

BONNEVILLE POWER ADMINISTRATION



Event-based RAS Implementation in Powerworld

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Overview

- Cover current practices
- Theory in implementation of RAS
- Functionality of RAS
 - Outage Conditions
 - Arming levels



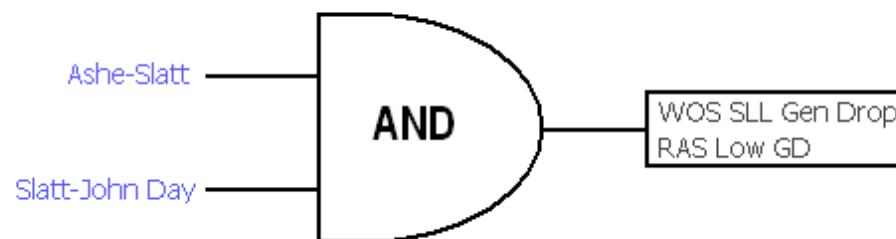
Problems with present practice

- RAS is currently being modeled inside each individual contingency
 - Means that contingency list has to be updated for every topology change that could affect which contingency triggers a RAS operation.
 - Condition-based RAS is only included with contingencies thought to cause its initiation
- RAS arming levels may also change with outage conditions.
 - These have to be updated manually when these impacting outages occur.



Current Methodology

- Given a contingent loss of both lines “Ashe-Slatt” and “Slatt-John Day” will result in some RAS Action(s)





Current Methodology (cont.)

- These RAS Actions are modeled inside of the contingency definition

The screenshot shows the 'Contingency Analysis' software interface. The main window displays a table of contingencies with columns for Label, Skip, Process, Solved, Violation, Max Branch %, Min Volt, # of unlinked actions, Memo, # of actions, and # of iterations. Below this is a 'Contingency Definition' section containing a table with columns for Actions, Model Criteria, Status, and Comm. The 'Actions' column lists several commands, some of which are highlighted with red boxes and labels: 'Perform the actions in block "WOS SLL Gen Drop"' and 'Perform the actions in block "RAS Low GD"'. The bottom of the screen shows toolbars for loading, saving, and running the analysis.

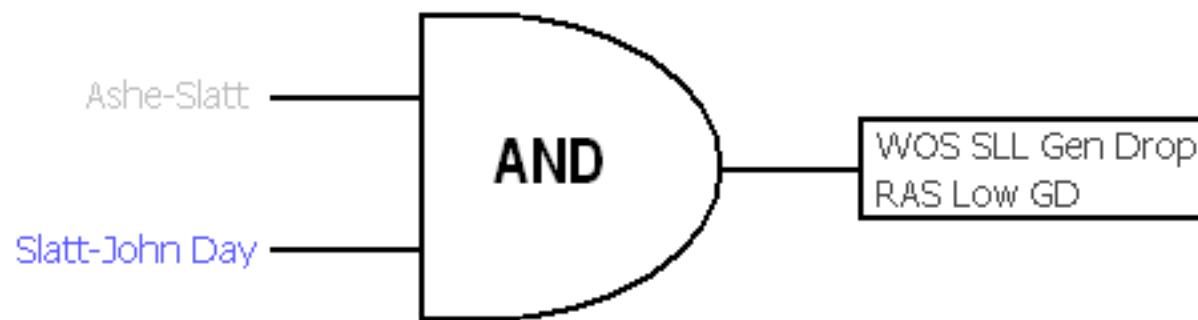
Label	Skip	Process	Solved	Violation	Max Branch %	Min Volt	# of unlinked actions	Memo	# of actions	# of iterations
80 BFR 4870 Big Eddy-John Day/Big Eddy TX 8	NO	YES	YES	0				0 N-2 BIG EDDY JOHN DAY BIGEDDY1	2	1
94 BFR 5003 (or 5006) Boardman PH	NO	YES	YES	0				0 N-2 SLATT BOARD F	2	1
95 BFR 501B Ashe-Slatt/Slatt-John Day	NO	YES	YES	0				0 N-2 ASHE SLATT JOHN DAY RAS= WOS SLL Gen Drop RAS Low GD	4	2
96 BFR 502B Buckley-Grizzly/Grizzly-Summer L	NO	YES	YES	0				0 N-2 GRIZZLY GRIZZ R3 PONDROSA SUMMER L BUCKLEY RAS= RAS LI	3	4

Actions	Model Criteria	Status	Comm
1 OPEN Line ASHE_500.0 (40061) TO SLATT_500.0 (40989) CKT 1	CHECK		
2 OPEN Line JOHN DAY_500.0 (40585) TO SLATT_500.0 (40989) CKT 1	CHECK		
3 Perform the actions in block "WOS SLL Gen Drop"	CHECK		
4 Perform the actions in block "RAS Low GD"	CHECK		



Current Methodology (cont.)

- Outage conditions will alter which contingencies could cause a RAS Action





Current Methodology (cont.)

- This then requires the manual manipulation of contingency definitions

Contingency Analysis

Label	Skip ▲	Process	Solved	Violation	Max Branch %	Min Volt	# of unlinked actions	Memo	# of actions	# of iterations
1 BFR_4131 Slatt-John Day/John Day Grizzly 2	NO	YES	YES	0				0 N-2 JOHN DAY SLATT GRIZZLY RAS= RAS Low GD	4	3
2 L/D McNary-John Day/Ashe-Slatt	NO	YES	YES	0				0 N-2 MCNARY JOHN DAY ASHE SLATT	3	2
3 BFR_5018 Ashe-Slatt/Slatt-John Day	NO	YES	YES	0				0 N-2 ASHE SLATT JOHN DAY RAS= WOS SLL Gen Drop RAS Low GD	4	2
4 L/D Slatt-John Day/Ashe-Marion	NO	YES	YES	0				0 N-2 JOHN DAY SLATT ASHE R1 MARION RAS= WOS SLL Gen Drop	3	3
5 JOHN DAY 500-SLATT 500C1	NO	YES	YES	0				0 N-1 JOHN DAY SLATT RAS= WOS SLL Gen Drop	2	1
6 L/D Slatt-Buckley/Slatt-John Day NOT CREDIBLE	YES	NO	NO					0 N-2 BUCKLEY SLATT JOHN DAY ASHE RAS= WOS DLL Gen Drop RAS	4	

Violations | What Actually Occurred

Show related contingencies

Number	Name From
None	Defined

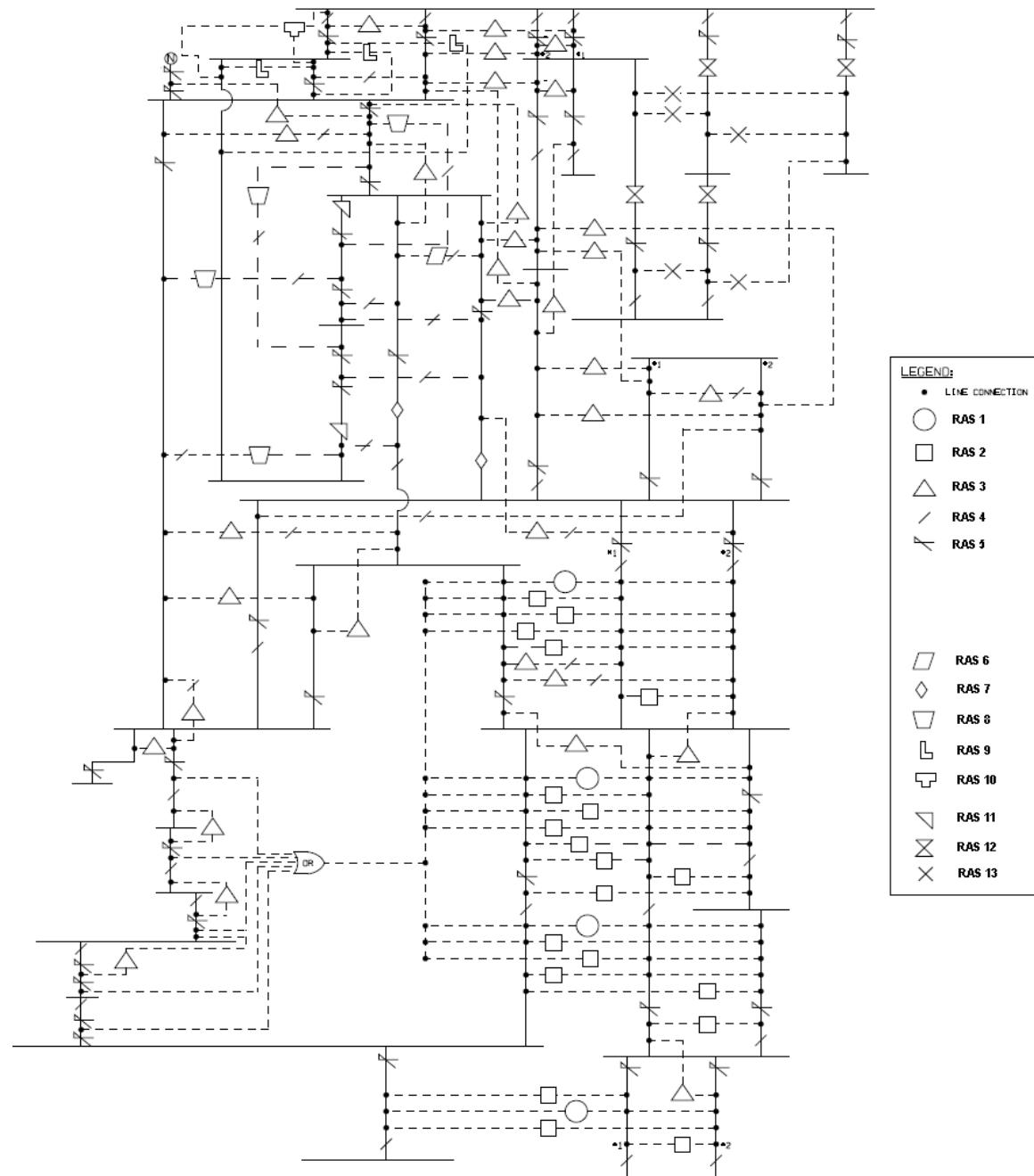
Contingency Definition

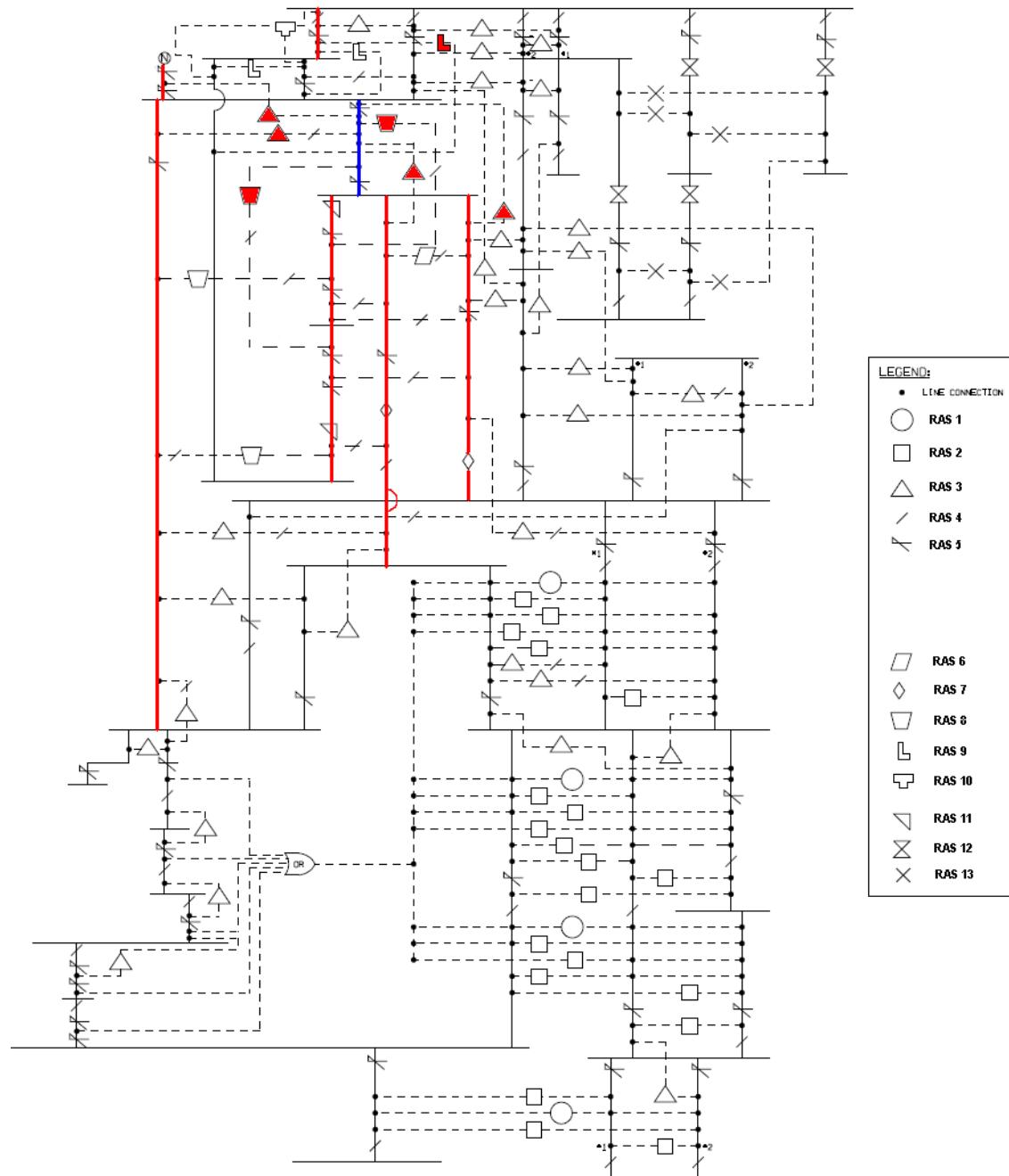
Actions	Model Criteria	Status	Comm ▲
1 OPEN MultiSectionLine BUCKLEY_500.0 (40155) TO SLATT_500.0 (40989) CKT 1	CHECK		
2 OPEN Line JOHN DAY_500.0 (40585) TO SLATT_500.0 (40989) CKT 1	CHECK		
3 OPEN Line ASHE_500.0 (40061) TO SLATT_500.0 (40989) CKT 1	CHECK		
4 Perform the actions in block "RAS Low GD"	CHECK		

Status: Initialized

Load Auto Insert Save Other > Start Run Close Help

Refresh Displays After Each Contingency







Theory behind RAS Improvements

- Automatic alterations of RAS actions in different system topologies
 - This required the need to separate the system topology from the base (outage) case from changes in topology caused by a contingency action



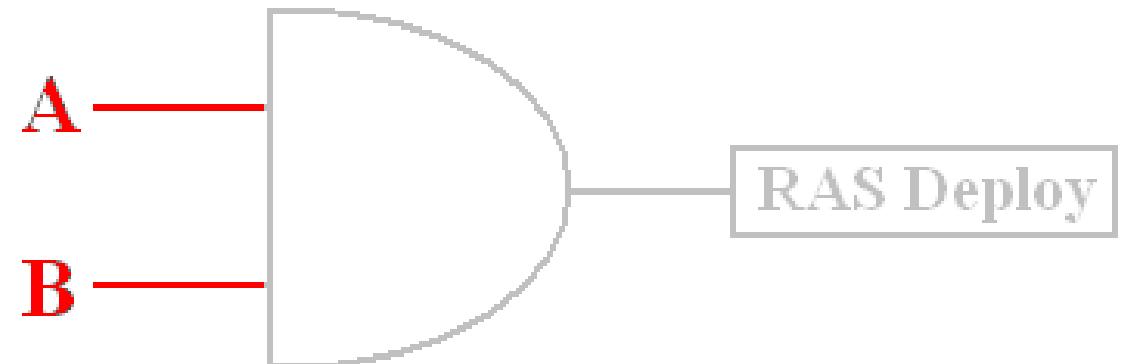
Defining Element “status”

- Powerworld has the ability to monitor any variable on any given element through any equality, inequality or equation.
 - This is called “**Model Condition**”
 - If it meets the given criteria it will output a logical “True”



Application

Model Condition(s)





Assignment of Model Conditions

Define Model Conditions

Model Condition Name: Ashe-Slatt 1 500kV Line (Open)

Evaluate in Contingency Reference State
 Disable if True in Contingency Reference State

Element Type: 45902 entries
 Area
 Branch
 Bus
 DC Transmission Line
 Generator
 Injection Group
 Interface
 Limit Set
 Load
 Model Expression
 Multi-Terminal DC Record
 Nomogram
 Owner
 Substation
 Super Area
 Switched Shunt
 Transformer
 Zone

Sort by: Name Number
Filter: Advanced Branch Use Area/Zone Filters

You can use wildcard characters * or ?

List of entries:

- ASCARATE (11020) TO TROWBRIG (11041) CKT 1 [115 kV]-[115 kV]
- ASCARATE (11020) FROM DURAZNO (11174) CKT 1 [115 kV]-[115 kV]
- ASCARATE (11020) FROM SUNSET_N (11157) CKT 1 [115 kV]-[115 kV]
- ASCARATE (11021) TO ASCARATE (11019) CKT 1 [13.8 kV]-[69 kV]
- ASCARATE (11022) TO ASCARATE (11019) CKT 1 [4.16 kV]-[69 kV]
- ASH TP (22012) FROM ASH (22008) CKT 1 [69 kV]-[69 kV]
- ASH TP (22012) FROM FELICITA (22286) CKT 1 [69 kV]-[69 kV]
- ASH TP (22012) FROM VALCNTR (22870) CKT 1 [69 kV]-[69 kV]
- ASH (22008) TO ASH TP (22012) CKT 1 [69 kV]-[69 kV]
- ASH (22008) FROM ESCNDIDO (22256) CKT 1 [69 kV]-[69 kV]
- ASH 132 (50327) TO ASH 13G1 (50298) CKT 1 [132 kV]-[13.8 kV]
- ASH 132 (50327) FROM GCL 132 (50325) CKT 1 [132 kV]-[132 kV]
- ASH 13G1 (50298) FROM ASH 132 (50327) CKT 1 [13.8 kV]-[132 kV]
- ASHE (40059) TO ASHE F (40060) CKT 1 [230 kV]-[230 kV]
- ASHE (40059) TO ASHE TAP (40065) CKT 1 [230 kV]-[230 kV]
- ASHE (40059) TO TRS (40064) CKT 1 [230 kV]-[230 kV]
- ASHE (40059) TO WHITE BL (41149) CKT 1 [230 kV]-[230 kV]
- ASHE (40059) TO WNP1 (40058) CKT 1 [230 kV]-[230 kV]
- ASHE (40061) TO ASHE R1 (40062) CKT 2 [500 kV]-[500 kV]
- ASHE (40061) TO CG5 (40063) CKT 1 [500 kV]-[25 kV]
- ASHE (40061) TO HANFORD (40499) CKT 1 [500 kV]-[500 kV]
- ASHE (40061) TO LOW MON (40683) CKT 1 [500 kV]-[500 kV]
- ASHE (40061) TO SLATT (40989) CKT 1 [500 kV]-[500 kV]

Meets the filter below

Select Filter Type: Branch

Pre-filter using Area/Zone/Owner Filters Enabled (normally checked)
 AND OR Not AND Not OR

Condition 1: Find... Status string starts with 0 Case Sens.
 Use Another Filter

Enable Field to Field Comparisons



Defining a logic gate

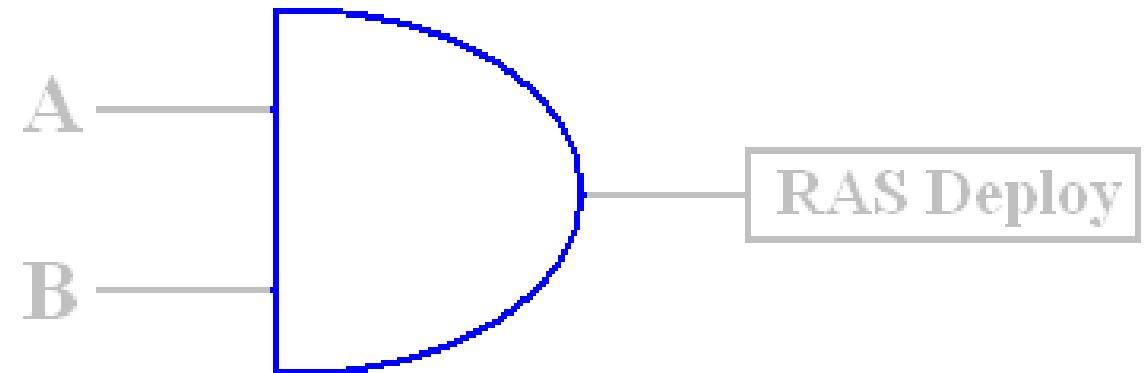
- A model condition can only be used to provide a logical output for a given element.
 - To pair multiple line conditions together, a “model filter” is used



Application

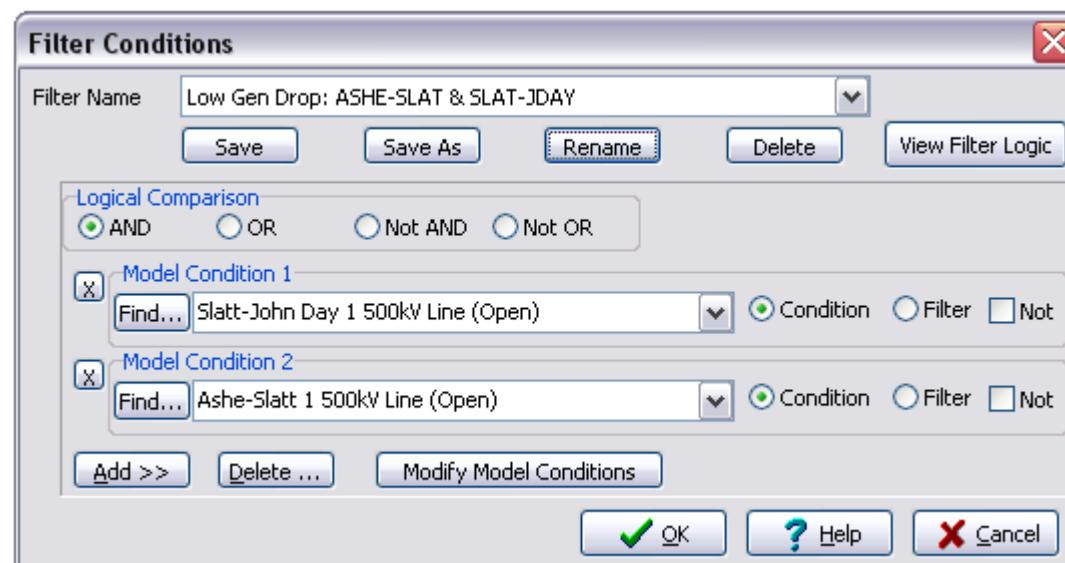
Model Filter

Model Condition(s)





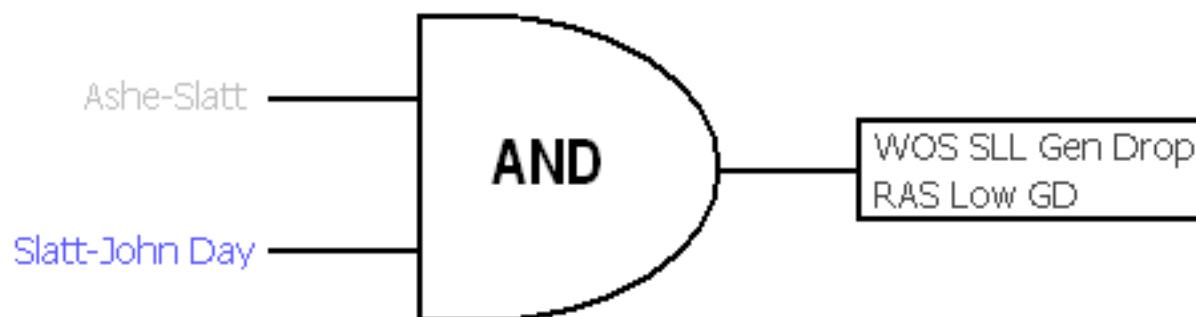
Assignment of Model Filters





Example

- If “Ashe-Slatt” is out of service in the base case, the logic status of the “Ashe-Slatt” will be ignored, therefore the only logic input that will be considered is for the “Slatt-John Day”. This means if the “Slatt-John Day” status changes for ANY contingency, the RAS Action will occur



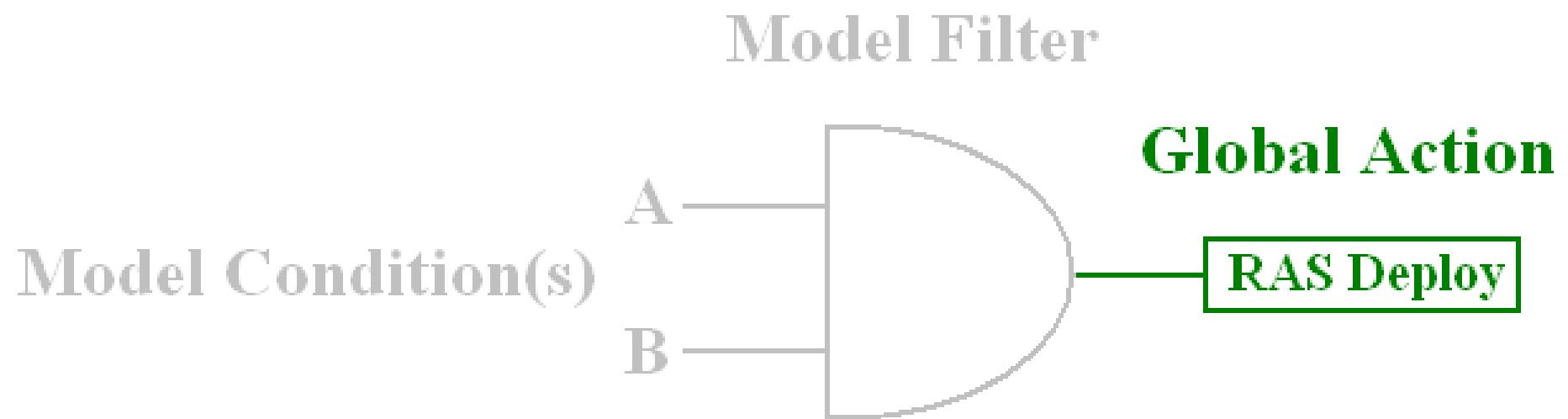


Defining a RAS action

- “Contingency Global Actions” are used for specifying the action that the RAS would cause when deployed.
- The requirement needed to be met for its action can either be a model condition or filter.



Application





Contingency Element Dialog

Choose the Element

Sort by Name Number

- Paul area load
- Pelton
- PG&E blocked
- Port Westward
- Priest Rapids
- Puget total load
- Puget variable load
- RAS BCH-NW Gen Drop Units
- RAS High Gen Drop Units
- RAS Jones Canyon Wind Gen
- RAS Low Gen Drop Units**
- RAS NOH Gen Drop Units
- RAS P-A/N-A Gen Drop Units
- RAS PDCI Gen Drop Units
- RAS Raver-Paul Gen Drop Units
- RAS South of Allston Gen Drop units
- RAS WOJD Gen Drop
- RAS WOM DLL Gen Drop Units
- RAS WOM SLL Gen Drop Units
- RAS WOM Gen Drop Units

Element Type

- Branch
- Generator
- Load
- Switched Shunt
- Bus
- Interface
- Injection Group
- Series Capacitor
- DC Line
- DC Converter
- Phase Shifter
- 3-Winding Transformer
- Area
- Solve Power Flow
- Contingency Block

Action Type

- Open
- Close
- Move
- Set To
- Change By

Amount

in

- Percent
- MW

Use Merit Order for Generators
 Evaluate in Reference State

Status:

Model Criteria:

Inclusion Filter:

Comment:

OK Cancel



Defining a Model Expression

- If the severity of the RAS action is dependent and varies based upon an independent variable (i.e. path flow), then a “Custom Model Expression” is used.
- The use of Model Expressions allow an equation, limit or inequality to be used for calculating values
 - Has the same capability as the “Model Condition” for defining any value as a variable
 - Can also use logical outputs from model Conditions or Filters as a conditional output

If(statement = "True",Output(true),Output(false))



Define Model Custom Expressions

Custom Expression Arming: HGD = COI minus 1000MW (COI>1200MW)

Save Save As Rename Delete

Choose the Type of Expression

Expression Lookup Table

x1= Interface COI (66) : MW Flow

Model Field

Element Type

Area
 Branch
 Bus
 DC Transmission Line
 Generator
 Injection Group
 Interface
 Limit Set
 Load
 Model Condition
 Model Expression
 Model Filter

93 entries
Sort by Name Number

Filter Advanced Interface Remove

Use PreFilters
Search Next
You can use wildcard characters * or ?

55 (BROWNLEE EAST)
58 (ELDORADO - MEAD 230 KV LINES)
59 (WALC BLYTHE - SCE BLYTHE 161 KV)
6 (WEST OF HATWAI)
60 (INYO - CONTROL 115 KV TIE)
61 (LUGO - VICTORVILLE 500 KV LINE)
62 (ELDORADO - MCCULLOUGH 500 KV)
63 (PERKINS - MEAD - MARKETPLACE 500)
65 (PDCI)
66 (COI)

Choose a Field: MW/MW Flow

OK Remove Help Cancel



Define Model Custom Expressions

Custom Expression Arming: HGD = COI minus 1000MW (COI>1200MW)

Save Save As Rename Delete

Choose the Type of Expression

Expression | Lookup Table |

x1= Define...	Interface COI (66) : MW Flow
x2= Define...	ModelFilter Arming: HGD = COI minus 1000MW (COI>1200MW)
x3= Define...	Choose a Model Field
x4= Define...	Choose a Model Field
x5= Define...	Choose a Model Field
x6= Define...	Choose a Model Field
x7= Define...	Choose a Model Field
x8= Define...	Choose a Model Field

function (x1, x2, x3, x4, x5, x6, x7, x8) =
 iif(x2=="YES",-iif(x1>1200,min(x1-1000,2700),0),0)

OK Help Cancel



Application

- This method allows the RAS action to then become responsive in it's severity to case conditions

Puget total load
Puget variable load
RAS High Gen Drop Units
RAS Low Gen Drop Units
RAS NOH Gen Drop Units

Action Type

Open
 Close
 Move
 Set To
 Change By

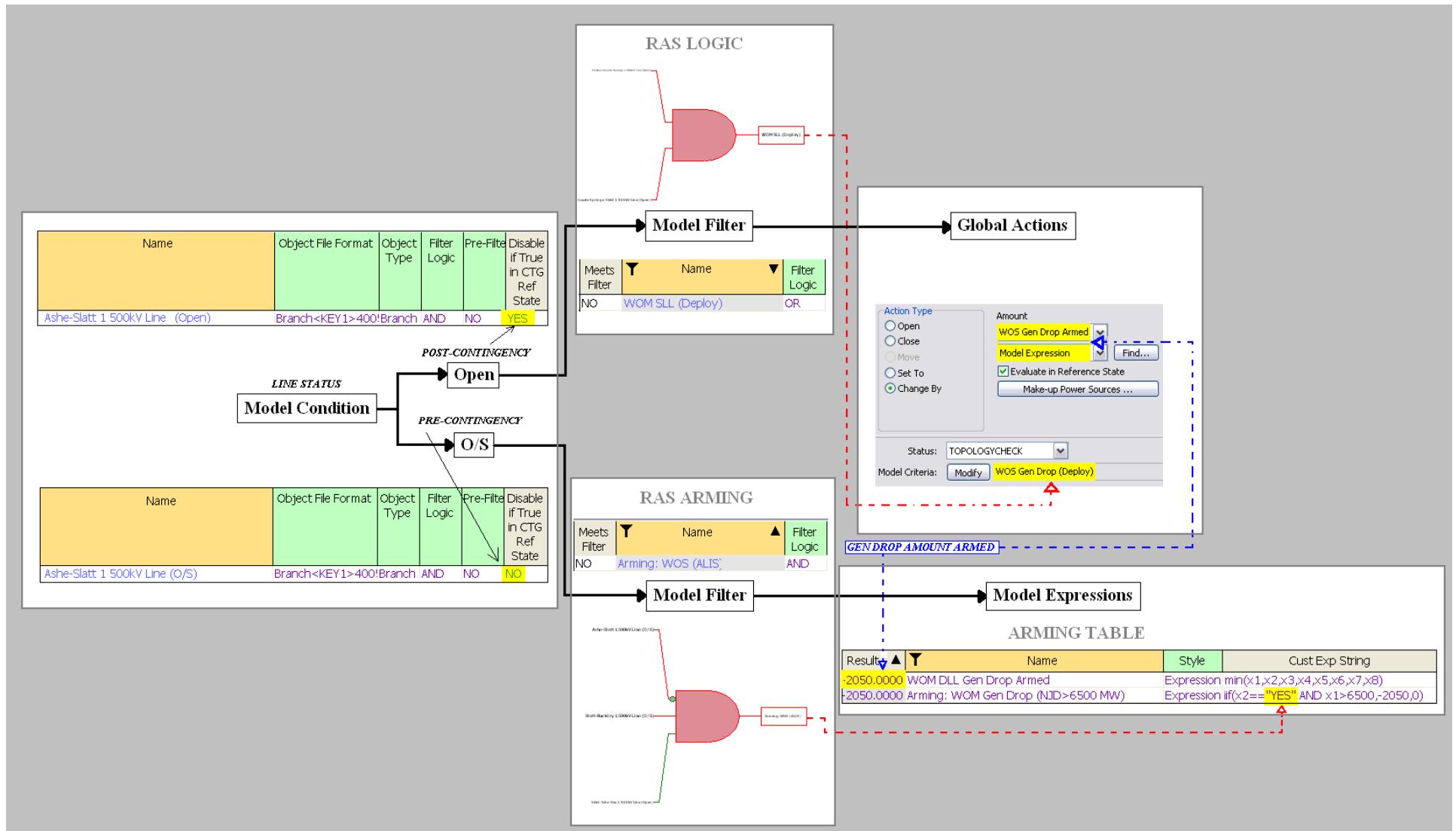
Amount

High Gen Drop Armed
Model Expression Find...
 Evaluate in Reference State

in

Percent
 MW

Use Merit Order for Generators
 Open Generators in Merit Order



B O N N E V I L L E P O W E R A D M I N I S T R A T I O N



B O N N E V I L L E P O W E R A D M I N I S T R A T I O N



B O N N E V I L L E P O W E R A D M I N I S T R A T I O N

