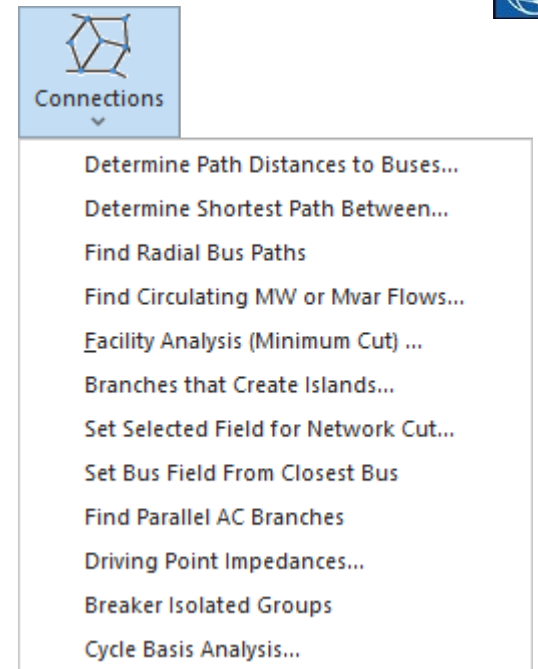


PowerWorld Simulator: Tools Connections Menu



PowerWorld Simulator Users Group
June 18, 2025

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Future Events: Series of Webinars

<https://www.powerworld.com/training/client-meetings>

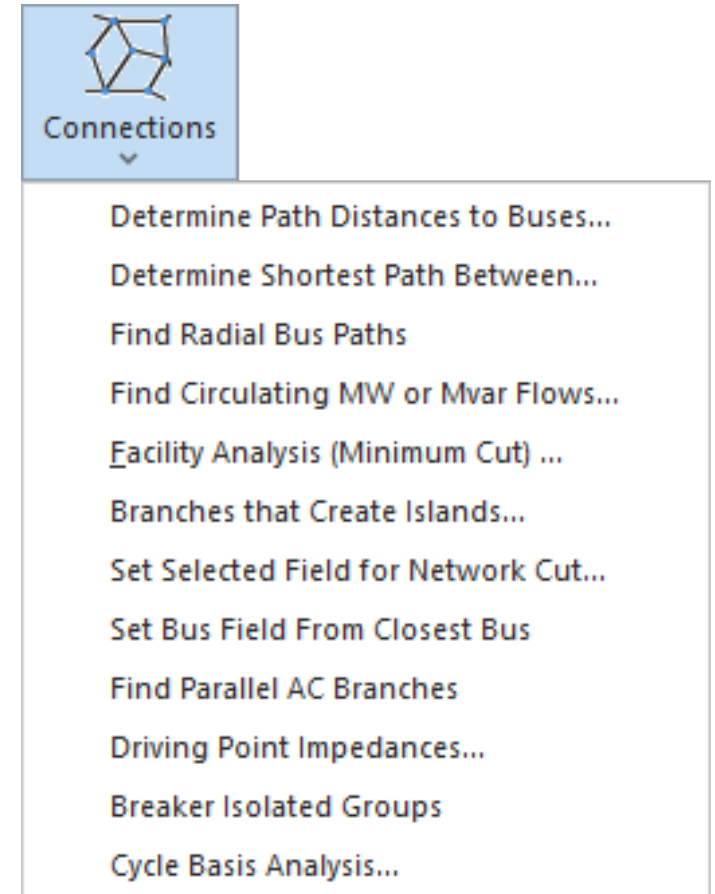
1. Title: What is New in PowerWorld Simulator 24
Date and Time: May 20, 2025, 3:00 pm Central Time (UTC -5)
Presenter: James Weber
2. Title: Historic Event Geomagnetic Disturbance (GMD) Analysis in PowerWorld Simulator
Date and Time: May 28, 2025, 3:00 pm Central Time (UTC -5)
Presenter: Scott Dahman
3. Title: PowerWorld Simulator Geographic Regions and Routes
Date and Time: June 11, 2025, 3:00 PM Central Time (UTC -5)
Presenter: Thomas Overbye
4. Title: PowerWorld Simulator Connection Menu Tools
Date and Time: June 18, 2025, 2:00 pm Central Time (UTC -5)
Presenter: James Weber
5. Title: PowerWorld Simulator Integration with EPRI GICHarm
Date and Time: June 24, 2025, 3:00 pm Central Time (UTC -5)
Presenter: Thomas Overbye
[Register here](#)



Connections Tools:

Revisit all of these Tools!

- Connection Menu tools
 - Calculations treat the transmission network as a mathematical “Graph”
 - **Vertex** of the Graph = **Bus** or **Node** of our Network
 - **Edges** of the Graph = **Branch** of our Network
 - Weights of the Graph are varied in the tools
 - Length of Branch
 - Series X reactance
 - Series Z impedance



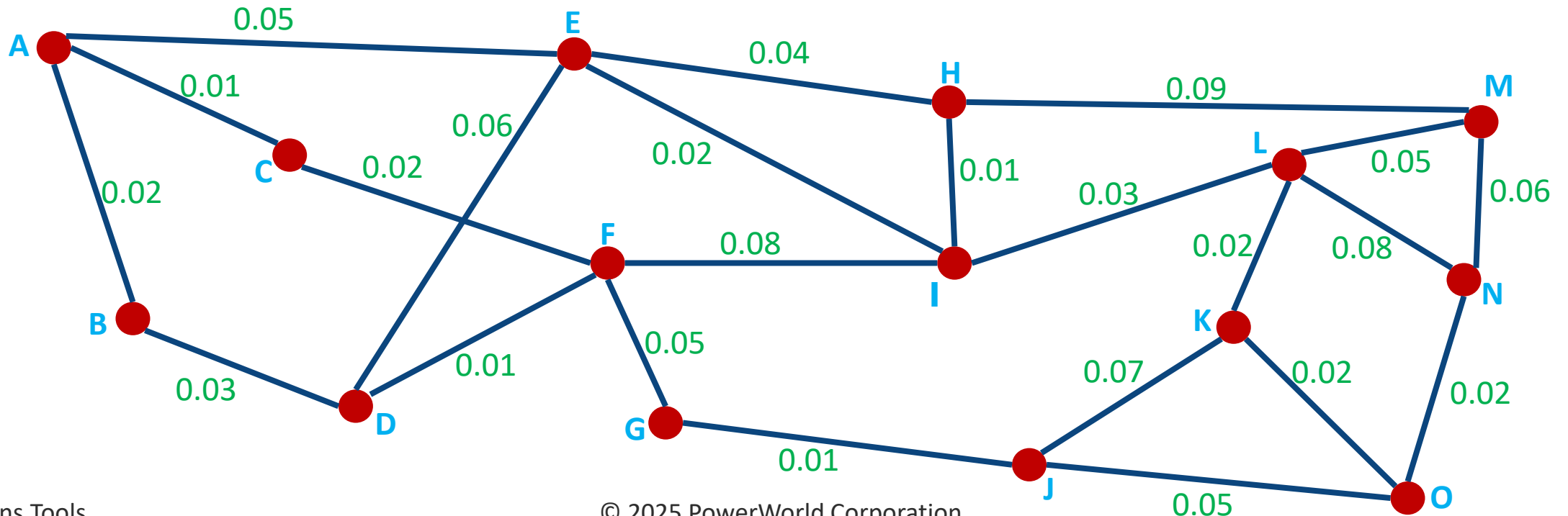


Graph: Vertex, Edge, Weight

Undirected Graph: Weights have no direction

●	Vertex or Node
—	Edge or Branch
0.05	Weight or Distance

For a few Connection Tools, the Distance Measure is an Option



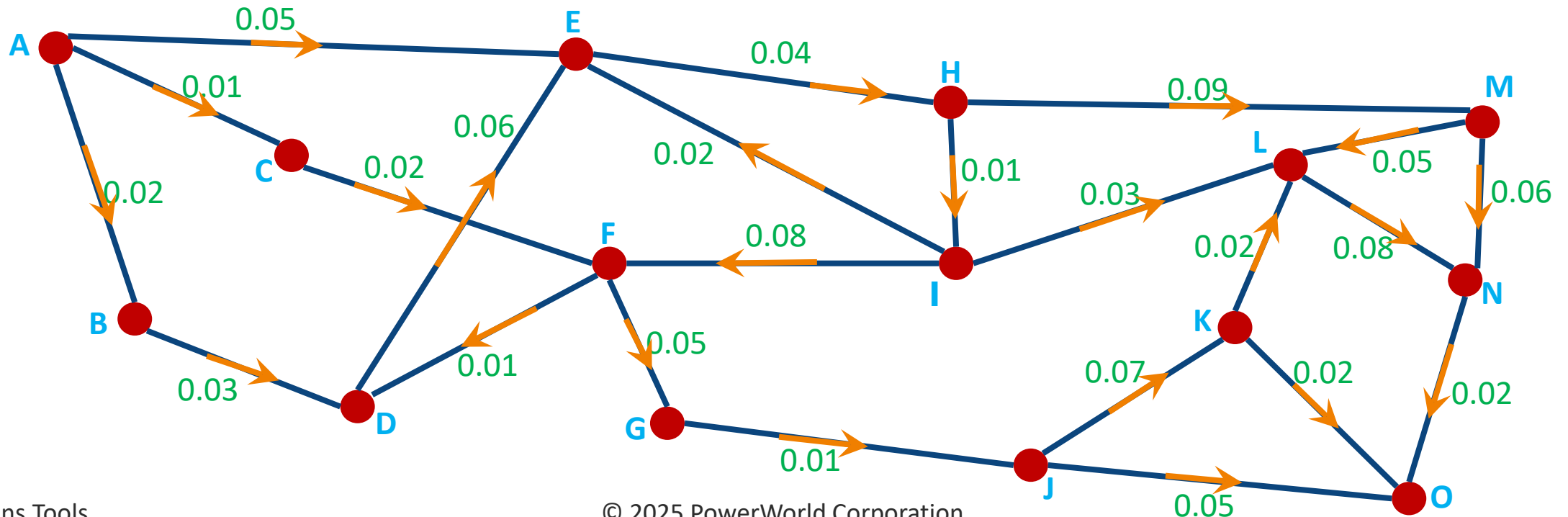


Graph: Vertex, Edge, Weight

Directed Graph: Weights have Direction

●	Vertex or Node
—	Edge or Branch
0.05	Weight or Distance
→	Direction

Find Circulating MW or Mvar Flows





Distance Measure Choices

- A few calculations require a user-input to specify what Distance Measurement should be used for a path distance
 - Determine Path Distance to Buses
 - Determine Shorted Path Between
 - Set Bus Field From Closest Bus
- **Distance Measure Choices**
 - **X** : use the series X impedance (some calculations require positive lengths)
 - **|Z|** : use the series Z impedance
 - **Length** : use the Branch object field Length (this is often not populated though)
 - **Other** : specify your own field to use (such as a custom integer or float)
 - **Number of Nodes** : every branch is assumed to have the same distance measure
 - **Number of FixedNumBus**
 - Branches between same FixedNumBus have a measurement of 0 and other branches are 1
 - **Number of SuperBus**
 - Branches between same SuperBus have a measurement of 0 and other branches are 1

Distance Measure

☐ X ☐ Number of Nodes

☒ |Z| ☐ Number of FixedNumBus

☐ Length ☐ Number of SuperBus

☐ Other Find...



Tools, Connections, Find Circulating MW or Mvar Flows

Mvar and MW Flow Cycle Dialog

Find Cycles

Cycle Type to Find

☒ Mvar Cycles

☐ MW Cycles

Flow Threshold

0.10

Mvar

Maximum Related Cycles

20

Records

Set

Columns

Options

Filter

Advanced

Flow Cycle

Find...

Remove

Quick Filter

Flow Cycles

Branches in Any Cycle

Buses in Any Cycle

	Related Cycle Group	A	Loss Mvar Reduction	Loss MW Reduction	Cycle X-Weighted Ave.	Cycle Min. Flow	Lines in Cycle	Min Bus Num	Max Bus Num	Min Tap Ratio	Max Tap Ratio	Max Percent MVA Flow
1	3 N		13.27	0.27	105.22	74.35	4	10368	10371	0.93750	1.01875	69.14
2	1 S		10.47	0.09	211.78	162.62	4	22356	22911	0.92857	1.00000	35.53
3	3 N		8.54	0.15	124.13	75.48	3	10369	10371	0.93750	1.00625	65.97
4	27 L		7.82	0.37	50.25	17.47	6	27113	27135	0.90000	1.06371	60.73
5	19 E		7.71	0.22	40.25	26.50	4	50279	81790	0.87745	1.06385	79.58
6	19 E		7.52	0.21	39.65	23.09	4	51068	81790	0.87745	1.06385	82.41
7	1 S		7.30	0.09	147.80	87.02	4	22356	22911	0.92857	1.00000	35.53

Branches in Selected Flow Cycle

Buses in Selected Cycle

	Near Bus Number	N	Near Bus Nom kV	Far Bus Number	F	Far Bus Nom kV	Circuit	Cycle Flow	Cycle Flow Direction	Loss MW Reduction	Loss Mvar Reduction	Tap Ratio	Phase (Deg)
1	10369	V	345.0	10370	V	115.0	1	91.69	To-From	0.04	2.13	1.00625	0.00
2	10370	V	115.0	10368	V	230.0	1	74.35	From-To	0.03	1.58	0.96250	0.00
3	10368	V	230.0	10371	V	115.0	1	100.24	To-From	0.10	3.64	1.01875	0.00
4	10371	V	115.0	10369	V	345.0	1	170.28	From-To	0.10	5.92	0.93750	0.00

Help

Close

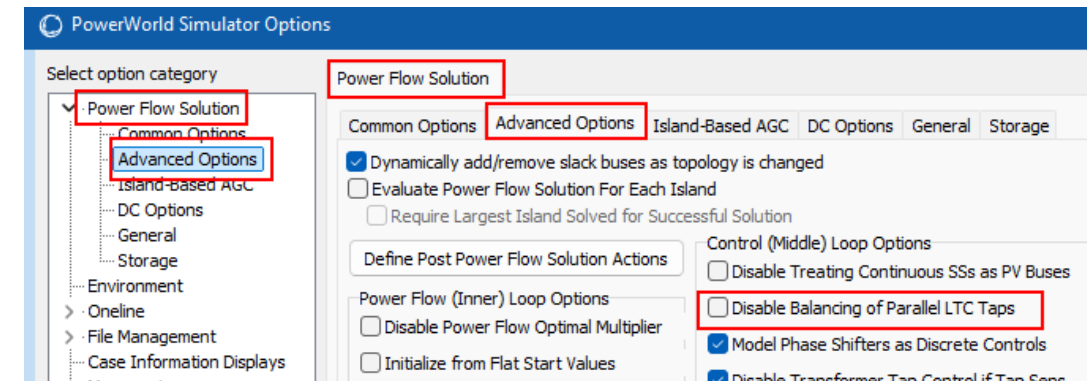


- Determine Path Distances to Buses...
- Determine Shortest Path Between...
- Find Radial Bus Paths
- Find Circulating MW or Mvar Flows...**
- Facility Analysis (Minimum Cut) ...
- Branches that Create Islands...
- Set Selected Field for Network Cut...
- Set Bus Field From Closest Bus
- Find Parallel AC Branches
- Driving Point Impedances...
- Breaker Isolated Groups
- Cycle Basis Analysis...



Connections Tools: Circulating Mvars

- Usually, these represent small input data mistakes
- Mostly they are unbalanced tap ratios on parallel paths
 - PowerWorld Simulator automatically detects more obvious mistakes like parallel taps between “ZBR Bus Groups”.
- Means multiple transformers share the same group of buses connected by low impedance branches as terminals
- This is what “tap balancing” tools
- Tap Balancing catches the obvious errors
- Sometimes the network topologies are more complicated (Mvar Cycles can find these)





Tools, Connections,

Find Circulating MW or Mvar Flows

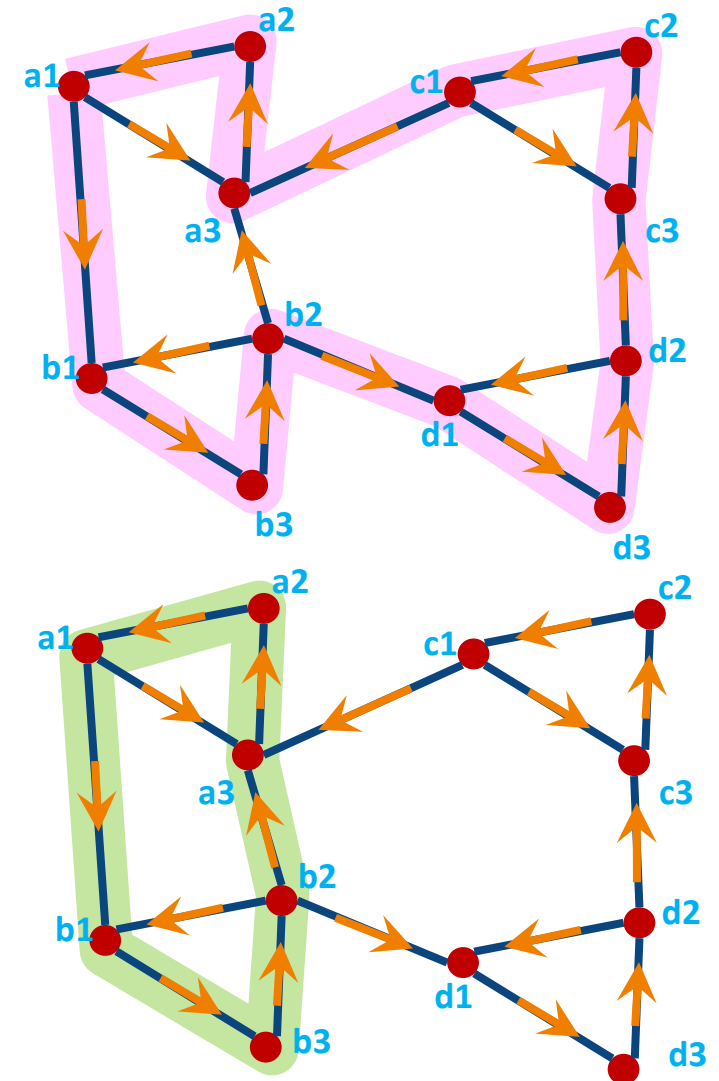
- Represents the power system as a directed graph: MW and Mvar flows have a flow direction
- Terminology
 - **Flow Cycle** = a series of transmission branches with positive flows that can be traversed to form a loop
 - **Flow Threshold** = Any flow with an absolute value less than this is ignored
 - **Related Cycles** = a pair of cycles are called related if both cycles can reach each other by a series of positive flow
 - These then create more large cycles with various combinations of smaller flow cycles. In a real power system this can result in potentially millions of combinations of cycles
 - PowerWorld has an input parameter for **Maximum Related Cycles** to prevent the presentation to you of too many results
 - Mathematicians call these *Strongly Connected Components*
 - PowerWorld will present you with the related cycles that have the largest minimum flow



Related Cycles:

The Count of Flow Cycles gets very large

- a3,a2,a1
- b3,b2,b1
- c3,c2,c1
- d3,d2,d1
- a3,a2,a1,b1,b3,b2,d1,d3,d2,c3,c2,c1,a3
- a3,a2,a1,b1,b3,b2,a3
- And many, many more
- Mathematicians call this a “Strongly Connected Graph” meaning each vertex can be reach from all other vertices
 - PowerWorld calls them **Related Cycles**

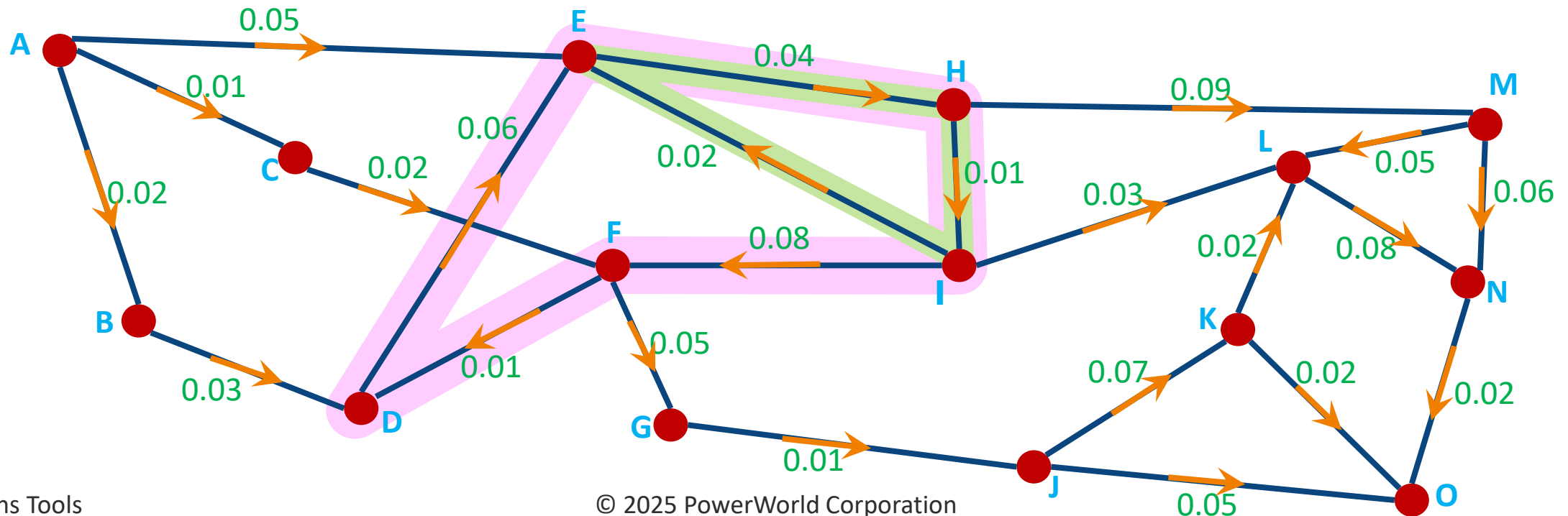




Find Circulating MW or Mvar Flows

These are operating on a Directed Graph

- There are 2 “Flow Cycles” in the Graph Below
- $E \rightarrow H \rightarrow I \rightarrow E$ and $E \rightarrow H \rightarrow I \rightarrow F \rightarrow D \rightarrow E$
- These 2 flow cycles are Related





Causes of Flow Cycles in Power System Network Model

- We do not expect to see any flow cycles in a power system, but a few things can cause these cycles
- MW and Mvar Flow Cycles will occur for parallel paths between buses with
 - One path has a positive series X impedance
 - One path has a negative series X impedance
 - So parallel paths where one path has a series capacitor
 - Normally you do not see this because a series capacitors in series with another branch with a series X larger in magnitude than the series cap
 - Lines are not more than 100% compensated!
 - You might see a small positive impedance representing a switching device that bypasses the series cap and is parallel with it → those show up as both MW and Mvar cycles, but the flow is very small so ignore them
- Mvar Flow Cycles: **Unbalanced Transformer Tap Ratios**
 - This is a very common reason
 - We would recommend the use of this tool to fix these in your power system models
- MW Flow cycles: Unbalanced transformer phase shifts
 - This is a very rare occurrence, but also possible

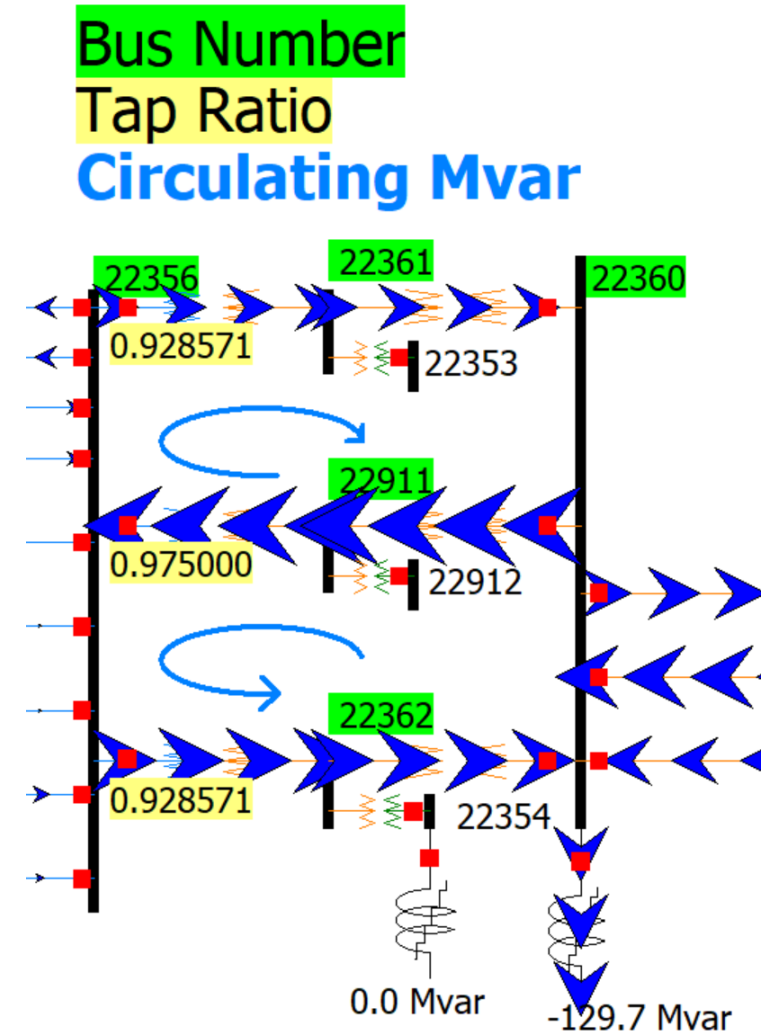
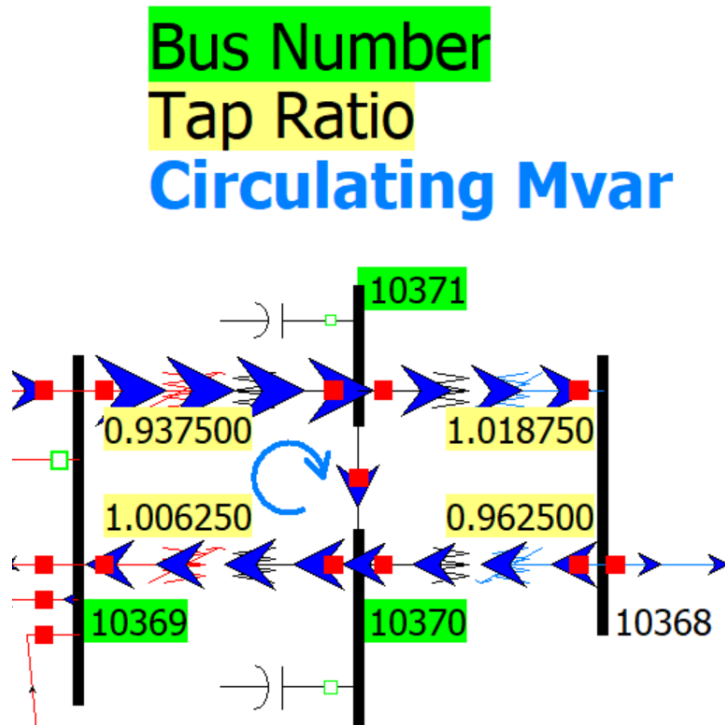


Mvar Cycle Examples:

Almost always unbalanced tap ratios

- DataCheckExample.pwb
- Mvar cycles

Notice the
Blue arrows
are going in a
circle





Flow Cycle Results

	Related Cycle Group	Area Name	Loss Mvar Reduction	Loss MW Reduction	Cycle X-Weighted Ave.	Cycle Min. Flow	Lines in Cycle	Min Bus Num	Max Bus Num	Min Tap Ratio	Max Tap Ratio	Max Percent MVA Flow
1	3	N	13.27	0.27	105.22	74.35	4	10368	10371	0.93750	1.01875	69.14
2	1	S	10.47	0.09	211.78	162.62	4	22356	22911	0.92857	1.00000	35.53
3	3	N	8.54	0.15	124.13	75.48	3	10369	10371	0.93750	1.00625	65.97

Default Column	Description of Default Column
Related Cycle Group	Cycles with the same integer are related
Area Names	Names of the Areas of Buses in the Flow Cycle
Loss Mvar Reduction	An estimate of how much the Mvar loss on all branches in the cycle will be reduced if the flow cycle is reduced by the X-Weighted average flow
Cycle X-Weighted Ave	Weighted Average flow in the cycle (weighted by the Series X)
Cycle Min Flow	The minimum flow on any branch in the flow cycle
Lines in Cycle	Number of branches in the cycle
Min and Max Bus Num	Minimum and maximum Bus Number in the flow cycle
Min and Max Tap Ratio	The minimum and maximum transformer tap ratio for a transformer branch in this cycle. These are normally the cause of these cycles



Visualizing Results

- Use the Branches in Any Cycle and Buses in Any Cycle tab to set a parameter (for example a “Custom Float”)
- Use the Parameter to select and format branches on a oneline
- Use the parameter to create a Dynamic Formatting
 - Set Custom Integer = 1 for all branches in a cycle
 - Set Dynamic Formatting to highlight transformers and transmission line display objects on all ones if CustomInteger = 1
 - Show the Bus View and bus 70320 in DataCheckExamples



Visualizing Results of Cycle Flows

Branches in Any Cycle Custom Int

Mvar and MW Flow Cycle Dialog

Find Cycles

Cycle Type to Find: ☒ Mvar Cycles ☐ MW Cycles

Flow Threshold: 0.10 Mvar

Maximum Related Cycles: 20

Filter: Advanced Branch

Flow Cycles	Branches in Any Cycle	Buses in Any Cycle
Cust Int 1	From Number	From Name
1	1	10368 WESTMESA
2	1	10368 WESTMESA
3	1	10369 WESTMESA
4	1	10369 WESTMESA
5	1	10370 WESTMS 1
6	1	11020 ASCARATE
7	1	11020 ASCARATE
8	1	11020 ASCARATE
9	1	11023 AUSTIN
10	1	11025 AUSTIN
11	1	11043 MARLOW
12	1	11062 DYER
13	1	11063 DYER
14	1	11063 DYER
15	1	11085 LANE_#
16	1	11094 MANN
17	1	11094 MANN
18	1	11143 SCOTSDAL
19	1	11143 SCOTSDAL

Dynamic Formatting

Dynamic Formatting (Case Info / All Views And Onelines)

Format Name: highlight_cycles

Object Type: Branch

Filter Criteria: CustomInteger:0 = 1

☒ Formatting Active ☒ Show Dynamic Formatting Features

☐ Force Visibility ☐ Show Lookup Tables

Line/Fill Font Xout/Blink Flow Arrows

change ☒ Line Thickness 10

change ☐ Dashed

change ☒ Line Color

change ☐ Use Background Fill

Choose Context Objects

☐ All ☒ Specified

Type of Context Object

☐ Case Information Memo

☐ Circuit Breaker

☐ Display PWOBJect

☐ Display PWOBJect

☐ Display Series Capacitor

☒ Display Transformer

☒ Display Transmission Line

☐ Document Link

☐ Field (Generic Model) ...->

☐ Field (Series Capacitor) ...->

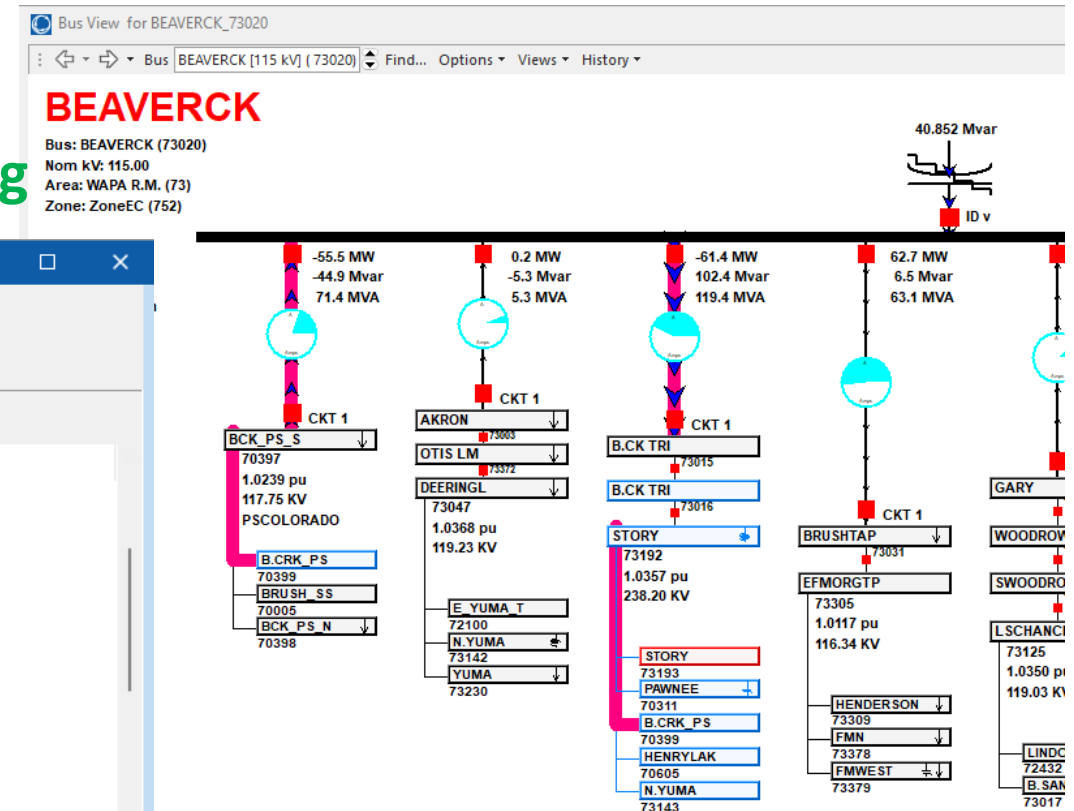
☐ Field (Transformer) ...->

☐ Field (Transmission Line) ...->

☐ Gauge (Branch) ...->

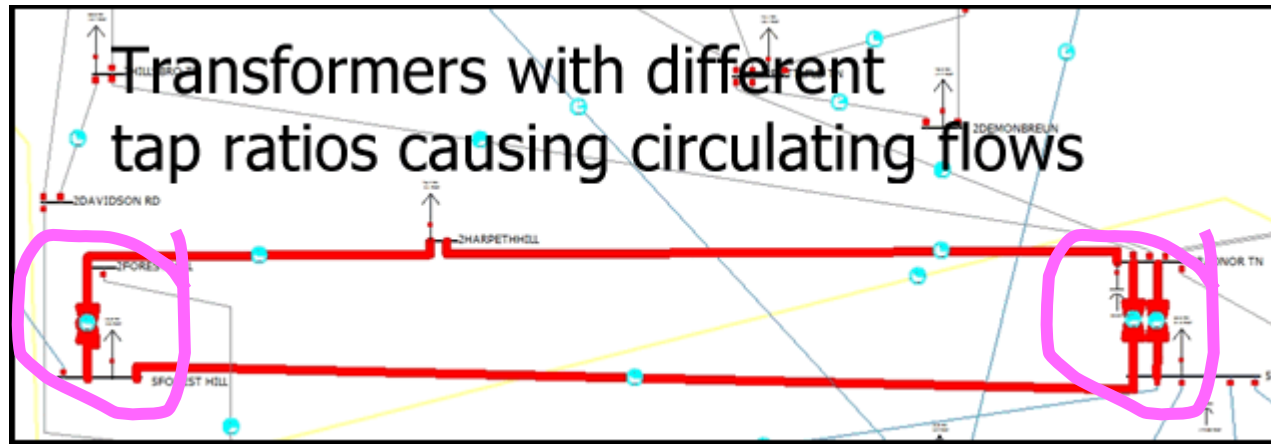
OK Help Cancel

Bus View Highlighted

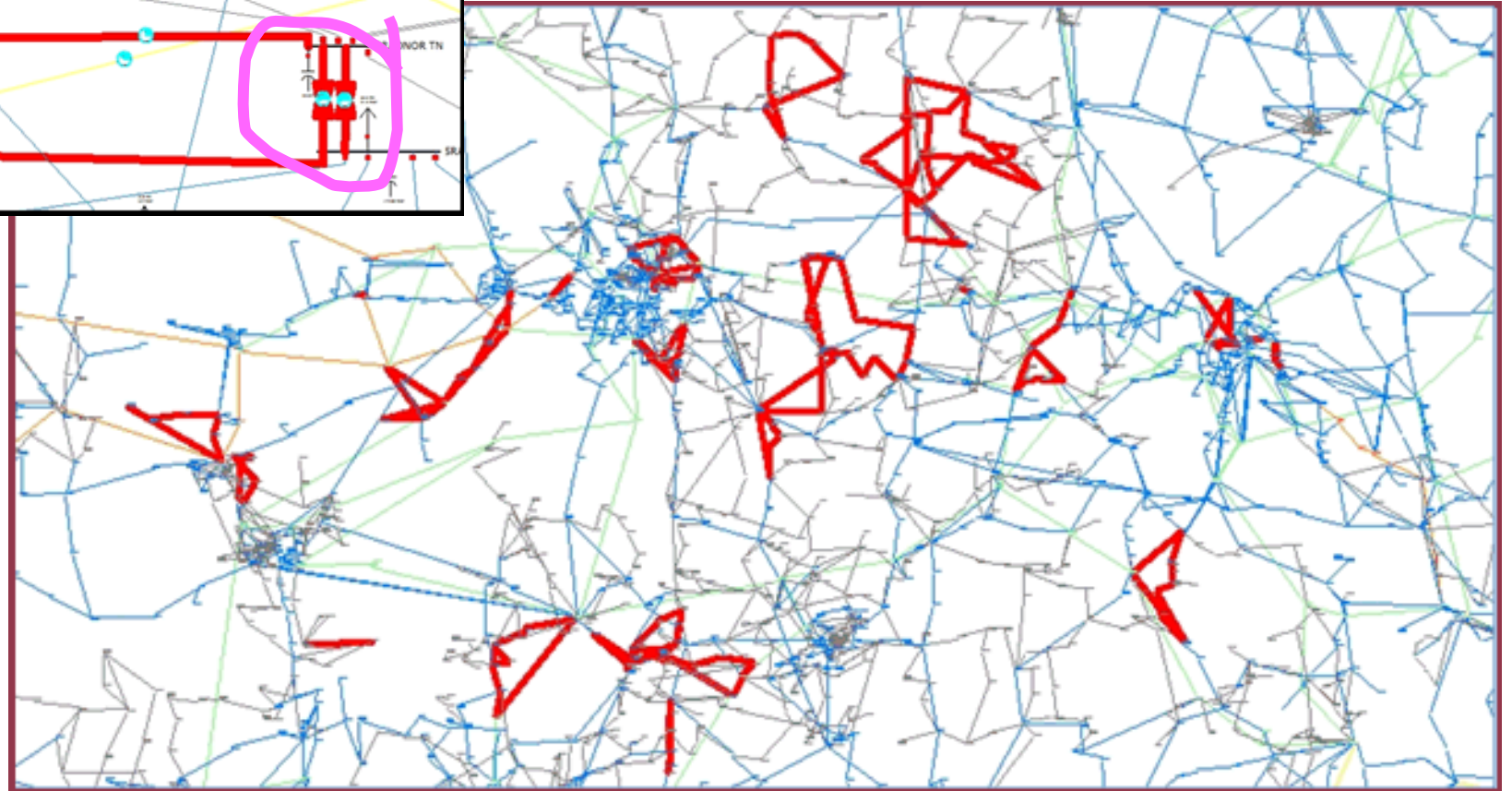




Visualizing Results of Cycle Flows



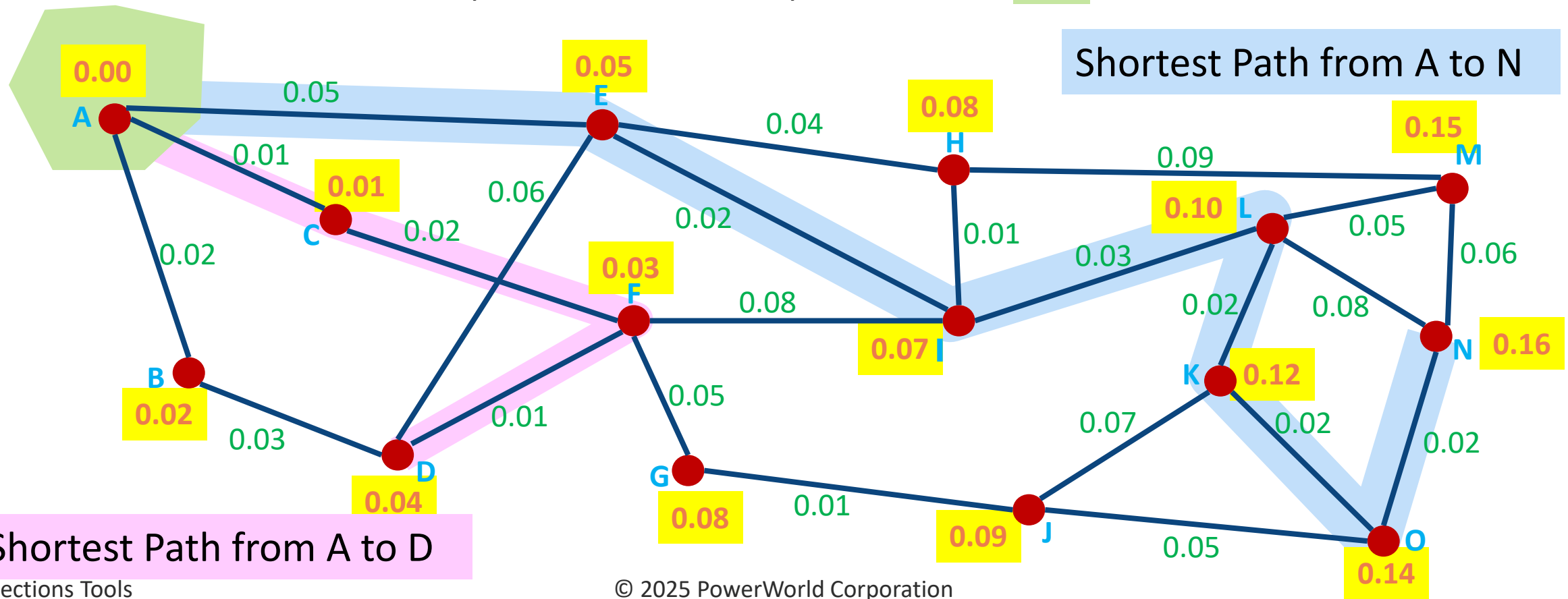
Not directly parallel,
but they are nearby
in a parallel
configuration





Determine Path Distances to Buses

- Choose a Start: Point **A** in this example
- Calculation will populate a field with the **yellow numbers** showing the summation of the distances for the shortest path between each point and the Start





Connection Menu:

Determine Path Distances to Buses

Determine Path Distances to Buses

Start
Element Type
☒ Bus
☐ Substation
☐ Area
☐ Zone
☐ Super Area
☐ Injection Group

Sort by ☒ Name ☐ Number
champa

CHAMPAIGN 2 2 (56700) [69.00 kV]
CHAMPAIGN 2 3 (56701) [18.00 kV]
CHAMPAIGN 2 4 (56702) [161.0 kV]
CHAMPAIGN 2 6 (56703) [161.0 kV]
CHAMPAIGN 1 1 (44692) [100.0 kV]
CHAMPAIGN 10 1 (44705) [100.0 kV]
CHAMPAIGN 11 1 (44706) [500.0 kV]
CHAMPAIGN 11 2 (44707) [230.0 kV]
CHAMPAIGN 11 3 (44708) [100.0 kV]

Distance Measure
☐ X
☒ |Z|
☐ Length
☐ Other

Number of Nodes
Number of FixedNumBus
Number of SuperBus

Lines to Process
☒ All
☐ Only closed
☐ Filter
☐ Selected

Bus Field to Populate
Custom[Floating Point 1] Find...

Calculate

Results

	Number	Sub Num	Sub Name	Name	Area Name	Zone Name	Nom kV	PU Volt	Angle (Deg)	Load MW	Load Mvar	Gen MW	Gen Mvar	Cust Float
1	44706	23610	CHAMPAIGN 11	CHAMPAIGN 11 1	Illinois Downstate	Bay City	500.00	1.03755	-21.76					0.000000
2	44709	23610	CHAMPAIGN 11	CHAMPAIGN 11 4	Illinois Downstate	Bay City	500.00	1.03866	-21.77					0.001052
3	46749	24675	FITHIAN	FITHIAN 4	Illinois Downstate	Bay City	500.00	1.04187	-24.48					0.005735
4	46746	24675	FITHIAN	FITHIAN 1	Illinois Downstate	Bay City	500.00	1.04229	-24.30					0.006907
5	46750	24675	FITHIAN	FITHIAN 6	Illinois Downstate	Bay City	500.00	1.04229	-24.30					0.007993
6	46436	24620	TILTON 5	TILTON 5 5	Illinois Downstate	Bay City	500.00	1.04247	-26.36					0.009547
7	44912	23736	CHARLESTON 55	CHARLESTON 55 1	Illinois Downstate	Bay City	500.00	1.04145	-16.62					0.009894
8	46432	24620	TILTON 5	TILTON 5 1	Illinois Downstate	Bay City	500.00	1.04324	-26.29					0.010696
9	44707	23610	CHAMPAIGN 11	CHAMPAIGN 11 2	Illinois Downstate	Bay City	230.00	1.03750	-21.80					0.011079
10	46437	24620	TILTON 5	TILTON 5 7	Illinois Downstate	Bay City	500.00	1.04324	-26.29					0.011815
11	44710	23610	CHAMPAIGN 11	CHAMPAIGN 11 6	Illinois Downstate	Bay City	230.00	1.03740	-21.76	55.17	16.14			0.012229
12	42675	22706	CAYUGA 4	CAYUGA 4 7	Indiana	Bay City	500.00	1.04385	-26.39					0.014035
13	46748	24675	FITHIAN	FITHIAN 3	Illinois Downstate	Bay City	13.80	1.04590	-23.41			216.74	46.22	0.014769
14	42669	22706	CAYUGA 4	CAYUGA 4 1	Indiana	Bay City	500.00	1.04500	-26.36					0.015166
15	42676	22706	CAYUGA 4	CAYUGA 4 8	Indiana	Bay City	500.00	1.04500	-26.36					0.016367



Determine Path Distances to Buses...

Determine Shortest Path Between...

Find Radial Bus Paths

Find Circulating MW or Mvar Flows...

Facility Analysis (Minimum Cut) ...

Branches that Create Islands...

Set Selected Field for Network Cut...

Set Bus Field From Closest Bus

Find Parallel AC Branches

Driving Point Impedances...

Breaker Isolated Groups

Cycle Basis Analysis...



Distance Measure Choices (Reminder from earlier slide)

- **Distance Measure Choices**

- **X** : use the series X impedance (some calculations require positive lengths)
- **|Z|** : use the series Z impedance
- **Length** : use the Branch object field Length (this is often not populated though)
- **Other** : specify your own field to use (such as a custom integer or float)
- **Number of Nodes** : every branch is assumed to have the same distance measure
- **Number of FixedNumBus**
 - Branches between same FixedNumBus have a measurement of 0 and other branches are 1
- **Number of SuperBus**
 - Branches between same SuperBus have a measurement of 0 and other branches are 1

Distance Measure

☐ X

☒ |Z|

☐ Length

☐ Other

☐ Number of Nodes

☐ Number of FixedNumBus

☐ Number of SuperBus

Find...



Determine Path Distances to Buses

- Choose a Start Element: All buses in the Start have distance = 0.000
- Distance Measure
 - Specify the numeric value used for branch distance
- Lines to Process
 - Lines not meeting this selection will be ignored
 - (treated as infinite distance)
- Bus Field To Populate
 - Result of calculation will be placed in this field

Determine Path Distances to Buses

Start

Element Type: ☒ Bus ☐ Substation ☐ Area ☐ Zone ☐ Super Area ☐ Injection Group

Sort by: ☒ Name ☐ Number

champa

CHAMPAIGN 11 1 (44692) [100.0 kV]
 CHAMPAIGN 10 1 (44705) [100.0 kV]
 CHAMPAIGN 11 1 (44706) [500.0 kV]
 CHAMPAIGN 11 2 (44707) [230.0 kV]
 CHAMPAIGN 11 3 (44708) [100.0 kV]

Distance Measure: ☐ X ☒ |Z| ☐ Length ☐ Other

Number of Nodes ☐ Number of FixedNumBus ☐ Number of SuperBus

Find...

Lines to Process: ☒ All ☐ Only closed ☐ Filter ☐ Selected

Choose Filter Define...

Bus Field to Populate: Custom[Floating Point 1] Find...

Calculate

Results

	Number	Sub Num	Sub Name	Name	Area Name	Zone Name	Nom kV	PU Volt	Angle (Deg)	Load MW	Load Mvar	Gen MW	Gen Mvar	Cust Float
1	44706	23610	CHAMPAIGN 11	CHAMPAIGN 11 1	Illinois Downstate	Bay City	500.00	1.03755	-21.76					0.000000
2	44709	23610	CHAMPAIGN 11	CHAMPAIGN 11 4	Illinois Downstate	Bay City	500.00	1.03866	-21.77					0.001052
3	46749	24675	FITHIAN	FITHIAN 4	Illinois Downstate	Bay City	500.00	1.04187	-24.48					0.005735
4	46746	24675	FITHIAN	FITHIAN 1	Illinois Downstate	Bay City	500.00	1.04229	-24.30					0.006907
5	46750	24675	FITHIAN	FITHIAN 6	Illinois Downstate	Bay City	500.00	1.04229	-24.30					0.007993
6	46436	24620	TILTON 5	TILTON 5 5	Illinois Downstate	Bay City	500.00	1.04247	-26.36					0.009547
7	44912	23736	CHARLESTON 55	CHARLESTON 55 1	Illinois Downstate	Bay City	500.00	1.04145	-16.62					0.009894
8	46432	24620	TILTON 5	TILTON 5 1	Illinois Downstate	Bay City	500.00	1.04324	-26.29					0.010696
9	44707	23610	CHAMPAIGN 11	CHAMPAIGN 11 2	Illinois Downstate	Bay City	230.00	1.03750	-21.80					0.011079
10	46437	24620	TILTON 5	TILTON 5 7	Illinois Downstate	Bay City	500.00	1.04324	-26.29					0.011815
11	44710	23610	CHAMPAIGN 11	CHAMPAIGN 11 6	Illinois Downstate	Bay City	230.00	1.03740	-21.76	55.17	16.14			0.012229
12	42675	22706	CAYUGA 4	CAYUGA 4 7	Indiana	Bay City	500.00	1.04385	-26.39					0.014035
13	46748	24675	FITHIAN	FITHIAN 3	Illinois Downstate	Bay City	13.80	1.04590	-23.41			216.74	46.22	0.014769
14	42669	22706	CAYUGA 4	CAYUGA 4 1	Indiana	Bay City	500.00	1.04500	-26.36					0.015166
15	42676	22706	CAYUGA 4	CAYUGA 4 8	Indiana	Bay City	500.00	1.04500	-26.36					0.016367



Uses of Determine Path Distances to Buses

- Generator Interconnection Study or a Large Load Integration Study
 - More detailed Limit Monitoring Settings
 - Toggle the Monitor (YES/NO) field for branches and buses that are nearby the point of interconnection or integration
 - Contingency Analysis
 - Auto-insertion of contingencies of branches that are nearby the new facility



Connection Menu:

Determine Shortest Path Between

Determine Shortest Path Between

Start
Element Type: ☒ Bus
Sort by: ☒ Name ☐ Number
champa

End
Element Type: ☒ Bus
Sort by: ☐ Name ☒ Number
16402

Distance Measure: ☐ X ☒ |Z| ☐ Length ☐ Other
Lines to Process: ☒ All ☐ Only closed ☐ Filter ☐ Selected

Calculate
Calculate and Visualize on a Spatial View Online

Path Buses Path Lines and Transformers

	Number	Sub Num	Sub Name	Name	Area Name	Zone Name	Sub Name	Nom kV	PU Volt	Angle (Deg)	Load MW	Load Mvar	Gen MW
16	37337	19720	BEACHWOOD	BEACHWOOD	Ohio Lake Erie	Bay City	BEACHWOOD	500.00	1.04263	-78.75			
17	37934	20098	KENT 3	KENT 3	Ohio Lake Erie	Bay City	KENT 3	500.00	1.04341	-77.75			
18	15579	8094	SHARON 5	SHARON 5	Pennsylvania	Bay City	SHARON 5	500.00	1.04307	-73.84			
19	15044	7776	MEADVILLE	MEADVILLE	Pennsylvania	Bay City	MEADVILLE	500.00	1.03449	-74.13			
20	15833	8247	KENNERDELL	KENNERDELL	Pennsylvania	Bay City	KENNERDELL	500.00	1.02633	-73.24			
21	15882	8254	CLARION 4	CLARION 4	Pennsylvania	Bay City	CLARION 4	500.00	1.03256	-72.99			
22	13719	7106	ROARING BR	ROARING BR	Pennsylvania	Bay City	ROARING BR	500.00	1.03543	-76.10			
23	13865	7131	WILLIAMSPORT	WILLIAMSPORT	Pennsylvania	Bay City	WILLIAMSPORT	500.00	1.03301	-76.80			
24	14876	7673	STATE COLL	STATE COLL	Pennsylvania	Bay City	STATE COLL	500.00	1.04370	-77.87			
25	14877	7673	STATE COLL	STATE COLL	Pennsylvania	Bay City	STATE COLL	345.00	1.04202	-79.01			
26	14880	7673	STATE COLL	STATE COLL	Pennsylvania	Bay City	STATE COLL	345.00	1.04129	-79.07			
27	14883	7674	STATE COLL	STATE COLL	Pennsylvania	Bay City	STATE COLL	345.00	1.03929	-79.20			
28	15597	8104	LEWISTOWN	LEWISTOWN	Pennsylvania	Bay City	LEWISTOWN	345.00	1.04293	-80.10			
29	12595	6389	HARRISBURG	HARRISBURG	Pennsylvania	Bay City	HARRISBURG	345.00	1.04280	-83.48			
30	13822	7123	HARRISBURG	HARRISBURG	Pennsylvania	Bay City	HARRISBURG	345.00	1.04350	-83.62			
31	13816	7123	HARRISBURG	HARRISBURG	Pennsylvania	Bay City	HARRISBURG	345.00	1.04394	-83.53			

Help Close



Determine Path Distances to Buses...

Determine Shortest Path Between...

Find Radial Bus Paths

Find Circulating MW or Mvar Flows...

Facility Analysis (Minimum Cut) ...

Branches that Create Islands...

Set Selected Field for Network Cut...

Set Bus Field From Closest Bus

Find Parallel AC Branches

Driving Point Impedances...

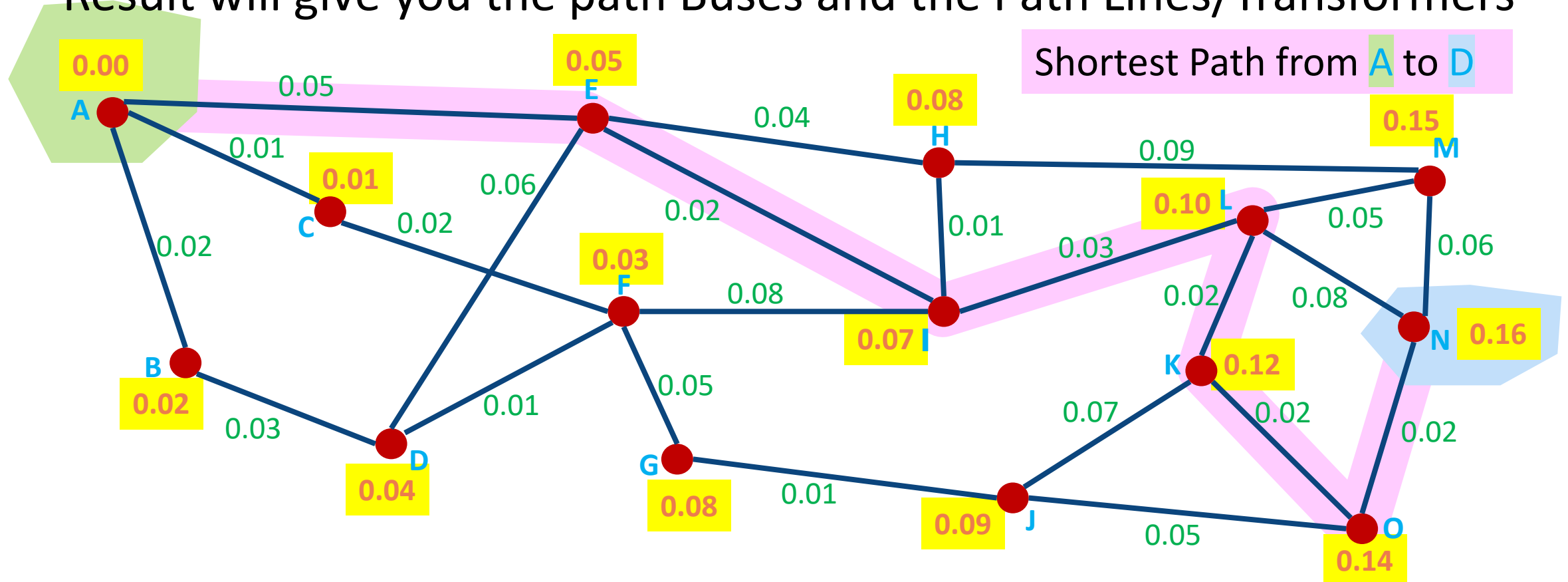
Breaker Isolated Groups

Cycle Basis Analysis...



Related Calculation: Determine Shortest Path Between

- Example: Start= Point **A** and End = Point **N**
- Result will give you the path Buses and the Path Lines/Transformers





Related Calculation: Determine Shortest Path Between

- Choose **Start** and **End**
- Choose **Distance Measure**
- Choose **Lines to Process**
- Result is two lists
 - Path Buses
 - Path Lines and Transformers
- If case has Geography
Calculate and Visualize on a Spatial View Online

Determine Shortest Path Between

Start
Element Type: ☒ Bus
Sort by: ☒ Name ☐ Number
champa

End
Element Type: ☒ Bus
Sort by: ☐ Name ☒ Number
16402

Distance Measure
☐ X
☒ |Z|
☐ Length
☐ Other

Lines to Process
☒ All
☐ Only closed
☐ Filter
☐ Selected

Calculate
Calculate and Visualize on a Spatial View Online

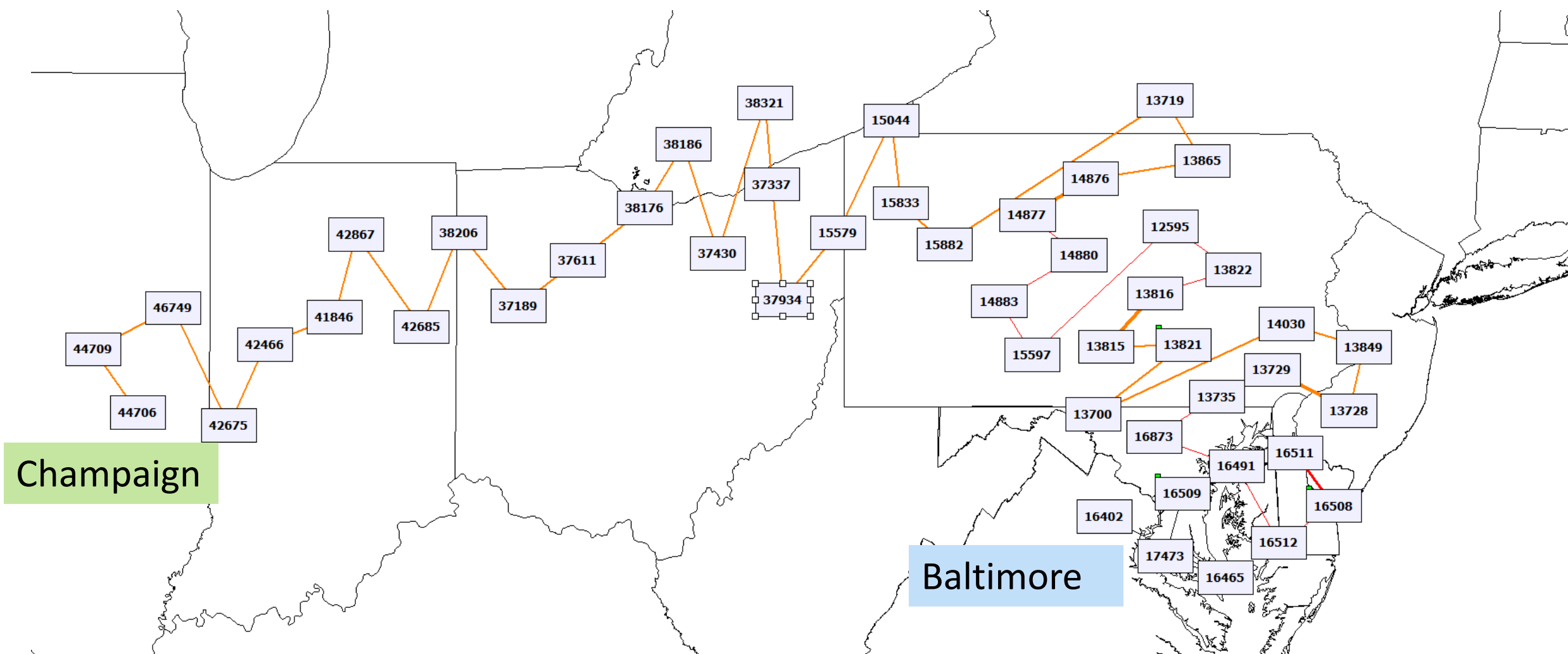
Path Buses

Number	Sub Num	Sub Name	Name	Area Name	Zone Name	Sub Name	Nom kV	PU Volt	Angle (Deg)	Load MW	Load Mvar	Gen MW
16	37337	19720	BEACHWOOD	Ohio Lake Erie	Bay City	BEACHWOOD	500.00	1.04263	-78.75			
17	37934	20098	KENT 3	Ohio Lake Erie	Bay City	KENT 3	500.00	1.04341	-77.75			
18	15579	8094	SHARON 5	Pennsylvania W	Bay City	SHARON 5	500.00	1.04307	-73.84			
19	15044	7776	MEADVILLE	Pennsylvania W	Bay City	MEADVILLE 3	500.00	1.03449	-74.13			
20	15833	8247	KENNERDELL	Pennsylvania W	Bay City	KENNERDELL 2	500.00	1.02633	-73.24			
21	15882	8254	CLARION 4	Pennsylvania W	Bay City	CLARION 4	500.00	1.03256	-72.99			
22	13719	7106	ROARING BRAE	Pennsylvania E	Bay City	ROARING BRAE	500.00	1.03543	-76.10			
23	13865	7131	WILLIAMSPORT	Pennsylvania E	Bay City	WILLIAMSPORT	500.00	1.03301	-76.80			
24	14876	7673	STATE COLLEGE	Pennsylvania W	Bay City	STATE COLLEGE	500.00	1.04370	-77.87			
25	14877	7673	STATE COLLEGE	Pennsylvania W	Bay City	STATE COLLEGE	345.00	1.04202	-79.01			
26	14880	7673	STATE COLLEGE	Pennsylvania W	Bay City	STATE COLLEGE	345.00	1.04129	-79.07			
27	14883	7674	STATE COLLEGE	Pennsylvania W	Bay City	STATE COLLEGE	345.00	1.03929	-79.20			
28	15597	8104	LEWISTOWN	Pennsylvania W	Bay City	LEWISTOWN 1	345.00	1.04293	-80.10			
29	12595	6389	HARRISBURG	Pennsylvania E	Bay City	HARRISBURG 2	345.00	1.04280	-83.48			
30	13822	7123	HARRISBURG	Pennsylvania E	Bay City	HARRISBURG 2	345.00	1.04350	-83.62			
31	13816	7123	HARRISBURG	Pennsylvania E	Bay City	HARRISBURG 2	345.00	1.04394	-83.53			

Help Close



Visualize on a Spatial View Online



Champaign

Baltimore



New Connection Tool:

Set Bus Field From Closest Bust

Radial End Dialog

Calculate Radial Paths ☒ Path Traverses Open Branches ☐ Treat Parallel Branches as Not Radial

Clear Radial Paths

Traverse Path By
☐ Bus
☒ Superbus

Bus Radial Ends All Buses All Branches

Radial Path Length	Number	FixedNumBus	Sub Node Number	Sub Num
3	180156	180156	1	180156
4	180153	180153	1	180153
5	162102	162102	5	162101
6	130021	130021	1	73410
7	110511	110511	1	110511
8	110231	110231	1	42090

Buses in Radial Path Branches in Radial Path

Radial Path	Radial F Index	Radial Path Length	Number	FixedNumBus	Sub Node Number	Sub Num	Sub Name
1	180156	1	4	180156	1	180156	SWEETWN3
2	180156	2	4	180157	8	180156	SWEETWN3
3	180156	3	4	180158	11	180156	SWEETWN3
4	180156	4	4	180165	15	180156	SWEETWN3



- Determine Path Distances to Buses...
- Determine Shortest Path Between...
- Find Radial Bus Paths
- Find Circulating MW or Mvar Flows...
- Facility Analysis (Minimum Cut) ...
- Branches that Create Islands...
- Set Selected Field for Network Cut...
- Set Bus Field From Closest Bus**
- Find Parallel AC Branches
- Driving Point Impedances...
- Breaker Isolated Groups
- Cycle Basis Analysis...



New Connection Tool: Set Bus Field from Closest Bus

Choose Buses to
“Set To”

Choose Buses to
“Copy From”

Set Bus Field From Closest

Specify a Filter for Buses to Set a Value

Choose Filter

Distance Measure

☐ X

☒ [Z]

☐ Length

☐ Other

Number of Nodes

Number of FixedNumBus

Number of SuperBus

Find...

Lines to Process

☒ All

☐ Only closed

☐ Filter

☐ Selected

Choose Filter

Define...

Bus Field to Populate

Custom\Floating Point 1

Find...

Copy Field

Results

	Sub Num	Sub Name	Name	Area Name	Zone Name	Sub Name	Nom kV	PU Volt	Angle (Deg)	Load MW	Load Mvar	Gen MW	Gen Mvar	Selected	Cust Flo
1	86	BRGRS	BEARGRASS_9	BEPC_TSP	BEPC_LEON	BRGRS	138.00	1.01698	31.16					YES	3.000000
2	27	HAMMOND	HAMMOND	BEPC_TSP	BEPC_ROBERTS	HAMMOND	138.00	1.01115	25.27					YES	2.000000
3	1	RPR	ROANSPRARE	BEPC_TSP	BEPC_GRIMES	RPR	138.00	1.02735	29.63					YES	1.000000
4	1	RPR	ROANSPRARE_2	BEPC_TSP	BEPC_GRIMES	RPR	138.00	1.02735	29.63					NO	
5	1	RPR	ROANSPRARE_3	BEPC_TSP	BEPC_GRIMES	RPR	138.00	1.02735	29.63					NO	
6	2	KEITHSW	KEITHSW_3	BEPC_TSP	BEPC_GRIMES	KEITHSW	138.00	1.02414	29.55					NO	
7	2	KEITHSW	KEITHSW	BEPC_TSP	BEPC_GRIMES	KEITHSW	138.00	1.02414	29.55					NO	
8	2	KEITHSW	KEITHSW_5	BEPC_TSP	BEPC_GRIMES	KEITHSW	138.00	1.02414	29.55					NO	
9	2	KEITHSW	KEITHSW_6	BEPC_TSP	BEPC_GRIMES	KEITHSW	138.00	1.02414	29.55					NO	
10	2	KEITHSW	KEITHSW_7	BEPC_TSP	BEPC_GRIMES	KEITHSW	138.00	1.02414	29.55					NO	
11	2	KEITHSW	KEITHSW_8	BEPC_TSP	BEPC_GRIMES	KEITHSW	138.00	1.02414	29.55					NO	
12	2	KEITHSW	KEITHSW_2	BEPC_TSP	BEPC_GRIMES	KEITHSW	138.00	1.02414	29.55					NO	
13	2	KEITHSW	KEITHSW_10	BEPC_TSP	BEPC_GRIMES	KEITHSW	138.00	1.02414	29.55					NO	
14	2	KEITHSW	KEITHSW_11	BEPC_TSP	BEPC_GRIMES	KEITHSW	138.00	1.02414	29.55					NO	

Help Close



Script command For SetBusFieldFromClosest

- SetBusFieldFromClosest(variablename, BusFilterSetTo, BusFilterFromThese, BranchFilterTraverse, BranchDistMeas);
 - VariableName: specified which field to copy between Bus objects
 - BusFilterTo: name of Filter specified buses to “Copy To”
 - BusFilterFromThese: name of filter of bus from which to copy
 - BranchFilterTraverse: specify which branches to traverse in the search
 - BranchDistMeas: X, Z, Length, Nodes, FixedNumBus, SuperBus, or VariableName (set how to measure distance)

```
SetBusFieldFromClosest(SubNumber,"SubNumber IsBlank","SubNumber NotIsBlank",All,Z);
```



Connection Menu: Facility Analysis (Minimum Cut)

Facility Analysis (Minimum Cut)

Select The Buses Facility Analysis

Note: This form is for choosing BUSES. The options regarding Areas and Zones are included to aid the task of selecting or unselecting blocks of buses.

Records Geo Set Columns

Make-up of the study and external systems

Buses	Areas	Zones	Substations			
Number	Name	Which system?	Selected	# Neighb (in service only)	Sub Num	Sub Name
1	AUBURN 1 1	Study	NO	3	1	AUBURN 1
2	AUBURN 1 2	Study	NO	2	1	AUBURN 1
3	AUBURN 1 3	Study	NO	1	1	AUBURN 1
4	AUBURN 1 4	Study	NO	3	1	AUBURN 1
5	AUBURN 1 5	Study	NO	3	1	AUBURN 1
6	AUBURN 1 7	Study	NO	1	1	AUBURN 1
7	AUBURN 2 1	Study	NO	5	2	AUBURN 2
8	AUBURN 2 2	Study	NO	2	2	AUBURN 2
9	AUBURN 2 3	Study	NO	1	2	AUBURN 2
10	AUBURN 3 1	Study	NO	2	3	AUBURN 3
11	AUBURN 4 1	Study	NO	2	4	AUBURN 4
12	DURHAM 1 1	Study	NO	2	5	DURHAM 1
13	GREENE 1 1	Study	NO	1	6	GREENE 1
14	GREENE 1 2	Study	NO	3	6	GREENE 1
15	GREENE 2 1	Study	NO	2	7	GREENE 2
16	GREENE 3 1	Study	NO	2	8	GREENE 3
17	LEEDS 1 1	Study	NO	3	9	LEEDS 1
18	LEEDS 1 2	Study	NO	1	9	LEEDS 1

Select what to add to the study and external systems

External

Areas Find... Add

Zones Find... Add

Buses Find... Add

Add First Neighbors to External

Include All in Same Substation

Include how many tiers of neighbors? 0

Set all as external

Set Branch Terminals External ...

Set Branch Terminals Study...

Select buses using a network cut

Study

Areas Find... Add

Zones Find... Add

Buses Find... Add

Add First Neighbors to Study

Include All in Same Substation

Filter by kV

Filter by KV: ☒

Max 9999.0

Min 0.0

Save buses to file

Load buses from file

Close Help

Set the bus Selected field to define the Facility

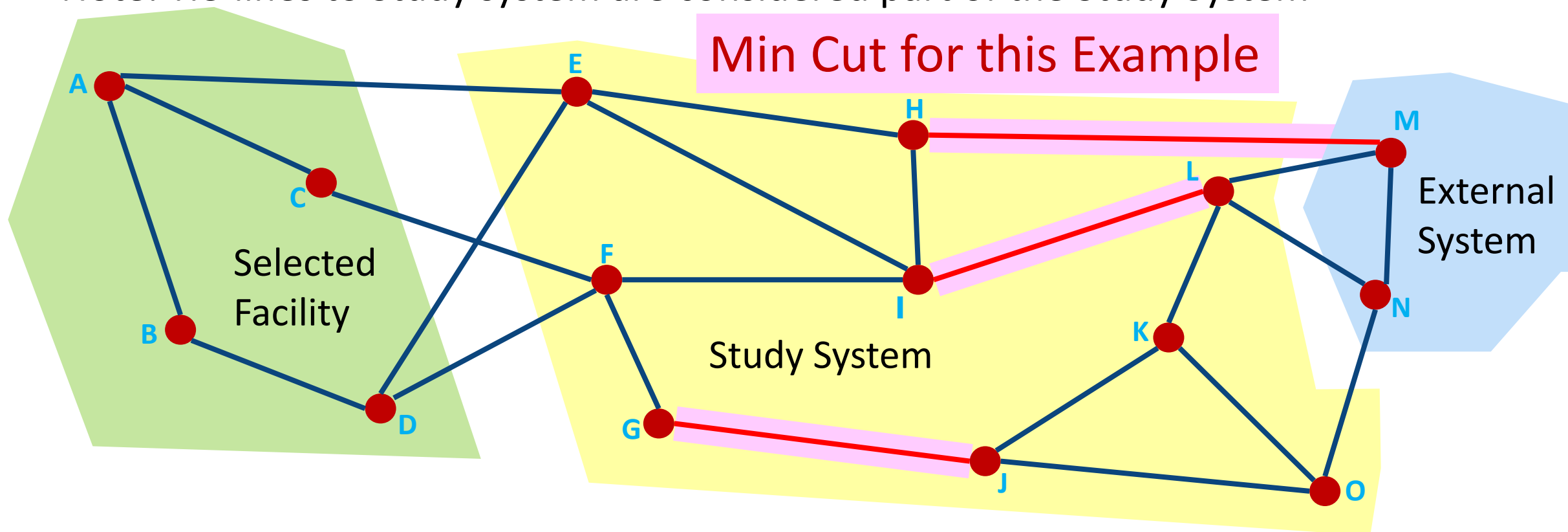


- Determine Path Distances to Buses...
- Determine Shortest Path Between...
- Find Radial Bus Paths
- Find Circulating MW or Mvar Flows...
- Facility Analysis (Minimum Cut) ...**
- Branches that Create Islands...
- Set Selected Field for Network Cut...
- Set Bus Field From Closest Bus
- Find Parallel AC Branches
- Driving Point Impedances...
- Breaker Isolated Groups
- Cycle Basis Analysis...



Facility Analysis (Minimum Cut)

- Find the minimum number of branches in the Study System that when removed will disconnect the Selected Facility from the External System
- Note: Tie-lines to Study system are considered part of the Study System





Facility Analysis (Minimum Cut) Dialog

- Specify Buses in the Facility
 - Selected = YES
- Specify Buses in External System
 - Which System?
 - Equiv = External
- Study System is then Buses with
 - (Selected = NO)
AND
(Equiv = Study)
- Dialog is built on top of the old Equivalencing dialog

Facility Analysis (Minimum Cut)

Select The Buses Facility Analysis

Note: This form is for choosing BUSES. The options regarding Areas and Zones are included to aid the task of selecting or unselecting blocks of buses.

Make-up of the study and external systems

Buses	Areas	Zones	Substations
1	1	AUBURN 1 1	Study
2	2	AUBURN 1 2	Study
3	3	AUBURN 1 3	Study
4	4	AUBURN 1 4	Study
5	5	AUBURN 1 5	Study
6	6	AUBURN 1 7	Study
7	7	AUBURN 2 1	Study
8	8	AUBURN 2 2	Study
9	9	AUBURN 2 3	Study
10	10	AUBURN 3 1	Study
11	11	AUBURN 4 1	Study
12	12	DURHAM 1 1	Study
13	13	GREENE 1 1	Study
14	14	GREENE 1 2	Study
15	15	GREENE 2 1	Study
16	16	GREENE 3 1	Study
17	17	LEEDS 1 1	Study
18	18	LEEDS 1 2	Study

Select what to add to the study and external systems

External

Areas Find... Add

Zones Find... Add

Buses Find... Add

Add First Neighbors to External

Include All in Same Substation

Study

Areas Find... Add

Zones Find... Add

Buses Find... Add

Add First Neighbors to Study

Include All in Same Substation

Filter by kV

☒ Filter by kV:

Max 9999.0

Min 0.0

Save buses to file

Load buses from file

Close Help



Facility Analysis (Minimum Cut) Dialog:

Example on Conus82.pwb

- Selected = YES: Define the Facility
 - Areas 33 (Indiana)
- Which System = External : Define the part of the system you would like the facility to be disconnected from
 - Areas 1, 2, 3 (Maine, New Hampshire, Vermont)
- Facility Analysis
 - Go to this tab to do the Minimum Cut Calculation



Facility Analysis (Minimum Cut) Dialog:

Example on Conus82.pwb

- Shows the Number of Buses in the External and Facility
- Capacity = Count of branches connecting each to the study system

List of Branches
representing the
minimum cut

(Added Custom
Integer column to
populate with a 1)

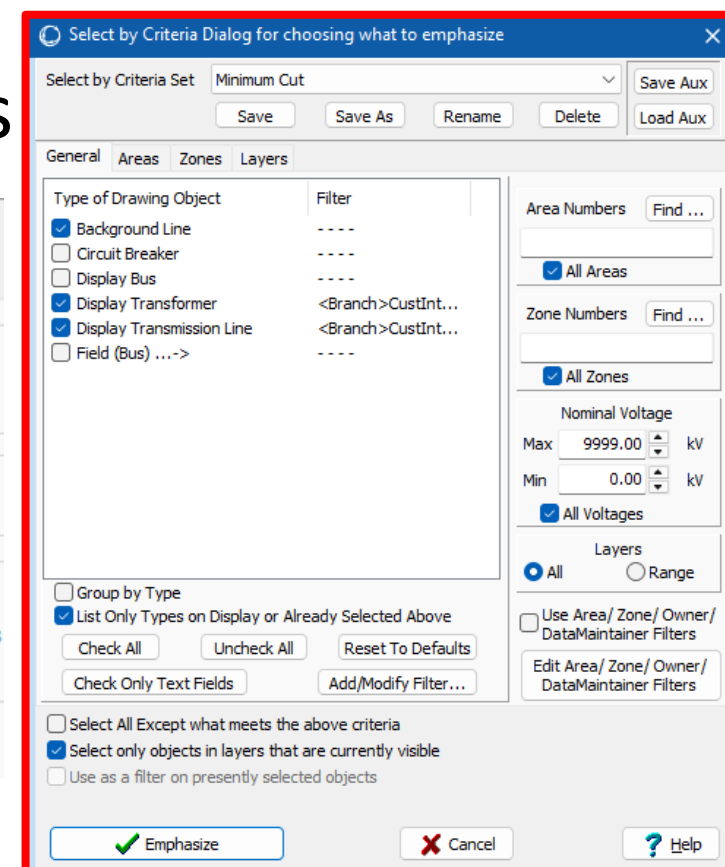
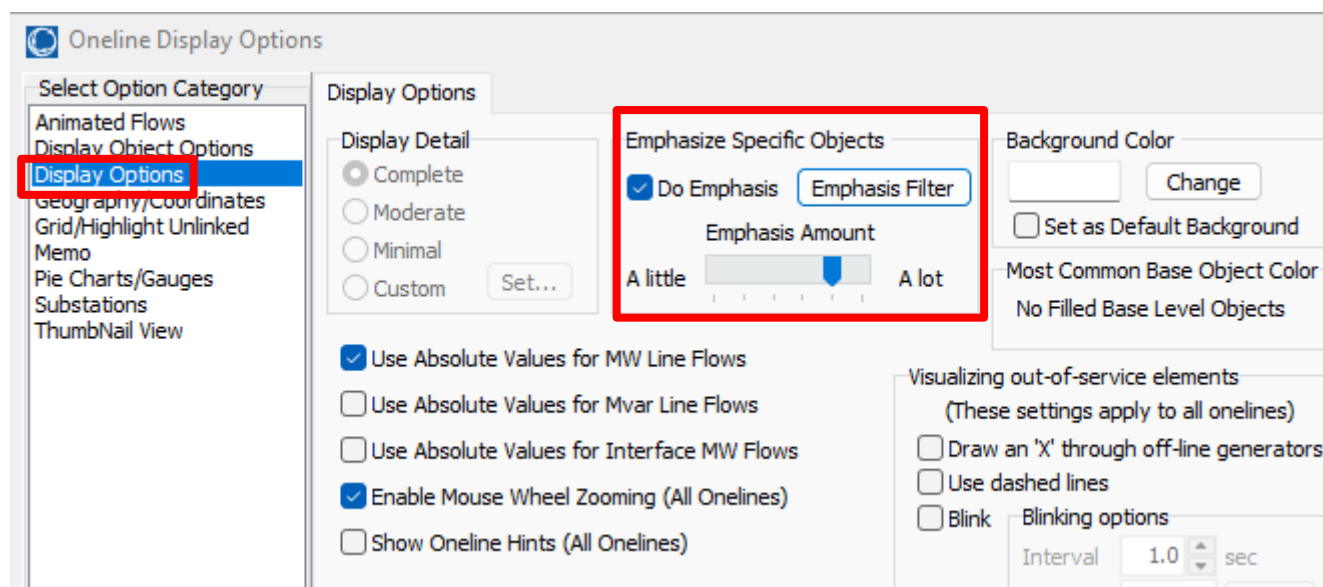
Select The Buses		Facility Analysis											
Number of Buses	Capacity	External Region	Facility										
2673	90	1943	199										
Find Minimum Cut													
<input type="checkbox"/> Set Selected Field for Branches													
Status: PATH 21: 297 branches													
Min Cut Found													
				Close									
				Help									
				Show Paths									

	Cust Int 1	From Number	From Name	From Area Name	To Area Name	To Number	To Name	Circu	MW From	Mvar From	Status	Lim MVA
1	1	4741	DANBURY 1 4	Connecticut	New York City	6320	CARMEL 5 1 1		44.5	-5.7	Closed	237.4
2	1	4813	NORWALK 10 2	Connecticut	New York City	6791	BEDFORD 1 1		139.8	6.4	Closed	298.2
3	1	4848	STAMFORD 8 4	Connecticut	New York City	6858	SCARSDALE 1		224.3	1.9	Closed	297.5
4	1	5501	STAMFORD 10 1	Connecticut	New Jersey	10314	TEANECK 2 1		769.0	-73.3	Closed	2898.2
5	1	5503	STAMFORD 10 3	Connecticut	New York City	6849	PORT CHES 1		119.2	-9.0	Closed	272.2
6	1	5811	HOPEWELL JUNCTION 1 1	New York City	New York City	5813	HOPEWELL 1		-3.8	-3.9	Closed	235.3
7	1	6787	NEW PALTZ 3 1	New York City	Upstate New York	9763	TILLSON 2 1		-178.3	19.4	Closed	320.6
8	1	6814	MAMARONECK 2 1	New York City	New York City	6817	MAMARON 1		884.9	24.4	Closed	1255.7
9	1	6875	TARRYTOWN 1 1	New York City	New York City	6847	PORT CHES 1		-160.1	56.1	Closed	281.4
10	1	6915	YORKTOWN HEIGHTS 1 1	New York City	New York City	6809	KATONAH 2 1		-68.1	1.5	Closed	250.9
11	1	7363	DELANSON 3 1	Upstate New York	Upstate New York	7361	DELANSON 1		-70.2	37.2	Closed	291.2
12	1	7402	SCHENECTADY 10 1	Upstate New York	Upstate New York	7333	ALBANY 7 1 1		12.2	6.8	Closed	265.9
13	1	8208	GLOVERSVILLE 4 3	Upstate New York	Upstate New York	9478	LITTLE FALLS 1		262.6	-57.4	Closed	2430.7
14	1	8274	LEEDS 2 1	Upstate New York	Upstate New York	8258	CAIRO 3 1 1		16.8	-4.7	Closed	264.5
15	1	8283	LONG LAKE 1 1	Upstate New York	Upstate New York	8178	TUPPER LAK 1		-49.9	-0.2	Closed	282.5
16	1	9235	KINGSTON 8 3	Upstate New York	New York City	7278	NEWBURGH 1		1129.0	-60.8	Closed	3277.9
17	1	9241	SAUGERTIES 3 1	Upstate New York	Upstate New York	9231	KINGSTON 1 1		122.1	-18.7	Closed	298.3
18	1	9465	COLTON 3 2	Upstate New York	Upstate New York	9162	RUSSELL 1 1 1		52.8	-22.7	Closed	289.9
19	1	9708	SELKIRK 3 1	Upstate New York	Upstate New York	9715	SELKIRK 3 8 1		203.8	146.5	Closed	0.0
20	1	9988	PYRITES 4	Upstate New York	Upstate New York	9130	CANTON 6 1		-59.9	-2.3	Closed	290.1
21	1	10110	OGDENSBURG 5 4	Upstate New York	Upstate New York	9466	COLTON 3 2 1		-63.8	16.2	Closed	2291.8



Visualization of Minimum Cut

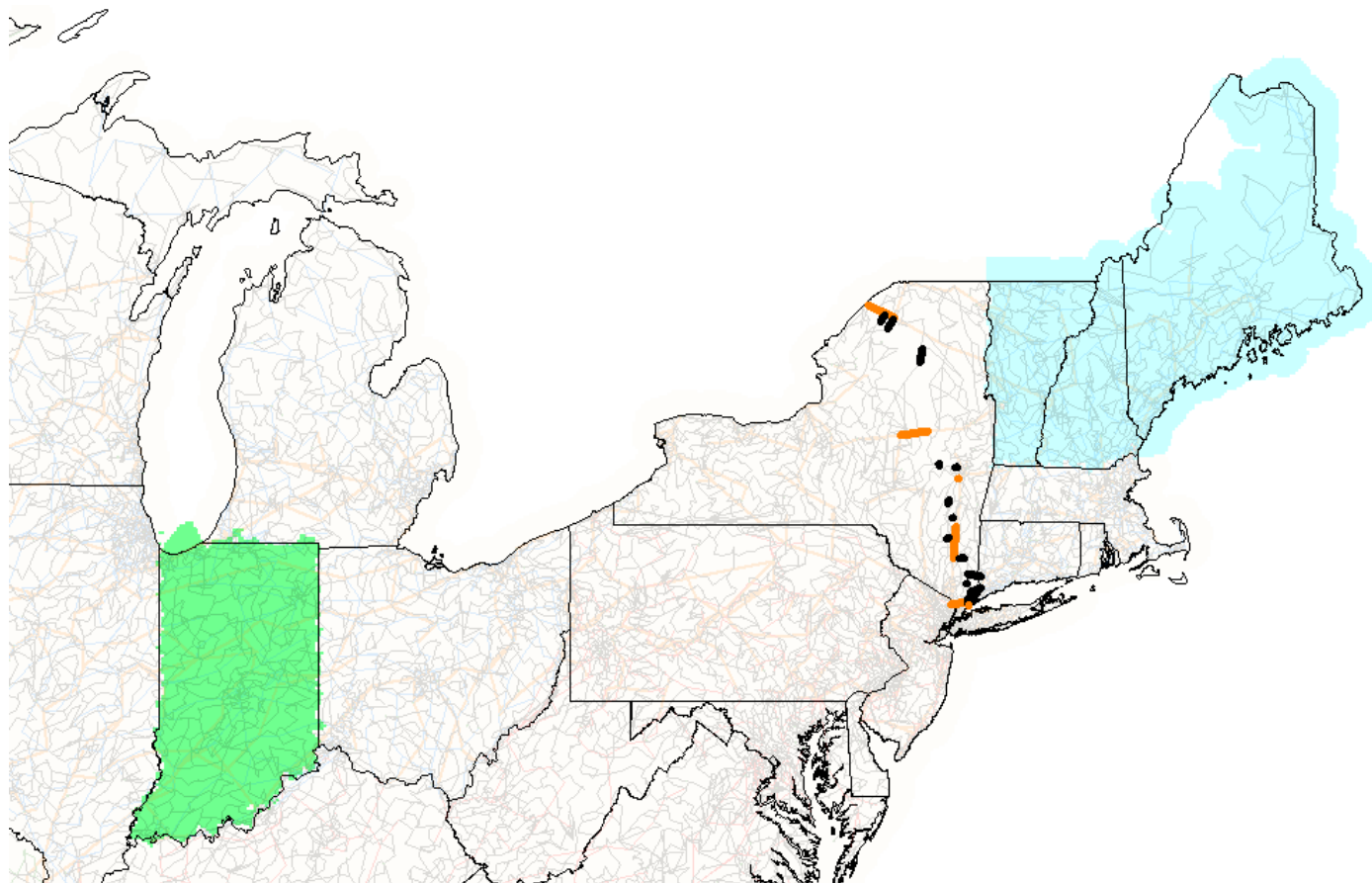
- Change the Custom Integer for each branch in the minimum Cut to 1 (shown on previous slide)
- Use Emphasis Filter in Online Options





Visualization of Minimum Cut

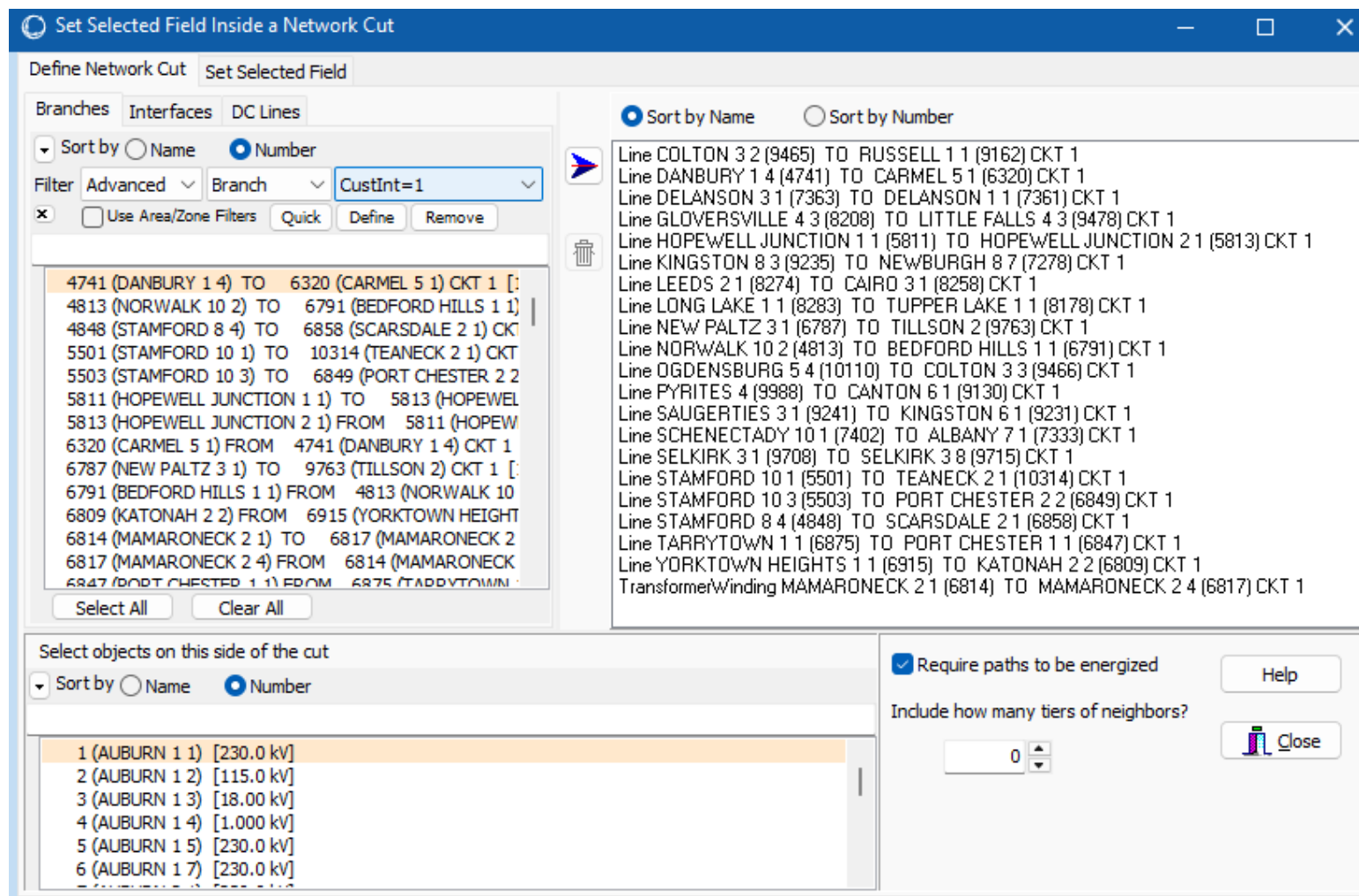
- Also use Select By Criteria to Select Branch ins the cut
- Format to make line have large thickness so we can see them
- Use Contouring to highlight area 1-3 in Blue and Area 33 in Green





Connections Menu:

Set Selected Field for Network Cut

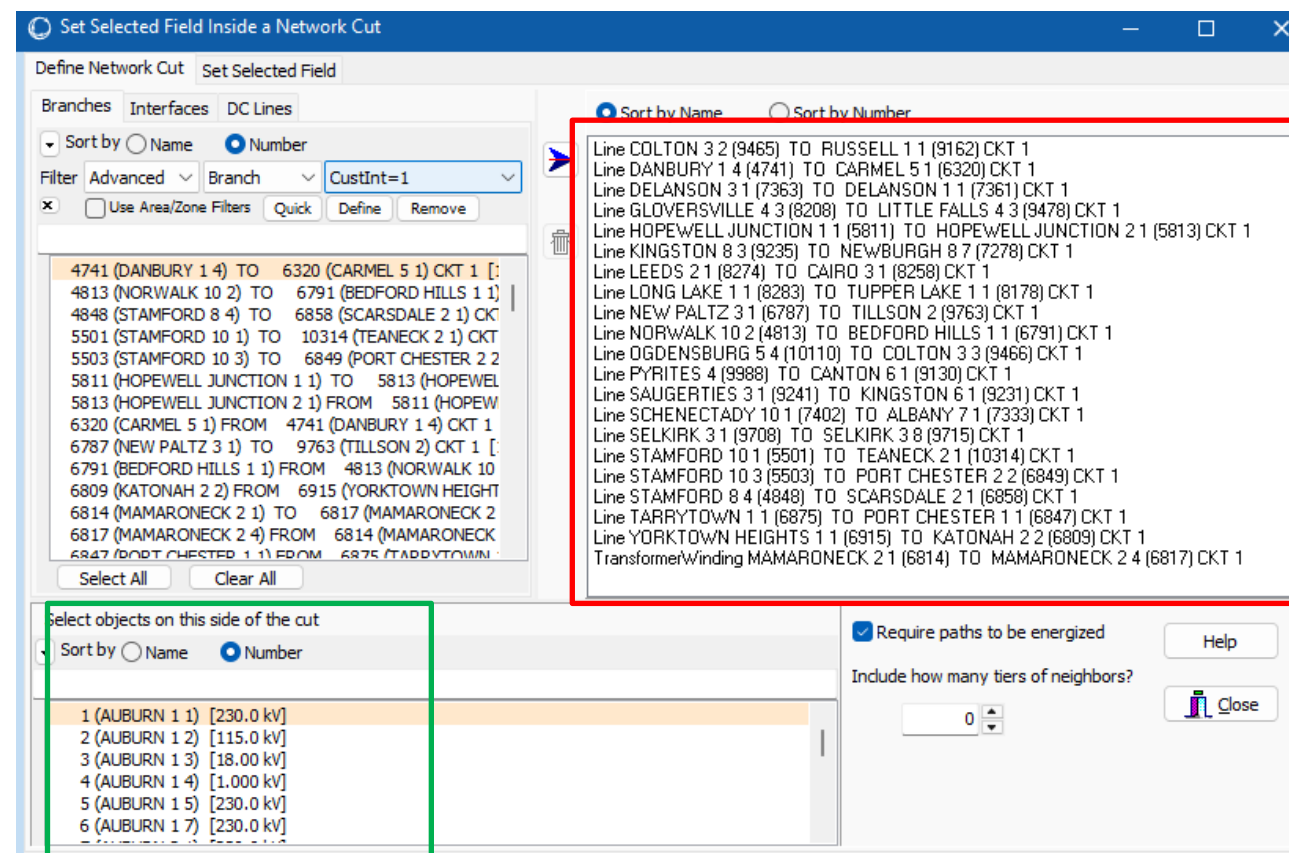


- Determine Path Distances to Buses...
- Determine Shortest Path Between...
- Find Radial Bus Paths
- Find Circulating MW or Mvar Flows...
- Facility Analysis (Minimum Cut) ...
- Branches that Create Islands...
- Set Selected Field for Network Cut...**
- Set Bus Field From Closest Bus
- Find Parallel AC Branches
- Driving Point Impedances...
- Breaker Isolated Groups
- Cycle Basis Analysis...



Set Selected For Network Cut: Define Network Cut

- Assumes you know what the network cut is ahead of time
- Input to tool
 - Specify the **list of branches and interfaces** that will cut the system into two parts
 - Specify a bus on the inside** of the cut.
 - Then go to Set Selected Field tab

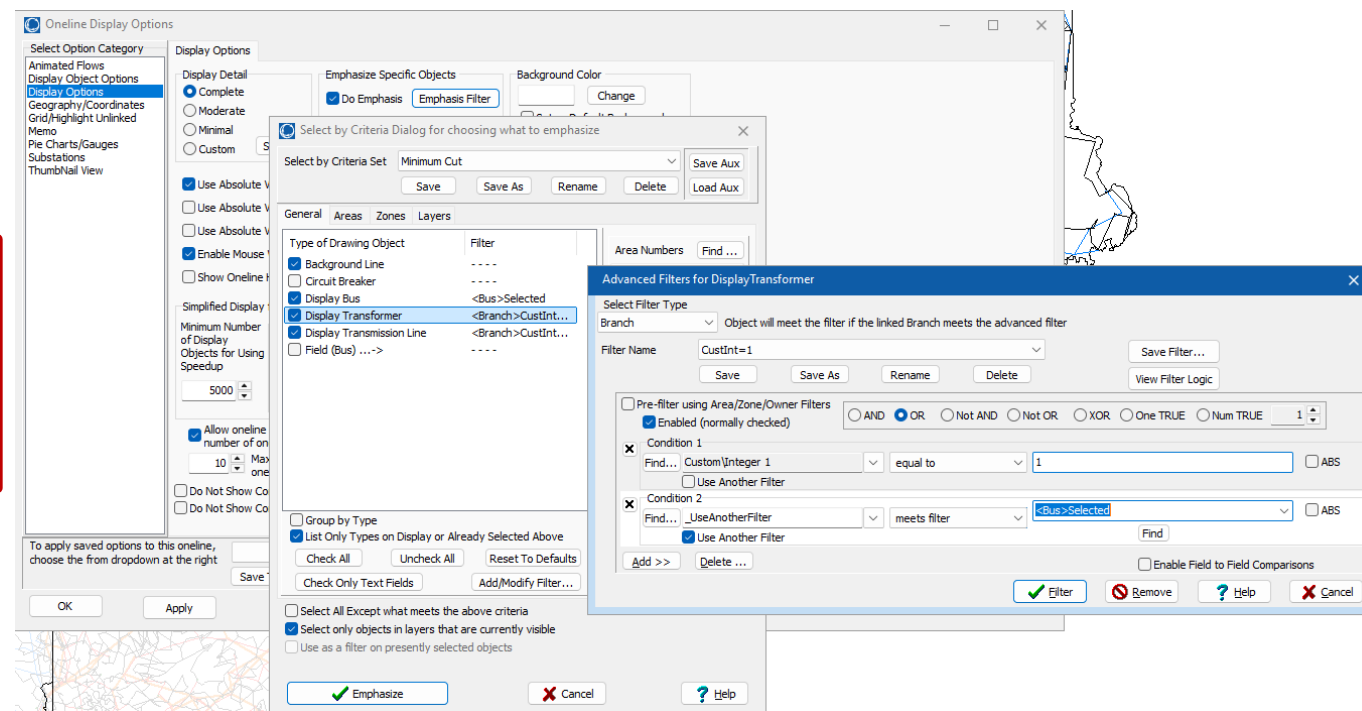
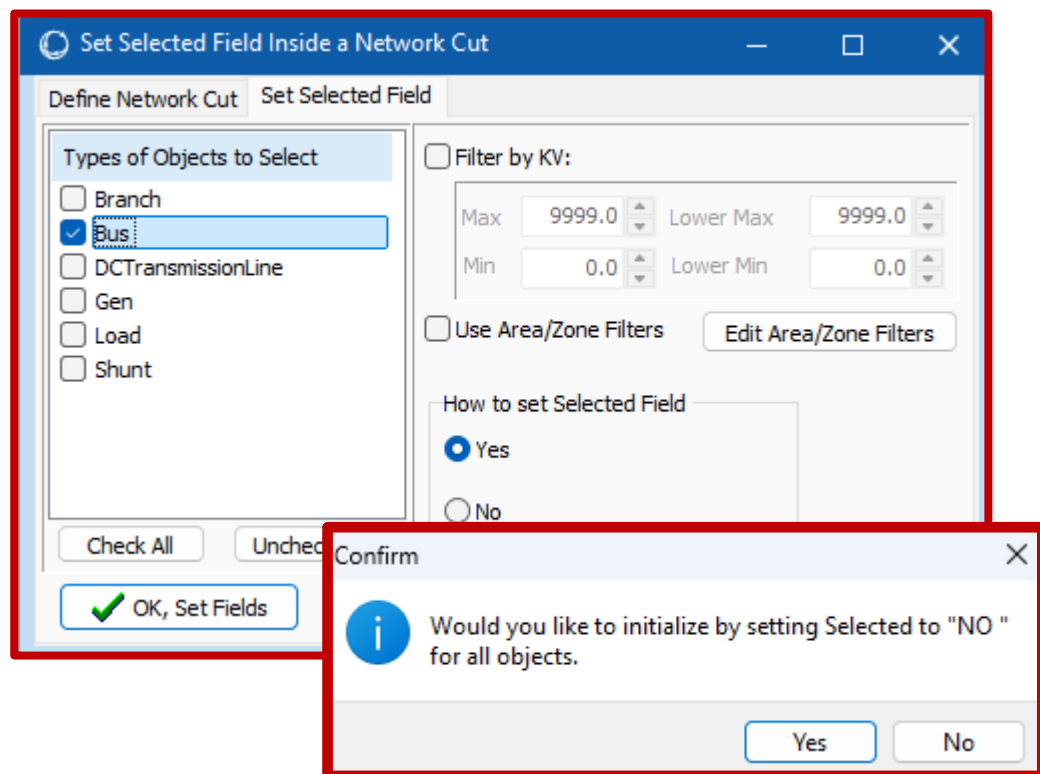


Most support questions on this tool are because a complete network cut has not actually been specified. Make sure it really is a cut



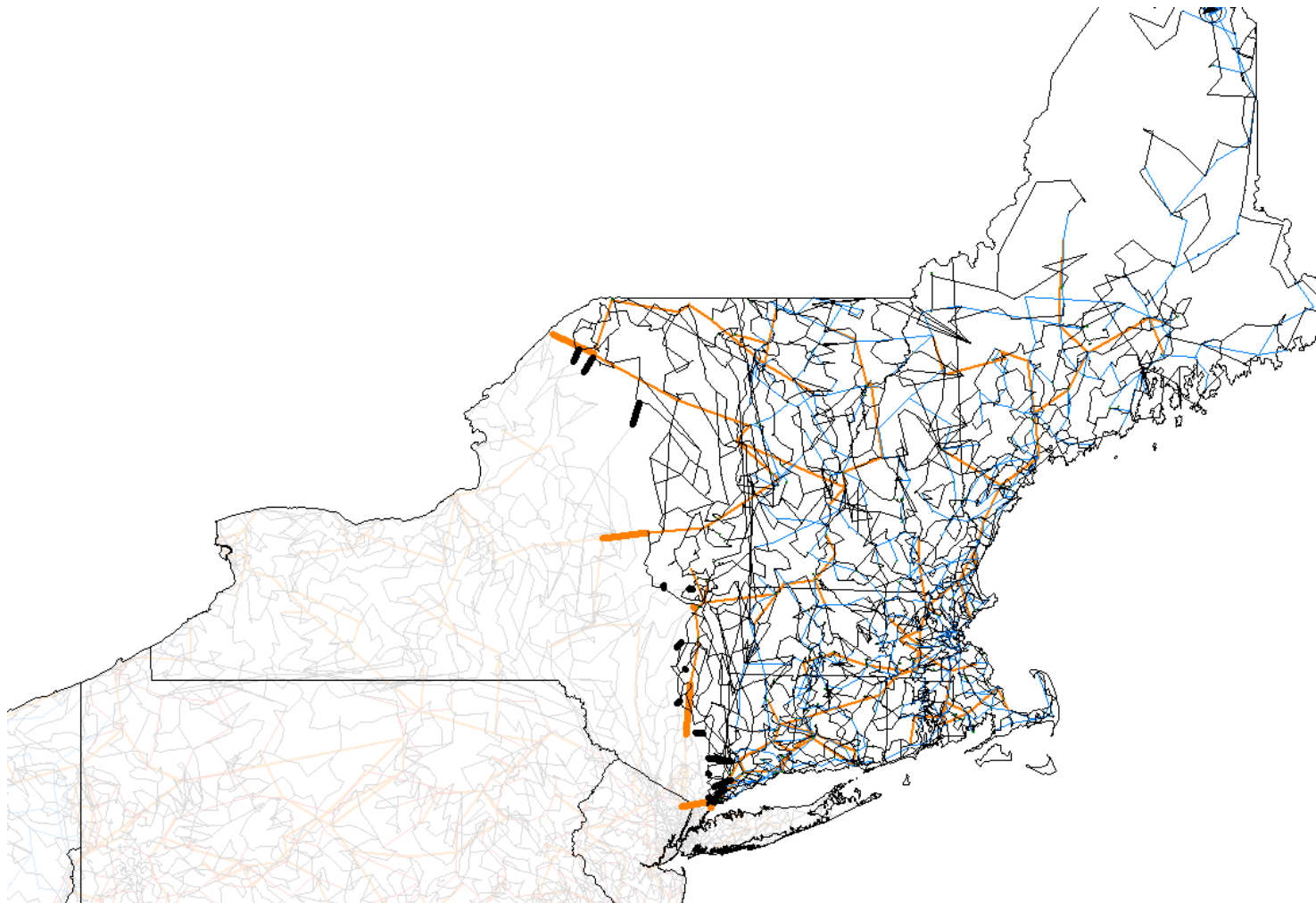
Set Selected For Network Cut: Define Network Cut

- Modify Emphasis Filter to emphasize branches that are Selected also)





Visualization of the portion of the system that is cut by the Minimum Cut





New Connection Tool: Find Radial Bus Paths

Radial End Dialog

Calculate Radial Paths ☒ Path Traverses Open Branches ☐ Treat Parallel Branches as Not Radial

Clear Radial Paths

Traverse Path By
☐ Bus
☒ Superbus

Bus Radial Ends All Buses All Branches

Radial Path Length	Number	FixedNumBus	Sub Node Number	Sub Num
3	180156	180156	1	180156
4	180153	180153	1	180153
5	162102	162102	5	162101
6	130021	130021	1	73410
7	110511	110511	1	110511
8	110231	110231	1	42090

Buses in Radial Path Branches in Radial Path

Radial Path	Radial F Index	Radial Path Length	Number	FixedNumBus	Sub Node Number	Sub Num	Sub Name
1	180156	1	4	180156	1	180156	SWEETWN3
2	180156	2	4	180157	8	180156	SWEETWN3
3	180156	3	4	180158	11	180156	SWEETWN3
4	180156	4	4	180165	15	180156	SWEETWN3



Determine Path Distances to Buses...

Determine Shortest Path Between...

Find Radial Bus Paths

Find Circulating MW or Mvar Flows...

Facility Analysis (Minimum Cut) ...

Branches that Create Islands...

Set Selected Field for Network Cut...

Set Bus Field From Closest Bus

Find Parallel AC Branches

Driving Point Impedances...

Breaker Isolated Groups

Cycle Basis Analysis...

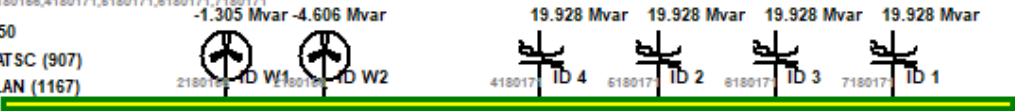


Find Radial Bus Paths

Radial Bus

SWEETWN_WND3

Bus: SWEETWN_WND3 (180156) [FixedNumBus=180156]
180156,180171,2180168,4180171,6180171,8180171,7180171
10.282 MW 38.292 Mvar
-1.305 Mvar -4.606 Mvar
Nom kV: 34.50
Area: E_LCRATSC (907)
Zone: E_NOLAN (1167)
1.1764 pu
40.59 KV



Radial End Dialog

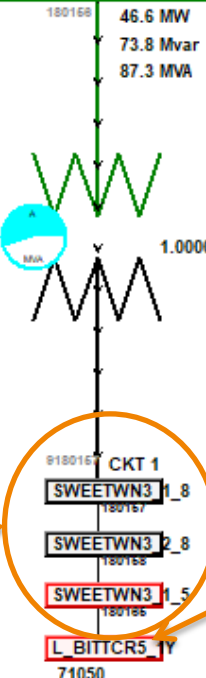
Calculate Radial Paths ☒ Path Traverses Open Branches
Clear Radial Paths ☐ Treat Parallel Branches as Not Radial

Traverse Path By
☐ Bus
☒ Superbus

Bus Radial Ends All Buses All Branches

Radial Path Length	Number	FixedNumBus	Sub Node Number	Sub Num
3	180156	180156	1	180156
4	180153	180153	1	180153
5	162102	162102	5	162101
6	130021	130021	1	73410
7	110511	110511	1	110511
8	110231	110231	1	42090

Radial Path	Radial F Index	Radial Path Length	Number	FixedNumBus	Sub Node Number	Sub Num	Sub Name
1	180156	1	180156	180156	1	180156	SWEETWN3
2	180156	2	180157	180157	8	180156	SWEETWN3
3	180156	3	180158	180158	11	180156	SWEETWN3
4	180156	4	180165	180165	15	180156	SWEETWN3



Termination of radial path (bus has multiple connections)

Other Buses on Radial Path



Connections Menu:

Find Parallel AC Branches

Radial End Dialog

Calculate Radial Paths ☒ Path Traverses Open Branches ☐ Treat Parallel Branches as Not Radial

Clear Radial Paths

Traverse Path By
☐ Bus
☒ Superbus

Bus Radial Ends All Buses All Branches

Radial Path Length	Number	FixedNumBus	Sub Node Number	Sub Num
3	180156	180156	1	180156
4	180153	180153	1	180153
5	162102	162102	5	162101
6	130021	130021	1	73410
7	110511	110511	1	110511
8	110231	110231	1	42090

Buses in Radial Path Branches in Radial Path

Radial Path	Radial F Index	Radial Path Length	Number	FixedNumBus	Sub Node Number	Sub Num	Sub Name
1	180156	1	4	180156	1	180156	SWEETWN3
2	180156	2	4	180157	8	180156	SWEETWN3
3	180156	3	4	180158	11	180156	SWEETWN3
4	180156	4	4	180165	15	180156	SWEETWN3



- Determine Path Distances to Buses...
- Determine Shortest Path Between...
- Find Radial Bus Paths
- Find Circulating MW or Mvar Flows...
- Facility Analysis (Minimum Cut) ...
- Branches that Create Islands...
- Set Selected Field for Network Cut...
- Set Bus Field From Closest Bus
- Find Parallel AC Branches**
- Driving Point Impedances...
- Breaker Isolated Groups
- Cycle Basis Analysis...



More Existing Tools:

Find Parallel AC Branches

- Good for finding parallel transformers with “from/to” bus terminals flipped. Makes coordinating transformer taps confusing
- Buses 22648 and 22644 are 3 parallel transformers, but from/to bus designations are flipped
 - Tap ratios are 1.07159 and 0.93261
 - Yes... Balanced...
 - But confusing
 - You should flip these from/to

Find Parallel AC Branches

Calculation Options
Branch fields to populate:

Label for each group of branches: Custom\Integer 1 Find...

Number of branches per group: Custom\Integer 2 Find...

Calculate

Result Filter Options
Only show groups with ≥ 2 AND ≤ 100 branches,
AND ☒ with either zero/nonzero-impedance branches
☐ with atleast one zero-impedance branch
☐ with only nonzero-impedance branches
☒ Identify parallel transformers with conflicting tap orientation

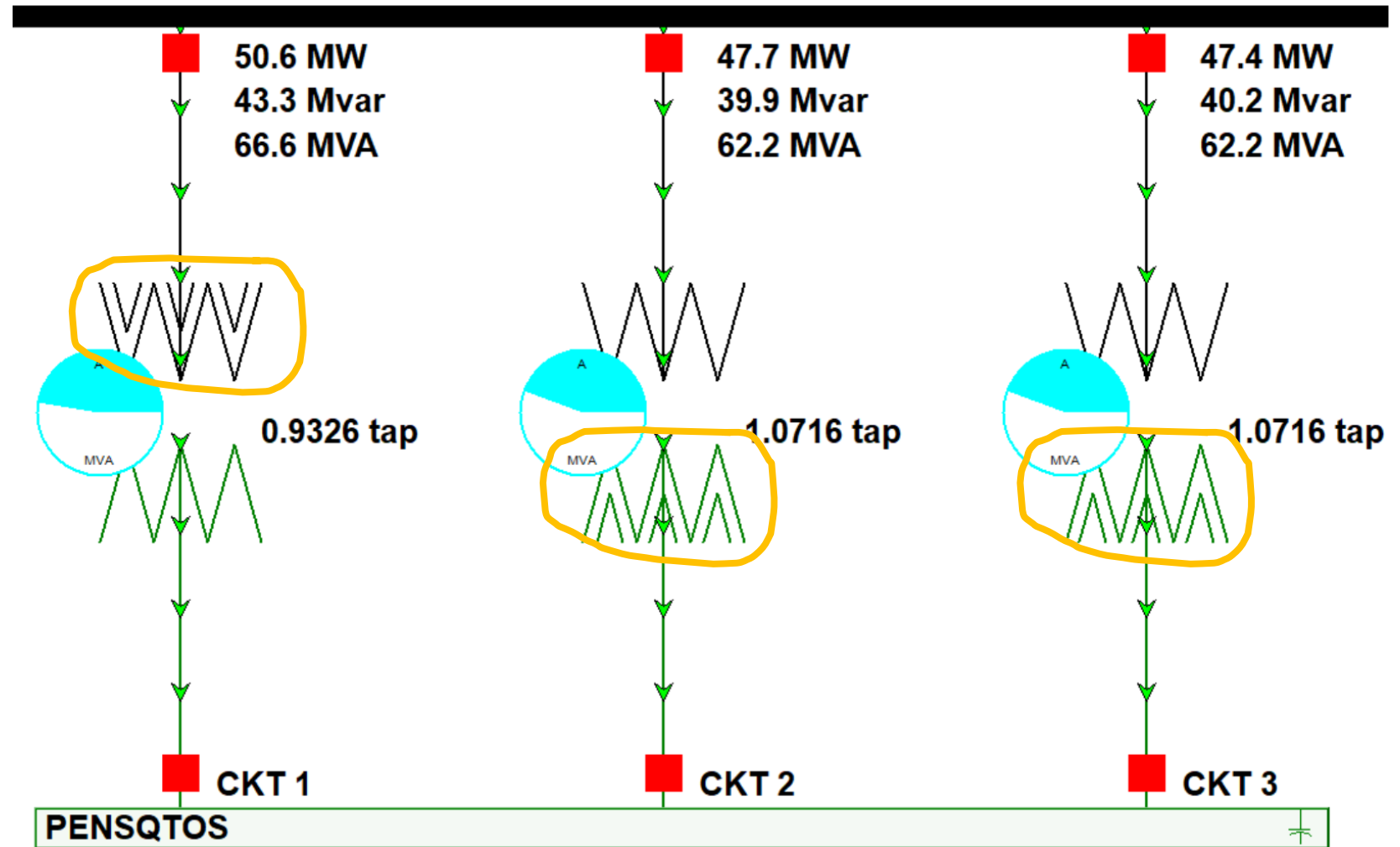
Branches

	From Number	From Name	To Number	To Name	Circuit	Status	ZMag	From ZBR Bus Primary	To ZBR Bus Primary	Branch Device Type	Xfrmr	Type	Tap Ratio	Phas
2	12181	GLDSTNPS	12101	GLADSTON	1	Closed	0.05400	12181	12101	Transformer	YES	Phase	1.00000	48
3	22648	PENSQTOS	22644	PENSQTOS	1	Closed	0.09984	22648	22644	Transformer	YES	Fixed	0.93261	0
4	22644	PENSQTOS	22648	PENSQTOS	3	Closed	0.09238	22644	22648	Transformer	YES	Fixed	1.07159	0
5	22644	PENSQTOS	22648	PENSQTOS	2	Closed	0.09234	22644	22648	Transformer	YES	Fixed	1.07159	0
6	26089	AIRPORT	26560	AIR A M	A	Closed	0.10793	26089	26560	Transformer	YES	LTC	0.95826	0



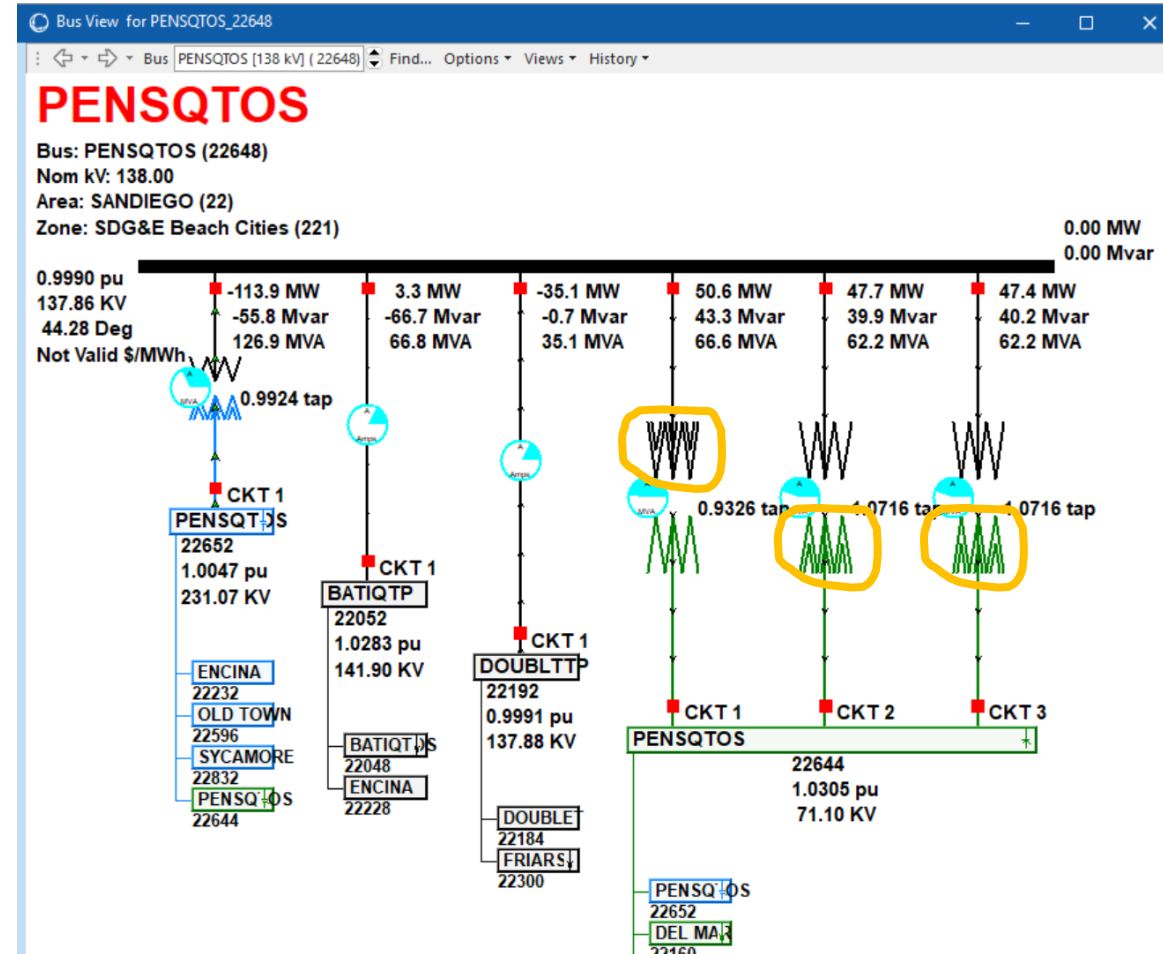
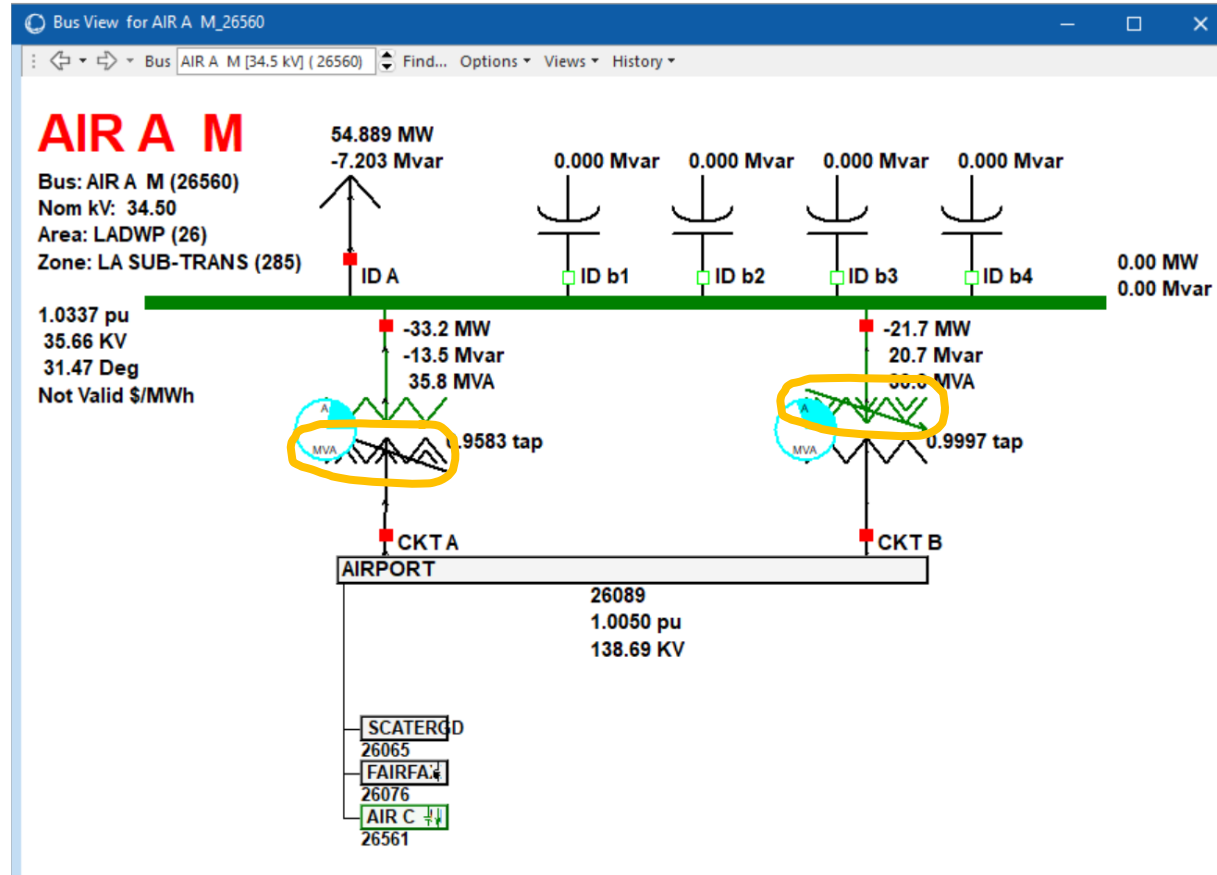
New Transformer Winding Symbol Indicates the Variable Tap side (from bus)

- Double lines represent the From Bus (Variable Tap side)



Parallel Transformer with From/To Bus

Numbers flipped from each other





Connections Menu: Breaker Isolated Groups

Breaker Isolated Groups

Find Isolated Groups Filter Display Below By Range: Update Filter

☐ Use Branch Normal Status for Groupings

Bus Gen Load Shunt Branch

Records Geo Set Columns f(x)

	Number	FixedNumBus	Sub Node Number	Sub Num	Sub Name	Implicit Breakers	Breaker Group Number
1090	3071	3071				NO	55
1091	3085	3085				NO	55
1092	36002493	2493	36	2486	Sub2486	NO	55
1093	7003076	3076	7	3075	Sub3075	NO	55
1094	19002342	2342	19	2342	Sub2342	NO	55
1095	2126	2126				NO	55
1096	8000210	210	8	210	Sub210	NO	56
1097	13000210	210	13	210	Sub210	NO	56
1098	202	202	1	202	Sub202	NO	56
1099	5000202	202	5	202	Sub202	NO	56
1100	19000203	203	19	202	Sub202	NO	57
1101	10000203	203	10	202	Sub202	NO	57
1102	12000203	203	12	202	Sub202	NO	57
1103	2317	2317	20	2316	Sub2316	NO	57
1104	2000217	217	2	217	Sub217	NO	57
1105	12317	12317				NO	57
1106	203	203	6	202	Sub202	NO	57



- Determine Path Distances to Buses...
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- Set Bus Field From Closest Bus
- Find Parallel AC Branches
- Driving Point Impedances...
- Breaker Isolated Groups**
- Cycle Basis Analysis...



Connections Menu:

Breaker Isolated Groups

- Can be used with a Full-Topology Model
 - All the breakers/disconnects and other switching devices are in the model
 - Algorithm will look for groups of buses and their connected devices that are isolated by opening the same group of switching devices
- Alternative, populate the bus field called “Implicit Breakers” (YES or NO)
 - YES means every branch connected to this bus is assumed to have switching devices at a bus end which is marked Implicit Breakers = YES
 - Similar search algorithm



Breaker Isolated Groups:

Just Click **Find Isolated Groups**

- Bus Breaker Group Number Integer will be populated with an integer
 - Buses that are grouped together have the same integer
 - Generators, Loads, Shunt shows a column with Breaker Group Number
 - Branches table will show the from and to bus integer

Breaker Isolated Groups

Find Isolated Groups Filter Display Below By Range: Update Filter

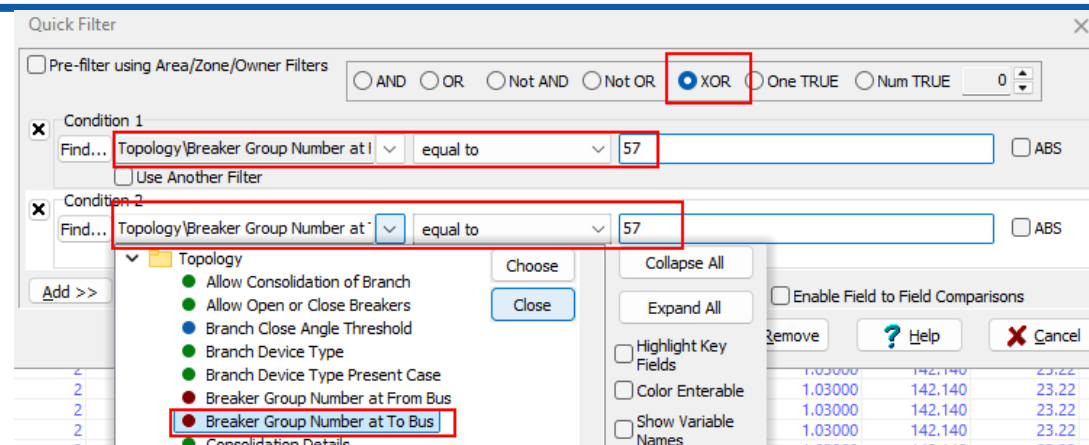
☐ Use Branch Normal Status for Groupings

Bus	Gen	Load	Shunt	Branch	Number	FixedNumBus	Sub Node Number	Sub Num	Sub Name	Implicit Breakers	Breaker Group Number
1090					3071	3071				NO	55
1091					3085	3085				NO	55
1092		36002493			2493	2493	36	2486	Sub2486	NO	55
1093		7003076			3076	3076	7	3075	Sub3075	NO	55
1094		19002342			2342	2342	19	2342	Sub2342	NO	55
1095		2126			2126	2126				NO	55
1096		8000210			210	210	8	210	Sub210	NO	56
1097		13000210			210	210	13	210	Sub210	NO	56
1098		202			202	202	1	202	Sub202	NO	56
1099		5000202			202	202	5	202	Sub202	NO	56
1100		19000203			203	203	19	202	Sub202	NO	57
1101		10000203			203	203	10	202	Sub202	NO	57
1102		12000203			203	203	12	202	Sub202	NO	57
1103		2317			2317	2317	20	2316	Sub2316	NO	57
1104		2000217			217	217	2	217	Sub217	NO	57
1105		12317			12317	12317				NO	57
1106		203			203	203	6	202	Sub202	NO	57
1107		5000217			217	217	5	217	Sub217	NO	57
1108		3000217			217	217	3	217	Sub217	NO	57
1109		19002424			2424	2424	19	2424	Sub2424	NO	57
1110		17002424			2424	2424	17	2424	Sub2424	NO	57
1111		15000203			203	203	15	202	Sub202	NO	57
1112		2002318			2318	2318	2	2316	Sub2316	NO	57
1113		217			217	217	1	217	Sub217	NO	57
1114		4000217			217	217	4	217	Sub217	NO	57
1115		5000204			204	204	5	204	Sub204	NO	58
1116		6000204			204	204	6	204	Sub204	NO	58
1117		9000204			204	204	9	204	Sub204	NO	58
1118		2000204			204	204	2	204	Sub204	NO	58



Showing the Branches that Isolate a Group

- Filter Branch table to show the logical XOR of the From/To Breaker Group Number being equal to the integer group number of interest
 - This gives only the branches that will create an isolated group
- These are the switching devices that will isolate this group



Breaker Isolated Groups

Find Isolated Groups Filter Display Below By Range: Update Filter

☐ Use Branch Normal Status for Groupings

Bus	Gen (Filter:Quick)	Load (Filter:Quick)	Shunt (Filter:Quick)	Branch (Filter:Quick)	From Number	From FixedNumBus	To Number	To FixedNumBus	Circuit	From Breaker Group Number	To Breaker Group Number
1					203	203	7000203	203	1	57	91
2	10000203				203	203	11000203	203	1	57	786
3	12000203				203	203	13000203	203	1	57	13193
4	14000203				203	203	15000203	203	1	5486	57
5	217				217	217	7000217	217	1	57	10668
6	5000217				217	217	6000217	217	1	57	9890
7	217				217	217	7000217	217	P1	57	10668
8	5000217				217	217	6000217	217	P1	57	9890
9	2317				2317	2317	24002317	2317	1	57	12919
10	2318				2318	2318	2002318	2318	1	792	57
11	16002424				2424	2424	17002424	2424	1	9996	57



Connections Tools Summary

- There are a lot of different tools
- Some are new features
- Others have been in PowerWorld Simulator a long time
- We have not traditionally covered these in a training session due to limited time
- Make good use of them, and the visualization tools that go with them



In-Person PowerWorld Simulator Training

Sept 30 – Oct 2: ERCOT, Austin, Texas

- September 30 – October 2: PowerWorld Training hosted by ERCOT in Austin, Texas
 - Agenda (registration is done for each day, so attend a few days or all 5 days)
<https://www.powerworld.com/files/TrainingAgendaERCOT202509.pdf>
 - Tuesday: OPF, LMP Markets, Contingency Analysis, SCOPF
 - Tuesday: Advanced OPF, Case Info, Auxiliary Files, OPF automation
 - Wednesday: Transient Stability
 - Location/Time
 - Location: ERCOT, 8000 Metropolis Drive Austin, Texas 78744
 - 8:30 AM start time each day. Ends 4:30 or 4:45 PM
 - <https://www.powerworld.com/training/training-calendar>
- We are looking forward to it!