

Introduction to PowerWorld Simulator: Interface and Common Tools



I5: Data Aggregation using Areas, Zones,
Interfaces, Super Areas, Injection Groups



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Aggregation of Data



- Areas and Zones
- Interfaces
 - Flowgates, Cutplanes, and Paths can be defined as interfaces
- Nomograms
- Bus Pairs
- Super Areas
- Injection Groups
- Substations
- Supplemental Data
- Object Groups
- Difference Flows to compare different cases or different states of the same case
 - values in the case (loads, gen MW outputs, etc...)
 - Also compare the topology of the case
- Owners, Balancing Authorities, and Data Maintainer

Area and Zone Records

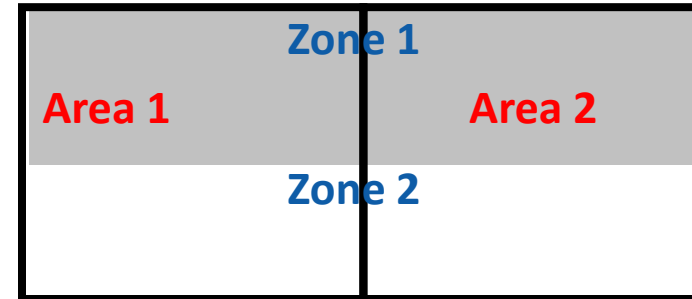


- Area and Zone definitions are part of standard power system case text formats
- Each bus is assigned to exactly one area
- Each bus is assigned to exactly one zone
- Generators, Shunts, and Loads are normally assigned to the same area as their terminal bus
 - However, they may also be given their own area and zone designation

Area and Zone Layouts



- Areas and Zones do NOT have to be contiguous
- Zones are often “sub-areas”, but this is NOT required. They can overlap as shown below
 - Areas (thick lines)
 - Zones (shaded/nonshaded)
 - A single area may consist of multiple zones, while a single zone can include buses from multiple areas



What are Areas and Zones For?



- Areas and Zones
 - Provide summary data about a group of power system elements (total load, generation, losses, etc...)
 - Provide way to filter data (Area/Zone filters)
 - Limit Monitoring Settings for Area/Zone
 - Toggle settings for equivalencing, scaling, etc...
- Areas ONLY (control settings)
 - Ability to perform automatic generation control (AGC)
 - Ability to specify MW transfer between areas
 - Ability to toggle control settings across a group of elements
 - AGC, Generator AVR, Shunts, Transformers
 - Ability to enable OPF/SCOPF constraint enforcement

Assigning Area and Zone Designations



- To create a new Area or Zone
 - Select Insert... from the local menu (right-click) in Area Records or Zone Records; OR
 - Auxiliary files or Copy/Paste from Excel
 - Open Model Explorer and choose Network → Buses or open the Bus Dialog and assign an existing bus to a new Area/Zone number; OR

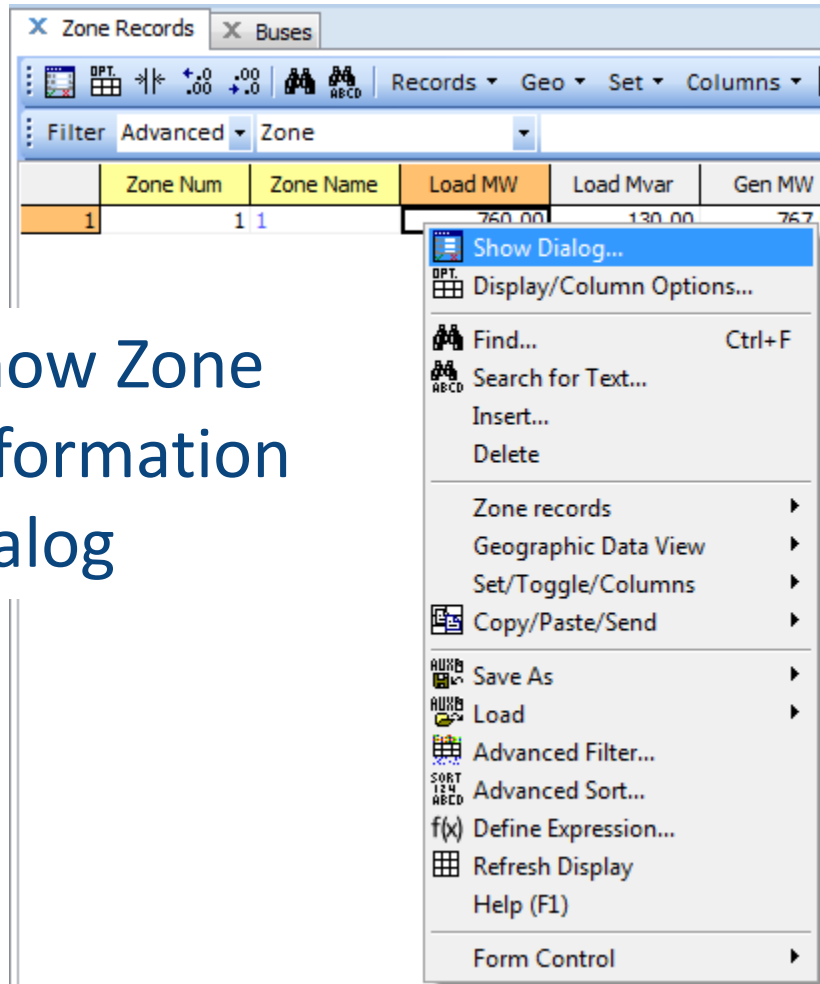
	Number	Name	Area Num	Area Name	Nom kv	PU Volt	Volt (kV)
1	1	One	4	Top	138.00	1.05000	144.90
2	2	Two	1	Top	138.00	1.04000	143.50
3	3	Three	1	Top	138.00	0.99269	136.90
4	4	Four	1	Top	138.00	1.00000	138.00
5	5	Five	1	Top	138.00	1.00665	138.90
6	6	Six	2	Left	138.00	1.04000	143.50
7	7	Seven	3	Right	138.00	1.04000	143.50

Enter a new number to create a new Area

Moving Bus Zones and Creating New Zones via the Zone Dialog



Show Zone
Information
dialog



- Buses can be assigned individually to zones using the Bus dialog.
- Groups of buses can be moved to different zones using the Zone Information dialog.
- The Zone Information dialog is available by right-clicking on the zone name on the Zone Records display.

Run Mode Zone Information Dialog



Zone Number: 2
Zone Name: Zone 2
Labels: no labels

Information | Tie Lines | OPF | Zone Buses | Zone Gens | Zone Loads | Zone Switched Shunts | Custom

Load and Generation

	MW	Mvar
Load	190.0	70.0
Generation		
Shunts		
Losses	3.15	-6.06
Interchange	-193.1	-63.9

Generation AGC Range

Maximum Gen Increase (MW): 0.0
Maximum Gen Decrease (MW): 0.0

Load MW Multiplier: 1.000
Load Mvar Multiplier: 1.000

Generation by Generic Fuel Type

	Actual MW	Max MW (On)	Max MW (All)
Natural Gas	0.0	0.0	0.0
Coal	0.0	0.0	0.0
Wind	0.0	0.0	0.0
Nuclear	0.0	0.0	0.0
Solar	0.0	0.0	0.0
Hydro	0.0	0.0	0.0
DFO	0.0	0.0	0.0
Storage	0.0	0.0	0.0
Wood/Bio	0.0	0.0	0.0
Jef Fuel	0.0	0.0	0.0
Geothermal	0.0	0.0	0.0
HydroPS	0.0	0.0	0.0
Waste Heat	0.0	0.0	0.0
RFO	0.0	0.0	0.0
Other	0.0	0.0	0.0
Unknown	0.0	0.0	0.0
Total All	0.0	0.0	0.0

OK Save Cancel Help Print

Use combo box and/or arrows to view other zones without leaving the dialog

Range of AGCable generation in zone

Zones can have tie-lines,
but AGC on zones is not allowed
Generator as a tie-line, as it occurs in a
different zone than its terminal bus

Zone Information

Zone Number: 2
Zone Name: Zone 2
Labels: no labels

Information | Tie Lines | OPF | Zone Buses | Zone Gens | Zone Loads | Zone Switched Shunts | Custom

	Tie Type	Near Zone Name	Near Number	Near Name	Far Zone Name	Far Number	Far Name	Ckt	Metered	Me
1	Gen	1	4	Four	Zone 2			1		4
2	Branch (Line)	Zone 2	3	Three	1		1 One	1		1
3	Branch (Line)	Zone 2	3	Three	1		2 Two	1		2
4	Branch (Line)	Zone 2	4	Four	1		2 Two	1		2
5	Branch (Line)	Zone 2	4	Four	1		5 Five	1		4

OK Save Cancel Help Print

Interface Definition



- Interfaces are groupings of branches and sometimes other elements
- The sum of the flows on these elements can then be monitored in the analysis tools
- Common interfaces are the grouping of tie lines between areas, and groupings of lines between important parts of the system.
- Interfaces can be used to model several commonly described groupings of lines
 - Flowgates – term used in the Eastern United States
 - Cut-Planes – term used in the Western United States
 - Paths – term used in the state of California
 - Nomograms – Used throughout the industry

Interface Records



- Interface records can be used to show flows between areas and/or zones.
- Interface records showing area to area flows can be automatically inserted by
 - Open Model Explorer and choose **Aggregations → Interfaces** to display interface records
 - Select **Interface records → Auto Insert Interfaces** from the local menu to display Auto Insertion of Interfaces Dialog

Interface Records



The 'Interface Definitions' window displays a table of interface records. The 'Auto Insertion of Interfaces' dialog box is open, showing options for 'Type of Interfaces to Insert' (Area to Area, Zone to Zone) and 'Limits' (Automatically calculate from component ratings, Use these: Limit A, Limit B, Limit C, Limit D, Limit E).

Number	Name	Interface MW Flow	MW Limit	Percent	Monitor Direction	Monitor Both Directions	Lim A MW	Lim B MW	Lim C MW	Has Contingency
1	Left-Right	40.1	0.0		FROM -> TO	NO	0.0	0.0	0.0	No
2	Left-Top	-40.1	0.0		FROM -> TO	NO	0.0	0.0	0.0	No
3	Right-Top	40.1	0.0		FROM -> TO	NO	0.0	0.0	0.0	No

The 'Auto Insertion of Interfaces' dialog box shows the following options:

- Type of Interfaces to Insert:
 - ☒ Area to Area
 - ☐ Zone to Zone
- Optional Prefix (3 characters maximum):
- ☐ Delete Existing Interfaces
- ☐ Only Insert Area/Zones with Area/Zone Filters Set
- Limits:
 - ☐ Automatically calculate from component ratings
 - ☒ Use these:
 - Limit A: 0.000
 - Limit B: 0.000
 - Limit C: 0.000
 - Limit D: 0.000
 - Limit E: 0.000

Right-click and select **Interface records** → **Auto Insert Interfaces**

Select either Area to Area, or Zone to Zone flows

Defining Custom Interface Records



- Open Model Explorer and choose **Aggregations** → **Interfaces** to view the Interface display.
- Right-click and select **Insert** to add a new interface.
- The **Interface Dialog** is shown.
- We'll set up an interface showing flow on two parallel lines.

The screenshot shows the 'Interface Dialog' window with the following settings:

- Interface Name: new interface
- Interface Number: 1
- Labels: (empty)
- Limits (MW): Limit A: 0.000, Limit B: 0.000, Limit C: 0.000, Limit D: 0.000, Limit E: 0.000
- Monitoring Direction: ☒ FROM --> TO, ☐ TO --> FROM
- Monitor Both Directions: ☐
- Noncontingent MW Flow Contribution: 0.7
- Contingent MW Flow Contribution: 0.0
- Total MW Flow: 0.7
- PTDF Value (%): 0.00
- Interface Elements: OFF, Custom
- Either: ☒ Insert New Element, ☐ Clone Elements From Another Interface or Right-Click to show the Element Dialog
- Element Identifiers: ☒ Name (Number), ☐ Name, ☐ Number (Name), ☐ Number
- Table:

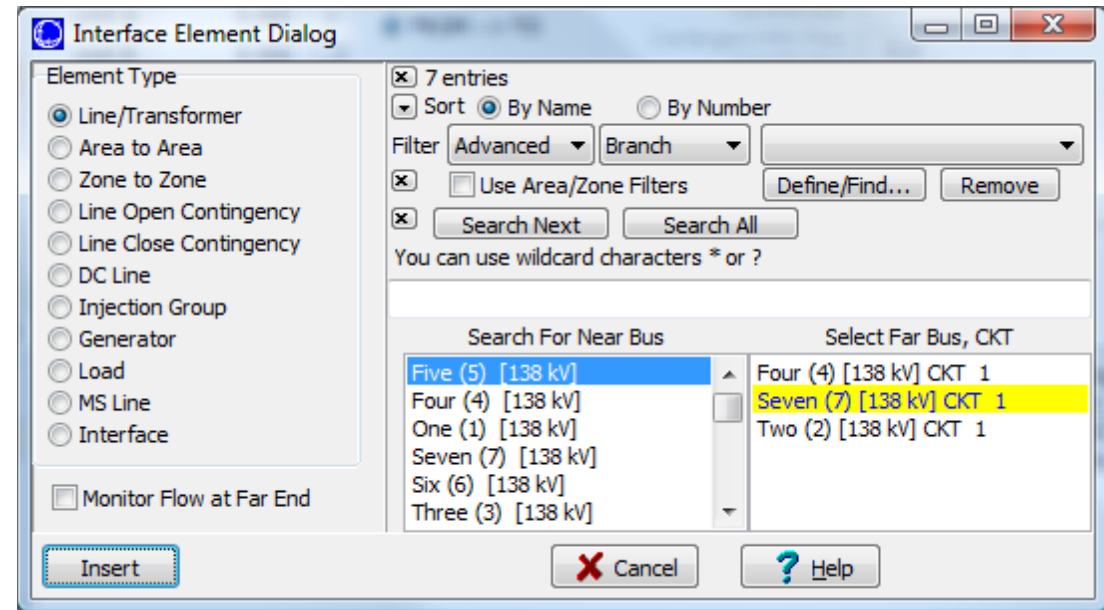
	Description	Flow	Weighting	Pre-Weight Flow
1	Line MW flow from bus 'Two (2)' to bus 'Six (6)' circuit 1	40.07	1.00	40.07
2	Line MW flow from bus 'Five (5)' to bus 'Seven (7)' circuit 1	-39.41	1.00	-39.41

Buttons at the bottom: OK, Save, Cancel, Help, Print.

Monitored Interface Dialog



- Change Interface Name: *Top Export*
- Modify Interface Limit A (MW): *400*
- Click **Insert New Element** button to add a new Interface Element
 - Type: *Line/Transformer*
 - Near : *2 (Two)*
 - Far : *6(Six) CKT 1*
- Repeat For
 - Type: *Line/Transf.*
 - Near : *5 (Five)*
 - Far : *7 (Seven) CKT 1*



Interface Element Type



- Line/Transformer
 - Monitor the flows on a line (direction is important!)
- Area to Area, and Zone to Zone
 - Monitor the sum of the flows on all tie lines
- Line Open/Close Contingency
 - When defining these, it means that all monitoring on this interface is done after this Line Open/Close contingency
- DC Line
 - Monitor the flow on a DC Line
- Injection Group, Generator, Load
 - Monitor the output of a group of generators or loads
 - Allows you to put a limit on the sum of outputs
- MS Line
 - Monitor the flow on a multi-section line
- Interface
 - Monitor the flow/output of another interface
 - *Be careful not to create circular references*

Monitored Interface Dialog



The dialog box is titled "Interface Dialog". It contains the following fields and controls:

- Interface Name:** A dropdown menu showing "Top Export". An arrow points to it from the text "Interface Name".
- Interface Number:** A text box containing "1".
- Buttons:** "Find Interface...", "Add New Interface", and "Delete Interface". An arrow points to the "Add New Interface" button from the text "Add a new element to the interface".
- Limits (MW):** A list of five limits (A, B, C, D, E) with values 400, 0.000, 0.000, 0.000, and 0.000 respectively.
- Monitoring Direction:** Radio buttons for "FROM --> TO" (selected) and "TO --> FROM".
- Noncontingent MW Flow Contribution:** 0.7
- Contingent MW Flow Contribution:** 0.0
- Total MW Flow:** 0.7
- PTDF Value (%):** 0.00
- Interface Elements:** A tabbed section with "OPF" and "Custom" tabs. The "Custom" tab is active.
- Element Identifiers:** Radio buttons for "Name (Number)" (selected) and "Number (Name)".
- Buttons:** "Insert New Element", "Clone Elements From Another Interface", and "or Right-Click to show the Element Dialog".
- Table:** A table with columns "Description", "Flow", "Weighting", and "Pre-Weight Flow". It contains two rows of data.
- Buttons:** "OK", "Save", "Cancel", "Help", and "Print" at the bottom.

	Description	Flow	Weighting	Pre-Weight Flow
1	Line MW flow from bus 'Two (2)' to bus 'Six (6)' circuit: 1	40.07	1.00	40.07
2	Line MW flow from bus 'Five (5)' to bus 'Seven (7)' circuit: 1	-39.41	1.00	-39.41

Interface Name

Add a new element to the interface

Lists all elements in interface. Right-Click and Choose **Show Dialog** to modify

Add or delete interfaces

Set weighting of individual elements

Use spin button to view other interfaces



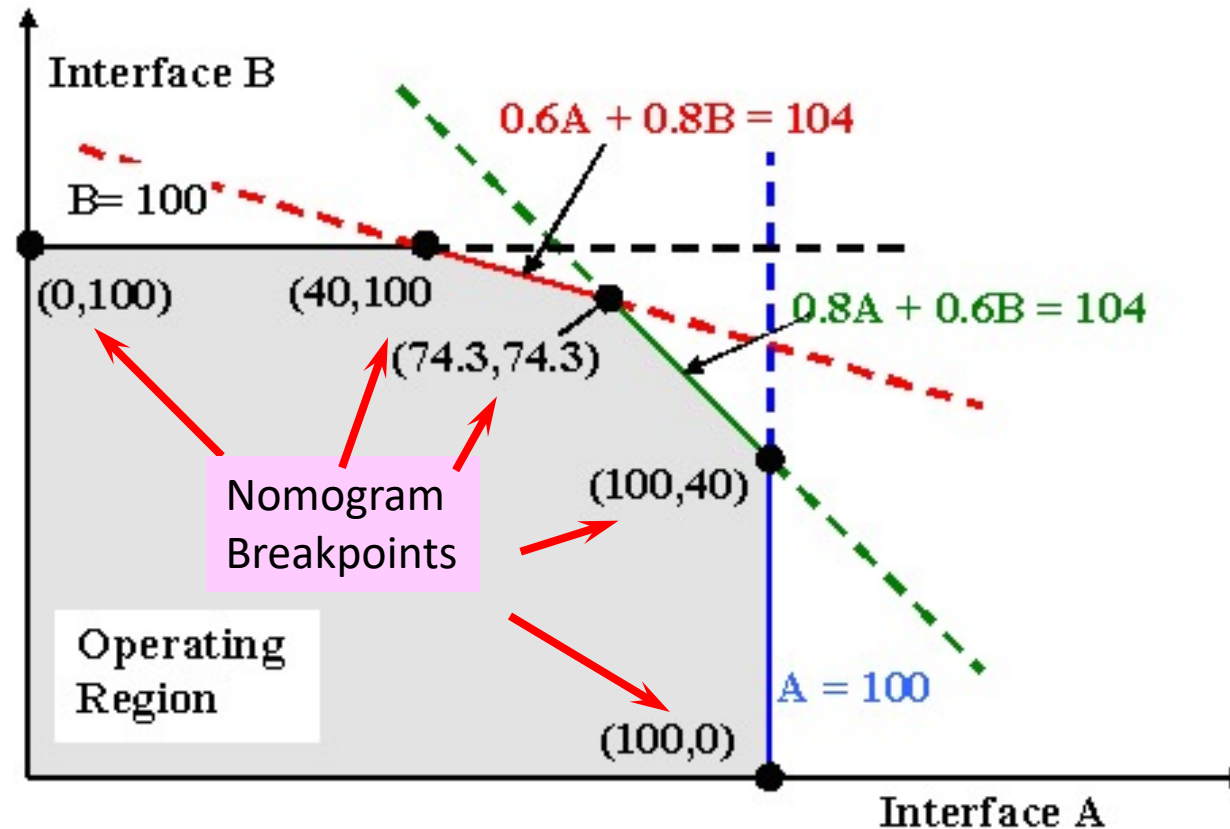
Interface Element Weightings



- Right-click on the list of elements and choose **Display/Column Options**
- Add the columns **Weighting** and **Pre-Weight Flow**
- This allows your interface to monitor the *weighted sum* of flows instead of the pure sum
- This will be used extensively with Nomogram Definitions

Nomograms

- Nomograms allow definition of 2-dimensional limit spaces using 2 interfaces





Nomograms



- Open Model Explorer and choose **Aggregations** → **Nomograms** to bring up a list of Nomograms
- Right-click and choose **Insert...** to bring up the Nomogram Dialog for adding a new Nomogram
- A nomogram is defined by
 - Interface A
 - Interface B
 - A set of breakpoints
 - Breakpoints MUST create a “convex” region
- Nomogram limits can be used in ATC, contingency analysis, and OPF/SCOPF

Nomogram Dialog



Interfaces are defined the same as before

Define Interface A

Define Interface B

Specify Breakpoints

Nomogram Dialog

Nomogram: No nomograms defined. Click Save to create one.

Buttons: Save, Save As, Rename, Delete

Interface A: Insert New Element, Clone Elements From ...

Description	Flow	Weighting	Pre-Weight Flow
1 Line MW flow from bus 'Two (2)' to bus 'Five (5)' circuit 1	78.74	1.00	78.74

Interface B: Insert New Element, Clone Elements From ...

Description	Flow	Weighting	Pre-Weight Flow
1 Line MW flow from bus 'Two (2)' to bus 'Four (4)' circuit 1	32.12	1.00	32.12

Nomogram Breakpoints

Int A [MW]	Int B [MW]
0	100
40	100
74.29	74.29
100	40
100	0

Nomogram Limiting Boundary

Interface B [MW]

Interface A [MW]

Operating Region (Blue area)

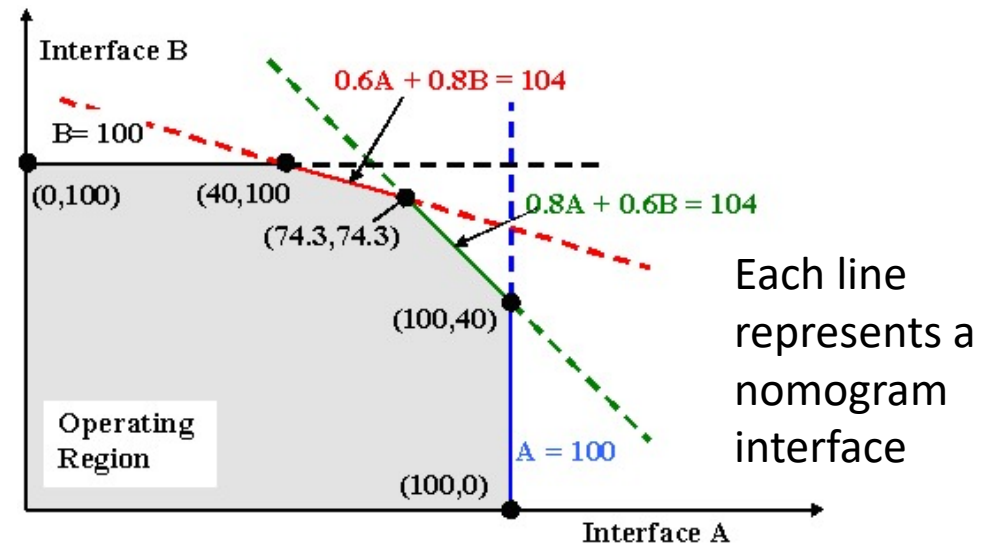
Operating Point (Red dot)

Buttons: OK, Cancel, Help

graphical representation of the breakpoints; operating region may span 4 quadrants

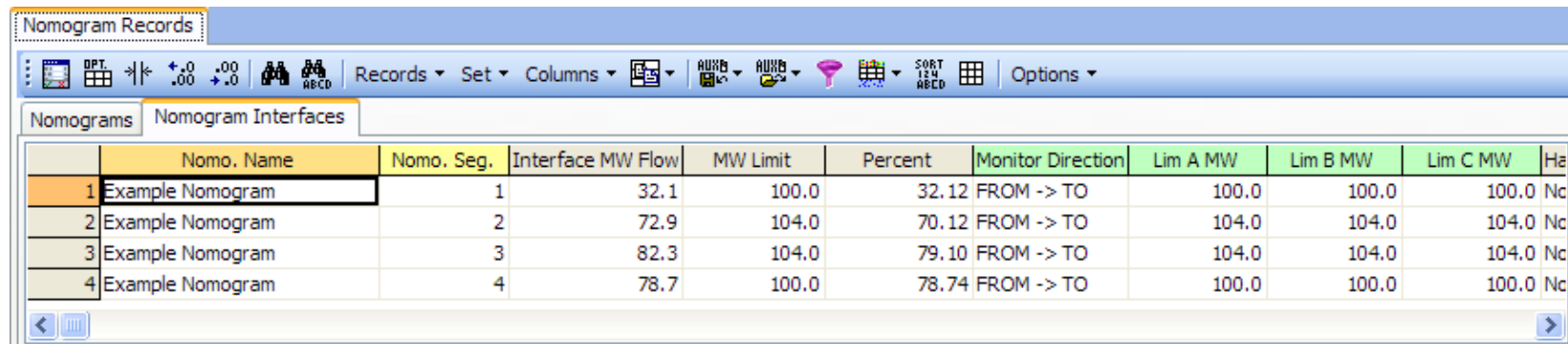
Nomogram Interfaces

- For each nomogram, Simulator creates a list of *nomogram interfaces* which are managed internally
 - This is done by using element weightings based on Interface A, Interface B, and the Breakpoints
 - “number of breakpoints minus 1” nomogram interfaces are made
- The “monitoring” will then occur for each nomogram interface level.
 - Everywhere you see references to interfaces you will now also see references to nomogram interfaces



Nomogram Interfaces

- Once you have defined a Nomogram, then the **Aggregations** → **Nomogram Records** tab will have a second sub-tab that lists the Nomogram Interfaces
 - Note: you can not edit Nomogram Interfaces directly. You must modify the Nomogram itself instead
 - Nomogram Interfaces are identified by their Nomogram Name and Nomogram Segment



	Nomo. Name	Nomo. Seg.	Interface MW Flow	MW Limit	Percent	Monitor Direction	Lim A MW	Lim B MW	Lim C MW	Hz
1	Example Nomogram	1	32.1	100.0	32.12	FROM -> TO	100.0	100.0	100.0	Nc
2	Example Nomogram	2	72.9	104.0	70.12	FROM -> TO	104.0	104.0	104.0	Nc
3	Example Nomogram	3	82.3	104.0	79.10	FROM -> TO	104.0	104.0	104.0	Nc
4	Example Nomogram	4	78.7	100.0	78.74	FROM -> TO	100.0	100.0	100.0	Nc



Bus Pairs



- Bus Pairs can be used to compute voltage angle differences between buses
- Angle limits may be set for normal and contingency conditions in Limit Monitoring Settings (covered in another section)

Bus Pairs													
Filter Advanced Bus Pair Find... Remove Quick Filter													
	Name	From Bus	To Bus	Description	Angle	Limit Angle Used	Limit Angle Used CTG	Monitor	Limit Group	Limit Angle A	Limit Angle B	Limit Angle C	Limit Angle D
1	2 to 5	Bus '2'	Bus '5'	2 to 5	5.059	6.000	6.000	YES	Default	6.000	0.000	0.000	0.000

From Bus and To Bus define the Pair

Present Angle Difference

Area/Zone/Interface Online Graphics



- Online diagrams traditionally contain information regarding individual power system elements (buses, lines, generators, etc...)
- Simulator also allows you to create diagrams based off the aggregate data objects

Area Fields



- Area fields can be added to onelines to show a number of area fields.
- Area fields can also be used to specify base transactions.
- Area fields are inserted in Edit Mode from the **Draw** ribbon tab, choosing **Field** → **Area Field**
- By default, area fields are linked to the area associated with the closest bus on the oneline.



Area Field Dialog



Anchor the field to the area object so that both can be moved together

include units suffix

Use combo box to select an area or entire case

Other Area Number
(Required for certain field types)

AGC Status can be toggled on the oneline

Area number 0 (zero) represents the whole system!

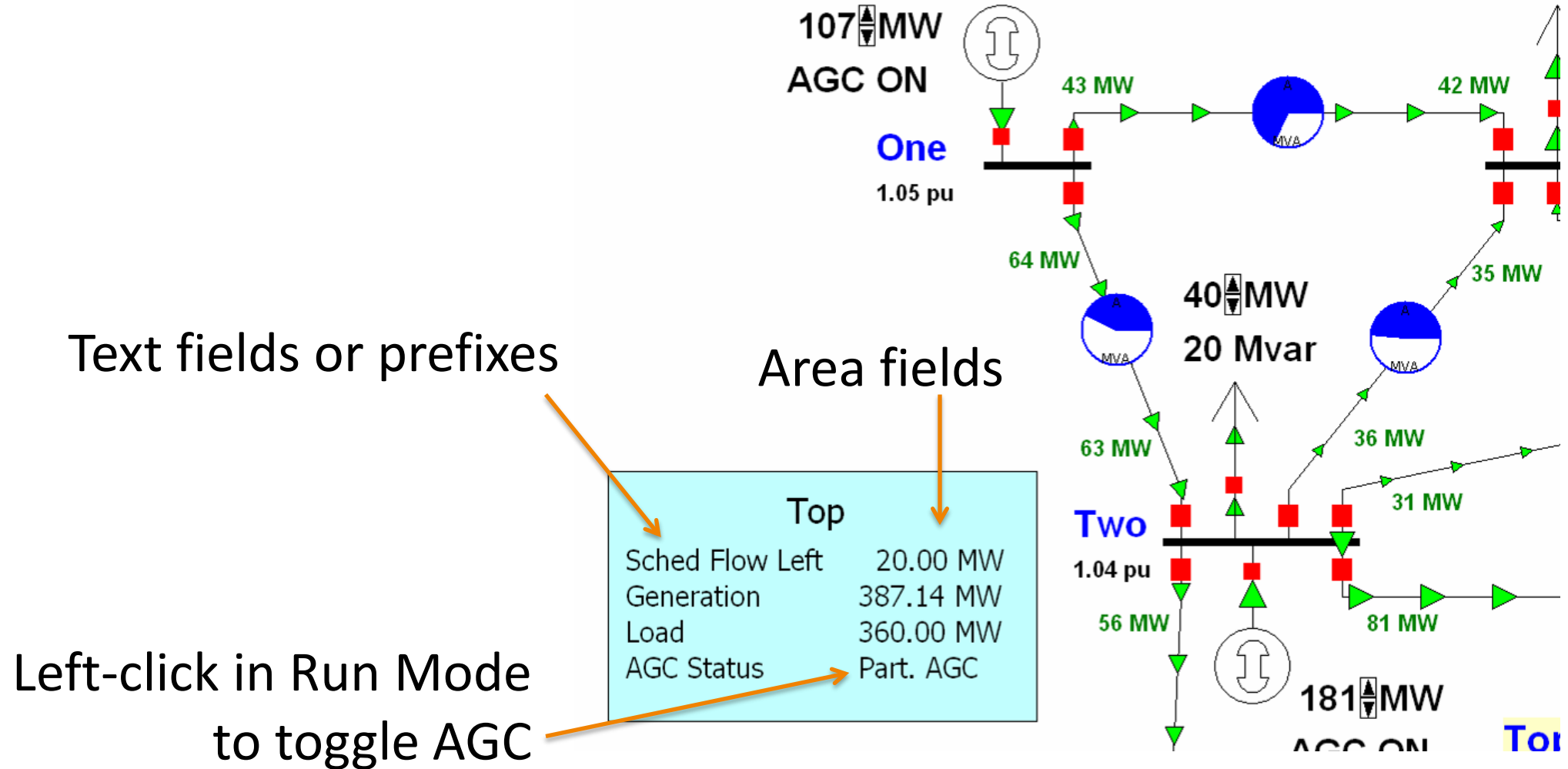


Area Field Example



- Add several area fields to the B7FLAT case
 - Area Name
 - Area MW Flow to Other Area (or case)
 - Scheduled Flow to Other Area
 - Load Schedule Multiplier
 - AGC Status

B7FLAT with Area Fields

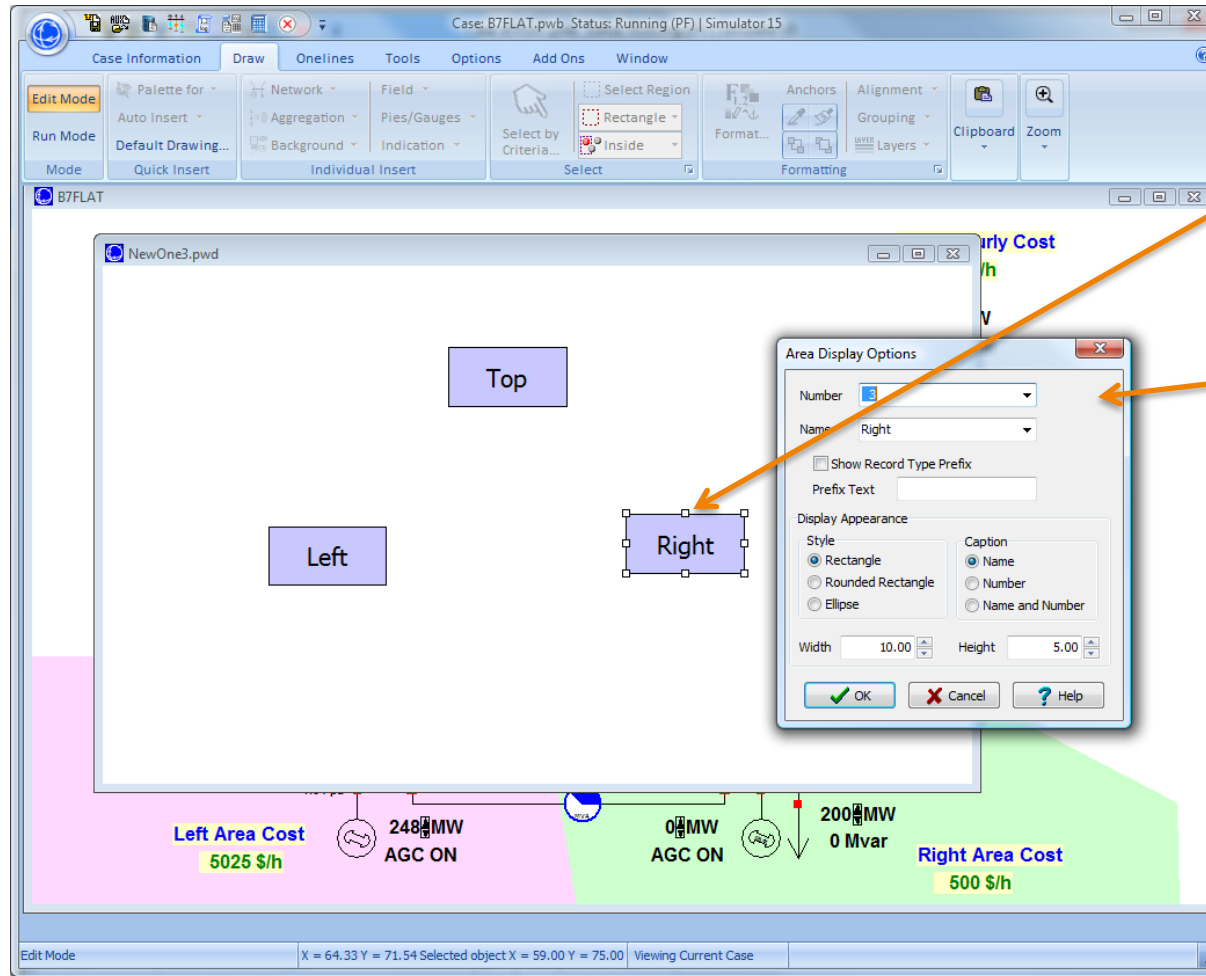


Area, Zone, and Super Area Objects



- Separate oneline object types for Areas, Zones, and Super Areas
- On B7FLAT case
 -  — From the File Menu, select **New Oneline** to make a new oneline
 -  — Add area objects for each of three areas
 -  — From the File Menu, select **Save Oneline** to save the oneline. Use “B7FLATa” for the name.
- Zone and Super Area objects are similar

B7FLATa Display



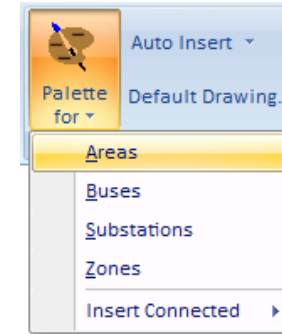
Right-click on object,
then select
Information Dialog...
for the Area Display
Options

Same procedure for
zones or super areas



Area or Zone Palette

- Similar to the Bus Palette, you can also bring up an Area or Zone Palette
 - On the **Draw** ribbon tab, select **Show Insert Palette For → Zones** (or Areas)



Zone Palette for Midwest.pwd

History List ▼ Define a Filter... ? Help

Displayed (7)	Displayed Neighbors	Undisplayed Neighbors	All Undisplayed (169)
190 (190)	WEST 8C (236)	EASTERN (201)	655 (655)
TVAWEST (265)	AP (1)	WESTERN (206)	69KV (142)
AEP-AP (50)	AEP-OP (51)	DUKE.DUK (210)	AE RIVER (180)
WEST 8C (236)	AEP-KP (54)	SOUTH 6B (235)	AEC (250)
AP (1)		WEST 8A (238)	AEP-CS (53)
AEP-OP (51)		VP 500KV (239)	AEP-IM (52)
AEP-KP (54)		TVAEAST (267)	AEP-IM-I (56)
		OVEC (6)	AEP-OP-I (55)
		AEP-CS (53)	APC (241)
		AEP-OP-I (55)	ASEC (546)



Interface Fields



- Several types of objects are used to display interface data on the oneline
 - Interface Objects: like transmission lines
 - Interface Fields: like line fields
 - Interface Pie Charts: like line flow pie charts



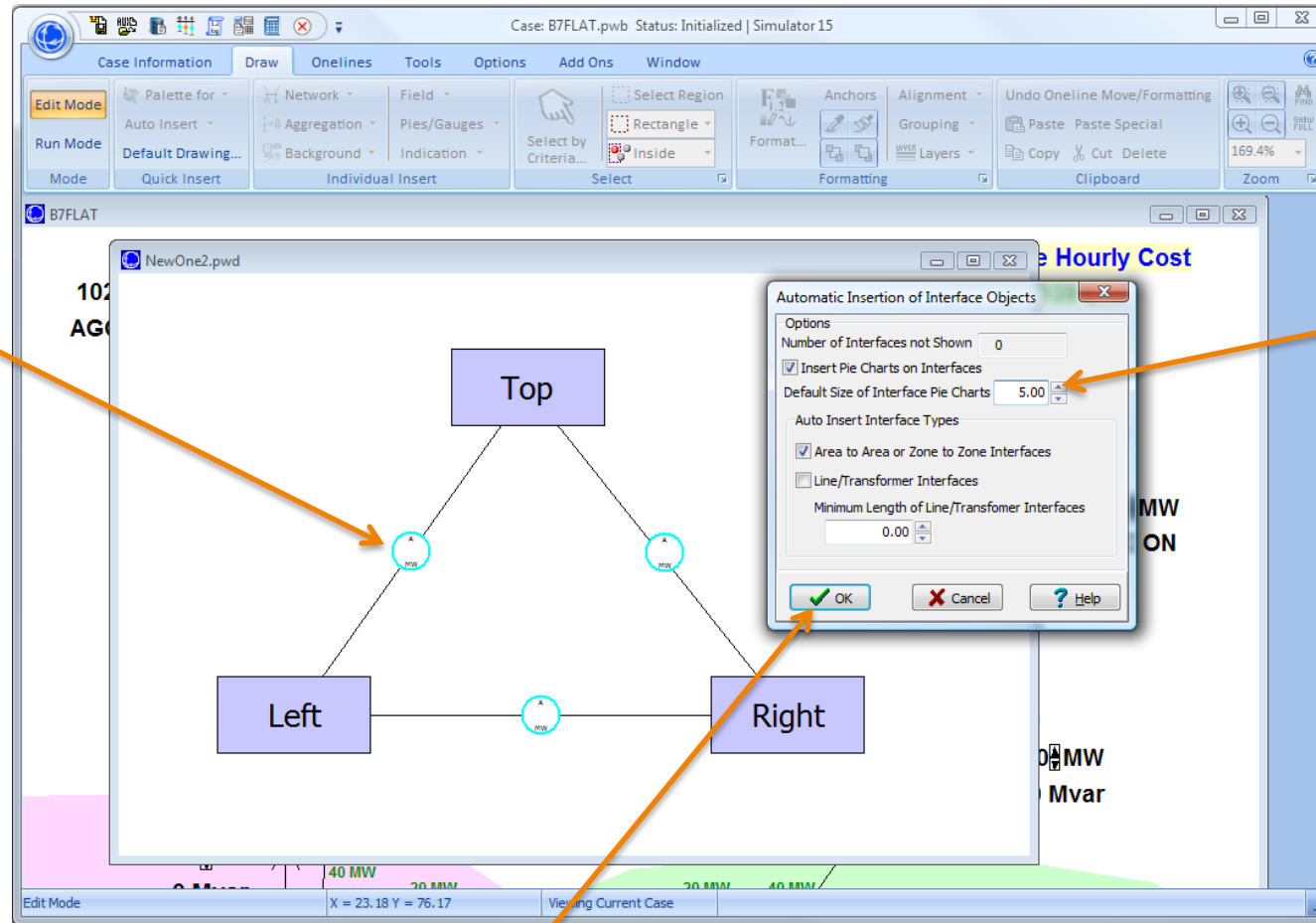
Auto Insertion of Interface Objects



- Interface objects can be auto inserted (just like line objects).
- In edit mode, from the **Draw** ribbon tab, select **Auto Insert** → **Interfaces**.
- Allows insertion of interfaces and pie charts.
- Interfaces are automatically anchored to area/zone objects.

Auto Insertion of Interface Objects

Example
interface object
showing flow
from Top area to
Left area



Set default
pie chart
size

Select **OK** to auto insert the interface objects

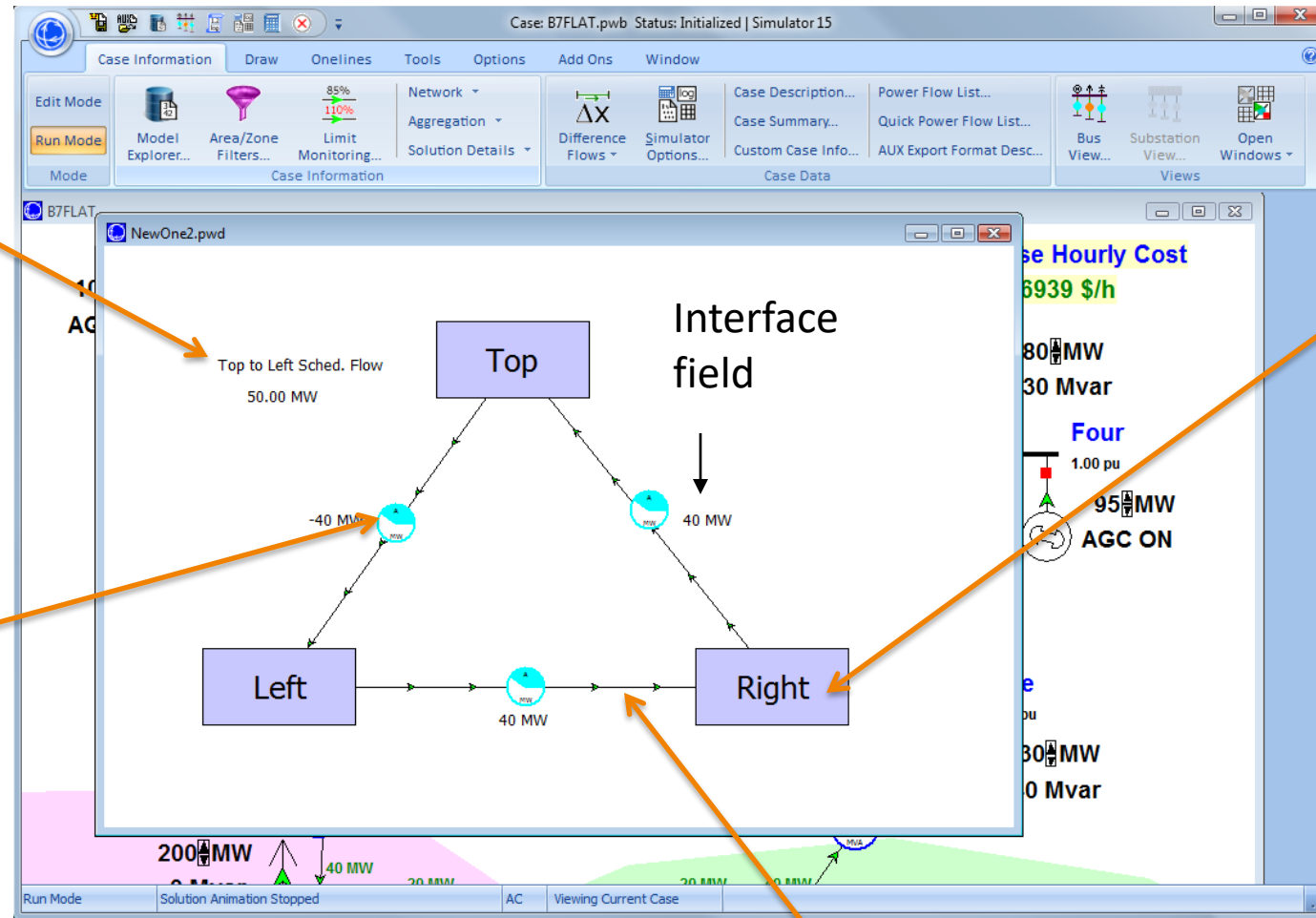


With Interface/Area Fields



Text field and
area field

Pie charts
require that
interface limits
be defined



Right-click on
object to view
area dialog

Animated flows can be shown

Super Areas



- Super areas are groupings of individual areas; analogous to an area being a grouping of individual buses
- Super areas can be used to control several areas together
- Open Model Explorer and choose **Aggregations → Super Areas** to see the Super Area Records
 - Right-click and select **Insert...**
 - Super Area Dialog is displayed with default name assigned to the new super area

Super Area Dialog



Areas already included

Area Num	Area Name	Part. Factor
1	1 Top	1.0000
2	2 Left	1.0000
3	3 Right	1.0000

Control for Super Area; this control overrides all individual area control settings unless on *No Super Area Control*

Add by name or by number(s)

Super Area Dialog



Area Interchange
Information

Super Area Information

Name: DefaultSA1 [Add New] [Rename] [Save] [Delete]

Area in Super Area | Summary Information | OPF | Custom

Transactions

ACE Total (MW): 0.00

ACE Tolerance (MW): 2.00

Total Scheduled Transactions: 0.0

Cost Information

Lambda: Off ED

Hourly Cost (\$/hr): 0.00

Load and Generation

	MW	Mvar
Load	0.0	0.0
Generation	0.0	0.0
Shunts	0.0	0.0
Losses	0.00	0.00
Interchange	0.0	0.0

[OK] [Cancel] [Print] [Help]

Super area
summary
information

Injection Groups



- Represents grouping of injections of power
 - Loads
 - Generators
 - Switched Shunts
 - Other Injection Groups (*be careful of circular references*)
- Useful for defining more specific groups of sources and sinks in many tools
 - Especially useful for ATC, PVQV tools; also for Sensitivities (PTDF, TLR, etc...)
 - Also useful for general reporting, e.g. make an aggregation of generators and show the sum of their output

Injection Groups



- Open Model Explorer and choose **Aggregations → Injection Groups**
 - Right-click, select **Insert...**
 - Injection Groups Dialog is displayed with default name assigned to the new injection group
 - Right-click in the Participation Points grid and Insert elements into the injection group or click **Insert Points**
- Auto Insertion also available from the local menu in Model Explorer

Injection Groups



Add loads, generators, shunts, or other injection groups

Click to Add

Elements already in the injection group

Points for Injection Group DEFAULTIG1

Sort by Name | Sort by Number

GEN	One (1) #1	1.0000

Elements available for adding

Choose how to determine the participation factor for each element

Injection Group Participation Points



- Injection Groups are made up of “Participation Points” which have two main attributes
 - Reference to a generator, load, switched shunt, or another injection group
 - Participation factor
 - Note: this participation factor is *independent* of the generator object’s participation factor
- When you create a participation point, you can define the initial participation factor for the point using various methods.
 - This is depicted on the following slide

Injection Group Participation Points: Participation Factors



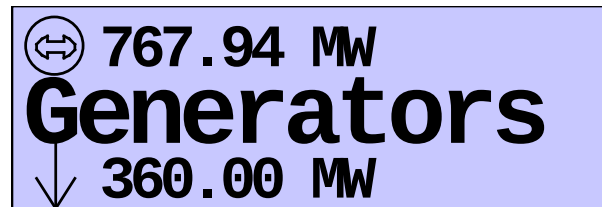
- For a generator, the choices for participation factor are shown to the right
 - Specify particular value
 - Use generator's participation factor
 - Base on positive reserve (Max – Present MW)
 - All units will hit their maximum at same time
 - Base on negative reserve (Present – Min)
 - All units will hit their minimum at same time
 - Base on MW capability (Max MW)
 - Use Custom Floating Point Field
- Recalculate Factors Dynamically
 - Normally the participation factor will only be calculated at this time.
 - Check this box to automatically recalculate the factors *EVERY TIME* they are used
 - This way, if you use the injection group with a different case or different system state it will still be what you intend.

A screenshot of a software dialog box titled "Participation Factors". It contains several radio button options: "Specify a value:" (with an adjacent text input field), "Use present participation factor" (which is selected), "Base on positive reserve", "Base on negative reserve", "Base on MW capability", "Use Custom Field:" (with a dropdown menu showing "Cust Float 1"), and a checkbox labeled "Recalculate factors dynamically".

Injection Group Display Objects



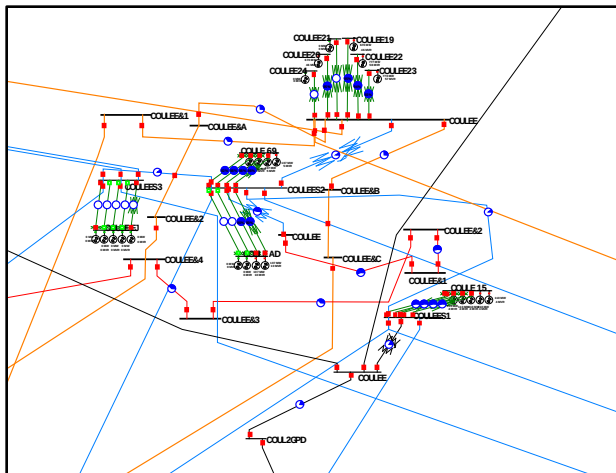
- You can also insert display objects which represent Injection Groups
- On the **Draw** ribbon tab, choose **Aggregation** → **Injection Group**
- Click on the oneline where you would like to place the injection group
- Display objects show the generation and load which exist inside the group



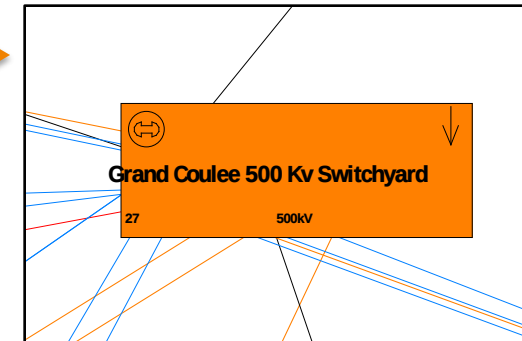
Substations



- Some substations in a power system have a large number of buses in them
 - Large power stations
 - Other important places in a power system
- Traditional Power System Cases do not have any reference to which “substation” a bus is inside (but this is changing)
- Simulator allows you to define this relationship and then create substation-based diagrams



27 Grand Coulee Buses
are placed in a single
substation

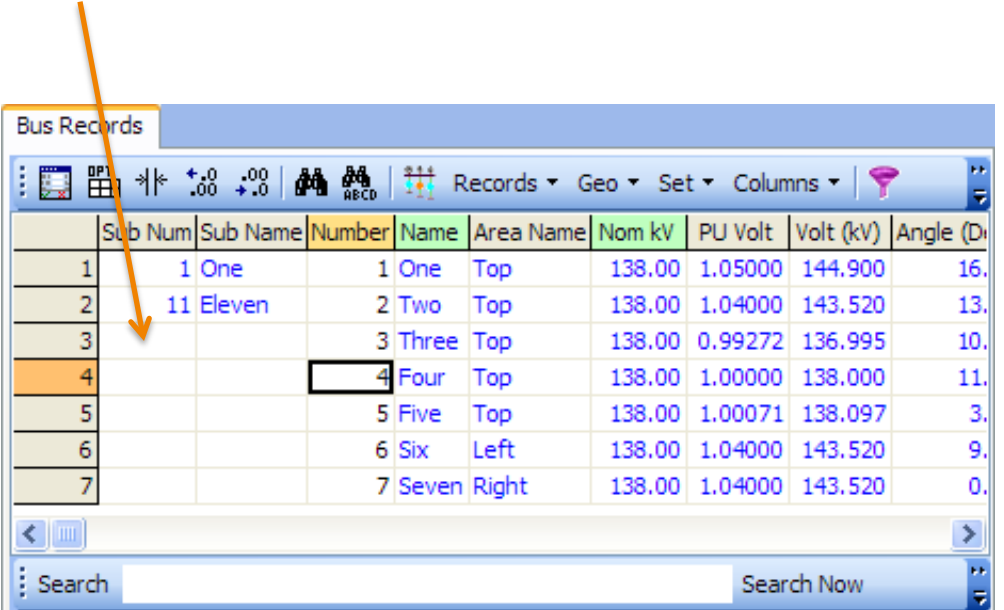


Creating Substations



- To create a new Substation
 - Make sure you're in Edit Mode (for all methods)
 - Select **Insert...** from the local menu (right-click) in Substation Records; OR
 - Auxiliary files or Copy/Paste from Excel; OR
 - Open **Network → Buses** in the Model Explorer or open the Bus Dialog and assign an existing bus to a new Substation number

Enter a new number to create a new Substation



The screenshot shows the 'Bus Records' window with a table of bus data. An orange arrow points to the 'Number' column of the 4th row, which is currently empty, indicating where to enter a new number.

	Sub Num	Sub Name	Number	Name	Area Name	Nom kV	PU Volt	Volt (kV)	Angle (D)
1		1 One	1	One	Top	138.00	1.05000	144.900	16.
2		11 Eleven	2	Two	Top	138.00	1.04000	143.520	13.
3			3	Three	Top	138.00	0.99272	136.995	10.
4				4 Four	Top	138.00	1.00000	138.000	11.
5			5	Five	Top	138.00	1.00071	138.097	3.
6			6	Six	Left	138.00	1.04000	143.520	9.
7			7	Seven	Right	138.00	1.04000	143.520	0.

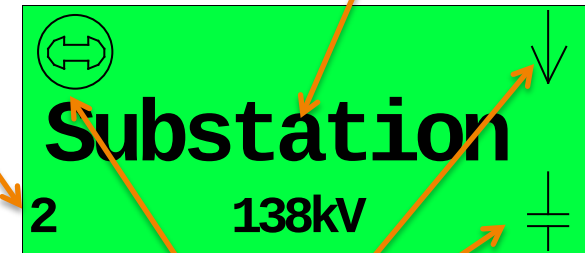
Substation Display Objects



- You can also insert display objects which represent Substations
- From the **Draw** ribbon tab, choose **Aggregation** → **Substation**
- Click on the oneline where you would like to place the injection group
- Note: You can also auto-insert transmission lines between Substation objects

Number of buses assigned to the substation

Name of Substation



Symbols indicate whether Generation, Load, or Shunts exist inside the substation

Supplemental Data



- Used for linking information about non-power system elements or infrastructure to power system elements
- Example: link data centers to loads they are fed from
 - *A Supplemental Classification* is a category of *Supplemental Data* (e.g. “Data Centers”)
 - Individual data centers then belong to the Supplemental Classification “Data Centers” and each can be assigned to one or more load objects (or buses, substations, etc.)
- Supplemental Data can be used in filtering, dynamic formatting, Select by Criteria, and custom hints

Supplemental Classification Example



- In the Model Explorer, navigate to Aggregations → Other Aggregations → Supplemental Data → Supplemental Classification
- Right-click to open the local menu, then **Insert...**
- Give it the name “Data Centers”

Enter “Load”
for these fields

YES means a power system Object
can belong to more than one of
this Classification

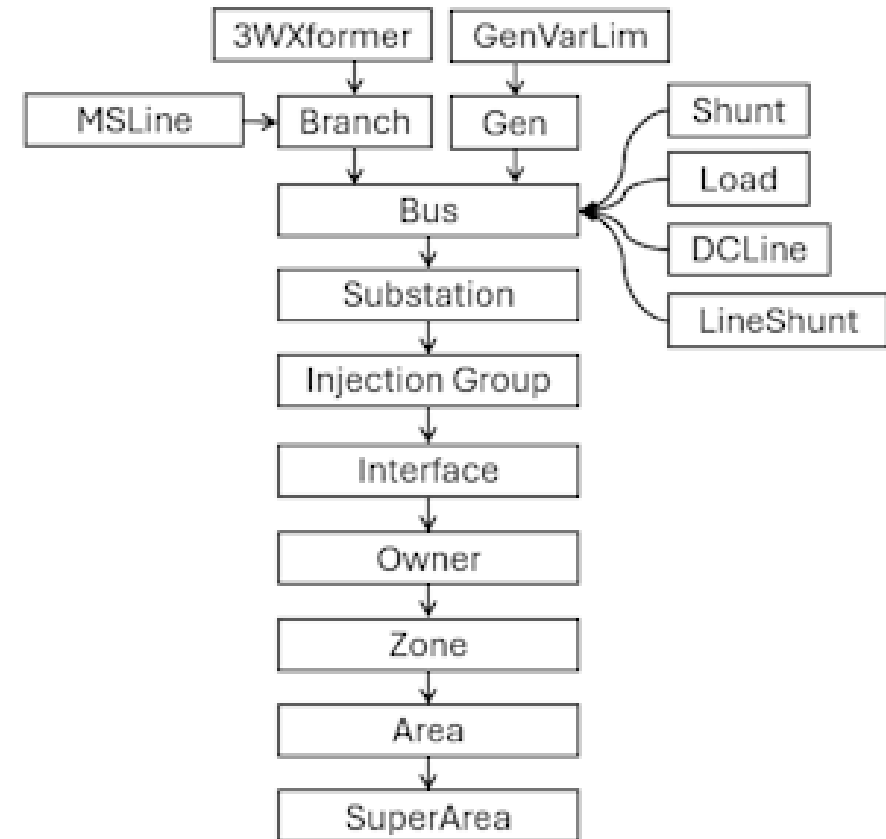
Supplemental Classification		Supplemental Data		Supplemental Data Assigned Objects		
	Name	Contains Objects of Type	User Assignable Object Types	Allow Multiple	Inherits from Model Structure	Object Type
1	Data Centers	Load	Load	YES	YES	DataCenters

Described on next slide

Inherits from Model Structure

- YES allows objects to inherit which Supplemental Data they are contained by from the model structure. For example, if a classification is assigned buses, you may want a generator to inherit Supplemental Data from its terminal bus

Contained Inheritance Hierarchy



Add Supplemental Data Objects

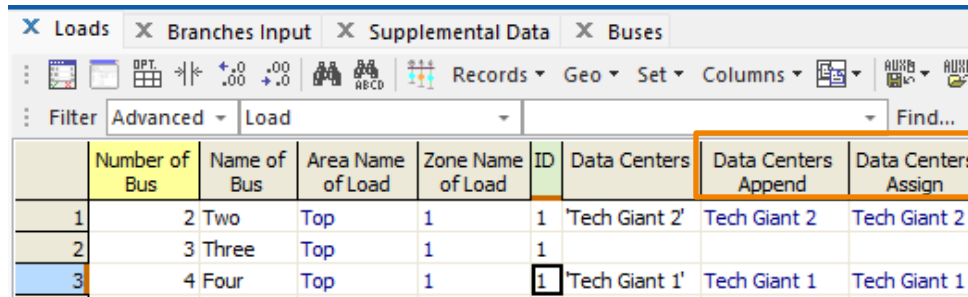


- On the *Supplemental Data* tab, right-click to open the local menu, then **Insert...**
- Add one or more data centers to the *Supplemental Classification* “Data Centers”

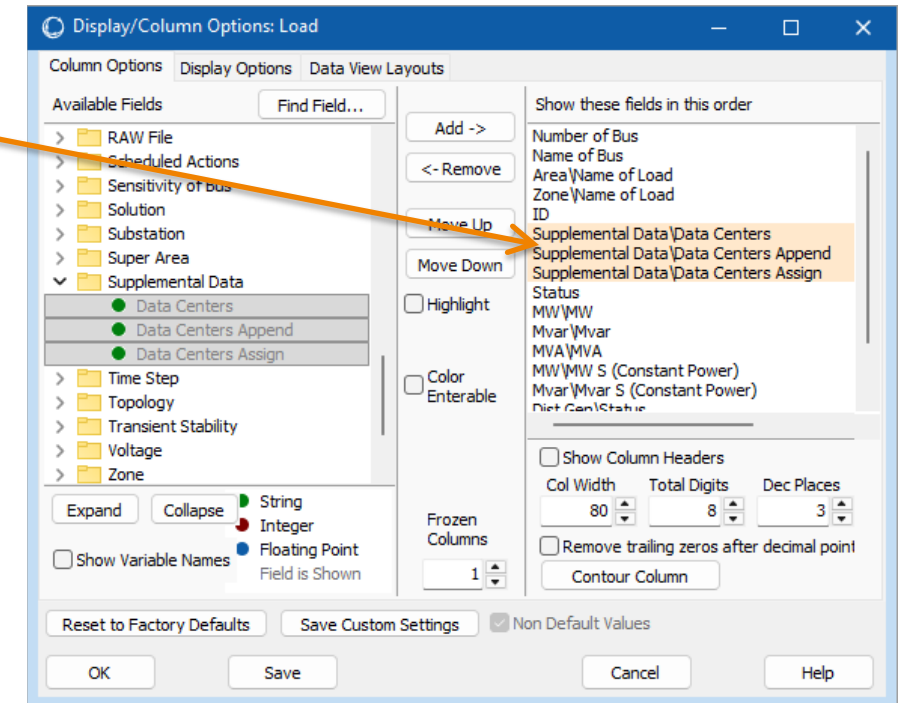
A screenshot of a software dialog box titled "Define Supplemental Data". It features a blue header bar with standard window controls. The main area contains a "Classification" dropdown menu set to "Data Centers" with a "New..." button to its right. Below this is a "Name" text field containing "Tech Giant 1". At the bottom, there are three buttons: "OK" with a green checkmark, "Save", and "Cancel" with a red X.

Assign Power System Objects to Supplemental Data

- In the Model Explorer, navigate to Network → Loads
- Reveal the Supplemental Data Columns using Display/Column Options
- Assign individual Data Centers to Loads
 - *Append* fields allow you to enter one at a time
 - *Assign* fields allow you to edit the entire set as a comma-separated list



	Number of Bus	Name of Bus	Area Name of Load	Zone Name of Load	ID	Data Centers	Data Centers Append	Data Centers Assign
1	2	Two	Top	1	1	'Tech Giant 2'	Tech Giant 2	Tech Giant 2
2	3	Three	Top	1	1			
3	4	Four	Top	1	1	'Tech Giant 1'	Tech Giant 1	Tech Giant 1



- Much more detail in the Web Help

https://www.powerworld.com/WebHelp/Default.htm#MainDocumentation_HTML/Supplemental_Data.htm

Object Groups



- Most power system objects (buses, generators, loads, branches, etc.) may be assigned to one or more Object Groups
- Example use: Assign a group of hydro generators to a river basin
 - In the Model Explorer, navigate to Aggregations → Other Aggregations → Object Groups
 - Right-click to open the local menu, then **Insert...**
 - Give it the name “Big River”

	Name	Gen MW	Load MW	Load DistMW	Bus NomkV Max	Bus NomkV Min
1	Big River					

Assign Power System Objects to Object Groups



- In the pane below, view tabs for each object type
 - *ObjectGroup Append* fields allow you to enter one at a time
 - *ObjectGroup Assign* fields allow you to edit the entire set as a comma-separated list

Assignments to [Big River]

Contained by [Big River]

☐ Show only objects that have been assigned to a group [Big River]

All	Bus	Generator	Load	Switched Shunt	Branch	Branch	Line Shunt	3W Transform	
	ObjectGroup Assign	ObjectGroup Append	Number of Bus	Name of Bus	ID	Status	Gen MW	Gen Mvar	Min MW
1	Big River	☐	1	One	1	Closed	102.21	5.15	100.00
2	Big River		2	Two	1	Closed	170.50	33.14	150.00
3			4	Four	1	Closed	95.37	19.88	50.00
4			6	Six	1	Closed	199.58	-6.33	150.00
5			7	Seven	1	Closed	200.31	51.41	0.00

Difference Flows

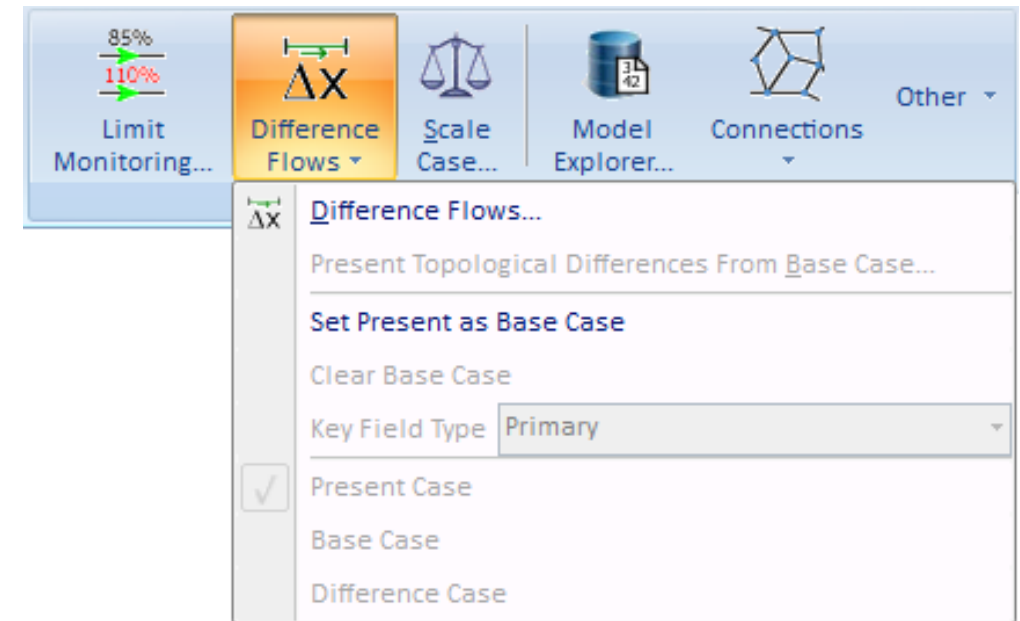


- Simulator allows two different power system cases to be simultaneously loaded
 - Present Case
 - Base Case
- Difference flows allow viewing of either case or of the differences between the cases
- Changes in status are shown using OPEN/CLOSED fields (present case status listed first)

Difference Flows Dialog



- The Difference Flows dialog is used to control which case is being viewed.
- The Difference Flows dialog can be viewed by either
 - **Difference Flows** option on oneline local menu
 - **Difference Flows** on the **Tools** ribbon tab



Difference Flows Dialog



Select to set present case as the base case and enable the other options

Select to change which case is being viewed

Difference Case

Set Present as Base Clear Base

Display Mode

☒ Present Mode
☐ Base Mode
☐ Difference Mode
☐ Change Mode

Key Fields to Use

☒ Primary
☐ Secondary
☐ Label

☐ Show Present|Base in Difference and Change Mode

OK Reset Case ... Help

Difference Case

Set Present as Base Clear Base

Display Mode

☒ Present Mode
☐ Base Mode
☐ Difference Mode
☐ Change Mode

Key Fields to Use

☒ Primary
☐ Secondary
☐ Label

☐ Show Present|Base in Difference and Change Mode

OK Reset Case ... Help

The difference flows options affect the onelines AND the case information displays

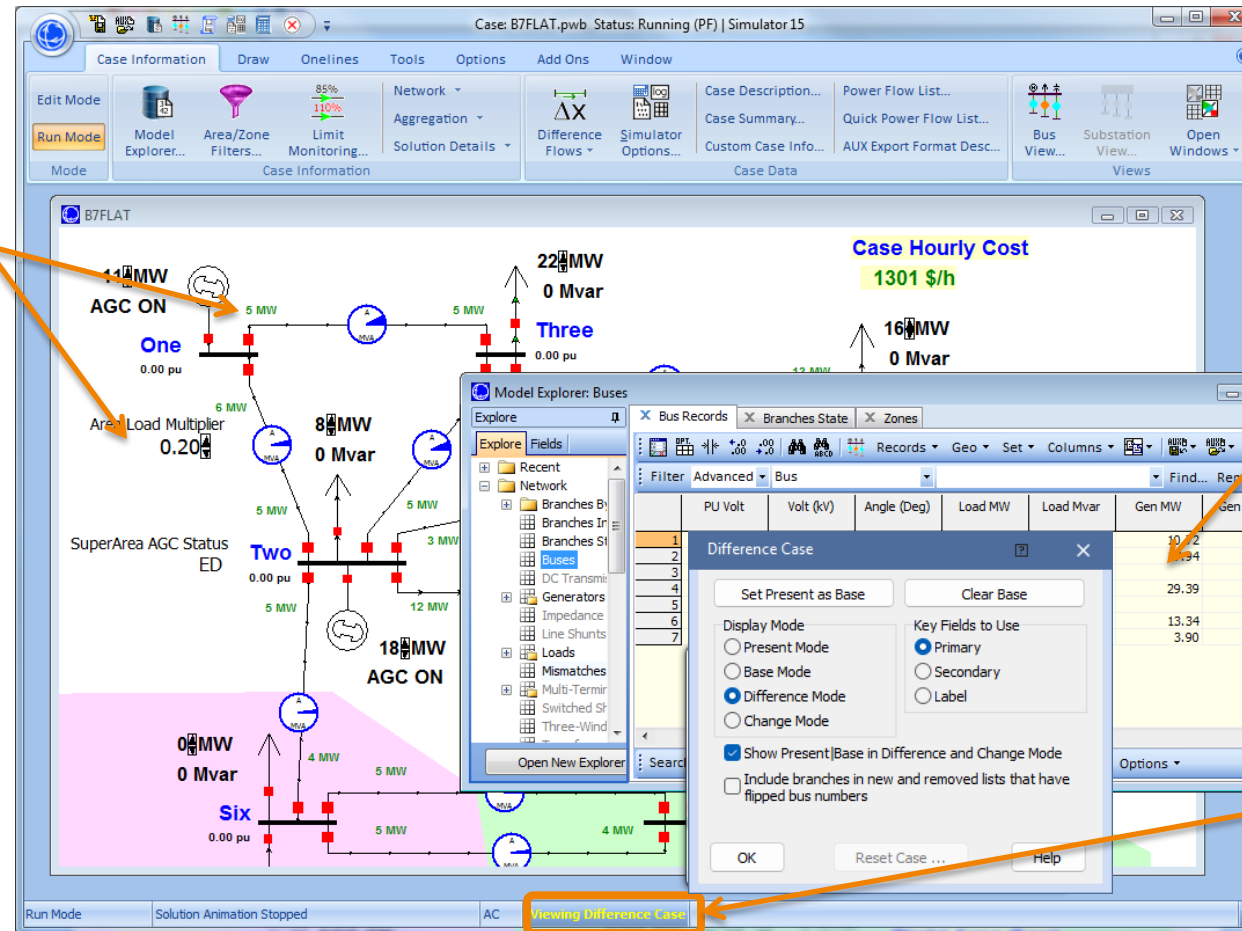
Once base case has been set, its values can not be changed

Clears the base case from memory

Difference Flows



All fields now show the difference between the present case and the base case



Case Information Displays also show differences

Viewing the Difference Case

You can NOT change values in the difference mode!

Difference Flows: Change Mode



- Shows the *present values* of quantities that are different in the present case than in the base case
- Quantities that are equal (within tolerance) in both cases are blank

	Area Num	Area Name	AGC Status	Gen MW	Load MW	Shunt MW	Tot Sched MW	Int MW	ACE MW	Lambda	Loss MW
1	10			2547.41	2781.16		-350.90	-350.78	0.12		117.03
2	11			1313.80	1882.00			-623.71	0.29		55.52
3	14			22558.45	19289.28		2822.60	2823.61	1.01		445.56
4	18			5093.24	6459.37	1.42	-1497.90	-1497.98	-0.08		130.43
5	19	WAPA L.C.	Area Slack	3652.77	1150.73	0.00	2401.00	2400.92	-0.08	Off Control	101.12
6	20			2537.17	2794.19		-300.00	-300.50	-0.50		43.48
7	21	WAPA U.W.		1652.61	1142.93		446.40	445.99	-0.41		63.69
8	22			3918.60	4623.00		-878.00	-877.70	0.30		173.30
9	24			15359.82	22529.33		-7559.00	-7559.62	-0.62		390.11
10	26			5715.96	6671.65		-1294.80	-1294.77	0.03		339.09
11	30			27596.35	27459.77		-880.00	-879.80	0.20		1016.38
12	40			30347.73	25283.03	0.86	3959.90	3960.90	1.00		1102.94
13	50			11292.33	7822.75		2900.00	2899.39	-0.61		570.20
14	52			587.02	770.99		-200.00	-200.95	-0.95		16.98
15	54			10977.80	11121.40			-459.72	0.28		316.13
16	60			2462.51	3579.40		-1253.00	-1253.00	0.00		136.11
17	62			3148.82	2072.15		958.40	958.35	-0.05		118.31
18	63	WAPA U.W.		55.74	-51.50		100.80	100.70	-0.10		6.54
19	64			2637.66	2393.10		168.00	167.63	-0.37		76.94
20	65			10635.11	9314.16	-0.01	986.90	986.64	-0.26		334.33
21	70			7840.07	8165.08		-469.00	-469.23	-0.23		144.23
22	73			6575.65	5406.26		1022.60	1022.46	-0.14		146.93

Comparing Two Different Case Files



- Simulator only allows one case to be open at a time.
- When you open a case, all information about the previously opened case is removed, with one exception
 - The Difference flows information is kept
- Thus to compare two cases, you
 - Open case #1, and go to Run Mode
 - Open Difference Flows and choose Set Present as Base Case
 - Open case #2
 - Open Difference Flows and change to Difference Case

Topological Comparison of Cases



- On the **Tools** ribbon tab, choose **Difference Flows** → **Present Topological Differences from Base Case ...**

Go to folders for detailed lists

Set tolerances for different fields for use in **Change Mode**

Present Case Topological Differences from the Base Case

Choose how to view by: By New/Removed/Both | By Type

Summary

Difference Mode: ☐ Present ☐ Base ☐ Difference ☒ Change ☐ Show Present|Base in Difference and Change [Change Tolerance...](#)

Below is a summary of the comparison between the present case: 18HS4.epc and the base case: 16HS3a.epc saved from the Difference Flows Dialog.

☐ For summary table statistics, show counts using Area/Zone/Owner/DataMaintainer filtering

Element Type	New	Removed	Both
Bus	1716	773	20493
Load	1098	681	10036
Switched Shunt	666	308	2596
Generator	424	276	3787
Reactive Capability	5118	3774	1546
Branch	3390	2267	24073
Transformer Correction	3		27
Transformer	1691	1055	8518
3W Transformer	254	49	538
Line Shunt	39	49	159
DC Transmission Line	2		4
Voltage Source Converter DC L			
Multi-Terminal DC Record			2
Multi-Terminal DC Bus			8
Multi-Terminal DC Transmission			6
Multi-Terminal DC Converter			4
Voltage Control Group			
Voltage Droop Control			

Element Type	New	Removed	Both
Area	1		21
Study MW Transactions	8		45
Balancing Authority	42		1
Zone	31	11	457
Owner	72	11	502
Super Area			
Data Maintainer			
Interface			70
Interface Element	49	49	261
Bus Pair			
Injection Group	1		
Participation Point	62		
Substation	992		
Multi-Section Line	52	119	121
Model Group	39		
Nomogram			
Limit Set			1
Rating Set Name Branch			15
Rating Set Name Bus			4
Rating Set Name BusPair			4
Rating Set Name Interface			15

Save To > Remove Field Customizations for All Difference Tables Close

Columns show the number of new, removed elements

New: elements in the present case which are not in the base case

Removed: elements not in the present case which were in the base case

Both: element in the present case and the base case

Topological Differences: Elements Removed Tab



- **Removed → Network → Branch** provides a list of branches in the **Base Case** that are not found in the **Present Case**
- **Link Status**: provides reason they were not found in the **Present Case**

Present Case Topological Differences from the Base Case

Choose how to view by
By New/Removed/Both By Type

Summary
New (15750)
Removed (9422)
Network (9232)
Bus (773)
Load (681)
Switched Shunt (30)
Generator (276)
Reactive Capability
Branch (2267)
Transformer Correct
3W Transformer (46)
Line Shunt (49)
DC Transmission Lin
Voltage Source Con
Multi-Terminal DC R
Multi-Terminal DC B
Multi-Terminal DC Tr
Multi-Terminal DC C
Voltage Control Gro
Voltage Droop Cont
Aggregation (190)
Both (73314)
Create Bus Swap List

Assume base Areas/Zones/Owners and Data Maintainers that are not in present case meet the filters

Difference Mode ☐ Present ☐ Base ☐ Difference ☒ Change ☐ Show Present/Base in Diffe

Elements which exist in the base case: 16HS3a.epc
but not the present case: 18HS4.epc

Removed/Network/Branch (2267)

Link Status	From Number	From Name	From Nom kv	From Name_Nom kv	From Area Name	From Area Num
No To Bus	10004	ALCAZAR	115.00	ALCAZAR_1	NEW MEXIC	
No From Bus	10398	YAHALL11	115.00	YAHALL11_	NEW MEXIC	
No From Bus	10051	BROARN11	46.00	BROARN11_	NEW MEXIC	
No To Bus	10024	B-A	115.00	B-A_115.0	NEW MEXIC	
No Branch with ID	10025	B-A	345.00	B-A_345.0	NEW MEXIC	
No From Bus	10378	SANB-A12	345.00	SANB-A12_	NEW MEXIC	
No To Bus	10030	BALLP_T	46.00	BALLP_T_46	NEW MEXIC	
No To Bus	10039	BEV_WOOD	115.00	BEV_WOOD	NEW MEXIC	
No To Bus	10048	BROADWAY	46.00	BROADWAY	NEW MEXIC	
No From Bus	10158	FT_CAP11	46.00	FT_CAP11_	NEW MEXIC	
No From Bus	10399	YAHWIND11	115.00	YAHWIND11	NEW MEXIC	
No From Bus	10190	KAICOC12	46.00	KAICOC12_	NEW MEXIC	
No From Bus	10148	EL-EL-14	46.00	EL-EL-14_46	NEW MEXIC	
No To Bus	10099	EL-PE	46.00	EL-PE_46.0	NEW MEXIC	
No To Bus	10103	EMBUDO	115.00	EMBUDO_11	NEW MEXIC	
No From Bus	10507	NE_SUB	115.00	NE_SUB_11	NEW MEXIC	
No To Bus	10107	FT_MARCY	46.00	FT_MARCY_	NEW MEXIC	
No From or To Bus	10109	EL-EL-11	46.00	EL-EL-11_46	NEW MEXIC	
No From or To Bus	10110	EL-EL-12	46.00	EL-EL-12_46	NEW MEXIC	
No From Bus	10507	NE_SUB	115.00	NE_SUB_11	NEW MEXIC	
No From Bus	10270	PERHAZ11	46.00	PERHAZ11_	NEW MEXIC	
No From Bus	10132	HW-11	115.00	HW-11_115	NEW MEXIC	
No From or To Bus	10146	EL-EL-13	46.00	EL-EL-13_46	NEW MEXIC	
No From Bus	10175	EMBJUA11	115.00	EMBJUA11_	NEW MEXIC	

Save To > Remove Field Customizations for All Difference Tables Close



Owners



- Like Areas and Zones:
 - each Bus is assigned to exactly one Owner
 - Gens/Loads/Shunts typically belong to the Owner as their terminal Buses, but they may be assigned to different ones
 - Can be used to select objects for System Scaling
- Generators, Shunts, and Branches may have multiple owners with associated ownership percentages
- Can be used Case Information Display filtering (Area/Zone/Owner/DataMaintainer Filters)



Balancing Authority



- Like Areas and Zones:
 - each Bus is assigned to exactly one Balancing Authority
 - Gens/Loads/Shunts typically belong to the Balancing Authority as their terminal Buses, but they may be assigned to different ones
- Balancing Authority is used primarily for aggregation of quantities like total generation/load



Data Maintainer



- Designate entities responsible for maintaining the input data for objects in the model
 - Provides contact information: name, email, phone number
 - Some features allow a user to write out only the data that belongs to a particular DataMaintainer
- Can be used for Case Information Display filtering (Area/Zone/Owner/DataMaintainer filters)
 - enable first in **Simulator Options → Case Information Displays**

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