

PowerWorld Simulator Users' Group Meeting



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Hosted by Exelon Corporation

New Features in Simulator 10.0



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Overview



- Customizable Tool Bars
- Case Info Displays
 - Custom Case Info Displays
 - Color Coded Case Information Display
 - More Custom Floating Point and String Fields
- One-line Diagrams
 - Customizable Bus Views
 - Screen Layers
 - Customization of Substation Objects

Overview



- Data Improvements
 - Interface Element Weightings and Nomograms
 - Automated File Archiving
 - Merge Buses
 - New Interface Objects
- Contingency Analysis
 - New Contingency Actions
 - More report writing options
 - Robust Solution Process

Overview

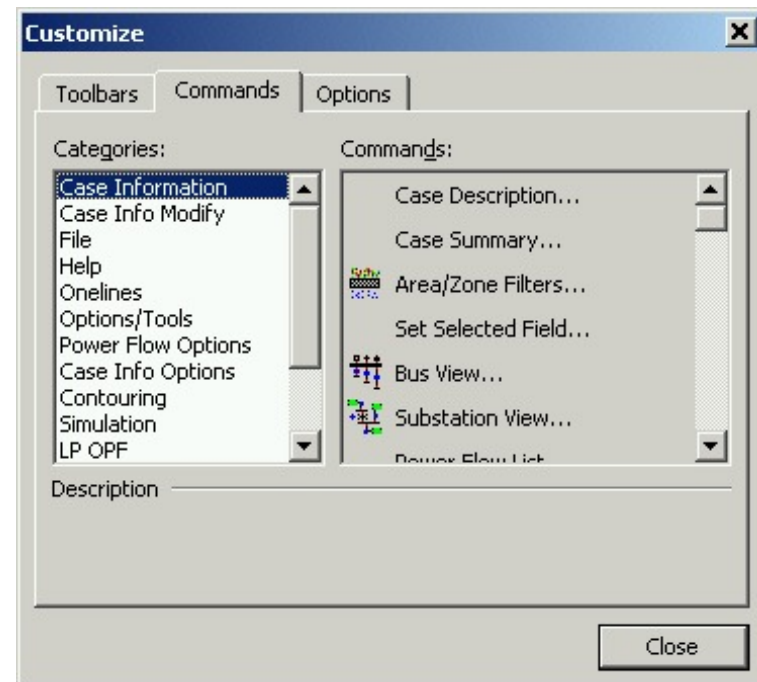
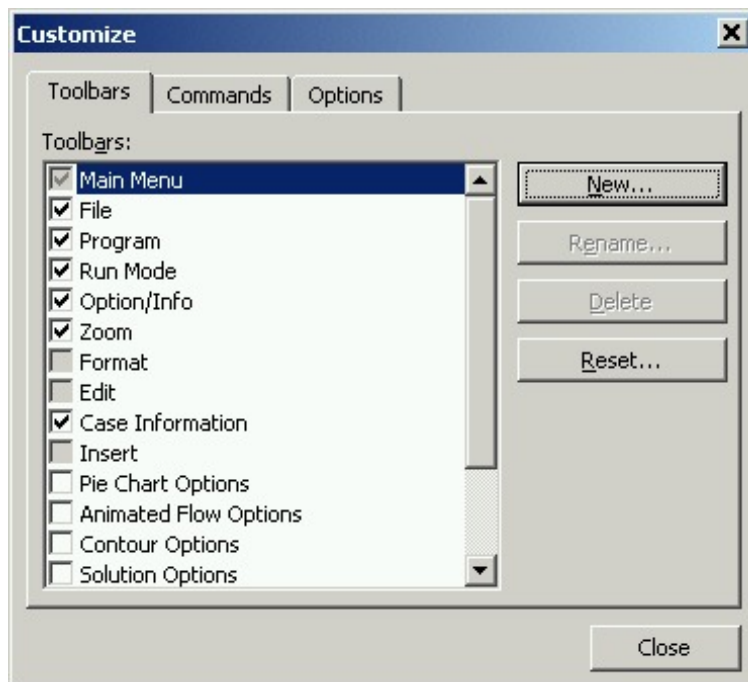


- Power Flow Improvements: Island-based AGC
- OPF/SCOPF
 - OPF Maximum Violation Cost (Penalty Curve)
 - Splitting MW Marginal Costs into components
 - MW area to area transactions as a control

Custom Tool Bars



- Right clicking in the tool bar area brings up a local menu to show, hide, create, or customize contents of tool bars
- Feature is similar to that commonly found in other windows applications



Custom Case Info Displays



- Create spreadsheet-like case info displays with any type of information of interest
- Select Case Information -> Custom Case Info

The screenshot shows a window titled "Custom Case Information Display" with a spreadsheet interface. The spreadsheet has columns labeled A through F and rows numbered 1 through 9. The data in the spreadsheet is as follows:

	A	B	C	D	E	F
1						
2						
3		Type to enter custom strings				
4			Top	Gen 4 Area Name		
5		double-click on a cell to enter	95.0325 MW	Gen 4 MW		
6		a model field	YES	Gen 4 AGC Status		
7						
8						
9						

Below the spreadsheet, there are several controls:

- Buttons: Rename Sheet, New Sheet, Delete Sheet.
- Custom Case Info Mode section:
 - Define Fields/Strings
 - Change Field Data
 - Show Fields Primary
 - Show Fields Secondary
- Buttons: Close, Help.

Other Case Info Improvements



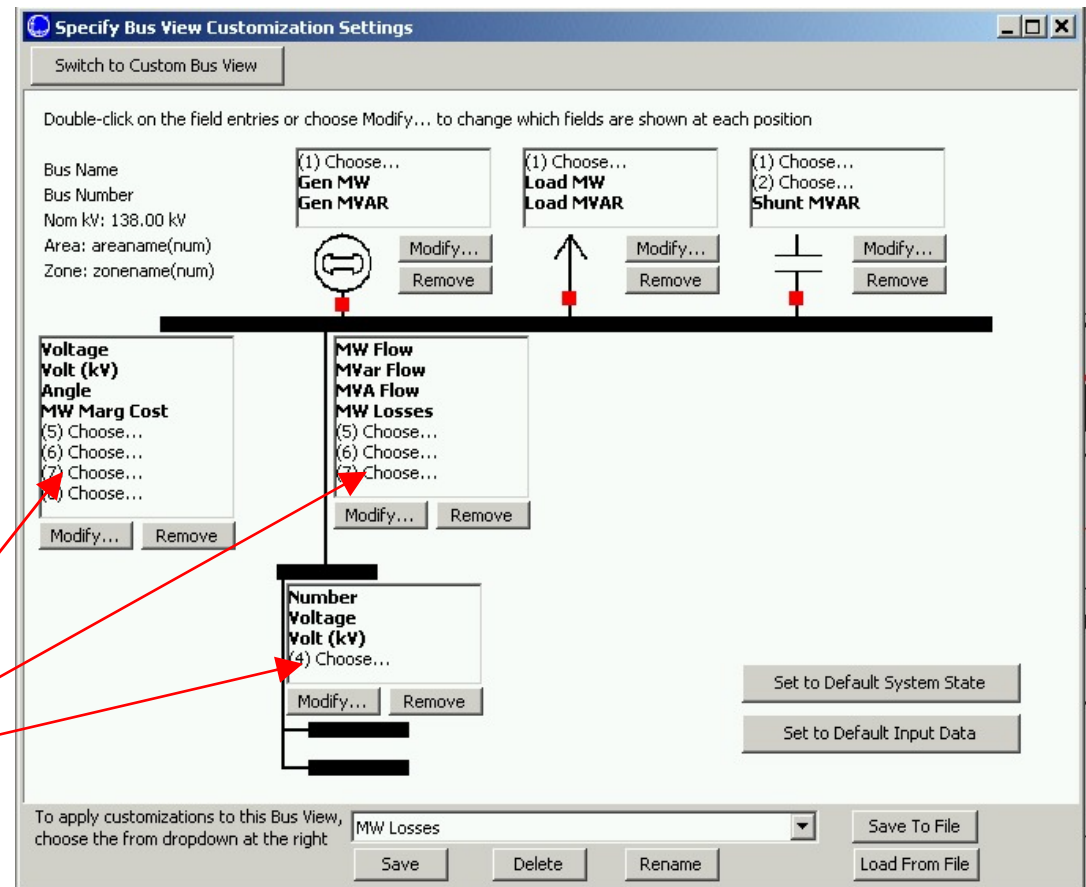
- Color-coded headings for key and required fields
- Coloring of sorted columns
- Available centering of column text
- Captions to identify the active advanced filter
- New Custom Floating Point Fields and Custom String Fields are available for most object types
 - Buses
 - Generators
 - Loads
 - Shunts
 - Lines
 - Etc...

Customize Bus View



- Add custom fields to bus view one-line
- Select Views -> Define Custom View from bus view one-line

Add new object fields to certain positions

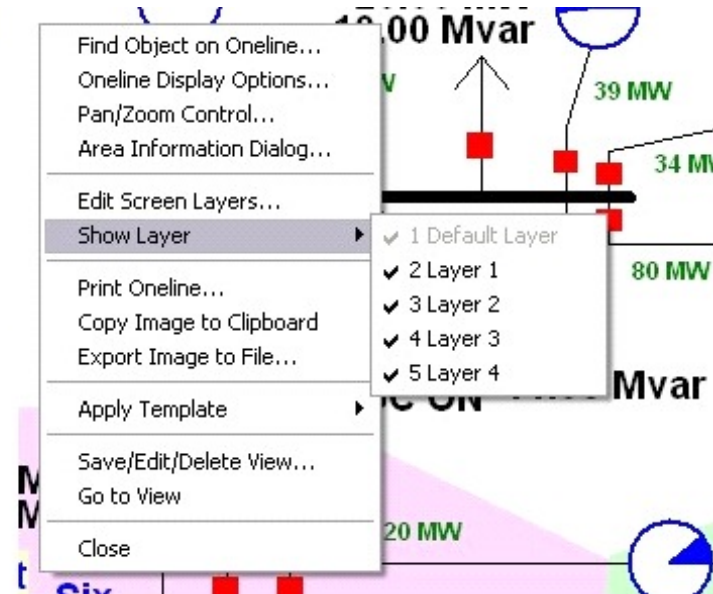


Screen Layers



- Add one-line objects to layers for customized views
- Select Options/Tools -> Screen Layers to create or modify screen layers
- Assign Objects to Layers using the Format -> Display/Zoom Level in Edit Mode

	Layer Name	Shown	Use Con
1	Default Layer	YES	NO
2	Layer 1	NO	NO
3	Layer 2	YES	NO
4	Layer 3	YES	NO
5	Layer 4	YES	NO



Customization of All Substation Objects on a Display



- The general layout of a substation is specified in the Online Display Options
- If substations exist on your diagram, a tab will be available labeled Substation
 - Specify whether to use name/number for the identifier
 - Specify extra fields which appear above, below, left and right of the identifier
 - Specify special symbols to appear in the corners of the substation object
 - Specify the relative sizes of all these fields and symbols
 - Specify how to treat long identifier string (truncate or shrink)

Substation Object Customization



- Play with the settings on this dialog
 - The upper right graphic will change accordingly.

Online Display Options

Display Options | Pie Charts | Animated Flows | ThumbNail View | Memo | Movie | **Substations**

Upper % of Height: 0.0 | Buffer %: 6.0
Identifier % of Height: 55.0 | Buffer %: 6.0
Lower % of Height: 33.0
Left % of Width: 0.0 | Buffer %: 0.0
Identifier % of Width: 100.0 | Buffer %: 0.0
Right % of Width: 0.0 | Buffer %: 0.0

Substation Identifier:
 Name Name (Number)
 Number Number (Name)

What should be done when identifier text does not fit inside the width:
 Dynamically decrease the font size so that the string fits
 Dynamically remove characters from the end of string

Extra Substation Fields

Field	Value	Find...	Digits	Decimals	Units?
Upper	No Field	Find...	0	0	<input checked="" type="checkbox"/>
Lower	Min kV of Highest Nom kV	Find...	6	0	<input type="checkbox"/>
Left	No Field	Find...	6	2	<input checked="" type="checkbox"/>
Right	No Field	Find...	6	2	<input checked="" type="checkbox"/>

Upper-Left Symbol (UL):
 None Switched Shunt
 Generator Number of Buses
 Load

Upper-Right Symbol (UR):
 None Switched Shunt
 Generator Number of Buses
 Load

Lower-Left Symbol (LL):
 None Switched Shunt
 Generator Number of Buses
 Load

Lower-Right Symbol (LR):
 None Switched Shunt
 Generator Number of Buses
 Load

OK | Save Options to Case... | Cancel | Help

Other One-line Improvements

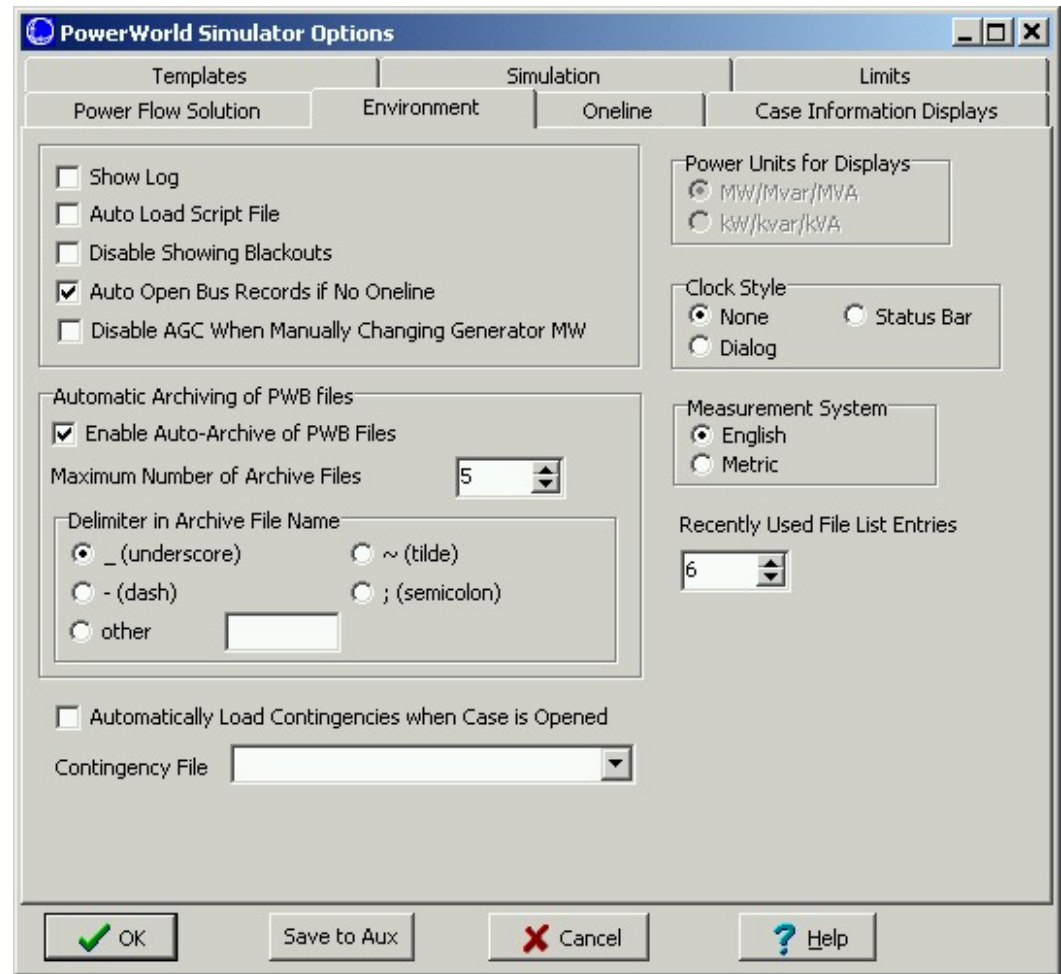


- Multi-section line objects may be displayed as a single object instead of component lines.
- Text on the oneline may be rotated.
- All open onelines may be browsed simultaneously to find objects.
- Transformers may have different colors on the high and low voltage sides
- Pie Charts now display what their percentage is based on (MVA, Amps, etc...) and also what limit the percentage is based on (A, B, C, ...)
- Save One-line Display Options
- You may optionally hide the suffix of a text field
- Keyboard short-cuts for Opening a specific Oneline diagram to a Saved View

Automated File Archiving



- Enables old versions of PWB files to be automatically archived each time the file is saved



Interface Element Weightings



- Interface elements may have specified multipliers for calculating interface flow by a “weighted sum of flows”

The screenshot shows the 'Interface Dialog' window. At the top, the 'Interface Name' is '2-5, 2-4' and the 'Interface Number' is '1'. Below this are fields for 'Limit A' (65.0), 'Limit B' (0.0), and 'Limit C' (0.0). The 'Direction for Flow Monitoring' is set to 'FROM --> TO'. To the right, there are fields for 'Noncontiguous MW Flow' (65.0), 'Contiguous MW Flow' (0.0), 'Total MW Flow' (65.0), and 'PTDF Value (%)' (0.00). The 'Interface Elements' section is set to 'OPF' and includes an 'Insert New Element' button. At the bottom, there is a table with the following data:

	Description	Weighting	Pre-Weight Flow	Flow
1	0.60 times the Line MW flow from bus 'Two' to bus 'Five' circuit	0.60	81.89	49.14
2	0.40 times the Line MW flow from bus 'Two' to bus 'Four' circuit	0.40	40.64	16.26

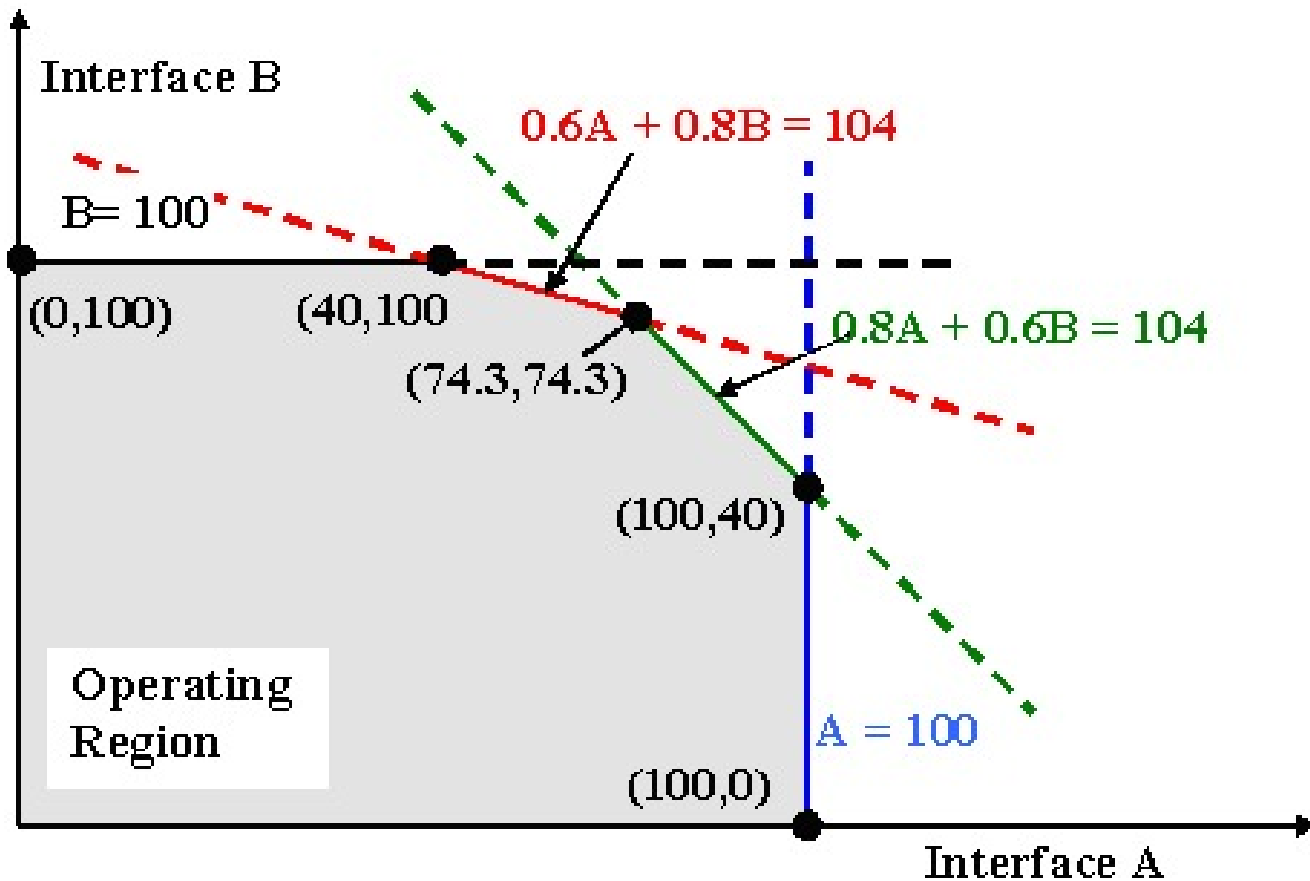
Weightings Specified

Weighted Flows

Nomograms

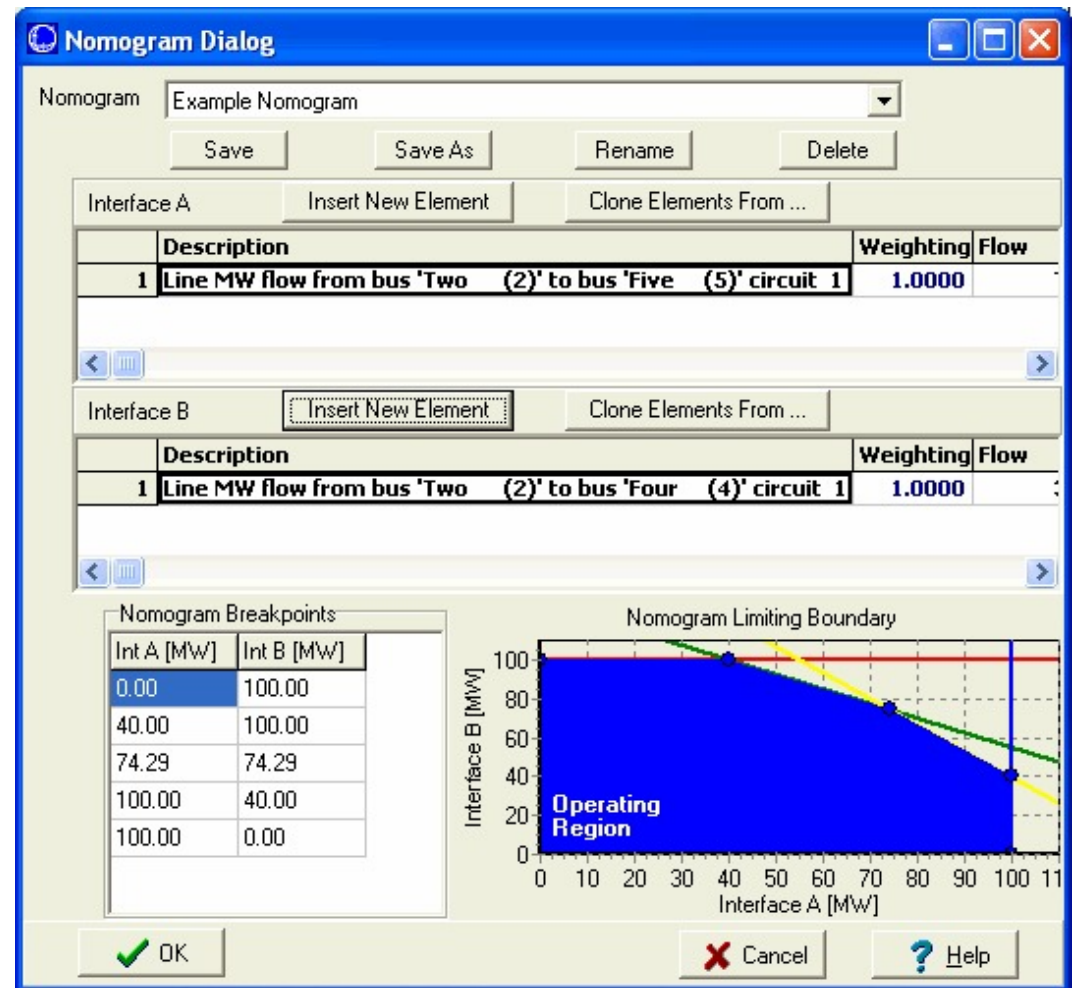


- Nomograms allow definition of 2-dimensional limit spaces using 2 interfaces



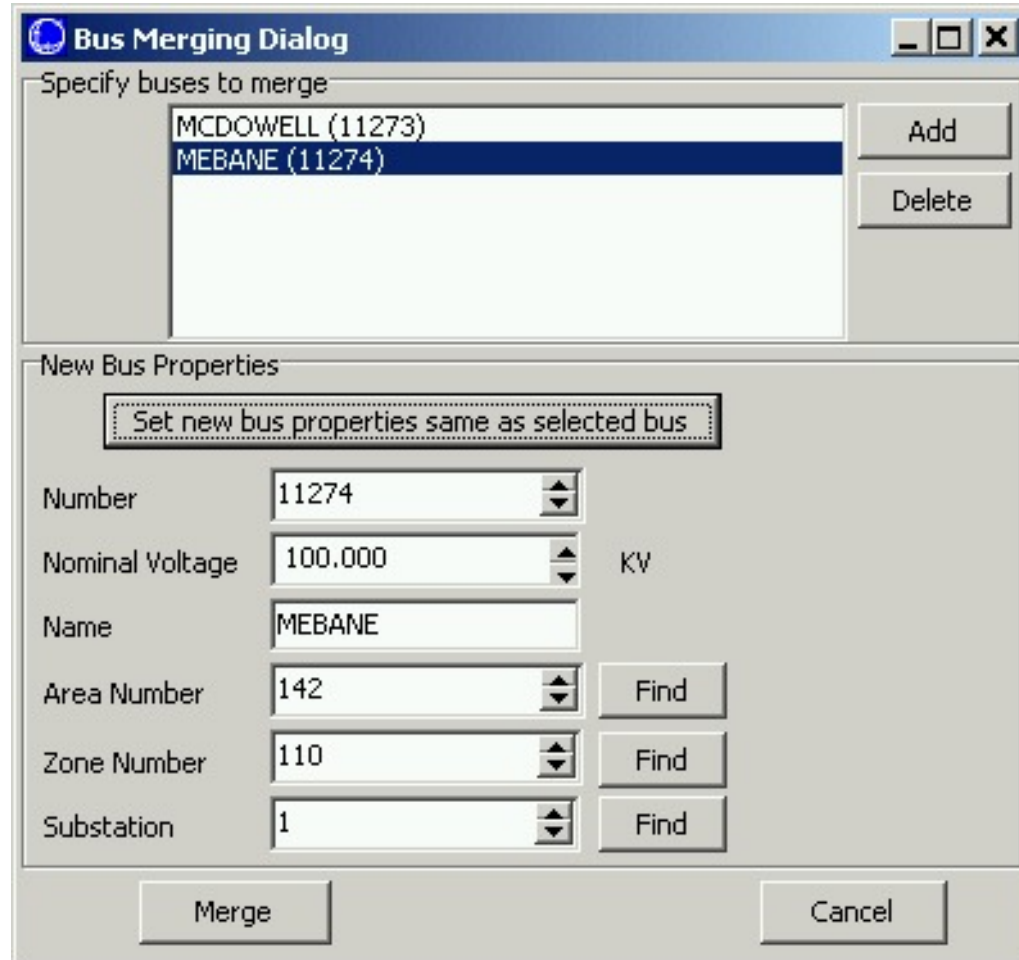
Nomograms

- Select Case Information -> Nomograms to define the Nomograms, interfaces, and set breakpoints



Merge Buses

- Combine loads, generators, and shunts from two or more buses onto a single bus
- In Edit Mode, select Options/Tools -> Merge Buses



The screenshot shows a dialog box titled "Bus Merging Dialog". It has a standard Windows-style title bar with minimize, maximize, and close buttons. The dialog is divided into two main sections. The top section, "Specify buses to merge", contains a list box with two entries: "MCDOWELL (11273)" and "MEBANE (11274)". The "MEBANE (11274)" entry is selected and highlighted in blue. To the right of the list box are two buttons: "Add" and "Delete". The bottom section, "New Bus Properties", contains a text box with the text "Set new bus properties same as selected bus". Below this are several input fields: "Number" (11274), "Nominal Voltage" (100.000 KV), "Name" (MEBANE), "Area Number" (142), "Zone Number" (110), and "Substation" (1). Each of the last three fields has a "Find" button to its right. At the bottom of the dialog are two large buttons: "Merge" and "Cancel".

Other New Data Features



- New elements may be added to interfaces
 - DC line flows
 - Generator outputs: may be used to specify the total output from a power plant (sum of generator outputs < max value)
 - Load values
 - Injection groups
- TLR/GSF: The “P Sensitivity” for out-of-service buses may be set to the value at the closest in-service bus
- Up to 8 transmission line and interface limit values may be stored

Contingency Analysis: Nomograms



- Nomogram limit violations can be reported in contingency analysis, and may also be binding in ATC, OPF, and SCOPF analysis

Contingency Analysis

Contingencies | Lines, Buses, Interfaces | Options | Summary

Lines/Transformers | Buses | Interfaces | Nomogram Interfaces

	Nomo. Name	Nomo. Seg.	Violations	Max % Load
1	Example Nomogram	1	0	
2	Example Nomogram	2	7	76.95
3	Example Nomogram	3	10	106.93
4	Example Nomogram	4	10	109.53

Contingencies

Show Other Violations | Combined Tables >

	Label	Category	Value	Limit	Percent
1	L_00001One-00003ThreeC1	Nomogram MW	79.92	107.33	74.46
2	L_00002Two-00003ThreeC1	Nomogram MW	81.45	107.33	75.89
3	L_00002Two-00006SixC1	Nomogram MW	81.33	107.33	75.78
4	L_00004Four-00005FiveC1	Nomogram MW	62.45	107.33	58.18
5	L_00007Seven-00005FiveC1	Nomogram MW	82.60	107.33	76.95
6	L_00006Six-00007SevenC1	Nomogram MW	68.58	107.33	63.90
7	L_00006Six-00007SevenC2	Nomogram MW	68.58	107.33	63.90

Contingency Definition

Actions	
1	OPEN Branch Two

Status: Finished with 30 Violations and 0 Unsolvable Contingencies. Initial Stat Refresh Displays After Each Contingency

Load | Auto Insert | Save | Other > | Start Run | Close | ? Help

Contingency Analysis: Report Writing



- New options for report writing

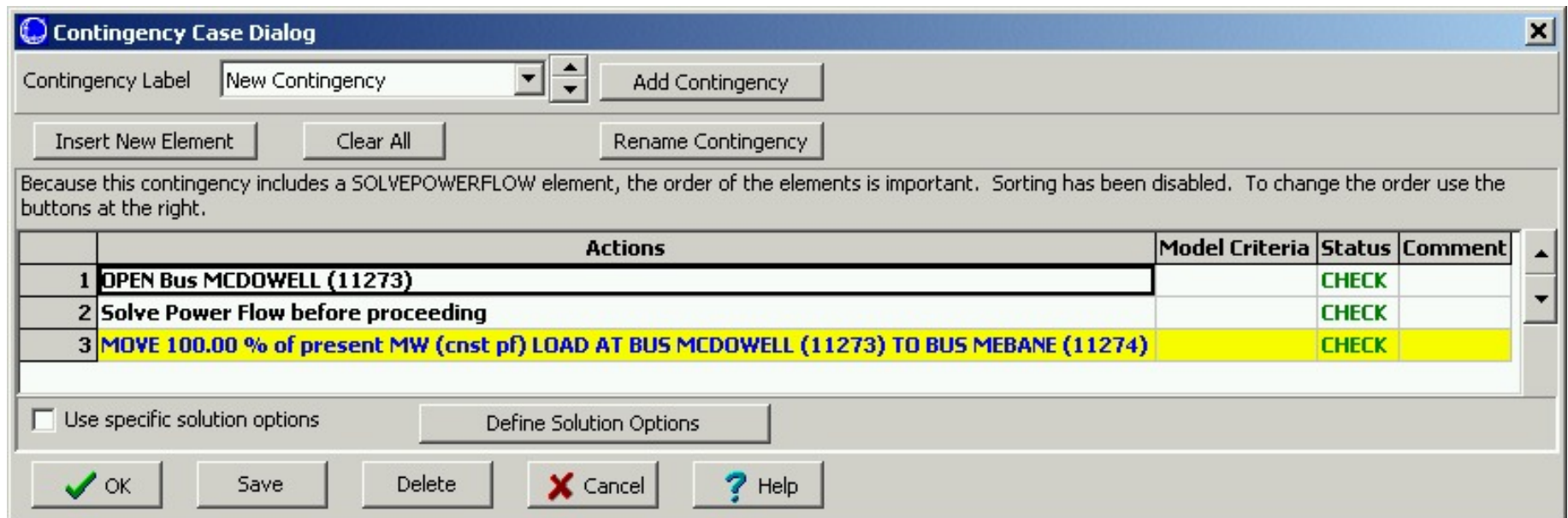
The screenshot shows the 'Contingency Analysis' software window with the 'Options' tab selected. The interface is divided into several sections:

- Optional Report Contents:** A list of checkboxes for report sections: Case summary, Option settings, Monitored areas, Line flow extremes, Interface flow extremes, Bus voltage extremes, Monitored zones, Base-case outages, and All.
- Identify buses by:** Radio buttons for Name, Number, Name(Number), and Number(Name). A checkbox for 'Identify with Nominal Voltage' is also present.
- Limit Type Violations to Include:** A grid of checkboxes for various violation types: Line and Transformer Flows, Interface Flows, Low Bus Voltages, High Bus Voltages, Line/%fmr Change Flows, Interface Change Flows, Low Bus Change Voltages, and High Bus Change Voltages.
- Maximum Violations of a single type to report:** A dropdown menu set to '9999'.
- Field separator:** A dropdown menu set to '\$'.
- Buttons:** 'Product Report', 'Set Options', 'Reset', 'Close', and 'Help'.
- Status:** A field showing 'Initialized' and a checkbox for 'Refresh Displays After Each Contingency'.
- Navigation:** Tabs for 'Contingencies', 'Lines, Buses, Interfaces', 'Options', and 'Summary' at the top, and 'Modeling', 'Advanced Limit Monitoring', 'Advanced Modeling', 'Report Writing', and 'Miscellaneous' at the bottom.

Contingency Analysis: New Actions



- Solve power flow



The image shows a screenshot of the 'Contingency Case Dialog' window. The window title is 'Contingency Case Dialog'. At the top, there is a 'Contingency Label' dropdown menu set to 'New Contingency' and an 'Add Contingency' button. Below this are three buttons: 'Insert New Element', 'Clear All', and 'Rename Contingency'. A text box below the buttons contains the message: 'Because this contingency includes a SOLVEPOWERFLOW element, the order of the elements is important. Sorting has been disabled. To change the order use the buttons at the right.' Below the text box is a table with the following data:

	Actions	Model Criteria	Status	Comment
1	OPEN Bus MCDOWELL (11273)		CHECK	
2	Solve Power Flow before proceeding		CHECK	
3	MOVE 100.00 % of present MW (cnst pf) LOAD AT BUS MCDOWELL (11273) TO BUS MEBANE (11274)		CHECK	

At the bottom of the dialog, there is a checkbox labeled 'Use specific solution options' which is currently unchecked, and a 'Define Solution Options' button. The bottom-most row contains five buttons: 'OK' (with a green checkmark icon), 'Save', 'Delete', 'Cancel' (with a red X icon), and 'Help' (with a blue question mark icon).

Contingency Analysis: Robust Solution Process



- Located on Options -> Modeling tab of CTG Analysis Dialog
- Also available on PVQV and ATC analysis

Contingency Analysis

Contingencies | Lines, Buses, Interfaces | **Options** | Summary

Calculation Method

- Full Power Flow
- Linearized Lossless DC
- Linearized Lossless DC With Phase Shifters

Limit Monitoring Settings ...

For DC methods, allow amp limits by assuming a constant voltage magnitude

Retry solution using the Robust Solution Process after a contingency solution failure

Use specific solution options for contingencies

Define Contingency Solution Options

Make-Up Power

When a contingency involving generation/load MW changes or outages does not specify how to compensate for the lost power import the required power from these sources:

Determine Make Up Using

- Area Participation Factors specified below
- Generator Participation Factors From Entire Case Directly
- Same as Power Flow case

Area Num	Area Name	CTG Make Up Gen
1	25 PJM500	0.00
2	26 PENELEC	0.00
3	27 METED	0.00
4	28 JCP&L	0.00
5	29 PL	0.00
6	30 PEPCO	0.00
7	31 PSE&G	0.00
8	32 BG&E	0.00
9	33 PEPCO	0.00
10	34 AE	0.00
11	35 DP&L	0.00

Modeling | Advanced Limit Monitoring | Advanced Modeling | Report Writing | Miscellaneous

Status: **Initialized** Refresh Displays After Each Contingency

Set Options | Reset | Close | ? Help

Other Contingency Improvements

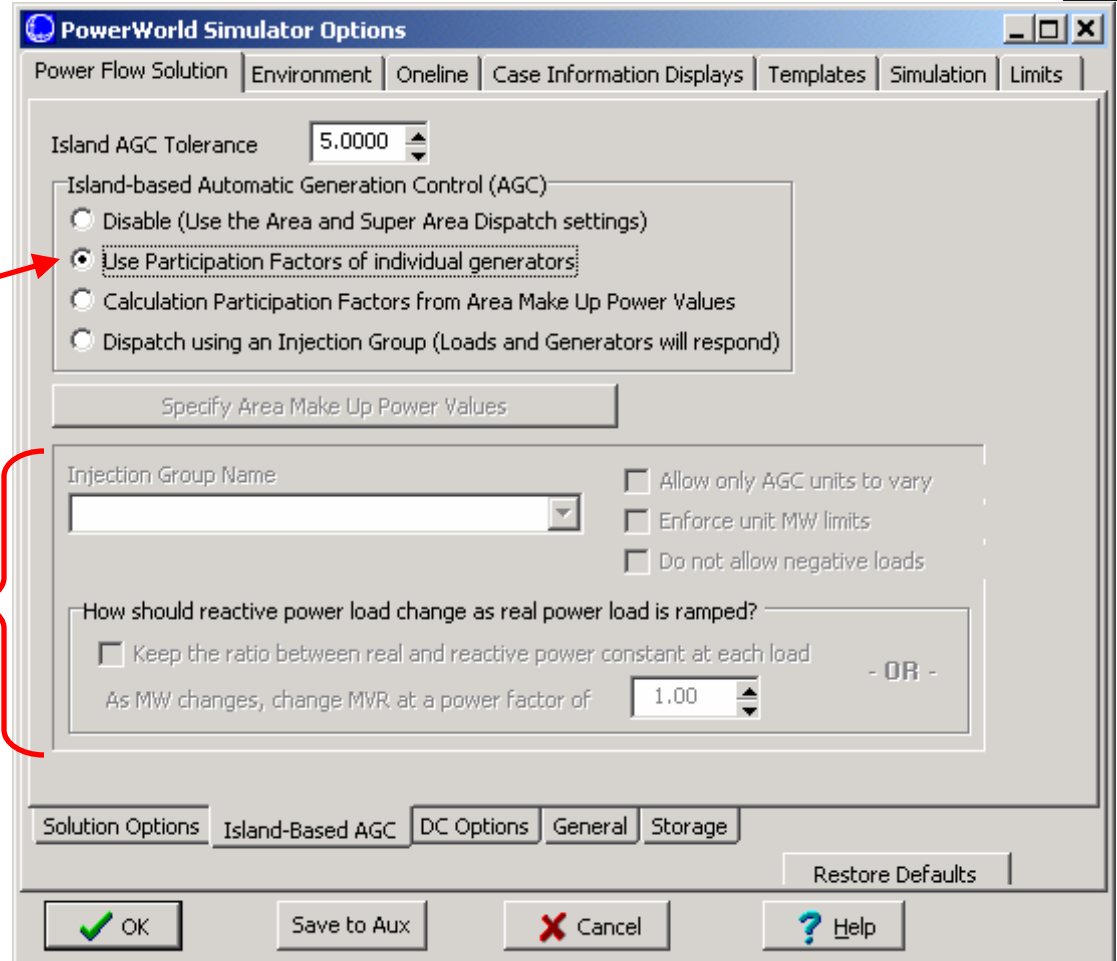


- May now specify “Load Throwover” records for buses so that loads automatically move if they are outaged during a contingency
- Better support for islands created during contingencies when using the linearized AC or DC methods
- Record the total amount of load islanded during a contingency
- Available script commands for auto-inserting contingencies.

Island-Based AGC

- Allow load and generation balancing across an island, instead of Areas or Super Areas

Options used for Injection Group Dispatch



Other Power Flow Improvements



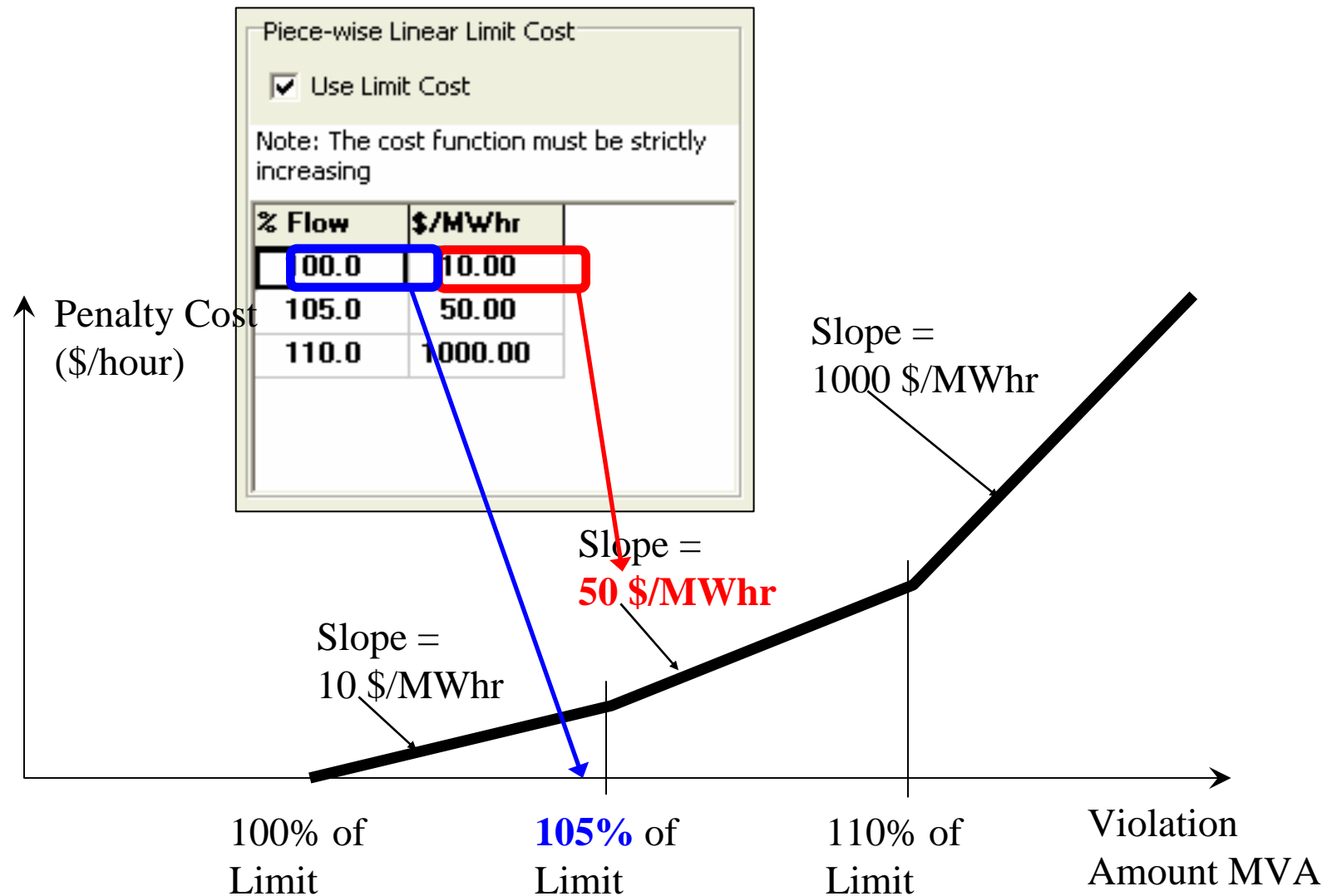
- Switched Shunt Control Range: Specify different target voltages after reaching high limit vs. low limit
- Modified Line-Drop-Compensation: all generators at a bus perform LDC voltage control together
- Improvement to the optimal multiplier technique for calculating power flow solution near voltage collapse
- Tap-changing transformers (LTCs) which are in parallel with each other now coordinate their switching actions so they maintain similar taps
- Continuous Switched Shunts are treated directly in the power flow equations as “PV buses”
- You may now specify Post Power Flow Solution Actions
 - represent conditional actions that occur at the end of every power flow solution
 - Example would be loads that turn off if the voltage is too low.

Specifying a Piece-wise Limit Cost with the Limit Groups



- Starting in Simulator 10.0, each Limit Group can specify a piece-wise limit cost which will then override the maximum violation cost specified in the OPF
 - Go to Case Information, Limit Monitoring Settings
 - Go to the Modify/Create Limit Groups tab
 - Right click on your limit group and choose Show Dialog.
 - On the right side of this dialog, you may define the limit cost
- This allows for a more complex *penalty function* as shown on next slide
 - This allows the OPF to “dispatch” the amount of overload similar to a generator dispatch

Specifying a Piece-wise Limit Cost with the Limit Groups



Area Transactions as OPF Controls



- You may now define an area-to-area MW transactions which can be dispatched by the OPF
 - You must give the transaction a Minimum/Maximum transfer amount
 - Allow OPF to determine the price
 - If both areas are on OPF, then it will just figure out the appropriate amount of transfer and price (within the range specified)
 - Or may enter a Cost Curve for the transaction
 - If one area is on OPF, and the other is on Part. Factor, then this the area on OPF will “dispatch” the area on part. Factor as though it’s a big “generator”

Area Transactions as OPF Controls



Specify a Min/Max Range for transfer

Specify an Export Cost Curve and and Import Cost Curve

Check to allow dispatch

Check to have OPF determine price (cost curves will not be used then)

The screenshot shows the 'Transaction Dialog' window with the following configuration:

- Transaction ID: 1
- Exporting Area: 1 (Top)
- Importing Area: 2 (Left)
- Transaction MW Amount: 50.00
- Transaction Minimum MW: -100.00
- Transaction Maximum MW: 100.00
- Transmission Charge: 0.00
- Transaction Enabled:
- Transaction Dispatchable in OPF:
- Determine Price in OPF:

Piecewise Linear Transaction Cost Curves

Note: the cost function must both be strictly increasing.

Export Transactions		Import Transactions	
MW	\$/MWh	MW	\$/MWh
50.00	20.00	60.00	25.00
100.00	30.00	120.00	35.00

OPF Splitting of MW Marginal Cost into Losses, Energy, Congestion



- This was covered in OPF Section
 - The components of Loss, Energy, Congestion sum to the total MW Marginal Cost
 - Must specify a reference for Energy
 - Allows you to calculate a cost of energy
 - Must specify a reference for Losses
 - Allows you to calculate a cost of losses
 - Cost of Congestion is the leftover
 - The way these values are “split up” is arbitrary depending on references chosen
 - The MW Marginal Cost is UNIQUE however

Other OPF/SCOPF Improvements



- Load Multipliers to approximate losses for DC solution method
- Load available as an SCOPF Control