

Transient Stability Analysis with PowerWorld Simulator



T10: Transient Limit Monitors



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Traditional Transient Stability Analysis



- For decades, transient stability analysis has consisted of the following general steps
 - 1. Setup a stability run
 - 2. Save results to a file – a really large file
 - 3. Query the results through the use of plots and other post-processing to determine if any reliability criteria were violated.
 - PowerWorld Simulator supports this through Results Storage to RAM and to Hard Drive as well as the integrated plotting tools

Pros and Cons



- Pros

- All the results are available in your results files to look at later
- Plots reaffirm that the software (and you) are doing something
- Plots are needed for displaying your results when violations occur

- Cons

- Storage requirements can become extreme
- What if we run 1000 stability simulations?
 - Terabit hard-drives
- Reduce storage by only saving results every 10 time-steps
 - May miss something
 - Frequency dip for only 2 time steps may be missed.

Analogy to Contingency Analysis



- Keeping all these results is like storing every branch flow and every bus voltage for every contingency solution
- Is this really necessary?
- Alternative: run transient stability and only store violations (like contingency analysis)
 - Options: Generic Limit Monitors
 - Transient Limit Monitors

Generic Limit Monitors: Synchronous Generators



- Synchronous Generators Limit Monitors
 - **Absolute Angle Deviation**
 - Monitors change in rotor angle change relative to initial rotor angle
 - Crude attempt to monitor for out-of-step generators
 - **Over Speed**
 - Monitors high speed generators
 - **Under Speed**
 - Monitors low speed generators
 - Can specify that they not be applied to generators which already have relay models

Generic Limit Monitors



- Available under Options\Generic Limit Monitors

Options

Note: Changes made to option entries are saved immediately and will be applied during the next transient stability run.

General Power System Model Remedial Actions Result Options Generic Limit Monitors User Defined Models Distributed Computing Transfer to Power Flow

Synchronous Generator Limit Monitors

☒ Only Apply to Generators Without Relays

Monitor Type	Action to Take	Pickup Value	Pickup Time
Absolute Angle Deviation	Ignore	180.0 Deg	0.000 Seconds
Over Speed	Ignore	1.02 pu	2.000 Seconds
Under Speed	Ignore	0.97 pu	2.000 Seconds

Note: speed pickup values are in per unit. Thus a value of 1.0 means synchronous speed for the generator.

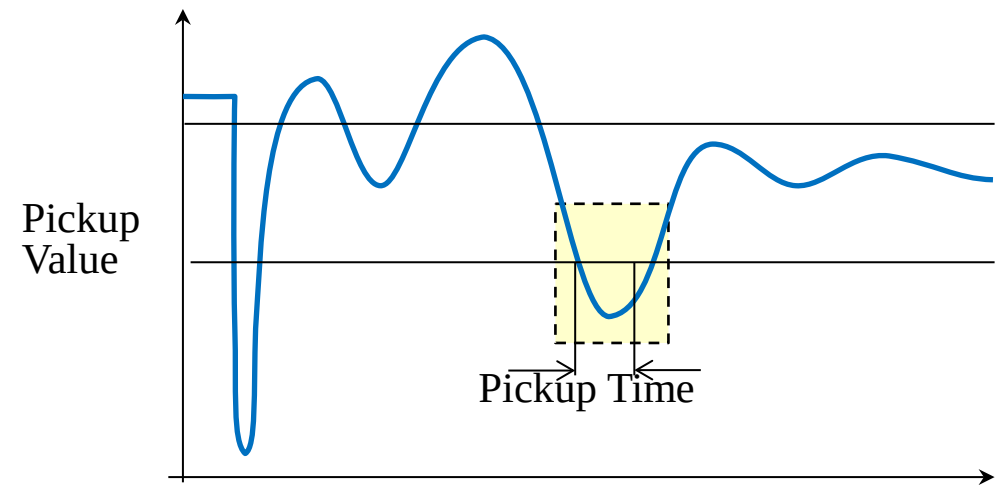
Breaker Delay Time (Cycles) 0.0

Generic Limit Monitors: Action to Take



- **Pickup Value, Pickup Time**

- For Under Frequency, value must fall below the pickup value and stay below the pickup value for a duration of Pickup Time
- For Over Frequency and Absolute Angle Deviation are same except they must go above the pickup value.
- This will cause the monitor to be violated and the **Action to Take** will be used



Generic Limit Monitors: Action to Take



- **Action to Take**

- *Ignore*

- Don't do anything. Disable the Monitor.
 - Default for Absolute Angle Deviation monitor
 - Default for Over Frequency and Under Frequency monitors for systems smaller than 100 buses

- *Log Warning*

- Will create an Event in the Transient Stability Results indicating that a violation occurred and when it occurred

- *Trip*

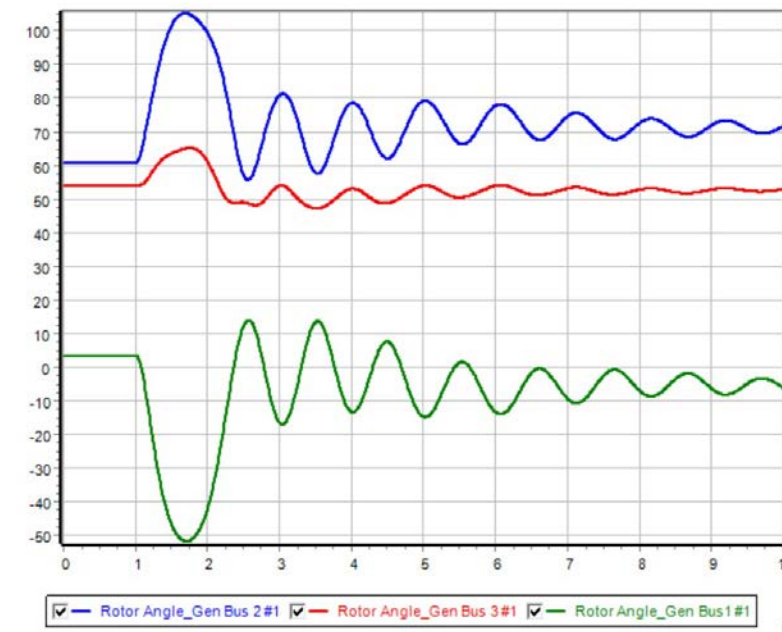
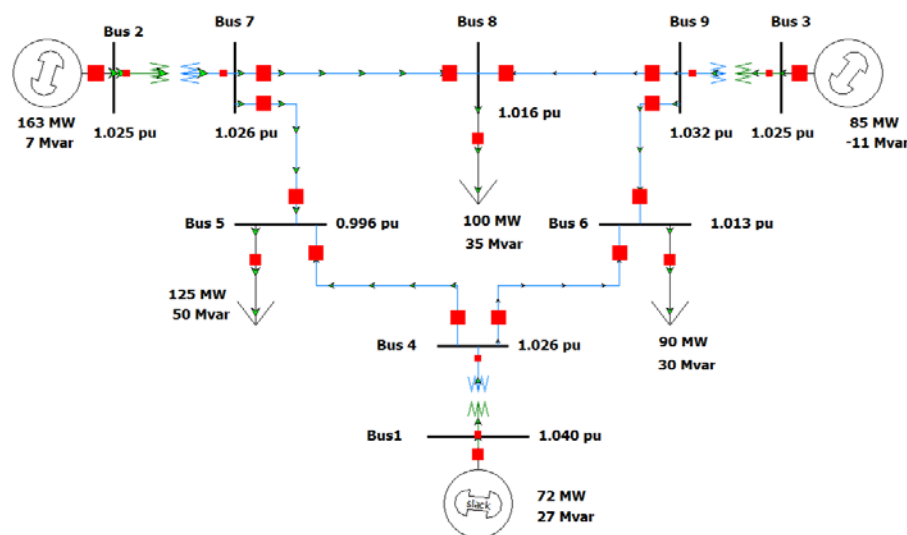
- Will cause the generator to trip after a time delay specified by **Breaker Delay Time**
 - Default for Over Frequency and Under Frequency for system larger than or equal to 100 buses

- *Abort*

- Will immediately abort the simulation

Example: Generic Limit Monitors

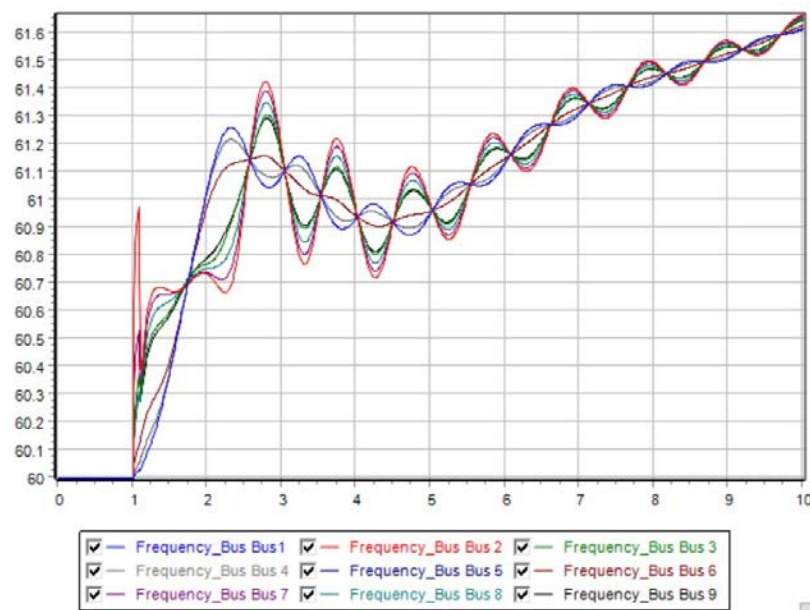
Open “WSCC_9Bus”



The left figure shows the initial power flow solution for the WSCC 9 bus case. The right figure shows the generator angles for a fault on the line between buses 5 and 7 near the bus 7 terminal, which is cleared after 0.077 seconds by opening the bus 5 to 7 line. Change the fault clearing time to verify that system loses stability for a clearing time between 0.079 and 0.08. **This fault and the associated plots are already set up in the case, starting with a clearing at 0.077 seconds.**

Example: Generic Limit Monitors

- Because this case has no governors and no infinite bus, the bus frequency keeps rising throughout the simulation, even though the rotor angles are stable.
- Go to the Generic Limit Monitors tab of the Options page. Set the generators to automatically trip as above.



Options

Note: Changes made to option entries are saved immediately and will be applied during the next transient stability run.

General Power System Model Remedial Actions Result Options Generic Limit Monitors User Defined Models Distributed Computing

Synchronous Generator Limit Monitors

☒ Only Apply to Generators Without Relays

Monitor Type	Action to Take	Pickup Value	Pickup Time
Absolute Angle Deviation	Ignore	180.0 Deg	0.000 Seconds
Over Speed	Trip (Open)	1.02 pu	2.000 Seconds
Under Speed	Trip (Open)	0.97 pu	2.000 Seconds

Note: speed pickup values are in per unit. Thus a value of 1.0 means synchronous speed for the generator.

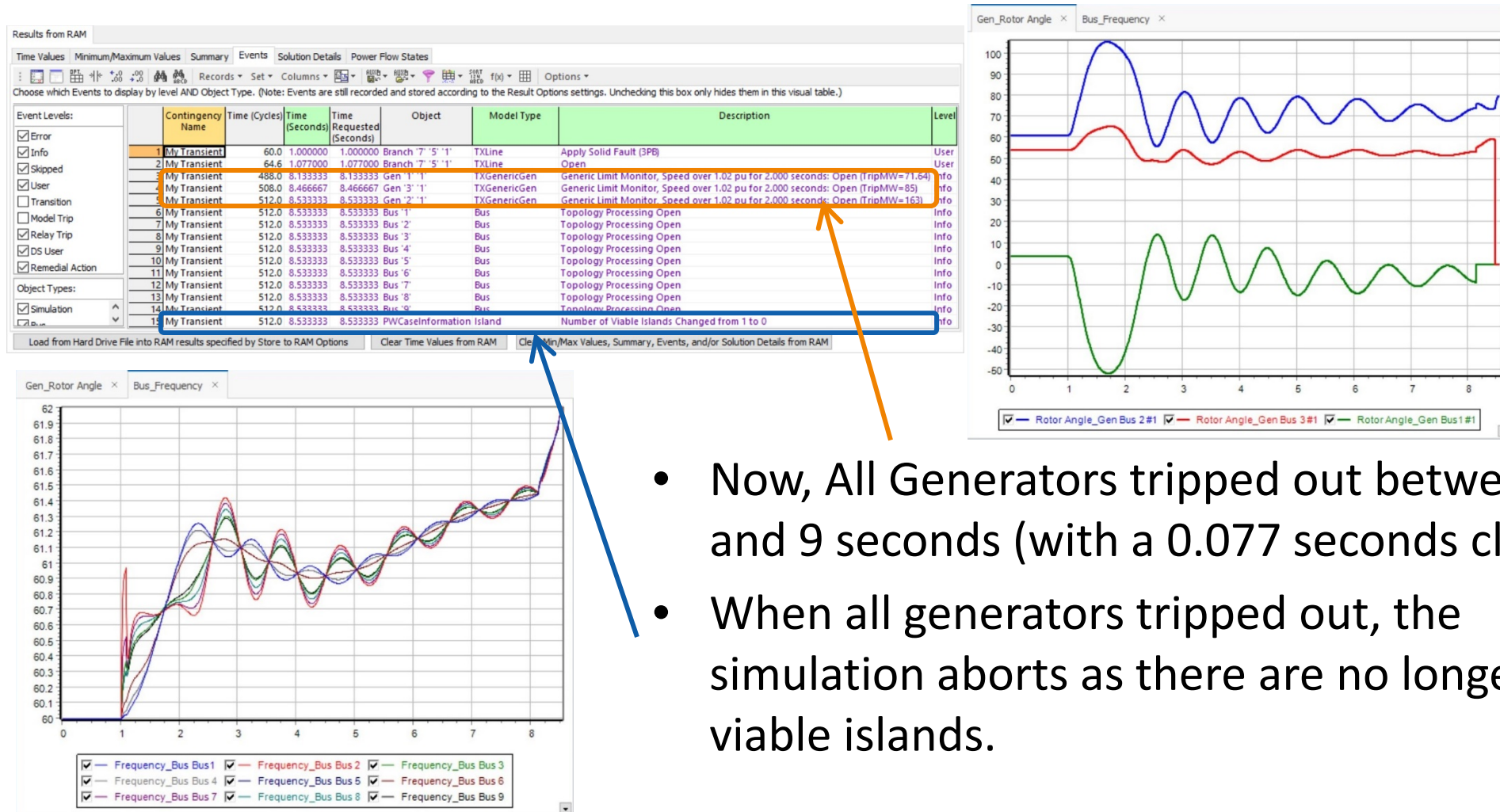
Breaker Delay Time (Cycles) 0.0

Maximum Allowable Angle Difference (degrees) 1080.0

Change to 1.02 pu (arrow pointing to Over Speed Pickup Value)

Set to Trip (Open) (arrow pointing to Over Speed Action to Take)

Example: Generic Limit Monitors



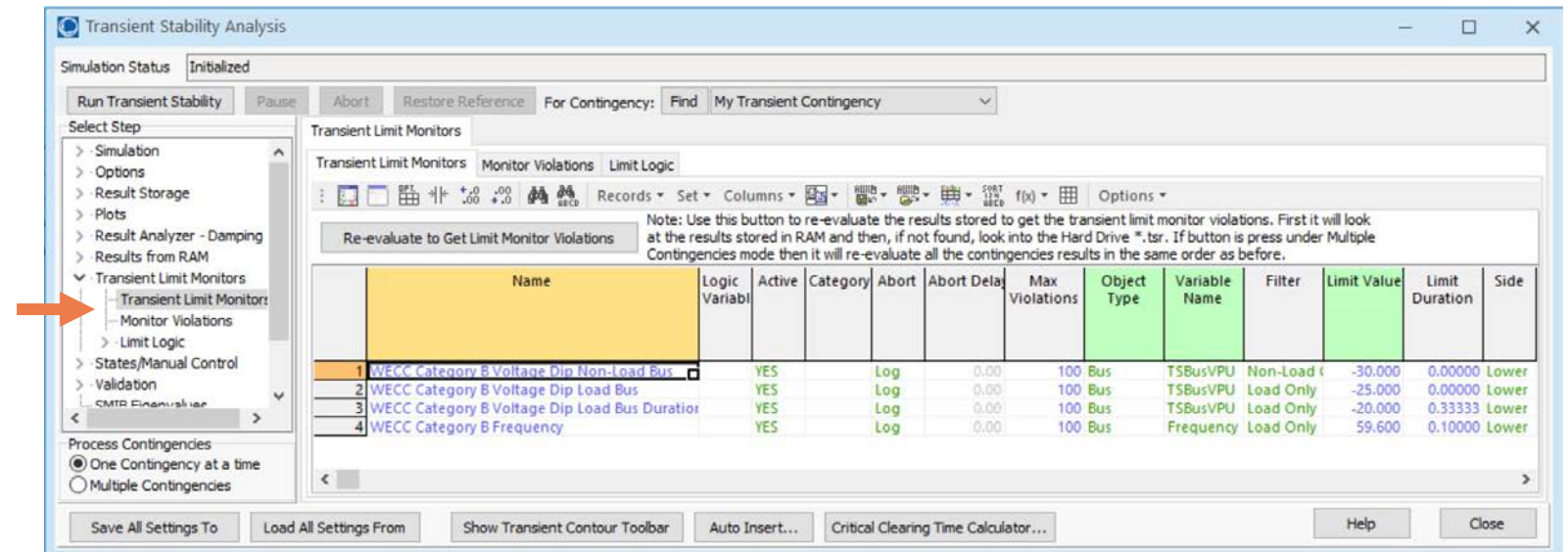
- Now, All Generators tripped out between 8 and 9 seconds (with a 0.077 seconds clearing).
- When all generators tripped out, the simulation aborts as there are no longer any viable islands.

Transient Limit Monitors



- Transient Limit Monitors in Simulator provide a great deal of flexibility for automatic monitoring during the simulation without having to store much data
- Similar to Limit Monitoring in traditional power-flow-based contingency analysis, only violations of limits will be reported
- Monitor a particular field for all objects of a type to meet a specified transient performance requirement
 - You will choose a field of a type of object
 - Then build a description of what is considered a limit violation

On the Transient Limit Monitors page of the Transient Stability Analysis dialog

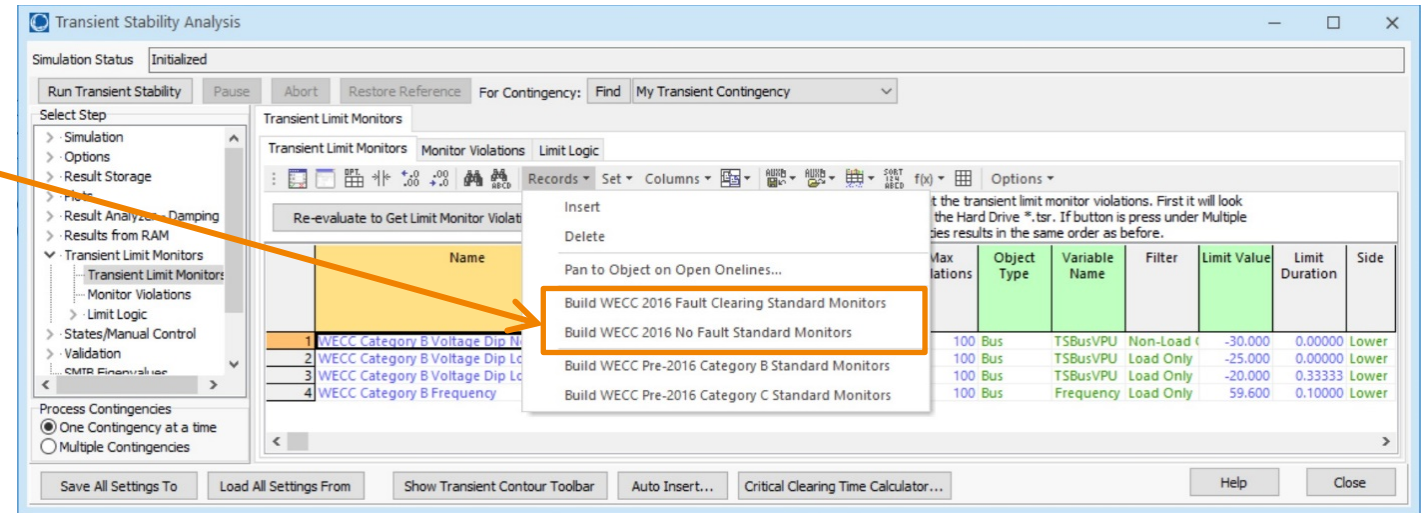


Built-In Transient Limit Monitors



Under **Records** menu, choices are available to **Build WECC Category B Standard Monitors (also C)**

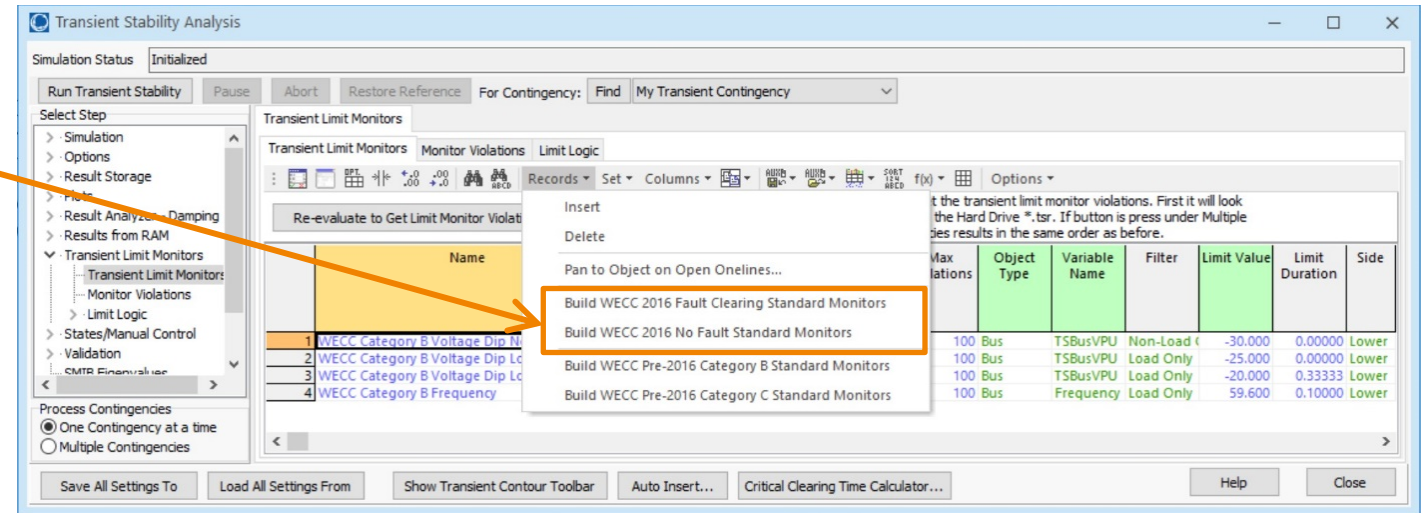
- WECC 2016 Fault Clearing Standard Monitors WR1 1.3
 - Monitor all load buses for voltages below to 80% of the initial value voltages for a duration of 20 seconds.
- WECC 2016 Fault Clearing Standard Monitors WR1 1.4 Part 1
 - Monitor all load buses for voltages below to 70% of the initial value voltages for a duration of 30 cycles. Will start monitoring voltages if they are above 80% of the initial value.
- WECC 2016 Fault Clearing Standard Monitors WR1 1.4 Part 2
 - Monitor all load buses for voltages below to 80% of the initial value voltages for a duration of 2 seconds. Will start monitoring voltages if they are above 80% of the initial value.



Built-In Transient Limit Monitors



Under **Records** menu, choices are available to **Build WECC Category B Standard Monitors** (also C)

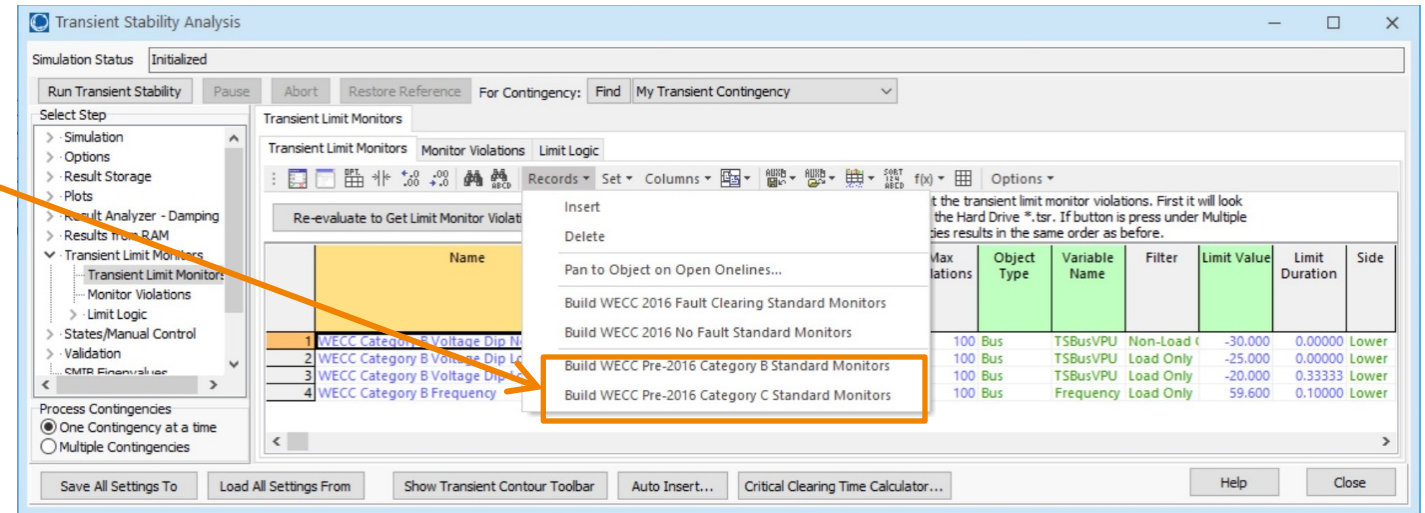


- WECC 2016 No Fault Standard Monitors WR1 1.5 Part 1
 - Monitor all load buses for voltages below to 70% of the initial value voltages for a duration of 30 cycles.
- WECC 2016 No Fault Standard Monitors WR1 1.5 Part 2
 - Monitor all load buses for voltages below to 80% of the initial value voltages for a duration of 2 seconds.

Built-In Transient Limit Monitors



Under **Records** menu, choices are available to **Build WECC Category B Standard Monitors (also C)**



- WECC Pre-2016 Category B Voltage Dip for Non-Load Buses
 - Monitor all non-load buses for any voltage dip of 30% below the initial voltage value at any time
- WECC Pre-2016 Category B Voltage Dip for Load Bus
 - Monitor all load buses for a voltage dip of 25% below the initial voltage at any time
- WECC Pre-2016 Category B Voltage Dip for Load Bus Duration
 - Monitor all load buses for a voltage dip of 20% below the initial voltage for a duration of 0.3333 seconds (20 cycles)
- WECC Pre-2016 Category B Frequency
 - Monitor all load buses for a frequency dip below 59.6 Hz for a duration of 0.10 seconds (6 cycles)

Built-In Transient Limit Monitors



- Differences as compared to Category B standards are highlighted in Red.
 - WECC Pre-2016 Category C Voltage Dip for Any Bus
 - Monitor all buses for any voltage dip of 30% below the initial voltage value at any time
 - WECC Pre-2016 Category C Voltage Dip for Any Bus Duration
 - Monitor all buses for a voltage dip of 20% below the initial voltage for a duration of 0.66667 seconds (40 cycles)
 - WECC Pre-2016 Category C Frequency
 - Monitor all load buses for a frequency dip below 59.0 Hz for a duration of 0.10 seconds (6 cycles)

Example: Transient Limit Monitors



- Open “GSO_37Bus”
- Open the Transient Stability Analysis dialog to the Transient Limit Monitors page
- In the current case, there are several Transient Limit Monitors which are all initially inactive
- Toggle all items in the Active column to YES

This case has Bus and Gen Object monitors

Toggle to YES
to enable the
Transient Limit
Monitors

Transient Limit Monitors

Transient Limit Monitors Monitor Violations Limit Logic

Re-evaluate to Get Limit Monitor Violations

Note: Use this button to re-evaluate the results stored to get the transient limit monitor violations. First it will look at the results stored in RAM and then, if not found, look into the Hard Drive *.tsr. If button is press under Multiple Contingencies mode then it will re-evaluate all the contingencies results in the same order as before.

Name	Logic Variable	Active	Category	Abort	Abort Delay	Max Violations	Object Type	Variable Name	Filter	Limit Value	Limit Duration	Side	Type
1 WECC Category B Voltage Dip New Load Bus		YES		Log	0.00	100	Bus	SBUSVPU	Non-Load Only	-30.000	0.00000	Lower	Percent Deviation
2 WECC Category B Voltage Dip Load Bus		YES		Log	0.00	100	Bus	SBUSVPU	Load Only	-25.000	0.00000	Lower	Percent Deviation
3 WECC Category B Voltage Dip Load Bus Duration		YES		Log	0.00	100	Bus	SBUSVPU	Load Only	-20.000	0.33333	Lower	Percent Deviation
4 WECC Category B Frequency		YES		Log	0.00	100	Bus	Frequency	Load Only	59.600	0.10000	Lower	Actual
5 Generator Out-of-Step		YES		Log	0.00	100	Gen	SGenDeltaNoshift		180.000	0.00000	Upper	Actual Deviation

Field that the limit monitor applies to

Object filters in use

Transient Limit Monitors Dialog



- Right click on a Transient Limit Monitor and select “Show Dialog”
- Same options are available here as on the case information display
- **Meaning of values specified (Examples)**
 - For a system with 60 Hz nominal frequency, the following are equivalent
 - *Actual value, Limit Value = 59.6 Hz*
 - *Deviation from initial value, Limit Value = -0.4 Hz*
 - When monitoring voltage, the following are equivalent
 - *Percent of initial value, Limit Value = 70%*
 - *Percent deviation from initial value, Limit Value = -30%*

Transient Limit Monitoring Dialog



- When does transient limit monitoring start?
 - Normally transient limit monitoring does not start until AFTER the last user contingency event
 - Special options can be specified to start or stop limit monitoring as well
 - Values specified in special triggers obey the **Meaning of values specified**

Transient Limit Monitoring Dialog

Name: WECC Category B Voltage Dip Non-Load Bus

Save Save As Rename Delete

☐ Active Categories:

What to Monitor When to Monitor

Special Triggers to Start or Stop Transient Limit Monitoring

	Use	Value	
Stop monitoring if a value is above	☐	0.00	%
Start monitoring if a value is above	☐	0.00	%
Stop monitoring if a value is below	☐	0.00	%
Start monitoring if a value is below	☐	0.00	%

Time to Begin Checking

☐ After last event - Time after last event: 0.000

☐ Immediately

☐ Custom Time 0.000

☒ Default to Global Option

Time to Stop Checking

☐ For Custom Duration 0.000

☐ Until Custom Time 0.000

☒ Never (global option is always never)

OK Help Cancel

Defining Transient Limit Monitors



- When creating a new Transient Limit Monitor, give it a name and check the “Active” checkbox to make it active
- Set a particular object type and a particular field or variable name to which the limit should apply
- Set the value and type of the limit (Actual, Deviation, Percent Actual, Percent Deviation)
- Optionally, set the simulation to stop when limits are violated
- Optionally, set when monitoring of the limit should start and stop
 - “Stop below,” “Start below,” “Stop above,” “Start above” values, plus YES/NO fields to enable each
 - This allows the monitoring of a limit to be used for customizable situations

Stop Below Use	Stop Below	Start Below Use	Start Below	Stop Above Use	Stop Above	Start Above Use	Start Above
NO	0.000	NO	0.000	NO	0.000	NO	0.000
NO	0.000	NO	0.000	NO	0.000	NO	0.000
NO	0.000	NO	0.000	NO	0.000	NO	0.000
NO	0.000	NO	0.000	NO	0.000	NO	0.000
NO	0.000	NO	0.000	NO	0.000	NO	0.000

Transient Limit Monitoring Dialog



Define what is monitored

Uncheck to ignore monitoring temporarily

Choose a particular Field and Device Type

Can abort the simulation or trip device a specified time after violation

Choose Filter for which devices to monitor
Filter decision is based on the power flow solution (initial steady state)

The screenshot shows the 'Transient Limit Monitoring Dialog' with the following settings:

- Name: WECC Category B Voltage Dip Non-Load Bus
- Buttons: Save, Save As, Rename, Delete
- ☒ Active
- Categories: (empty)
- What to Monitor: (selected)
- When to Monitor: (empty)
- Objects and Field Monitored:
 - Device Type: Bus
 - Field: V pu
- Filter objects for monitoring:
 - ☐ All
 - ☐ Meets Filter
 - ☐ Load Buses Only
 - ☒ Non Load Buses Only
 - ☐ Area/Zone Filters
- Action To Take:
 - ☒ Log Violation Only
 - ☐ Abort Simulation
 - ☐ Trip (Open) Device
- Use a time delay of: 0.00 Seconds
- Maximum number of violations of this limit monitor to store: 100
- Limit Value: -30.00 %
- Limit Duration: 0.0000 Seconds
- Limit Duration Units:
 - ☒ Seconds
 - ☐ Cycles
- Limit Type:
 - ☒ Lower
 - ☐ Upper
- Meaning of the values specified:
 - ☐ Actual value
 - ☐ Percent of initial value
 - ☐ Deviation from initial value
 - ☒ Percent deviation from initial value
- ☐ ABS: After using meaning, take absolute value

Annotations with orange arrows point to:

- The 'Active' checkbox.
- The 'Device Type' and 'Field' dropdowns.
- The 'Action To Take' section.
- The 'Filter objects for monitoring' section.
- The 'Maximum number of violations of this limit monitor to store' spinner.

A small graph on the right shows a voltage waveform with a 'Violation' point marked by a red circle and a horizontal line indicating the 'Limit Value'.

Maximum number of violations to store

Transient Limit Monitoring Dialog



Define what is considered a limit violation

Specify Limit Value and Duration

Is this an Upper or Lower Limit?

Specify how the Limit Value and special triggers are interpreted

Absolute Value

Comma Delimited String Categories

Transient Limit Monitors: Monitor Violations



- As a transient stability run is processed, any violations of the Transient Limit Monitors will be shown in the Monitor Violations table
 - Shows which Limit Monitor was violated
 - Shows contingency under which violation occurs
 - Shows violated device
- If violations are found, you can revisit the run and store appropriate results
- Option to “Make a New Plot” on the Records Menu and right-click menu, will automatically generate a new Plot Definition

With multiple contingencies, you can see which one caused each violation

Transient Limit Monitors												
Monitor Violations												
Limit Logic												
	Limit Monitor Name	Contingency Name	Violated Device	Limit Monitor Variable	Initial Value	Actual Value	Converted Value	Time of Value	Actual Value Start	Converted Value Start	Time of Value Start	Actual Value Extreme
1	WECC Category B Frequency	My Transient Contingency	Bus '3'	Frequency	60.000000	59.597542	59.597542	4.7000	59.599815	59.599815	4.5917	59.592346
2	WECC Category B Frequency	My Transient Contingency	Bus '5'	Frequency	60.000000	59.597450	59.597450	4.7000	59.599785	59.599785	4.5917	59.592316
3	WECC Category B Frequency	My Transient Contingency	Bus '10'	Frequency	60.000000	59.597546	59.597546	4.7000	59.599815	59.599815	4.5917	59.592323
4	WECC Category B Frequency	My Transient Contingency	Bus '12'	Frequency	60.000000	59.597523	59.597523	4.7000	59.599804	59.599804	4.5917	59.592323
5	WECC Category B Frequency	My Transient Contingency	Bus '13'	Frequency	60.000000	59.597511	59.597511	4.7000	59.599785	59.599785	4.5917	59.592316

Transient Limit Monitors: Monitor Violations



- Two other places where the Monitor Violations can be seen:

Simulation: Control and Violation Tabs

The left screenshot shows the 'Simulation' tab with the 'Violations' sub-tab selected. It displays simulation parameters such as Start Time (0.000), End Time (20.000), and Time Step (0.500). Below these, there is a table of Transient Contingency Elements. The right screenshot shows the 'Violations' tab, which displays a detailed table of limit monitor violations. The table includes columns for Limit Monitor Name, Contingency Name, Violated Device, Limit Monitor Variable, Initial Value, Actual Value, Converted Value, Time of Value, Actual Value Start, Converted Value Start, and Time of Value Start.

Limit Monitor Name	Contingency Name	Violated Device	Limit Monitor Variable	Initial Value	Actual Value	Converted Value	Time of Value	Actual Value Start	Converted Value Start	Time of Value Start
1 WECC Category B Frequency	My Transient Contingency	Bus '3'	Frequency	60.000000	59.597542	59.597542	4.7000	59.599815	59.599815	4.5917
2 WECC Category B Frequency	My Transient Contingency	Bus '5'	Frequency	60.000000	59.597450	59.597450	4.7000	59.599785	59.599785	4.5917
3 WECC Category B Frequency	My Transient Contingency	Bus '10'	Frequency	60.000000	59.597546	59.597546	4.7000	59.599815	59.599815	4.5917
4 WECC Category B Frequency	My Transient Contingency	Bus '12'	Frequency	60.000000	59.597523	59.597523	4.7000	59.599804	59.599804	4.5917
5 WECC Category B Frequency	My Transient Contingency	Bus '13'	Frequency	60.000000	59.597511	59.597511	4.7000	59.599785	59.599785	4.5917
6 WECC Category B Frequency	My Transient Contingency	Bus '14'	Frequency	60.000000	59.597466	59.597466	4.7000	59.599907	59.599907	4.5917
7 WECC Category B Frequency	My Transient Contingency	Bus '15'	Frequency	60.000000	59.597431	59.597431	4.7000	59.599766	59.599766	4.5917
8 WECC Category B Frequency	My Transient Contingency	Bus '16'	Frequency	60.000000	59.597446	59.597446	4.7000	59.599773	59.599773	4.5917
9 WECC Category B Frequency	My Transient Contingency	Bus '17'	Frequency	60.000000	59.597527	59.597527	4.7000	59.599796	59.599796	4.5917
10 WECC Category B Frequency	My Transient Contingency	Bus '18'	Frequency	60.000000	59.597477	59.597477	4.7000	59.599773	59.599773	4.5917
11 WECC Category B Frequency	My Transient Contingency	Bus '19'	Frequency	60.000000	59.597530	59.597530	4.7000	59.599796	59.599796	4.5917
12 WECC Category B Frequency	My Transient Contingency	Bus '20'	Frequency	60.000000	59.597519	59.597519	4.7000	59.599960	59.599960	4.5917
13 WECC Category B Frequency	My Transient Contingency	Bus '21'	Frequency	60.000000	59.597416	59.597416	4.7000	59.599766	59.599766	4.5917
14 WECC Category B Frequency	My Transient Contingency	Bus '24'	Frequency	60.000000	59.597431	59.597431	4.7000	59.599777	59.599777	4.5917
15 WECC Category B Frequency	My Transient Contingency	Bus '27'	Frequency	60.000000	59.597458	59.597458	4.7000	59.599777	59.599777	4.5917
16 WECC Category B Frequency	My Transient Contingency	Bus '30'	Frequency	60.000000	59.597576	59.597576	4.7000	59.599854	59.599854	4.5917
17 WECC Category B Frequency	My Transient Contingency	Bus '33'	Frequency	60.000000	59.597565	59.597565	4.7000	59.599907	59.599907	4.5917
18 WECC Category B Frequency	My Transient Contingency	Bus '34'	Frequency	60.000000	59.597492	59.597492	4.7000	59.599926	59.599926	4.5917
19 WECC Category B Frequency	My Transient Contingency	Bus '37'	Frequency	60.000000	59.597477	59.597477	4.7000	59.599773	59.599773	4.5917
20 WECC Category B Frequency	My Transient Contingency	Bus '44'	Frequency	60.000000	59.597424	59.597424	4.7000	59.599812	59.599812	4.5917
21 WECC Category B Frequency	My Transient Contingency	Bus '48'	Frequency	60.000000	59.597416	59.597416	4.7000	59.599758	59.599758	4.5917
22 WECC Category B Frequency	My Transient Contingency	Bus '53'	Frequency	60.000000	59.597427	59.597427	4.7000	59.599758	59.599758	4.5917
23 WECC Category B Frequency	My Transient Contingency	Bus '54'	Frequency	60.000000	59.597424	59.597424	4.7000	59.599766	59.599766	4.5917

Transient Limit Monitors: Monitor Violations



- Values reported by Monitor Violations

- Violation (Point C)

- Value
 - Time of Value

- Extreme (Point B)

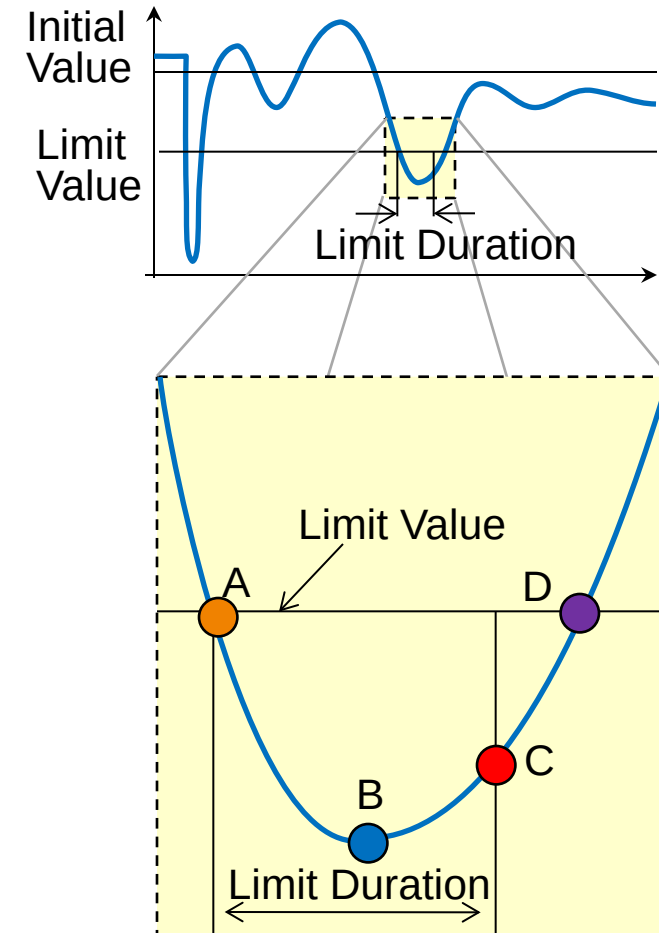
- Extreme Value
 - Time of Extreme Value
 - Note: could be after point C also

- Start of Violation (Point A)

- Value Start
 - Time of Value Start

- Value no longer violating (Point D)

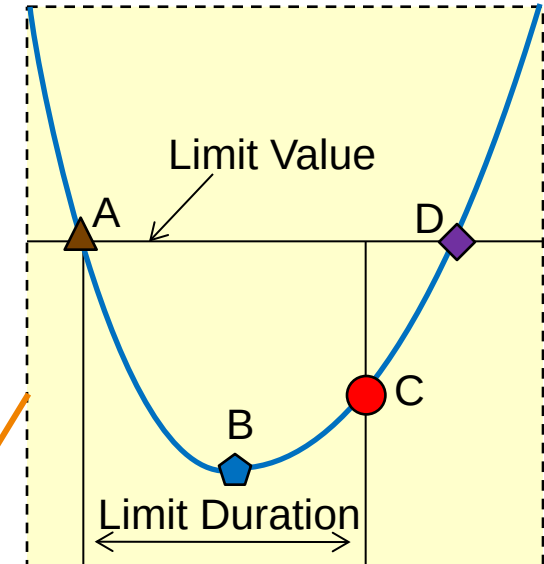
- Value No Violation
 - Time of Value No Violation
 - Note: Point may not exist



Monitor Violations: Example

- Run the simulation
- Open the Transient Limit Monitors page and view the violations
- The “Generator Out-of-Step” limit monitor has several violations

For this example, points A and C are the same because the Limit Duration is 0



Monitor Violations Tab- View the violations

Transient Limit Monitors																
Monitor Violations																
Limit Monitor Name	Contingency Name	Violated Device	Limit Monitor Variable	Initial Value	Actual Value	Converted Value	Time of Value Start	Actual Value Start	Converted Value Start	Time of Value Start	Actual Value Extreme	Converted Value Extreme	Time of Value Extreme	Actual Value No Longer	Converted Value No Longer	Time of No Longer
1 WECC Category B Frequency	My Transient Contingency Bus '3'	Frequency	60.000000	59.597542	59.597542	4.7000	59.599815	59.599815	4.5917	59.592346	59.592346	5.4500	59.600174	59.600174	6.3667	
2 WECC Category B Frequency	My Transient Contingency Bus '5'	Frequency	60.000000	59.597450	59.597450	4.7000	59.599785	59.599785	4.5917	59.592316	59.592316	5.4500	59.600231	59.600231	6.3667	
3 WECC Category B Frequency	My Transient Contingency Bus '10'	Frequency	60.000000	59.597546	59.597546	4.7000	59.599815	59.599815	4.5917	59.592323	59.592323	5.4500	59.600128	59.600128	6.3667	
4 WECC Category B Frequency	My Transient Contingency Bus '12'	Frequency	60.000000	59.597523	59.597523	4.7000	59.599804	59.599804	4.5917	59.592323	59.592323	5.4500	59.600159	59.600159	6.3667	
5 WECC Category B Frequency	My Transient Contingency Bus '13'	Frequency	60.000000	59.597511	59.597511	4.7000	59.599785	59.599785	4.5917	59.592316	59.592316	5.4500	59.600155	59.600155	6.3667	
6 WECC Category B Frequency	My Transient Contingency Bus '14'	Frequency	60.000000	59.597466	59.597466	4.7000	59.599907	59.599907	4.5917	59.592388	59.592388	5.4500	59.600105	59.600105	6.3500	
7 WECC Category B Frequency	My Transient Contingency Bus '15'	Frequency	60.000000	59.597431	59.597431	4.7000	59.599766	59.599766	4.5917	59.592278	59.592278	5.4500	59.600182	59.600182	6.3667	
8 WECC Category B Frequency	My Transient Contingency Bus '16'	Frequency	60.000000	59.597446	59.597446	4.7000	59.599773	59.599773	4.5917	59.592289	59.592289	5.4500	59.600182	59.600182	6.3667	

Monitor Violations: Example



- You can add Plot Definitions for variables which are violating the limit monitors
- Select all the violations, right click, choose “Make New Plot”

Create Plot
Definitions for
violating fields

The screenshot shows the 'Transient Limit Monitors' window with the 'Monitor Violations' tab active. A table lists various limit monitors and their violation details. A context menu is open over the table, showing options like 'Show Data View', 'Display/Column Options...', 'Find...', 'Delete', and 'Make New Plot...'.

Limit Monitor Name	Contingency Name	Violated Device	Limit Monitor Variable	Initial Value	Actual Value	Converted Value	Time of Value	Actual Value Start	Converted Value Start	Time of Value Start	Actual Value Extreme	Converted Value Extreme	Time of Value Extreme	Actual Value No Longer	Converted Value No Longer	Time of No Longer
1 Generator Out-of-Step			TSGenDeltaNoshift	17.725307	-163.117813	180.843124	3.3500	-163.117813	180.843124	3.3500	-2043.583984	2061.309326	20.0000			
2 Generator Out-of-Step			TSGenDeltaNoshift	22.623854	-158.105499	180.729355	3.3583	-158.105499	180.729355	3.3583	-2036.636108	2059.260010	20.0000			
3 Generator Out-of-Step			TSGenDeltaNoshift	2.574129	-178.453781	181.027908	3.3583	-178.453781	181.027908	3.3583	-2057.233398	2059.807617	20.0000			
4 Generator Out-of-Step			TSGenDeltaNoshift	24.365929	-156.319229	180.685150	3.3667	-156.319229	180.685150	3.3667	-2033.891724	2058.257568	20.0000			
5 Generator Out-of-Step			TSGenDeltaNoshift	24.365929	-156.319229	180.685150	3.3667	-156.319229	180.685150	3.3667	-2033.891724	2058.257568	20.0000			
6 Generator Out-of-Step			TSGenDeltaNoshift	3.176225	-177.749176	180.925400	3.3750	-177.749176	180.925400	3.3750	-2054.343262	2057.519531	20.0000			
7 Generator Out-of-Step			TSGenDeltaNoshift	10.092613	-170.477280	180.569885	3.3750	-170.477280	180.569885	3.3750	-2047.111206	2057.203857	20.0000			
8 Generator Out-of-Step			TSGenDeltaNoshift	7.365517	-173.132202	180.497711	3.3917	-173.132202	180.497711	3.3917	-2050.164795	2057.530273	20.0000			

Monitor Violations: Example



Plots

Plot Designer Plot Definition Grids

Device Type: Generator

Generate Selected Plots Close Plots

Show/Save Selected Plot Data Save Plot Images for Auto-Save Options

Choose Fields

- Efd
- I pu
- Ifd
- Mvar
- MW
- MW Accel
- MW Governor Ref
- MW Mech
- Power Angle
- Rotor Angle
- Rotor Angle No Shift

Add >> Add >> By Field Add >> By Object

Choose Objects

Sort by ☒ Name ☐ Number

BLT138 (53) #1 [138.0 kV]
 BLT69 (54) #1 [69.00 kV]
 BOB69 (48) #1 [69.00 kV]
 JO345 (28) #1 [345.0 kV]
 JO345 (28) #2 [345.0 kV]
 LAUF69 (44) #1 [69.00 kV]
 ROGER69 (50) #1 [69.00 kV]
 SLACK345 (31) #1 [345.0 kV]
 WEBER69 (14) #1 [69.00 kV]

Select All Clear All

☐ Show only objects available in results

Plots, Subplots, Axis Groups

- Gen_Speed_All
 - Speed _ Gen WEBER69 #1
 - Speed _ Gen JO345 #1
 - Speed _ Gen JO345 #2
 - Speed _ Gen SLACK345 #1
 - Speed _ Gen LAUF69 #1
 - Speed _ Gen BOB69 #1
 - Speed _ Gen ROGER69 #1
 - Speed _ Gen BLT138 #1
 - Speed _ Gen BLT69 #1
- Gen
 - Rotor Angle No Shift _ Gen BLT138 #1
 - Rotor Angle No Shift _ Gen LAUF69 #1
 - Rotor Angle No Shift _ Gen BOB69 #1
 - Rotor Angle No Shift _ Gen JO345 #1
 - Rotor Angle No Shift _ Gen JO345 #2
 - Rotor Angle No Shift _ Gen WEBER69 #1
 - Rotor Angle No Shift _ Gen ROGER69 #1
 - Rotor Angle No Shift _ Gen SLACK345 #1
- Add new plots here
- Add objects/field combinations here

Add Plot Delete Plot

Collapse All Expand All

Save Plot Definitions to Auxiliary File Load Auxiliary File

Plot Title Block Chart Horizontal Axis Vertical Axis Plot Series List

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

Axis Group Number 1 Add Axis Group Delete Axis Group

	Object	Variable	Value Type	Style	Visible	Color	Fade	Thickness	Dashed
1	Gen '53' '1'	TSGenDeltaNoshift	Actual Line	YES	YES	Blue	0	1	Solid
2	Gen '44' '1'	TSGenDeltaNoshift	Actual Line	YES	YES	Red	0	1	Solid
3	Gen '48' '1'	TSGenDeltaNoshift	Actual Line	YES	YES	Green	0	1	Solid
4	Gen '28' '1'	TSGenDeltaNoshift	Actual Line	YES	YES	Orange	0	1	Solid
5	Gen '28' '2'	TSGenDeltaNoshift	Actual Line	YES	YES	Purple	0	1	Solid
6	Gen '14' '1'	TSGenDeltaNoshift	Actual Line	YES	YES	Brown	0	1	Solid
7	Gen '50' '1'	TSGenDeltaNoshift	Actual Line	YES	YES	Black	0	1	Solid
8	Gen '31' '1'	TSGenDeltaNoshift	Actual Line	YES	YES	Light Blue	0	1	Solid

New Plot Definitions created from Monitor Violations