What's New in Simulator 22?

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Highlights

Enhancements

- Case Information Display
- Difference Case
- More flexible Distributed Computation Configuration Tool
- Read/Write of several file formats
- Remedial Action Schemes (RAS) in Contingency Analysis, and extending support to Transient Stability
- Re-Evaluation of Limit Monitor in Transient Stability
- Batch-Saving Plots after a Transient Stability run, and saving to a PDF file
- Faster Contour Rendering

New Features

- Multi-direction Available Transfer Capacity (ATC)
- Contingency Combination Tool (N-1-1 analysis)
- Transient Stability Result Analyzer

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64-bit Simulator 22

- Only 64-bit version is installed
- Simulator 20 and 21 have already been 64-bit
- 32-bit version is not available
  - Simulator 20 was the last one

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Auxiliary Files (SCRIPT and DATA)
New Script Commands

- Special keywords
  - `@CASEFILENAME` (without path and extension)
  - `@CASEFILEPATH` (just the case path)
    - To use anywhere that `@CASENAME` can be used
    - Example: `LogSave("@CASENAME.txt", NO);`
    - The message log is saved to a text file named as the case-name.

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Auxiliary Files (SCRIPT and DATA) New Script Commands

- ATC Related Actions
  - `ATCWriteAllOptions("filename", AppendFile, KeyField);`
    - Saves same objects as `ATCWriteResultsAndOptions` but always uses the concise format for object fields and headers and does not use `SubData`. RAS and contingency actions are saved using dependencies.

- Case Related Actions
  - `EstimateVoltages(filter);`
    - Estimate voltages and angles at specified buses based on voltages and angles at surrounding buses.

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Auxiliary Files (SCRIPT and DATA)
New Script Commands

- Contingency Related Actions
  - `CTGProcessRemedialActionsAndDependencies (DoDelete, filter);`
    - Batch processing of Remedial Actions and related objects

- Fault Related Actions
  - `LoadPTISEQData(filename, version);`
    - Loads a PTI SEQ file

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Auxiliary Files (SCRIPT and DATA)
New Script Commands

- Program Related Actions
  - `LogShow(DoShow);`
    - If YES the message log will be displayed.
    - If NO the message log will be hidden.

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Auxiliary Files (SCRIPT and DATA) Modified Script Commands

- General Script Commands
  - `SaveData(…, Append);`
  - `SaveDataWithExtra(…, Append);`
    - If YES and the specified file exists, the file will be appended with the saved data. If NO any existing file will be overwritten.

- Power Flow Related Actions
  - `DiffFlowWriteCompleteModel(…, IncludeClearPowerFlowSolutionAidValues);`
    - By default this is YES. When set to YES the `ClearPowerFlowSolutionAidValues` script command is included in the auxiliary file saved from the case differences.

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Auxiliary Files (SCRIPT and DATA) Modified Script Commands

- ATC Related Actions
  - `ATCWriteToExcel(…, [fieldlist]);`
  - `ATCWriteToText(…, [fieldlist]);`
    - If the `[fieldlist]` is specified, the results will be saved with these specified fields. Otherwise, the results will be saved with the fields specified with the TransferLimiter DataGrid.
    - It is possible that the results could be blank if the TransferLimiter DataGrid has not been initialized by either opening the ATC dialog or loading the DataGrid settings from an auxiliary file.
    - To make sure that results are stored and the desired fields are included, it is suggested that the `[fieldlist]` option be used

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Auxiliary Files (SCRIPT and DATA) Modified Script Commands

- ATC Related Actions
  - `ATCWriteResultsAndOptions(…);`
    - No change in input arguments
    - Interface and Injection Group dependencies are also saved (which might have been used to define Source/Sink, ATC Extra Monitors, Multiple Scenarios, and Remedial Actions)
    - Unchanged from before: All Model Conditions, Model Filters, Model Expressions, and other possible dependencies of Remedial Actions are saved even if they aren't used as part of a Remedial Action
  - Same behavior when saving ATC results and options from the ATC dialog

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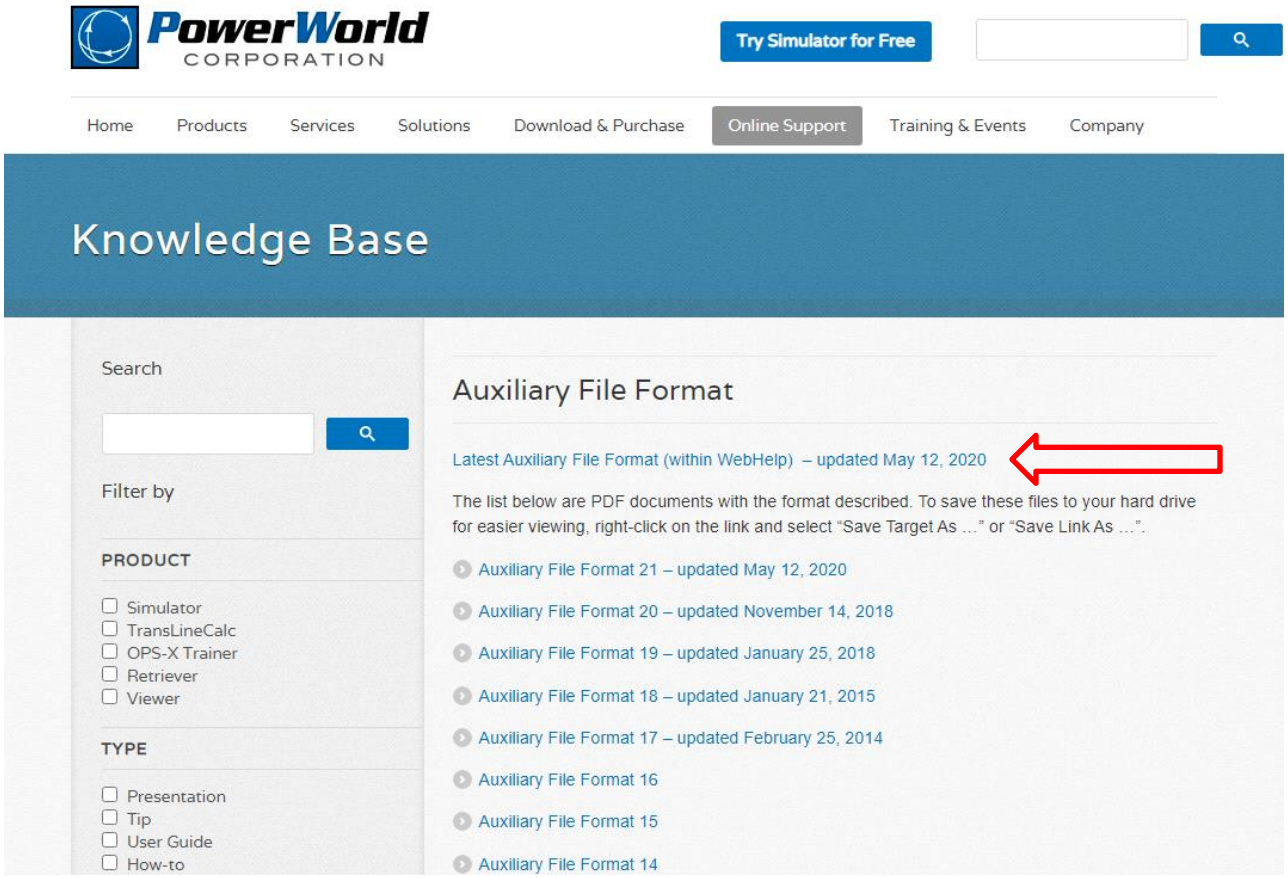
Auxiliary Files (SCRIPT and DATA) File Format

- www.powerworld.com/knowledge-base/auxiliary-file-format



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Available Transfer Capability

- Multiple directions specified with ATC tool to be run in sequence rather than having to launch tool separately for each direction studied.

Completion expected before the release of version 22

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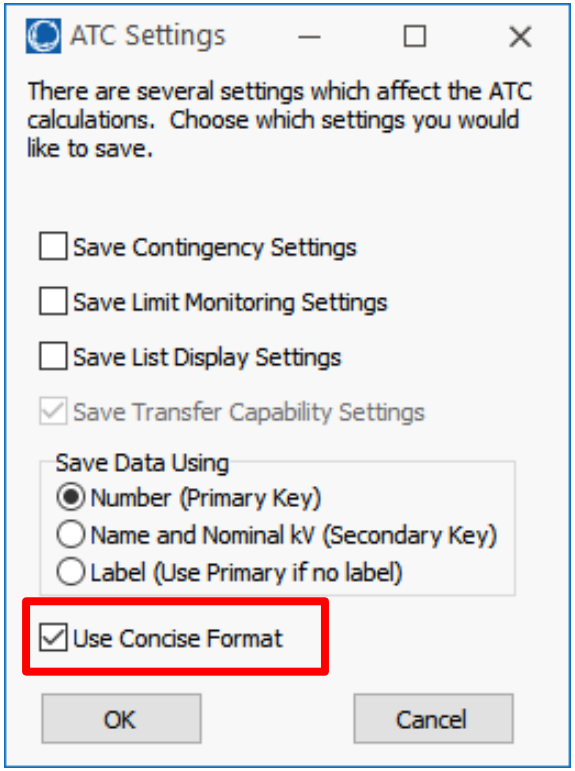
Available Transfer Capability

- "*Use Concise Format*" in ATC Settings
  - To save ATC options and results.
  - Will use the concise format for object fields and headers, and does not use `SubData`.
  - Default: Version 21 – Unchecked
    Version 22 – Checked



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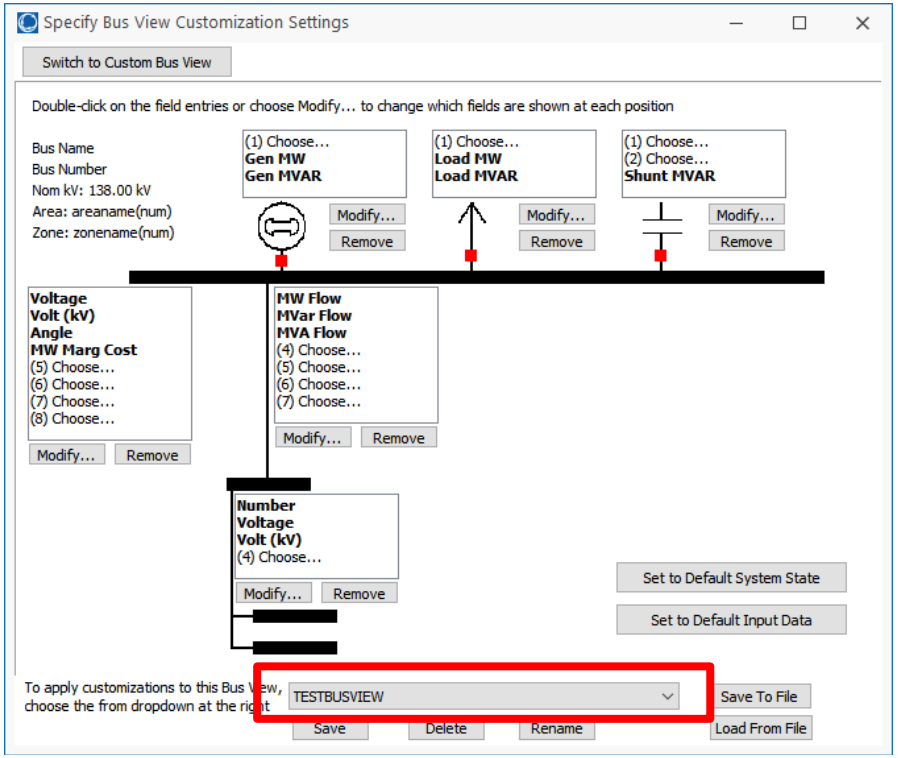
Bus and Substation View Onelines

- Name of the currently chosen “Custom View” is now stored in the system registry for Bus View settings
  - Retained when Simulator is closed, and applied when reopened
  - Used with any PWB if the named custom view is saved with the PWB



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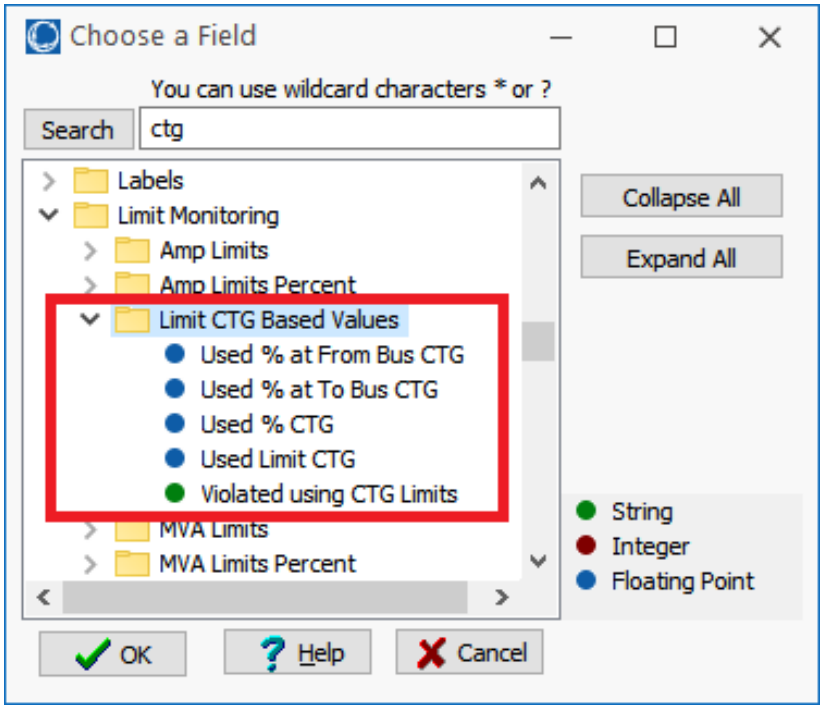
Case Information Displays

- New fields for Branches to show loading percentages based on Limit Monitoring Settings using Contingency Ratings.
  - *Used % at From Bus CTG*
  - *Used % at To Bus CTG*
  - *Used % CTG*
  - *Used Limit CTG*
  - *Violated using CTG Limits*



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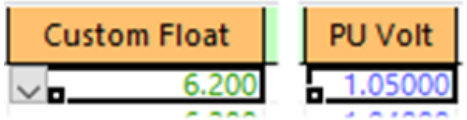
Case Information Displays

- Positioning of Quick Fill in Cells of a Grid
  - If text is right-aligned, then button AND handle on the left.

  - If text is left-aligned then button AND handle on the right.



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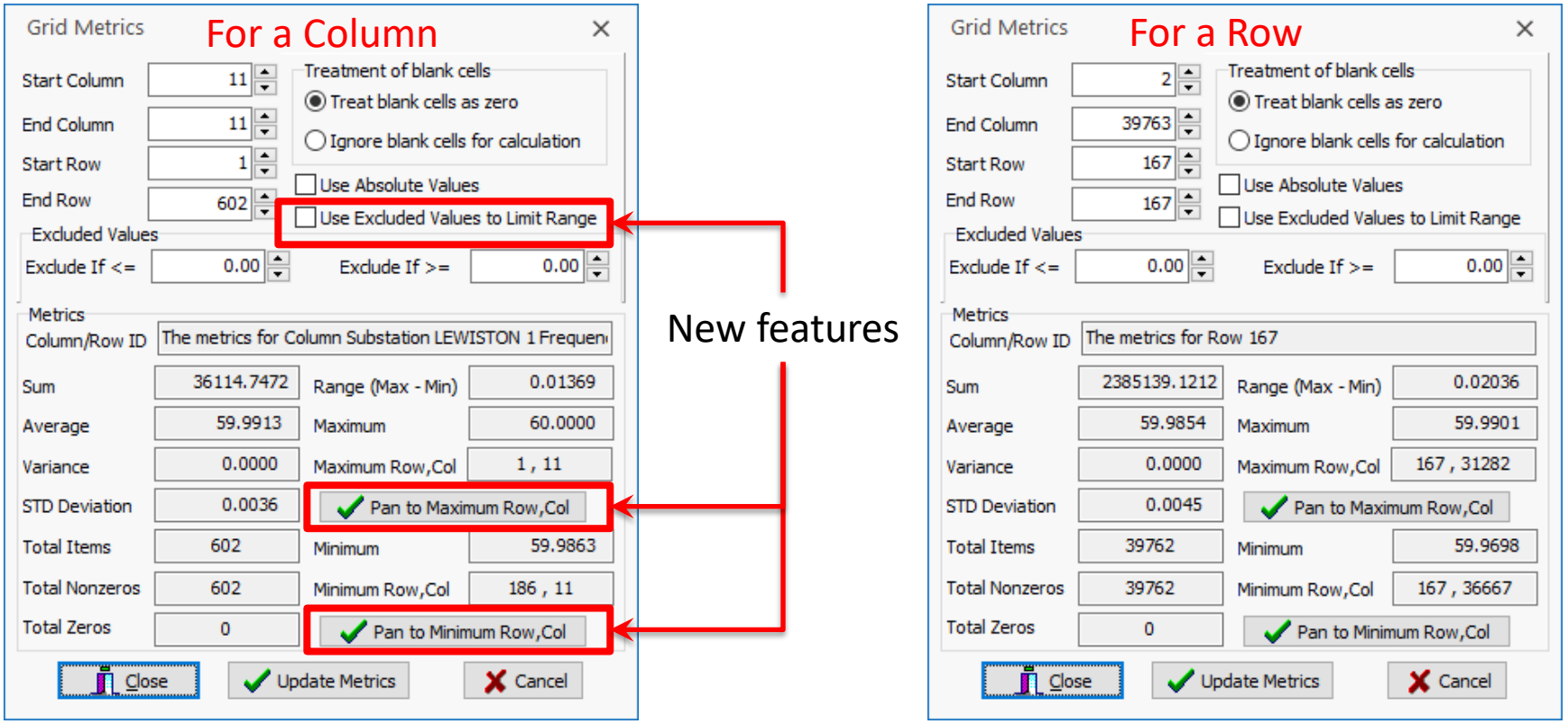
Case Information Displays

- New “Row Metrics” and String grid “Column Metrics”
  - Right-click on grids > Set/Toggle/Columns



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Case Information Displays

- "Save As Auxiliary With Options" feature
  - More flexibility to save using `Data` instead of `SubData` sections and choosing which contained objects to save
  - Will also include options to save using Auxiliary Export Format Description.

Completion expected before the release of version 22

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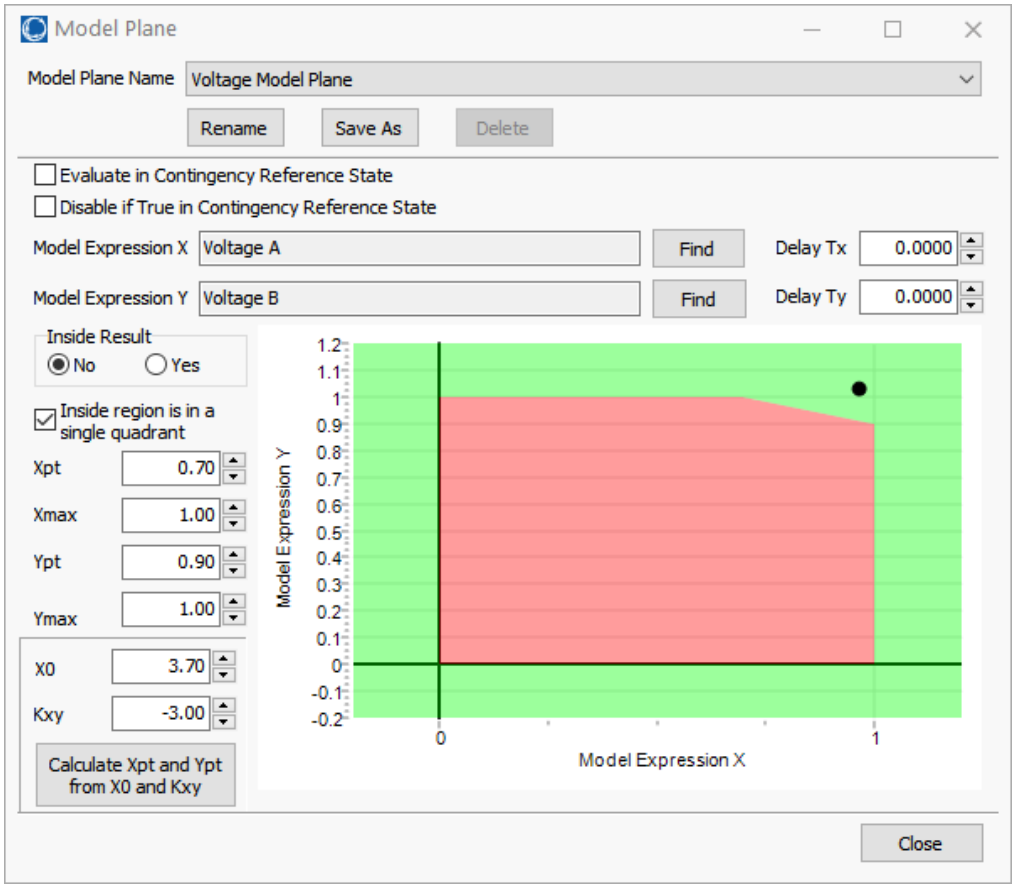
Contingency Analysis

- New tool for defining Model Planes
  - To use with defining remedial actions along with Model Conditions & Model Filters.



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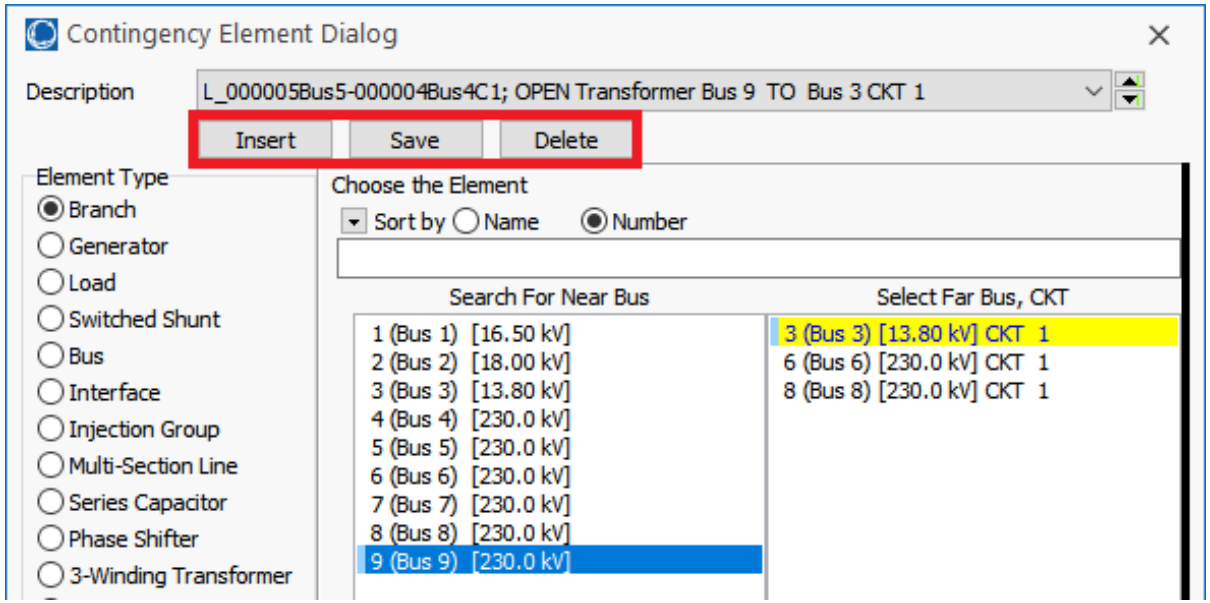
Contingency Analysis

- Contingency Element Dialog
  - Now allows multiple elements to be added to the **same contingency** without closing the dialog.



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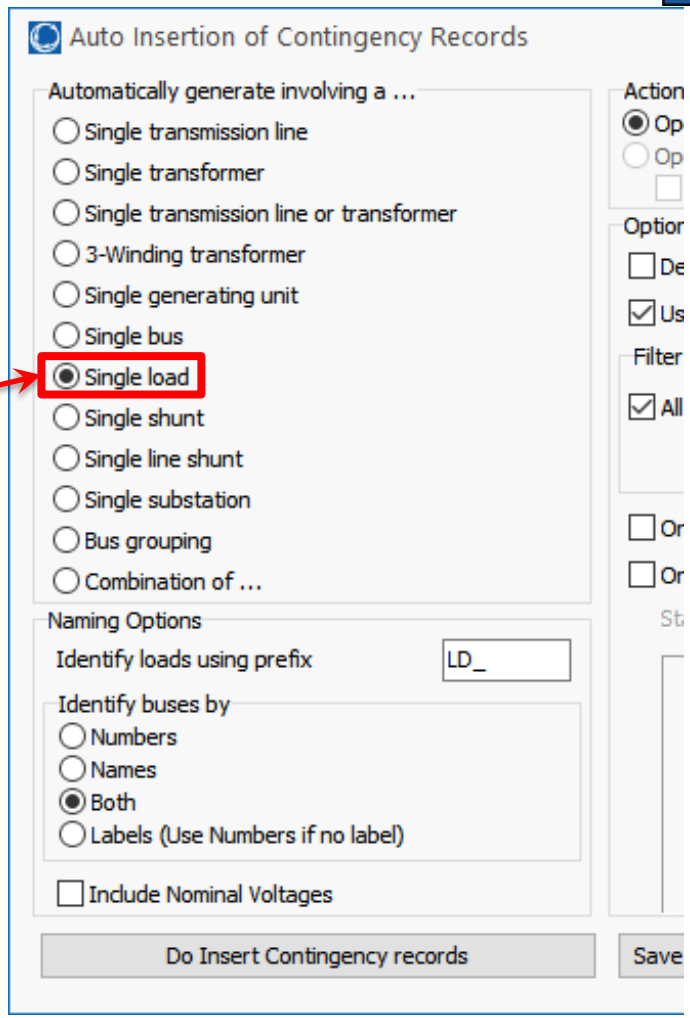
Contingency Analysis

- Loads are now included for auto-inserting contingencies



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Contingency Analysis

- Option to delete Remedial Actions and any referenced Model Conditions, Model Filters, Model Expressions, and Model Planes.
  - EXCEPT any Model Conditions, Model Filters, Model Expressions, and Model Planes that are actually being used somewhere other than the Remedial Actions
  - Contingency Analysis dialog: *Other > Manage Contingency Definitions > "Delete Remedial Actions and Dependencies"*
  - Local menu of Remedial Actions case information displays: *"Delete Remedial Actions and Dependencies"* and *"Delete Remedial Actions and Dependencies (only selected records)"*
  - Script command `CTGProcessRemedialActionsAndDependencies(…);`

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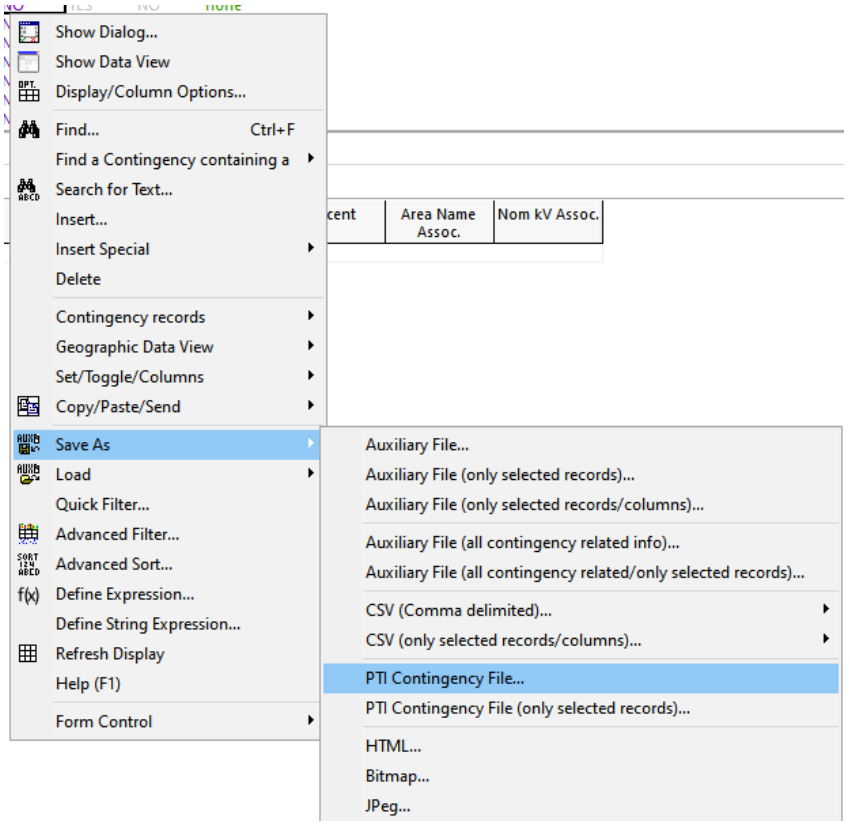
Contingency Analysis



- Contingency case information display
  - Right-Click > Save As
    > "PTI Contingency File..."
    > "PTI Contingency File (only selected records)..."

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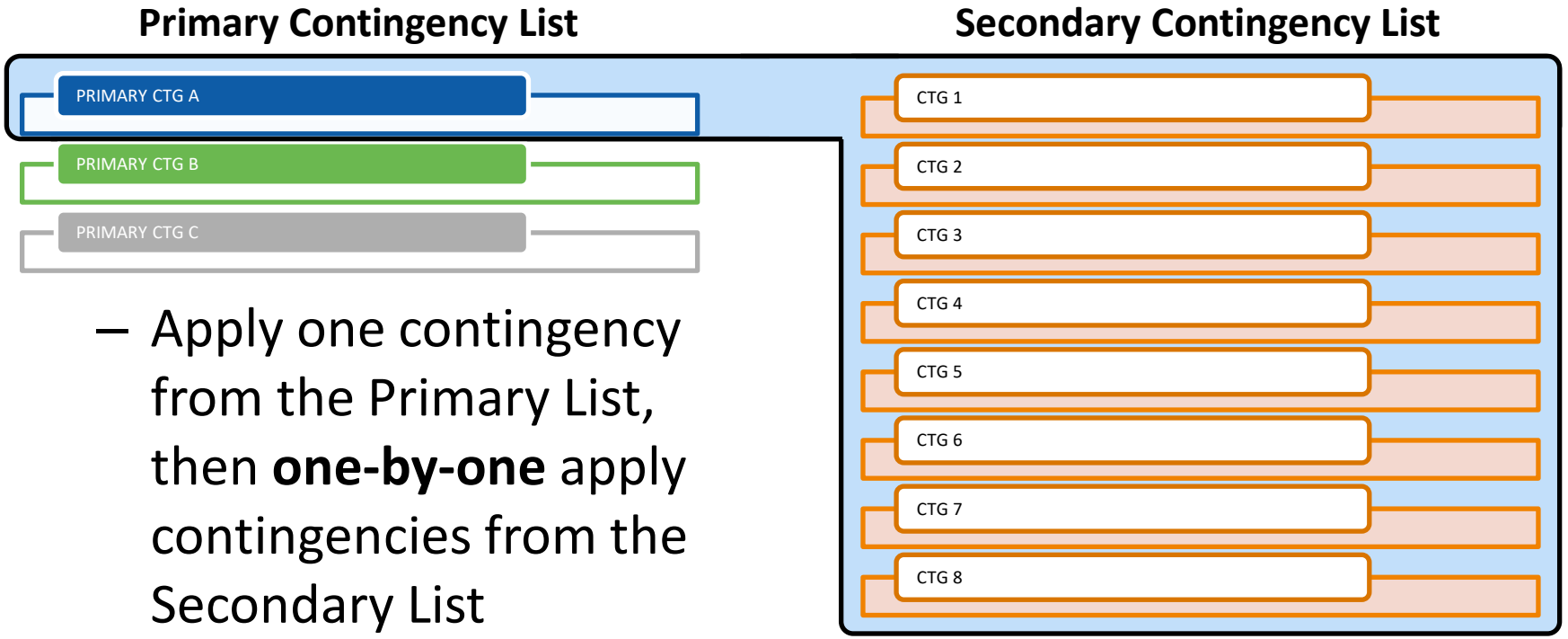
Contingency Analysis

- Contingency Combination Tool, a.k.a. N-1-1 contingencies



  - Apply one contingency from the Primary List, then **one-by-one** apply contingencies from the Secondary List

Completion expected before the release of version 22

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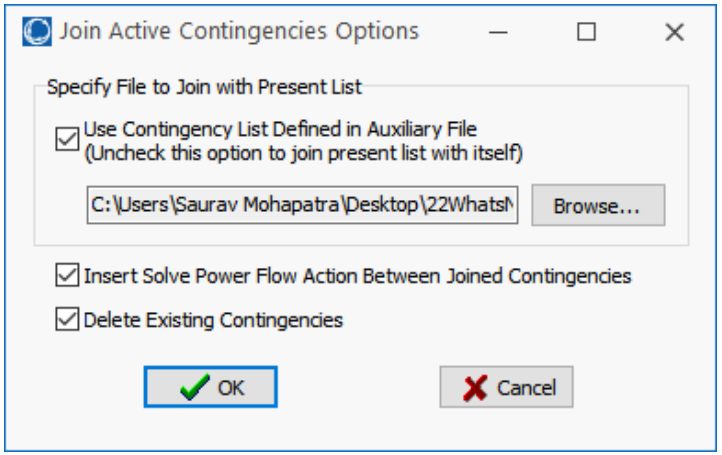
Contingency Analysis

- Currently possible to do N-1-1, but each combination need to be defined
- With n contingencies
  - Join with existing contingencies : $\binom{n}{2}$
  - Join with another list of m contingencies: $m \times n$

Side note:
if $n = 10{,}000$
$\binom{n}{2}$= 49,995,000

- New method will not need to define all combinations
- Easier to maintain lists

Available in version 21



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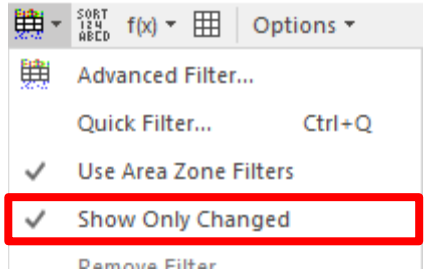
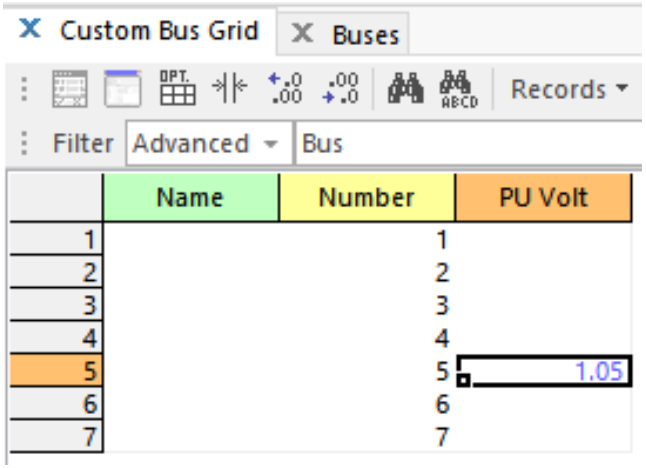
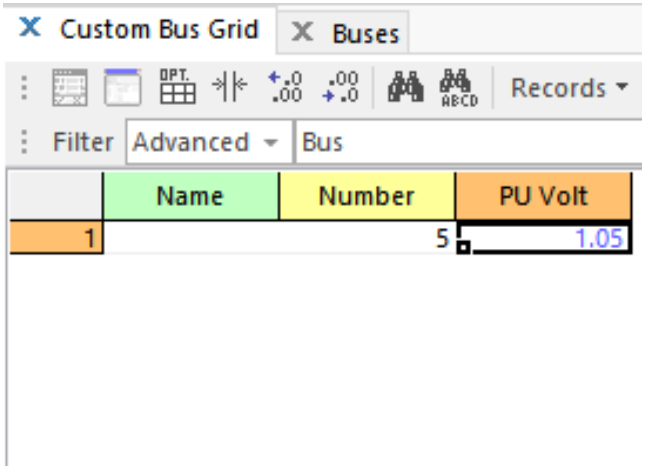
Difference Case





- "Show Only Changed" Filtering
  - When enabled, viewing in **Difference Mode** or **Change Mode** will hide any rows that do not display any changed values
  - Currently only available on User Defined Grids



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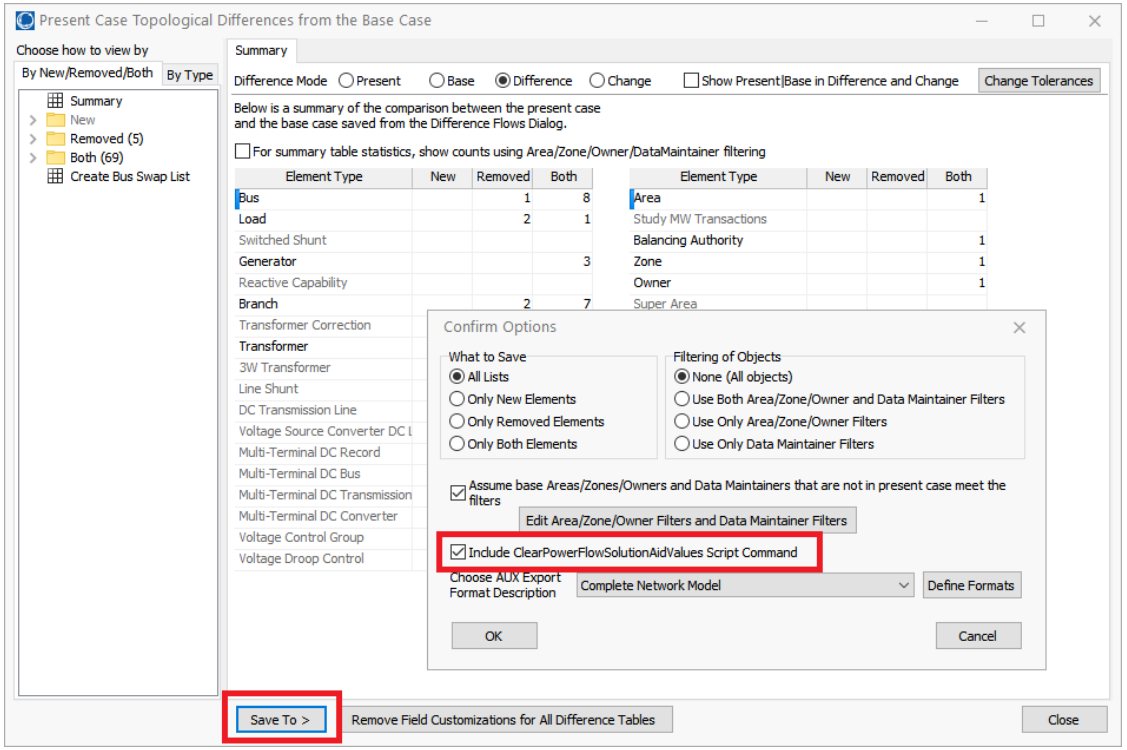
Difference Case

- Include `ClearPowerFlowSolutionAidValues` script command when saving Complete Model from Preset Topological Differences from Base Case:
  - Option is checked by default.
  - Was always included prior to this option being added.



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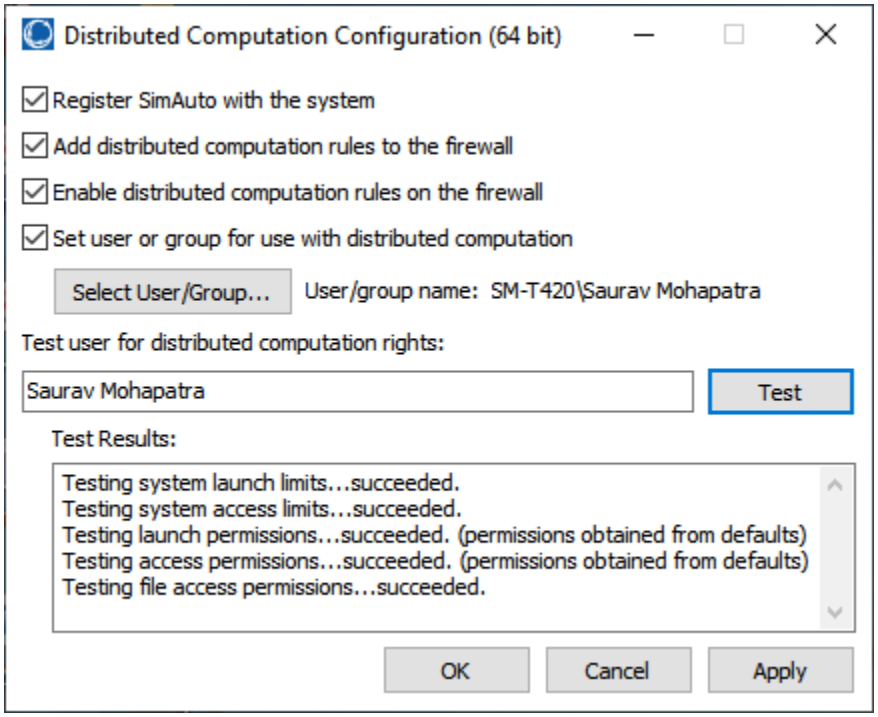
Distributed Computation

- Updated the Distributed Computation Configuration
  - User configuration allows a user or a security group



- Command line tool has also been added to aid in scripting the automatic configuration of multiple machines across a network.

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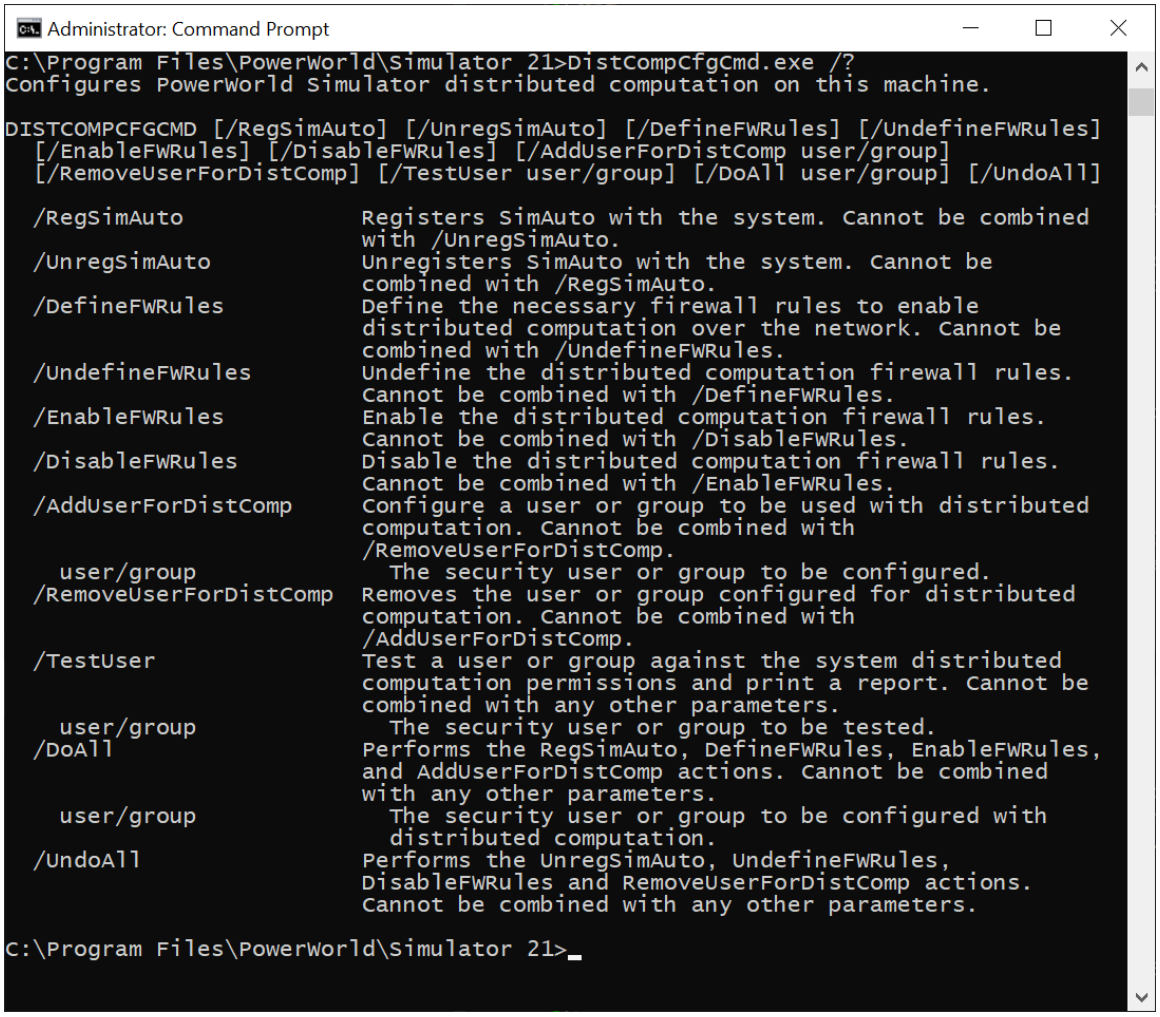
Distributed Computation



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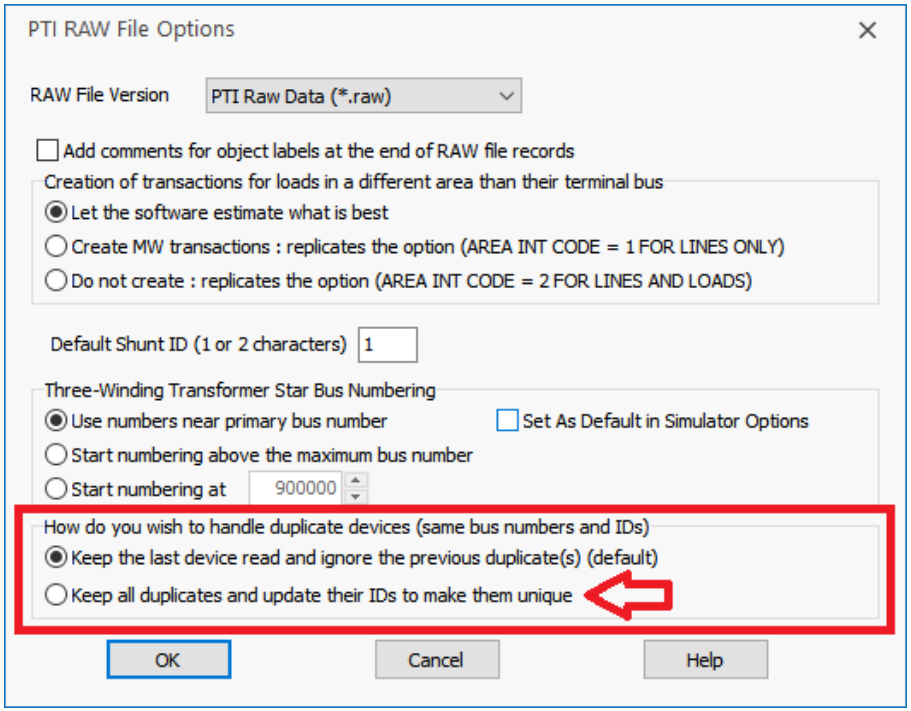
File Formats

- PTI RAW files: Open file with options
  - Option to keep duplicate devices that are read in
  - Device ID is changed, so that each device remains unique.



  - **By default**, only the last read duplicate device is kept, and all previous occurrences in a RAW file are ignored.

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File Formats

- PSLF OTG files
  - Improved support for reading of transient stability contingency events.

- PTI MON files
  - Added support to read interfaces specified in this format: MONITOR flowgate 3 'My Flowgate' biratings -10000 10000

- PTI IDV files
  - Improved support for loading status of Transient Stability models.

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Geomagnetically Induced Currents

- Simulator can now read a 3D E-field input time series represented in the GeoJSON format (file extension *.json)

- NOAA publishes near-real time electric field data at 2 degrees lat/long and 60 second resolution at https://services.swpc.noaa.gov/text/lists/rgeojson/geoelectric/geojsons/
  - Files must be downloaded to local or network location
  - Each time period is a separate file, but multiple files may be loaded in a single step

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Geomagnetically Induced Currents

- Simulator can now read and write the supplemental PSLF GMD file that has data sections for:
  - `Substations`
  - `Branches`
  - `Transformers`
  - `Shunts`
  - `Constant_Efield`, `Efield` sections are ignored for now

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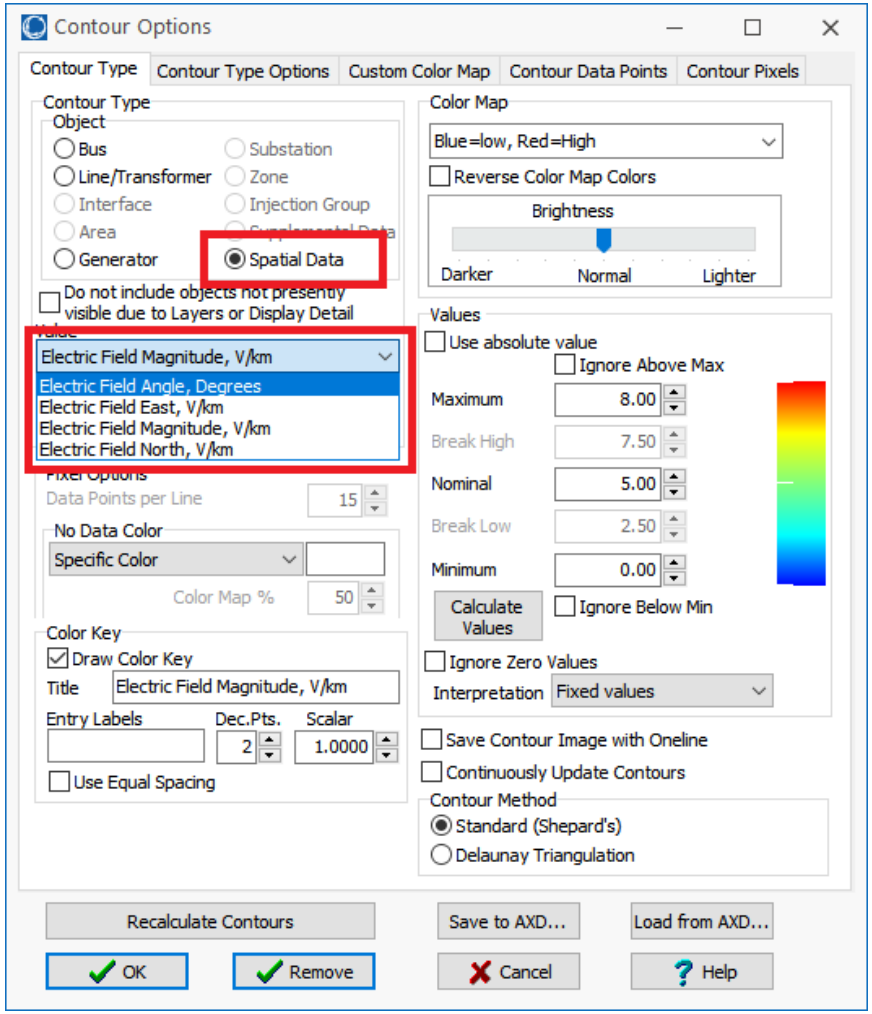
Geomagnetically Induced Currents

- Added “Spatial Data” Object to Contour Type
  - Allows contouring of spatial data **without** explicit one-line objects



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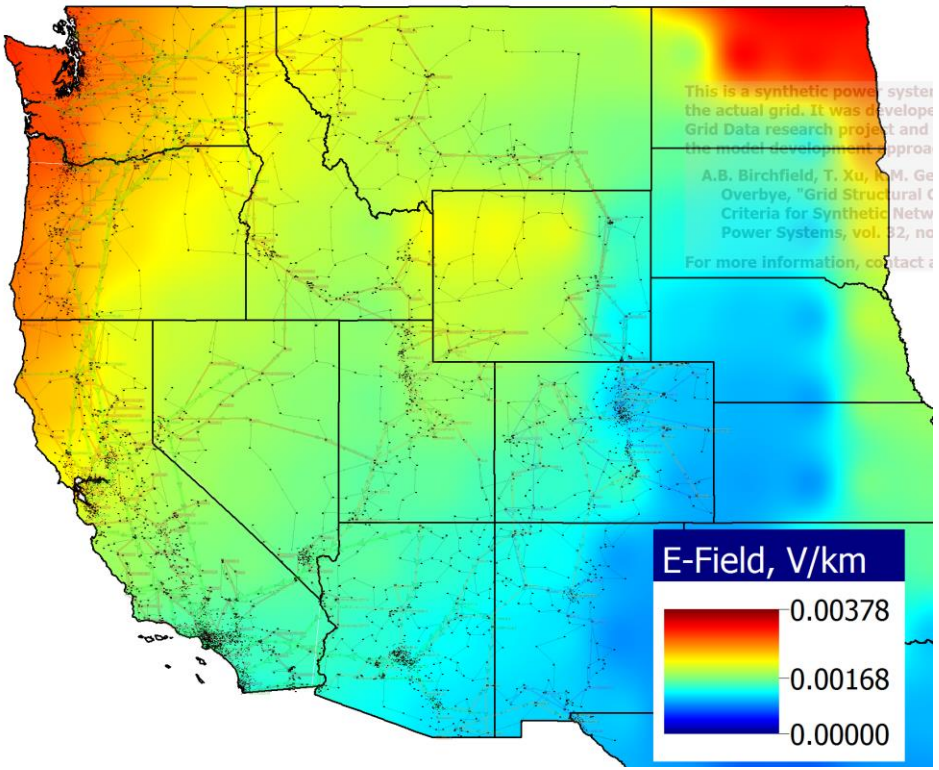
Geomagnetically Induced Currents

- Added “Spatial Data” Object to Contour Type
  - Allows contouring of spatial data **without** explicit one-line objects
  - Useful for GIC Electric Fields



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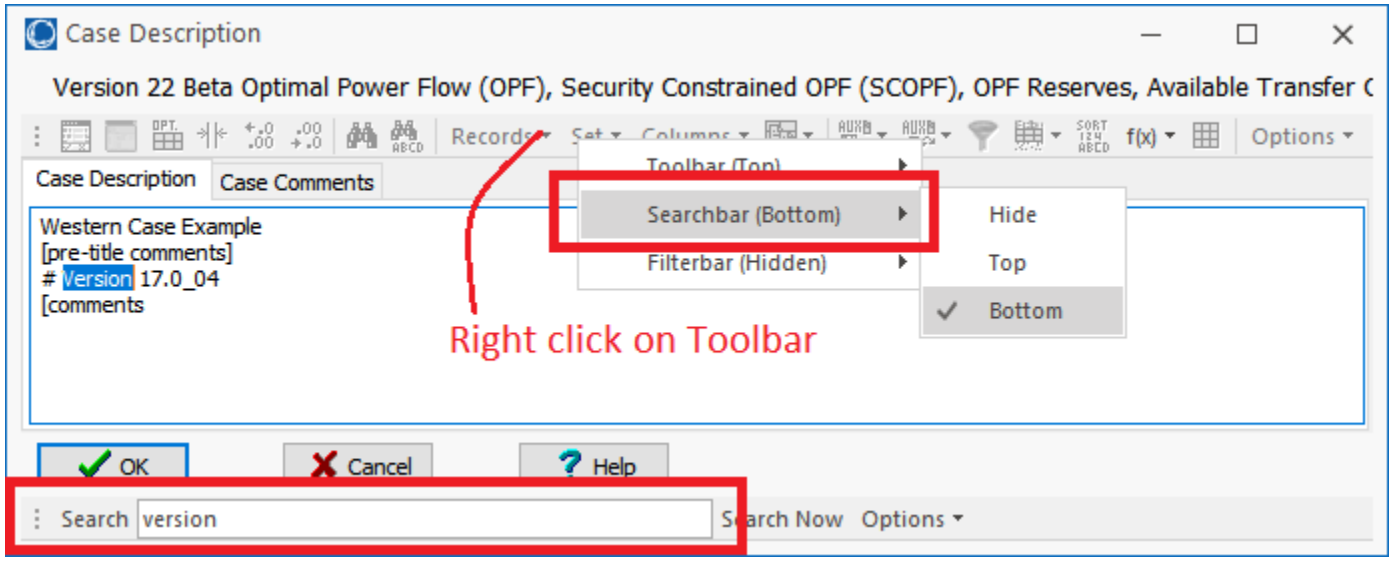
General

- Added the ability to search the Case Description using the Search Bar that can be added to the dialog.



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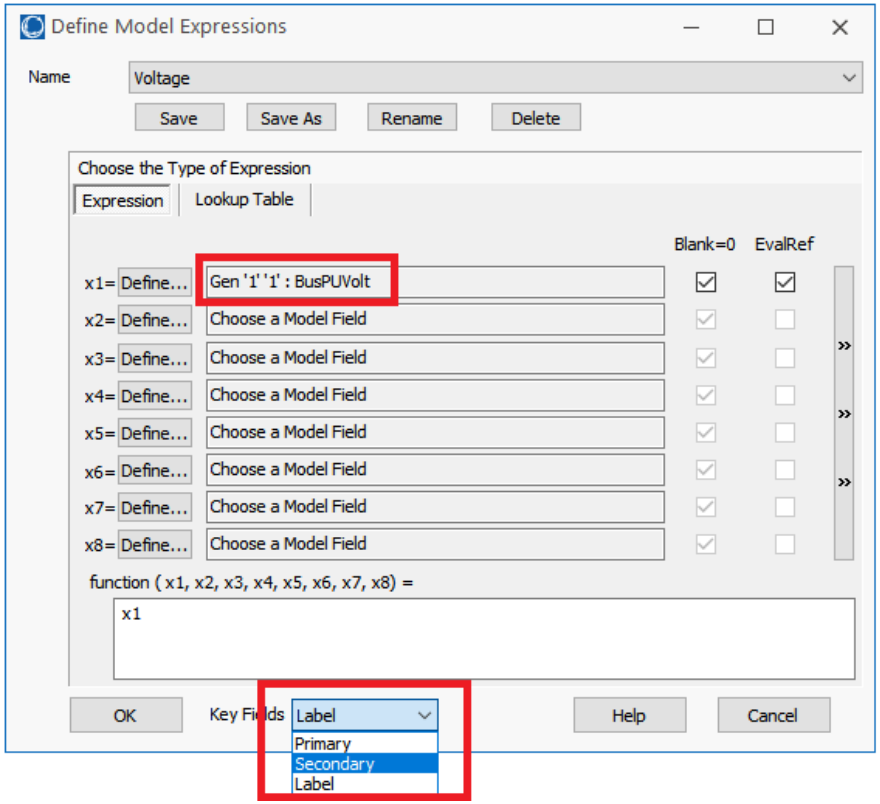
General – User Interface Dialogs

- Model Expression Dialog
  - Dropdown to change the key field identifier to use
- Option only affects the key field identifier used in this dialog
  - Does not impact the setting used with case information display options.



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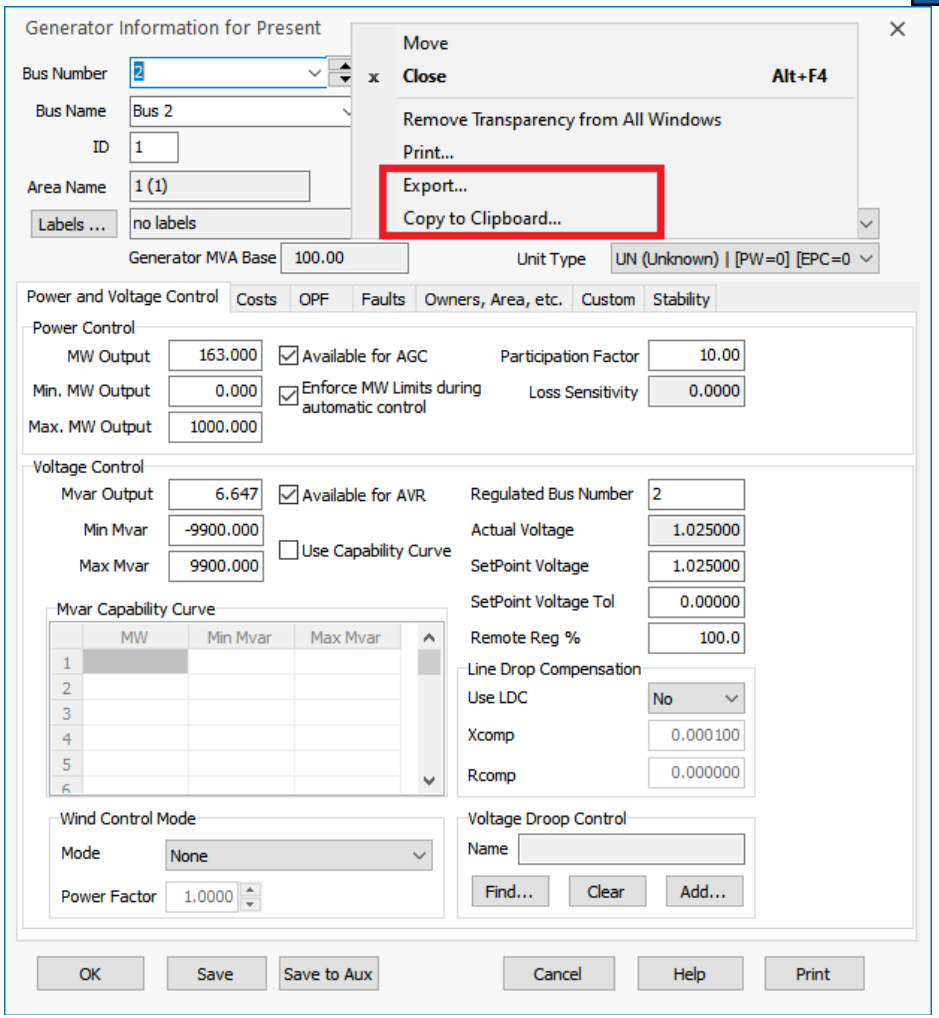
General – User Interface Dialogs

- On a dialog caption bar, right-click
  - There are now options for "Export" and "Copy to Clipboard" that export or copy images of the dialog.



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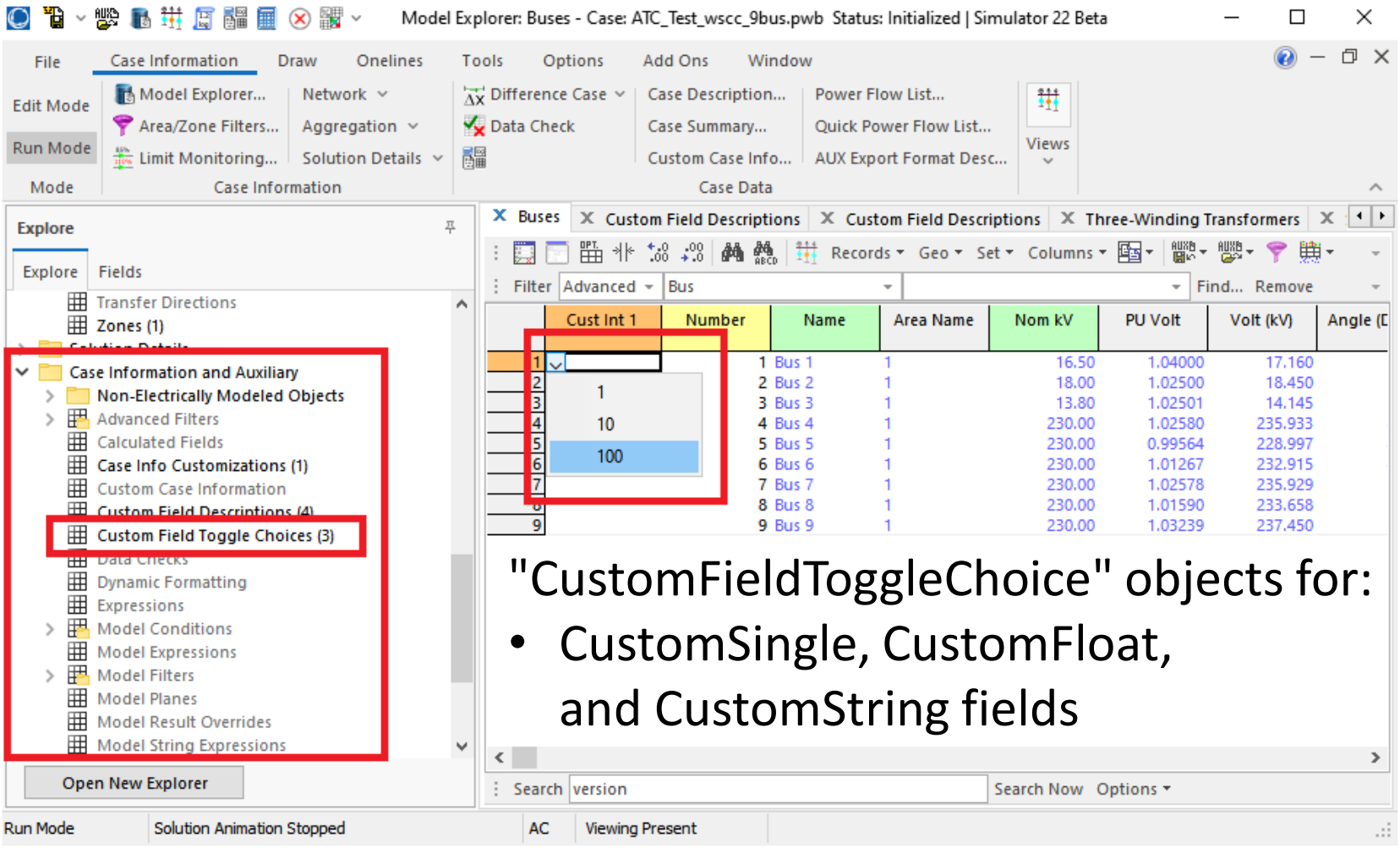
General



"CustomFieldToggleChoice" objects for:

- CustomSingle, CustomFloat, and CustomString fields

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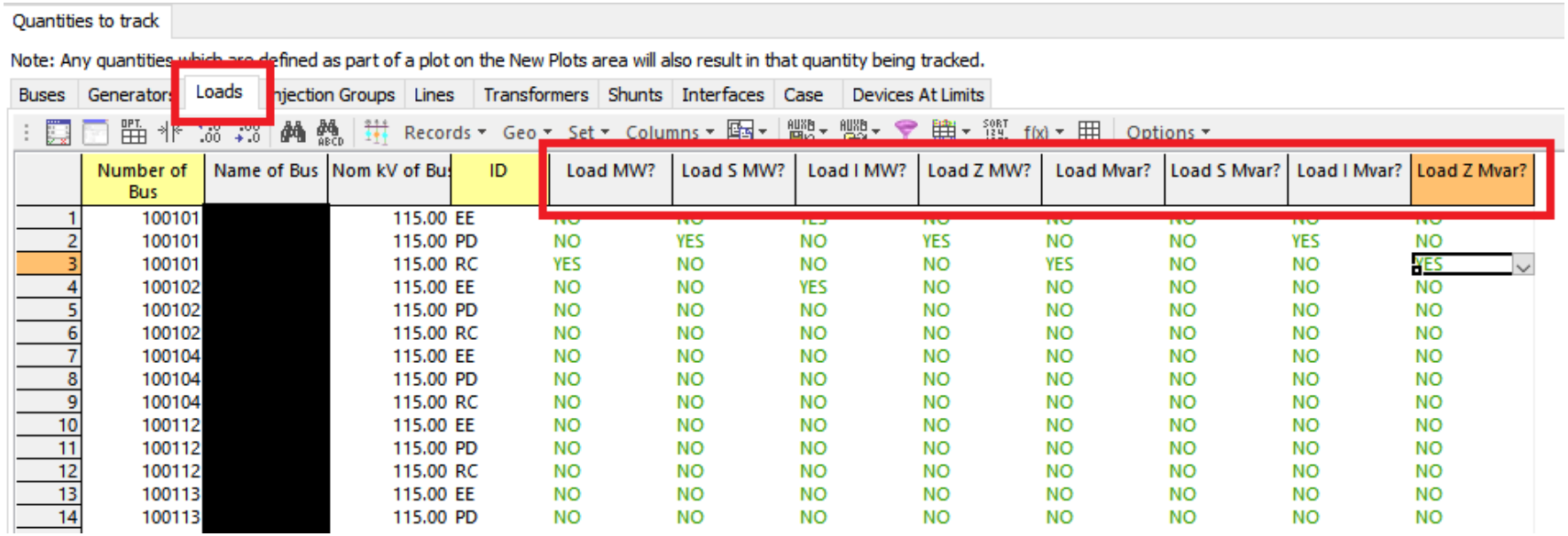
General – PV and QV Curves

- Added options to track Loads in Quantities to Track with the PV and QV tools.
  - MW, SMW, IMW, ZMW, Mvar, SMvar, IMvar, and ZMvar can now all be tracked and plotted.



	Number of Bus	Name of Bus	Nom kV of Bus	ID	Load MW?	Load S MW?	Load I MW?	Load Z MW?	Load Mvar?	Load S Mvar?	Load I Mvar?	Load Z Mvar?
1	100101	[redacted]	115.00	EE	NO	NO	YES	NO	NO	NO	NO	NO
2	100101		115.00	PD	NO	YES	NO	YES	NO	NO	YES	NO
3	100101		115.00	RC	YES	NO	NO	NO	YES	NO	NO	YES
4	100102		115.00	EE	NO	NO	YES	NO	NO	NO	NO	NO
5	100102		115.00	PD	NO	NO	NO	NO	NO	NO	NO	NO
6	100102		115.00	RC	NO	NO	NO	NO	NO	NO	NO	NO
7	100104		115.00	EE	NO	NO	NO	NO	NO	NO	NO	NO
8	100104		115.00	PD	NO	NO	NO	NO	NO	NO	NO	NO
9	100104		115.00	RC	NO	NO	NO	NO	NO	NO	NO	NO
10	100112		115.00	EE	NO	NO	NO	NO	NO	NO	NO	NO
11	100112		115.00	PD	NO	NO	NO	NO	NO	NO	NO	NO
12	100112		115.00	RC	NO	NO	NO	NO	NO	NO	NO	NO
13	100113		115.00	EE	NO	NO	NO	NO	NO	NO	NO	NO
14	100113		115.00	PD	NO	NO	NO	NO	NO	NO	NO	NO

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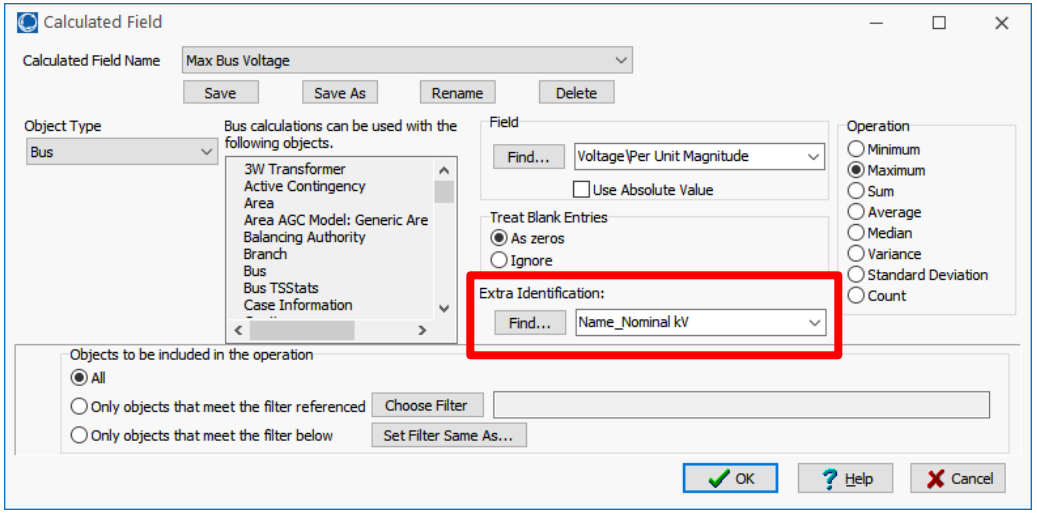
General

- Calculated Fields: Extra Identification option
  - Available for Minimum or Maximum operations.
  - Allows displaying any field associated with the object
  - This is useful for using calculated fields with a combination of filtering to return specific results.



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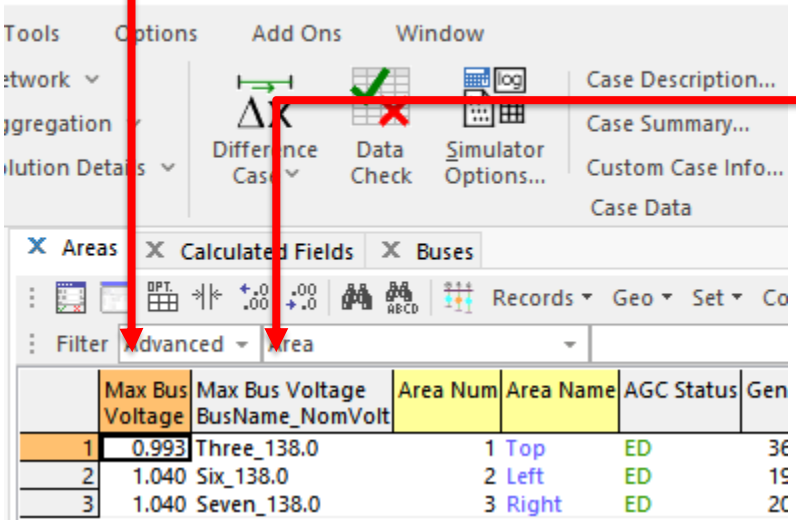
General

- Example for Calculated Fields with Extra Identification
  - Calculated Field: Maximum Voltage Magnitude amongst all Buses per Area
  - Extra Identification: Name_Nominal kV of the Bus where the maximum voltage occurs in each Area



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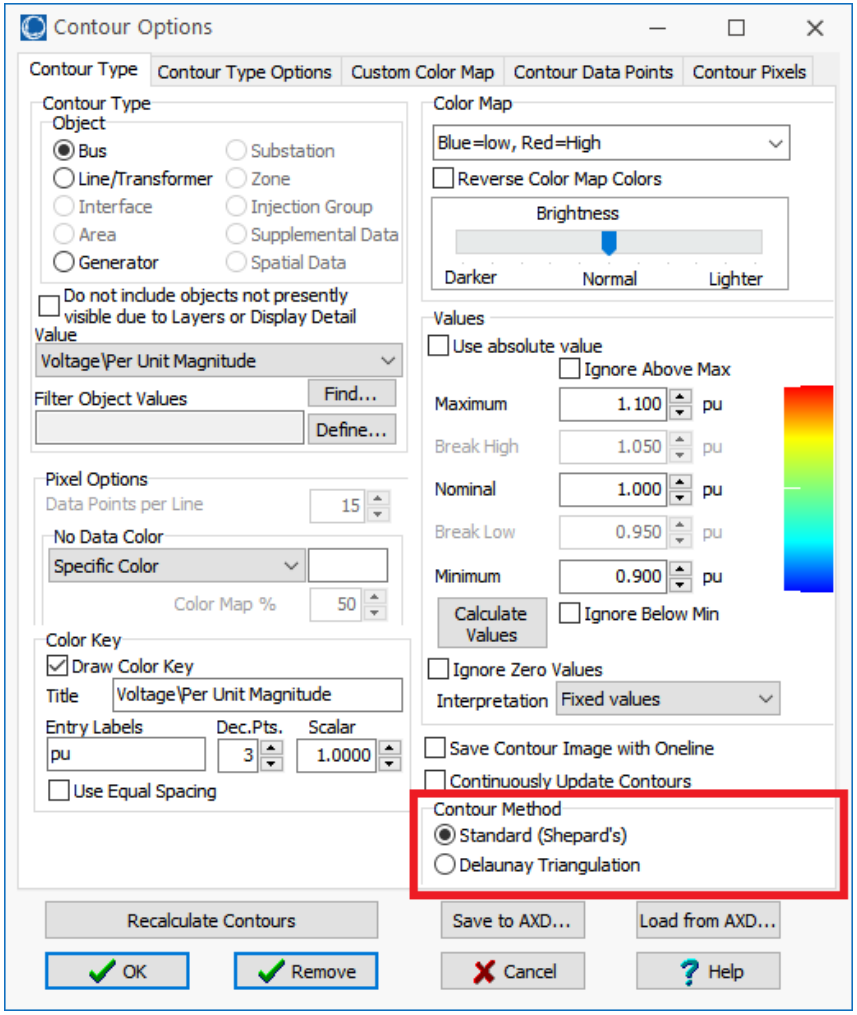
Oneline Diagrams

- Contouring Method
  - Standard (Shepard's)
  - Delaunay Triangulation
    - Faster contour rendering
    - Example: Useful when animating wide-area frequency or voltage contours from a Transient Stability run



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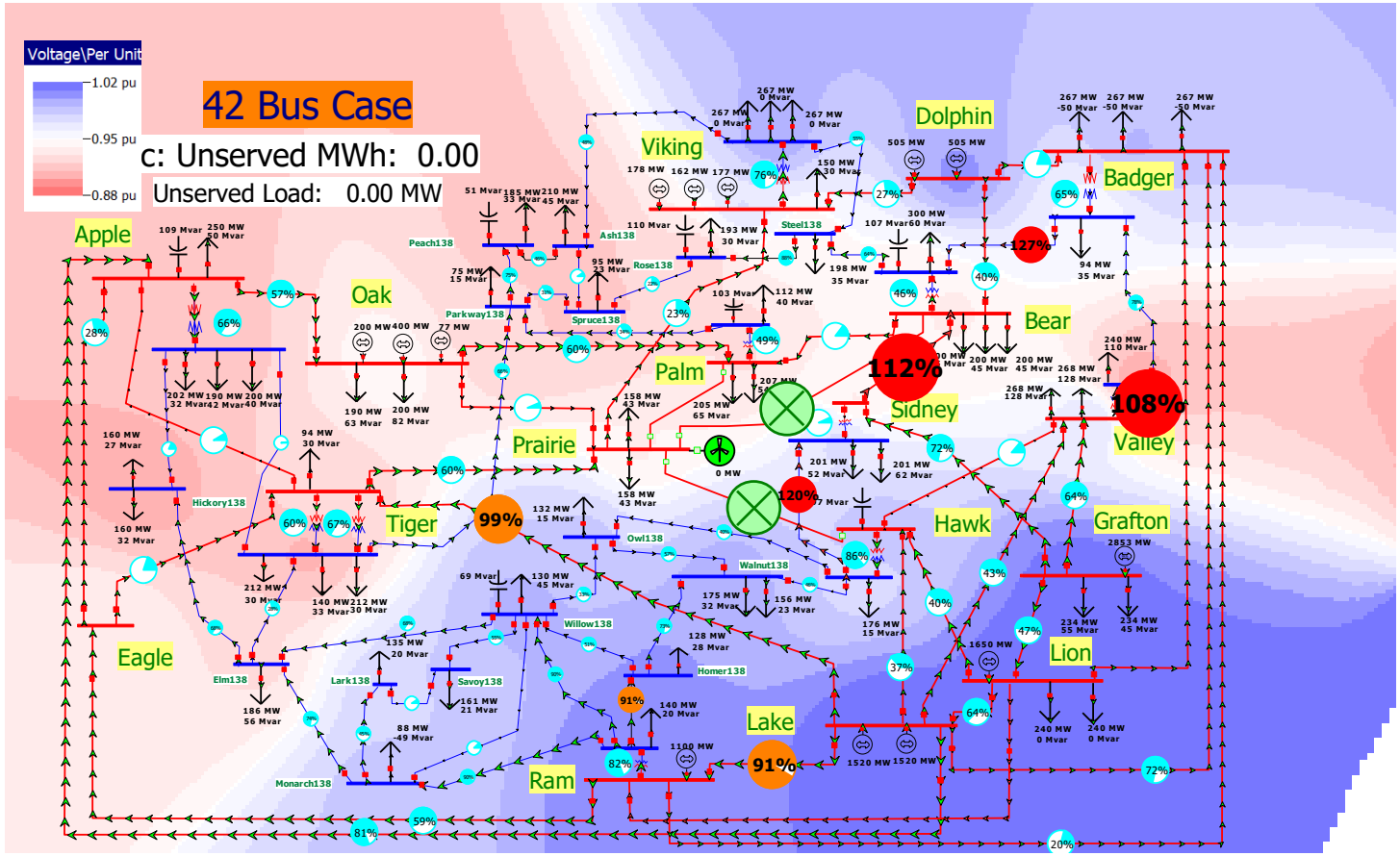
Oneline Diagrams

- Contouring Method: Standard (Shepard's)



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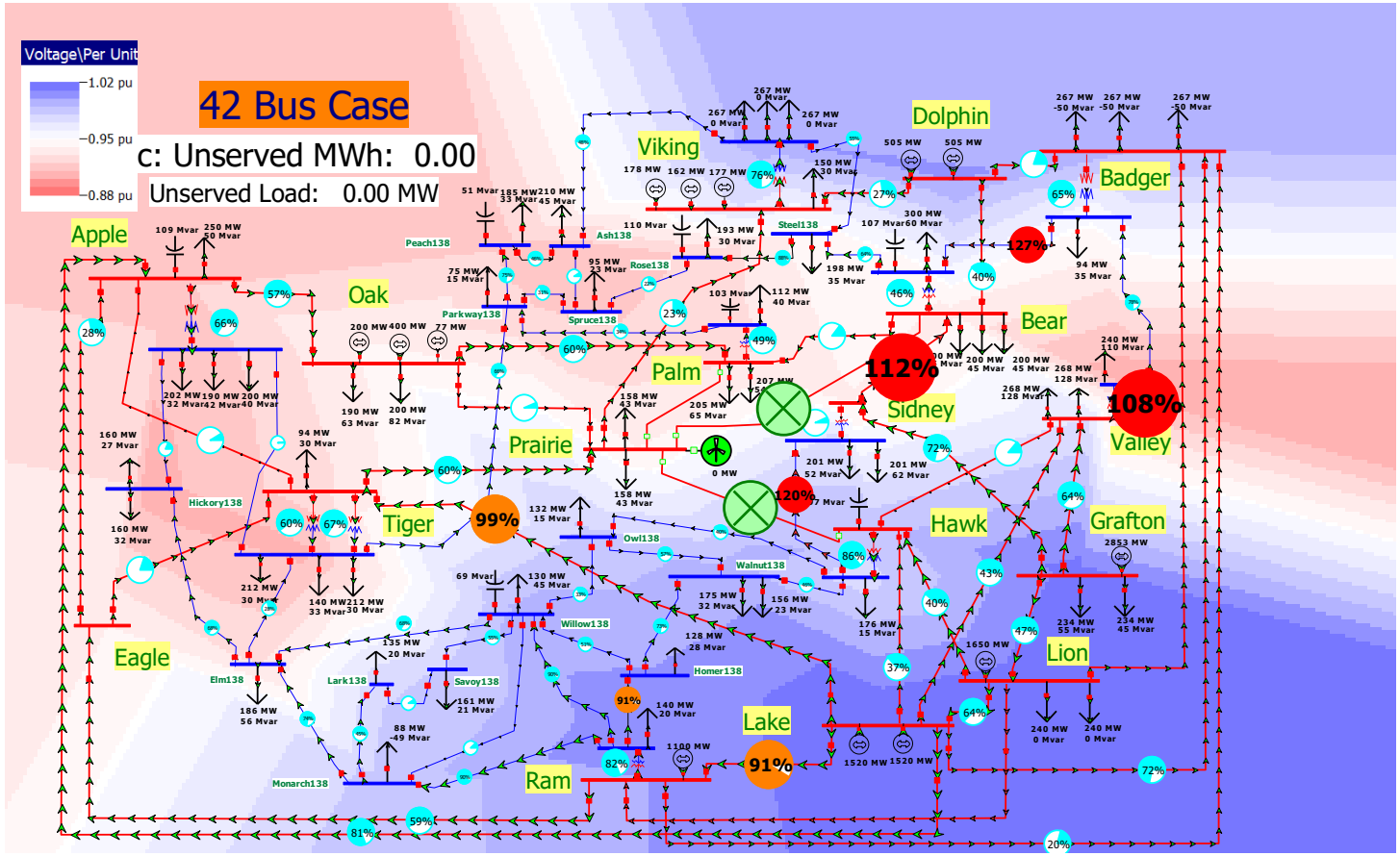
Oneline Diagrams

- Contouring Method: Delaunay Triangulation



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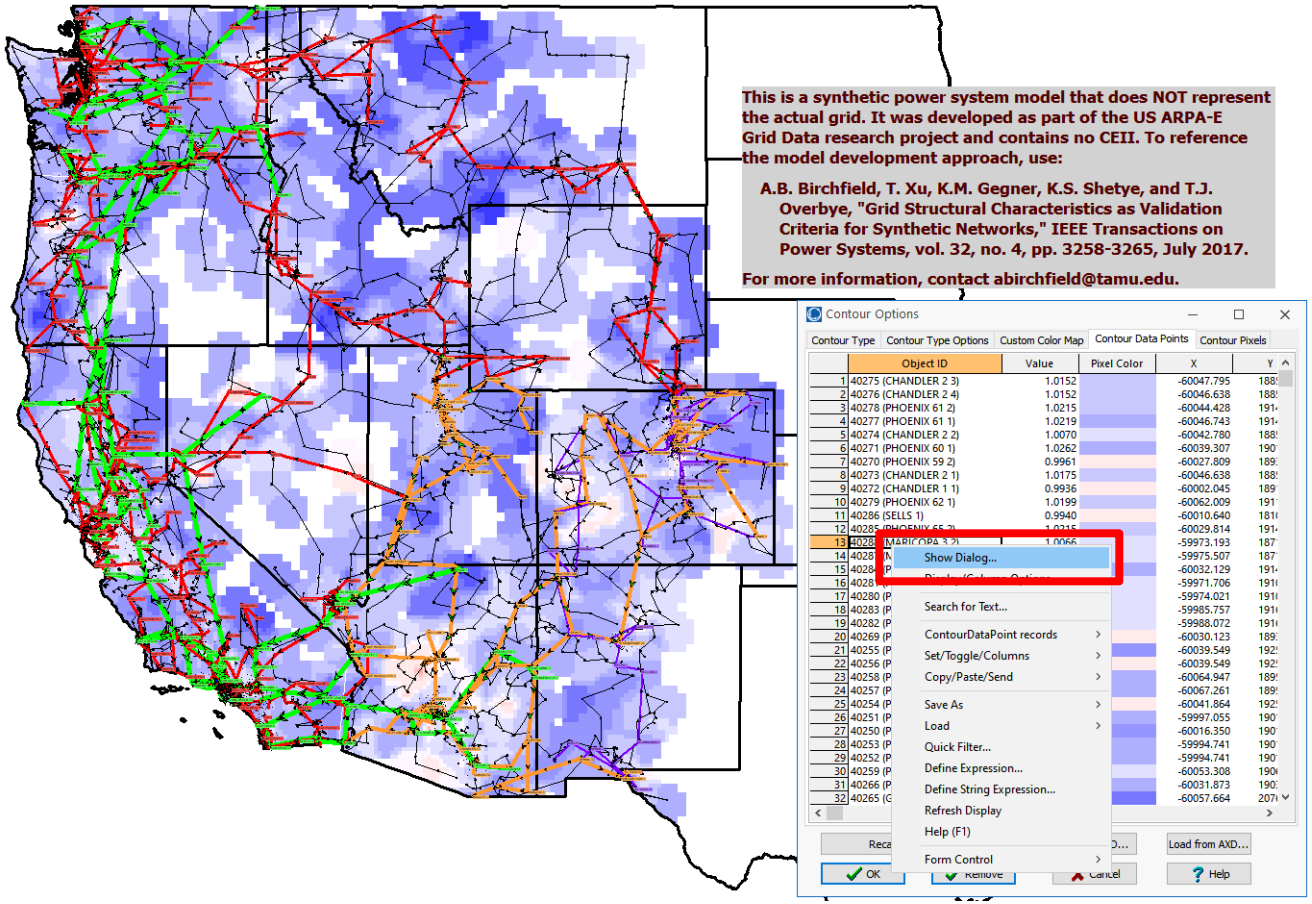
Oneline Diagrams

- Contouring Data Points > Right Click > Show Dialog



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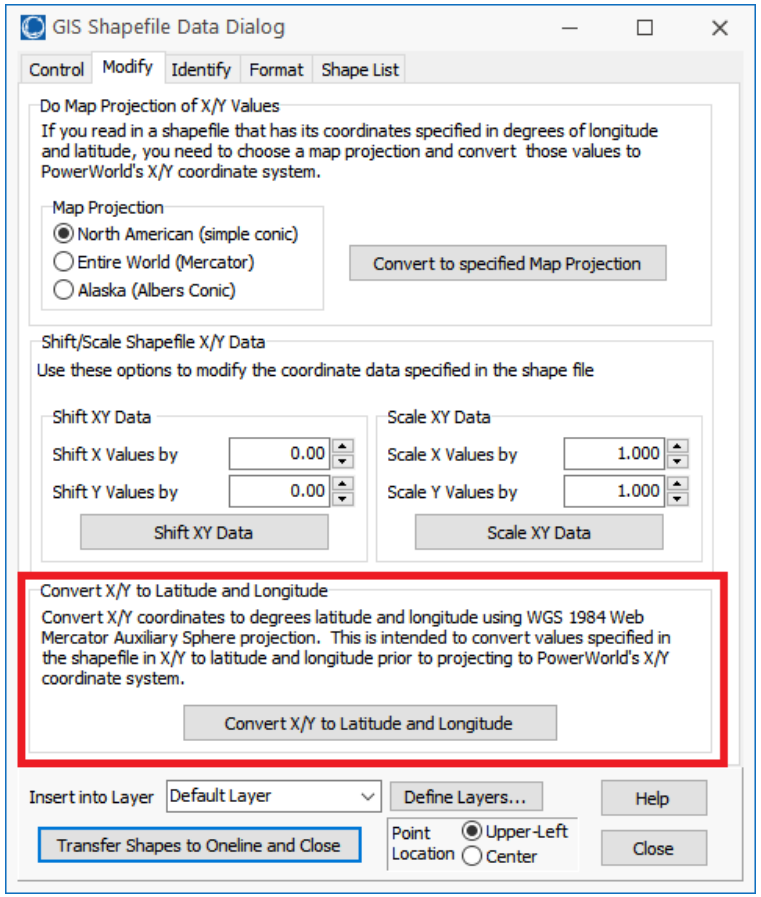
Oneline Diagrams

- GIS Shapefile Data Dialog: Button to "Convert X/Y to Latitude and Longitude".
  - Converts projected X/Y values (specified in the shapefile) to degrees latitude and longitude using the WGS 1984 Web Mercator Auxiliary Sphere projection.
  - Conversion is required before the projecting to PowerWorld's X/Y coordinates.



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Transient Stability

- Machines
  - REGC_C
- Governors
  - WTGT_B
- Generator Relays
  - VPERHZ1
- Load Relays
  - LDS4
- Switched Shunt
  - CHSVCT
- DC Line
  - CDC1T
- Paux Controllers
  - WTGIBFFR_A
  - PROBOOST
- Plant Controllers
  - PFC1
  - PFC2
  - VARC1
  - VARC2

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Transient Stability

- Exciters (Chapter 7 of the IEEE Std 421.5-2016)
  - AC1C
  - AC2C
  - AC3C
  - AC4C
  - AC5C
  - AC6C
  - AC7C
  - AC8C
  - AC9C
  - AC10C
  - AC11C

Available in version 21

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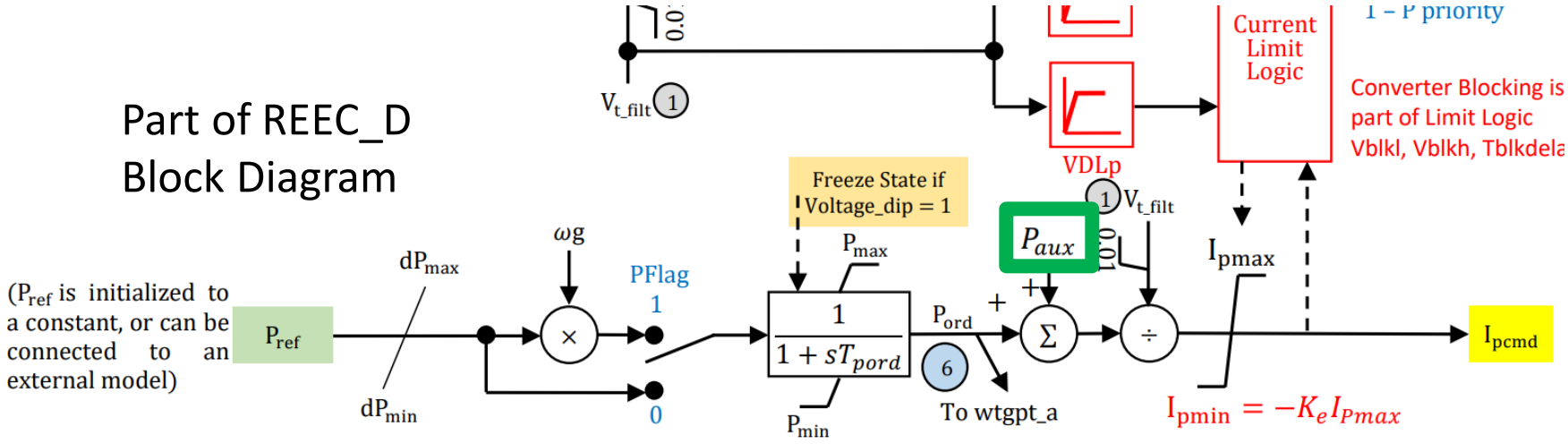
Transient Stability

- Paux Controller models
  - WTGIBFFR_A
  - PROBOOST
- For inertial-based fast frequency response (IBFFR)
  - PAux signal feeds in to augment the effect of PRef



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Transient Stability

- Plant Controllers: Power Factor (PF) and Reactive Power (VAR) regulators
  - Chapter 13 of the IEEE Std 421.5-2016
  - 4 new plant controller models (2 pf and 2 VAR controllers)
  - The output of the controllers is an incremental variable that feeds forward into the voltage reference (**Vref**) of an excitation system model.

Completion expected before the release of version 22

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Transient Stability

- Transient Stability Contingency Element
  - Added options for Switched Shunts that allow Set Values To and Change Values By (Mvar or Percent) as Percent of Start Nominal Mvar

- Remedial Action Elements
  - Switched Shunt actions for Set To and Change By (Mvar or Percent) are now translated for use in Transient Stability Remedial Actions.

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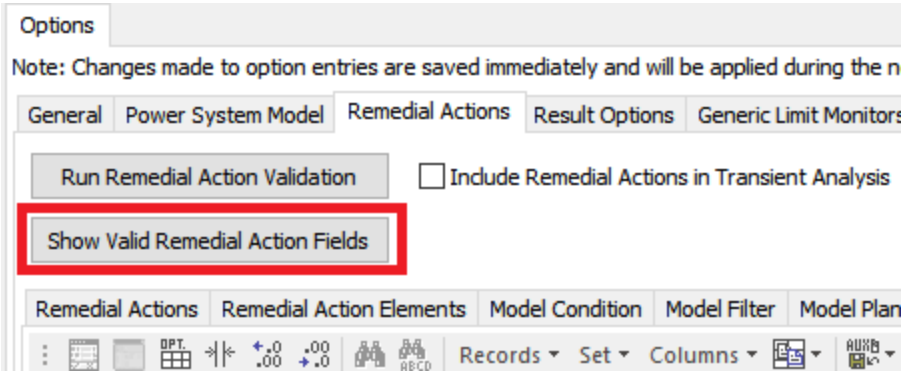
Transient Stability

- Transient Stability > Options > Remedial Actions
  - "Show Valid Remedial Action Fields" button that will display a case information display with all fields that can be evaluated each time step.



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Transient Stability

- Modeling Remedial Actions with Transient Stability
  - Support continues to grow with more fields and object types supported.
  - Model Expressions allow time derivatives and filter times to be specified for expression variables.

Valid Fields for Evaluation Each Transient Stabili...

Records Set Columns

	Object Type	Variable Name	Allow Derivative	Always Every Time Step
1	Branch	LineStatus	NO	YES
2	Branch	LineMW	YES	NO
3	Branch	LineMW:1	YES	NO
4	Branch	LineMVR	YES	NO
5	Branch	LineMVR:1	YES	NO
6	Branch	LineMVA	YES	NO
7	Branch	LineMVA:1	YES	NO
8	Branch	LineAmp	YES	NO
9	Branch	LineAmp:1	YES	NO
10	Branch	BusObjectOnline	NO	YES
11	Branch	BusObjectOnline:1	NO	YES
12	Branch	DerivedStatus	NO	YES
13	Bus	BusPUVolt	YES	NO
14	Bus	BusKVVolt	YES	NO
15	Bus	BusAngle	YES	NO
16	Bus	BusRad	YES	NO
17	Bus	BusStatus	NO	YES
18	Bus	Frequency	YES	NO
19	Generator	GenStatus	NO	YES
20	Generator	BusObjectOnline	NO	YES
21	Generator	DerivedStatus	NO	YES
22	Interface	FGMW	YES	NO
23	Load	LoadStatus	NO	YES
24	Load	BusObjectOnline	NO	YES
25	Load	DerivedStatus	NO	YES
26	Model Condition	MeetsCriteria	NO	NO
27	Model Expression	CustomExpression	YES	NO
28	Model Filter	MeetsCriteria	NO	NO
29	Model Plane	Meets	NO	NO
30	Switched Shunt	SSStatus	NO	YES
31	Switched Shunt	BusObjectOnline	NO	YES
32	Switched Shunt	DerivedStatus	NO	YES

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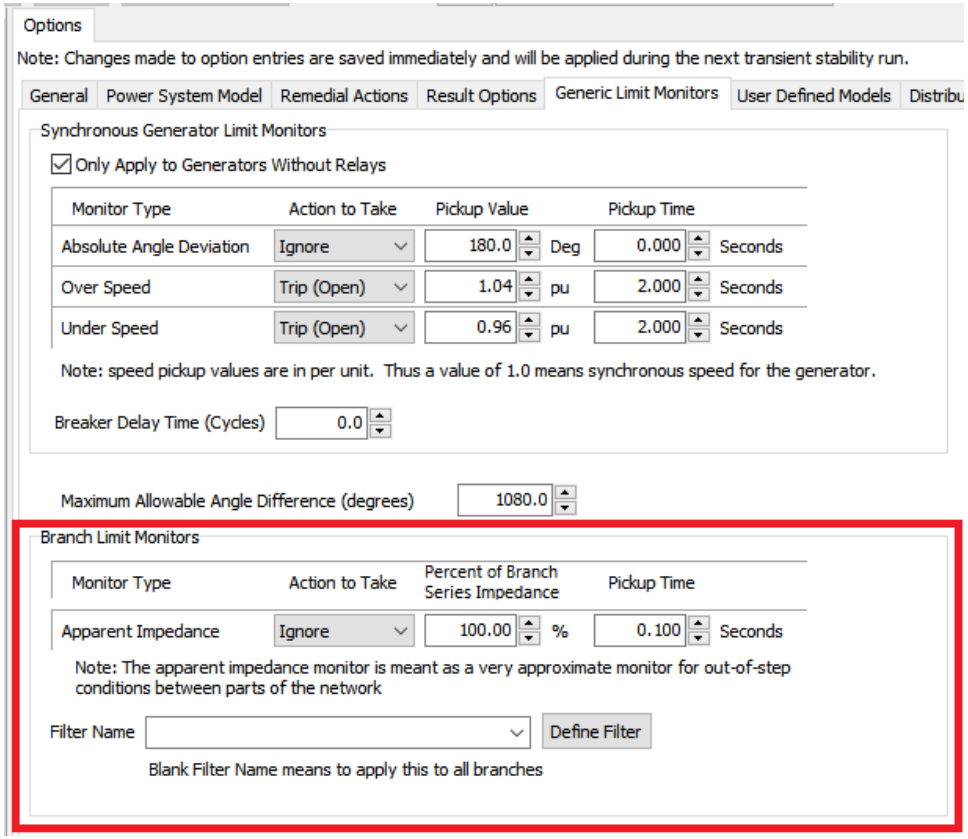
Transient Stability



- Generic Branch Monitor
  - Apparent impedance is monitored at both ends
  - Uses a simple impedance relay within a reach circle
  - Can be applied to all AC branches in the case, or to only those branches that meet a filter.
  - a.k.a., out of step monitor in other software

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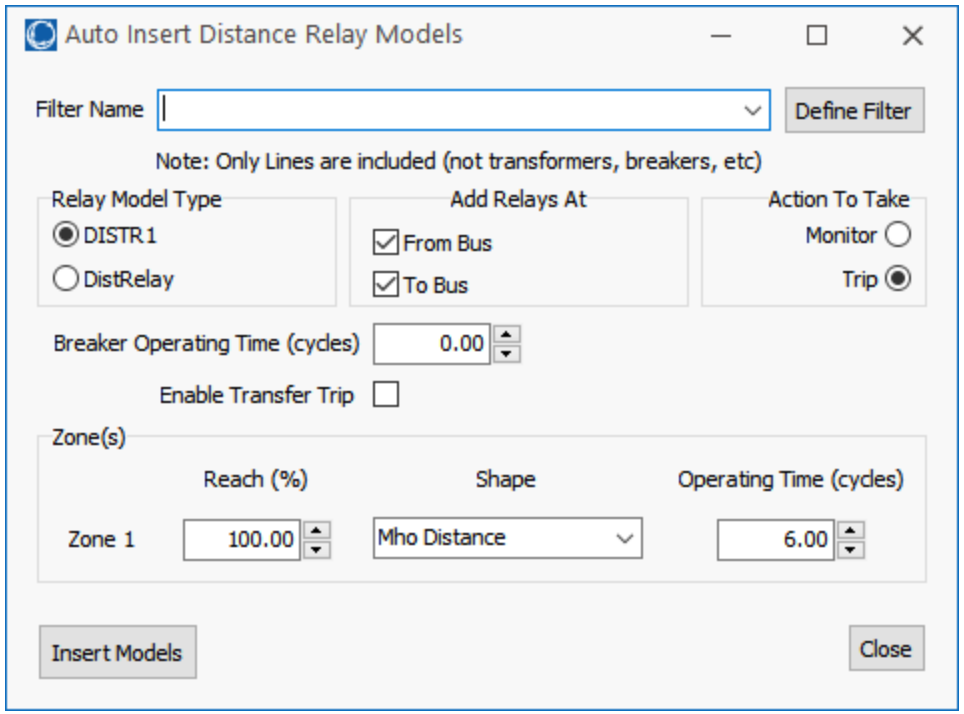
Transient Stability

- Redesigned the Auto-Insert Distance Relay Tool
  - Supports inserting either DISTR1 or DistRelay
  - Allows specifying whether to Monitor or Trip the line relay.



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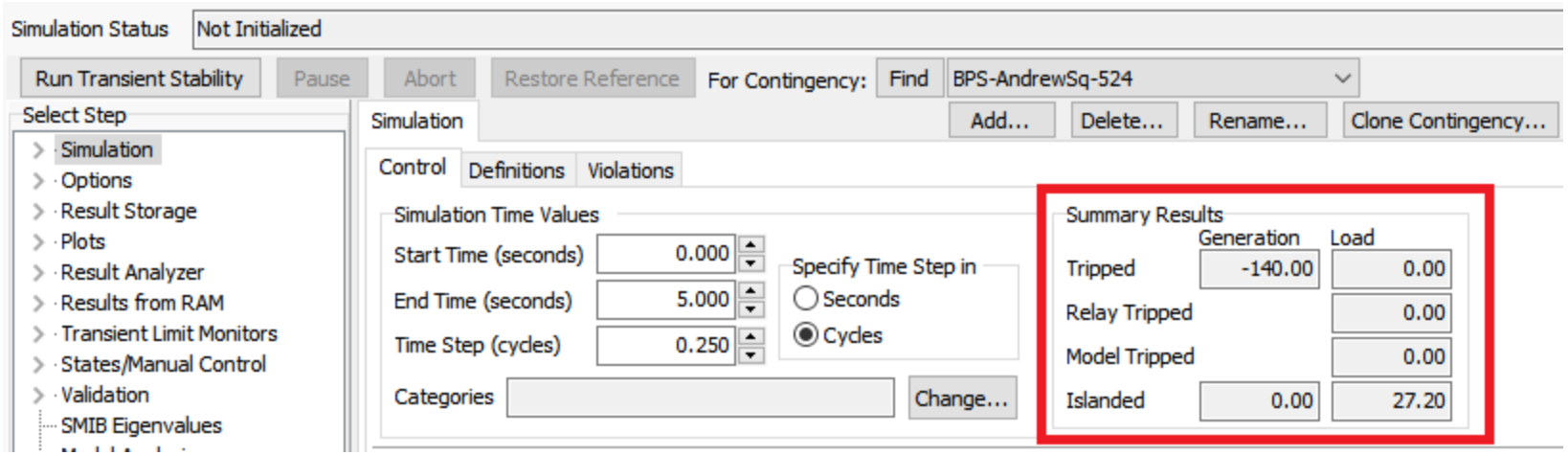
Transient Stability

- New fields for TSContingency objects to show totals for "Relay Tripped" and "Model Tripped" Load MW.



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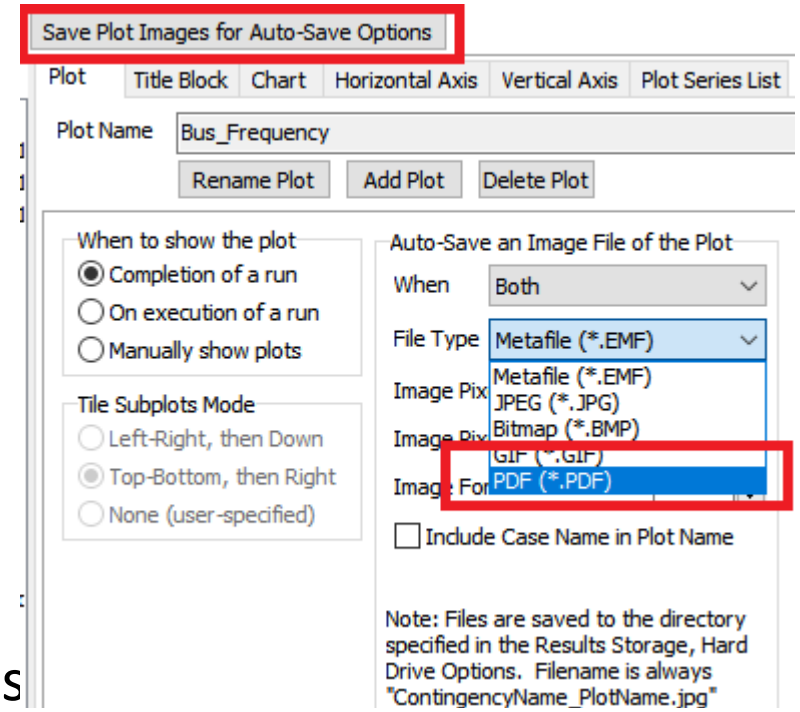
Transient Stability

- Button to “Save Plot Images for Auto-Save Options”
  - Will allow plots (marked to auto-save) to be saved after the run has completed.



- Saving plots to a PDF file
  - One file per Contingency
  - Plus, one additional file if plotting Multiple Contingencies
  - File name: ContingencyName/Multiple_CaseName.pdf

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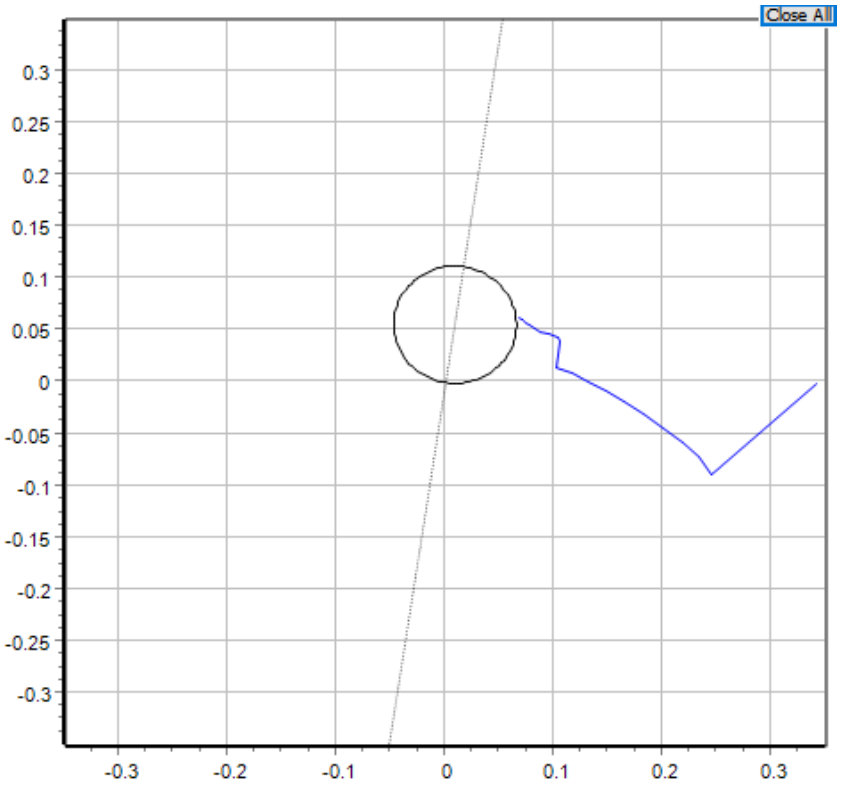
Transient Stability

- Plot of Apparent Impedance X vs. R at the **same** end of an AC line
  - Automatically shows an impedance circle at 100% of the branch series impedance
  - Only when no impedance relays are specified on that end of the branch
  - To show multiple impedance zones, it will need actual relay models to be present.



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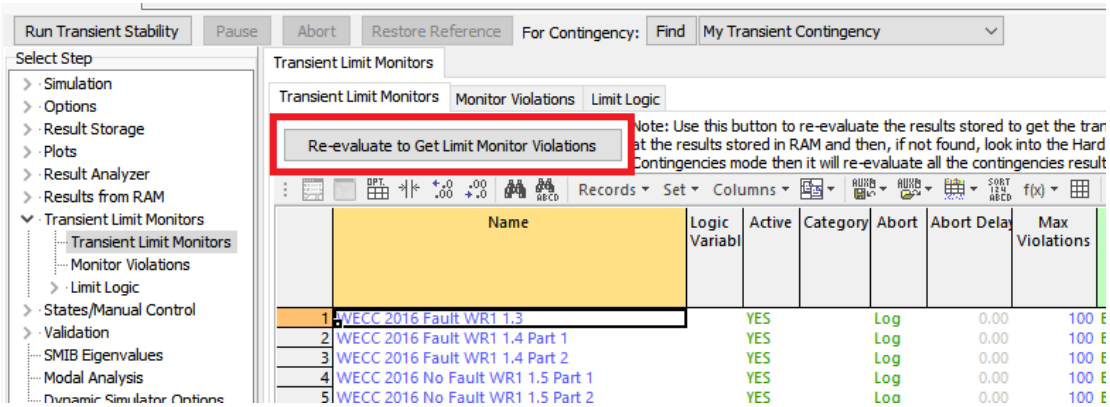
Transient Stability

- "Re-evaluate to Get Limit Monitor Violations" button to go through the stored results and get the transient limit monitor violations.
  - First it will look at the results stored in RAM and then, if no results are found, look in the Hard Drive *.tsr file.
  - If the button is pressed under Multiple Contingencies mode it will re-evaluate all the contingencies results.



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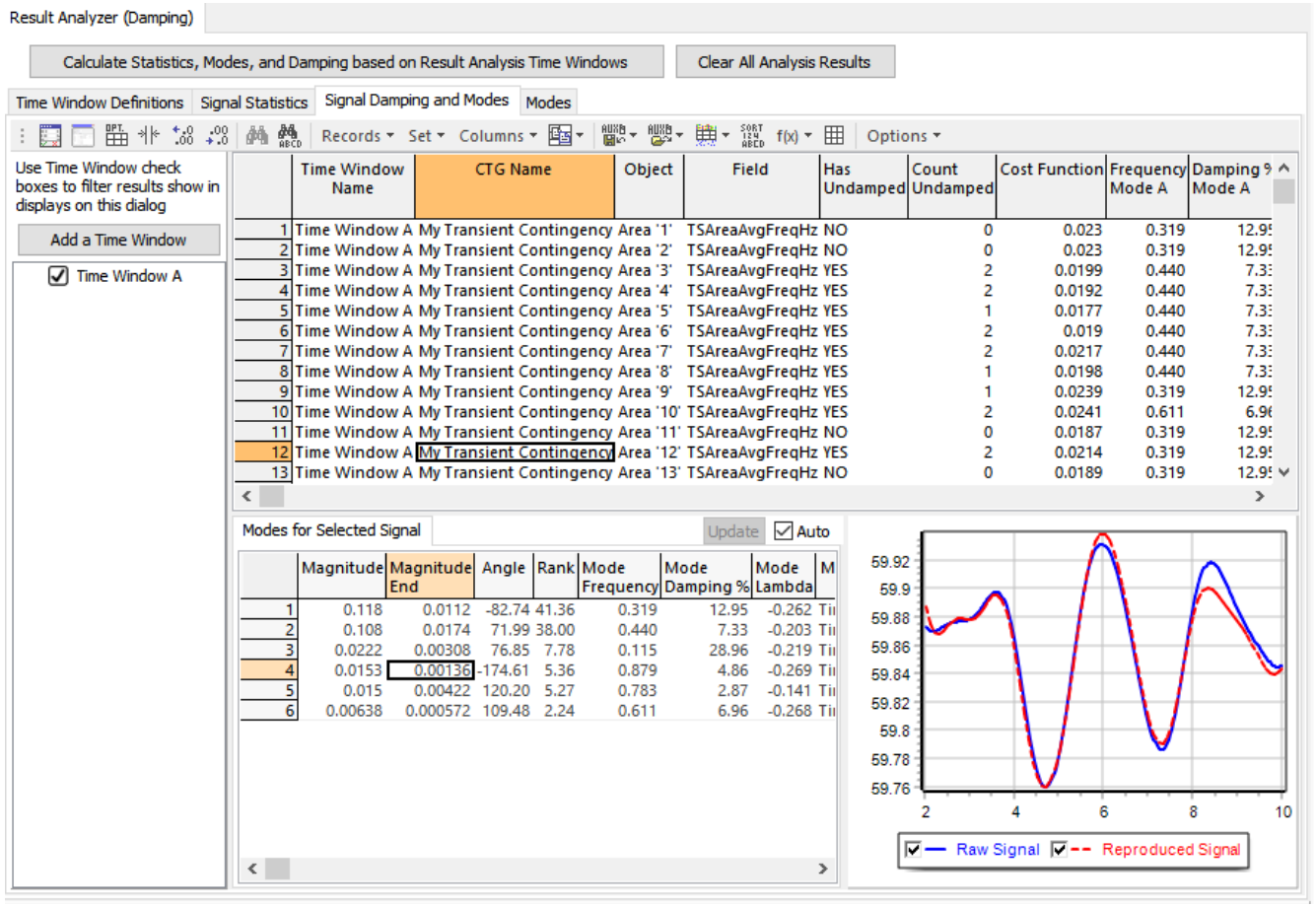
Transient Stability

- Result Analyzer – Statistics, Damping and Modes



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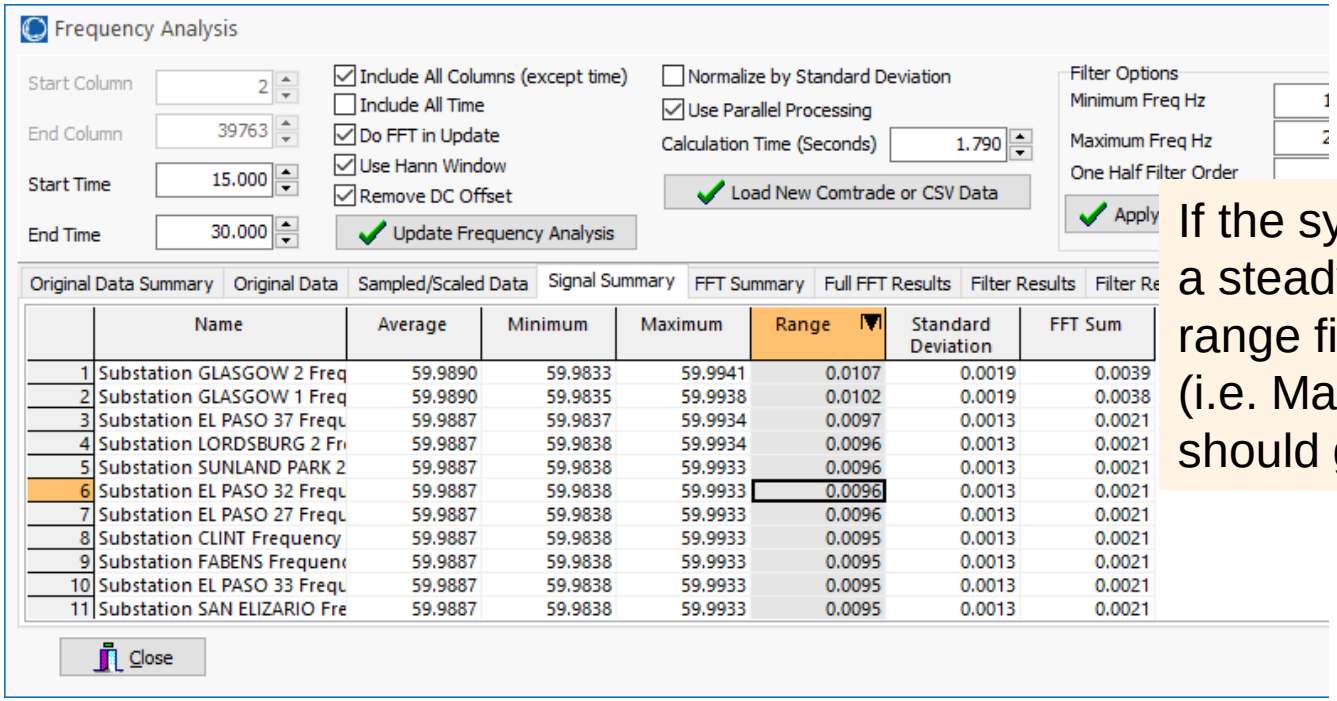
Transient Stability

- Frequency Analysis – New **Signal Summary** tab
  - Start and End times can be adjusted to get metrics on just a subset of time



	Name	Average	Minimum	Maximum	Range	Standard Deviation	FFT Sum
1	Substation GLASGOW 2 Freq	59.9890	59.9833	59.9941	0.0107	0.0019	0.0039
2	Substation GLASGOW 1 Freq	59.9890	59.9835	59.9938	0.0102	0.0019	0.0038
3	Substation EL PASO 37 Frequ	59.9887	59.9837	59.9934	0.0097	0.0013	0.0021
4	Substation LORDSBURG 2 Fr	59.9887	59.9838	59.9934	0.0096	0.0013	0.0021
5	Substation SUNLAND PARK 2	59.9887	59.9838	59.9933	0.0096	0.0013	0.0021
6	Substation EL PASO 32 Frequ	59.9887	59.9838	59.9933	0.0096	0.0013	0.0021
7	Substation EL PASO 27 Frequ	59.9887	59.9838	59.9933	0.0096	0.0013	0.0021
8	Substation CLINT Frequency	59.9887	59.9838	59.9933	0.0095	0.0013	0.0021
9	Substation FABENS Frequen	59.9887	59.9838	59.9933	0.0095	0.0013	0.0021
10	Substation EL PASO 33 Frequ	59.9887	59.9838	59.9933	0.0095	0.0013	0.0021
11	Substation SAN ELIZARIO Fre	59.9887	59.9838	59.9933	0.0095	0.0013	0.0021

If the system is settling to a steady-state, then the range field (i.e. Maximum – Minimum) should go to zero

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End