit
GeneratingUnit	highReasonabilityRamp RateLimit	x	>= lowReasonabilityRampRateLimit
GeneratingUnit	hotintTime	x	
GeneratingUnit	hotStartTime	x	<= intStartTime
GeneratingUnit	intColdTime	x	
GeneratingUnit	intStartTime	x	<= coldStartTime
GeneratingUnit	lowReasonabilityLimit	x	>= 0
GeneratingUnit	lowReasonabilityRamp RateLimit	x	
GeneratingUnit	maxDailyStarts	x	
GeneratingUnit	maximumOperatingMW	x	equal to highReasonabilityLimit
GeneratingUnit	maxONTime	x	
GeneratingUnit	maxWeeklyEnergy	x	
GeneratingUnit	maxWeeklyStarts	x	>= maxDailyStarts
GeneratingUnit	minimumOperatingMW	x	equal to lowReasonabilityLimit
GeneratingUnit	minOFFTime	x	
GeneratingUnit	minONTime	x	<= maxONTime
GeneratingUnit	modelDetail	x	
GeneratingUnit	penaltyFactor	x	

©2009 Electric Reliability Council of Texas, Inc.

GeneratingUnit	seasonalMaxSustainableRating	x	>= seasonalMinSustainableRating
GeneratingUnit	seasonalMinEmergencyRating	x	
GeneratingUnit	seasonalMinSustainableRating	x	
GeneratingUnit	stepChange	x	
GeneratingUnit	teid	x	>=0 and <= 999999999
GenericEquipment	teid	x	>=0 and <= 999999999
GenericUnderfrequency Relay	relayDelayTime	x	
GenericUnderfrequency Relay	teid	x	>=0 and <= 999999999
Ground	teid	x	>=0 and <= 999999999
GroundDisconnector	initiallyOpen	x	
GroundDisconnector	normalOpen	x	
GroundDisconnector	teid	x	>=0 and <= 999999999
HeatExchanger	teid	x	>=0 and <= 999999999
HeatRecoveryBoiler	teid	x	>=0 and <= 999999999
HostControlArea	areaControlMode	x	
HostControlArea	forGeneration	x	
HostControlArea	forNetwork	x	
HostControlArea	teid	x	>=0 and <= 999999999
HydroGeneratingUnit	coldStartTime	x	
HydroGeneratingUnit	controlPulseHigh	x	
HydroGeneratingUnit	controlPulseLow	x	
HydroGeneratingUnit	controlResponseRate	x	
HydroGeneratingUnit	efficiency	x	>= 0.001 and <= 1.2
HydroGeneratingUnit	freqBias	x	
HydroGeneratingUnit	freqDevDeadband	x	

HydroGeneratingUnit	governorMPL	x	
HydroGeneratingUnit	governorSCD	x	
HydroGeneratingUnit	highReasonabilityLimit	x	>= lowReasonabilityLimit
HydroGeneratingUnit	highReasonabilityRampRateLimit	x	>= lowReasonabilityRampRateLimit
HydroGeneratingUnit	hotintTime	x	
HydroGeneratingUnit	hotStartTime	x	<= intStartTime
HydroGeneratingUnit	intColdTime	x	
HydroGeneratingUnit	intStartTime	x	<= coldStartTime
HydroGeneratingUnit	lowReasonabilityLimit	x	>= 0
HydroGeneratingUnit	lowReasonabilityRampRateLimit	x	
HydroGeneratingUnit	maxDailyStarts	x	
HydroGeneratingUnit	maximumOperatingMW	x	equal to highReasonabilityLimit
HydroGeneratingUnit	maxONTime	x	
HydroGeneratingUnit	maxWeeklyEnergy	x	
HydroGeneratingUnit	maxWeeklyStarts	x	>= maxDailyStarts
HydroGeneratingUnit	minimumOperatingMW	x	>=0 and <= 999 and equal to lowReasonabilityLimit
HydroGeneratingUnit	minOFFTime	x	
HydroGeneratingUnit	minONTime	x	<= maxONTime
HydroGeneratingUnit	modelDetail	x	
HydroGeneratingUnit	penaltyFactor	x	
HydroGeneratingUnit	seasonalMaxSustainableRating	x	>= seasonalMinSustainableRating
HydroGeneratingUnit	seasonalMinEmergencyRating	x	
HydroGeneratingUnit	seasonalMinSustainableRating	x	
HydroGeneratingUnit	stepChange	x	
HydroGeneratingUnit	teid	x	>=0 and <= 999999999

©2009 Electric Reliability Council of Texas, Inc.

HydroPowerPlant	teid	x	>=0 and <= 999999999
HydroPump	teid	x	>=0 and <= 999999999
HydroTurbine	teid	x	>=0 and <= 999999999
InductionMotorLoad	conformingLoadFlag	x	
InductionMotorLoad	pfixedPct	x	
InductionMotorLoad	pnomPct	x	
InductionMotorLoad	qfixed	x	
InductionMotorLoad	qnomPct	x	
InductionMotorLoad	teid	x	>=0 and <= 999999999
IrregularIntervalSchedule	startTime	x	
IrregularIntervalSchedule	value1Unit	x	
IrregularIntervalSchedule	value2Unit	x	
IrregularTimePoint	time	x	
IrregularTimePoint	value1	x	
IrregularTimePoint	value2	x	
Jumper	initiallyOpen	x	
Jumper	normalOpen	x	
Jumper	teid	x	>=0 and <= 999999999
Junction	teid	x	>=0 and <= 999999999
LevelVsVolumeCurve	curveStyle	x	
LevelVsVolumeCurve	xUnit	x	
LevelVsVolumeCurve	y1Unit	x	
LevelVsVolumeCurve	y2Unit	x	
Line	teid	x	>=0 and <= 999999999
Load	conformingLoadFlag	x	
Load	pfixedPct	x	
Load	pnomPct	x	

©2009 Electric Reliability Council of Texas, Inc.

Load	qfixedPct	x	
Load	qnomPct	x	
Load	teid	x	>=0 and <= 999999999
LoadBasedRegulation Curve	curveStyle	x	
LoadBasedRegulation Curve	xUnit	x	
LoadBasedRegulation Curve	y1Unit	x	
LoadBasedRegulation Curve	y2Unit	x	
LoadBasedRegulation Curve	aliasName	x	
LoadBreakSwitch	initiallyOpen	x	
LoadBreakSwitch	normalOpen	x	
LoadBreakSwitch	teid	x	>=0 and <= 999999999
LoadDemandModel	startTime	x	
LoadDemandModel	value1Unit	x	
LoadDemandModel	value2Unit	x	
LoadResource	maxWeeklyEnergy	x	
LoadResource	minNoticeTime	x	
LoadResource	maxDailyDeployment	x	
LoadResource	maxInterruptionTime	x	>= minInterruptionTime
LoadResource	maxWeeklyDeployment	x	>= maxDailyDeployment
LoadResource	minInterruptionTime	x	
LoadResource	teid	x	>=0 and <= 999999999
LoadResource	aliasName	x	
MeasurementArgument	referenceName	x	Required if ReferenceFlag = True
MeasurementValue	cstatus	x	

MeasurementValueQuality	hasCOV	x
MeasurementValueQuality	hasQuality	x
MeasurementValueQuality	hasTimestamp	x
MeasurementValueSource	biverAus	x
MeasurementValueSource	biverTay	x
MeasurementValueSource	BufferTime	x
MeasurementValueSource	defaultDataSetPeriod	x
MeasurementValueSource	GraceTime	x
MeasurementValueSource	iccpDomainAus	x
MeasurementValueSource	iccpDomainTay	x
MeasurementValueSource	IntegrityPeriod	x
MeasurementValueSource	lnkapp	x
MeasurementValueSource	MaxDisPerDataset	x
MeasurementValueSource	maxScanRate	x
MeasurementValueSource	protocolVersion	x
MeasurementValueSource	remoteIdAus	x
MeasurementValueSource	remoteIdTay	x
MeasurementValueSource	savecaseType	x
MeasurementValueSource	trsfr	x
ModelVersion	date	x
ModelVersion	information	x
ModelVersion	version	x
MVArCapabilityCurve	curveStyle	x
MVArCapabilityCurve	xUnit	x
MVArCapabilityCurve	y1Unit	x
MVArCapabilityCurve	y2Unit	x
MVArCapabilityCurve	aliasName	x

NonConformLoad	conformingLoadFlag	x	
NonConformLoad	pfixedPct	x	
NonConformLoad	pnomPct	x	
NonConformLoad	qfixedPct	x	
NonConformLoad	qnomPct	x	
NonConformLoad	teid	x	>=0 and <= 999999999
NuclearGeneratingUnit	coldStartTime	x	
NuclearGeneratingUnit	controlPulseHigh	x	
NuclearGeneratingUnit	controlPulseLow	x	
NuclearGeneratingUnit	controlResponseRate	x	
NuclearGeneratingUnit	efficiency	x	>= 0.001 and <= 1.2
NuclearGeneratingUnit	freqBias	x	
NuclearGeneratingUnit	freqDevDeadband	x	
NuclearGeneratingUnit	governorMPL	x	
NuclearGeneratingUnit	governorSCD	x	
NuclearGeneratingUnit	highReasonabilityLimit	x	>= lowReasonabilityLimit
NuclearGeneratingUnit	highReasonabilityRampRateLimit	x	>= lowReasonabilityRampRateLimit
NuclearGeneratingUnit	hotintTime	x	
NuclearGeneratingUnit	hotStartTime	x	<= intStartTime
NuclearGeneratingUnit	intColdTime	x	
NuclearGeneratingUnit	intStartTime	x	<= coldStartTime
NuclearGeneratingUnit	lowReasonabilityLimit	x	>= 0
NuclearGeneratingUnit	lowReasonabilityRampRateLimit	x	
NuclearGeneratingUnit	maxDailyStarts	x	
NuclearGeneratingUnit	maximumOperatingMW	x	equal to highReasonabilityLimit
NuclearGeneratingUnit	maxONTime	x	
NuclearGeneratingUnit	maxWeeklyEnergy	x	

NuclearGeneratingUnit	maxWeeklyStarts	x	>= maxDailyStarts
NuclearGeneratingUnit	minimumOperatingMW	x	equal to lowReasonabilityLimit
NuclearGeneratingUnit	minOFFTime	x	
NuclearGeneratingUnit	minONTime	x	<= maxONTime
NuclearGeneratingUnit	modelDetail	x	
NuclearGeneratingUnit	penaltyFactor	x	
NuclearGeneratingUnit	seasonalMaxSustainableRating	x	>= seasonalMinSustainableRating
NuclearGeneratingUnit	seasonalMinEmergencyRating	x	
NuclearGeneratingUnit	seasonalMinSustainableRating	x	
NuclearGeneratingUnit	stepChange	x	
NuclearGeneratingUnit	teid	x	>=0 and <= 999999999
OwnerShareLimits	highReasonabilityLimit	x	>= lowReasonabilityLimit
OwnerShareLimits	lowReasonabilityLimit	x	
OwnerShareLimits	maxWeeklyEnergy	x	
OwnerShareLimits	teid	x	>=0 and <= 999999999
OwnerShareLimits	aliasName	x	
OwnerShareRating	teid	x	>=0 and <= 999999999
Ownership	ownPercent	x	>= 0 and <= 100
Ownership	teid	x	>=0 and <= 999999999
PenstockLossCurve	curveStyle	x	
PenstockLossCurve	xUnit	x	
PenstockLossCurve	y1Unit	x	
PenstockLossCurve	y2Unit	x	
PhaseShifterImpedance Curve	curveStyle	x	
PhaseShifterImpedance Curve	xUnit	x	

PhaseShifterImpedance Curve	y1Unit	x	
PhaseShifterImpedance Curve	y2Unit	x	
PhaseShifterImpedance Curve	aliasName	x	
PhysicalTiePoint	teid	x	>=0 and <= 999999999
PlanningBay	teid	x	>=0 and <= 999999999
Plant	teid	x	>=0 and <= 999999999
PowerCutZone	teid	x	>=0 and <= 999999999
PowerSystemResource	teid	x	>=0 and <= 999999999
PowerTransformer	bmagSat	x	
PowerTransformer	transformerType	x	
PowerTransformer	voltageSensitivity	x	
PowerTransformer	teid	x	>=0 and <= 999999999
PricingVector	teid	x	>=0 and <= 999999999
PrimeMover	teid	x	>=0 and <= 999999999
ProtectedSwitch	initiallyOpen	x	
ProtectedSwitch	normalOpen	x	
ProtectedSwitch	teid	x	>=0 and <= 999999999
ProtectionEquipment	teid	x	>=0 and <= 999999999
PseudoCompany	teid	x	>=0 and <= 999999999
PWRSteamSupply	teid	x	>=0 and <= 999999999
RampRateCurve	Emergency	x	
RampRateCurve	curveStyle	x	
RampRateCurve	xUnit	x	
RampRateCurve	y1Unit	x	
RampRateCurve	y2Unit	x	
RampRateCurve	aliasName	x	

Rating	ratingType	x	
Rating	TempPoint	x	
Rating	forNetwork	x	
RectifierInverter	teid	x	>=0 and <= 999999999
RegularIntervalSchedule	startTime	x	
RegularIntervalSchedule	value1Unit	x	
RegularIntervalSchedule	value2Unit	x	
RegulatingCondEq	teid	x	>=0 and <= 999999999
RegulationSchedule	startTime	x	
RegulationSchedule	value1Unit	x	
RegulationSchedule	value2Unit	x	
RemedialActionScheme	active	x	
RemedialActionScheme	isRAP	x	
RemedialActionScheme	isRAS	x	
RemoteUnit	teid	x	>=0 and <= 999999999
Reservoir	teid	x	>=0 and <= 999999999
ResourceController	externalJointUnit	x	
ResourceController	frequencyBias	x	
ResourceController	gross	x	
ResourceController	jointUnit	x	
ResourceController	physical	x	
ResourceController	teid	x	>=0 and <= 999999999
SeasonDayTypeSchedule	startTime	x	
SeasonDayTypeSchedule	value1Unit	x	
SeasonDayTypeSchedule	value2Unit	x	
SeriesCompensator	r	x	
SeriesCompensator	x	x	

SeriesCompensator	teid	x	>=0 and <= 999999999
ShuntCompensator	aVRDelay	x	
ShuntCompensator	maximumkV	x	
ShuntCompensator	minimumkV	x	
ShuntCompensator	nominalkV	x	
ShuntCompensator	nominalMVAr	x	
ShuntCompensator	switchingPriority	x	
ShuntCompensator	voltSensitivity	x	
ShuntCompensator	avrEnabled	x	
ShuntCompensator	teid	x	>=0 and <= 999999999
StaticVarCompensator	b	x	
StaticVarCompensator	capacitiveRating	x	> 0
StaticVarCompensator	fixedMVAr	x	< 0
StaticVarCompensator	highVoltageChangeThreshold	x	
StaticVarCompensator	inductiveRating	x	< 0
StaticVarCompensator	lowVoltageChangeThreshold	x	
StaticVarCompensator	maximumkV	x	
StaticVarCompensator	minimumkV	x	
StaticVarCompensator	steadyStateMVARMax	x	postContingencyMVARMax >steadyStateMVARMax > steadyStateMVARMin > postContingencyMVARMin
StaticVarCompensator	steadyStateMVARMin	x	postContingencyMVARMax >steadyStateMVARMax > steadyStateMVARMin > postContingencyMVARMin
StaticVarCompensator	teid	x	>=0 and <= 999999999

StationSupply	conformingLoadFlag	x	
StationSupply	pfixedPct	x	
StationSupply	pnomPct	x	
StationSupply	qfixed	x	
StationSupply	qnomPct	x	
StationSupply	teid	x	>=0 and <= 999999999
StationSupplyWRCurve	aliasName	x	
SteamSupply	teid	x	>=0 and <= 999999999
SteamTurbine	teid	x	>=0 and <= 999999999
SubControlArea	ControlAreaNumber	x	
SubControlArea	teid	x	>=0 and <= 999999999
Subcritical	teid	x	>=0 and <= 999999999
SubGeographicalRegion	isWeatherZone	x	
SubGeographicalRegion	aliasName	x	if isWeatherZone=true
Substation	forNetwork	x	
Substation	forScada	x	
Substation	teid	x	>=0 and <= 999999999
Supercritical	teid	x	>=0 and <= 999999999
Switch	teid	x	>=0 and <= 999999999
SynchrocheckRelay	teid	x	>=0 and <= 999999999
SynchronousMachine	baseMVAr	x	
SynchronousMachine	inertia	x	
SynchronousMachine	maximumKV	x	>=0 and <= 1100
SynchronousMachine	maximumMVAr	x	
SynchronousMachine	minimumKV	x	>=0 and <= 1100
SynchronousMachine	minimumMVAr	x	
SynchronousMachine	r	x	

©2009 Electric Reliability Council of Texas, Inc.

SynchronousMachine	ratedMVA	x	>= maximumMVAr
SynchronousMachine	x	x	>=0 and <= 500
SynchronousMachine	xSubtrans	x	
SynchronousMachine	xTrans	x	
SynchronousMachine	teid	x	>=0 and <= 999999999
TapChanger	avrEnabled	x	
TapChanger	awrEnabled	x	
TapChanger	highStep	x	>=0 and <= 99
TapChanger	initialDelay	x	
TapChanger	lowStep	x	>=0 and <= 99
TapChanger	maximumkV	x	
TapChanger	minimumkV	x	
TapChanger	neutralAngle	x	
TapChanger	neutralKV	x	>=0 and <= 1100
TapChanger	neutralStep	x	>=0 and <= 99
TapChanger	normalStep	x	>=-99 and <= 99 , >= lowStep and <= highStep
TapChanger	stepVoltageIncrement	x	>=0 and <= 100
TapChanger	subsequentDelay	x	
TapChanger	teid	x	>=0 and <= 999999999
ThermalGeneratingUnit	coldStartTime	x	
ThermalGeneratingUnit	controlPulseHigh	x	
ThermalGeneratingUnit	controlPulseLow	x	
ThermalGeneratingUnit	controlResponseRate	x	
ThermalGeneratingUnit	efficiency	x	>= 0.001 and <= 1.2
ThermalGeneratingUnit	freqBias	x	
ThermalGeneratingUnit	freqDevDeadband	x	

ThermalGeneratingUnit	governorMPL	x	
ThermalGeneratingUnit	governorSCD	x	
ThermalGeneratingUnit	highReasonabilityLimit	x	>= lowReasonabilityLimit
ThermalGeneratingUnit	highReasonabilityRampRateLimit	x	>= lowReasonabilityRampRateLimit
ThermalGeneratingUnit	hotintTime	x	
ThermalGeneratingUnit	hotStartTime	x	<= intStartTime
ThermalGeneratingUnit	intColdTime	x	
ThermalGeneratingUnit	intStartTime	x	<= coldStartTime
ThermalGeneratingUnit	lowReasonabilityLimit	x	>= 0
ThermalGeneratingUnit	lowReasonabilityRampRateLimit	x	
ThermalGeneratingUnit	maxDailyStarts	x	
ThermalGeneratingUnit	maximumOperatingMW	x	equal to highReasonabilityLimit
ThermalGeneratingUnit	maxONTime	x	
ThermalGeneratingUnit	maxWeeklyEnergy	x	
ThermalGeneratingUnit	maxWeeklyStarts	x	>= maxDailyStarts
ThermalGeneratingUnit	minimumOperatingMW	x	>=0 and <= 999 and equal to lowReasonabilityLimit
ThermalGeneratingUnit	minOFFTime	x	
ThermalGeneratingUnit	minONTime	x	<= maxONTime
ThermalGeneratingUnit	modelDetail	x	
ThermalGeneratingUnit	penaltyFactor	x	
ThermalGeneratingUnit	seasonalMaxSustainableRating	x	>= seasonalMinSustainableRating
ThermalGeneratingUnit	seasonalMinEmergencyRating	x	
ThermalGeneratingUnit	seasonalMinSustainableRating	x	
ThermalGeneratingUnit	stepChange	x	
ThermalGeneratingUnit	teid	x	>=0 and <= 999999999

TieCorridor	teid	x	>=0 and <= 999999999
TieEnd	teid	x	>=0 and <= 999999999
TieLine	teid	x	>=0 and <= 999999999
TransformerWinding	b	x	>=-100 and <= 100
TransformerWinding	connectionType	x	
TransformerWinding	emergencyMVA	x	<= shortTermMVA
TransformerWinding	g	x	>=0 and <= 999
TransformerWinding	grounded	x	
TransformerWinding	r	x	>=-50 and <= 500
TransformerWinding	r0	x	>=-5000 and <= 5000
TransformerWinding	ratedMVA	x	
TransformerWinding	rground	x	>=0 and <= 10
TransformerWinding	shortTermMVA	x	
TransformerWinding	x	x	>= -1000 and <= 1000
TransformerWinding	x0	x	>= -10000 and <= 10000
TransformerWinding	teid	x	>=0 and <= 999999999
VoltageControlZone	teid	x	>=0 and <= 999999999
VoltageLevel	teid	x	>=0 and <= 999999999
VoltageRelay	teid	x	>=0 and <= 999999999
WindGeneratingUnit	coldStartTime	x	
WindGeneratingUnit	controlPulseHigh	x	
WindGeneratingUnit	controlPulseLow	x	
WindGeneratingUnit	controlResponseRate	x	
WindGeneratingUnit	efficiency	x	>= 0.001 and <= 1.2
WindGeneratingUnit	freqBias	x	
WindGeneratingUnit	freqDevDeadband	x	
WindGeneratingUnit	governorMPL	x	

WindGeneratingUnit	governorSCD	x	
WindGeneratingUnit	highReasonabilityLimit	x	>= lowReasonabilityLimit
WindGeneratingUnit	highReasonabilityRampRateLimit	x	>= lowReasonabilityRampRateLimit
WindGeneratingUnit	hotintTime	x	
WindGeneratingUnit	hotStartTime	x	<= intStartTime
WindGeneratingUnit	intColdTime	x	
WindGeneratingUnit	intStartTime	x	<= coldStartTime
WindGeneratingUnit	lowReasonabilityLimit	x	>= 0
WindGeneratingUnit	lowReasonabilityRampRateLimit	x	
WindGeneratingUnit	maxDailyStarts	x	
WindGeneratingUnit	maximumOperatingMW	x	equal to highReasonabilityLimit
WindGeneratingUnit	maxONTime	x	
WindGeneratingUnit	maxWeeklyEnergy	x	
WindGeneratingUnit	maxWeeklyStarts	x	>= maxDailyStarts
WindGeneratingUnit	minimumOperatingMW	x	>=0 and <= 999 and equal to lowReasonabilityLimit
WindGeneratingUnit	minOFFTime	x	
WindGeneratingUnit	minONTime	x	<= maxONTime
WindGeneratingUnit	modelDetail	x	
WindGeneratingUnit	penaltyFactor	x	
WindGeneratingUnit	seasonalMaxSustainableRating	x	>= seasonalMinSustainableRating
WindGeneratingUnit	seasonalMinEmergencyRating	x	
WindGeneratingUnit	seasonalMinSustainableRating	x	
WindGeneratingUnit	stepChange	x	
WindGeneratingUnit	teid	x	>=0 and <= 999999999

©2009 Electric Reliability Council of Texas, Inc.

APPENDIX B - VALIDATION RULES – REQUIRED ASSOCIATIONS

This appendix lists all of the validation rules for associations that must be defined for a specific class.

ClassA	ClassB
Accumulator	MeasurementType
Accumulator	Operatorship
Accumulator	Ownership
Accumulator	Terminal
Accumulator	Unit
AccumulatorLimitSet	Accumulator
AccumulatorValue	MeasurementGroup
AccumulatorValue	MeasurementValueSource
AccumulatorValue	PermissionArea
AccumulatorValue	RemoteSource
ACLineSegment	BaseVoltage
ACLineSegment	Operatorship
ACLineSegment	Ownership
AggregateHub	SettlementHUB
AlternateLimit	AlternateLimitSet
Analog	Operatorship
Analog	Ownership
Analog	Unit
AnalogLimit	AnalogLimitSet
AnalogLimitSet	Analog
AngleDifference	MonitoredGroup
Bay	Operatorship
Bay	Ownership
BranchGroup	MonitoredGroup
Breaker	Operatorship
Breaker	Ownership
BusbarSection	BaseVoltage
BusbarSection	Operatorship
BusbarSection	Ownership
BWRSteamSupply	Operatorship
BWRSteamSupply	Ownership
CAESPlant	Operatorship
CAESPlant	Ownership
CogenerationPlant	Operatorship
CogenerationPlant	Ownership
CombinedCyclePlant	Operatorship
CombinedCyclePlant	Ownership
CombustionTurbine	Operatorship
CombustionTurbine	Ownership
ConformLoad	ConformLoadGroup
ConnectivityNode	EquipmentContainer
Connector	Operatorship
Connector	Ownership
ControllableLoadResource	Operatorship

ControllableLoadResource	Ownership
ControllableLoadResource	Operatorship
ControllableLoadResource	Ownership
CurrentRelay	Operatorship
CurrentRelay	Ownership
CurveData	Curve
CustomerLoad	ConformLoadGroup
CustomerLoad	Operatorship
CustomerLoad	Ownership
Disconnector	Operatorship
Disconnector	Ownership
Discrete	MeasurementType
Discrete	Operatorship
Discrete	Ownership
Discrete	Unit
EndCap	EquipmentContainer
EndCap	Operatorship
EndCap	Ownership
EnergyConsumerResource	Operatorship
EnergyConsumerResource	Ownership
EPSMeter	PricingVector
FlowgateGroup	MonitoredGroup
HydroGeneratingUnit	Operatorship
HydroGeneratingUnit	Ownership
InductionMotorLoad	Operatorship
InductionMotorLoad	Ownership
Junction	Operatorship
Load	ConformLoadGroup
Load	EquipmentContainer
Load	Operatorship
Load	Ownership
LoadResource	EnergyConsumer
LoadResource	Operatorship
Measurement	Unit
MeasurementLocation	PermissionArea
Monitored	MonitoredGroup
MonitoredRating	MonitoredGroup
MVArCapabilityCurve	SynchronousMachine
NuclearGeneratingUnit	Operatorship
NuclearGeneratingUnit	Ownership
OwnerShareLimits	Operatorship
OwnerShareLimits	Ownership
PowerTransformer	Operatorship
ResourceController	Operatorship
ResourceController	Ownership
SeriesCompensator	Operatorship
SeriesCompensator	Ownership
SettlementLoadZone	Substation

ShuntCompensator	Operatorship
ShuntCompensator	Ownership
StaticVarCompensator	Operatorship
StaticVarCompensator	Ownership
StationSupply	Operatorship
StationSupply	Ownership
StringMeasurement	Unit
StringMeasurementValue	PermissionArea
SubGeographicalRegion	GeographicalRegion
Substation	SubGeographicalRegion
Substation	Operatorship
Substation	Ownership
SynchronousMachine	Operatorship
SynchronousMachine	Ownership
TapChanger	Operatorship
TapChanger	Ownership
ThermalGeneratingUnit	CombinedCyclePlant
ThermalGeneratingUnit	Operatorship
ThermalGeneratingUnit	Ownership
TransformerWinding	Operatorship
TransformerWinding	Ownership
TransmissionPath	ServicePoint
TransmissionPath	ServicePoint
VLSBusBarMonitored	MonitoredGroup
VoltageLevel	Substation
VoltageLevel	Operatorship
VoltageLevel	Ownership
VoltageMonitored	MonitoredGroup
WindGeneratingUnit	Operatorship
WindGeneratingUnit	Ownership

APPENDIX C - VALIDATION RULES – COMPLEX RULES

This appendix lists all of the validation rules that are more complex than required fields and range checks. These include validation rules that are conditional based upon certain conditions, involve associations with other attributes, and those that describe specific data relationships. The validation rule is explained descriptively and not in a formal language.

Rule No.	Validation Rule
R1	The abstract classes GeneratingUnit, Switch, EnergyConsumer,EnergyCosumerResource should not be used. Only the classes representing the actual classes should be used. For ex: Only instances of ThermalGeneratingUnit, NuclearGeneratingUnit, HydroGeneratingUnit or WindGeneratingUnit should be created instead of the generic GeneratingUnit Class
R2	Each PowerTransformer and its associated TransformerWindings and TapChangers must be contained within one substation.
R3	A PowerTransformer must be contained by a Substation. A TransformerWinding must be contained by a PowerTransformer. A TapChanger must be contained by a TransformerWinding(Check for associations between transformer, winding and tap.
R4	A Measurement must be associated with a PowerSystemResource to convey containment information for the Measurement.
R5	Transmission line measurements should be associated with an ACLineSegment or SeriesCompensator not with a Line. Transmission line measurements must be associated with a terminal.
R6	Transformer measurements should be associated with a PowerTransformer. Transformer Windings should not have measurements.
R7	A Measurement can be associated with at most one Terminal.
R8	Combined Cycle configuration names should be unique for each Combined Cycle Plant.
R9	ConnectivityNodes may only be placed within ConnectivityNodeGroup.
R10	SynchronousMachine's minimumMVAr and maximumMVAr attributes and the minimum/maximum MVAr value specified in the associated MVArCapabilityCurve data should match.
R11	Terminals connected to the same piece of Equipment can not be connected to the same connectivitynode
R12	Voltage Levels can't be empty. There should always be classes associated to voltage levels.
R13	The normal and neutral tap of the transformer must be within low and high steps

©2009 Electric Reliability Council of Texas, Inc.

R14 If there are 2 identical transformers in parallel with one marked Master and the other as Follower , the tap changer of the follower should always point towards the master tapchanger and not to itself.

R15 Connectivity nodes must be associated to atleast 2 terminals.

R16 Terminal associated to a any given equipment should have unique names.

R17 ACLinesegment cannot go between different voltage levels.

R18 Seriescompensator cannot go between different voltage levels and should be contained within one substation

R19 The regulated terminal of a shuntcompensator must be in the same substation as the shuntcompensator's terminal (RegulatingCondEq->Terminal)

R20 A shuntcompensator's SwitchedBy switch's terminal must be connected to shuntcompensator's terminal through a connectivitynode.

R21 Transformer and Line ratings should follow these rules.
NormalRating<=twohourrating<=15minrating

R22 Sum of Ownership.ownershippercent should total 100% for SplitGenerationUnits(SGR). An SGR will have 1 record in one of the GeneratingUnit classes and "n" number of OwnerShareLimits that are associated to that GeneratingUnit. Each OwnerShareLimit will point to a OwnerShip record. The sum of all these ownership.ownershippercent should be equal to 100.

R23 DCTie Psuedo Load breaker default value must be "Closed".

R24 BLT(BlockLoadTransfer) must only group loads and only zero or one psuedo GeneratingUnit per BLT. The breaker for this psuedo gen if modeleld must have a default value of OPEN.

R25 HubBus must have atleast one electrical bus.

R26 The ConnectivityNodes in a ConnectivityNodeGroup must be in the SAME STATION i.e. ConnectivityNodes in a given ConnectivityNodeGroup cannot span multiple Stations.

R27 If a HubBus is associated to more than 1 ConnectivityNodeGroup then ALL the associated ConnectivityNodeGroups must belong to the same station.

R28 SynchronousMachine's 'ratedMVA' attribute should be greater than or equal to the 'baseMW' attribute of the GeneratingUnit it is associated to.

R29 Check the baseVoltage (if not null) of each conducting equipment connected to a connectivityNode to be the same.

©2009 Electric Reliability Council of Texas, Inc.

R30 Only AnalogLimit instances that are children of an AnalogLimitSet instance with the LimitSet.forNetwork = False/Null should have the LimitAlarmCategory and AnalogLimitName associations populated.
OR
If the parent AnalogLimitSet instance's the LimitSet.forNetwork = True of if the AnalogLimit instance's parent is a Rating instance, the two associations do not need to be populated.

R31 The energy consumer that is part of the DCTie must have ONE and ONLY one controllable load resource mapped to it. This energyconsumer can NOT be associated to a "non-controllable load resource". It has to be associated only to "controllable load resource".

R32 Only AnalogLimit instances that are children of an AnalogLimitSet instance with the LimitSet.forNetwork = False/Null should have the lower and upper thresholds

R33 Substation names should not exceed 8 chars.

R34 The target voltage setting specified by the regulation schedules must be within 80% to 120% of the rated kV

R35 The number of CurveData associated with the MVArCapabilityCurves and RampRateCurve should not exceed 10

R36 Two RampRateCurves (one with Emergency = True) should be associated with a ControllableLoadResource, a Configuration and a ThermalGeneratingUnit / HydroGeneratingUnit / NuclearGeneratingUnit / WindGeneratingUnit which has no association to a DCTie and a PrivateAreaNetwork (NetworkType: Non Modeled Generation, Mothballed, Retired) or a CombinedCyclePlant.

R37 The FromConfig and ToConfig of a TransState shouldn't be same

R38 FromConfig and ToConfig of a TransState must belong to the same CombinedCyclePlant

R39 A Contingency can't contain duplicate ContingencyElements

R40 The controllable load resource must be associated with exactly two RampRateCurves, one for normal condition and the other for emergency condition

R41 There is no duplicated CC configuration, i.e. there should not be 2 CC configurations that contain the same CCU combination with exactly same status of Primary/Alternate flag

R42 Each CC plant must have at least one CC configuration to startup/shutdown

R43 If a ThermalGeneratingUnit is a unit in a CombinedCyclePlant, then it cannot be a SplitGenerationResource.

R44 If any Measurement instance has more than one (MeasurementValue instance that is associted with MeasurementValueSource instance) then only one can have Company != ERCOT

©2009 Electric Reliability Council of Texas, Inc.

R45 Each CustomerLoad instance should be associated with
One instance of SettlementNOIELoadZone, Or
One instance of DCTie, Or
Its parent Substation should be associated with one instance of SettlementLoadZone

R46 For any instance of MeasurementArgument with ReferenceFlag = True, the Calculation link on the associated MeasurementValue instance should not be same as the parent Calculation instance of the MeasurementArgument instance.

R47 MeasurementValue instances that are sourced from or output of a calculation should have its Primary Site as “DE”.

R48 Every ElectricalBus should be in a LoadZone or a NOIE load zone

R49 PsuedoTerminal shoud not be Associated to a connectivityNode

R50 Psuedoterminal should not be associated to a RegulatingconductingEquipment

R51 EnergyConsumerResource(LoadResource and ControllableLoadResource) should not have any association to ResourceNode

R52 If PAN.networktype = retired or mothbolled, then there should be only one genunit associated to it.

R53 x/r ratio for ACLineSegment should follow these rules. For 345kv x/r > 7, 138kv x/r> 1.5, 69kv x/r > 1

R54 A resourceNode that is associated to a PrivateUseNetwork(PUN), should not be associated to any Physical Generating Unit

R55 Every GeneratingUnit(Thermal, Hydro, Nuclear, Wind) should have an association to a ResourceNode unless the GeneratingUnit is associated to a DCTie, NonModelledGeneration or BlockLoadType resource.

R56 If a Load is assigned to a NOIE load zone, then its electrical bus can ONLY have loads that are assigned to the same NOIE load zone, i.e. cannot have other loads at the same electrical bus assigned to different load zone
In other words, all loads that connect to the same EB must belong to the same load zone. All those loads must either be associated to the same NOIE load zone, or none of them has this association.

R57 DCTIE ElectricalBus can only connect to DCTIE load. The ElectricalBus connecting to terminal of DCTIE pseudo load (DCTIE attribute of CUSTOMERLOAD instance) cannot have other loads connect to it

R58 Each CombinedCyclePlant Configuration instance should have at least one association to a ConfigurationMember instance

R59 PricingVector's should have a unique name

R60 MeasurementGroup and Calculation instances associated to a Zonal MeasurementLocation should have unique names. Similarly MeasurementGroup and Calculation instances associated to a Nodal MeasurementLocation should have unique names

R61 Measurementargument and ConstantArgument instances associated to a Calculation should have unique names

R62 Zonal Measurements(Analog, Discrete) associated to a terminal should have unique names.

R63 Nodal Measurements(Analog, Discrete) associated to a terminal should have unique names.

R64 At least one Ownersharelimit instance should be associated with every LoadResource, ControllableLoadResource, ThermalGeneratingUnit, HydroGeneratingUnit, WindGeneratingUnit, NuclearGeneratingUnit,

R65 Every zonal AnalogLimitSet should be associated with a zonal Analog - Every Nodal AnalogLimitSet should be associated with Nodal Analog.

R66 Every Zonal AnalogValue with NO association to a AnalogName should be associated with a zonal MeasurementValueQuality and MeasurementValueSource. Every Nodal AnalogValue with no association to a AnalogName should be associated with a Nonal MeasurementValueQuality and MeasurementValueSource

R67 Every zonal AnalogValue with association to a AnalogName should be associated with a zonal site and should be associated to atleast one zonal MeasurementGroup or one zonal Calculation - Every Nodal AnalogValue with association to a AnalogName should be associated with a zonal site and should be associated to atleast one Nodal MeasurementGroup or one Nodal Calculation

R68 Every zonal DiscreteValue with association to a DiscreteName should be associated with a zonal site and should be associated to atleast one zonal MeasurementGroup or one zonal Calculation - Every Nodal discreteValue with association to a discreteName should be associated with a zonal site and should be associated to atleast one Nodal MeasurementGroup or one Nodal Calculation

R69 Every zonal Analog should be associated with a zonal AnalogValue - Every Nodal Analog should be associated with a Nodal AnalogValue

R70 Every zonal analoglimit associated with analoglimitname should be associated with a zonal analoglimitset. Every nodal analoglimit associated with analoglimitname should be associated with a nodal analoglimitset

R71 Every zonal MeasurementArgument and ConstantArgument should be associated with a zonal Calculation - Every Nodal MeasurementArgument and ConstantArgument should be associated with a Nodal Calculation

R72 Every zonal ConstantValue should be associated with a zonal ConstantArgument - Every Nodal ConstantValue should be associated with a Nodal ConstantArgument

R73 Every configuration should either be able to StartUp or Shutdown or transition into another configuration, else it is invalid.

R74 Attributes, HightReasonabilityLimit, LowReasonabilityLimit and MaxWeeklyenergy should be populated for any ownersharelimits associated with a LoadResource, a ControllableLoadResource, and a ThermalGeneratingUnit / HydroGeneratingUnit / NuclearGeneratingUnit / WindGeneratingUnit which has no association to a DCTie and a PrivateAreaNetwork (NetworkType: Non Modeled Generation Retired, Mothballed, BlockLoadTransfer).

R75 Attributes (Operational Resource Parameters), MinOnlineTime, minOfflineTime, hotstartTime, IntStartTime, ColdStartTime, Maxweeklystarts, maxonlinetime, maxdailystarts, maxweeklystarts, hotinttime, intcoldtime, syscondensercapable should be populated for any Configuration and any ThermalGeneratingUnit / HydroGeneratingUnit / NuclearGeneratingUnit / WindGeneratingUnit which has no association to a CombinedCyclePlant, a DCTie and a PrivateAreaNetwork (NetworkType: Non Modeled Generation, Retired, Mothballed, BlockLoadTransfer) .

R76 Attributes (Resource Parameters), HighReasonabilityLimit, LowReasonabilityLimit, HighReasonabilityRampRateLimit, LowReasonabilityRampRateLimit, MaxSustainableRating, MinSustainableRating, MaxEmergencyRating, MinEmergencyRating should be populated for any Configuration and any ThermalGeneratingUnit / HydroGeneratingUnit / NuclearGeneratingUnit / WindGeneratingUnit which has no association to a DCTie and a PrivateAreaNetwork (NetworkType: Non Modeled Generation, Retired, Mothballed, BlockLoadTransfer).

R77 Each Configuration must have at least one PRIMARY CCU (defined as CONFIGURATIONMEMBER with PRIMARY flag = 'TRUE')

R78 Each CombinedCyclePlant must have at least one configuration that can start up (i.e. STARTUPFLAG = 'TRUE')

R79 Each CombinedCyclePlant must have at least one configuration that can shut down (i.e. SHUTDOWNFLAG = 'TRUE')

R80 Each Configuration must satisfy at least one of the two conditions a) have at least one in-transstate (i.e. transstate with that configuration as TOCONFIG_CONFIGURATION) or b) its STARTUPFLAG is set to 'True'

R81 Each Configuration must have at least one of the two conditions a) have at least one out-transstate (i.e. transstate with that configuration as FROMCONFIG_CONFIGURATION) or b) its SHUTDNFLAG is set to 'True'

R82 All Configurations must have path to transit from start-up configuration AND transit to shut-down figuration in some way. This can be direct transstate or through other configurations. This is to prevent CC Plant being trapped ONLINE or OFFLINE

R83 Validate the UpTransition Attribute on a TransState:
If UpTransition = True, count of primary members in the FromConfiguration < count of primary members in the ToConfiguration
and if UpTransition = False, count of primary members in the FromConfiguration > count of primary members in the ToConfiguration.

©2009 Electric Reliability Council of Texas, Inc.

R84 Every Zonal DiscreteValue with no association to a DiscreteName should be associated with a zonal MeasurementValueQuality and a zonal MeasurementValueSource. Every Nodal DiscreteValue with no association to a DiscreteName should be associated with a Nodal MeasurementValueQuality and a nodal MeasurementValueSource.

R85 All x_axisdata data points in a MVArCapabilityCurve should be unique

R86 Only one y1_axisdata point in a MVArCapabilityCurve can be 0.

R87 Only one y2_axisdata point in a MVArCapabilityCurve can be 0.

R88 For every ICCPQualityConversion instance,
a. Only One of the following attributes ICalculated, IManual, IEstimated, ITelemetered should be true, and
b. Only One of the following attributes IValid, INotValid, ISuspect, IHeld should be true, and
c. Only One of the following attributes OValid, ONotValid, OSuspect, OHeld should be true, and
d. Only One of the following attributes OCalculated, OManual, OEstimated, ITelemetered should be true.

R89 There should be atleast one swing bus in the model. i.e. atleast one connectivity node with SlackBusPriority = True

R90 There should be no Pricingvector associated to a BusbarSection or a Endcap.

R91 For an EnergyConsumer (CustomerLoad or StationSupply), if conformingLoadFlag = True, then the EnergyConsumer should be associated to a ConformLoadGroup

R92 When a MeasurementLocation has more than one children (MeasurementGroup or Calculation),
(All zonal analogvalues and discretevalues associated to the child MeasurementGroup) and (All zonal Analogvalues and discretevalues associated with measurementargument having referencefalg = False within the child calculation) should be associated to the same terminal. All Nodal analogvalues and discretevalues associated to the child MeasurementGroup) and (All Nodal Analogvalues and discretevalues associated with measurementargument having referencefalg = False within the child calculation) should be associated to the same terminal.
For example
1. MeasLoc1 -> MeasGrp1 -> AnalogValue1 ->Analog1 ->Terminal1
2. MeasLoc1 -> MeasGrp1 -> AnalogValue2 ->Analog2->Terminal1
3. MeasLoc1 -> Calc1 -> MeasArg1 (referenceflag = false) -> AnalogValue3 ->Analog3 ->Terminal1
4. MeasLoc1 -> Calc1 -> MeasArg1 (referenceflag = false) -> AnalogValue4 ->Analog4->Terminal1

R93 A TriggerCondition may have multiple Gates associated with it. One of them must be its resulting Gate, (i.e. the Gate determing the trigger condition). This resulting Gate must be of type: or/and/nand/nor

R94 If a Gate is of the following types: gt/ge/ lt/le/eq/ne, then its input must be exactly One PinFlow or PinBranchGroup or PinVoltage. If input is PinFlow then PinFlow.InputIsFlow must be TRUE,

©2009 Electric Reliability Council of Texas, Inc.

R95 If a Gate is of the following types: or/and/nand/nor, then its input must be one or more PinGate or PinSwitch. or PinFlow. If input is PinFlow then PinFlow.InputIsFlow must be FALSE

R96 If a Gate is of the following types: not, then its input must be exactly one PinGate or PinSwitch.

R97 MRID and TEIDs in the entire model should be unique.

R98 Any Company with CompanyType = QSE or ERCOT can Own and Operate Zero Or One Substation with ForNetwork = False and ForSCADA = True.

R99 For any GeneratingUnit, LoadResource and ControllableLoadResource each QSE operator of the GeneratinUnit needs to Own a Substation with ForNetwork = False and ForSCADA = True. Ex. GU->OSL->Operatorship->Company->Ownership ->Substation (forNetwork = False and ForSCADA = True)

R100 The owner of a GeneratingUnit , LoadResource and ControllableLoadResource should always be an RE or ERCOT. Operator should be a QSE or ERCOT.

R101 For every generating unit that's not associated to a combined cycle plant, maximumOperatingMW = HRL and minimumOperatingMW = LRL

R102 All instances of the following classes should have a unique name,
Contingencies
ContingencyGroups
RemedialActionSchemes
SharedProtectiveActions
VoltageLimitSets , ResourceNode, HubBus

R103 The total number of CalculationArguments (MeasurementArgument and/or ConstantArgument) associated to a Calculation must be equal to or greater than the total number of FunctionArguments the associated Function

R104 In a Calculation every associated CalculationArgument (MeasurementArgument and/or ConstantArgument) should be associated to a unique FunctionArgument in the function associated to the Calculation

R105 The Name of a measurementlocation should be same as the name of the associated PowerSystemResource unless the PowerSystemResource is of the Type = CombinedCyclePlant. In case of a CombinedCyclePlant the name of the MeasurementLocation should be same as the aliasname of the associated combinedcycleplant.

R106 All conformLoads should have conformingloadflag = True and all nonconformloads should have conformingloadflag = False

R107 A BLT-load, DCTie-load and a PUN-load should be of the type NonConformLoad

R108

Length Limitations
2 AclineSegment.
4
TapChanger ,ConnectivityNode,ContingencyGroup
Configuration,MeasurementGroup,Calculation
VoltageLimitSet,VoltageLevel,CurveData,PowerTransformer
Gate,PinBranchGroup,PinFlow,PinGate,PinSwitch
PinTriggerCondition,PinVoltgae,Stage,StageTrigger
AnalogName,Analog,AnalogLimit,AnalogLimitName
DiscreteName,Discrete,MeasurementArgument,ConstantArgument
ConstantValue
6
Company.(IO.Localname)
8
Substation,LoadbasedRegulationCurve
MVArCapabilityCurve,PhaseShifterImpedanceCurve
RampRateCurve,StationSupplyWRCurve,RemedialActionScheme
TriggerCondition,Function,Site
12
IccpQualityConversionSet,IccpQualityConversion
14
Breaker,Disconnector,TransformerWinding,CutomerLoad
LoadResource,Line,ShuntCompensator,StaticVarCompensator
ResourceController,Company.(IO.AliasName),TieLine
TieCorridor,ThermalGeneratingUnit,HydroGeneratingUnit
NuclearGeneratingUnit,WindGeneratingUnit,SynchronousMachine
SubLoadArea,LogicalConfiguration,PrivateUseNetwork

R109 Every PowerSystemResource can have only one MeasurementLocation of a Particular Devicetype, i.e.
Given a condition Device1 ->MeasLoc1 (RDFID: ABCD) DeviceTypeName: LD,
Device1 ->MeasLoc1 (RDFID: FGHD) DeviceTypeName: LD : Invalid
Device1 ->MeasLoc1 (RDFID: ABCD) DeviceTypeName: LDRES : Valid.

R110 Measurement Argument or Constant argument under a Calculation should not be mapped to same Measurement Value or Constant Value.

R111 An electrical bus must be associated with a connectivity node when:
* a load is attached to the node.
* Three or more switches are attached to the node and the node has a voltage reading

R112 The RID for EPSmeter must be unique

R113 customerLoad and Load instances cannot have association to PrivateAreaNetwork of type ERCOTPANTYPE.PrivateUseNetwork or SelfServe or BLT_Normally_out

R114 Number of CurveScheduleData under PhaseShifterImpedanceCurve and TransformerImpedanceCurve are the same as Number of TapChanger step within PowerTransformer where the curve is asscociated to

R115 FlowgateElement must associate with terminal of line/transformer/series (not allow association to other type of equipment)

R116 OwnerShareLimit.name should be unique for Split generation resource .

R117 A HubBus associates with 1..n ConnectivityNodeGroups. If a HubBus is associated to more than 1 ConnectivityNodeGroups, then ALL the associated ConnectivityNodeGroups must belong to the same Substation

R118 Each DCTIE must associate with ONE and ONLY ONE ThermalGeneratingUnit

R119 If a breaker or disconnector is modeled under a Bay instead of a VoltageLevel, then the association between Breaker/Disconnector to VoltageLevel should be populated.

R120 If the Transformer is a Phase Shifting Transformer, a Phase Shifter Impedance Curve should be associated through the “Has A (PhaseShifterImpedanceCurve)” linkage.

R121 If the Transformer is equipped with a Tap Ratio Curve, a Tap Ratio Curve should be associated through the “Has A (TapRatioCurve)” linkage.

APPENDIX D – CLASSES NOT ALLOWED

Classes that are marked as “Not Allowed” cannot have data instances within the ERCOT CIM XML data file. The importers would ignore this data, but references between a "NOT_ALLOWED" class and a "USED" class could produce an invalid model/solution, especially if topology related. A list of classes and their compatibility with ERCOT applications will be published, and the classes marked as “Not Allowed” must NOT be populated via NOMCRs or they will be rejected in the NMMS validation step.

In the future, data for some of the classes currently “Not Allowed” may be allowed, but only after the impact has been evaluated and the changes tested by all affected ERCOT applications. Newly created classes could also be allowed after being tested by affected ERCOT applications.

BASICINTERVALSCHEDULE	NOT_ALLOWED - ABSTRACT
COMPOSITESWITCH	NOT_ALLOWED - TOPOLOGY
CONDUCTINGEQUIPMENT	NOT_ALLOWED - ABSTRACT
CONDUCTOR	NOT_ALLOWED - ABSTRACT
CONFORMLOAD	NOT_ALLOWED - ABSTRACT
CONNECTOR	NOT_ALLOWED - TOPOLOGY
CURVE	NOT_ALLOWED - ABSTRACT
DCLINESEGMENT	NOT_ALLOWED - TOPOLOGY
ENERGYAREA	NOT_ALLOWED - ABSTRACT
ENERGYCONSUMER	NOT_ALLOWED - ABSTRACT
ENERGYCONSUMERRESOURCE	NOT_ALLOWED - ABSTRACT
EQUIPMENT	NOT_ALLOWED - ABSTRACT
EQUIPMENTCONTAINER	NOT_ALLOWED - ABSTRACT
EQUIVALENTSOURCE	NOT_ALLOWED - TOPOLOGY
FEEDER	NOT_ALLOWED - TOPOLOGY
FREQUENCYCONVERTER	NOT_ALLOWED - TOPOLOGY
FUSE	NOT_ALLOWED - TOPOLOGY
GATEINPUTPIN	NOT_ALLOWED - ABSTRACT
GENERATINGUNIT	NOT_ALLOWED - ABSTRACT

GROUND	NOT_ALLOWED - TOPOLOGY
GROUNDDISCONNECTOR	NOT_ALLOWED - TOPOLOGY
JUMPER	NOT_ALLOWED - TOPOLOGY
JUNCTION	NOT_ALLOWED - TOPOLOGY
LIMIT	NOT_ALLOWED - ABSTRACT
LIMITSET	NOT_ALLOWED - ABSTRACT
LOADBREAKSWITCH	NOT_ALLOWED - TOPOLOGY
LOADGROUP	NOT_ALLOWED - ABSTRACT
MEASUREMENT	NOT_ALLOWED - ABSTRACT
POWERSYSTEMRESOURCE	NOT_ALLOWED - ABSTRACT
PROTECTEDSWITCH	NOT_ALLOWED - ABSTRACT
RECTIFIERINVERTER	NOT_ALLOWED - TOPOLOGY
REGULARINTERVALSCHEDULE	NOT_ALLOWED - ABSTRACT
REGULATINGCONDEQ	NOT_ALLOWED - ABSTRACT
SWITCH	NOT_ALLOWED - ABSTRACT

©2009 Electric Reliability Council of Texas, Inc.