

What's New in Simulator Version 20



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What's New in Version 20



- Version 20 is a version with many, many, many small changes throughout
- Concentration this past year has been on improving existing features
 - Scheduled Actions
 - Transient Stability
 - Remedial Action Schemes (RAS)
- Concentration on Data Management Features as well
 - Difference Case Tool
 - Dependency Explorer
 - Data Checks
 - Data View
- These are the highlights
 - Comprehensive list found at <http://www.powerworld.com/products/simulator/whats-new>

Simulator Version 20 Installation



- MSI file will be used for installations and patches
- User installation will be possible without admin privileges
 - Will still be able to install for all users as an administrator
- There is no separate zip file for patching
- Locally installed Help is separate and optional
 - Default Help link is the PowerWorld website
 - Previously this was 60% of the installation file!
 - <https://www.powerworld.com/download-purchase/download-help-files>

64-bit Simulator



- This was introduced in Simulator 20
- 32-bit and 64-bit are both installed simultaneously

SimAuto

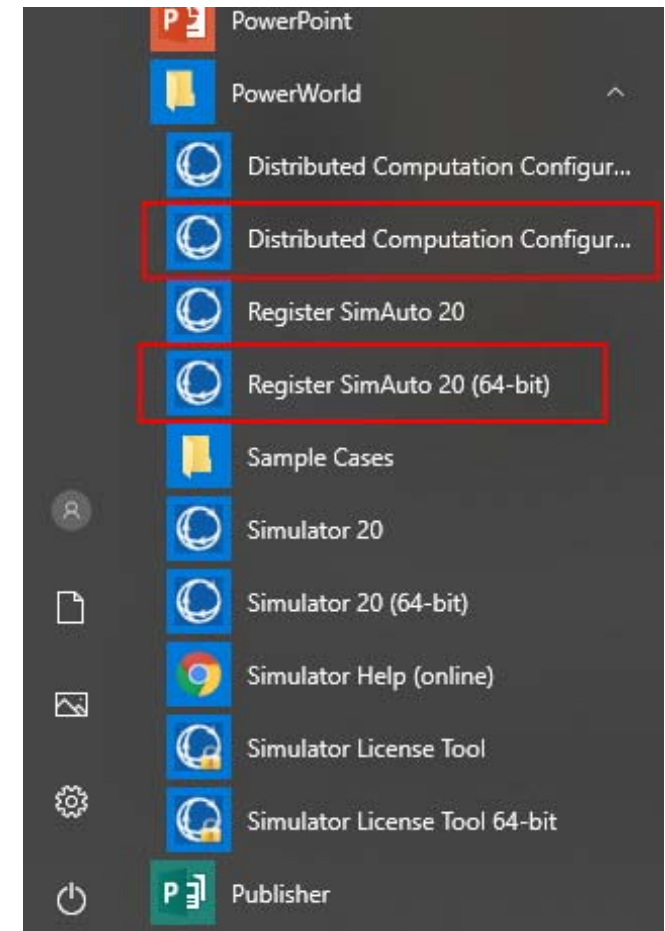


- Be careful with 64-bit registration
 - If your code is 64-bit, Windows will use the 64-bit version of Simulator if registered, otherwise it will look for 32-bit
 - If your case is 32-bit, Windows will use the 32-bit version of Simulator if registered, otherwise it will look for 64-bit
- Can optionally make Simulator visible while running SimAuto
 - SimAuto property UIVisible set to TRUE or FALSE
- Need to link to pwrworld 19.0 type library

Tools to help with Computer Configuration



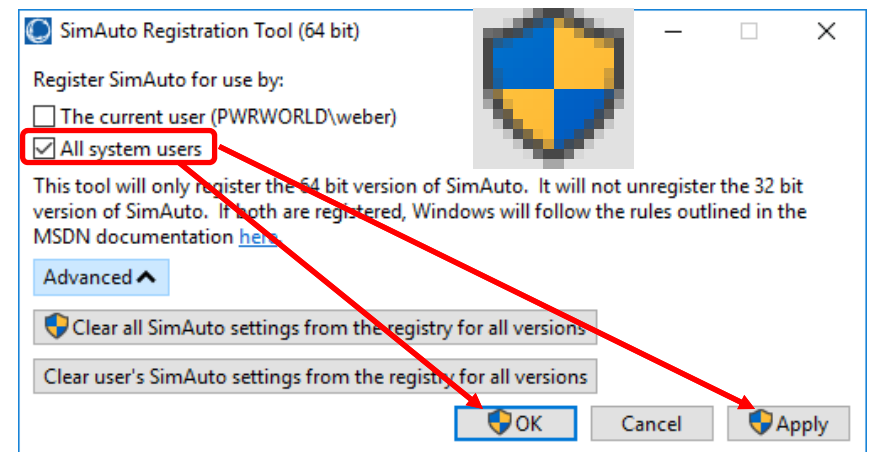
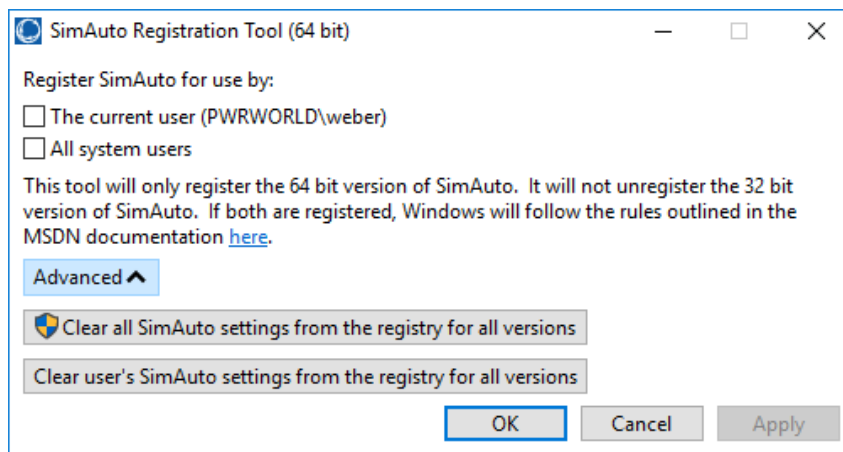
- SimAuto Registration Tool
 - RegSimAuto.exe
- Distributed Computation Configuration Tool
 - DistCompCfg.exe



SimAuto Registration Tool



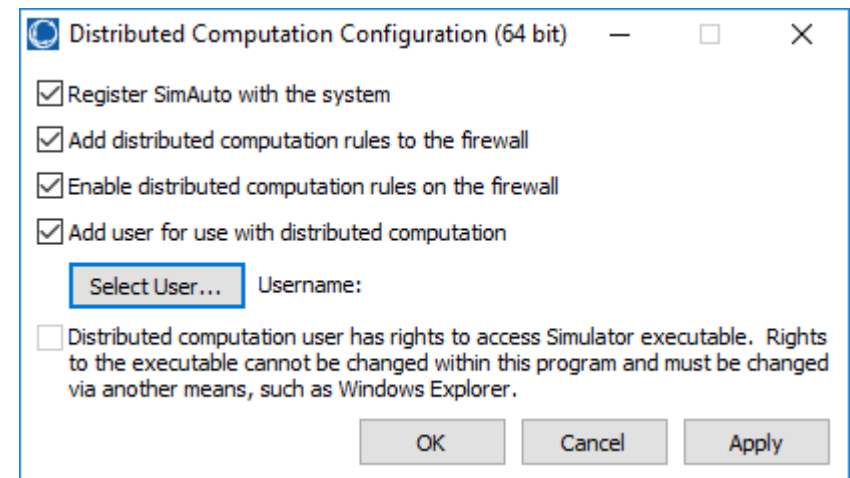
- Allows you to register SimAuto for the Windows current user only (previously it was always only for all, which required admin rights)
- The tool in Simulator is has more options



Distributed Computation Configuration Tool



- New tool for configuring Distributed Computing tools
 - You run this tool on the remote machine that you configure for Distributed Computation
 - Need Windows local Admin privileges on remote machine to use this tool
 - The User you select here is the user you configure on the primary Simulator

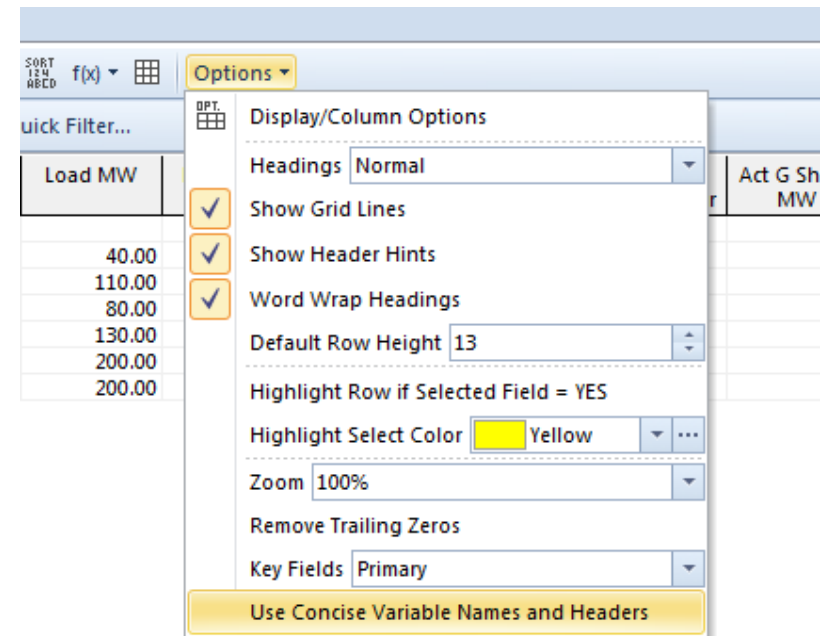


Special Auxiliary File Improvements

Continue into Version 19



- All variable names throughout Simulator have been overhauled
- Easier access to concise format
 - New option on Case Information Toolbar to show in concise format
 - If option selected, any saved auxiliary file will be in concise format
 - Default option in Version 19 is to not use this, but in Version 20 we changed default



Concise vs. Legacy Variable Names



- Concise names no longer use the location integer (:0, :1, etc.) wherever possible
- Concise names better reflect their purpose and have been made more understandable
 - For BRANCH object LineMW:1 (legacy) is now MWTo (concise)
- For fields in which a dynamic number is available the concise names will still use the location integer
 - CustomInteger, CustomFloat, CustomString, and other Custom fields
 - Multiple direction PTDF
 - Multiple Element TLR
 - LODF Matrix
 - Bus OPF Results
 - OPF Load and Generator Linear Bids

Concise vs. Legacy Variable Names



- *Export Case Object Fields...* will provide a comparison of the legacy and concise names

	A	B	C	D	BusNomVolt	NomkVFrom
1	Object Type	SUBDATA Allowed	Key/Required Fields	Variable Name	BusNomVolt:1	NomkVTo
1205	Branch			BusName	BusNum	BusNumFrom
1206				BusName:1	BusNum:1	BusNumTo
1207			*A*	BusName_NomVolt	BusNum:2	MSBusNumFrom
1208			*B*	BusName_NomVolt:1		
1209				BusName_NomVolt:2		
1210				BusName_NomVolt:3		
1211				BusNomVolt		
1212				BusNomVolt:1		
1213			*1*	BusNum	BusNumFrom	Integer
1214			*2*	BusNum:1	BusNumTo	Integer
1215				BusNum:2	MSBusNumFrom	Integer

Switch between showing legacy

Branch	BusNum(1)	BusName	BusNum:1(2)	BusName:1	LineCircuit(3C)	LineStatus	BranchDeviceType	LineXfmr	LineMW	LineMVR	LineMVA	LineLimMVA
1	1	One	2	Two	1	Closed	Line	NO	59.1	4.5	59.2	150.0

and concise variable names on a case information display

Branch	BusNumFrom(1)	BusNameFrom	BusNumTo(2)	BusNameTo	Circuit(3C)	Status	BranchDeviceType	IsXF	MWFrom	MvarFrom	MVAFrom	Li
1	1	One	2	Two	1	Closed Line	Line	NO	59.1	4.5	59.2	

New Script Commands



- ClearPowerFlowSolutionAidValues
- CTGSaveViolationMatrices
- DeleteDevice
- DiffFlowWriteRemovedEPC
- IdentifyBreakersForScheduledActions
- ImportDDLAsTranslation
- InjectionGroupCreate
- LoadAuxDirectory
- LoadEMS
- MessageBox
- ObjectFieldsInputDialog
- RelinkAllOpenOnelines
- SaveDataEPC
- SetScheduleView
- SetScheduleWindow
- TSAutoInsertDistRelay
- TSAutoInsertZPOTT
- TSCalculateCriticalClearTime
- TSLoadRDB
- TSLoadRelayCSV
- UpdateIslandsAndBusStatus

Script Command Modifications



- CalculateLODF, CalculateLODFMatrix
 - Added parameter PostClosureLCDF. If YES calculate the closure sensitivities relative to post-closure flow (LCDF). If NO calculate the closure sensitivities relative to pre-closure voltages and angles (MLCDF).
- CalculateTLR
 - Added AbortOnError parameter that indicates if the TLR calculation fails whether the auxiliary file containing the command should cease processing or continue
- CTGWriteResultsAndOptions, CTGWriteAllOptions
 - Added SaveDependencies parameter to specify if all objects needed to define selected objects are also saved
- CloseWithBreakers
 - Added parameter CloseNormallyClosedDisconnects that will close any disconnect that is normally closed but currently open when searching for breakers
- DiffFlowMode
 - diffmode can also be specified as CHANGE
- OpenOnline
 - Wildcards are allowed in the filename when opening a DDL file. This is useful for loading DDLs via browsing path searches.
- OpenWithBreakers
 - Added parameter OpenNormallyOpenDisconnects that will open any disconnect that is normally open but currently closed when searching for breakers
- Renumber3WXformerStarBuses
 - Added Delimiter parameter for specifying the file delimiter
- RenumberMSLineDummyBuses
 - Added Delimiter parameter for specifying the file delimiter
- ReassignIDs
 - Added parameter UseRight that will use the last two characters of the specified field that contains the new IDs
- SetCurrentDirectory
 - Filedirectory can now be specified using the special keywords starting with @, i.e. @BUILDDATE, @DATETIME, @DATE, @TIME, @VERSION, @CASENAME, and @MODELFIELD. The & format that allows specification of a Model Expression or model field can also be used.

Script Command Modifications

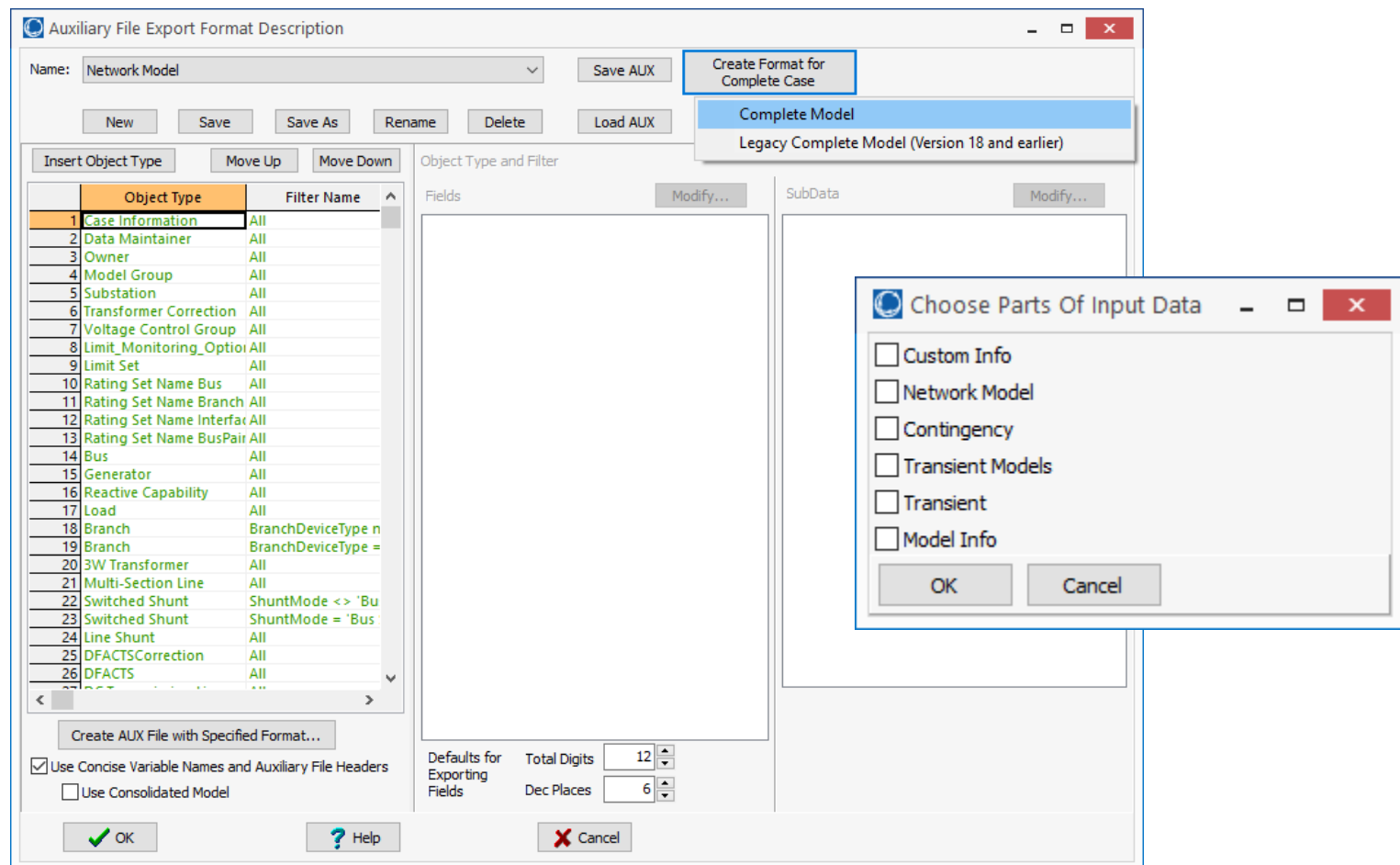


- @MODELFIELD keyword
 - Can be used to insert the value of a model field as part of filenames and other text specified in script commands
 - @MODELFIELD<objecttype 'key1' 'key2' 'key3'
variablename:digits:rod>

AUX Export Format Description



- Added more built-in definitions for creating auxiliary files for various tools



Case Information Displays



- Added support for filtering on DateTime fields
- Added DateTime-related functions to Expressions
 - Text() , DateValue(), TimeValue() and DateTime(Value)
- Added DataMaintainer Filtering globally
 - Works similar to the Area/Zone/Owner filtering
- Added a property of DataMaintainer called AllowEdit
 - If AllowEdit = NO, then you will not be able edit any data for that DataMaintainer
 - This includes in the user-interface
 - This also includes by loading from an AUX file
 - Be careful! This will change how AUX file function!

File Formats



- EPC file
 - Version 21
- RAW file
 - Working on version 34
- hdbexport CSV file
 - Use the option *Close Breakers to Energize Switched Shunts* by default when loading a file
 - DC system translation
 - RASMOM loading is now supported
 - Modified assignment of the BS.MMINJMW, BS.MMINJMR
- ABB Spider
 - Use the option *Close Breakers to Energize Switched Shunts* by default when loading a file

Translate the DC System (POLE, DCCNV, VSC, DCND, DCLN) into multi-terminal DC systems and VSC DC Lines

When to do DC System Translation

- ☐ Never translate
- ☒ Always translate if possible
- ☐ Prompt each time a case is loaded

General



- 15 Negative interface limits
 - Integrated into Contingency Analysis, ATC, and OPF tools

Difference Case Tool



- See separate presentation
- *Change Case* is new mode that shows only the fields that have changed

Data View

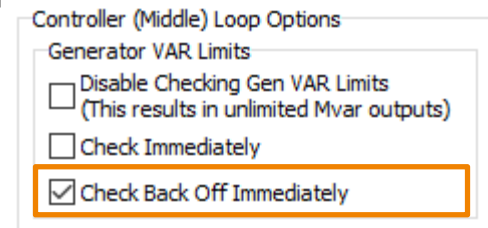


- User-customizable dialog for ANY object in Simulator
 - Built right off the case information displays
 - Separate Presentation later.

Power Flow Solution



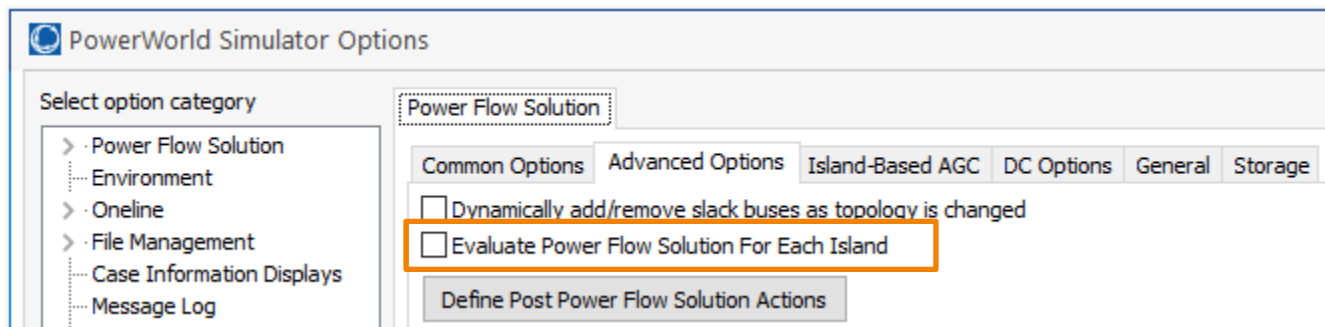
- *Check Back Off Immediately* option
 - Check done in inner power flow loop to determine if generators at Mvar limits can back off the limit
 - PQ type bus goes to PV type bus
 - No check is done for generators hitting limits
 - PV type bus goes to PQ type bus
 - **Default in Version 20 is to check this option**



Power Flow Solution



- *Evaluate Power Flow Solution for Each Island*
 - Solution for a particular island will be abandoned, but the solution for other islands will continue as long as at least one island converges
 - *Solved* field with Island objects will indicate which ones solved
 - Mismatch messages in the log will indicate the maximum mismatch for each island, as well as, the maximum mismatch across the entire case
 - When not using this option, the power flow will be reported as unsolved if any island does not converge



Switched Shunts

Status Branch



- *Status Branch* field for switched shunt
 - Defines a branch that will affect the status of a switched shunt
 - If the branch is open, the switched shunt will also be open
 - Allows line shunts to be modeled as switched shunts with automatic controls

The screenshot shows the 'Switched Shunt Options' dialog box and the 'Switched Shunts' table. The dialog box has fields for Bus Number (3), Bus Name (Three), Shunt ID (1), and Labels (no labels). It also has buttons for 'Find By Number', 'Find By Name', and 'Find ...'. The 'Status' section has radio buttons for 'Open' and 'Closed' (selected). The 'Status Branch' section has a text field containing 'Branch '1' '3' '1'' and buttons for 'Choose Branch' and 'Remove'. The 'Switched Shunts' table has columns for Number of Bus, Name of Bus, ID, Reg Bus Num, Status Branch, and Status. The first row shows a shunt with ID 1, Name 3 Three, and Status Branch 'Branch '1' '3' '1''.

Number of Bus	Name of Bus	ID	Reg Bus Num	Status Branch	Status
1	3 Three	1	3	Branch '1' '3' '1'	Closed

SVCs



- SVCs can now control any switched shunt except other SVCs
 - When SVC is in service it will control the controlled shunt and controlled shunt will act as if it is fixed
 - When SVC is out of service, switched shunt being controlled will obey its own Control Mode

Bus Pairs



- New object to monitor differences between angles at two different buses
- Uniquely identified by Name
- Specify up to 4 angle limits
- Limit Monitoring Settings options used for identifying violations on the angle difference
 - Percentage, Normal Rating Set, and Contingency Rating Set are specified
 - Each Bus Pair must be assigned to a Limit Group
 - Area and Zone Reporting options are ignored for bus pairs
- Contingency violation: *Bus Pair Angle*

Limit Monitoring



- *Only show the primary bus for each superbuss*
 - Also applies to the contingency analysis option
When using Integrated Topology Processing, monitor only the primary bus for each superbuss
 - Will now monitor the primary bus for each superbuss, bus with the highest low voltage limit, and bus with the lowest high voltage limit so as not to miss any possible violations
- Option *Do not monitor radial lines and buses* is ignored if using Topology Processing

Contingency Analysis

General



- Contingency records have highlighting based on results
 - If *Processed* = YES then colors indicate the following values of the *Solved* field
 - YES – normal fill color
 - NO – light red
 - ABORTED – light orange
 - RESERVE LIMITS – light yellow
 - PARTIAL – light yellow

Contingency Analysis

General



- When choosing to either Save Case or Save Case As, a check is now done to help ensure that a user does not save a post-contingency system state accidentally
 - If all conditions are met, a dialog will appear asking the user to confirm that they want to save the case
 - The check evaluates the following three conditions
 - Contingency Analysis dialog is open
 - Contingency Reference State exists
 - At least one system device status in the present system is different than the status in the Contingency Reference State

Contingency Analysis Violations

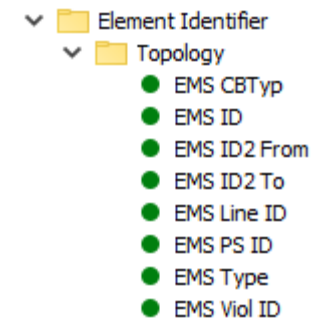


- New violation Category of *Unsolved* indicates if the contingency solution did not converge
 - Element will be *System*
- Added 7 new fields with LimitViol object type that give information about the violated end of the violated element
 - BusNumViolEnd, BusNameViolEnd, NomkVViolEnd, AreaNameViolEnd, BANameViolEnd, ZoneNameViolEnd, and SubNameViolEnd
 - These fields are then available in the ViolationCTG object as well
 - LV_BusNumViolEnd, LV_BusNameViolEnd, LV_NomkVViolEnd, LV_AreaNameViolEnd, LV_BANameViolEnd, LV_ZoneNameViolEnd, and LV_SubNameViolEnd

Contingency Analysis Violations



- Contingency records can be filtered by filters created for object type LimitViol. This is useful for finding contingencies that have violations of specific elements.
- Added ability for the LimitViol and ViolationCTG object types to return EMS identifying information

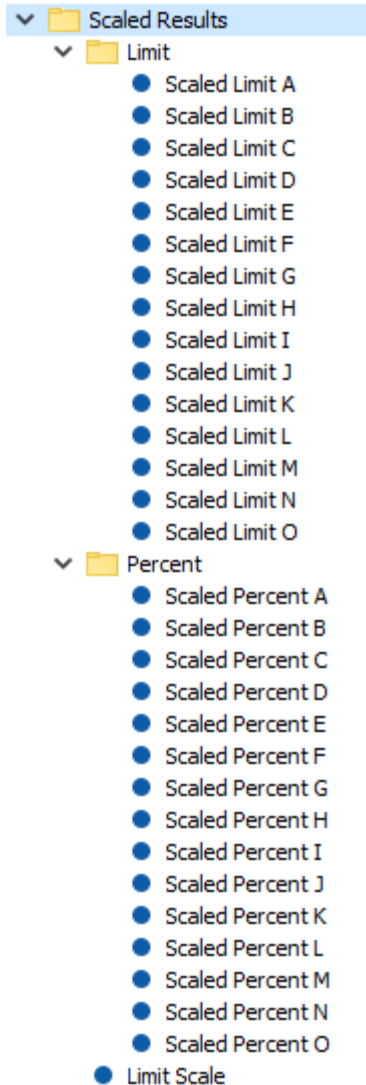


Contingency Analysis Violations



- Percent field for a voltage violation will now show a value that is based on the voltage limit
 - Value = 0.90 with Limit = 0.95 will show Percent = $(0.90/0.95)*100 = 94.74$.
- New *Source List* field with LimitViol object type that is used to indicate the origin of the violation when comparing two lists of results
 - Options are *Both*, *Comparison*, or *Controlling*
- Added fields to LimitViol and ViolationCTG object types for showing Reference State fields in the Comparison Case

Contingency Analysis Violations



- Scaled Results

- *Limit Scale*

- Value is stored when violation is recorded to maintain what respective device limit was used to calculate the stored limit
 - Used with the Scaled Limit A...Scaled Limit O and Scaled Percent A...Scaled Percent O terms to show what the limit would have been using the present device limits
 - Allows storing the limit violations against the most restrictive rating set and still show what the percentage would be against all limit sets

- *Scaled Limit x*

- $(Limit/LimitScale) * PresentDeviceLimitx$

- *Scaled Percent x*

- $Percent * LimitScale / PresentDeviceLimitx$

Contingency Analysis

Fields New and Changed



- *Solved*
 - PARTIAL is now an option if only some of the islands have solved
- *Include Remedial Actions*
 - Specifies whether or not a given contingency should also include Remedial Actions
- *Screen Allow*
 - Specifies if the contingency should be screened or just always run the full solution
- *Calculation Method*
 - Unknown, AC, FullDC, DC, DCPS, ScreenDC, ScreenDCPS, IteratedDC, IteratedDCPS, IteratedScreenDC, IteratedScreenDCPS
 - *Unknown* means that no solution has been attempted
 - *AC* means that the full solution method was used while in ac power flow mode
 - *FullDC* means that the full solution method was used while in dc power flow mode
 - *DC* means the linear method without enforcing phase shifters was used
 - *DCPS* means that the linear method enforcing phase shifters was used
 - *Screen* indicates the solution was achieved by screening process only
 - *Iterated* indicates that the Iterate on Action Status option was used with one of the linear methods
- *Screening Rank for Branches, Buses, BusPairs, and Interfaces*
 - Shows the ranking for each contingency for each of the screening categories

Contingency Analysis

Fields New and Changed



- *Substation Names and Substation Numbers*
 - Lists all of the substations represented by all contingency elements
- *Voltage Reduced Load MW*
 - Amount that the total MW load has been reduced due to the options for Minimum Voltage for Constant Power and Constant Current Load
- *Bus Pair Angle Violations*
 - Number of bus pair angle violations
- *Max Bus Pair Angle*
 - Value of the maximum bus pair angle violation
- Comparison fields for bus pair angle violations

Contingency Analysis

New Options



- Post Contingency Solution Auxiliary File
 - Loaded after the contingency is solved
 - Previously existing *Post Contingency Auxiliary File* is loaded before the contingency is implemented and solved

A screenshot of a software interface titled 'Auxiliary Files'. It contains two sections. The first section, 'Post Contingency Auxiliary File', has a text input field and a 'Browse' button. Below it, text states: 'This auxiliary file is loaded at the start of each contingency. Special post-contingency settings can be entered in this auxiliary file.' The second section, 'Post Contingency Solution Auxiliary File', is highlighted with an orange border. It also has a text input field and a 'Browse' button. Below it, text states: 'This auxiliary file is loaded after the contingency is solved. Special results can be saved using this auxiliary file.'

Contingency Dialog Options



- Previously in Simulator 19 if you had the contingency dialog open and then loaded an AUX file, the dialog would not always immediately update to reflect any changes that were made from loading the AUX file
 - This update was ONLY done when using the Load AUX button on that dialog
 - It will now always update regardless of how you cause an AUX file to be loaded.

Active Contingency Object



- New object type ContingencyActive to access all fields associated with a Contingency record for the currently active contingency
 - Useful with the new Post Contingency Solution Auxiliary File for saving results and identifying the correct contingency
- CTG_Options object type *Active Contingency* field provides the name of the active contingency
 - This can be added to a oneline using the Case Information Memo Field object with the *Contingency Analysis Active Contingency Name* field

Contingency Analysis

New Options



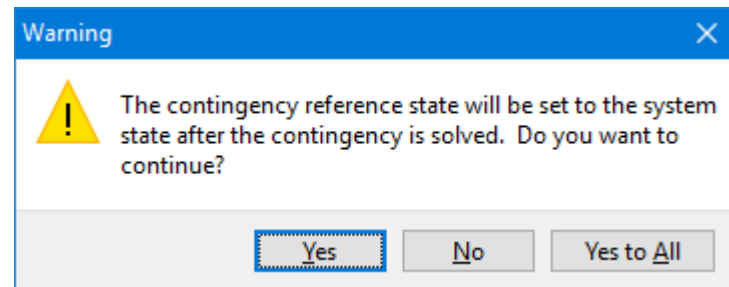
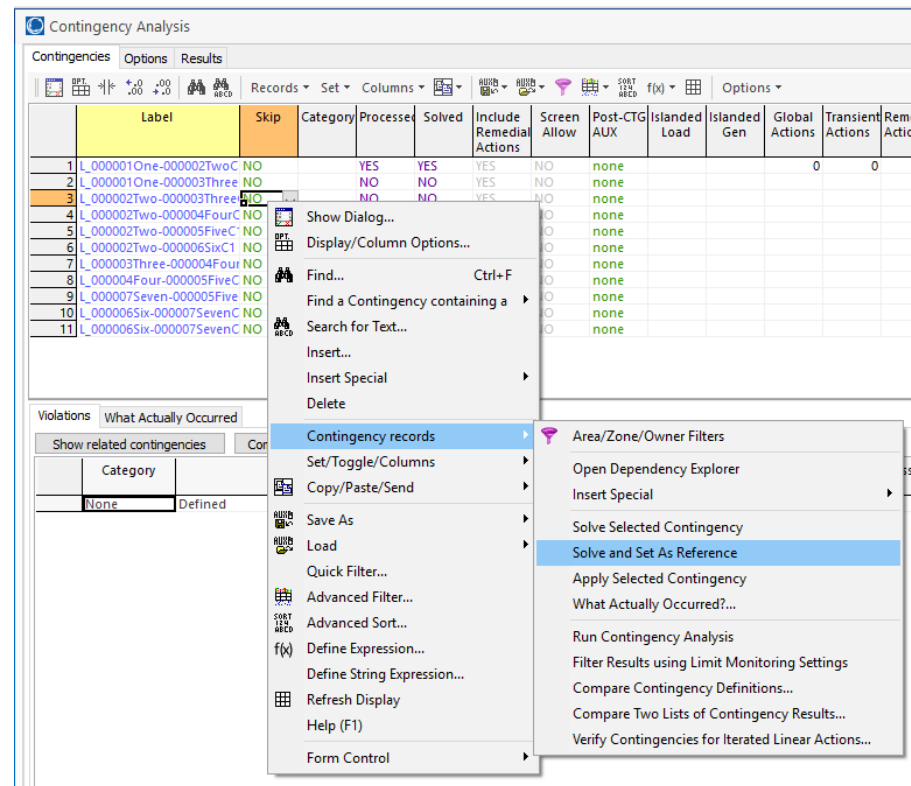
- *Ignore Remedial Action Elements if Model Criteria is True in Contingency Reference State*
 - Individual elements of a Remedial Action are ignored if their Model Criteria evaluates to true in the reference state
 - Other elements of a Remedial Action will still be implemented
 - When loading an Areva contingency file this is set based on the SCNBCRAS field in the ITEMS record

Remedial Action					
☐ Ignore Remedial Action Elements if Model Criteria is True in Contingency Reference State					
Records ▾ Set ▾ Columns ▾ Options ▾					
	Label	Skip	Arming Criteria	Arming Status	Armed
1	Freeville Generation Run-Back Scheme	NO		CHECK	YES
2	BigGen OvalOffice Gen Drop	NO		CHECK	YES

Solve and Set As Reference Warning Message



- Warning message will now appear when selecting *Solve and Set As Reference*
- YES* – contingency will be solved and that state will be set as the reference state
- NO* – contingency will not be solved and the references state will not change
- Yes to All* – contingency will be solved and that state will be set as reference state. This will be done for all subsequent calls of this option and no more prompting will occur. Prompting will appear again once contingency analysis dialog is closed and reopened.

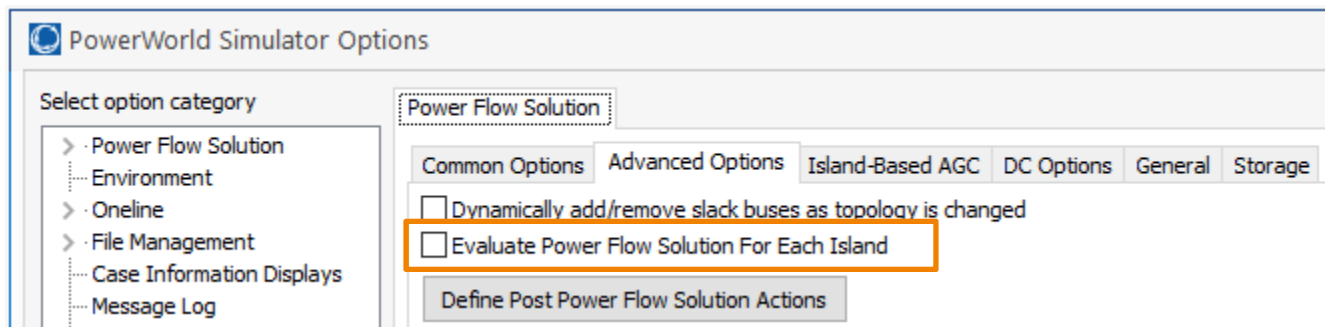


Contingency Analysis

Handling Islands



- Power flow solution option *Evaluate Power Flow Solution for Each Island* will prevent a failed contingency solution if at least one island solves
 - Solved field for Contingency can be PARTIAL to indicate multiple islands in the solution with only some solving



Contingency Analysis

Handling Islands



- *Prevent new island without enough controllable generation*
 - During contingency solution that creates new islands, new islands will not be considered viable, i.e. even attempted as part of the solution, if they do not have enough controllable (Online = YES and AGC = YES) generation to meet the load and losses in the island
 - This check is only done on islands in which the load estimate is less than 50% of the total load in an attempt to only do this for small islands and not the largest island in the case

The screenshot shows the 'Contingency Analysis' software window. The 'Options' tab is selected, and the 'Basics' section is expanded. The 'Prevent new island without enough controllable generation' checkbox is highlighted with an orange box. The 'Make-up Power' section is also visible, showing options for determining make-up power and a tolerance value of 5.0000.

Contingency Analysis

Contingencies Options Results

Modeling

- Basics
- DC and Screening Options
- Generator Post-Contingency AGC
- Bus Load Throw Over
- Generator Maximum MW Response
- Generator Line Drop and RCC
- Switched Shunt Post CTG
- Auxiliary Files
- Transient Models
- Result Storage

Limit Monitoring

- Advanced Limit Monitoring
- Island Monitoring

Basics

Calculation Method

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

Topology Processing Mode

- ☒ Preserve All Breakers Included in Contingencies
- ☐ Use Incremental Topology Processing Mode

AC Method Options

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

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

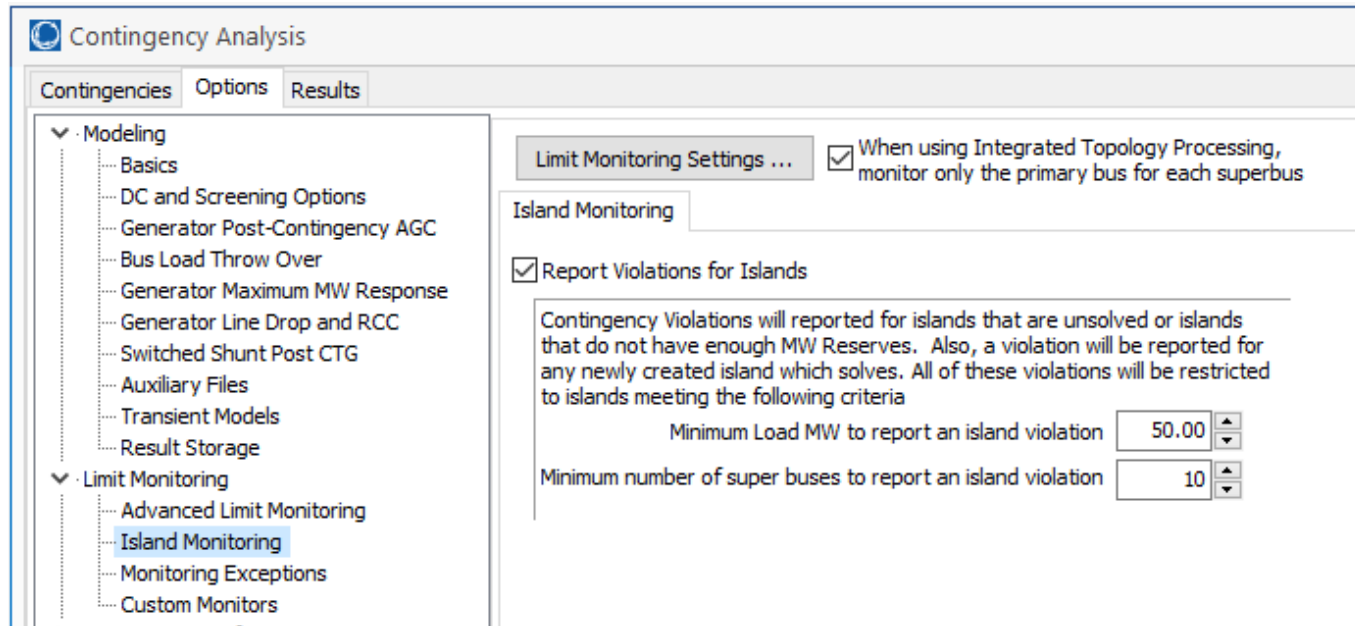
- ☒ Area Participation Factors specified below
- ☐ Generator Participation Factors From Entire Case Directly
- ☐ Same as Power Flow case

Make-up Power Tolerance 5.0000

☐ Prevent new island without enough controllable generation

Contingency Analysis

Island Monitoring



- *Report Violations for Islands*
 - Check this to include island violations with the results
 - This only affects the reporting of island violations and does not impact if an island is created or not

Contingency Analysis

Report Violations for Islands



- Island violations can be restricted to only report if the island is “large enough”
 - *Minimum Load MW to report an island violation*
 - Specify the MW amount of load that must exist in the island
 - Determined after the solution for islands for which a solution was determined or during the island check for islands that are not viable because of the *Prevent new island without enough controllable generation* option
 - *Minimum number of super buses to report an island violation*
 - For systems that are not using Integrated Topology Processing, the number of buses is used instead

Contingency

Island Violation Categories



- Island violations are reported only if there is at least one island that solves in the case
 - Violation with Category = *Unsolved* for Element = *System* will result instead
- The Category field for violations now has the following options for reporting island violations
 - Island Unsolved
 - An unsolved island was found during the solution
 - This could result from an existing island or a new island created during the contingency
 - Island Reserve Limits
 - An island was found that did not have enough make-up generation
 - This could result from an existing island or a new island created during the contingency
 - Island Solved
 - This will result only for an island that was created during the contingency

Contingency

Island Violations Fields



- Islands are identified by the island slack bus as the violation Element
- Special fields are available for island violations
 - These will be blank for other types of violations
- View Results by Element
 - Island violations will appear with Bus violations



Contingency Screening



- Process uses linear contingency analysis to screen contingencies prior to running full ac analysis on contingencies that pass the screening
- Attempts to speed up the process by only running full ac analysis on a subset of contingencies

Contingency Screening



- *DC and Screening Options* page on Contingency Analysis dialog provides options for using screening

The screenshot shows the 'Contingency Analysis' dialog box with the 'Options' tab selected. The left sidebar lists various modeling options, with 'DC and Screening Options' highlighted. The main panel is divided into two sections: 'DC Method Options' and 'Full AC Power Flow Screening Options'.

DC Method Options

- ☐ For DC methods, allow amp limits by assuming a constant voltage magnitude
- Model reactive power for DC methods by...**
 - ☒ Ignoring reactive power
 - ☐ Assuming constant voltage magnitude
 - ☐ Assuming reactive power does not change
- ☒ Iterate on Action Status
(Do NOT treat all Statuses as CHECK)

Full AC Power Flow Screening Options

Use Screening

- ☐ No
- ☒ Yes
- ☐ Screen Only
- ☒ Include Voltage

Maximum number to select

Category	Value
Branches	20
Interfaces	10
Buses	20
BusPairs	10

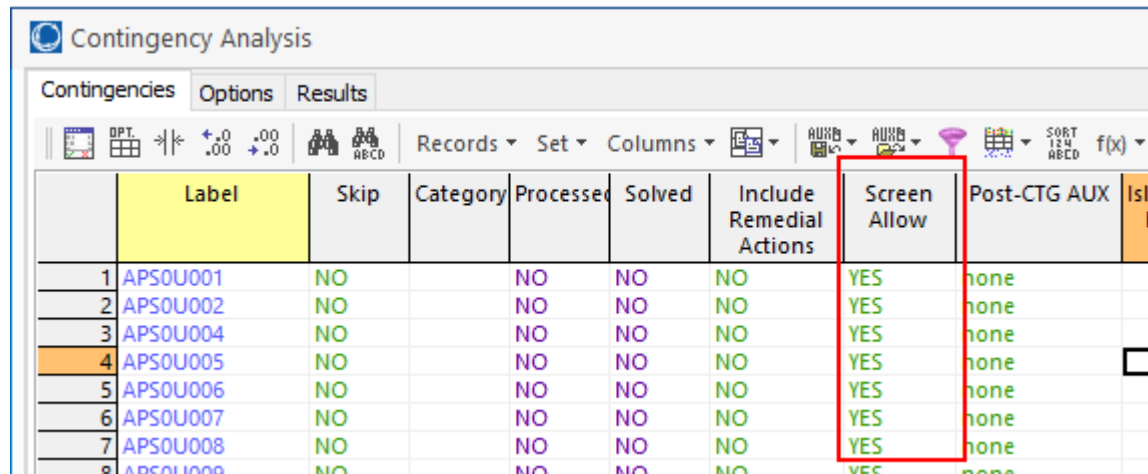
Screening Method

- ☒ Linearized Lossless DC
- ☐ Linearized Lossless DC With Phase Shifters

Contingency Screening



- *Screen Allow* field must be set to YES for any contingency that should be screened
 - If set to NO, full ac analysis will be done on that contingency



The screenshot shows the 'Contingency Analysis' software interface. It features a table with columns: Label, Skip, Category, Processed, Solved, Include Remedial Actions, Screen Allow, Post-CTG AUX, and Island. The 'Screen Allow' column is highlighted with a red box, showing 'YES' for all listed contingencies. The 'Skip' column shows 'NO' for all. The 'Include Remedial Actions' column shows 'NO' for all. The 'Post-CTG AUX' column shows 'none' for all. The 'Island' column is partially visible on the right.

	Label	Skip	Category	Processed	Solved	Include Remedial Actions	Screen Allow	Post-CTG AUX	Island
1	APS0U001	NO		NO	NO	NO	YES	none	
2	APS0U002	NO		NO	NO	NO	YES	none	
3	APS0U004	NO		NO	NO	NO	YES	none	
4	APS0U005	NO		NO	NO	NO	YES	none	
5	APS0U006	NO		NO	NO	NO	YES	none	
6	APS0U007	NO		NO	NO	NO	YES	none	
7	APS0U008	NO		NO	NO	NO	YES	none	
8	APSCU000	NO		NO	NO	NO	YES	none	

Iterated Linear Contingency Analysis



- Attempts to model remedial actions using linear sensitivity calculations
 - No actual system changes are made
 - Linear sensitivities are used to determine the impact of conditional actions
 - At each iteration all actions that were implemented at prior steps in addition to any new actions that meet conditions at current step will be “implemented”

Iterated Linear Contingency Analysis



- Linear impact of line flows and MW injection changes can be modeled
 - No voltage changes are modeled
- *Verify Contingencies for Iterated Linear Actions*
 - Checks conditional actions to determine if monitored fields are handled or not
 - Because no actual system changes are made, Simulator needs to know which values need to be calculated linearly

Validate Contingencies for Iterated Linear Actions



```
-----  
Valid Fields Found  
-----  
Branch,MWFrom,"MW\MW at From Bus"  
ModelExpression,Result,Result  
Branch,DerivedOnline,"Derived Online"  
Branch,PercentMVACFrom,"Limit Monitoring\MVA Limits\% of MVA Limit C at From Bus"  
Branch,PercentMVABTo,"Limit Monitoring\MVA Limits\% of MVA Limit B at To Bus"  
Branch,MVAFrom,"MVA\MVA at From Bus"  
Branch,PercentMVACTo,"Limit Monitoring\MVA Limits\% of MVA Limit C at To Bus"  
Interface,MW,"MW\MW Flow"  
MTDCCConverter,Online,Online  
Branch,PercentMVAAFrom,"Limit Monitoring\MVA Limits\% of MVA Limit A at From Bus"  
Branch,MWFromIntoBus,"MW\MW at From Bus (Into Bus)"  
Branch,PercentMVABFrom,"Limit Monitoring\MVA Limits\% of MVA Limit B at From Bus"  
Branch,Status,Status  
Branch,PercentMVAATo,"Limit Monitoring\MVA Limits\% of MVA Limit A at To Bus"  
Branch,MWToIntoBus,"MW\MW at To Bus (Into Bus)"  
Branch,MWTo,"MW\MW at To Bus"  
Branch,MVATo,"MVA\MVA at To Bus"  
  
-----  
Invalid Fields Found  
-----  
Gen,Mvar,"Mvar Output\Mvar"  
Bus,kV,"Voltage\kV Actual"
```

Screening

Limit Monitoring Settings



- Specify tolerances with Limit Groups to determine how limits for screening should be treated

The screenshot shows the 'Limit Group Dialog' window. At the top, the 'Limit Group Name' is set to 'M_AESO'. There is a 'Disabled' checkbox and buttons for 'Add New Limit Group' and 'Rename Limit Group'. Below this are four tabs: 'Lines/Interfaces', 'Buses/Summary', 'Contingency Options', and 'Contingency Screening'. The 'Contingency Screening' tab is active. It contains two sections: 'Tolerances in % of Limit' and 'Tolerances in Per Unit Voltage'. The first section has three rows: 'Branch' (90.000), 'Interface' (90.000), and 'BusPair' (90.000). The second section has three rows: 'Low Bus Voltage' (0.01000), 'High Bus Voltage' (0.01000), and 'Change Bus Voltage' (0.01000). At the bottom of the dialog are buttons for 'OK', 'Delete', 'Cancel', 'Print', and 'Help'.

Tolerances in % of Limit		Tolerances in Per Unit Voltage	
Branch	90.000	Low Bus Voltage	0.01000
Interface	90.000	High Bus Voltage	0.01000
BusPair	90.000	Change Bus Voltage	0.01000

Screen Ranking



- Branch Screening
 - A branch will be included in the ranking for branches if $(MW > Limit * ScreenBranchPercent)$ and it is a monitored branch
 - Branch ranking is the sum of $(Limit * ScreenBranchPercent - MW)$ for all branches meeting the ranking criteria
- Interface Screening
 - An interface will be included in the ranking for interfaces if $(MW > Limit * ScreenInterfacePercent)$ and it is a monitored interface
 - Interface ranking is the sum of $Abs(MW - Limit * ScreenInterfacePercent)$ for all interfaces meeting the ranking criteria

Screen Ranking



- Bus Pair Screening
 - A bus pair will be included in the ranking for bus pairs if ($\text{Abs}(\text{AngleDiff}) > \text{Limit} * \text{ScreenBusPairPercent}$) and it is a monitored bus pair
 - Bus pair ranking is the sum of ($\text{Abs}(\text{AngleDiff}) - \text{Limit} * \text{ScreenBusPairPercent}$) for all bus pairs meeting the ranking criteria
- Bus Voltage
 - $\text{ScreenLowLim} = \text{LowLimit} + \text{ScreenTolLowVolt}$
 - $\text{ScreenHighLim} = \text{HighLimit} - \text{ScreenTolHighVolt}$
 - If ($\text{Volt} > \text{ScreenHighLim}$) then $\text{Rank} = \text{Volt} - \text{ScreenHighLim}$
Else if ($\text{Volt} < \text{ScreenLowLim}$) then $\text{Rank} = \text{ScreenLowLim} - \text{Volt}$
Rank is calculated for all buses that are monitored
 - Bus ranking is the sum of Rank for all buses meeting the ranking criteria
 - Voltage change can also contribute to the ranking if the options *Always report as a violation if the ...* are in use

Voltage Screening



- *Include Voltage* option must be checked for voltage screening to occur
 - This is a time consuming process that is not done linearly
 - Linear contingency process determines which actions should be implemented
 - Actions are actually implemented and 2 power flow iterations are done

Screening Results



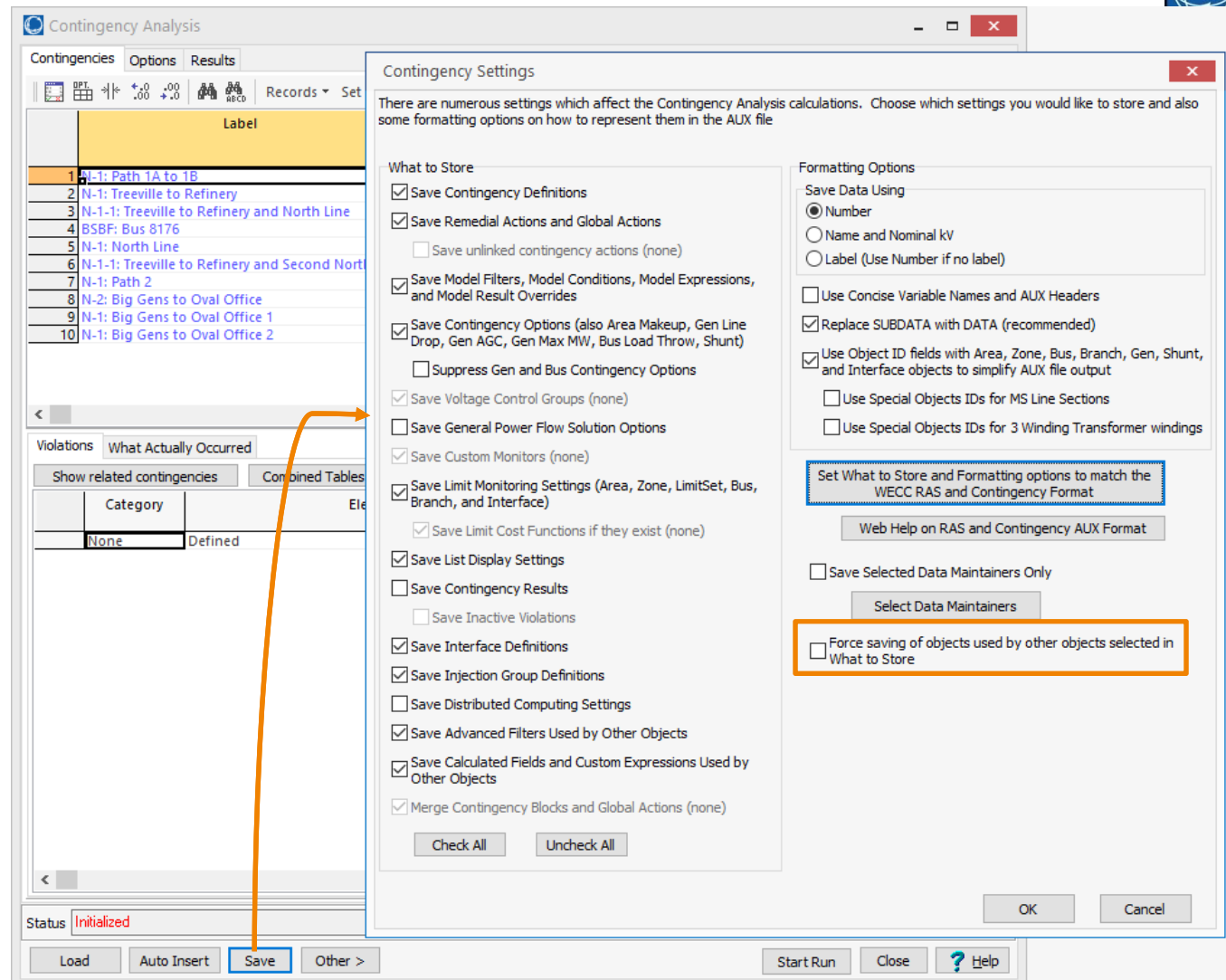
Ranking by each of the different screening categories

Contingencies Options Results													
Records Set Columns Options													
	Label	Skip	Category	Processed	Solved	Include Remedial Actions	Calculation Method	Screen Allow	Screen Rank Branch	Screen Rank Bus	Screen Rank BusPair	Screen Rank Interface	Pc AL
1	APSOU001	NO		YES	YES	NO	IteratedScreenDC	YES	6.8	0.3	0.0	0.00	nc
2	APSOU002	NO		YES	YES	NO	IteratedScreenDC	YES	21.0	0.3	0.0	0.00	nc
3	APSOU004	NO		YES	YES	NO	IteratedScreenDC	YES	98.1	0.2	0.0	0.00	nc
4	APSOU005	NO		YES	YES	NO	AC	YES	488.6	1.3	0.0	0.00	nc
5	APSOU006	NO		YES	YES	NO	IteratedScreenDC	YES	6.8	0.3	0.0	0.00	nc
6	APSOU007	NO		YES	YES	NO	AC	YES	489.7	1.3	0.0	0.00	nc
7	APSOU008	NO		YES	YES	NO	IteratedScreenDC	YES	89.4	0.2	0.0	0.00	nc
8	APSOU009	NO		YES	YES	NO	IteratedScreenDC	YES	9.4	0.3	0.0	0.00	nc
9	APSOU010	NO		YES	YES	NO	IteratedScreenDC	YES	6.8	0.3	0.0	0.00	nc
10	APSOU011	NO		YES	YES	NO	IteratedScreenDC	YES	22.6	0.3	0.0	0.00	nc
11	APSOU012	NO		YES	YES	NO	IteratedScreenDC	YES	7.0	0.3	0.0	0.00	nc
12	APSOU013	NO		YES	YES	NO	IteratedScreenDC	YES	6.8	0.3	0.0	0.00	nc
13	APSOU014	NO		YES	YES	NO	IteratedScreenDC	YES	16.4	0.3	0.0	0.00	nc

Only contingencies with the top x specified ranking in each screening category will have the full AC method run.
Calculation Method specifies how the violation results are calculated.

Saving Contingencies and Options Dependencies

- New option on contingency dialog for saving options that makes it much easier to save all of the objects required to define remedial action schemes and other conditional actions



Saving Contingencies and Options Dependencies



- *Force saving of objects used by other objects selected in What to Store*
- The top of the hierarchy is specified by *What to Store* objects
- Other objects that are required, i.e. dependencies, to define objects higher up the hierarchy will also be saved
- When also saving by selected data maintainers, the data maintainer condition will only be enforced for the objects specified in *What to Store* and dependencies will not have this enforced

Saving Contingencies and Options Dependencies



- Remedial Action case information display local menu options
 - *Save As Auxiliary File (all related info)...*
 - *Save As Auxiliary File (all related/only selected records)...*
 - Allows filtering on remedial actions other than data maintainer to select which ones should be saved
 - Format options are the same as those required by the WECC RAS format

Contingency Analysis

Auto Insert Options



- Combinations of buses can be used in creating automatically inserted contingencies
- Contingencies can be created based on
 - Bus Groupings
 - Line Shunts

Bus Groupings and Implicit Breakers



- *Implicit Breaker* field added to buses
 - User specified field to indicate where breakers exist when using a case without all actual breakers defined
 - If set to YES implies that there is a breaker between the bus and every object connected to the bus
- Auto inserting contingencies by Bus Groupings
 - Software will automatically detect groups of buses contained inside implicit and explicit breakers
 - Contingencies will be made from the boundary branches (either explicit breakers or lines) that connect one bus group to another bus group
- Working on a dialog *Breaker Isolated Groups* to show the bus groupings that exist throughout the case

Contingency Analysis

New Actions and Action Changes



- New actions
 - Injection Group BEST FIT OPEN
 - Interface MERIT ORDER OPEN
 - Interface BEST FIT OPEN
 - Interface MW EFFECT OPEN
 - Phase Shifter ANGLE SET TO and CHANGE BY
 - Substation MW/PERCENT SET TO and CHANGY BY
 - VSCDCLine OPEN, CLOSE, SETTP, CHANGE BY

Change to OpenCBs or CloseCBs Contingency Actions



- Previously when using an “Open Breakers” or “Close Breakers” actions on a device, if breakers could not be automatically found in the case to achieve isolation (or connection), Simulator would do nothing
- Changed so it will now revert to close/open of the actual device itself instead
- This allows the same contingency list to be used on both a full-topology and bus/branch model
 - Be careful though, because you might get different results as before for more complex substation topologies

Remedial Actions

Arming Criteria



- Arming criteria can optionally be specified to determine if an entire Remedial Action should be ignored during the contingency
- Arming criteria is either a Model Filter or Model Condition that is evaluated during the contingency reference state
- New fields added to specify and indicate the arming
 - *Arming Criteria*
 - Specifies the Model Filter or Model Condition for the arming
 - *Arming Status*
 - CHECK means to evaluate the Arming Criteria or armed if no Arming Criteria specified
 - ALWAYS means always armed regardless of the Arming Criteria
 - NEVER means never armed regardless of the Arming Criteria
 - *Armed*
 - Read only field indicating if the remedial action is armed based on the Arming Criteria and Arming Status

Remedial Action Elements

Arming Criteria



- Arming criteria can optionally be specified to determine if a single Remedial Action Element should be ignored during the contingency
 - For a Remedial Action Element to be armed, it must be armed based on its own criteria as well as that of its Remedial Action
- Arming criteria is either a Model Filter or Model Condition that is evaluated during the contingency reference state
- New fields added to specify and indicate the arming
 - *Arming Criteria*
 - Specifies the Model Filter or Model Condition for the arming
 - *Arming Status*
 - CHECK means to evaluate the Arming Criteria or armed if no Arming Criteria specified (element might still not be armed if the Remedial Action is not armed)
 - ALWAYS means always armed regardless of the Arming Criteria (element might still not be armed if the Remedial Action is not armed)
 - NEVER means never armed regardless of the Arming Criteria
 - *Armed*
 - Read only field indicating if the remedial action element is armed based on its own Arming Criteria and Arming Status AND the Arming Criteria and Arming Status of its Remedial Action

Disable if True in Contingency Reference State



- Model Conditions already had this option
- Model Filters now have this option
 - Will be disabled if it evaluates to true and its *Disable if True in CTG Ref State* option is set to YES
 - Will also be disabled if all of the Model Conditions or Model Filters that are part of the Model Filter are disabled because they are all true in the reference state and are also using the *Disable if True in CTG Ref State* option

Model Result Override



- New object that will override the result of a Model Condition, Model Filter, or Model Expression
 - All logic will be ignored and the value specified with the override will be the result of the filter, condition, or expression
 - Each Model Result Override can specify a numeric result and a boolean result, with the appropriate one being used based on the object type to which the override is assigned
 - Useful with EMS cases and measurements for RAS arming
- Model Conditions, Model Filters, and Model Expressions have an *Overridden* field that indicates if there is an enabled Model Result Override acting on it

Model Result Override



Model Condition, Model Filter, or Model Expression

Result Boolean used with Model Conditions and Model Filters

The screenshot shows the 'Contingency Analysis' window with the 'Results' tab selected. On the left is a tree view with 'Model Result Override' highlighted. The main area displays a table with the following data:

	Name	Model Object	Result Value	Result Boolean	Enabled
1	Path 1 > 800 A Override	ModelCondition 'Path 1 > 800 A'		YES	YES
2	Mine Override	ModelExpression 'Mine'	12.00	YES	YES

Result Value used with Model Expressions

Set *Enabled* = YES to override the *Model Object*. If not enabled, the logic specified with the *Model Object* will be used to determine its result.

Overridden Model Condition



Define Model Conditions

Model Condition Name: Path 1 > 800 A

Buttons: Save, Save As, Rename, Delete

☐ Evaluate in Contingency Reference State

☐ Disable if True in Contingency Reference State

Element Type: Branch

Model Condition is overridden by a Model Result Override

49990 entries

Sort by: ☐ Name ☒ Number

Filter: Advanced Branch

☐ Use Area/Zone Filters Quick Define Remove

☒ Search Next Search All

You can use wildcard characters * or ?

1

8194 (Treeville) FROM 8195 (Treeville GT1) CKT 1 [115.0 kV]- [13.80 kV]
8194 (Treeville) FROM 8196 (Treeville GT2) CKT 1 [115.0 kV]- [13.80 kV]
8194 (Treeville) FROM 8197 (Treeville ST) CKT 1 [115.0 kV]- [13.80 kV]
8194 (Treeville) FROM 8220 (8220) CKT 1 [115.0 kV]- [115.0 kV]
8194 (Treeville) FROM 8222 (TapPath1) CKT 1 [115.0 kV]- [115.0 kV]
8194 (Treeville) FROM 10440 (Refinery) CKT 1 [115.0 kV]- [115.0 kV]
8195 (Treeville GT1) TO 8194 (Treeville) CKT 1 [13.80 kV]- [115.0 kV]
8196 (Treeville GT2) TO 8194 (Treeville) CKT 1 [13.80 kV]- [115.0 kV]
8197 (Treeville ST) TO 8194 (Treeville) CKT 1 [13.80 kV]- [115.0 kV]
8198 (8198) TO 8199 (8199) CKT 1 [115.0 kV]- [13.80 kV]
8198 (8198) TO 8200 (8200) CKT 1 [115.0 kV]- [13.80 kV]
8198 (8198) FROM 8178 (8178) CKT 1 [115.0 kV]- [115.0 kV]
8199 (8199) FROM 8198 (8198) CKT 1 [13.80 kV]- [115.0 kV]
8200 (8200) FROM 8198 (8198) CKT 1 [13.80 kV]- [115.0 kV]
8201 (Path1D) TO 8215 (Path1C) CKT 1 [115.0 kV]- [115.0 kV]
8201 (Path1D) TO 8223 (Path1E) CKT 1 [115.0 kV]- [115.0 kV]
8202 (8202) FROM 8179 (8179) CKT 1 [115.0 kV]- [115.0 kV]
8202 (8202) FROM 8203 (8203) CKT 1 [115.0 kV]- [115.0 kV]
8203 (8203) TO 8202 (8202) CKT 1 [115.0 kV]- [115.0 kV]
8203 (8203) FROM 8205 (8205) CKT 1 [115.0 kV]- [115.0 kV]
8204 (8204) TO 8205 (8205) CKT 1 [115.0 kV]- [115.0 kV]
8205 (8205) TO 8203 (8203) CKT 1 [115.0 kV]- [115.0 kV]

Meets the filter below Set Filter Same As

Select Filter Type: Branch

☒ Enabled (normally checked)

Logical Comparison: ☐ AND ☐ OR ☐ Not AND ☐ Not OR ☐ XOR ☐ One TRUE

Condition 1

Find... Amps(Amps (maximum)) greater than 800 ☐ ABS

☐ Use Another Filter ☐ Evaluate Field in Contingency Ref. State

Add >> Delete ...

☐ Enable Field to Field and Meta Comparisons

OK Help Cancel

Bright yellow on dialogs and comment indicate that a Model Condition, Model Filter, or Model Expression is being overridden by an enabled Model Result Override

Overridden Model Condition



- Empty Model Conditions can be created to give access to a Model Result Override boolean result
- Empty Model Expressions can be created to give access to a Model Result Override numeric result

A screenshot of the 'Define Model Conditions' dialog box. The title bar shows a circular arrow icon and the text 'Define Model Conditions'. The dialog has a light gray background. At the top, there is a text field for 'Model Condition Name' containing 'Path 1 > 800 A' and a dropdown arrow. Below this are four buttons: 'Save', 'Save As', 'Rename', and 'Delete'. There are two checkboxes: 'Evaluate in Contingency Reference State' and 'Disable if True in Contingency Reference State', both of which are unchecked. A yellow highlighted section at the bottom contains the text 'Element Type' followed by a dropdown menu showing 'None (useful with Model Result Override o' and a message 'Model Condition is overridden by a Model Result Override'. At the very bottom are three buttons: 'OK', 'Help', and 'Cancel'.

What Actually Occurred



- Actions using Open with Breakers will now report how much MW or MVA was opened on the element being isolated by breakers instead of just showing the flow on the breakers

Custom Monitors



Custom Monitor

Custom Monitor Name:

☒ Enabled

Categories:

Choose Object

☒ All objects of Element Type

☐ Specific object

Element Type:

11 entries

Sort by: ☐ Name ☒ Number

Filter:

☐ Use PreFilters

You can use wildcard characters * or ?

1 (One) TO 2 (Two) CKT 1

1 (One) TO 3 (Three) CKT 1

2 (Two) TO 3 (Three) CKT 1

2 (Two) TO 4 (Four) CKT 1

2 (Two) TO 5 (Five) CKT 1

2 (Two) TO 6 (Six) CKT 1

Choose a Field:

Choose a Pre Filter:

Choose a Post Filter:

☐ Report violations if the increase in field value >

☐ Report violations if the decrease in field value >

Meaning of Change Values

☒ Change from Initial Value

☐ % Change from Initial Value

Start Tripping Filter:

Use a Time Delay of seconds

Action to Take

☐ Log Violation Only

☒ Trip (Open) Device

☐ Abort Simulation

- New options for tripping a device or aborting the entire simulation
- Existing functionality for Custom Monitors is the same if using *Log Violation Only*
- *Pre Filter* must be met for *Trip* or *Abort* action to be implemented
- *Start Tripping Filter*
 - Filter that is checked until at least one device has tripped for this Custom Monitor
 - Once a tripping action occurs, *Post Filter* is used for all subsequent checks
- *Time Delay* is used in comparison to the time delays for other contingency actions and Custom Monitors to determine if a device should trip

Processing Order of Contingency



1. Apply ALWAYS actions, true CHECK actions, and unconditional actions (actions with no Model Criteria except for SOLUTIONFAIL actions)
2. Update topology (branch, bus status)
3. Apply true TOPOLOGYCHECK actions
4. Store reference state for use if solution failure occurs and SOLUTIONFAIL actions exist
5. Solve power flow
 - a) If the power flow solution fails and SOLUTIONFAIL actions are available, the reference state in step 4 is restored and any true SOLUTIONFAIL actions with the smallest Time Delay are then applied
 - b) If any SOLUTIONFAIL actions are applied, the process will go back to step 4 and repeat (This loop will abort after 100 solution failures)
6. Apply true POSTCHECK actions and true TOPOLOGYCHECK actions
 - a) TRANSIENT actions will also be evaluated
 - b) **CUSTOMMONITORs with Trip action will be evaluated**
 - c) TRANSIENT, **CUSTOMMONITOR**, POSTCHECK, or TOPOLOGYCHECK actions with smallest Time Delay will be applied
7. If any POSTCHECK, TOPOLOGYCHECK, or TRANSIENT actions are implemented then repeat steps 2-6 (This loop will abort after 100 iterations)

Violation CTG Note



- Contingency violations are not persistent objects
 - Once you rerun contingency analysis they are destroyed even if you end up with the same violations
- Any comments that would be associated directly with a violation would be lost
- Object that can persist is needed to store notes for violations

Violation CTG Notes



- Create from the Results tab of the Contingency Analysis dialog

Contingency Analysis

Contingencies Options Results

View Results By Element

- Lines/Transformers
- Buses
- Interfaces
- Bus Pairs
- Nomogram Interfaces
- Custom Monitors

View Results by Contingency

- Contingency Violation List
- Violation CTG Notes

Violation CTG Notes

Records Set Columns Options

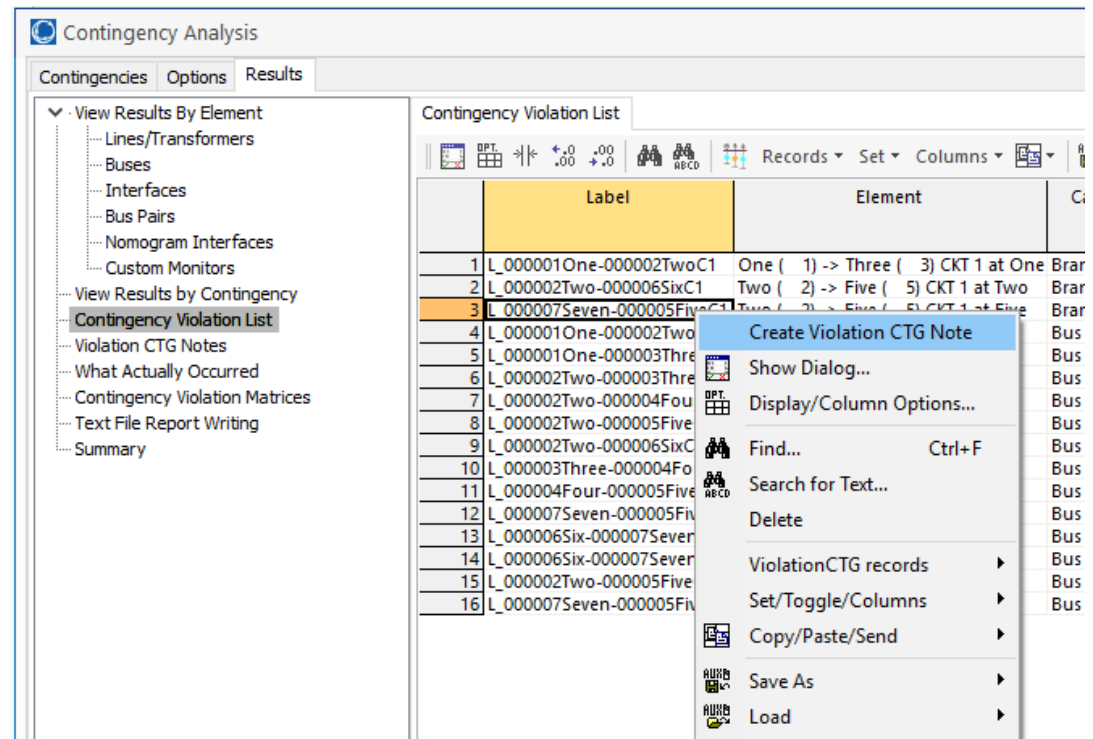
	Contingency	Object Type	Object	Category	Filter Substation	Filter Nom. kV Min	Filter Nom. kV Max	Filter	Note	New Note	Modified	Valid Contingency	Valid Substation
1	L_000001One-000002TwoC1	Branch							this is a bus violation note.		YES	YES	YES
2		Bus		Bus Low Volts					This is a branch violation note		YES	YES	YES

Violation CTG Note



- Can also be created from Contingency Violation List table with local menu option *Create Violation CTG Note*

– This is more convenient because it fills in parameters based on the current violation



Violation CTG Note



Fields can be added to violation tables to show the notes

Indicates if the violation has any notes, and if it does how many

Indicates if a note associated with the violation has been modified

Contingency Analysis

Contingencies Options Results

View Results By Element

- Lines/Transformers
- Buses
- Interfaces
- Bus Pairs
- Nomogram Interfaces
- Custom Monitors

View Results by Contingency

- Contingency Violation List
- Violation CTG Notes
- What Actually Occurred
- Contingency Violation Matrices

Contingency Violation List

Records Set Columns Options

	Label	Element	Category	Has Viol CTG Note	Mod Viol CTG Note	Viol CTG Note	Viol CTG Note New	Vi
1	L_000001One-000002TwoC1	One (1) -> Three (3) CKT 1 at One	Branch Amp	YES (2)	YES	(1)This is a bus violation note. (2)This is a bus violation note.	(1) (2)	40
2	L_000002Two-000006SixC1	Two (2) -> Five (5) CKT 1 at Two	Branch Amp	NO	NO			43
3	L_000007Seven-000005FiveC1	Two (2) -> Five (5) CKT 1 at Five	Branch Amp	NO	NO			47
4	L_000001One-000002TwoC1	Three (3)	Bus Low Volts	YES	YES	This is a branch violation note.		0.!
5	L_000001One-000003ThreeC1	Three (3)	Bus Low Volts	YES	YES	This is a branch violation note.		0.!
6	L_000002Two-000003ThreeC1	Three (3)	Bus Low Volts	YES	YES	This is a branch violation note.		0.!
7	L_000002Two-000004FourC1	Three (3)	Bus Low Volts	YES	YES	This is a branch violation note.		0.!

Actual *Note* associated with this violation. If more than one is applicable all will be displayed.

Actual *New Note* associated with this violation. If more than one is applicable all will be displayed.

Violation CTG Note



At a minimum, *ObjectType* must be specified. The *Element* of the violation must be this object type for the note to be applicable.

For a note to be applicable to a particular violation, the violation must match all of the identifying information within the Violation CTG Note. If the identifying information is left blank, a note is applicable to all violations of the specified *ObjectType*.

Category is the type of violation

The screenshot shows the 'Contingency Violation Note Dialog' window. It contains several input fields and buttons. Annotations with arrows point to specific fields:

- An arrow points from the text 'At a minimum, *ObjectType* must be specified...' to the **ObjectType** field, which contains the value 'Branch'.
- An arrow points from the text 'For a note to be applicable to a particular violation...' to the **Object** field, which is currently blank.
- An arrow points from the text 'Category is the type of violation' to the **Category** field, which is also blank.
- An arrow points from the text 'Object specifies particular object...' to the **Object** field.
- An arrow points from the text 'Filter is an advanced filter...' to the **Filter** field.

The dialog also includes fields for **Contingency**, **Filter Substation**, **Filter Min kV**, **Filter Max kV**, and a **Filter** field. Each of these fields has a corresponding 'Find' button. At the bottom, there are 'OK' and 'Cancel' buttons. A 'New Note' button is located near the 'Category' field.

Violation CTG Note



- New Note
 - This can act as an extra note or it can be used to update the Note field by using the Append, Prepend, and Replace buttons on the Contingency Violation Note Dialog
- *Modified* field
 - This is a user enterable field
 - Simulator will change this to YES any time that the Note has been modified

Contingency Result Storage



- Allows storing results to file instead of computer memory
- Only allows storing while contingency analysis is running
 - Cannot save to file in this format once the run has completed
 - Can access most any object that you would want to monitor during contingency analysis to get the value of fields following the contingency
 - All of this information is not stored in memory to be accessed later. That's why you are using this option in the first place!

Contingency Result Storage



When saving to hard drive there will be NO results in memory

File location and prefix of the file name. *Object Type* will be appended to this.

Contingency Analysis

Contingencies Options Results

Modeling

- Basics
- DC and Screening Options
- Generator Post-Contingency AGC
- Bus Load Throw Over
- Generator Maximum MW Response
- Generator Line Drop and RCC
- Switched Shunt Post CTG
- Auxiliary Files
- Transient Models
- Result Storage**
- Limit Monitoring
 - Advanced Limit Monitoring
 - Island Monitoring
 - Monitoring Exceptions
 - Custom Monitors
- Contingency Definitions
- Remedial Action Definitions
- Legacy Definitions
- Distributed Computing
- Miscellaneous

Result Storage

☒ Write to Hard Drive ☐ Fields Normal Name (Unchecked is Field Variable Name)

Add Defaults

File Name: D:\TestCode\ctgtestoutput.aux Browse

	Object Type	Restrict	Field Name	Order
1	Gen		MW	0
2	ViolationCTG	Gen	LV_Value	0
3	Branch		BusNumFrom	1
4	Bus		Number	1
5	Branch		BusNameFrom	2
6	Bus		Name	2
7	Branch		NomkVFrom	3
8	Bus		NomkV	3
9	Branch		BusNumTo	4
10	ViolationCTG	Bus	LV_ValueRef	4
11	Branch		BusNameTo	5
12	ViolationCTG	Bus	LV_Value	5
13	Branch		NomkVTo	6
14	ViolationCTG	Bus	LV_ValueRefChange	6
15	Branch		Circuit	7
16	ViolationCTG	Bus	LV_PercentRefChange	7
17	Branch		MWMax	8
18	Bus		LimitLowUsedCTG	8
19	Branch		MvarMax	9
20	Bus		LimitHighUsedCTG	9
21	Branch		MVAMax	10
22	Branch		AmpsMax	11
23	Branch		LimitAmpA	12
24	Branch		LimitAmpB	13
25	Branch		LimitMVAA	14
26	Branch		LimitMVAB	15
27	ViolationCTG		CTG_Name	18

Separate output file will be created for each different *Object Type*

Order in which the field will appear in the file with the lowest appearing first

Restrict specifies the only object type for which this field will be saved

Contingency Result Storage



- Results will only be stored for objects that are considered violations
 - Typical violations include line overloads and bus voltage violations
 - To store a result for something that is not a “typical” violation it must be monitored it using Custom Monitors
- ViolationCTG
 - Violations when stored in computer memory are kept in this object
 - All results will be written in an aux file format so that they can be loaded back into Simulator if necessary
 - Fields not relevant for this ViolationCTG will be prepended with the object type
 - Fields specified for this *Object Type* will be saved to all files unless *Restrict* limits where they are saved

Contingency Result Storage



Example for the Branch and Bus file

```
ViolationCTG(|Branch|BusNumFrom, |Branch|BusNameFrom, |Branch|NomkVFrom, |Branch|BusNumTo, |Branch|BusNameTo, |Branch|NomkVTo, |Branch|Circuit,
|Branch|MwMax, |Branch|MvarMax, |Branch|MVAMax, |Branch|AmpsMax, |Branch|LimitAmpA, |Branch|LimitAmpB, |Branch|LimitMVAA,
|Branch|LimitMVAB, CTG_Name)
{
  " 1" "One" "138.000000" " 3" "Three" "138.000000" " 1" "101.867912" "16.200129" "101.875053" "405.852468" "271.940304"
  "334.695776" "64.999998" "80.000001" "L_000001One-000002TwoC1"
  " 2" "Two" "138.000000" " 5" "Five" "138.000000" " 1" "108.006256" "10.669624" "108.009720" "434.499261" "418.369714"
  "418.369714" "100.000000" "100.000000" "L_000002Two-000006SixC1"
  " 2" "Two" "138.000000" " 5" "Five" "138.000000" " 1" "109.542859" "41.207544" "117.037172" "474.708496" "418.369714"
  "418.369714" "100.000000" "100.000000" "L_000007Seven-000005FiveC1"
}
```

Branch fields are prepended
with |Branch|

ViolationCTG fields are simply
the variablename with no
modification

Bus fields are prepended with
|Bus|

ViolationCTG fields that have *Restrict* = Bus
only appear in the bus file

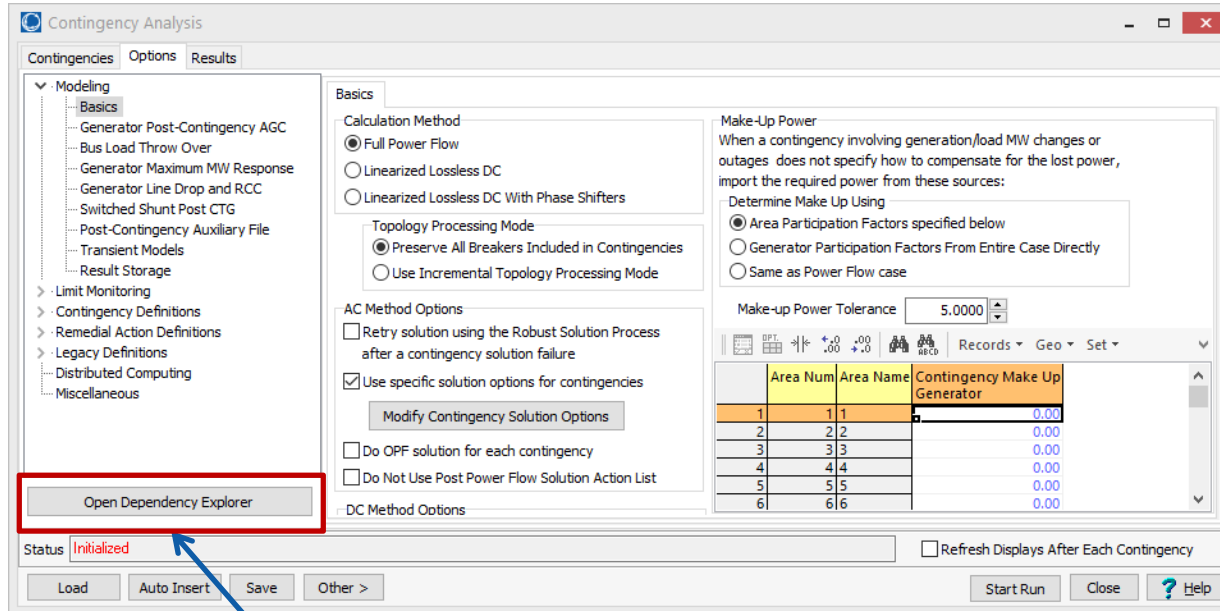
```
ViolationCTG(|Bus|Number, |Bus|Name, |Bus|NomkV, LV_ValueRef, LV_Value, LV_ValueRefChange, LV_PercentRefChange, |Bus|LimitLowUsedCTG,
|Bus|LimitHighUsedCTG, CTG_Name)
{
  " 3" "Three" "138.000000" "0.992688" "0.990533" "-0.002154" "0.215435" "1.000000" "1.100000" "L_000001One-000002TwoC1"
  " 3" "Three" "138.000000" "0.992688" "0.985778" "-0.006910" "0.691009" "1.000000" "1.100000" "L_000001One-000003ThreeC1"
  " 3" "Three" "138.000000" "0.992688" "0.984803" "-0.007885" "0.788510" "1.000000" "1.100000" "L_000002Two-000003ThreeC1"
  " 3" "Three" "138.000000" "0.992688" "0.992241" "-0.0004469" "0.044692" "1.000000" "1.100000" "L_000002Two-000004FourC1"
  " 3" "Three" "138.000000" "0.992688" "0.992339" "-0.0003490" "0.034904" "1.000000" "1.100000" "L_000002Two-000005FiveC1"
  " 5" "Five" "138.000000" "1.006646" "0.991720" "-0.014926" "1.492649" "1.000000" "1.100000" "L_000002Two-000005FiveC1"
  " 3" "Three" "138.000000" "0.992688" "0.992588" "-0.0001001" "0.010014" "1.000000" "1.100000" "L_000002Two-000006SixC1"
}
```

Dependency Explorer



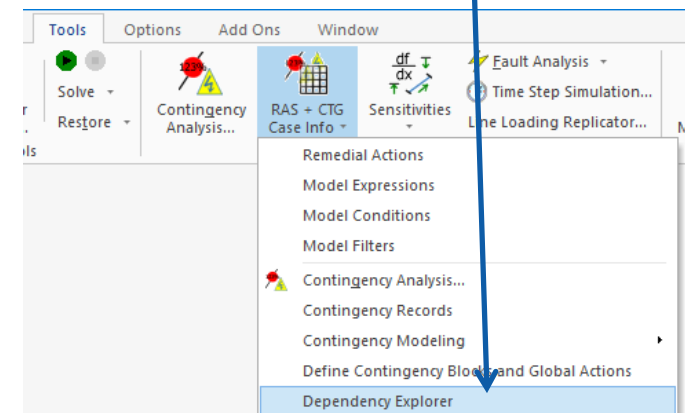
- Enhances the understanding of Remedial Action Schemes (RAS) used with contingency analysis
- Allows for the viewing and modification of all RAS associated objects
 - Remedial Actions, Remedial Action Elements, Model Filters, Model Conditions, etc.

Opening the Dependency Explorer



Select the Dependency Explorer option on the RAS + CTG Case Info dropdown on the Tools tab of Simulator ribbon interface

Click the Open Dependency Explorer button on the Options page of the Contingency Analysis dialog

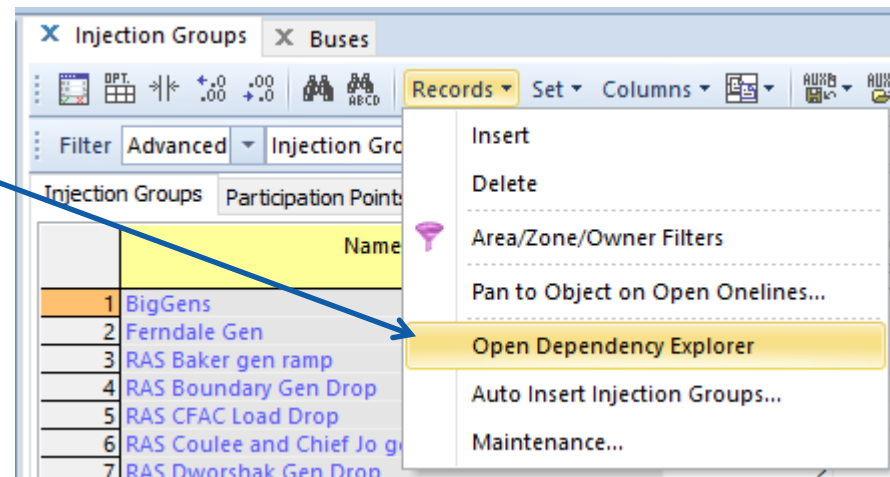


Opening the Dependency Explorer



- Option on local menu of objects that can have dependencies

Select the Open
Dependency Explorer
option on Records
dropdown of case
information toolbar (or use
right-click local menu)



Dependency Explorer



Currently selected object known as the *Top Object*

The screenshot shows the 'Dependency Explorer' application window. At the top, a search bar contains 'RemedialAction 'Treeville Generation Run-Back Scheme''. Below this, the interface is divided into four main panes:

- Used By pane:** Located on the left, it shows a tree structure under 'RemedialAction 'Treeville Generation Run-Back Scheme''. It includes buttons for 'Collapse', 'Expand', 'Navigate', and 'Dialog'.
- Contains pane:** Located in the middle-left, it shows a detailed tree structure of the selected object, including 'RemedialActionElement', 'ModelFilter', 'ModelFilterCondition', 'Bus', 'ModelExpression', and 'RemedialActionElement'. It also has 'Collapse', 'Expand', 'Navigate', 'Dialog', and 'Delete' buttons.
- Field Info pane:** Located in the middle-right, it displays the 'Model Filter Field Info' for the selected object. It includes fields for 'Name', 'Logic', 'DisableIfTrueInRef', 'Memo', 'DataMaintainerAssign', and 'Overridden'. It has a 'Dialog' button and a 'Headings' dropdown.
- Filter Visualization pane:** Located on the right, it shows a logic diagram for the selected filter. It includes a 'View Filter Logic' button, a 'Refresh' button, and a 'History List'. The diagram shows a red AND gate with four inputs: 'Path 1D to 1E > 95%', 'Path 1C to 1D > 95%', 'Path 1A to 1B > 95%', and 'Path 1B to 1C > 95%'. The output is 'Path 2 > 102%'.

Used By pane

Contains pane

Field Info pane

Filter Visualization pane

Transient Stability Contingencies



- Closing a generator through transient contingency action

Specify three parameters
with all defaulted to 0

Transient Stability Contingency Element Dialog

Description

Insert Save Delete

Object Type

☐ Branch/Transformer
☐ Bus
☒ Generator
☐ Load
☐ Switched Shunt
☐ DC Line
☐ Injection Group
☐ Line Shunt
☐ Simulation

Choose the Element

Sort by ☐ Name ☒ Number

Filter Advanced Generator

☒ Use Area/Zone Filters Quick Define Remove

4

1 (Bus 1) #1 [16.50 kV]
2 (Bus 2) #1 [18.00 kV]
3 (Bus 3) #1 [13.80 kV]

Time

Time (Seconds) 1.00000

Description

Type

☐ Open
☒ Close
☐ Ramp Values
☐ Set Values
☐ Change Values

Parameters

Action Field Exciter Setpoint

By Value

Angle Difference (Deg) 0.000
Voltage Setpoint, pu 0.000
Governor Setpoint, MW 0.000

Comment:

OK Help Cancel

Transient Contingency Generator Close Action



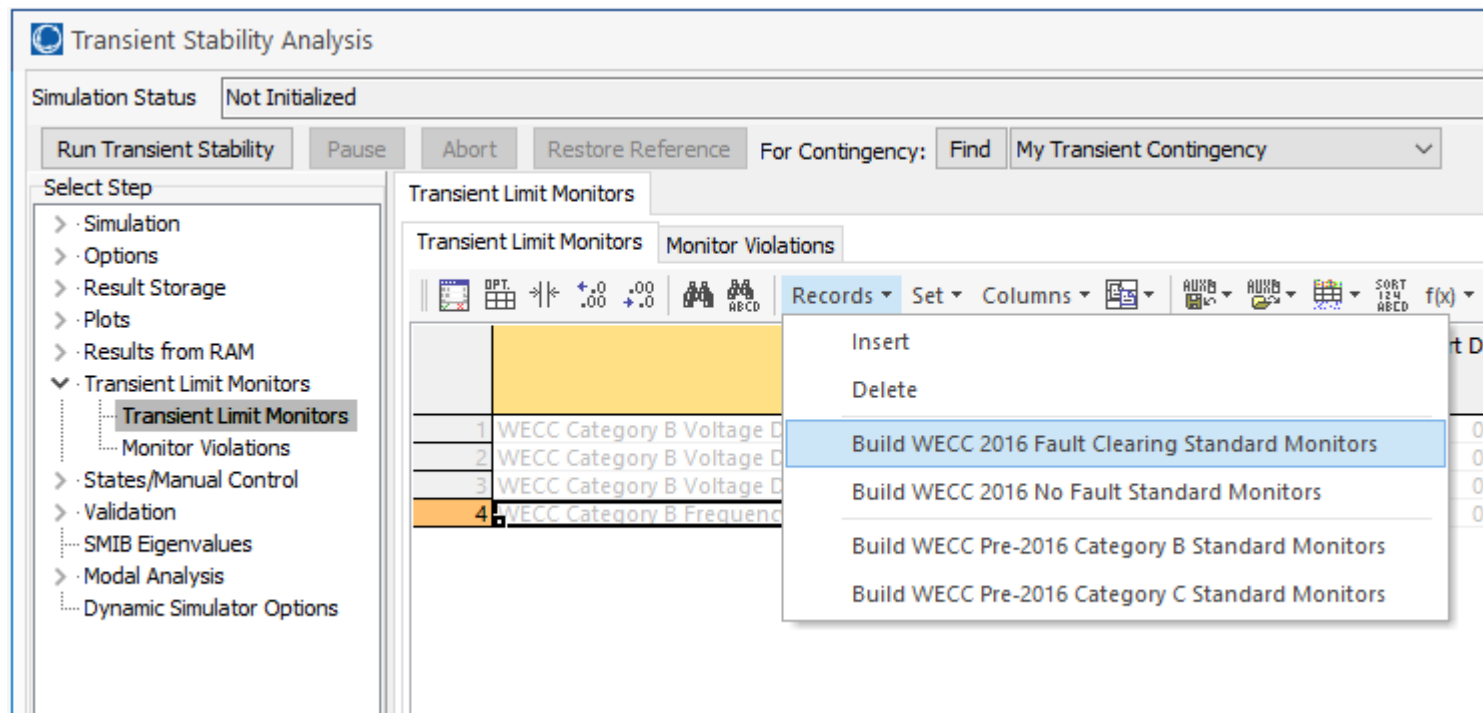
- Initialization of generator model states
 - $MW = 0.0$, $Mvar = 0.0$
 - Frequency is nominal (60 Hz normally)
 - Terminal voltage magnitude = generator bus voltage magnitude
 - Terminal voltage angle = (generator bus angle) – (*Angle Difference*)
- Exciter Vref initialization
 - If $\text{abs}(\text{Voltage Setpoint}) = 0$, Vref is unchanged
 - Else if $\text{abs}(\text{Voltage Setpoint}) < 0.5$ then $Vref = Vref + \text{Voltage Setpoint}$
 - Else $Vref = \text{Voltage Setpoint}$
- Governor Pref initialization
 - If $\text{abs}(\text{Governor Setpoint}) = 0$, Pref is unchanged
 - Else Pref is calculated such that the MW (P_{mech}) will be equal to *Governor Setpoint* when the system is operating at nominal frequency

Transient Stability

Transient Limit Monitor



- WECC voltage criteria monitoring is now available built-in to Simulator
- Selecting option from local menu for Transient Limit Monitors will create appropriate monitors
- WECC criteria states: “BES bus that is serving load is the bus with direct transformation from BES-level voltage to distribution-level voltage that serves load”
 - Transient Limit monitor filter for *Load Buses Only* monitors the bus that contains the load



New IEEE 421.5 - 2016 Transient Stability Models



- New Exciters (Following have been added)
 - AC1C, AC2C, AC3C,
AC4C, AC5C, AC6C,
AC7C, AC8C, AC9C,
AC10C, AC11C
 - DC1C, DC2C, DC4C
 - ST1C, ST2C, ST3C,
ST4C, ST5C, ST6C, ST7C

Transient Stability Models

New and Changed



- Over Excitation Limiter
 - OEL4C
- Under Excitation Limiter
 - UEL2_PTI
 - Combined Cycle Gas Plant Models (UCBGT, UCCPSS, UHRSG)
- Governor Models
 - H6e added
- Load Characteristics
 - CompLoad
 - Modified or added models to build up the pieces inside the CMPLDW model
 - MOTOR_CMP to represent the 3-phase induction motor used in CMPLDW
 - LD1PAC_CMP (same as LD1PAC but with many parameters hard-coded as done in CMPLDW)
 - LDELEC added pfel parameter to indicate the power factor
 - IEEL added pfs parameter to indicate the power factor
 - MOTORX (same as MOTORW but using circuit parameters as input)
 - CMLD – PSS/E version of CMPLDW

Transient Stability Models

New and Changed



- Line Relay
 - TICORSRF
 - DISTRelayRF
 - SCGAP
 - LSDT3A
- DC Line Model
 - CHVDC2
- Switched shunts being controlled by SVSMOx models can have their own switched shunt transient models, i.e. MSC1, MSR1, etc.
 - When the SVSMOx model is inservice the model at the controlled shunt is ignored
 - When the SVSMOx model is out of service the transient model at the controlled shunt is allowed to operate
- More Switched Shunt Models
 - mss1, mss2
 - ABBSVC1

Modular Load Model



- See separate presentation on CompLoad

Transient Stability

DYR Models



- USRMDL from DYR read into Simulator models
 - WTDTAU1/WTDTA1 (WTDAT1)
 - WTARAU1/WTARA1 (WTARA1)
 - WTTQAU1/WTTQA1 (WTTQA1)
 - WTPTAU1/WTPTA1 (WTPTA1)
 - REECAU1/REECA1 (REEC_A/REECA1)
 - REECBU1 (REEC_B/REECB1)
 - REGCAU1/REGCA1 (REGC_A)
 - REPCAU1/REPCA1 (REPCA1)
 - REPCTA1 (REPCTA1)
 - Combined Cycle Gas Plant Models (UCBGT, UCCPSS, UHRSG)

Load Distributed Generation Modeling



- Modeling distributed generation inside the load record existing since Version 19
- Continuing to improve ability to specify transient stability model data associated with this
 - In particular, specification of the “TSDistGenMVABase” with each load record was added
 - Allows you to assign a single DistGen model to the entire case, and then just have it scaled by this parameter associated with each load that has distributed generation

Transient Stability Options



- Changed the default time step from 0.5 cycle to 0.25 cycle
- Changed the default MVA convergence tolerance from 0.1 MVA to 0.01 MVA
- When Using PlayIn Models Set Initial Hz to First Value
 - Initialize models assuming that system is at the first frequency value in the PlayIn information rather than initializing at nominal frequency
- Network Equations Solution Options – Abort after number of failed solutions
 - Current injection models sometimes make it difficult to solve the network boundary equations during a fault. When this happens the current network solution is aborted (not the entire simulation) and we assume that we will solve on the next time step.
 - This option specifies the number of times that the network boundary equations are allowed to fail consecutively before the entire simulation is aborted

Transient Stability Options



- When to use Complex Load Models
 - Complex loads represent a composite of various load types. Examples include CLOD, CMLD, CMPLDW, MOTORW, and CompLoad
 - If load doesn't meet these criteria, load falls back to the hierarchy of load models
 - Minimum Load P (MW) - default is 0.5
 - Minimum Load P/Q Ratio – default is 0.25
 - Minimum Initial per unit voltage – default is 0.0
 - If these criteria are not met, the distribution equivalent will also not be used for load
- Distribution Equivalent Models Options – Min Nom kV for Transformer
 - Default is 0.0
 - Xxf parameter of a distribution equivalent represents the transformer impedance. If nominal kV of bus is below this threshold then Xxf will be treated as zero.
 - When loading a DYD file this value is determined based on the CMPLDW data
- Frequency Measurement Options- Calculate Bus ROCOF (Rate of Change of Freq)
 - ROCOF can be monitored for buses only if this option is checked
 - Takes extra time to calculate the derivative of the frequency (derivative of the derivative of the angle) and only do this if you really want the value

Transient New Fields



- Generator Tab how a new field
TSGovMWCap
 - Return MW Base for the active governor model of the generator
 - Will show blank if the active governor has no MWBase, or if there is no governor

Transient Stability Options



- Island Synchronization
 - Specify what happens when you close in a line that connects two energized islands
 - Angle Options
 - *Set to Degree Value*
 - Shift all angles in one island so that across the line you are going to close the angle difference is zero
 - *Set if > Degree Value specified*
 - Only do the shift if the difference across the line is greater than the specified value
 - *No Change*
 - Don't do anything
 - Frequency Options
 - *Set to Hz Value*
 - Makes changes so that the frequency is the same in both islands
 - Instantaneously changes the speed of all of the synchronous generators and reinitializes the bus frequency calculation
 - *Set if > Hz Value*
 - Only does change if the frequency difference across the line being closed is greater than the specified value
 - *No Change*
 - This option seems to make the most sense with reality

Transient Stability

Store to RAM Options



- Branch
 - Minimum Profile Vpu
 - Calculates the minimum voltage along the length of the series R and X of a branch
 - Can approach zero even when terminals are not zero – indication that the system is going out-of-step
- Bus
 - ROCOF (Hz)
 - Rate of change of frequency
 - Derivative of frequency needed for output signal for standard format C37.118 for measured streaming data
 - This will only be calculated if the option to calculate it is also set

Transient Stability

Store to RAM Options



- Area
 - Weight Avg Speed
 - Average generator speed for all synchronous generators weighted by MVA base
 - GIC Mvar Losses
- Zone
 - Weight Avg Speed
- Substation
 - GIC EField Magnitude
 - GIC EField Direction
- Case Information
 - GIC Total Mvar Losses
 - GIC Maximum Transformer Ieffective (Amps)

Transient Stability Plotting



- Added Font Size
 - Vertical Axis Labels
 - Horizontal Axis Labels
 - Legend Labels
- Added new feature to append the case name to the auto-generated image files of plots

Transient Stability Plotting



- Value Type when plotting can now be *Derivative*
 - Difference between the present point and the previous point is divided by the time difference

Generate Selected Plots Close Plots

Show/Save Selected Plot Data

Plots, Subplots, Axis Groups

- TS9 Bus Bus Fault FinalPlot
 - SubPlot 1
 - PlotVertAxisGroup 1
 - MW _ Gen Bus1 #1
 - MW _ Gen Bus 2 #1
 - MW _ Gen Bus 3 #1
 - PlotVertAxisGroup 2
 - Rotor Angle No Shift
 - Rotor Angle No Shift
 - Rotor Angle No Shift
 - SubPlot 2
 - Rotor Angle _ Gen Bus1
 - Rotor Angle _ Gen Bus :
 - Rotor Angle _ Gen Bus :
 - SubPlot 3
 - Speed Gen Bus1 #1

Note: The vertical axis contains the list of plot series below

Axis Group Number 1 Add Axis Group Delete Axis Group

Records Set Columns

	Object	Variable	Value Type	Style	Visible	Color	Thick
1	Gen '1' '1'	TSGenP	Actual	Line	YES	Blue	
2	Gen '2' '1'	TSGenP					
3	Gen '3' '1'	TSGenP					

Value Type dropdown menu:

- Actual
- Percent
- Actual Deviation
- Percent Deviation
- Derivative

Bus Driving Point Impedances



- Found under Tools → Connections → Driving Point Impedances
- Driving point impedance is the impedance looking from a bus out into the system
- Would typically use this dialog after loading in transient stability data
 - Use Ybus from transient stability, which includes the internal impedances of generators and loads (induction motors for example)
 - Without Bus Local Shunts
 - Subtract out local impedances at the bus, i.e. bus shunts, switched shunts, internal impedances of generators, internal impedances of induction motors, etc.
 - This is similar to what is done in the SMIB two bus equivalent calculations and is the most appropriate option to choose
 - Including Bus Local Shunts
 - No subtraction of local impedances
- Power Flow Use
 - Use power flow Ybus to calculate
 - Depends on the slack bus and does not include the internal impedance of generators

Merit Order Close Ramping



- Available with PV, ATC, Scale, and Time Step Simulation tools
- Generators within an injection group will be dispatched in merit order determined by their specific participation factors from highest to lowest
- Economic generator limits will be enforced during this process regardless of how options to enforce generator MW limits are set
 - *MW Economic Minimum* and *MW Economic Maximum*
 - *MW Economic Maximum* must be greater than zero in order for a generator to participate in the dispatch
- If increasing the injection and the next generator in merit order is not already online, the *Status* of the generator will be set to CLOSED with an initial Mvar output of 0
 - Breakers will be closed as necessary to connect a generator
- If decreasing the injection and generators are being backed down to their minimum limit, generators will remain online when they hit their minimum limit
- Generators will only be adjusted to pick up a change in generation
 - No change to base dispatch is done

PV Curve Tool

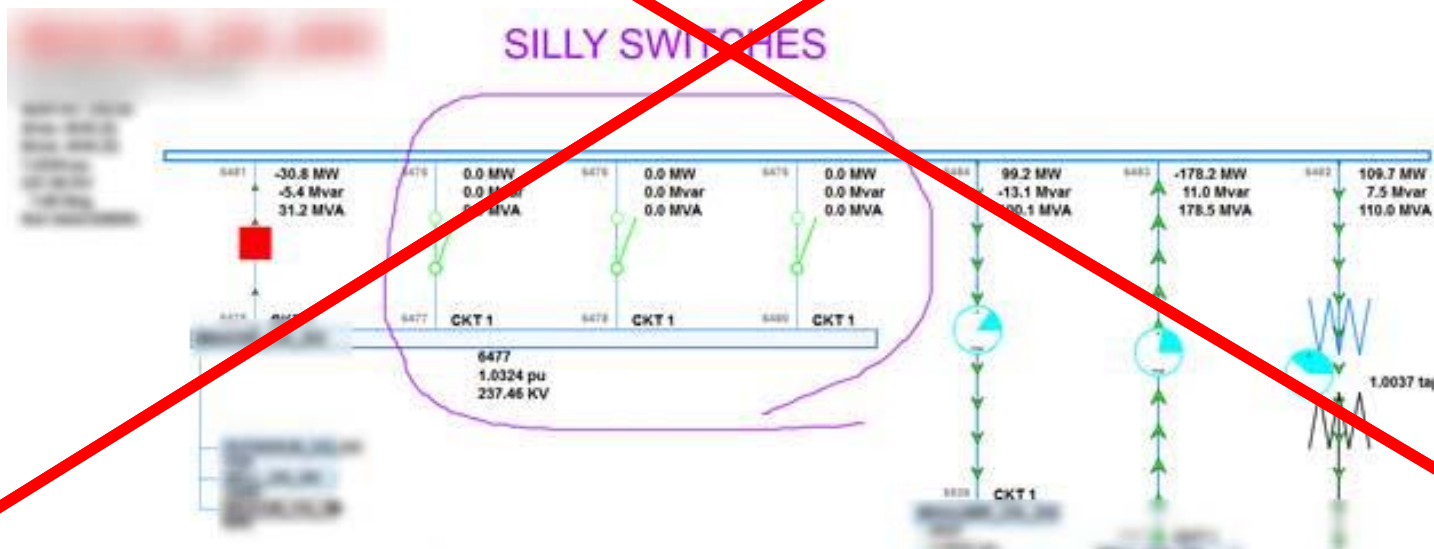


- Added Maximum Transfer as a critical reason with PV results.
 - Would have always stopped if the "Stop when transfer exceeds" transfer level is met.
 - Now its more clear in GUI this occurred
- Added Font Size to Axis Labels and Legend fonts
- Storing states when doing reverse transfer works now
- Added new load record "ScaleMvar"
 - Set to NO to prevent scaling of load Mvar in ATC, PVQV and System Scaling

Integrated Topology Processing



- Consolidation changes
 - If there is a CLOSED switching device in parallel (between exact same buses) to an OPEN switching device, the OPEN switching device is consolidated if the CLOSED one cannot be consolidated
 - This is a special situation because normally both switching devices would be consolidated
 - In this situation the CLOSED switching device is marked as Allow Consolidation = NO or is part of an interface or tie-line



These open breakers are NOT consolidated in version 20

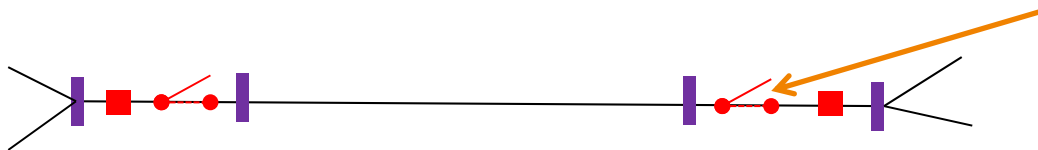
Full Topology Features



- *Open or Close with Breakers* local menu options on case information displays and oneline have additional options for what should be switched

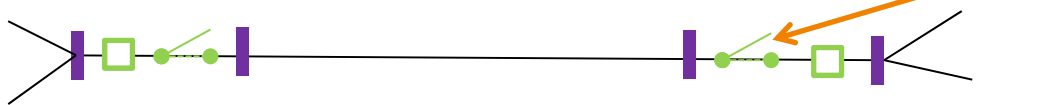
- *With Options*

- *Open Normally Open Disconnects*



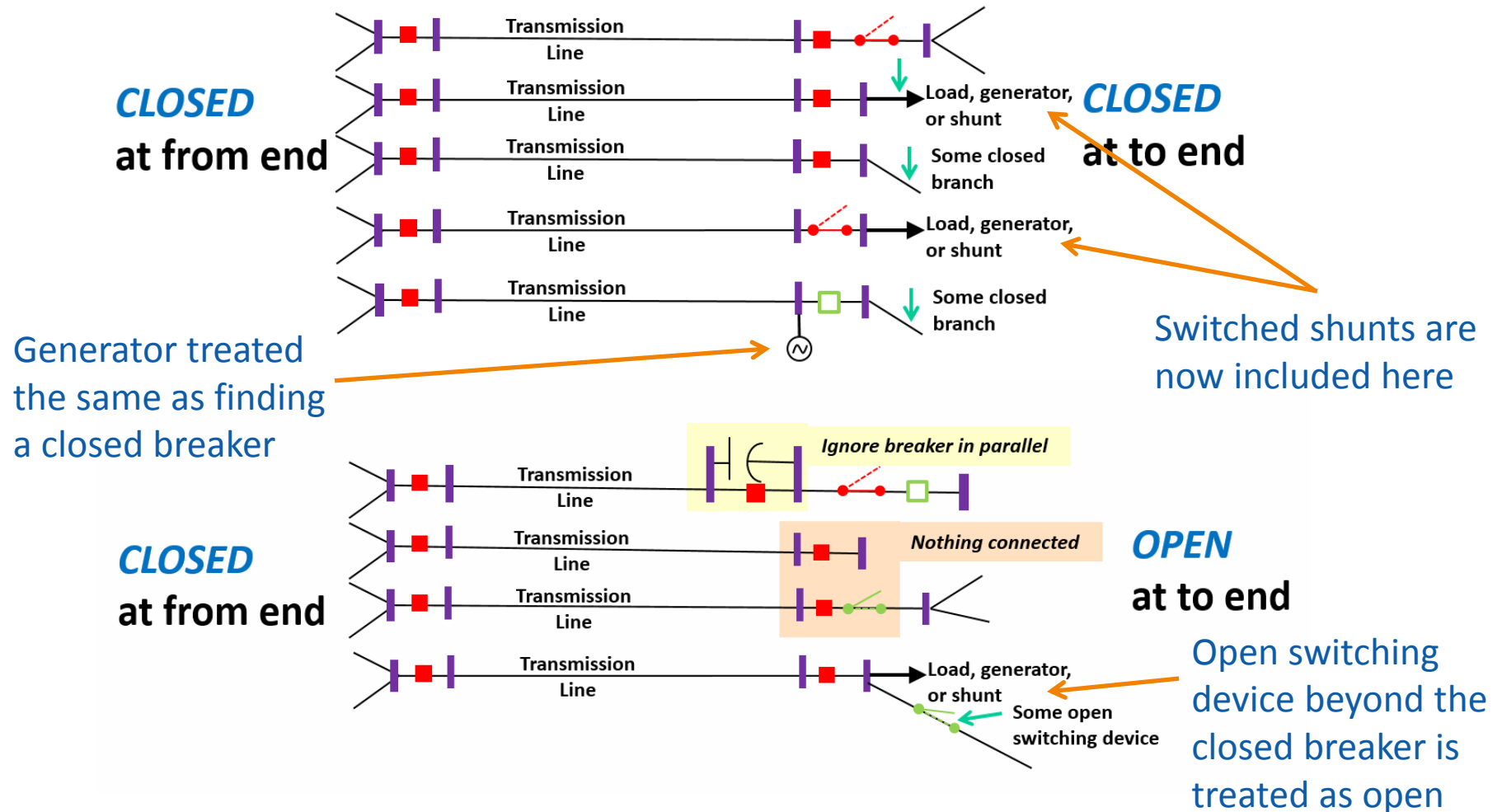
If normally open this will be opened and the search for breakers will terminate

- *Close Normally Closed Disconnects*



If normally closed this will be closed and the search for open breakers will continue

Derived Status



Full Topology Features

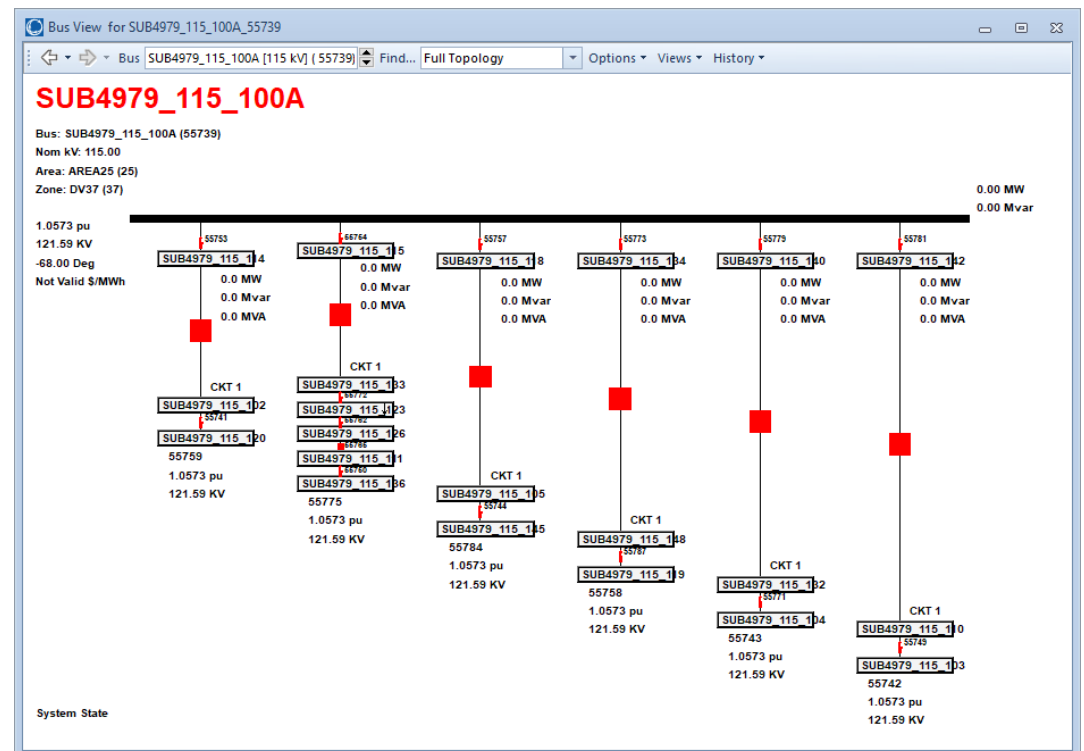


- Close with Breakers
 - Previously if a branch was connected we would never perform Close with Breakers
 - We will now also do this if a branch is either “OPEN FROM” or “OPEN TO”

Full Topology Bus View



- Full-Topology Bus View biases series devices to show the “more important one” prominently
 - Breakers preferred over Disconnects
 - Lines, Transformer preferred to Breakers



Online Features



- Areva Diagram Import
 - New translations have been added to properly render overview diagram objects
 - See separate presentation for more details
- Online Viewer
 - Performance has been greatly improved
 - Backward, forward, and history buttons have been added
 - Custom menus
 - Menu definitions from EMS system can be imported
 - CustomMenuNode object allows menus to be saved to and loaded from auxiliary files
- Online Browsing Path
 - Order in which paths are defined is the order in which they will be searched
 - Useful with loading Areva DDL files

Online BranchCloseAngleThreshold

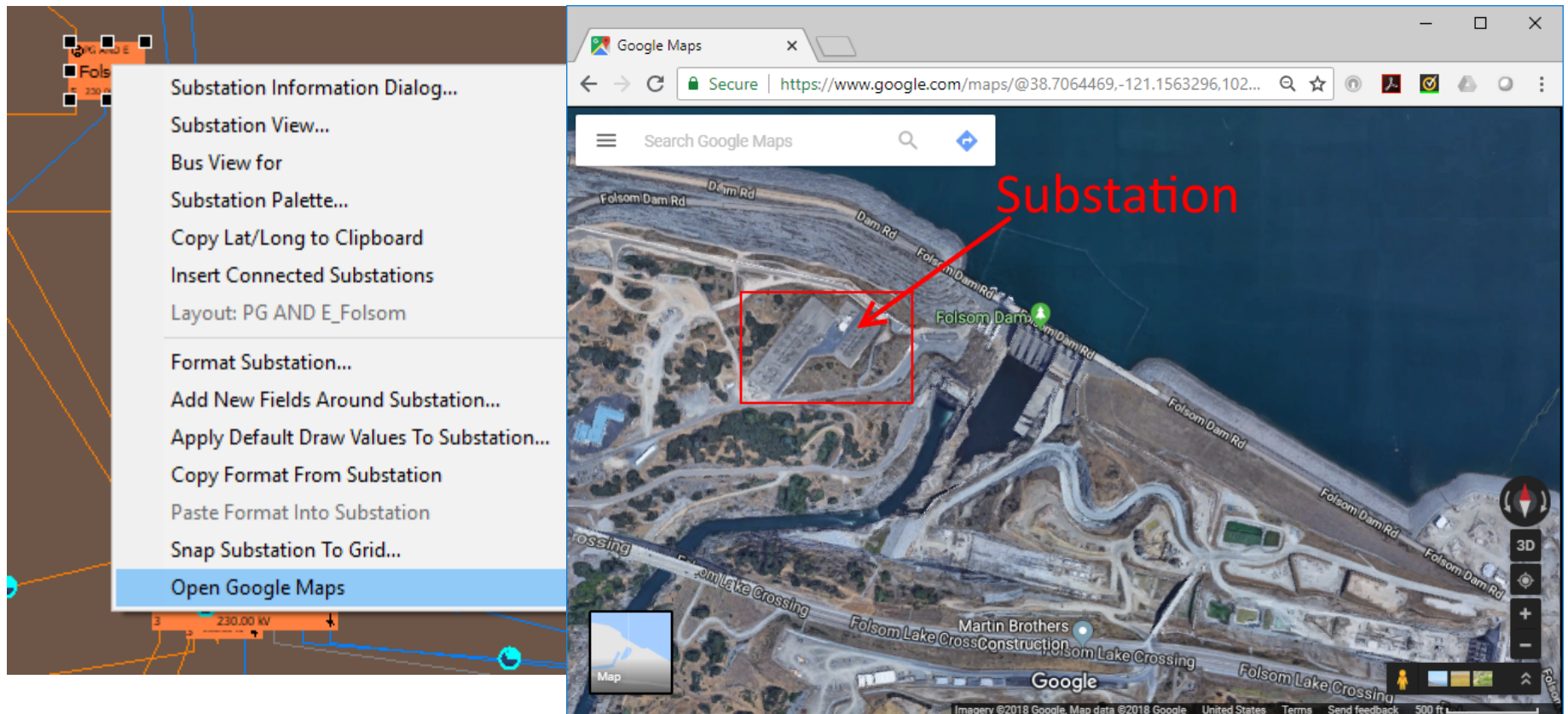


- New field of a branch was added called BranchCloseAngleThreshold
 - Set to a non-zero value to prevent online circuit breaker objects from closing across and angle larger than this.

Online, Right-Click Option Open Google Maps



- <https://www.google.com/maps/@38.7057692423,-121.1536179384,1000m/data=!3m1!1e3>



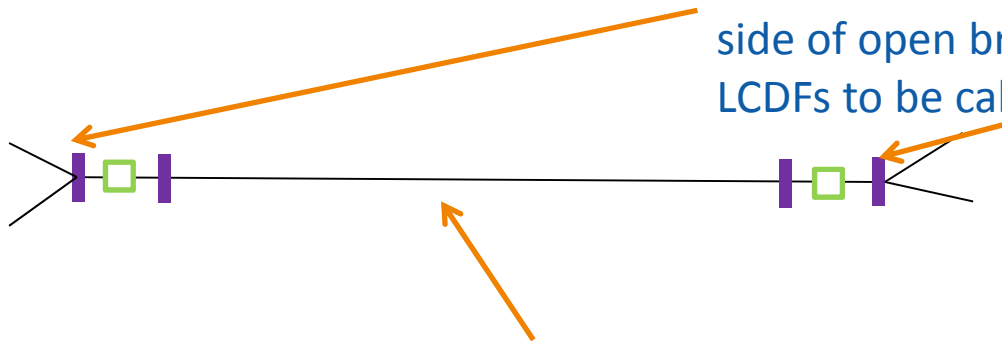
Sensitivities



- Line Closure Sensitivities

- *Breaker Status* and *Breaker and Load Break Disconnect Status*

Using *Breaker...* options, the calculation is transferred to the connected buses on the other side of open breakers. This will allow non-zero LCDFs to be calculated.



Line being closed. If using *Line Status* option, the LCDF for this line is calculated based on the line only. This will always return 0 because both terminals of the line are disconnected due to the open breakers.

Sensitivities



- Line Closure Sensitivities
 - Calculate based on post-closure flow (LCDF)
 - $LCDF_{l,k} = \frac{\Delta P_{l,k}}{\tilde{P}_k}$ where $\tilde{P}_k$ is the post-closure flow
 - We haven't closed the line so $\tilde{P}_k$ must be calculated from
$$\tilde{P}_k = \frac{P_k}{1 + PTDF_k}$$
 - Calculate based on pre-closure flow (MLCDF)
 - $MLCDF_{l,k} = \frac{\Delta P_{l,k}}{P_k}$ where P_k is the pre-closure flow calculated from the present voltages and angles
 - Simpler to calculate because we do not need to store the $PTDF_k$ factor
 - Useful if trying to do your own calculations with multiple line outages

GIC



- See separate presentation