

# Basic RAS Modeling Demonstration in PowerWorld Simulator

---

Prepared for : WECC MSRATF

Date : May 10, 2013  
June 25, 2013 (added new section 6)

Prepared by : James D. Weber, Ph.D  
Director of Operations  
PowerWorld Corporation  
217-384-6330 ext. 13  
weber@powerworld.com



**PowerWorld**  
Corporation

2001 South First Street  
Champaign, IL 61820  
(217) 384-6330  
[www.powerworld.com](http://www.powerworld.com)

---

## Table of Contents

1	Summary .....	1
2	Test Case Description.....	2
2.1	Basic Contingency List .....	3
2.2	Make-Up Power .....	3
2.3	Remedial Action Scheme Descriptions .....	3
2.3.1	Event RAS: OPEN Stampeder G1 .....	4
2.3.2	Event RAS: Open Cowboy G1 .....	4
2.3.3	Event RAS: Open Viking G1 and G2.....	4
2.3.4	Event RAS: Open Viking G1 .....	4
2.3.5	Condition RAS: Viking-Dolphin 1 Overload .....	4
2.3.6	Condition RAS: Viking-Dolphin 2 Overload .....	4
2.4	Implementation Tests .....	4
3	PowerWorld Structures for Defining RAS .....	5
3.1	Contingency Analysis Make-up Power .....	5
3.1.1	Generator Participation Factor Control .....	6
3.1.2	Island-Based Participation Factor Control .....	6
3.1.3	Island-Based Participation Factor in Contingency Analysis Make-up Power.....	7
3.2	Injection Groups.....	8
3.3	Advanced Filters.....	8
3.4	Model Conditions.....	9
3.5	Model Filters .....	10
3.6	Disable if True in Reference State for Model Condition .....	12
3.7	Conditional Contingency Actions.....	12
3.8	Global Contingency Actions (Could call them RAS Definitions).....	14
3.9	Figuring out What Actually Occurred.....	15
4	Applying PowerWorld Simulator's Features to Modeling RAS.....	16
4.1	Define Contingency Analysis Make-up Power .....	16
4.2	Define Model Conditions in GUI .....	16
4.3	Define Model Filters in GUI.....	17
4.4	Define Injection Groups .....	18
4.5	Define Global Contingency Actions.....	19
5	Test Results .....	20
5.1	All Lines In-Service .....	20
5.2	Outage of Roughrider-Raven 3 69kV Line.....	20
5.3	Outage of Cowboy-Lion 345/138kV Transformer Bank.....	21
5.4	Outage of Dolphin-Raider 1 138kV Line.....	21
5.5	Discussion of Contingency L-2_Cowboy-Cardinal/Cowboy-Seahawk.....	21
6	Using Transient Stability Models directly in Power Flow Contingency Analysis.....	24
7	Auxiliary Files for Example .....	26
7.1	Defining Labels for Example.....	26

7.2	Auxiliary Files Defining the Basic Contingency Lists.....	27
7.2.1	AUX File using Bus Numbers .....	28
7.2.2	AUX File using Bus Names and KVs .....	29
7.2.3	AUX File using Labels.....	30
7.3	Auxiliary File Defining the RAS .....	31
7.3.1	AUX File using Bus Numbers .....	31
7.3.2	AUX File using Bus Names and KVs .....	33
7.3.3	AUX File using Labels.....	36

## 1 Summary

This document is in response to a request from the WECC MSRTF to demonstrate on a concrete example the implementation of Remedial Action Scheme (RAS) modeling in PowerWorld Simulator's power flow-based contingency analysis processor. Section 2 of this document presents the test case which James O'Brien of BPA has put together to serve as the concrete example. Section 3 covers various structures in PowerWorld Simulator that are used to define a RAS. This includes Injection Groups, Advanced Filters, Model Conditions, Model Filters, Conditional Contingency Actions, and Global Contingency Actions. Section 4 shows how these features are applied to the test example from Section 2. Section 5 shows the Test Results. Finally Section 6 contains pages of sample auxiliary files which define both the basic list of contingencies and separately the list of RAS. We also include a list of object labels to demonstrate a naming convention independent of bus numbers or names.

The actual implementation of the RAS inside PowerWorld Simulator for these examples is actually very straightforward and an experienced user of PowerWorld Simulator could do this extremely quickly (In a couple hours at most). For those who aren't as familiar with all these features however, this document covers them in great detail so that you can see every step in the process of doing this. Also, to serve as a demonstration of how a file format might permit the use of different key identifiers for objects, additional space is taken at the end of the document to show how a PowerWorld Auxiliary file (AUX file) can be configured to identify devices in three different ways

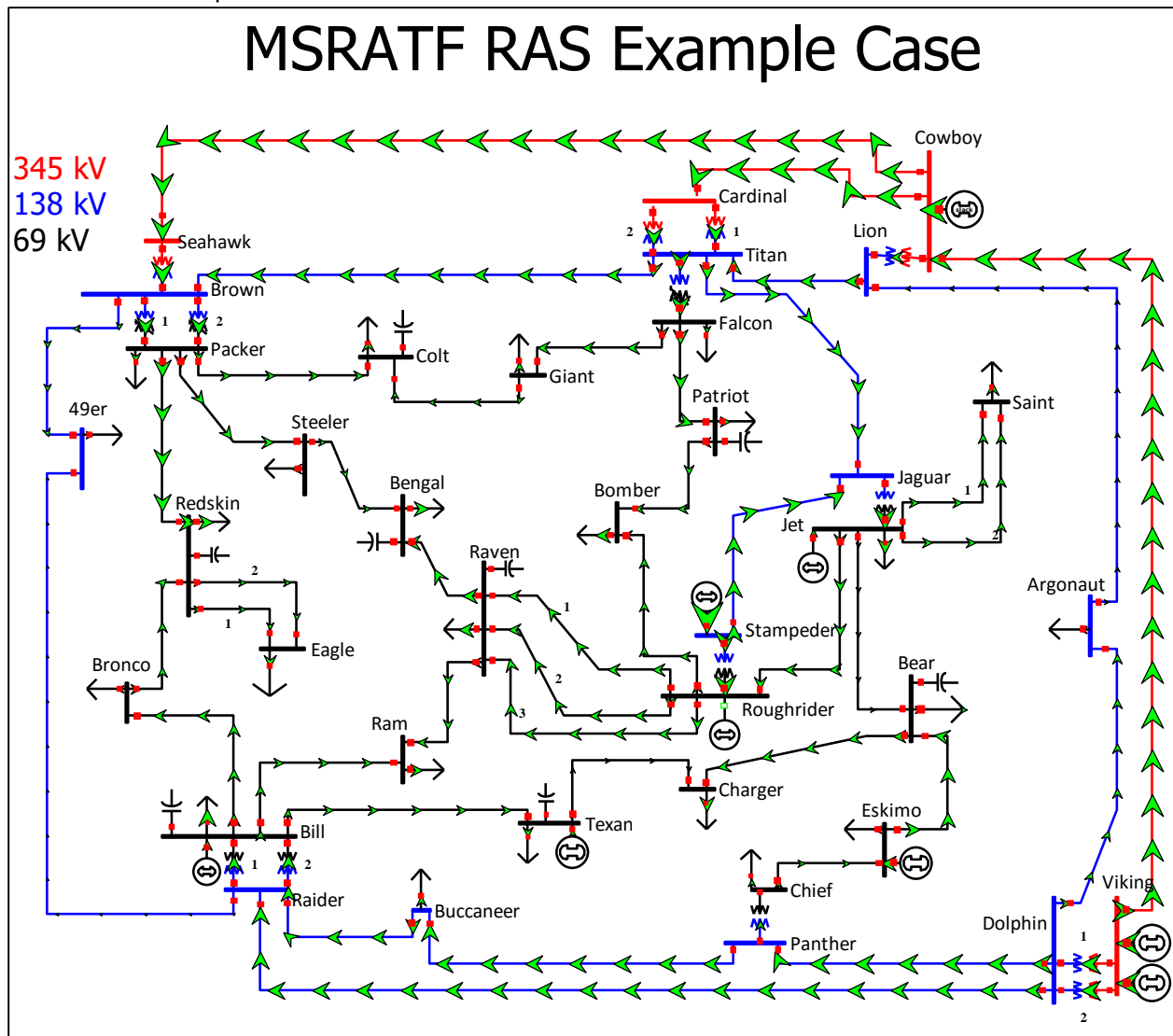
- By bus number (PowerWorld calls them *primary keys*)
- By bus name and nominal kVs (PowerWorld calls them *secondary keys*)
- By unique alphanumeric keys much like an EMS database would use (PowerWorld calls them *labels*).

As a result of this detail, the document is rather long, but do not be concerned by this as it consists largely of screen shots and pages of example AUX files. We're just trying to be overly thorough for anyone who is not familiar with PowerWorld's user-interface or nomenclature.

## 2 Test Case Description

The following system operates at 3 voltage levels (345,138 & 69) kV and has the following:

1. 37 Bus
2. 43 Transmission Lines
3. 14 Transformers
4. 9 Generators
5. 26 Loads
6. 8 Shunt Caps



**Figure 1 Test Case Oneline**

This case was used from a seed-case provided by PowerWorld. James O'Brien changed the names (based on NFL post-draft power rankings, and a couple of CFL teams)

## 2.1 Basic Contingency List

Here is the contingency list that we will use where the prefixes “L-2\_” means a double-line outage, “L\_” means a single-line outage, and “T\_” means a single transformer outage.

L-2_Roughrider-Raven 2&3	L_Chief-Eskimo	L_Raven-Ram	T_Titan-Cardinal
L-2_Roughrider-Raven 1&2	L_Cowboy-Cardinal	L_Dolphin-Raider	L_Titan-Brown
L_Falcon-Patriot	L_Buccaneer-Raider	L_Panther-Dolphin	L_Titan-Jaguar
T_Falcon-Titan	L_Packer-Colt	L_Raven-Bengal	T_Bill-Raider
L_Packer-Redskin	L_Lion-Titan	L_Cowboy-Viking	T_Bill-Raider
L_Raven-Roughrider	L_Bengal-Steeler	L_Argonaut-Dolphin	T_Jet-Jaguar
L_Raven-Roughrider	L_Colt-Giant	L_Buccaneer-Panther	L_Jaguar-Stampeder
L_Raven-Roughrider	L_Redskin-Eagle	T_Viking-Dolphin	L_Jet-Roughrider
T_Roughrider-Stampeder	L_Redskin-Eagle	T_Lion-Cowboy	L_Texan-Charger
T_Packer-Brown	L_Bear-Charger	L_Texan-Bill	L_Falcon-Giant
T_Packer-Brown	L_Roughrider-Bomber	T_Chief-Panther	L-2_Dolphin-Panther/Dolphin-Raider
L_Packer-Steeler	L_Bear-Eskimo	T_Viking-Dolphin	L_49er-Raider
L_Bear-Jet	L_Saint-Jet	L_Ram-Bill	T_Seahawk-Brown
L_Patriot-Bomber	L_Saint-Jet	L_Lion-Argonaut	L-2_Cowboy-Cardinal\Cowboy-Seahawk
L_Bronco-Bill	L_Bronco-Redskin	T_Titan-Cardinal	L_Seahawk-Cowboy
L_49er-Brown			

A description of how these contingency definitions can be stored in a PowerWorld Auxiliary File is contained in Section 7.2.

## 2.2 Make-Up Power

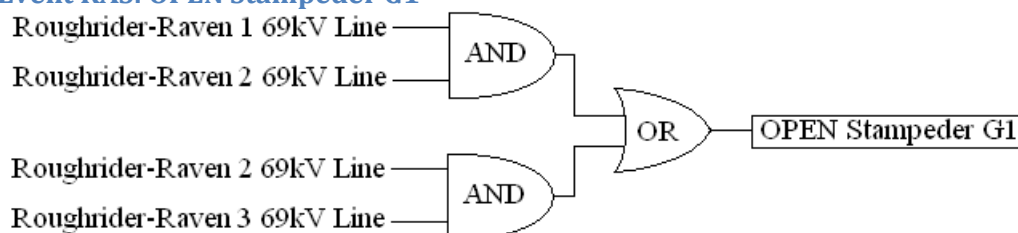
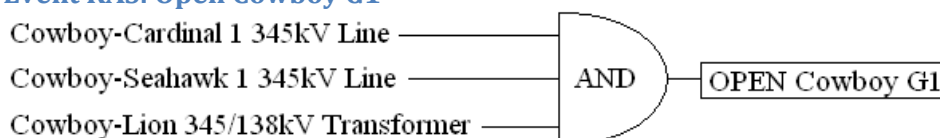
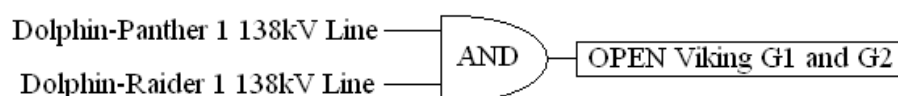
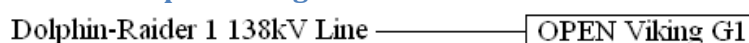
All make-up power (generation) will come from all online generators, distributed as a proportion of the maximum power output of each generator.

## 2.3 Remedial Action Scheme Descriptions

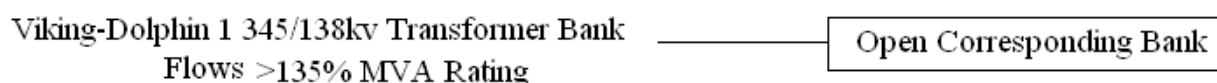
For the Condition-based RAS, the model condition check will be only on the flow as a percent of its limit at the time of evaluation.

Event-based RAS is shown as logic diagrams as follows with a line’s pre-contingency and post-contingency in-service status indicating the Boolean outcome of the Model Condition as follows.

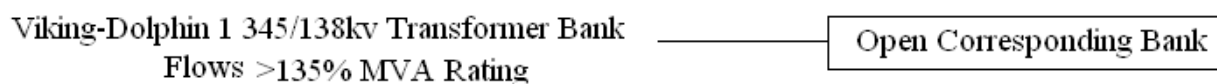
Branch States for Pre and Post Contingency	Resulting Evaluation of the Model Conditions
Pre-Contingency State = Out-Of-Service	<u>Ignore</u> condition. Ignoring is different than just saying condition is always TRUE or always FALSE. It depends on whether the condition feeds an AND or OR gate.
Pre-Contingency Status = In-service Post-Contingency Status = In-service	FALSE
Pre-Contingency Status = In-service Post-Contingency Status = Out-of-service	TRUE

**2.3.1 Event RAS: OPEN Stampeder G1****2.3.2 Event RAS: Open Cowboy G1****2.3.3 Event RAS: Open Viking G1 and G2****2.3.4 Event RAS: Open Viking G1****2.3.5 Condition RAS: Viking-Dolphin 1 Overload**

The Viking-Dolphin 345/138kV Transformer Bank 1 will trip when the flow exceeds 135% of MVA Rating

**2.3.6 Condition RAS: Viking-Dolphin 2 Overload**

The Viking-Dolphin 345/138kV Transformer Bank 2 will trip when the flow exceeds 135% of MVA Rating

**2.4 Implementation Tests**

The WECC MSRATF has presented four tests of the RAS implementation which are as follows.

1. All Lines In-Service
2. Outage of Roughrider-Raven 3 69kV Line
3. Outage of Cowboy-Lion 345/138kV Transformer Bank
4. Outage of Dolphin-Raider 1 138kV Line

PowerWorld will demonstrate the ability to implement the RAS independently from the contingency definition, as will be demonstrated by the outage conditions.

### 3 PowerWorld Structures for Defining RAS

#### 3.1 Contingency Analysis Make-up Power

When a contingency ends up involving generation or load MW changes or outages, then it is extremely important to specify how this change in MWs will be made-up by the rest of the system. This is especially true for many RAS schemes as they often involve the tripping of large amounts of generation. Within WECC, sometimes this may involve making up thousands of MWs. Some mechanism must be specified for this example so that all generation which remains online in system will respond to the change in MWs in direct proportion to the Maximum MW output of the generator. The example system has the following initial MW outputs and maximum MWs.

Number	Name	ID	Status	Gen MW	Max MW
14	Texan	1	Closed	10	35
28	Viking	1	Closed	150	150
28	Viking	2	Closed	150	150
31	Cowboy	1	Closed	185.76	220
44	Bill	1	Closed	20	150
48	Jet	1	Closed	16	52
50	Eskimo	1	Closed	49.01	80
53	Stampeder	1	Closed	245.04	400
54	Roughrider	1	Open	0	110

Thus for the loss of the Viking 1 generator (150 MW), the generation will be made up by all the other Closed generators in proportion to their maximum MW output. Assuming that the loss of 150 MW at Viking does not change the losses in the system at all (not a good assumption, but let's just use this as an example), then the change in MWs will be distributed as follows.

Number	Name	ID	Status	Gen MW	Max MW	Percentage	150 MW Change	New Output
14	Texan	1	Closed	10.0	35	$35/937=0.037$	5.6	15.6
31	Cowboy	1	Closed	185.8	220	$220/937=0.235$	35.2	221.0
44	Bill	1	Closed	20.0	150	$150/937=0.160$	24.0	44.0
48	Jet	1	Closed	16.0	52	$52/937=0.055$	8.3	24.3
50	Eskimo	1	Closed	49.0	80	$80/937=0.085$	12.8	61.8
53	Stampeder	1	Closed	245.0	400	$400/937=0.427$	64.1	309.1
			<b>SUM</b>	<b>525.8</b>	<b>937</b>		<b>SUM</b>	<b>150</b>
								<b>675.8</b>

The **Percentage** column represents the calculation of the percentage of the net change that will be assigned to the respective generator. The **150 MW Change** column represents the MWs that will be made-up by this generator. Finally, the **New Output** column shows the what the new MW output.

Note in the example above that we have left out Viking 2 generator. This is because it's already operating at its maximum MW output so can't go higher. Also, notice that the Cowboy 1 generator ends up above its Max MW limit slightly. The software should allocate this excess to the other generators responding so we do not violate generator MW limits (Simulator does this.)



### 3.1.1 Generator Participation Factor Control

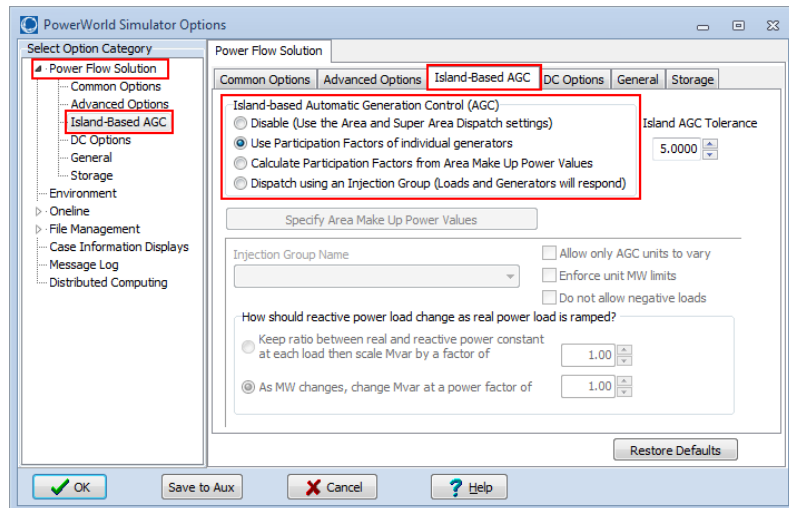
The recommended generator re-dispatch routine in PowerWorld Simulator is called Participation Factor Control. When using participation factor control, all the generators in a controlling group will respond in direct proportion to a user-specified generator field called the Participation Factor. Each generator has this field and when loading from a typical text file format such as an EPC or RAW file, this value is initialized to the Maximum MW of the generator. These values are without any units so when a group of generators needs to respond to something, then Simulator will automatically normalize them against the sum of the participation factors in the group. In addition to the participation factor value, there is a field AGC which may be set to either YES or NO and specifies whether the particular generator is allowed to move. Setting a generator's AGC to NO is the same as setting its participation factor to zero.

Number of Bus	Name of Bus	ID	Status	Gen MW	Gen Mvar	Set Volt	AGC	AVR	Min MW	Max MW	Min Mvar	Max Mvar	Cost Model	Part. Factor
1	14 Texan	1	Closed	10.00	5.00	1.01150	YES	YES	10.00	35.00	0.00	5.00	None	35.00
2	28 Viking	1	Closed	150.00	0.92	1.03000	YES	YES	0.00	150.00	-60.00	60.00	None	150.00
3	28 Viking	2	Closed	150.00	0.92	1.03000	YES	YES	0.00	150.00	-60.00	60.00	None	150.00
4	31 Cowboy	1	Closed	185.76	84.50	1.03000	YES	YES	0.00	220.00	-90.00	120.00	None	220.00
5	44 Bill	1	Closed	20.00	40.00	1.01150	YES	YES	20.00	150.00	-20.00	40.00	None	150.00
6	48 Jet	1	Closed	16.00	-14.00	1.00000	YES	YES	16.00	52.00	-14.00	26.00	None	52.00
7	50 Eskimo	1	Closed	49.01	5.84	1.02000	YES	YES	38.00	80.00	-18.00	33.00	None	80.00
8	53 Stampeder	1	Closed	245.04	45.00	1.02000	YES	YES	0.00	400.00	0.00	45.00	None	400.00
9	54 Roughrider	1	Open	0.00	0.00	1.01000	YES	YES	15.00	110.00	-20.00	60.00	None	110.00

Most commonly in Simulator, this control is based on maintaining the scheduled MW exports for Areas or Super Areas in the model. A direct link to PowerWorld's web-based help on area control is as follows:  
[http://www.powerworld.com/WebHelp/#html/Area\\_Control.htm](http://www.powerworld.com/WebHelp/#html/Area_Control.htm)

### 3.1.2 Island-Based Participation Factor Control

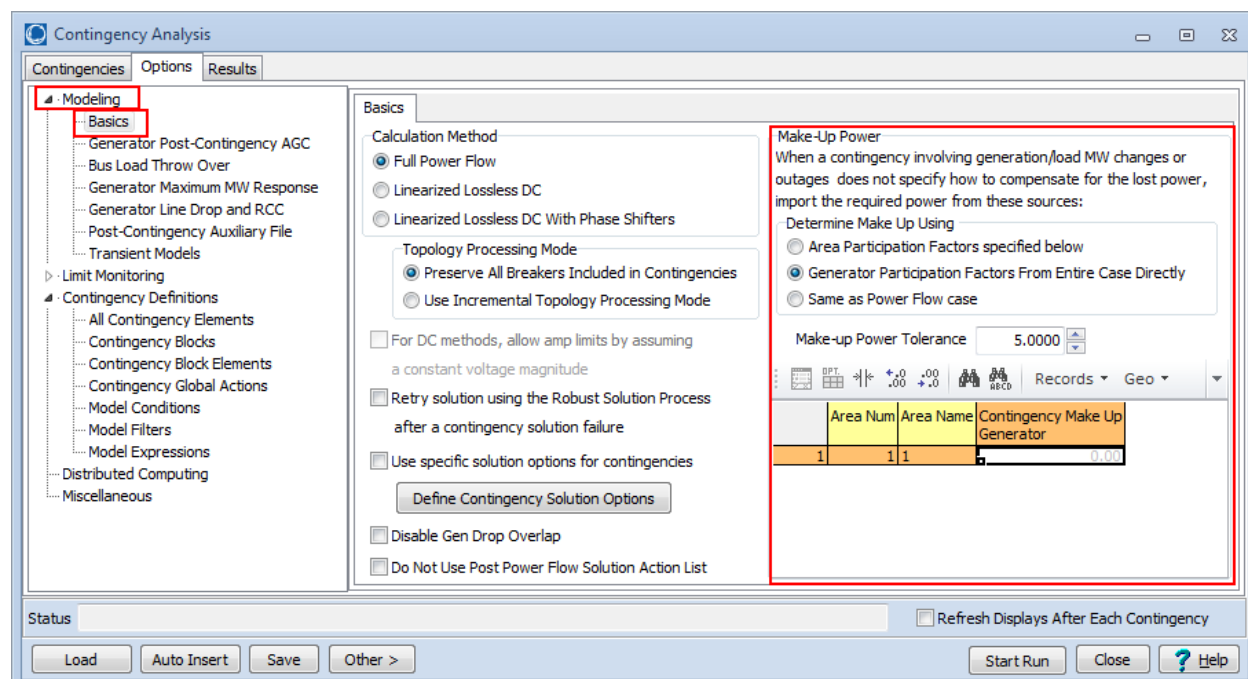
It is also possible however in Simulator to specify that the Area designations be ignored for generation re-dispatch and instead specify that each electrical island manage the change in load or generation. This is done by setting up Simulator to use Island-Based AGC instead on the Island-Based AGC tab of the Power Flow Solution Options page of Simulator Options.



A direct link to PowerWorld's web-based help on island-based control is as follows:  
[http://www.powerworld.com/WebHelp/#html/Power\\_Flow\\_Solution\\_Island\\_Based\\_AGC.htm](http://www.powerworld.com/WebHelp/#html/Power_Flow_Solution_Island_Based_AGC.htm)

### 3.1.3 Island-Based Participation Factor in Contingency Analysis Make-up Power

Within the contingency analysis tool in PowerWorld Simulator, on the contingency analysis dialog under Modeling\Basics, there are options to specify the Make-up Power. PowerWorld recommends that the option **Determine Make-Up Using** be set to *Generator Participation Factors from Entire Case Directly*.



When doing this all generators in each electrical island will respond to events in proportion to their participation factors (assuming their field AGC = YES).

A direct link to PowerWorld's web-based help on the basic options of Contingency Analysis is as follows: [http://www.powerworld.com/WebHelp/#html/Contingency\\_Options\\_Tab\\_Modeling.htm](http://www.powerworld.com/WebHelp/#html/Contingency_Options_Tab_Modeling.htm). Within this topic, look for the section on Make-up Power.

Although beyond the scope of this example, Simulator allows even more complex specification of post-contingency generator response by allowing the following.

- Specify a special Post-Contingency Participation Factor which may be different than the normal participation factor as well as a special Post-Contingency AGC status. A direct link to PowerWorld's web-based help on this topic is as follows: [http://www.powerworld.com/WebHelp/#html/Contingency\\_Options\\_Gen\\_Post\\_Contingency\\_AGC.htm](http://www.powerworld.com/WebHelp/#html/Contingency_Options_Gen_Post_Contingency_AGC.htm)
- Specify a generator maximum MW response (how much the output can change during the contingency). This option will internally modify the minimum and maximum MW output during the contingency solution. A direct link to PowerWorld's web-based help on this topic is as follows: [http://www.powerworld.com/WebHelp/#html/Contingency\\_Options\\_Gen\\_Max\\_MW\\_Response.htm](http://www.powerworld.com/WebHelp/#html/Contingency_Options_Gen_Max_MW_Response.htm)

### 3.2 Injection Groups

An Injection Group in Simulator is a way to group together generators, loads and switched shunt objects. Within the contingency analysis tool it is then possible to perform contingency actions on the Injection Group itself. The simplest example is the action “Injection Group ‘IG\_Name’ OPEN”. This action will open all the devices assigned to the injection group named IG\_Name.

There are many other more complex contingency actions related to injection groups that allow you to specify a specific amount of MW to change the injection group by, to achieve this change by moving generation in merit order, as well as specify that this change be achieved by opening generators. These more complex Injection Group – related contingency features are not necessary for this basic test however.

The easiest way to create in injection group is to go to the Model Explorer and navigate to the *Aggregations\Injection Groups* folder. Then on the list of injection groups right-click and choose **Insert**. From there give your injection group a name and click on **Insert Points** to add generators, loads and switched shunts.

A direct link to PowerWorld’s web-based help on Injection Groups is as follows:

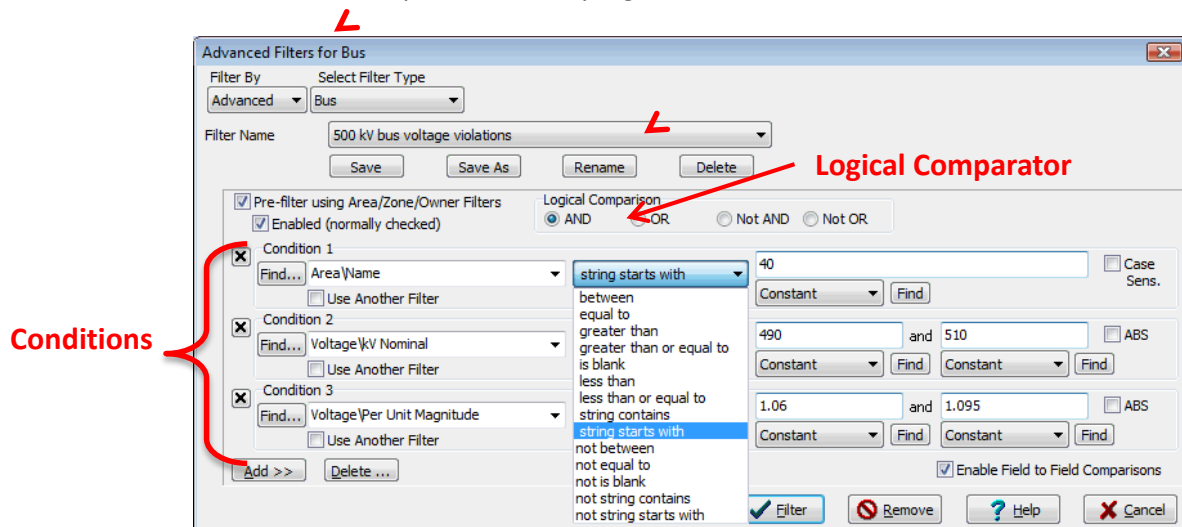
[http://www.powerworld.com/WebHelp/#html/injection\\_group\\_dialog.htm](http://www.powerworld.com/WebHelp/#html/injection_group_dialog.htm)

A direct link to PowerWorld’s web-based help on using Injection Groups in contingencies is as follows:

[http://www.powerworld.com/WebHelp/#html/Contingency\\_Element\\_Type\\_Injection\\_Group.htm](http://www.powerworld.com/WebHelp/#html/Contingency_Element_Type_Injection_Group.htm)

### 3.3 Advanced Filters

Within PowerWorld Simulator, Advanced Filters provide a completely generic way to create a Boolean expression of the fields of any type of model object in Simulator. These may be as simple as comparing a single field against a constant (Flow > 500) or comparing two fields against one another (Flow > Limit). In addition, Advanced Filters allow you to build any logical combination of other conditions and filters.



Advanced Filters have been an integral part of PowerWorld Simulator’s user interface for all our tools since about the year 2000. They are most commonly used to simply filter what is shown in the various case information displays (data tables). For emphasis, remember that an Advanced Filter applies to an

entire type of object. Thus you define *one* Advanced Filter and apply it to an entire table of buses and your table will be filtered to show only those buses for which the Advanced Filter evaluates to TRUE.

A direct link to PowerWorld's web-based help on Advanced Filtering is as follows:

[http://www.powerworld.com/WebHelp/#html/Advanced\\_Filtering.htm](http://www.powerworld.com/WebHelp/#html/Advanced_Filtering.htm)

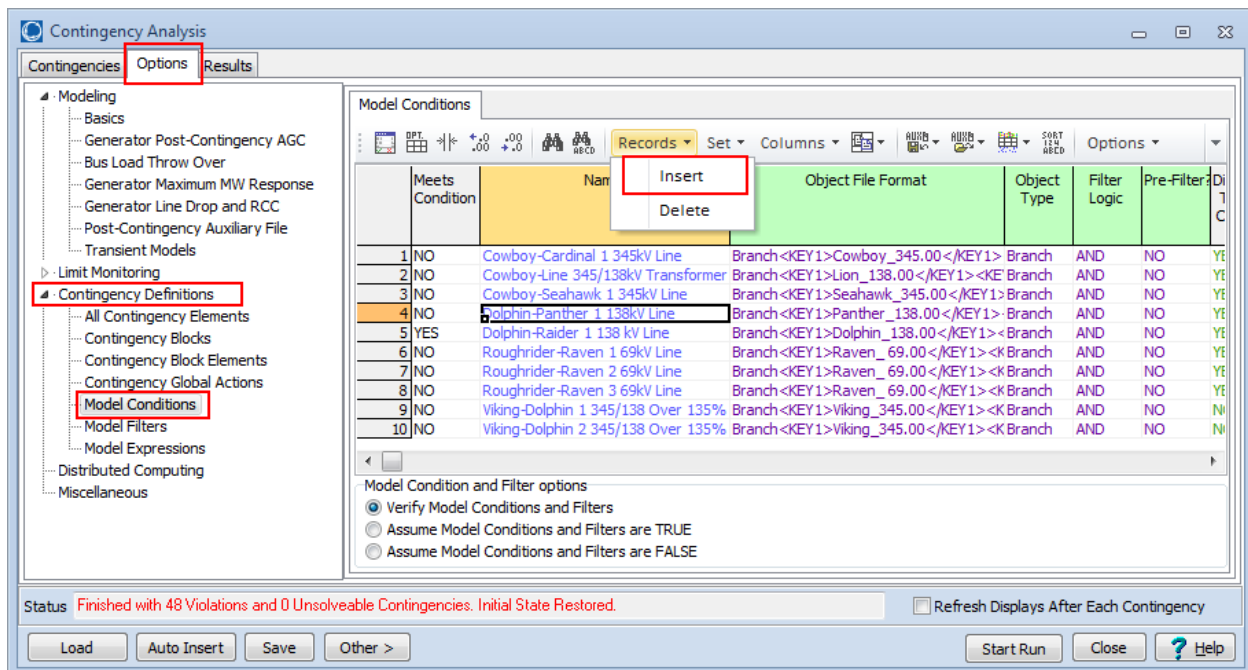
### 3.4 Model Conditions

Advanced Filters can then be used as a component of many other tools within the program. One such place is in the definition of a Model Condition. A Model Condition couples together two things: an Advanced Filter definition and one specific object. The Model Condition itself then evaluates to TRUE if the Advanced Filter evaluates to TRUE for the specific object. This Boolean can then be used by a Conditional Contingency Action as will be described in Section 3.7.

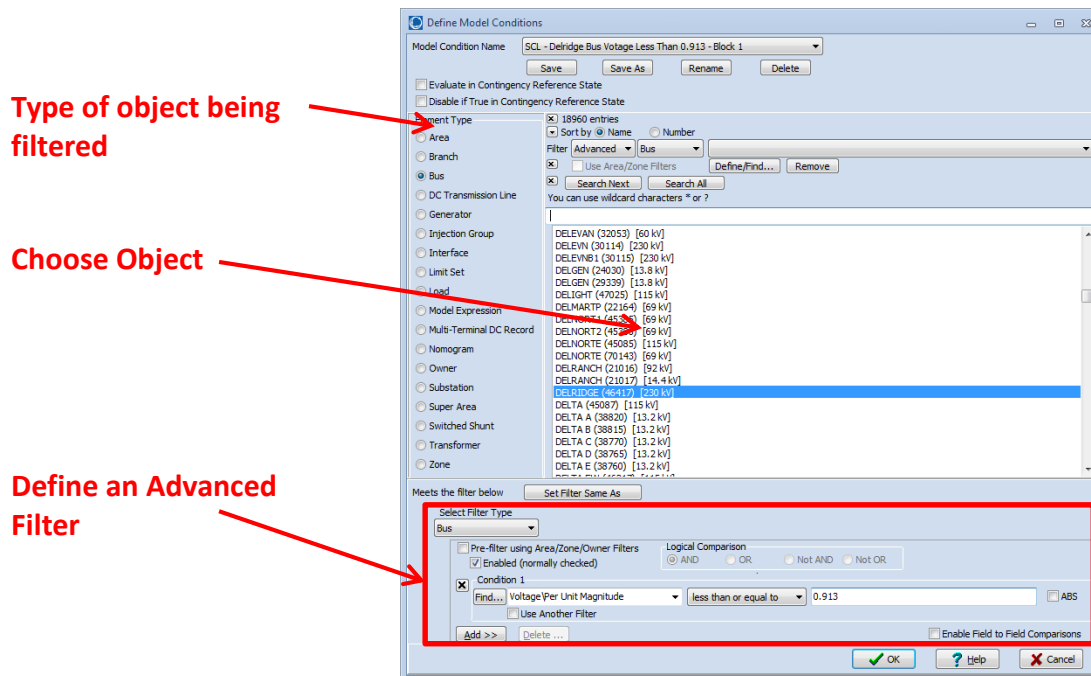
The easiest way to define a Model Condition is to go to the Tools Ribbon Tab at the top of Simulator.



Then click on the **Contingency Analysis** button. Then on the Contingency Analysis Dialog that appears, choose the **Options** Tab. Then open the entries under **Contingency Definitions** on the left of the dialog. One of the entries under there is **Model Conditions**. This will bring up the following dialog.



On case information display on the right of the dialog, you can then choose **Records>Insert** to bring up the following dialog for defining a Model Condition.



Defining a Model Condition is very straightforward. Simply choose the type of element you would to apply the condition to. Then choose the specific object. Finally define a set of conditions that apply to this object (essentially define an Advanced Filter).

A direct link to PowerWorld's web-based help on Model Conditions is as follows:  
[http://www.powerworld.com/WebHelp/#html/Model\\_Conditions\\_Display.htm](http://www.powerworld.com/WebHelp/#html/Model_Conditions_Display.htm)

### 3.5 Model Filters

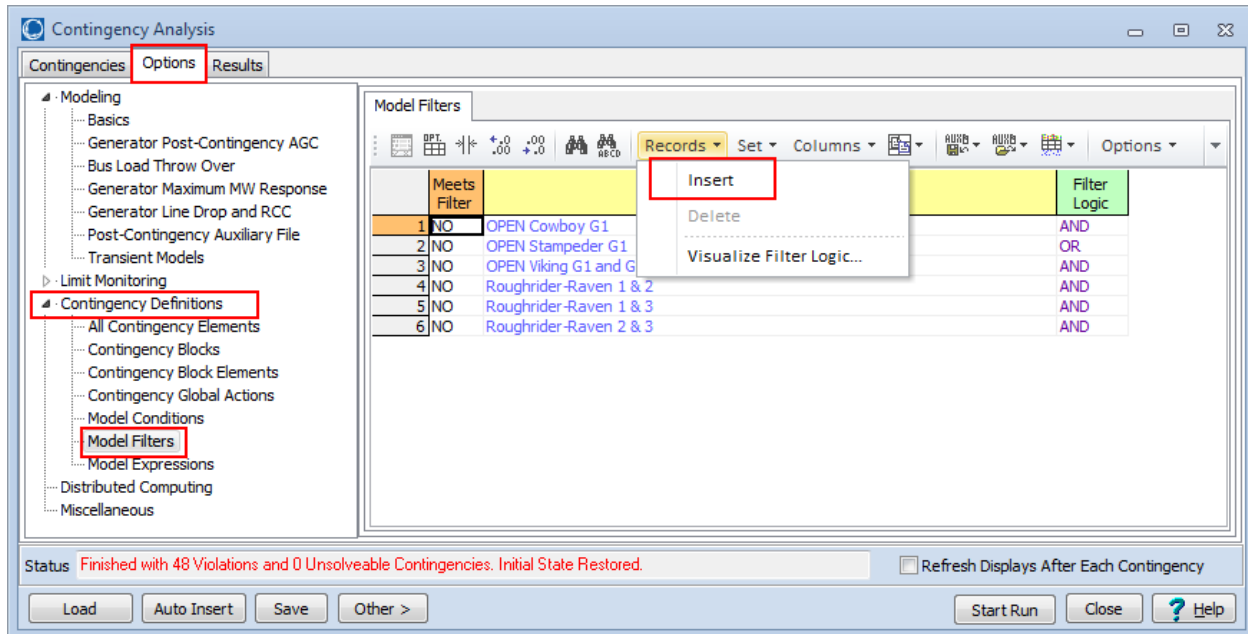
A model filter is simply a logical expression of a combination of Model Conditions and other Model Filters. For example, you may define three Model Conditions called A, B, and C. Then in order to define the logical expression "A and (B or C)" you would do the following

1. Define the Model Filter X which is equal to "B or C"
2. Define the Model Filter equal to "A and X"

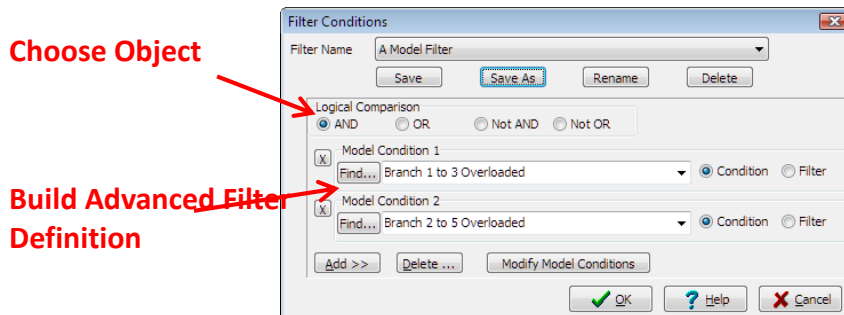
The easiest way to define a Model Filter is to go to the Tools Ribbon Tab at the top of Simulator. Then



click on the **Contingency Analysis** button. Then on the Contingency Analysis Dialog that appears, choose the **Options** Tab. Then open the entries under **Contingency Definitions** on the left of the dialog. One of the entries under there is **Model Filters**. This will bring up the following dialog.



On case information display on the right of the dialog, you can then choose **Records>Insert** to bring up the following dialog for defining a Model Filter.



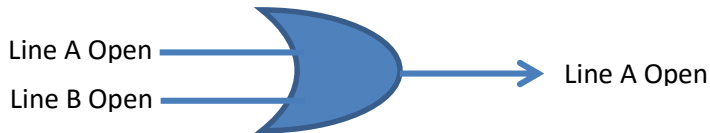
Again, defining the Model Filter is very straightforward. Simply choose a list of Model Conditions and Model Filters. Click **Add>>** to allow more of them to be grouped together. There is no limit to them number you can define. Also choose a Logical Comparison (AND, OR, Not AND, Not OR).

A direct link to PowerWorld's web-based help on Model Filters is as follows:

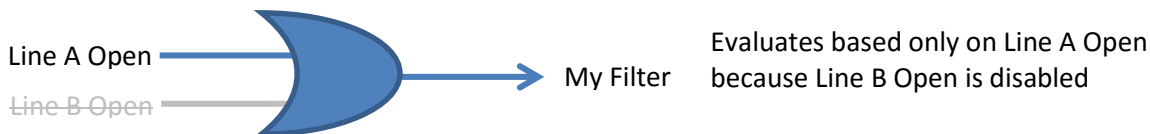
[http://www.powerworld.com/WebHelp/#html/Model\\_Filters\\_Display.htm](http://www.powerworld.com/WebHelp/#html/Model_Filters_Display.htm)

### 3.6 Disable if True in Reference State for Model Condition

When modeling some RAS actions, it will be important to implement a special feature that will disable a particular Model Condition if it evaluated to TRUE in the contingency reference state. As an example, consider the following Model Filter which does an OR on whether Line A is Open or Line B is Open.



The intent of this comparison may be that if either of these lines goes out-of-service during the contingency, then the RAS should be triggered. However, if Line B is Open in the reference state, then the RAS will always be triggered if this OR comparison is blindly done. To avoid this, PowerWorld Simulator adds an extra feature that specifies that a Model Condition should be disabled if it evaluated to TRUE in the reference state. Thus by specifying this, essentially My Filter will just evaluate based on the condition Line A Open instead.



If both Line A and Line B are open in the reference state, then My Filter will always be evaluated to FALSE because it has all disabled inputs.



A direct link to PowerWorld's web-based help on Model Conditions is as follows:

[http://www.powerworld.com/WebHelp/#html/Model\\_Conditions\\_Display.htm](http://www.powerworld.com/WebHelp/#html/Model_Conditions_Display.htm)

### 3.7 Conditional Contingency Actions

All contingency analysis processors, including PowerWorld Simulator, provide a mechanism to specify what actions occur during the contingency. These actions include opening or closing devices as well as setting or changing a numeric value. These definitions only specify that an action be done for that particular contingency.

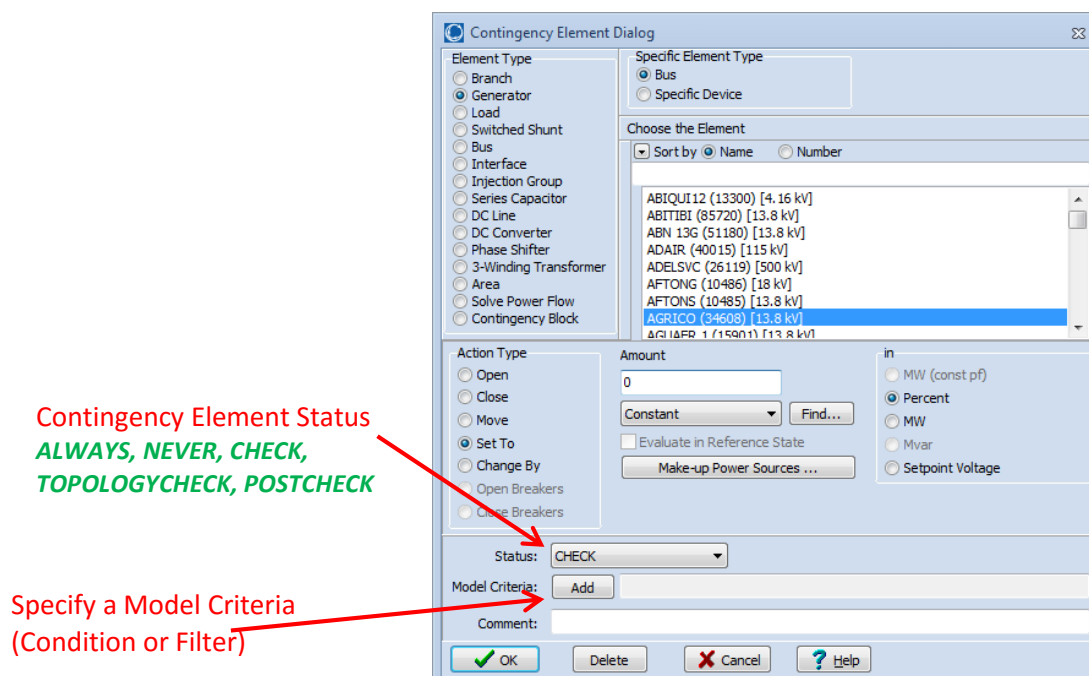
A direct link to PowerWorld's web-based help on the Contingency Element Dialog is as follows:

[http://www.powerworld.com/WebHelp/#html/contingency\\_element\\_dialog.htm](http://www.powerworld.com/WebHelp/#html/contingency_element_dialog.htm)

PowerWorld Simulator also includes the ability to specify criteria that must evaluate to TRUE in order for the action to be done. These criteria in PowerWorld Simulator are represented by either a Model Condition or a Model Filter.

On the contingency element dialog, as shown below, you specify the Model Criteria. By default it will be blank meaning that the action is always done, but you may also choose for it to be a Model Condition or Model Filter.





Once you specify that Contingency Element has a Model Criteria, it opens a question of when this model criteria should be evaluated. In PowerWorld Simulator, the user specifies a Status for the Contingency Element which answers this question. The Status field has five choices described as follows.

Contingency Element Status	Meaning of the Status
<b>NEVER</b>	The contingency action is never applied (just a way to disable it in the software)
<b>ALWAYS</b>	The contingency action is always applied (thus the Model Criteria is ignored)
<b>CHECK</b>	The Model Criteria will be evaluated in the pre-contingency reference state. If TRUE, then action is applied.
<b>TOPOLOGYCHECK</b>	After a topology check is performed on the system (but before a full power flow solution occurs), the Model Criteria will be evaluated. If TRUE, then action is applied. These elements are also evaluated along with the POSTCHECK actions.
<b>POSTCHECK</b>	After the full power flow solution occurs, the Model Criteria will be evaluated. If TRUE, then the action is applied.

When contingency elements with a Status of POSTCHECK or TOPOLOGY exist, then PowerWorld Simulator's contingency solution will occur in a loop which allows for a cascading set of actions to occur. If any POSTCHECK or TOPOLOGYCHECK actions occur during the contingency solution loop, then the loop will be repeated until no more actions newly evaluate to TRUE. The following describes this.

1. Apply ALWAYS actions and TRUE CHECK actions
2. Update topology (branch, bus status)
3. Apply TRUE TOPOLOGYCHECK actions
4. Solve full power flow
5. Apply TRUE POSTCHECK actions and TRUE TOPOLOGYCHECK actions
6. If any POSTCHECK or TOPOLOGYCHECK actions are done in step 5 then repeat steps 2-5

This loop can keep iterating forever until no more POSTCHECK or TOPOLOGYCHECK actions are done, or until the power flow solution fails.



A direct link to PowerWorld’s web-based help on the Contingency Element Status is as follows:

[http://www.powerworld.com/WebHelp/#html/Contingency\\_Element\\_Status.htm](http://www.powerworld.com/WebHelp/#html/Contingency_Element_Status.htm)

Note that when using a *Status* of TOPOLOGYCHECK, it really only makes sense for Model Criteria to use fields related to topological status. The following shows example topological status related fields

Object Type	Fields related to Status
Branch	Status, Derived Status, Online, Derived Online
Bus	Solution\Status
Generator, Load or Switched Shunt	Status, Derived Status, Online

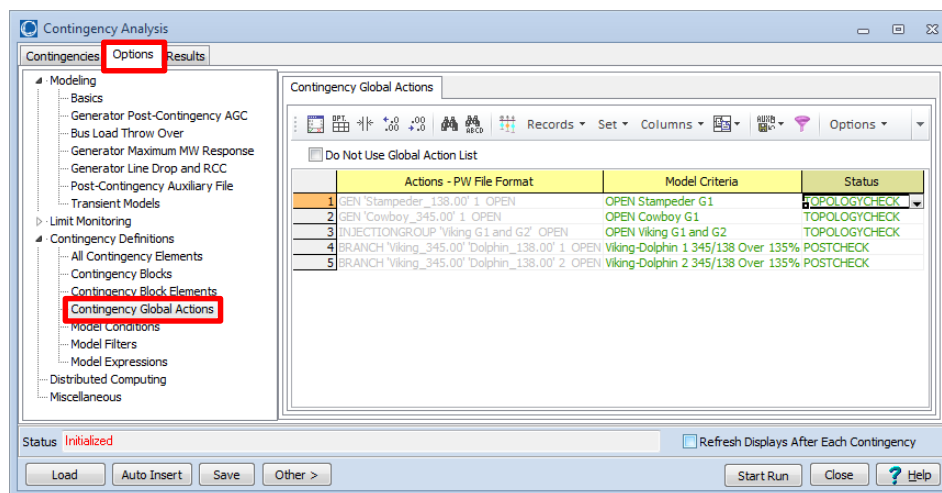
### 3.8 Global Contingency Actions (Could call them RAS Definitions)

The descriptions above for Conditional Contingency Actions provide a mechanism for modeling a RAS scheme. It would be possible to repeatedly define all these RAS actions inside of every contingency definition. This would be very cumbersome to maintain, so PowerWorld Simulator provides another mechanism to define the RAS definitions in one place and have them apply to all contingency solutions. This is achieved in PowerWorld Simulator by defining a list of Global Contingency Actions. Global Contingency Actions are simply a list of contingency elements that are stored in a separate list (thus “globally”), and then these particular elements are inherited and used by *every* contingency. You could call them “RAS Definitions” if you like. The contingency elements in the Global Contingency Actions are mostly identical to normal contingency elements otherwise. Examples are shown in the following image.

The easiest way to define a Global Contingency Action is to go to the Tools Ribbon Tab at the top of



Simulator. Then click on the **Contingency Analysis** button. Then on the Contingency Analysis Dialog that appears, choose the **Options** Tab, then open the entries under **Contingency Definitions** on the left of the dialog. One of the entries under there is **Contingency Global Actions**. This will bring up the following dialog.



On case information display on the right of the dialog, you can then choose **Records>Insert** to bring up the same dialog as discussed in the previous section on Contingency Contingency Actions.

A direct link to PowerWorld’s web-based help on the Contingency Global Actions is as follows:  
[http://www.powerworld.com/WebHelp/#html/Saving\\_Contingency\\_Records\\_to\\_a\\_File.htm](http://www.powerworld.com/WebHelp/#html/Saving_Contingency_Records_to_a_File.htm)

### 3.9 Figuring out What Actually Occurred

While modeling RAS can become complicated, what becomes even more complicated is trying to figure out and understand what you have done and whether you have done it correctly. To help with this, it is important for the software to report in a useful manner what actions occurred and which did not. In PowerWorld Simulator this is done in the result reporting objects called “What Actually Occurred”. When the PowerWorld Simulator contingency processor is running, it records a list of actions that are *Applied* as well as those that are *Skipped*. When the contingencies have completed processing, you may go to the Results tab on the Contingency Analysis Dialog. There is then an entry on the far left for **What Actually Occurred**. Choosing this will show the following.

Contingency	Applied or Skipped	Actions	Model Criteria	Status	Brief What Occurred	Origin of Action
62 L-Roughrider-BomberC1	Applied	OPEN Line Roughrider 69.0 (54) TO Bor		CHECK	Opened flow of 19.48 MVA	ELEMENT
63 L-2_Dolphin-Panther/Dolphin-Raider	Applied	OPEN Line Panther 138.0 (32) TO Dolp		CHECK	Opened flow of 128.29 MVA	ELEMENT
64 L-2_Dolphin-Panther/Dolphin-Raider	Applied	OPEN Line Dolphin 138.0 (29) TO Raide		CHECK	was already open	ELEMENT
65 L-2_Dolphin-Panther/Dolphin-Raider	Applied	OPEN InjectionGroup Viking G1 and G2	OPEN Viking G1 and G2	TOPOLOGYCHECK	Opened -300.00 MW	GLOBAL
66 L-2_Roughrider-Raven 1&2	Applied	OPEN Line Raven 69.0 (15) TO Roug		CHECK	Opened flow of 41.99 MVA	ELEMENT
67 L-2_Roughrider-Raven 1&2	Applied	OPEN Line Raven 69.0 (15) TO Roug		CHECK	Opened flow of 41.55 MVA	ELEMENT
68 L-2_Roughrider-Raven 1&2	Applied	OPEN Gen Stampeder 138.0 (53) #1	OPEN Stampeder G1	TOPOLOGYCHECK	Opened 245.04 MW	GLOBAL
69 L-2_Roughrider-Raven 2&3	Applied	OPEN Line Raven 69.0 (15) TO Roug		CHECK	Opened flow of 41.55 MVA	ELEMENT
70 L-2_Roughrider-Raven 2&3	Applied	OPEN Line Raven 69.0 (15) TO Roug		CHECK	Opened flow of 41.36 MVA	ELEMENT
71 L-2_Roughrider-Raven 2&3	Applied	OPEN Gen Stampeder 138.0 (53) #1	OPEN Stampeder G1	TOPOLOGYCHECK	Opened 245.04 MW	GLOBAL
72 L-2_Cowboy-Cardinal/Cowboy-Seahawk	Applied	OPEN Line Cowboy 345.0 (31) TO Car		CHECK	Opened flow of 166.48 MVA	ELEMENT
73 L-2_Cowboy-Cardinal/Cowboy-Seahawk	Applied	OPEN Line Seahawk 345.0 (1) TO Cowl		CHECK	Opened flow of 200.20 MVA	ELEMENT

The case information display that appears will list all the recorded entries to show what happened during each contingency. Columns of particular note in this table are

Column	Meaning
Applied or Skipped	Specify whether action was Applied or Skipped
Actions	Description of what the contingency action was
Model Criteria	Name of the Model Condition or Filter associated with the action
Status	Contingency Element Status discussed earlier
Brief What Occurred	More information about the state of the object before the action occurred
Origin of Action	Lists where the action was defined by the user. In this example it's always either ELEMENT or GLOBAL

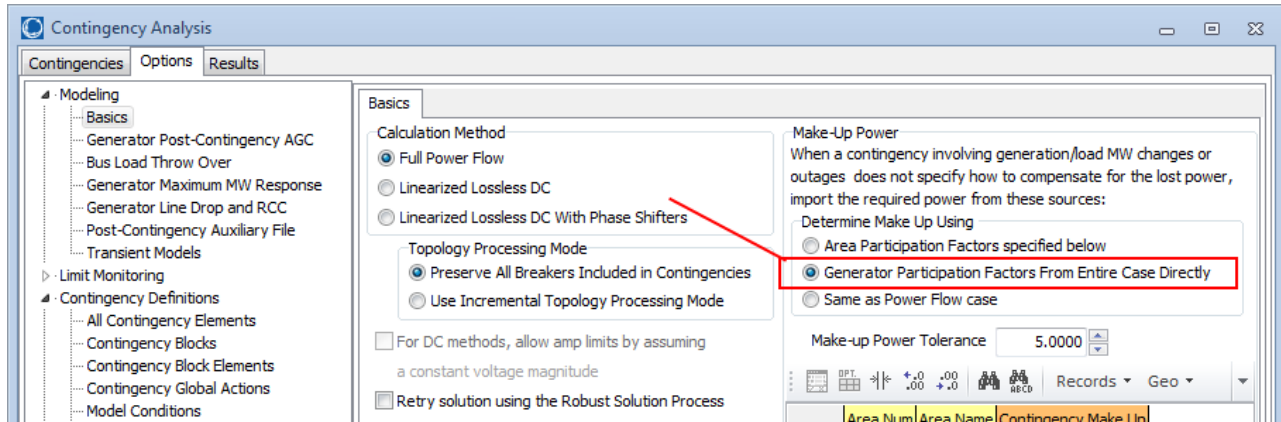
A direct link to PowerWorld’s web-based help on the ability of contingency analysis to report “what actually occurred” is as follows:

[http://www.powerworld.com/WebHelp/#html/Contingency\\_Results\\_What\\_Actually\\_Occurred.htm](http://www.powerworld.com/WebHelp/#html/Contingency_Results_What_Actually_Occurred.htm)

## 4 Applying PowerWorld Simulator's Features to Modeling RAS

### 4.1 Define Contingency Analysis Make-up Power

The default behavior in Simulator is to set the Participation Factors of all generators equal to their Maximum MW output. This mimics the behavior desired for this test. Thus the only thing that must be done is to configure the Make-up Power option to *Generator Participation Factor From Entire Case Directly*.



### 4.2 Define Model Conditions in GUI

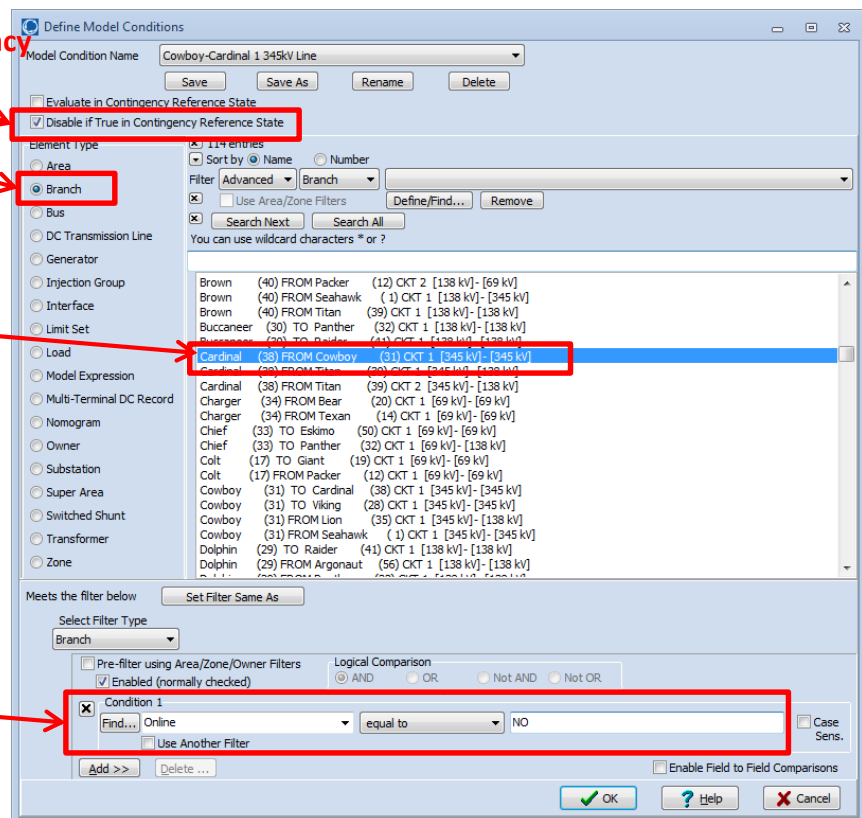
One particular Model Condition Dialog looks as follows

Disable if True in Contingency Reference State

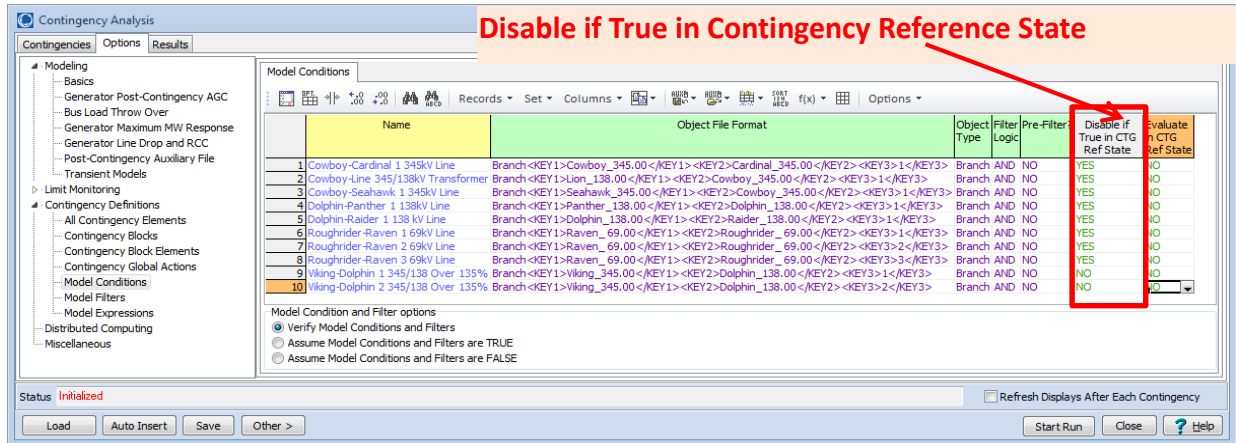
Choose Object Type

Choose Object

Choose Condition that Online = NO



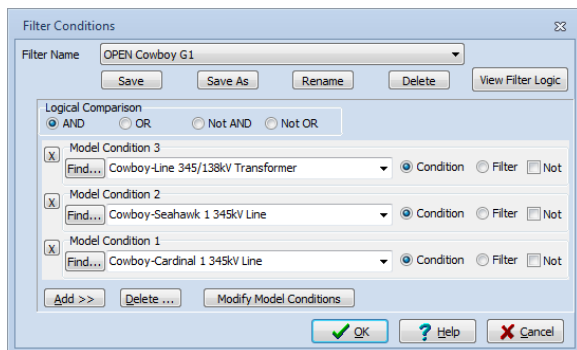
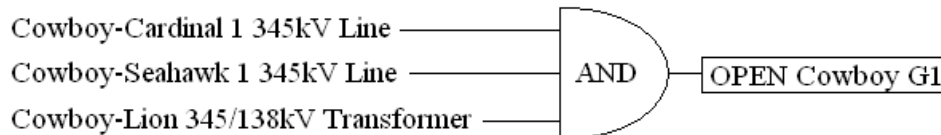
The case information display showing all the Model Conditions is as follows. Note that all the branch status-based Model Conditions are flagged as *Disable if True in CTG Ref State*. This is done so that if the particular branch is off-line in the reference state then that Model Conditions is ignored.



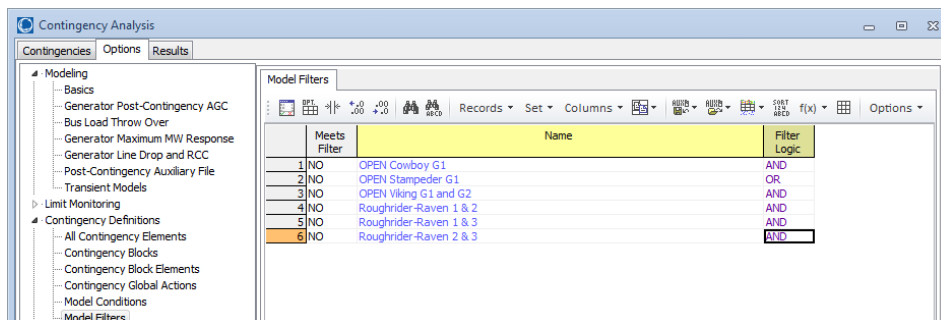
An Auxiliary File (AUX) which provides a text file description is shown in a later section.

### 4.3 Define Model Filters in GUI

One particular Model Filter Dialog that describes the OPEN Cowboy G1 criteria is as follows.

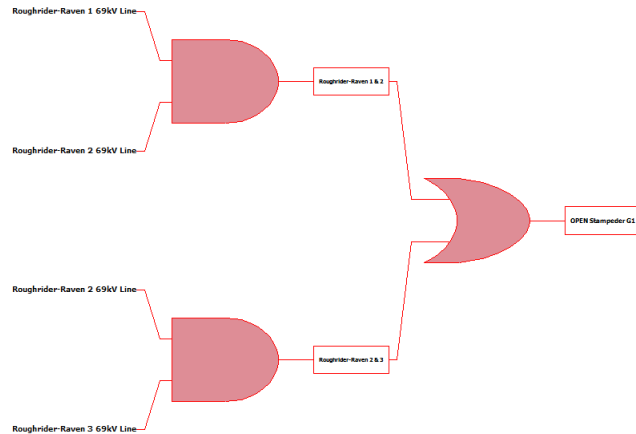


The case information display showing all the Model Filters is as follows.



You can also visualize the relationships such as for OPEN Stampeder G1 as shown on the right.

An Auxiliary File (AUX) which provides a text file description is shown in a later section.



#### 4.4 Define Injection Groups

One of the RAS schemes in this example will open two generators. To make it more concise so that one Global Contingency Action implements the entire RAS scheme, we create an injection group which contains both generators. This way we can create a Global Contingency Action that opens the injection group and thus both generators.

The case information display showing the injection group definition is shown as follows.

Model Explorer: Injection Groups

Explore

Fields

Recent

Network

Aggregations

- Areas (1)
- Injection Groups (1)**
- Interfaces
- Islands (1)
- Multi-Section Lines
- MW Transactions
- Nomograms
- Owners (1)
- Substations
- Super Areas
- Tie-lines between Areas

Open New Explorer

Injection Groups

Model Conditions

Buses

Generators

Branches Input

Zones

MS Lines

Areas

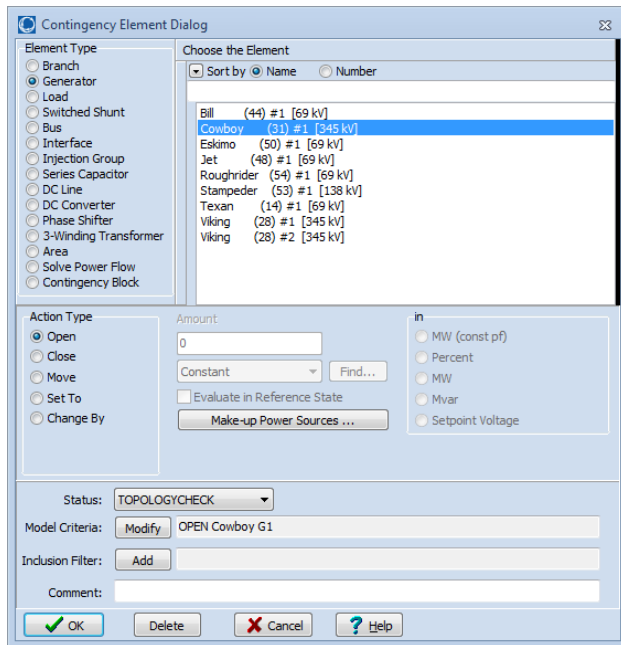
Adv...

<

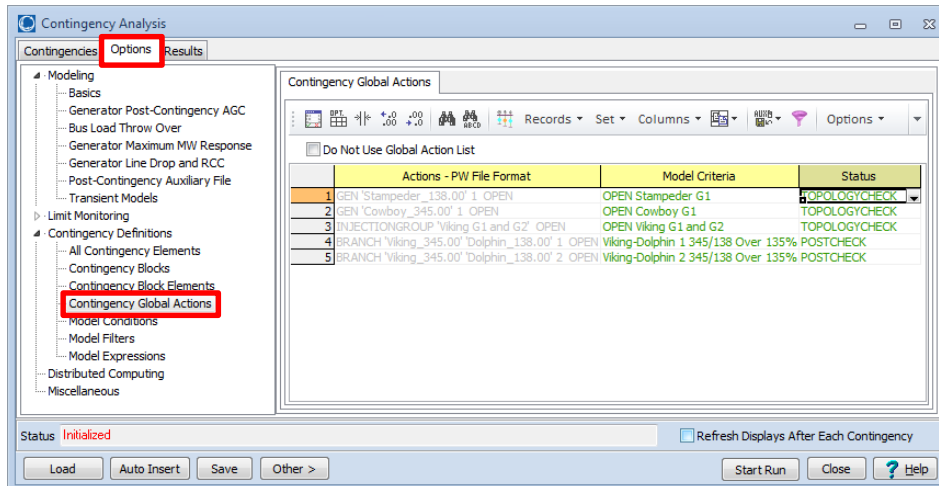
An Auxiliary File (AUX) which provides a text file description is shown in a later section.

## 4.5 Define Global Contingency Actions

One particular Global Contingency Action dialog that describes the RAS that will Open the Cowboy G1 generators is as follows.



The case information display showing all the Global Contingency Actions is as follows.



An Auxiliary File (AUX) which provides a text file description is shown in a later section.

## 5 Test Results

Test results will be presented to simply show which RAS is actually implemented under each outage conditions. Within this document we won't bother presenting the line overload violations determined by each contingency as we're most concerned with what actions are triggered and when.

### 5.1 All Lines In-Service

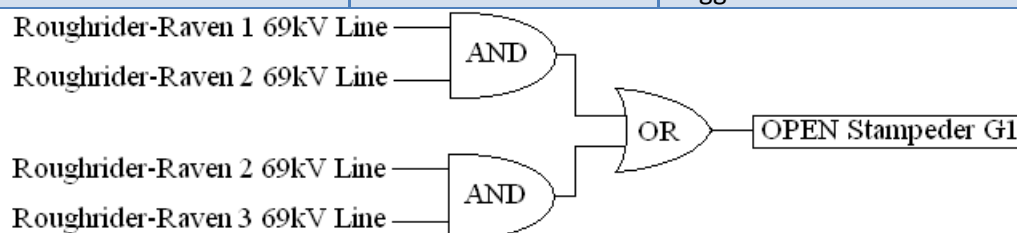
When running through this contingency list with all lines in-service, the following RAS schemes are applied under the following contingencies. These particular RAS schemes are triggered for these contingencies under all the various outage scenarios considered.

Contingency	RAS	Description
T_Viking-DolphinC1	Viking-Dolphin 2 Overload	There are two parallel transformers between Viking and Dolphin. When one transformer is outaged, the other one becomes overloaded by more than 135% and thus the RAS will open it.
T_Viking-DolphinC2	Viking-Dolphin 1 Overload	There are two parallel transformers between Viking and Dolphin. When one transformer is outaged, the other one becomes overloaded by more than 135% and thus the RAS will open it.
L_Cowboy-VikingC1	Viking-Dolphin 1 Overload Viking-Dolphin 2 Overload	Opening the 345 kV line leaving Viking toward Cowboy causes overloads by more than 135% on two Viking-Dolphin parallel transformers causing their RAS to open each
L_Dolphin-Raider	Open Viking G1	This RAS is triggered for the loss of this line
L-2_Dolphin-Panther/ Dolphin-Raider	Open Viking G1 and G2	This RAS is triggered for the loss of these two lines
L-2_Roughrider-Raven 1&2	OPEN Stampeder G1	This RAS is triggered for the loss of these two lines
L-2_Roughrider-Raven 2&3	OPEN Stampeder G1	This RAS is triggered for the loss of these two lines
L-2_Cowboy-Cardinal/ Cowboy-Seahawk	Viking-Dolphin 1 Overload Viking-Dolphin 2 Overload	Opening these two 345 kV line causes overloads by more than 135% on two Viking-Dolphin parallel transformers causing their RAS to open each

### 5.2 Outage of Roughrider-Raven 3 69kV Line

When running through this contingency list with the Roughrider-Raven Circuit 3 line outaged, the same sets of RAS are applied as for the All Lines In-Service case, but with the following addition.

Contingency	RAS	Description
L_Raven-RoughriderC2	OPEN Stampeder G1	Because circuit 3 is outaged presently, the option for "Disable if TRUE in Contingency Reference State" is obeyed and as single-line outage of Circuit 2 also triggers the RAS.

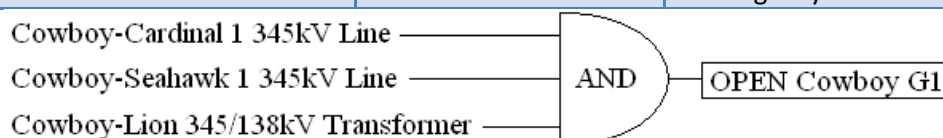




### 5.3 Outage of Cowboy-Lion 345/138kV Transformer Bank

When running through this contingency list with the Cowboy-Lion transformer outaged, the same sets of RAS are applied as for the All Lines In-Service case, but with the following addition.

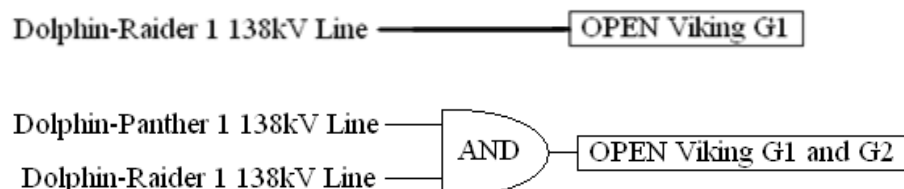
Contingency	RAS	Description
L-2_Cowboy-Cardinal\Cowboy-Seahawk	OPEN Cowboy G1	The system condition that triggers the OPEN Cowboy G1 RAS requires the outage of three lines, one of which is the Cowboy-Lion transformer, thus now this contingency results in all three lines being.



### 5.4 Outage of Dolphin-Raider 1 138kV Line

When running through this contingency list with the Dolphin-Raider transformer outaged, the same sets of RAS are applied as for the All Lines In-Service case, but with the following addition.

Contingency	RAS	Description
L_Dolphin-Raider	Nothing done	Because the Dolphin-Raider 1 line is already open in the reference case, Model Condition is disabled so the RAS doesn't occur.
L_Panther-DolphinC1	OPEN Viking G1 and G2	The system condition that triggers the OPEN Viking G1 and G2 RAS requires the outage of two lines, one of which is the Dolphi-Raider line, thus now this contingency results in both lines being out.



### 5.5 Discussion of Contingency L-2\_Cowboy-Cardinal/Cowboy-Seahawk

As an example of how precisely these definitions are processed in PowerWorld Simulator we will use the contingency L-2\_Cowboy-Cardinal/Cowboy-Seahawk. Consider first what happens in the system with all lines in service. The following figure shows the message log from PowerWorld Simulator which essentially progresses as follows.

1. Contingency Record elements are applied
2. TOPOLOGYCHECK is done, but nothing meets the criteria so nothing is done
3. Power Flow Solution Solves
4. POSTCHECK is done and Viking-Dolphin transformers are overloaded so they opened
5. TOPOLOGYCHECK is done, but nothing meets the criteria so nothing is done.
6. Power Flow Solution is attempted but fails.



Contingency Record elements are applied

TOPOLOGYCHECK is done, but nothing meets the criteria so nothing is done

Power Flow Solution Solves

```

Message Log: MSRTAF_RAS_Example.epc

5/8/2013 5:15:11 PM *****
5/8/2013 5:15:11 PM ***** Solving contingency L-2_Cowboy-Cardinal\Cowboy-Seahawk *****
5/8/2013 5:15:11 PM *****
5/8/2013 5:15:11 PM APPLYING: OPEN Line Cowboy _345.0 (31) TO Cardinal _345.0 (38) CKT 1
5/8/2013 5:15:11 PM APPLYING: OPEN Line Seahawk _345.0 (1) TO Cowboy _345.0 (31) CKT 1
5/8/2013 5:15:11 PM SKIPPING: OPEN Gen Stampeder _138.0 (53) #1
5/8/2013 5:15:11 PM SKIPPING: OPEN Gen Cowboy _345.0 (31) #1
5/8/2013 5:15:11 PM SKIPPING: OPEN InjectionGroup Viking G1 and G2
5/8/2013 5:15:11 PM SKIPPING: OPEN Gen Viking _345.0 (28) #1
5/8/2013 5:15:11 PM SKIPPING: OPEN Transformer Viking _345.0 (28) TO Dolphin _138.0 (29) CKT 1
5/8/2013 5:15:11 PM SKIPPING: OPEN Transformer Viking _345.0 (28) TO Dolphin _138.0 (29) CKT 2
5/8/2013 5:15:11 PM *****
5/8/2013 5:15:11 PM ***** Applying TOPOLOGYCHECK for Contingency L-2_Cowboy-Cardinal\Cowboy-Seahawk *****
5/8/2013 5:15:11 PM *****
5/8/2013 5:15:11 PM SKIPPING: OPEN Gen Stampeder _138.0 (53) #1
5/8/2013 5:15:11 PM SKIPPING: OPEN Gen Cowboy _345.0 (31) #1
5/8/2013 5:15:11 PM SKIPPING: OPEN InjectionGroup Viking G1 and G2
5/8/2013 5:15:11 PM SKIPPING: OPEN Gen Viking _345.0 (28) #1
5/8/2013 5:15:11 PM *****
5/8/2013 5:15:11 PM Number: 0 Max P: 146.025 at bus 38 Max Q: 144.604 at bus 1
5/8/2013 5:15:11 PM Number: 1 Max P: 19.933 at bus 38 Max Q: 52.793 at bus 1
5/8/2013 5:15:11 PM Number: 2 Max P: 1.509 at bus 1 Max Q: 0.706 at bus 1
5/8/2013 5:15:11 PM Number: 3 Max P: 0.001 at bus 1 Max Q: 0.004 at bus 1
5/8/2013 5:15:11 PM Gen(s) at bus 44 at max vars
5/8/2013 5:15:11 PM Gen(s) at bus 48 has backed off var limit
5/8/2013 5:15:11 PM Gen(s) at bus 50 at max vars
5/8/2013 5:15:11 PM Calculating Transformer Tap Sensitivities for 6 Transformers
5/8/2013 5:15:11 PM Transformer 48 TO 47 CKT 1 can not effectively control voltage at bus 48; control will be ig
5/8/2013 5:15:11 PM Transformer 1 TO 40 CKT 1 tap ratio moved from 0.90000 to 1.01875
5/8/2013 5:15:11 PM Transformer 12 TO 40 CKT 1 tap ratio moved from 0.99375 to 1.10000
    
```

POSTCHECK is done and Viking-Dolphin transformers are overloaded so they opened

TOPOLOCYCHECK is done, but nothing meets the criteria so nothing is done.

Power Flow Solution is attempted but fails.

```

5/8/2013 5:15:11 PM Finished voltage control loop iteration: 1
5/8/2013 5:15:11 PM *****
5/8/2013 5:15:11 PM ***** Applying POSTCHECK Iteration #1 for Contingency L-2_Cowboy-Cardinal\Cowboy-Seahawk *****
5/8/2013 5:15:11 PM *****
5/8/2013 5:15:11 PM SKIPPING: OPEN Gen Stampeder _138.0 (53) #1
5/8/2013 5:15:11 PM SKIPPING: OPEN Gen Cowboy _345.0 (31) #1
5/8/2013 5:15:11 PM SKIPPING: OPEN InjectionGroup Viking G1 and G2
5/8/2013 5:15:11 PM SKIPPING: OPEN Gen Viking _345.0 (28) #1
5/8/2013 5:15:11 PM APPLYING: OPEN Transformer Viking _345.0 (28) TO Dolphin _138.0 (29) CKT 1
5/8/2013 5:15:11 PM APPLYING: OPEN Transformer Viking _345.0 (28) TO Dolphin _138.0 (29) CKT 2
5/8/2013 5:15:11 PM *****
5/8/2013 5:15:11 PM ***** Applying TOPOLOGYCHECK for Contingency L-2_Cowboy-Cardinal\Cowboy-Seahawk *****
5/8/2013 5:15:11 PM *****
5/8/2013 5:15:11 PM SKIPPING: OPEN Gen Stampeder _138.0 (53) #1
5/8/2013 5:15:11 PM SKIPPING: OPEN Gen Cowboy _345.0 (31) #1
5/8/2013 5:15:11 PM SKIPPING: OPEN InjectionGroup Viking G1 and G2
5/8/2013 5:15:11 PM SKIPPING: OPEN Gen Viking _345.0 (28) #1
5/8/2013 5:15:11 PM *****
5/8/2013 5:15:11 PM Warning - Transformer 48 TO 47 CKT 1 regulated bus 48 is already being regulated to a diff
5/8/2013 5:15:11 PM Number: 0 Max P: 306.224 at bus 28 Max Q: 57.724 at bus 29
5/8/2013 5:15:11 PM Number: 1 Max P: 114.961 at bus 29 Max Q: 74.281 at bus 29
5/8/2013 5:15:11 PM Number: 2 Max P: 10.978 at bus 48 Max Q: 21.609 at bus 29
5/8/2013 5:15:11 PM Number: 3 Max P: 0.263 at bus 48 Max Q: 0.027 at bus 29
5/8/2013 5:15:11 PM Number: 4 Max P: 0.000 at bus 48 Max Q: 0.000 at bus 29
5/8/2013 5:15:11 PM Gen(s) at bus 48 at max vars
5/8/2013 5:15:11 PM Calculating Transformer Tap Sensitivities for 5 Transformers
5/8/2013 5:15:11 PM Transformer 35 TO 31 CKT 1 tap ratio moved from 0.99375 to 1.08125
5/8/2013 5:15:11 PM Transformer 33 TO 32 CKT 1 tap ratio moved from 0.98750 to 1.06250
5/8/2013 5:15:11 PM Transformer 44 TO 41 CKT 1 tap ratio moved from 1.04625 to 1.09625 (at max tap)
5/8/2013 5:15:11 PM Transformer 44 TO 41 CKT 2 tap ratio moved from 1.04625 to 1.09625 (at max tap)
5/8/2013 5:15:11 PM Taps at 4 transformers adjusted
5/8/2013 5:15:11 PM Finished voltage control loop iteration: 1
5/8/2013 5:15:11 PM Number: 0 Max P: 38.480 at bus 35 Max Q: 130.994 at bus 48
5/8/2013 5:15:11 PM Number: 1 Max P: 77.429 at bus 48 Max Q: 58.848 at bus 44
5/8/2013 5:15:11 PM Number: 2 Max P: 21.336 at bus 48 Max Q: 15.157 at bus 53
5/8/2013 5:15:11 PM Number: 3 Max P: 10.420 at bus 48 Max Q: 13.089 at bus 53
5/8/2013 5:15:11 PM Number: 4 Max P: 7.347 at bus 48 Max Q: 11.687 at bus 53
5/8/2013 5:15:11 PM Number: 5 Max P: 7.101 at bus 48 Max Q: 11.485 at bus 53
5/8/2013 5:15:11 PM Number: 6 Max P: 7.089 at bus 48 Max Q: 11.476 at bus 53
5/8/2013 5:15:11 PM Number: 7 Max P: 7.088 at bus 48 Max Q: 11.476 at bus 53
5/8/2013 5:15:11 PM Number: 8 Max P: 7.088 at bus 48 Max Q: 11.476 at bus 53
5/8/2013 5:15:11 PM Number: 9 Max P: 7.088 at bus 48 Max Q: 11.476 at bus 53
5/8/2013 5:15:11 PM NR PowerFlow - Power flow unable to converge
    
```

This example illustrates how the cascaded solution work. Now let's consider this same contingency run, but now the Cowboy-Lion 345/138kV Transformer Bank is outaged before the contingency is run. Now, the initial part of the contingency processes as follows:

1. Contingency Record elements are applied
2. TOPOLOGYCHECK is done and the OPEN Gen Cowboy event is done
3. Power Flow Solution Solves
4. Etc.

The key point here is that the power flow successfully solves and you can continue on with the process.

```

5/8/2013 5:38:57 PM *****
5/8/2013 5:38:57 PM ***** Solving contingency L-2_Cowboy-Cardinal\Cowboy-Seahawk *****
5/8/2013 5:38:57 PM *****
5/8/2013 5:38:57 PM APPLYING: OPEN Line Cowboy _345.0 (31) TO Cardinal _345.0 (38) CKT 1
5/8/2013 5:38:57 PM APPLYING: OPEN Line Seahawk _345.0 (1) TO Cowboy _345.0 (31) CKT 1
5/8/2013 5:38:57 PM SKIPPING: OPEN Gen Stampeder _138.0 (53) #1
5/8/2013 5:38:57 PM SKIPPING: OPEN Gen Cowboy _345.0 (31) #1
5/8/2013 5:38:57 PM SKIPPING: OPEN InjectionGroup Viking G1 and G2
5/8/2013 5:38:57 PM SKIPPING: OPEN Gen Viking _345.0 (28) #1
5/8/2013 5:38:57 PM SKIPPING: OPEN Transformer Viking _345.0 (28) TO Dolphin _138.0 (29) CKT 1
5/8/2013 5:38:57 PM SKIPPING: OPEN Transformer Viking _345.0 (28) TO Dolphin _138.0 (29) CKT 2
5/8/2013 5:38:57 PM *****
5/8/2013 5:38:57 PM The island of bus Eskimo (50) does not have a slack.
5/8/2013 5:38:57 PM Bus Eskimo (50) changed to slack bus.
5/8/2013 5:38:57 PM *****
5/8/2013 5:38:57 PM ***** Applying TOPOLOGYCHECK for Contingency L-2_Cowboy-Cardinal\Cowboy-Seahawk *****
5/8/2013 5:38:57 PM *****
5/8/2013 5:38:57 PM APPLYING: OPEN Gen Cowboy _345.0 (31) #1
5/8/2013 5:38:57 PM SKIPPING: OPEN Gen Stampeder _138.0 (53) #1
5/8/2013 5:38:57 PM SKIPPING: OPEN InjectionGroup Viking G1 and G2
5/8/2013 5:38:57 PM SKIPPING: OPEN Gen Viking _345.0 (28) #1
5/8/2013 5:38:57 PM *****
5/8/2013 5:38:57 PM Number: 0 Max P: 164.787 at bus 38 Max Q: 138.942 at bus 1
5/8/2013 5:38:57 PM Number: 1 Max P: 40.674 at bus 38 Max Q: 54.756 at bus 1
5/8/2013 5:38:57 PM Number: 2 Max P: 2.340 at bus 1 Max Q: 2.917 at bus 1
5/8/2013 5:38:57 PM Number: 3 Max P: 0.049 at bus 53 Max Q: 0.022 at bus 53
5/8/2013 5:38:57 PM Gen(s) at bus 28 at max vars
5/8/2013 5:38:57 PM Gen(s) at bus 44 has backed off var limit
5/8/2013 5:38:57 PM Gen(s) at bus 48 has backed off var limit
5/8/2013 5:38:57 PM Switched shunt at bus 44 moved from 0.0 to 20.0 Mvars
5/8/2013 5:38:57 PM Calculating Transformer Tap Sensitivities for 7 Transformers
5/8/2013 5:38:57 PM Transformer 44 TO 41 CKT 1 can not effectively control voltage at bus 44; control will be
5/8/2013 5:38:57 PM Transformer 44 TO 41 CKT 2 can not effectively control voltage at bus 44; control will be

```

What if we were relying on the POSTCHECK section to capture the triggering of OPEN Gen COWBOY RAS?

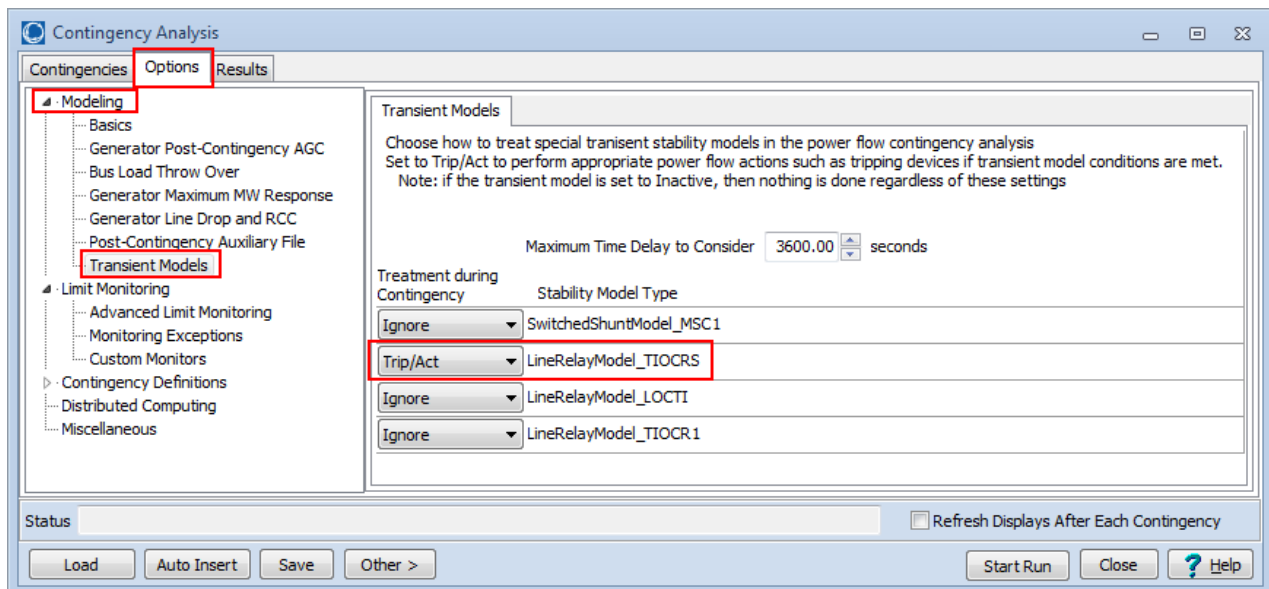
1. Contingency Record elements are applied
2. Power Flow Solution is attempted but FAILS!
3. Etc.

This happens in this particular example because there is not enough Mvar available from all the generation to keep the slack voltage at its setpoint.

## 6 Using Transient Stability Models directly in Power Flow Contingency Analysis

As was seen in the earlier section, the concept of a conditional contingency action gives great flexibility in specifying what happens when modeling RAS. However, for very simple conditional events such as the Viking – Dolphin transformers which open when their loading exceeds 135%, this seems like an unnecessary additional data input. Information like this is already entered in the transient stability relay models such as a TIOCRS which specifies an over-current relay for a transmission line. To overcome this, PowerWorld Simulator 17 has added the ability to specify that some types of transient stability models be utilized in the power flow-based contingency analysis. This feature must be hard-coded for each type of transient model for which this is applicable and as a result only a limit list is presently available.

By default, this will not be done for any transient models. To specify for which models to utilize this feature, go to the Contingency Analysis Dialog, go to the Options Tab, and then choose Modeling\Transient Models. On this part of the dialog there will be a list of transient models which have support for being utilized in the power flow based contingency analysis. Next to each model type will be a drop-down which can be toggled between *Ignore* and *Trip/Act*. This is depicted in the following figure. When choosing *Trip/Act*, then the relay model feature will be implemented in power flow contingency solution.



Choosing any *Trip/Act* options will augment the power flow contingency solution process (introduced earlier on page 13) with two additional steps 7 and 8 below.

1. Apply ALWAYS actions and TRUE CHECK actions
2. Update topology (branch, bus status)
3. Apply TRUE TOPOLOGYCHECK actions
4. Solve full power flow
5. Apply TRUE POSTCHECK actions and TRUE TOPOLOGYCHECK actions
6. If any POSTCHECK or TOPOLOGYCHECK actions are done in step 5 then repeat steps 2-5
7. Apply TRUE TRANSIENT actions that will trip next based on the time delays in transient model
8. Repeat steps 2-7 until no more TRANSIENT actions are done

When implementing evaluating the TRANSIENT actions in Step 7 above, Simulator will evaluate all stability models which have been enabled for **Treatment during Contingency** as *Trip/Act*. If multiple stability models indicate that an action would occur, then Simulator will look at when these actions will occur. It will then take only those actions that will occur first (it's possible multiple actions would occur simultaneously if they have the same time delay). Only these actions will then be applied and the process will reset back to step 2. This will continue until no new TRANSIENT actions will occur anymore.

Also note that starting in Version 18 of Simulator, a choice of *Monitor* will also be given for **Treatment during Contingency**. Choosing this option will cause Simulator to evaluate these types of transient models during the storage of contingency limit violations. If the stability model would have caused an action to occur, this will be noted as a contingency violation. Also note that frequency a transient stability model itself will have a feature which denotes that it is "Monitor Only". In this situation in Simulator Version 18, If a user chooses the option *Trip/Act* for that type of model, then the model setting will override this and instead treat it as a *Monitor Only*.

## 7 Auxiliary Files for Example

Within PowerWorld Simulator you can use either bus numbers or the combination of bus name and nominal kV. We refer to these as primary (numbers) and secondary (Name\_kV) key fields. The example as presented does not include any identifiers that are not tied to bus names, nominal kVs, or numbers. It is also possible in PowerWorld Simulator to use unique identifiers such as those tied to the definition of the objects in the EMS database. In Simulator we call these unique identifier “labels”. The definition of the labels would need to be an integral part of defining the system model.

### 7.1 Defining Labels for Example

For this example, we have created labels that are equal to the bus names and ids of the branch and generator objects. They could really be any alphanumeric string, but this was a convenient choice for this example. The following Auxiliary file will define labels for the generators and branches for this example.

```
DATA (BRANCH, [BusNum,BusNum:1,LineCircuit,AllLabels])
{
  1   31 "1" "Seahawk_Cowboy_1"
  1   40 "1" "Seahawk_Brown_1"
  3   40 "1" "49er_Brown_1"
  3   41 "1" "49er_Raider_1"
  5   18 "1" "Bronco_Redskin_1"
  5   44 "1" "Bronco_Bill_1"
 10   13 "1" "Falcon_Patriot_1"
 10   19 "1" "Falcon_Giant_1"
 10   39 "1" "Falcon_Titan_1"
 12   17 "1" "Packer_Colt_1"
 12   18 "1" "Packer_Redskin_1"
 12   27 "1" "Packer_Steeler_1"
 12   40 "1" "Packer_Brown_1"
 12   40 "2" "Packer_Brown_2"
 13   55 "1" "Patriot_Bomber_1"
 14   34 "1" "Texan_Charger_1"
 14   44 "1" "Texan_Bill_1"
 15   16 "1" "Raven_Bengal_1"
 15   24 "1" "Raven_Ram_1"
 15   54 "1" "Raven_Roughrider_1"
 15   54 "2" "Raven_Roughrider_2"
 15   54 "3" "Raven_Roughrider_3"
 16   27 "1" "Bengal_Steeler_1"
 17   19 "1" "Colt_Giant_1"
 18   37 "1" "Redskin_Eagle_1"
 18   37 "2" "Redskin_Eagle_2"
 20   34 "1" "Bear_Charger_1"
 20   48 "1" "Bear_Jet_1"
 20   50 "1" "Bear_Eskimo_1"
 21   48 "1" "Saint_Jet_1"
 21   48 "2" "Saint_Jet_2"
 24   44 "1" "Ram_Bill_1"
 28   29 "1" "Viking_Dolphin_1"
 28   29 "2" "Viking_Dolphin_2"
 31   28 "1" "Cowboy_Viking_1"
 32   29 "1" "Panther_Dolphin_1"
 29   41 "1" "Dolphin_Raider_1"
 56   29 "1" "Argonaut_Dolphin_1"
 30   32 "1" "Buccaneer_Panther_1"
 30   41 "1" "Buccaneer_Raider_1"
 35   31 "1" "Lion_Cowboy_1"
 31   38 "1" "Cowboy_Cardinal_1"
 33   32 "1" "Chief_Panther_1"
 33   50 "1" "Chief_Eskimo_1"
 35   39 "1" "Lion_Titan_1"
 35   56 "1" "Lion_Argonaut_1"
 39   38 "1" "Titan_Cardinal_1"
 39   38 "2" "Titan_Cardinal_2"
```

```

39 40 "1" "Titan_Brown_1"
39 47 "1" "Titan_Jaguar_1"
44 41 "1" "Bill_Raider_1"
44 41 "2" "Bill_Raider_2"
48 47 "1" "Jet_Jaguar_1"
47 53 "1" "Jaguar_Stampeder_1"
48 54 "1" "Jet_Roughrider_1"
54 53 "1" "Roughrider_Stampeder_1"
54 55 "1" "Roughrider_Bomber_1"
}

DATA (GEN, [BusNum, GenID, AllLabels])
{
  14 "1 " "Texan_1"
  28 "1 " "Viking_1"
  28 "2 " "Viking_2"
  31 "1 " "Cowboy_1"
  44 "1 " "Bill_1"
  48 "1 " "Jet_1"
  50 "1 " "Eskimo_1"
  53 "1 " "Stampeder_1"
  54 "1 " "Roughrider_1"
}

```

All of the following examples are thus presented using three different potential key field identifiers.

## 7.2 Auxiliary Files Defining the Basic Contingency Lists

The following three sections show the contingency definitions using

- Bus Numbers
- Bus Names and kVs
- Labels

### 7.2.1 AUX File using Bus Numbers

```

DATA (CONTINGENCYELEMENT, [CTGLabel,WhoAmI:1,FilterName,ActionStatus], AUXDEF, YES)
{
"L_Seahawk-CowboyC1"      "BRANCH 1 31 1 OPEN" "" "CHECK"
"T_Seahawk-BrownC1"      "BRANCH 1 40 1 OPEN" "" "CHECK"
"L_49er-BrownC1"         "BRANCH 3 40 1 OPEN" "" "CHECK"
"L_49er-RaiderC1"        "BRANCH 3 41 1 OPEN" "" "CHECK"
"L_Bronco-RedskinC1"     "BRANCH 5 18 1 OPEN" "" "CHECK"
"L_Bronco-BillC1"        "BRANCH 5 44 1 OPEN" "" "CHECK"
"L_Falcon-PatriotC1"     "BRANCH 10 13 1 OPEN" "" "CHECK"
"L_Falcon-GiantC1"       "BRANCH 10 19 1 OPEN" "" "CHECK"
"T_Falcon-TitanC1"       "BRANCH 10 39 1 OPEN" "" "CHECK"
"L_Packer-ColtC1"        "BRANCH 12 17 1 OPEN" "" "CHECK"
"L_Packer-RedskinC1"     "BRANCH 12 18 1 OPEN" "" "CHECK"
"L_Packer-SteelerC1"     "BRANCH 12 27 1 OPEN" "" "CHECK"
"T_Packer-BrownC1"       "BRANCH 12 40 1 OPEN" "" "CHECK"
"T_Packer-BrownC2"       "BRANCH 12 40 2 OPEN" "" "CHECK"
"L_Patriot-BomberC1"     "BRANCH 13 55 1 OPEN" "" "CHECK"
"L_Texan-ChargerC1"      "BRANCH 14 34 1 OPEN" "" "CHECK"
"L_Texan-BillC1"         "BRANCH 14 44 1 OPEN" "" "CHECK"
"L_Raven-BengalC1"       "BRANCH 15 16 1 OPEN" "" "CHECK"
"L_Raven-RamC1"          "BRANCH 15 24 1 OPEN" "" "CHECK"
"L_Raven-RoughriderC1"   "BRANCH 15 54 1 OPEN" "" "CHECK"
"L_Raven-RoughriderC2"   "BRANCH 15 54 2 OPEN" "" "CHECK"
"L_Raven-RoughriderC3"   "BRANCH 15 54 3 OPEN" "" "CHECK"
"L_Bengal-SteelerC1"     "BRANCH 16 27 1 OPEN" "" "CHECK"
"L_Colt-GiantC1"         "BRANCH 17 19 1 OPEN" "" "CHECK"
"L_Redskin-EagleC1"      "BRANCH 18 37 1 OPEN" "" "CHECK"
"L_Redskin-EagleC2"      "BRANCH 18 37 2 OPEN" "" "CHECK"
"L_Bear-ChargerC1"       "BRANCH 20 34 1 OPEN" "" "CHECK"
"L_Bear-JetC1"           "BRANCH 20 48 1 OPEN" "" "CHECK"
"L_Bear-EskimoC1"        "BRANCH 20 50 1 OPEN" "" "CHECK"
"L_Saint-JetC1"          "BRANCH 21 48 1 OPEN" "" "CHECK"
"L_Saint-JetC2"          "BRANCH 21 48 2 OPEN" "" "CHECK"
"L_Ram-BillC1"           "BRANCH 24 44 1 OPEN" "" "CHECK"
"T_Viking-DolphinC1"     "BRANCH 28 29 1 OPEN" "" "CHECK"
"T_Viking-DolphinC2"     "BRANCH 28 29 2 OPEN" "" "CHECK"
"L_Cowboy-VikingC1"      "BRANCH 31 28 1 OPEN" "" "CHECK"
"L_Panther-DolphinC1"    "BRANCH 32 29 1 OPEN" "" "CHECK"
"L_Dolphin-RaiderC1"     "BRANCH 29 41 1 OPEN" "" "CHECK"
"L_Argonaut-DolphinC1"   "BRANCH 56 29 1 OPEN" "" "CHECK"
"L_Buccaneer-PantherC1"  "BRANCH 30 32 1 OPEN" "" "CHECK"
"L_Buccaneer-RaiderC1"   "BRANCH 30 41 1 OPEN" "" "CHECK"
"T_Lion-CowboyC1"        "BRANCH 35 31 1 OPEN" "" "CHECK"
"L_Cowboy-CardinalC1"    "BRANCH 31 38 1 OPEN" "" "CHECK"
"T_Chief-PantherC1"      "BRANCH 33 32 1 OPEN" "" "CHECK"
"L_Chief-EskimoC1"       "BRANCH 33 50 1 OPEN" "" "CHECK"
"L_Lion-TitanC1"         "BRANCH 35 39 1 OPEN" "" "CHECK"
"L_Lion-ArgonautC1"      "BRANCH 35 56 1 OPEN" "" "CHECK"
"T_Titan-CardinalC1"     "BRANCH 39 38 1 OPEN" "" "CHECK"
"T_Titan-CardinalC2"     "BRANCH 39 38 2 OPEN" "" "CHECK"
"L_Titan-BrownC1"        "BRANCH 39 40 1 OPEN" "" "CHECK"
"L_Titan-JaguarC1"       "BRANCH 39 47 1 OPEN" "" "CHECK"
"T_Bill-RaiderC1"        "BRANCH 44 41 1 OPEN" "" "CHECK"
"T_Bill-RaiderC2"        "BRANCH 44 41 2 OPEN" "" "CHECK"
"T_Jet-JaguarC1"         "BRANCH 48 47 1 OPEN" "" "CHECK"
"L_Jaguar-StampederC1"   "BRANCH 47 53 1 OPEN" "" "CHECK"
"L_Jet-RoughriderC1"     "BRANCH 48 54 1 OPEN" "" "CHECK"
"T_Roughrider-StampederC1" "BRANCH 54 53 1 OPEN" "" "CHECK"
"L_Roughrider-BomberC1"  "BRANCH 54 55 1 OPEN" "" "CHECK"
"L-2_Dolphin-Panther/Dolphin-Raider" "BRANCH 32 29 1 OPEN" "" "CHECK"
"L-2_Dolphin-Panther/Dolphin-Raider" "BRANCH 29 41 1 OPEN" "" "CHECK"
"L-2_Roughrider-Raven 1&2" "BRANCH 15 54 1 OPEN" "" "CHECK"
"L-2_Roughrider-Raven 1&2" "BRANCH 15 54 2 OPEN" "" "CHECK"
"L-2_Roughrider-Raven 2&3" "BRANCH 15 54 2 OPEN" "" "CHECK"
"L-2_Roughrider-Raven 2&3" "BRANCH 15 54 3 OPEN" "" "CHECK"
"L-2_Cowboy-Cardinal\Cowboy-Seahawk" "BRANCH 31 38 1 OPEN" "" "CHECK"
"L-2_Cowboy-Cardinal\Cowboy-Seahawk" "BRANCH 1 31 1 OPEN" "" "CHECK"
}

```



## 7.2.2 AUX File using Bus Names and KVs

```

DATA (CONTINGENCYELEMENT, [CTGLabel,WhoAmI:2,FilterName,ActionStatus], AUXDEF, YES)
{
"L_Seahawk-CowboyC1"      "BRANCH 'Seahawk_345.00' 'Cowboy_345.00' 1 OPEN"      "" "CHECK"
"T_Seahawk-BrownC1"      "BRANCH 'Seahawk_345.00' 'Brown_138.00' 1 OPEN"      "" "CHECK"
"L_49er-BrownC1"        "BRANCH '49er_138.00' 'Brown_138.00' 1 OPEN"      "" "CHECK"
"L_49er-RaiderC1"       "BRANCH '49er_138.00' 'Raider_138.00' 1 OPEN"      "" "CHECK"
"L_Bronco-RedskinC1"     "BRANCH 'Bronco_69.00' 'Redskin_69.00' 1 OPEN"      "" "CHECK"
"L_Bronco-BillC1"       "BRANCH 'Bronco_69.00' 'Bill_69.00' 1 OPEN"      "" "CHECK"
"L_Falcon-PatriotC1"     "BRANCH 'Falcon_69.00' 'Patriot_69.00' 1 OPEN"      "" "CHECK"
"L_Falcon-GiantC1"      "BRANCH 'Falcon_69.00' 'Giant_69.00' 1 OPEN"      "" "CHECK"
"T_Falcon-TitanC1"      "BRANCH 'Falcon_69.00' 'Titan_138.00' 1 OPEN"      "" "CHECK"
"L_Packer-ColtC1"       "BRANCH 'Packer_69.00' 'Colt_69.00' 1 OPEN"      "" "CHECK"
"L_Packer-RedskinC1"     "BRANCH 'Packer_69.00' 'Redskin_69.00' 1 OPEN"      "" "CHECK"
"L_Packer-SteelerC1"     "BRANCH 'Packer_69.00' 'Steeler_69.00' 1 OPEN"      "" "CHECK"
"T_Packer-BrownC1"      "BRANCH 'Packer_69.00' 'Brown_138.00' 1 OPEN"      "" "CHECK"
"T_Packer-BrownC2"      "BRANCH 'Packer_69.00' 'Brown_138.00' 2 OPEN"      "" "CHECK"
"L_Patriot-BomberC1"    "BRANCH 'Patriot_69.00' 'Bomber_69.00' 1 OPEN"      "" "CHECK"
"L_Texan-ChargerC1"     "BRANCH 'Texan_69.00' 'Charger_69.00' 1 OPEN"      "" "CHECK"
"L_Texan-BillC1"        "BRANCH 'Texan_69.00' 'Bill_69.00' 1 OPEN"      "" "CHECK"
"L_Raven-BengalC1"      "BRANCH 'Raven_69.00' 'Bengal_69.00' 1 OPEN"      "" "CHECK"
"L_Raven-RamC1"         "BRANCH 'Raven_69.00' 'Ram_69.00' 1 OPEN"      "" "CHECK"
"L_Raven-RoughriderC1"  "BRANCH 'Raven_69.00' 'Roughrider_69.00' 1 OPEN"    "" "CHECK"
"L_Raven-RoughriderC2"  "BRANCH 'Raven_69.00' 'Roughrider_69.00' 2 OPEN"    "" "CHECK"
"L_Raven-RoughriderC3"  "BRANCH 'Raven_69.00' 'Roughrider_69.00' 3 OPEN"    "" "CHECK"
"L_Bengal-SteelerC1"    "BRANCH 'Bengal_69.00' 'Steeler_69.00' 1 OPEN"      "" "CHECK"
"L_Colt-GiantC1"        "BRANCH 'Colt_69.00' 'Giant_69.00' 1 OPEN"      "" "CHECK"
"L_Redskin-EagleC1"     "BRANCH 'Redskin_69.00' 'Eagle_69.00' 1 OPEN"      "" "CHECK"
"L_Redskin-EagleC2"     "BRANCH 'Redskin_69.00' 'Eagle_69.00' 2 OPEN"      "" "CHECK"
"L_Bear-ChargerC1"      "BRANCH 'Bear_69.00' 'Charger_69.00' 1 OPEN"      "" "CHECK"
"L_Bear-JetC1"          "BRANCH 'Bear_69.00' 'Jet_69.00' 1 OPEN"      "" "CHECK"
"L_Bear-EskimoC1"       "BRANCH 'Bear_69.00' 'Eskimo_69.00' 1 OPEN"      "" "CHECK"
"L_Saint-JetC1"         "BRANCH 'Saint_69.00' 'Jet_69.00' 1 OPEN"      "" "CHECK"
"L_Saint-JetC2"         "BRANCH 'Saint_69.00' 'Jet_69.00' 2 OPEN"      "" "CHECK"
"L_Ram-BillC1"          "BRANCH 'Ram_69.00' 'Bill_69.00' 1 OPEN"      "" "CHECK"
"T_Viking-DolphinC1"    "BRANCH 'Viking_345.00' 'Dolphin_138.00' 1 OPEN"    "" "CHECK"
"T_Viking-DolphinC2"    "BRANCH 'Viking_345.00' 'Dolphin_138.00' 2 OPEN"    "" "CHECK"
"L_Cowboy-VikingC1"     "BRANCH 'Cowboy_345.00' 'Viking_345.00' 1 OPEN"    "" "CHECK"
"L_Panther-DolphinC1"   "BRANCH 'Panther_138.00' 'Dolphin_138.00' 1 OPEN"    "" "CHECK"
"L_Dolphin-RaiderC1"    "BRANCH 'Dolphin_138.00' 'Raider_138.00' 1 OPEN"    "" "CHECK"
"L_Argonaut-DolphinC1"  "BRANCH 'Argonaut_138.00' 'Dolphin_138.00' 1 OPEN"    "" "CHECK"
"L_Buccaneer-PantherC1" "BRANCH 'Buccaneer_138.00' 'Panther_138.00' 1 OPEN"    "" "CHECK"
"L_Buccaneer-RaiderC1"  "BRANCH 'Buccaneer_138.00' 'Raider_138.00' 1 OPEN"    "" "CHECK"
"T_Lion-CowboyC1"       "BRANCH 'Lion_138.00' 'Cowboy_345.00' 1 OPEN"      "" "CHECK"
"L_Cowboy-CardinalC1"   "BRANCH 'Cowboy_345.00' 'Cardinal_345.00' 1 OPEN"    "" "CHECK"
"T_Chief-PantherC1"     "BRANCH 'Chief_69.00' 'Panther_138.00' 1 OPEN"      "" "CHECK"
"L_Chief-EskimoC1"      "BRANCH 'Chief_69.00' 'Eskimo_69.00' 1 OPEN"      "" "CHECK"
"L_Lion-TitanC1"        "BRANCH 'Lion_138.00' 'Titan_138.00' 1 OPEN"      "" "CHECK"
"L_Lion-ArgonautC1"     "BRANCH 'Lion_138.00' 'Argonaut_138.00' 1 OPEN"      "" "CHECK"
"T_Titan-CardinalC1"    "BRANCH 'Titan_138.00' 'Cardinal_345.00' 1 OPEN"      "" "CHECK"
"T_Titan-CardinalC2"    "BRANCH 'Titan_138.00' 'Cardinal_345.00' 2 OPEN"      "" "CHECK"
"L_Titan-BrownC1"       "BRANCH 'Titan_138.00' 'Brown_138.00' 1 OPEN"      "" "CHECK"
"L_Titan-JaguarC1"      "BRANCH 'Titan_138.00' 'Jaguar_138.00' 1 OPEN"      "" "CHECK"
"T_Bill-RaiderC1"       "BRANCH 'Bill_69.00' 'Raider_138.00' 1 OPEN"      "" "CHECK"
"T_Bill-RaiderC2"       "BRANCH 'Bill_69.00' 'Raider_138.00' 2 OPEN"      "" "CHECK"
"T_Jet-JaguarC1"        "BRANCH 'Jet_69.00' 'Jaguar_138.00' 1 OPEN"      "" "CHECK"
"L_Jaguar-StampederC1"  "BRANCH 'Jaguar_138.00' 'Stampeder_138.00' 1 OPEN"    "" "CHECK"
"L_Jet-RoughriderC1"    "BRANCH 'Jet_69.00' 'Roughrider_69.00' 1 OPEN"      "" "CHECK"
"T_Roughrider-StampederC1" "BRANCH 'Roughrider_69.00' 'Stampeder_138.00' 1 OPEN" "" "CHECK"
"L_Roughrider-BomberC1" "BRANCH 'Roughrider_69.00' 'Bomber_69.00' 1 OPEN"    "" "CHECK"
"L-2_Dolphin-Panther/Dolphin-Raider" "BRANCH 'Panther_138.00' 'Dolphin_138.00' 1 OPEN" "" "CHECK"
"L-2_Dolphin-Panther/Dolphin-Raider" "BRANCH 'Dolphin_138.00' 'Raider_138.00' 1 OPEN" "" "CHECK"
"L-2_Roughrider-Raven 1&2" "BRANCH 'Raven_69.00' 'Roughrider_69.00' 1 OPEN" "" "CHECK"
"L-2_Roughrider-Raven 1&2" "BRANCH 'Raven_69.00' 'Roughrider_69.00' 2 OPEN" "" "CHECK"
"L-2_Roughrider-Raven 2&3" "BRANCH 'Raven_69.00' 'Roughrider_69.00' 2 OPEN" "" "CHECK"
"L-2_Roughrider-Raven 2&3" "BRANCH 'Raven_69.00' 'Roughrider_69.00' 3 OPEN" "" "CHECK"
"L-2_Cowboy-Cardinal\Cowboy-Seahawk" "BRANCH 'Cowboy_345.00' 'Cardinal_345.00' 1 OPEN" "" "CHECK"
"L-2_Cowboy-Cardinal\Cowboy-Seahawk" "BRANCH 'Seahawk_345.00' 'Cowboy_345.00' 1 OPEN" "" "CHECK"
}

```



## 7.2.3 AUX File using Labels

```

DATA (CONTINGENCYELEMENT, [CTGLabel,WhoAmI:1,FilterName,ActionStatus], AUXDEF, YES)
{
"L-2_Roughrider-Raven 2&3"      "BRANCH 'Raven_Roughrider_2'  OPEN"      "" "CHECK"
"L-2_Roughrider-Raven 2&3"      "BRANCH 'Raven_Roughrider_3'  OPEN"      "" "CHECK"
"L-2_Roughrider-Raven 1&2"      "BRANCH 'Raven_Roughrider_1'  OPEN"      "" "CHECK"
"L-2_Roughrider-Raven 1&2"      "BRANCH 'Raven_Roughrider_2'  OPEN"      "" "CHECK"
"L_Falcon-PatriotC1"           "BRANCH 'Falcon_Patriot_1'    OPEN"      "" "CHECK"
"T_Falcon-TitanC1"             "BRANCH 'Falcon_Titan_1'     OPEN"      "" "CHECK"
"L_Packer-RedskinC1"           "BRANCH 'Packer_Redskin_1'    OPEN"      "" "CHECK"
"L_Raven-RoughriderC2"         "BRANCH 'Raven_Roughrider_2'  OPEN"      "" "CHECK"
"L_Raven-RoughriderC3"         "BRANCH 'Raven_Roughrider_3'  OPEN"      "" "CHECK"
"L_Raven-RoughriderC1"         "BRANCH 'Raven_Roughrider_1'  OPEN"      "" "CHECK"
"T_Roughrider-StampederC1"     "BRANCH 'Roughrider_Stampeder_1' OPEN"      "" "CHECK"
"T_Packer-BrownC2"             "BRANCH 'Packer_Brown_2'     OPEN"      "" "CHECK"
"T_Packer-BrownC1"             "BRANCH 'Packer_Brown_1'     OPEN"      "" "CHECK"
"L_Packer-SteelerC1"           "BRANCH 'Packer_Steeler_1'    OPEN"      "" "CHECK"
"L_Bear-JetC1"                 "BRANCH 'Bear_Jet_1'         OPEN"      "" "CHECK"
"L_Patriot-BomberC1"           "BRANCH 'Patriot_Bomber_1'    OPEN"      "" "CHECK"
"L_Bronco-BillC1"              "BRANCH 'Bronco_Bill_1'      OPEN"      "" "CHECK"
"L_49er-BrownC1"               "BRANCH '49er_Brown_1'       OPEN"      "" "CHECK"
"L_Chief-EskimoC1"             "BRANCH 'Chief_Eskimo_1'     OPEN"      "" "CHECK"
"L_Cowboy-CardinalC1"          "BRANCH 'Cowboy_Cardinal_1'   OPEN"      "" "CHECK"
"L_Buccaneer-RaiderC1"         "BRANCH 'Buccaneer_Raider_1'  OPEN"      "" "CHECK"
"L_Packer-ColtC1"              "BRANCH 'Packer_Colt_1'       OPEN"      "" "CHECK"
"L_Lion-TitanC1"               "BRANCH 'Lion_Titan_1'       OPEN"      "" "CHECK"
"L_Bengal-SteelerC1"           "BRANCH 'Bengal_Steeler_1'    OPEN"      "" "CHECK"
"L_Colt-GiantC1"               "BRANCH 'Colt_Giant_1'       OPEN"      "" "CHECK"
"L_Redskin-EagleC1"            "BRANCH 'Redskin_Eagle_1'     OPEN"      "" "CHECK"
"L_Redskin-EagleC2"            "BRANCH 'Redskin_Eagle_2'     OPEN"      "" "CHECK"
"L_Bear-ChargerC1"             "BRANCH 'Bear_Charger_1'     OPEN"      "" "CHECK"
"L_Roughrider-BomberC1"        "BRANCH 'Roughrider_Bomber_1' OPEN"      "" "CHECK"
"L_Bear-EskimoC1"              "BRANCH 'Bear_Eskimo_1'      OPEN"      "" "CHECK"
"L_Saint-JetC1"                "BRANCH 'Saint_Jet_1'        OPEN"      "" "CHECK"
"L_Saint-JetC2"                "BRANCH 'Saint_Jet_2'        OPEN"      "" "CHECK"
"L_Bronco-RedskinC1"           "BRANCH 'Bronco_Redskin_1'    OPEN"      "" "CHECK"
"L_Raven-RamC1"                "BRANCH 'Raven_Ram_1'        OPEN"      "" "CHECK"
"L_Dolphin-RaiderC1"           "BRANCH 'Dolphin_Raider_1'    OPEN"      "" "CHECK"
"L_Panther-DolphinC1"          "BRANCH 'Panther_Dolphin_1'   OPEN"      "" "CHECK"
"L_Raven-BengalC1"             "BRANCH 'Raven_Bengal_1'     OPEN"      "" "CHECK"
"L_Cowboy-VikingC1"            "BRANCH 'Cowboy_Viking_1'     OPEN"      "" "CHECK"
"L_Argonaut-DolphinC1"         "BRANCH 'Argonaut_Dolphin_1'  OPEN"      "" "CHECK"
"L_Buccaneer-PantherC1"        "BRANCH 'Buccaneer_Panther_1' OPEN"      "" "CHECK"
"T_Viking-DolphinC2"           "BRANCH 'Viking_Dolphin_2'    OPEN"      "" "CHECK"
"T_Lion-CowboyC1"              "BRANCH 'Lion_Cowboy_1'       OPEN"      "" "CHECK"
"L_Texan-BillC1"               "BRANCH 'Texan_Bill_1'       OPEN"      "" "CHECK"
"T_Chief-PantherC1"            "BRANCH 'Chief_Panther_1'     OPEN"      "" "CHECK"
"T_Viking-DolphinC1"           "BRANCH 'Viking_Dolphin_1'    OPEN"      "" "CHECK"
"L_Ram-BillC1"                 "BRANCH 'Ram_Bill_1'         OPEN"      "" "CHECK"
"L_Lion-ArgonautC1"            "BRANCH 'Lion_Argonaut_1'     OPEN"      "" "CHECK"
"T_Titan-CardinalC1"           "BRANCH 'Titan_Cardinal_1'    OPEN"      "" "CHECK"
"T_Titan-CardinalC2"           "BRANCH 'Titan_Cardinal_2'    OPEN"      "" "CHECK"
"L_Titan-BrownC1"              "BRANCH 'Titan_Brown_1'       OPEN"      "" "CHECK"
"L_Titan-JaguarC1"             "BRANCH 'Titan_Jaguar_1'      OPEN"      "" "CHECK"
"T_Bill-RaiderC1"              "BRANCH 'Bill_Raider_1'       OPEN"      "" "CHECK"
"T_Bill-RaiderC2"              "BRANCH 'Bill_Raider_2'       OPEN"      "" "CHECK"
"T_Jet-JaguarC1"               "BRANCH 'Jet_Jaguar_1'       OPEN"      "" "CHECK"
"L_Jaguar-StampederC1"         "BRANCH 'Jaguar_Stampeder_1'  OPEN"      "" "CHECK"
"L_Jet-RoughriderC1"           "BRANCH 'Jet_Roughrider_1'    OPEN"      "" "CHECK"
"L_Texan-ChargerC1"            "BRANCH 'Texan_Charger_1'     OPEN"      "" "CHECK"
"L_Falcon-GiantC1"             "BRANCH 'Falcon_Giant_1'     OPEN"      "" "CHECK"
"L-2_Dolphin-Panther/Dolphin-Raider" "BRANCH 'Panther_Dolphin_1' OPEN"      "" "CHECK"
"L-2_Dolphin-Panther/Dolphin-Raider" "BRANCH 'Dolphin_Raider_1'   OPEN"      "" "CHECK"
"L_49er-RaiderC1"              "BRANCH '49er_Raider_1'      OPEN"      "" "CHECK"
"T_Seahawk-BrownC1"            "BRANCH 'Seahawk_Brown_1'     OPEN"      "" "CHECK"
"L-2_Cowboy-Cardinal\Cowboy-Seahawk" "BRANCH 'Cowboy_Cardinal_1'   OPEN"      "" "CHECK"
"L-2_Cowboy-Cardinal\Cowboy-Seahawk" "BRANCH 'Seahawk_Cowboy_1'   OPEN"      "" "CHECK"
"L_Seahawk-CowboyC1"           "BRANCH 'Seahawk_Cowboy_1'   OPEN"      "" "CHECK"
}

```

## 7.3 Auxiliary File Defining the RAS

The following three sections show the RAS definitions using

- Bus Numbers
- Bus Names and kVs
- Labels

### 7.3.1 AUX File using Bus Numbers

```
//-----
// Set the participation factor for all generators equal to the maximum MW output
//-----
SCRIPT
{
SetData(GEN, [GenParFac], ["@GenMWMax"], All);
}
//-----
// Specify that all generators in the island response in proportion to their size
//-----
DATA (CTG_OPTIONS, [UseAreaPartsMakeUpPower])
{
"Gen Part Factors"
}

//-----
// This creates an injection group containing both Viking Generators
//-----
DATA (PARTPOINT, [PPntType:1,PPntType,BusNum,PPntID,PPntPFinIt,PPntParFac,PPntUseFixedParFac], AUXDEF, YES)
{
"Viking G1 and G2" "GEN"      28 "1 " "SPECIFIED"    150.00 "NO"
"Viking G1 and G2" "GEN"      28 "2 " "SPECIFIED"    150.00 "NO"
}

//-----
// These represent the boolean evaluations of various objects in the system
// Some represent a test of whether "Online = YES"
// Some represent a test of whether a branch is more than 135% of its limit
//-----
DATA (MODELCONDITION, [FilterName,WhoAmI,ObjectType,FilterLogic,FilterPre,DisableIfTrueInCTGReferenceState,EvaluateInRef],AUXDEF,YES)
{
"Cowboy-Cardinal 1 345kV Line"      "Branch 31 38 1" "Branch" "AND" "NO" "YES" "NO"
  <SUBDATA Condition>
    BusObjectOnline = "NO"
  </SUBDATA>
"Cowboy-Line 345/138kV Transformer"  "Branch 35 31 1" "Branch" "AND" "NO" "YES" "NO"
  <SUBDATA Condition>
    BusObjectOnline = "NO"
  </SUBDATA>
"Cowboy-Seahawk 1 345kV Line"       "Branch  1 31 1" "Branch" "AND" "NO" "YES" "NO"
```

```

    <SUBDATA Condition>
      BusObjectOnline = "NO"
    </SUBDATA>
"Dolphin-Panther 1 138kV Line"      "Branch 32 29 1" "Branch" "AND" "NO" "YES" "NO"
  <SUBDATA Condition>
    BusObjectOnline = "NO"
  </SUBDATA>
"Dolphin-Raider 1 138 kV Line"      "Branch 29 41 1" "Branch" "AND" "NO" "YES" "NO"
  <SUBDATA Condition>
    BusObjectOnline = "NO"
  </SUBDATA>
"Roughrider-Raven 1 69kV Line"      "Branch 15 54 1" "Branch" "AND" "NO" "YES" "NO"
  <SUBDATA Condition>
    BusObjectOnline = "NO"
  </SUBDATA>
"Roughrider-Raven 2 69kV Line"      "Branch 15 54 2" "Branch" "AND" "NO" "YES" "NO"
  <SUBDATA Condition>
    BusObjectOnline = "NO"
  </SUBDATA>
"Roughrider-Raven 3 69kV Line"      "Branch 15 54 3" "Branch" "AND" "NO" "YES" "NO"
  <SUBDATA Condition>
    BusObjectOnline = "NO"
  </SUBDATA>
"Viking-Dolphin 1 345/138 Over 135%" "Branch 28 29 1" "Branch" "AND" "NO" "NO" "NO"
  <SUBDATA Condition>
    LineLimitPercent:2 > 135.00000
  </SUBDATA>
"Viking-Dolphin 2 345/138 Over 135%" "Branch 28 29 2" "Branch" "AND" "NO" "NO" "NO"
  <SUBDATA Condition>
    LineLimitPercent:2 > 135.00000
  </SUBDATA>
}

//-----
// The following describe the various Model Filters
// These perform boolean operations on combinations of Model Conditions and Filters
//-----
DATA (MODELFILTER, [FilterName,FilterLogic], AUXDEF, YES)
{
"OPEN Cowboy G1" "AND"
  <SUBDATA ModelCondition>
    "Cowboy-Cardinal 1 345kV Line"      "No"
    "Cowboy-Seahawk 1 345kV Line"      "No"
    "Cowboy-Line 345/138kV Transformer" "No"
  </SUBDATA>
"OPEN Stampeder G1" "OR"
  <SUBDATA ModelCondition>
    "Roughrider-Raven 1 & 2" "No"
    "Roughrider-Raven 2 & 3" "No"
  </SUBDATA>
"OPEN Viking G1 and G2" "AND"

```

```

<SUBDATA ModelCondition>
  "Dolphin-Raider 1 138 kV Line"  "No"
  "Dolphin-Panther 1 138kV Line"  "No"
</SUBDATA>
"Roughrider-Raven 1 & 2" "AND"
<SUBDATA ModelCondition>
  "Roughrider-Raven 1 69kV Line"  "No"
  "Roughrider-Raven 2 69kV Line"  "No"
</SUBDATA>
"Roughrider-Raven 2 & 3" "AND"
<SUBDATA ModelCondition>
  "Roughrider-Raven 2 69kV Line"  "No"
  "Roughrider-Raven 3 69kV Line"  "No"
</SUBDATA>
}

//-----
// THE FOLLOWING SECTION CONTAINS THE LIST OF GLOBAL CONTINGENCY ACTIONS
// These essentially function like "RAS" objects
//-----
DATA (GLOBALCONTINGENCYACTIONSELEMENT, [WhoAmI:1,FilterName,ActionStatus], AUXDEF, YES)
{
"GEN 53 1  OPEN"                "OPEN Stampeder G1"                "TOPOLOGYCHECK"
"GEN 31 1  OPEN"                "OPEN Cowboy G1"                  "TOPOLOGYCHECK"
"INJECTIONGROUP 'Viking G1 and G2'  OPEN" "OPEN Viking G1 and G2"            "TOPOLOGYCHECK"
"GEN 28 1  OPEN"                "Dolphin-Raider 1 138 kV Line"      "TOPOLOGYCHECK"
"BRANCH 28 29 1  OPEN"          "Viking-Dolphin 1 345/138 Over 135%" "POSTCHECK"
"BRANCH 28 29 2  OPEN"          "Viking-Dolphin 2 345/138 Over 135%" "POSTCHECK"
}

```

### 7.3.2 AUX File using Bus Names and KVs

```

//-----
// Set the participation factor for all generators equal to the maximum MW output
//-----
SCRIPT
{
SetData(GEN, [GenParFac], ["@GenMWMax"], All);
}
//-----
// Specify that all generators in the island response in proportion to their size
//-----
DATA (CTG_OPTIONS, [UseAreaPartsMakeUpPower])
{
"Gen Part Factors"
}

//-----
// This creates an injection group containing both Viking Generators
//-----
DATA (PARTPOINT, [PPntType:1,PPntType,BusName_NomVolt,PPntID,PPntPFinIt,PPntParFac,PPntUseFixedParFac], AUXDEF, YES)

```

```

{
"Viking G1 and G2" "GEN" "Viking_345.00" "1" "SPECIFIED" 150.00 "NO"
"Viking G1 and G2" "GEN" "Viking_345.00" "2" "SPECIFIED" 150.00 "NO"
}

//-----
// These represent the boolean evaluations of various objects in the system
// Some represent a test of whether "Online = YES"
// Some represent a test of whether a branch is more than 135% of its limit
//-----
DATA (MODELCONDITION, [FilterName,WhoAmI,ObjectType,FilterLogic,FilterPre,DisableIfTrueInCTGReferenceState,EvaluateInRef],AUXDEF,YES)
{
"Cowboy-Cardinal 1 345kV Line" "Branch 'Cowboy_345.00' 'Cardinal_345.00' '1'" "Branch" "AND" "NO" "YES" "NO"
  <SUBDATA Condition>
    BusObjectOnline = "NO"
  </SUBDATA>
"Cowboy-Line 345/138kV Transformer" "Branch 'Lion_138.00' 'Cowboy_345.00' '1'" "Branch" "AND" "NO" "YES" "NO"
  <SUBDATA Condition>
    BusObjectOnline = "NO"
  </SUBDATA>
"Cowboy-Seahawk 1 345kV Line" "Branch 'Seahawk_345.00' 'Cowboy_345.00' '1'" "Branch" "AND" "NO" "YES" "NO"
  <SUBDATA Condition>
    BusObjectOnline = "NO"
  </SUBDATA>
"Dolphin-Panther 1 138kV Line" "Branch 'Panther_138.00' 'Dolphin_138.00' '1'" "Branch" "AND" "NO" "YES" "NO"
  <SUBDATA Condition>
    BusObjectOnline = "NO"
  </SUBDATA>
"Dolphin-Raider 1 138 kV Line" "Branch 'Dolphin_138.00' 'Raider_138.00' '1'" "Branch" "AND" "NO" "YES" "NO"
  <SUBDATA Condition>
    BusObjectOnline = "NO"
  </SUBDATA>
"Roughrider-Raven 1 69kV Line" "Branch 'Raven_ 69.00' 'Roughrider_ 69.00' '1'" "Branch" "AND" "NO" "YES" "NO"
  <SUBDATA Condition>
    BusObjectOnline = "NO"
  </SUBDATA>
"Roughrider-Raven 2 69kV Line" "Branch 'Raven_ 69.00' 'Roughrider_ 69.00' '2'" "Branch" "AND" "NO" "YES" "NO"
  <SUBDATA Condition>
    BusObjectOnline = "NO"
  </SUBDATA>
"Roughrider-Raven 3 69kV Line" "Branch 'Raven_ 69.00' 'Roughrider_ 69.00' '3'" "Branch" "AND" "NO" "YES" "NO"
  <SUBDATA Condition>
    BusObjectOnline = "NO"
  </SUBDATA>
"Viking-Dolphin 1 345/138 Over 135%" "Branch 'Viking_345.00' 'Dolphin_138.00' '1'" "Branch" "AND" "NO" "NO" "NO"
  <SUBDATA Condition>
    LineLimitPercent:2 > 135.00000
  </SUBDATA>
"Viking-Dolphin 2 345/138 Over 135%" "Branch 'Viking_345.00' 'Dolphin_138.00' '2'" "Branch" "AND" "NO" "NO" "NO"
  <SUBDATA Condition>
    LineLimitPercent:2 > 135.00000

```

```

    </SUBDATA>
}

//-----
// The following describe the various Model Filters
// These perform boolean operations on combinations of Model Conditions and Filters
//-----
DATA (MODELFILTER, [FilterName,FilterLogic], AUXDEF, YES)
{
"OPEN Cowboy G1" "AND"
  <SUBDATA ModelCondition>
    "Cowboy-Cardinal 1 345kV Line"      "No"
    "Cowboy-Seahawk 1 345kV Line"      "No"
    "Cowboy-Line 345/138kV Transformer" "No"
  </SUBDATA>
"OPEN Stampeders G1" "OR"
  <SUBDATA ModelCondition>
    "Roughrider-Raven 1 & 2" "No"
    "Roughrider-Raven 2 & 3" "No"
  </SUBDATA>
"OPEN Viking G1 and G2" "AND"
  <SUBDATA ModelCondition>
    "Dolphin-Raider 1 138 kV Line" "No"
    "Dolphin-Panther 1 138kV Line" "No"
  </SUBDATA>
"Roughrider-Raven 1 & 2" "AND"
  <SUBDATA ModelCondition>
    "Roughrider-Raven 1 69kV Line" "No"
    "Roughrider-Raven 2 69kV Line" "No"
  </SUBDATA>
"Roughrider-Raven 2 & 3" "AND"
  <SUBDATA ModelCondition>
    "Roughrider-Raven 2 69kV Line" "No"
    "Roughrider-Raven 3 69kV Line" "No"
  </SUBDATA>
}

//-----
// THE FOLLOWING SECTION CONTAINS THE LIST OF GLOBAL CONTINGENCY ACTIONS
// These essentially function like "RAS" objects
//-----
DATA (GLOBALCONTINGENCYACTIONSELEMENT, [WhoAmI:2,FilterName,ActionStatus], AUXDEF, YES)
{
"GEN 'Stampeders_138.00' 1 OPEN"      "OPEN Stampeders G1"      "TOPOLOGYCHECK"
"GEN 'Cowboy_345.00' 1 OPEN"          "OPEN Cowboy G1"        "TOPOLOGYCHECK"
"INJECTIONGROUP 'Viking G1 and G2' OPEN"  "OPEN Viking G1 and G2"  "TOPOLOGYCHECK"
"GEN 'Viking_345.00' 1 OPEN"          "Dolphin-Raider 1 138 kV Line" "TOPOLOGYCHECK"
"BRANCH 'Viking_345.00' 'Dolphin_138.00' 1 OPEN" "Viking-Dolphin 1 345/138 Over 135%" "POSTCHECK"
"BRANCH 'Viking_345.00' 'Dolphin_138.00' 2 OPEN" "Viking-Dolphin 2 345/138 Over 135%" "POSTCHECK"
}

```

### 7.3.3 AUX File using Labels

```
//-----
// Set the participation factor for all generators equal to the maximum MW output
//-----
SCRIPT
{
SetData(GEN, [GenParFac], ["@GenMWMax"], All);
}
//-----
// Specify that all generators in the island response in proportion to their size
//-----
DATA (CTG_OPTIONS, [UseAreaPartsMakeUpPower])
{
"Gen Part Factors"
}

//-----
// This creates an injection group containing both Viking Generators
//-----
DATA (PARTPOINT, [PPntType:1,PPntType,BusName_NomVolt,PPntID,PPntPFinIt,PPntParFac,PPntUseFixedParFac], AUXDEF, YES)
{
"Viking G1 and G2" "GEN" "Viking_1" "" "SPECIFIED" 150.00 "NO"
"Viking G1 and G2" "GEN" "Viking_2" "" "SPECIFIED" 150.00 "NO"
}

//-----
// These represent the boolean evaluations of various objects in the system
// Some represent a test of whether "Online = YES"
// Some represent a test of whether a branch is more than 135% of its limit
//-----
DATA (MODELCONDITION, [FilterName,WhoAmI,ObjectType,FilterLogic,FilterPre,DisableIfTrueInCTGReferenceState,EvaluateInRef],AUXDEF,YES)
{
"Cowboy-Cardinal 1 345kV Line" "BRANCH 'Cowboy_Cardinal_1'" "Branch" "AND" "NO" "YES" "NO"
<SUBDATA Condition>
BusObjectOnline = "NO"
</SUBDATA>
"Cowboy-Line 345/138kV Transformer" "BRANCH 'Lion_Cowboy_1'" "Branch" "AND" "NO" "YES" "NO"
<SUBDATA Condition>
BusObjectOnline = "NO"
</SUBDATA>
"Cowboy-Seahawk 1 345kV Line" "BRANCH 'Seahawk_Cowboy_1'" "Branch" "AND" "NO" "YES" "NO"
<SUBDATA Condition>
BusObjectOnline = "NO"
</SUBDATA>
"Dolphin-Panther 1 138kV Line" "BRANCH 'Panther_Dolphin_1'" "Branch" "AND" "NO" "YES" "NO"
<SUBDATA Condition>
BusObjectOnline = "NO"
</SUBDATA>
"Dolphin-Raider 1 138 kV Line" "BRANCH 'Dolphin_Raider_1'" "Branch" "AND" "NO" "YES" "NO"
<SUBDATA Condition>
BusObjectOnline = "NO"
}
```

```

</SUBDATA>
"Roughrider-Raven 1 69kV Line"      "BRANCH 'Raven_Roughrider_1'" "Branch" "AND" "NO" "YES" "NO"
  <SUBDATA Condition>
    BusObjectOnline = "NO"
  </SUBDATA>
"Roughrider-Raven 2 69kV Line"      "BRANCH 'Raven_Roughrider_2'" "Branch" "AND" "NO" "YES" "NO"
  <SUBDATA Condition>
    BusObjectOnline = "NO"
  </SUBDATA>
"Roughrider-Raven 3 69kV Line"      "BRANCH 'Raven_Roughrider_3'" "Branch" "AND" "NO" "YES" "NO"
  <SUBDATA Condition>
    BusObjectOnline = "NO"
  </SUBDATA>
"Viking-Dolphin 1 345/138 Over 135%" "BRANCH 'Viking_Dolphin_1'"  "Branch" "AND" "NO" "NO"  "NO"
  <SUBDATA Condition>
    LineLimitPercent:2 > 135.00000
  </SUBDATA>
"Viking-Dolphin 2 345/138 Over 135%" "BRANCH 'Viking_Dolphin_2'"  "Branch" "AND" "NO" "NO"  "NO"
  <SUBDATA Condition>
    LineLimitPercent:2 > 135.00000
  </SUBDATA>
}

//-----
// The following describe the various Model Filters
// These perform boolean operations on combinations of Model Conditions and Filters
//-----
DATA (MODELFILTER, [FilterName,FilterLogic], AUXDEF, YES)
{
"OPEN Cowboy G1" "AND"
  <SUBDATA ModelCondition>
    "Cowboy-Cardinal 1 345kV Line"      "No"
    "Cowboy-Seahawk 1 345kV Line"      "No"
    "Cowboy-Line 345/138kV Transformer" "No"
  </SUBDATA>
"OPEN Stampedeer G1" "OR"
  <SUBDATA ModelCondition>
    "Roughrider-Raven 1 & 2"  "No"
    "Roughrider-Raven 2 & 3"  "No"
  </SUBDATA>
"OPEN Viking G1 and G2" "AND"
  <SUBDATA ModelCondition>
    "Dolphin-Raider 1 138 kV Line"  "No"
    "Dolphin-Panther 1 138kV Line"  "No"
  </SUBDATA>
"Roughrider-Raven 1 & 2" "AND"
  <SUBDATA ModelCondition>
    "Roughrider-Raven 1 69kV Line"  "No"
    "Roughrider-Raven 2 69kV Line"  "No"
  </SUBDATA>
"Roughrider-Raven 2 & 3" "AND"

```



```

<SUBDATA ModelCondition>
  "Roughrider-Raven 2 69kV Line"  "No"
  "Roughrider-Raven 3 69kV Line"  "No"
</SUBDATA>
}

//-----
// THE FOLLOWING SECTION CONTAINS THE LIST OF GLOBAL CONTINGENCY ACTIONS
// These essentially function like "RAS" objects
//-----
DATA (GLOBALCONTINGENCYACTIONSELEMENT, [WhoAmI:1,FilterName,ActionStatus], AUXDEF, YES)
{
"GEN 'Stampeder_1'  OPEN"           "OPEN Stampeder G1"           "TOPOLOGYCHECK"
"GEN 'Cowboy_1'  OPEN"             "OPEN Cowboy G1"             "TOPOLOGYCHECK"
"INJECTIONGROUP 'Viking G1 and G2'  OPEN" "OPEN Viking G1 and G2"       "TOPOLOGYCHECK"
"GEN 'Viking_1'  OPEN"             "Dolphin-Raider 1 138 kV Line" "TOPOLOGYCHECK"
"BRANCH 'Viking_Dolphin_1'  OPEN"      "Viking-Dolphin 1 345/138 Over 135%" "POSTCHECK"
"BRANCH 'Viking_Dolphin_2'  OPEN"      "Viking-Dolphin 2 345/138 Over 135%" "POSTCHECK"
}

```