Event-based RAS Implementation in Powerworld

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Overview

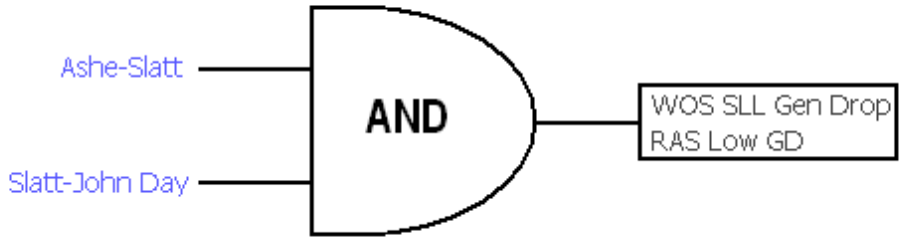
- Cover current practices
- Theory in implementation of RAS
- Functionality of RAS
  - Outage Conditions
  - Arming levels

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 it's initiation
- RAS arming levels may also change with outage conditions.
  - These have to be updated manually when these impacting outages occur.

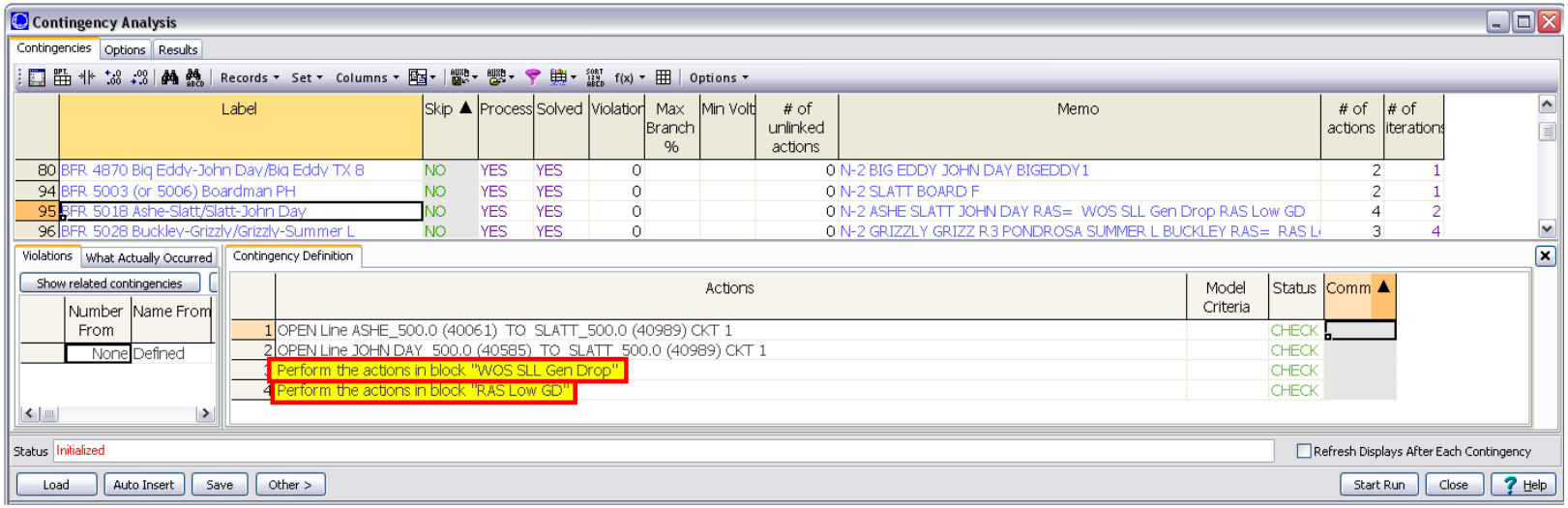
Current Methodology

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



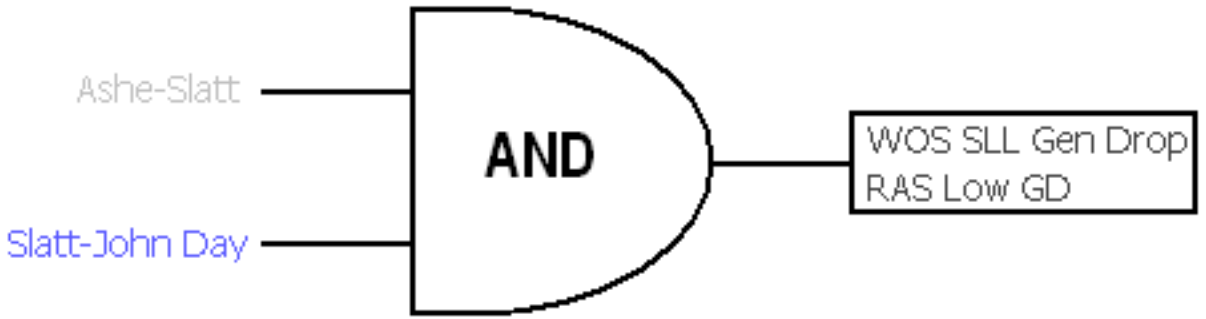
Current Methodology (cont.)

- These RAS Actions are modeled inside of the contingency definition



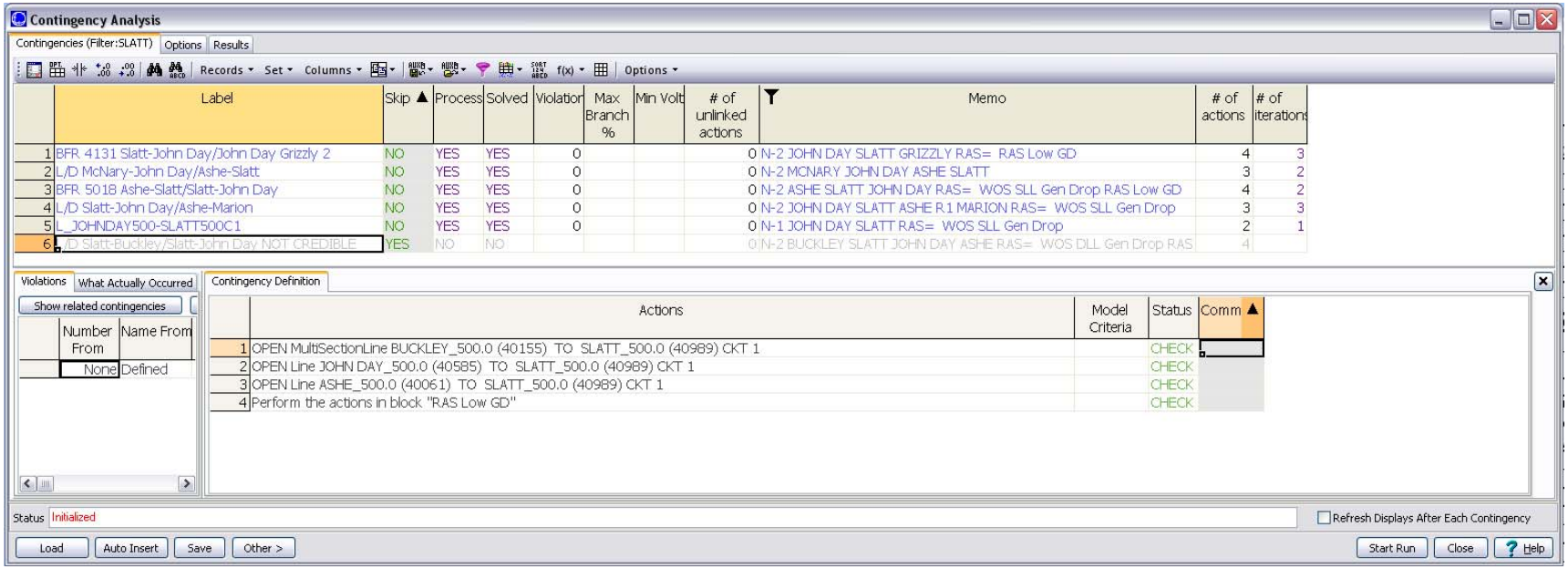
Current Methodology (cont.)

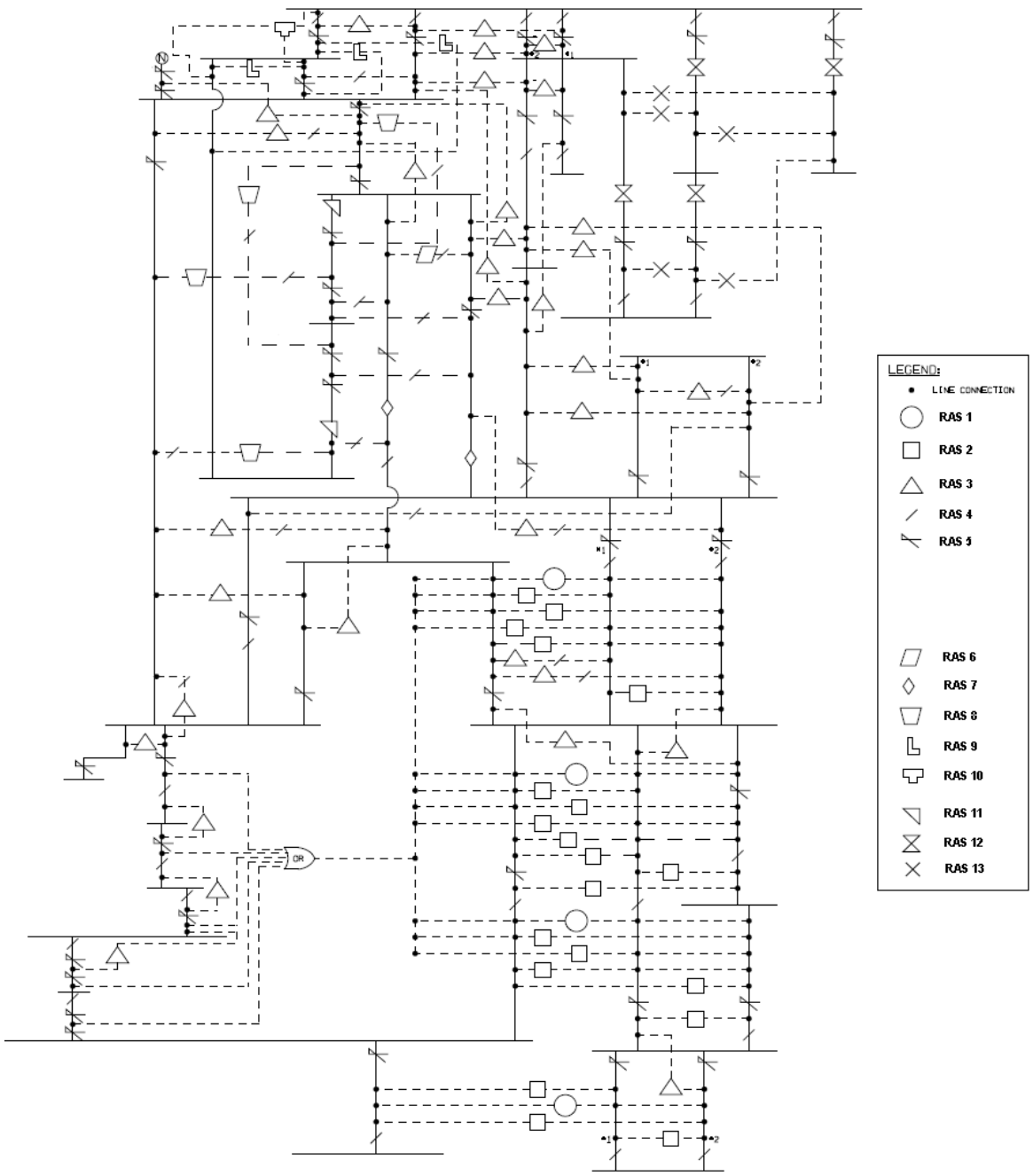
- Outage conditions will alter which contingencies could cause a RAS Action

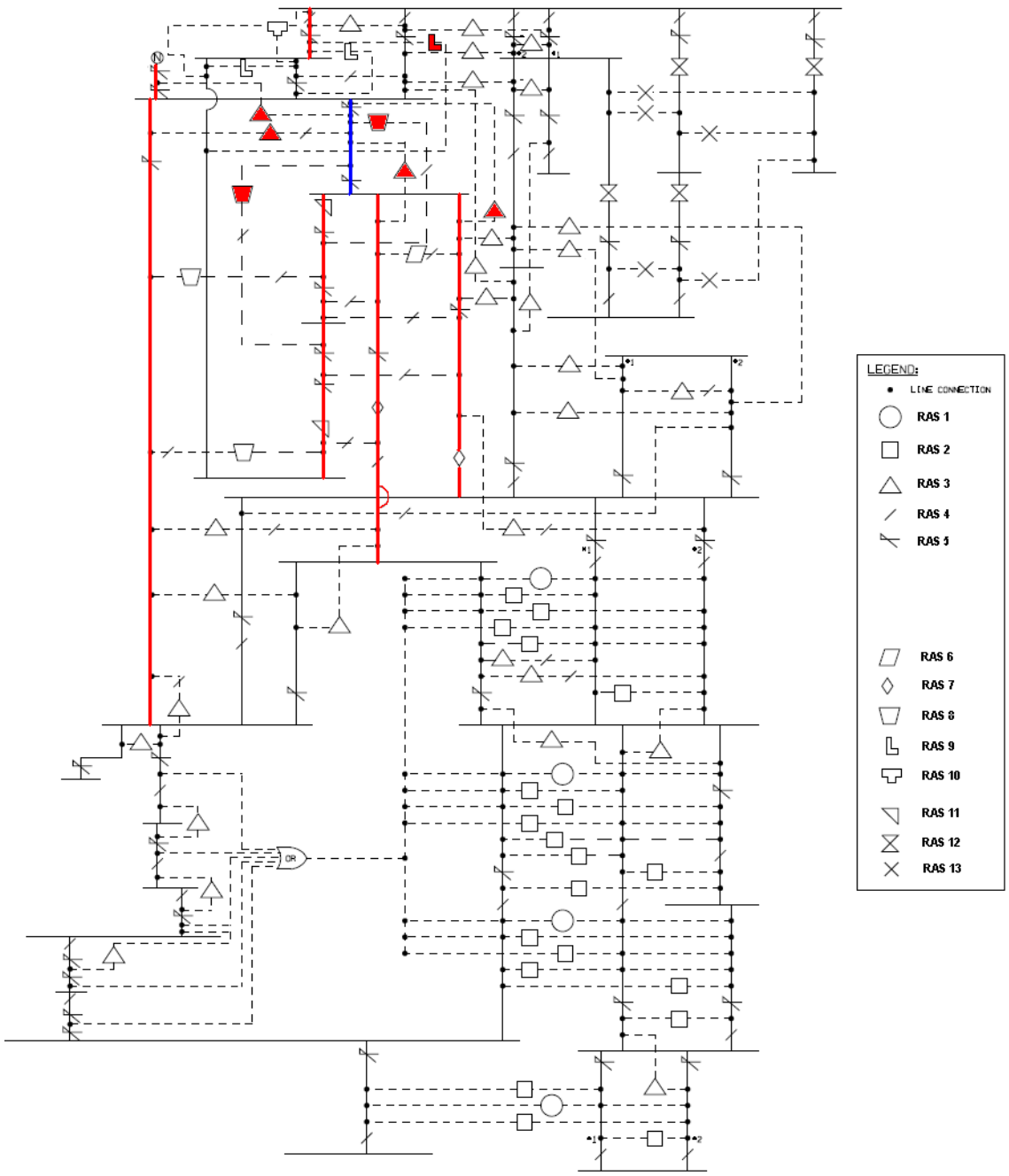


Current Methodology (cont.)

- This then requires the manual manipulation of contingency definitions




LEGEND:
LINE CONNECTION
RAS 1
RAS 2
RAS 3
RAS 4
RAS 5
RAS 6
RAS 7
RAS 8
RAS 9
RAS 10
RAS 11
RAS 12
RAS 13
OR


LEGEND:
LINE CONNECTION
RAS 1
RAS 2
RAS 3
RAS 4
RAS 5
RAS 6
RAS 7
RAS 8
RAS 9
RAS 10
RAS 11
RAS 12
RAS 13
OR

Theory behind RAS Improvements

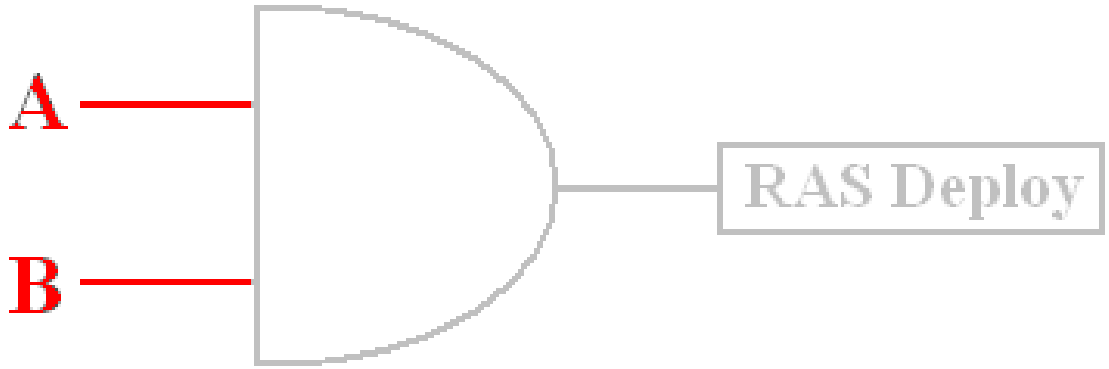
- Automatic alterations of RAS actions in different system topologies
  - This required the need to separate the system topology from the base (outage) case from changes in topology caused by a contingency action

Defining Element “status”

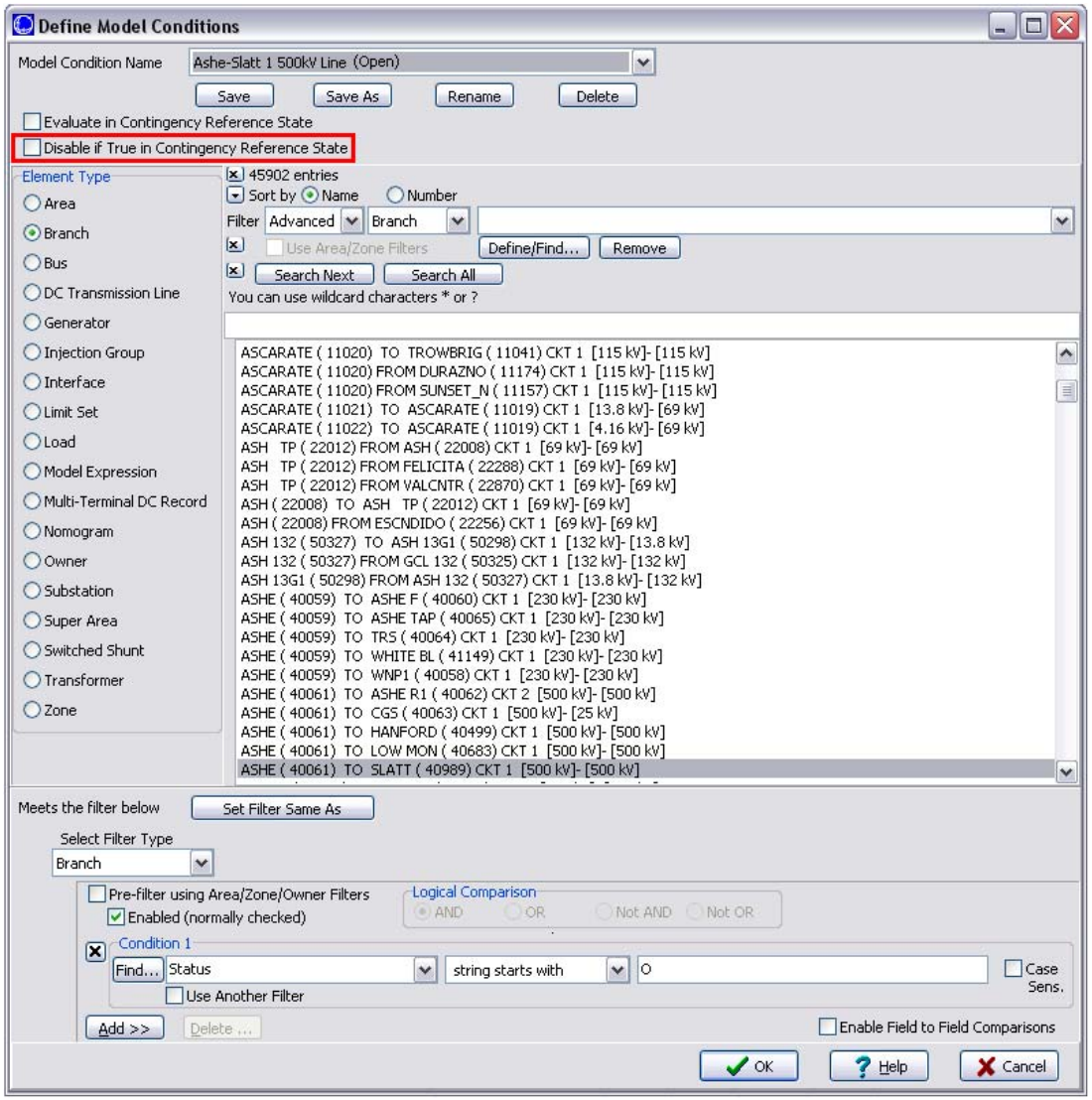
- Powerworld has the ability to monitor any variable on any given element through any equality, inequality or equation.
  - This is called “**Model Condition**”
  - If it meets the given criteria it will output a logical “True”

Application

Model Condition(s)



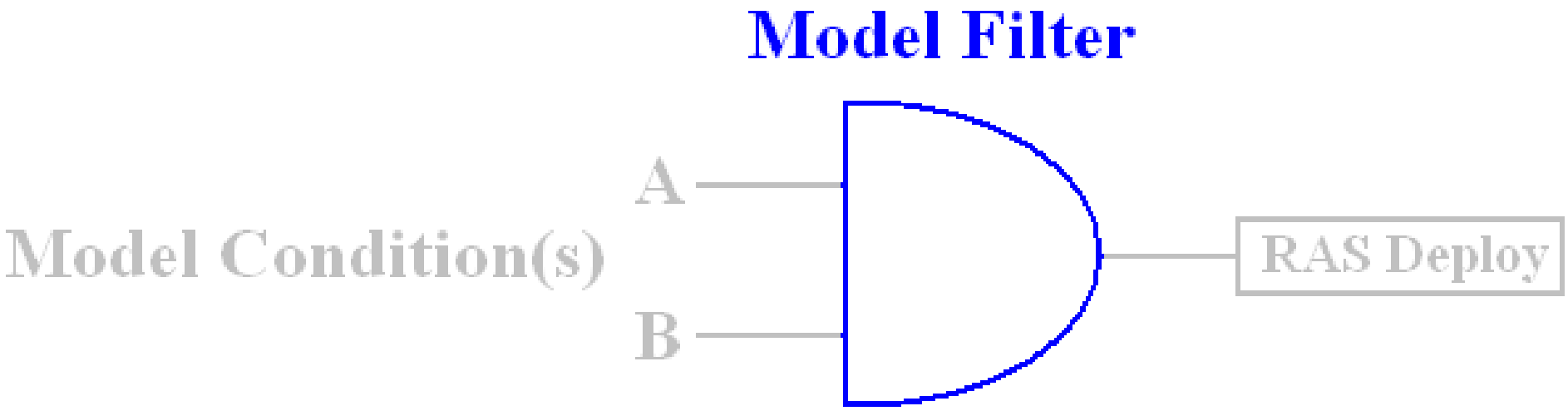
Assignment of Model Conditions



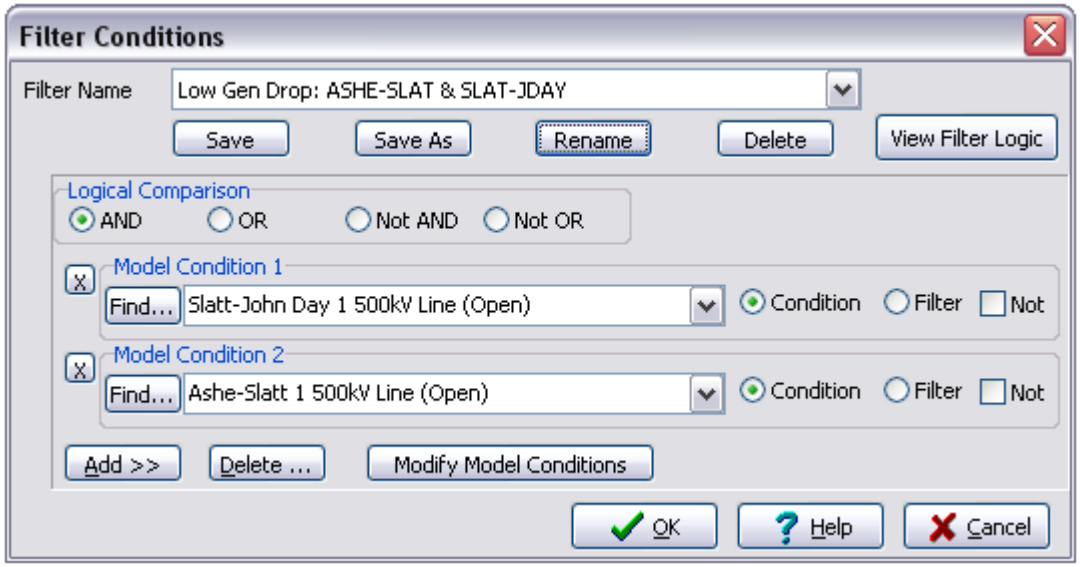
Defining a logic gate

- 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

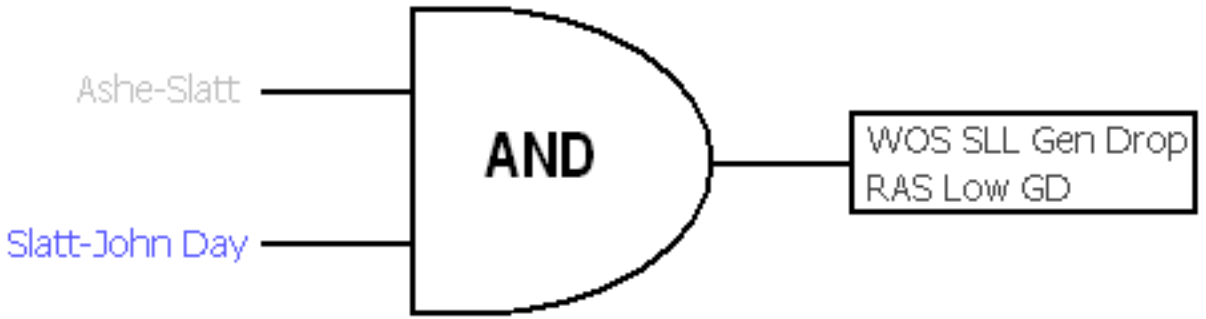


Assignment of Model Filters



Example

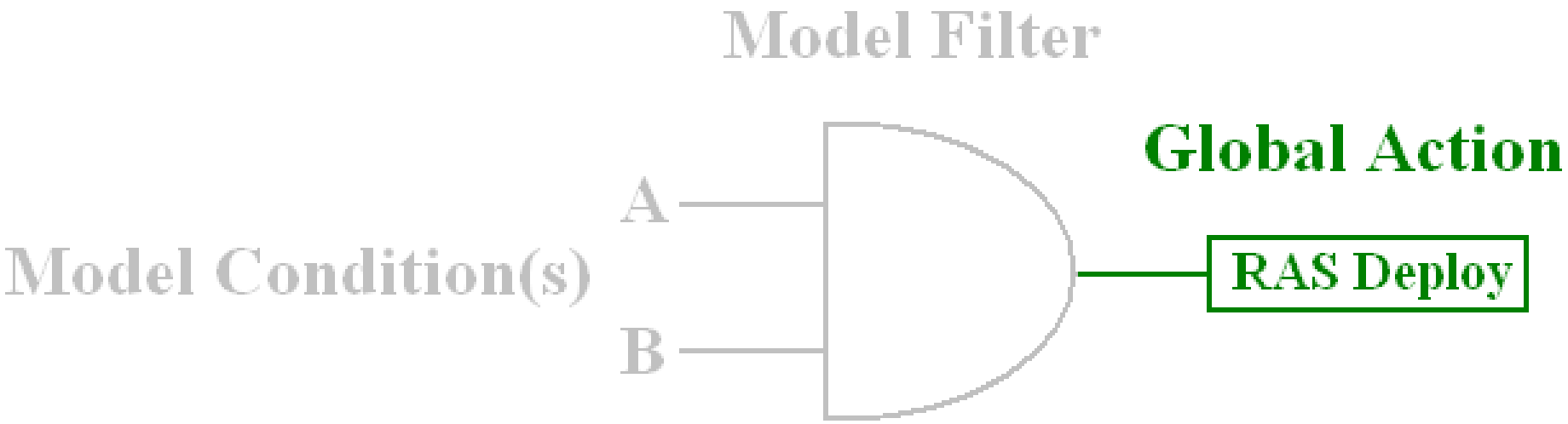
- If “Ashe-Slatt” is out of service in the base case, the logic status of the “Ashe-Slatt” will be ignored, therefore the only logic input that will be considered is for the “Slatt-John Day”. This means if the “Slatt-John Day” status changes for ANY contingency, the RAS Action will occur

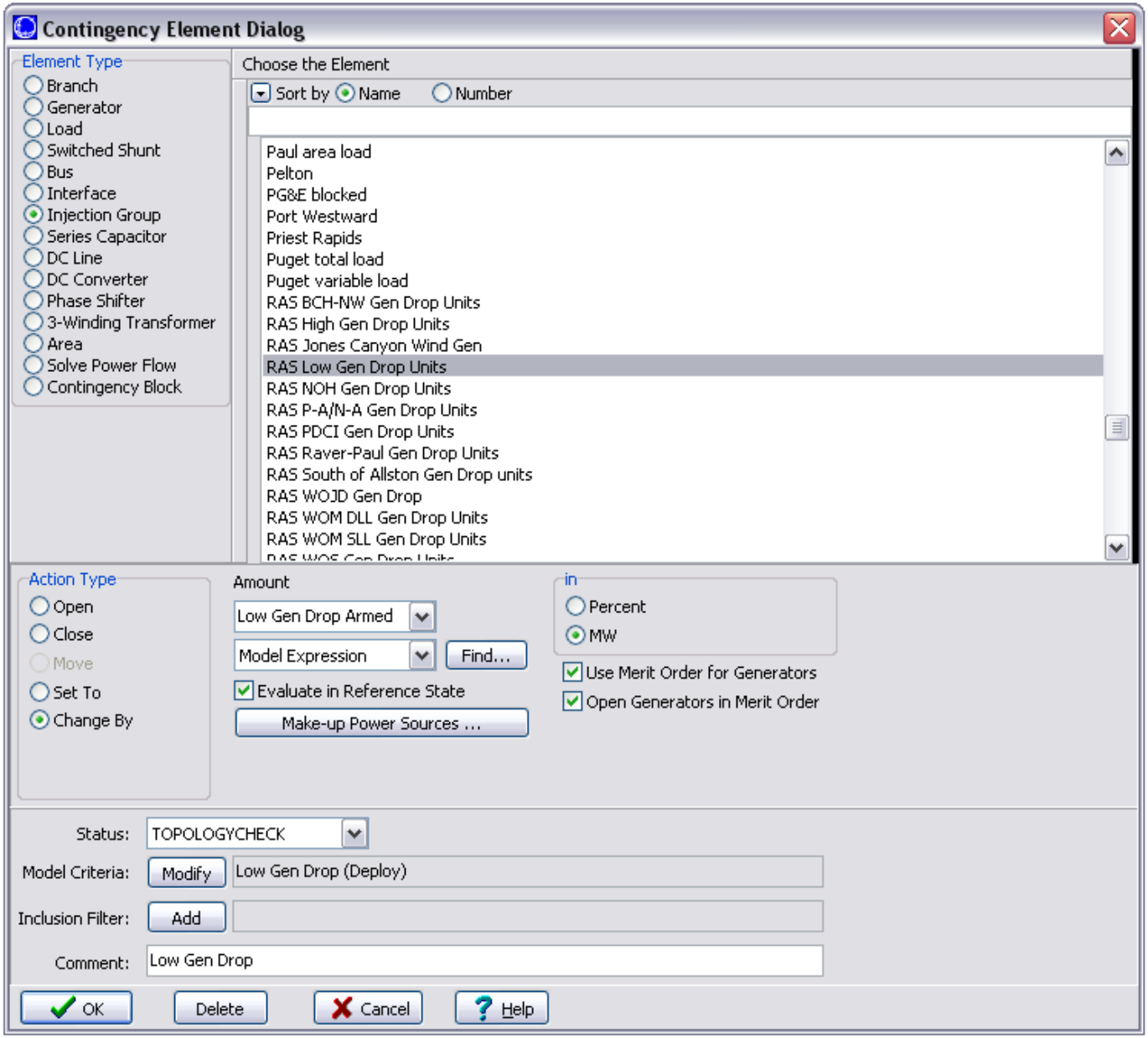


Defining a RAS action

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

Application

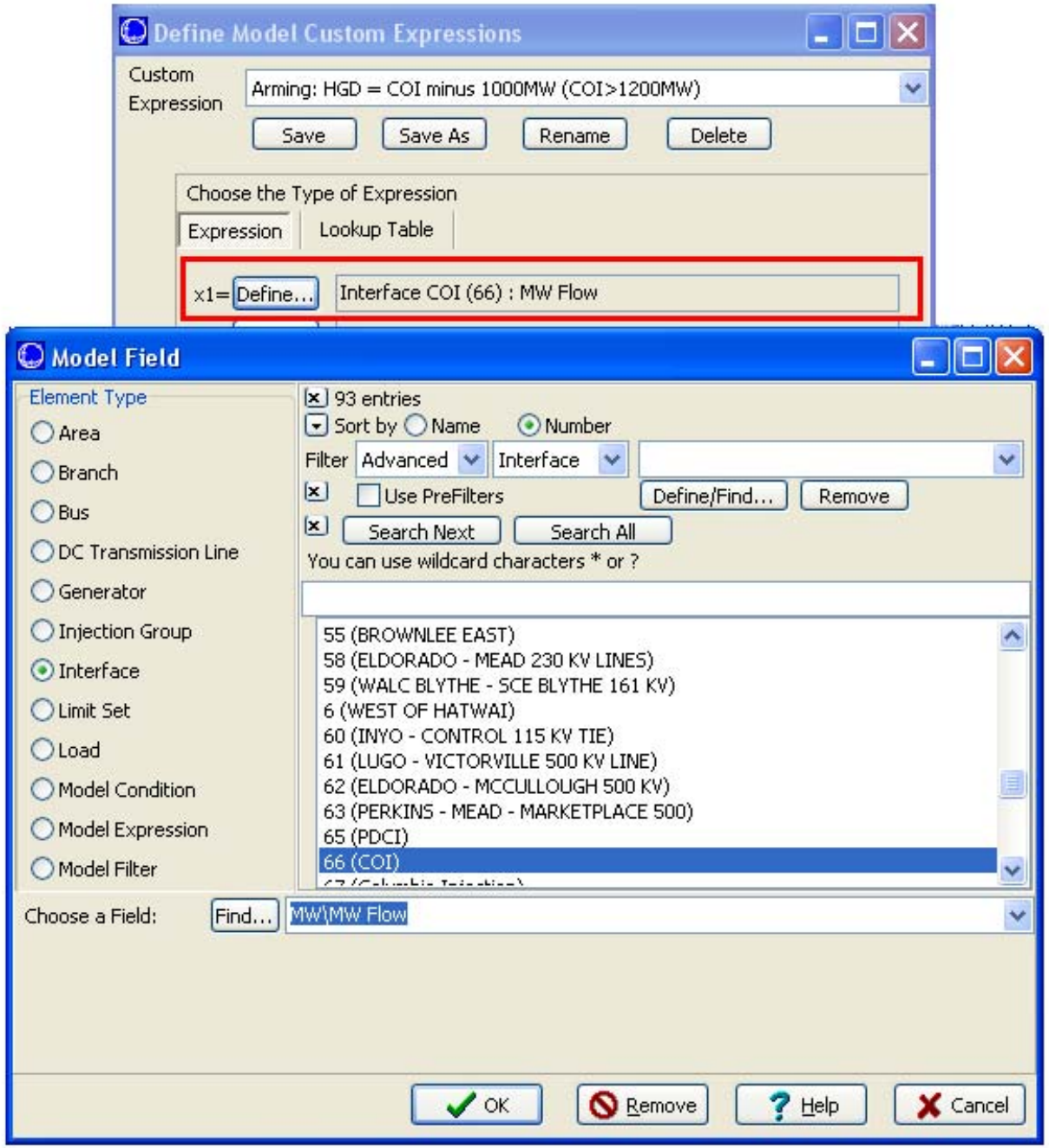


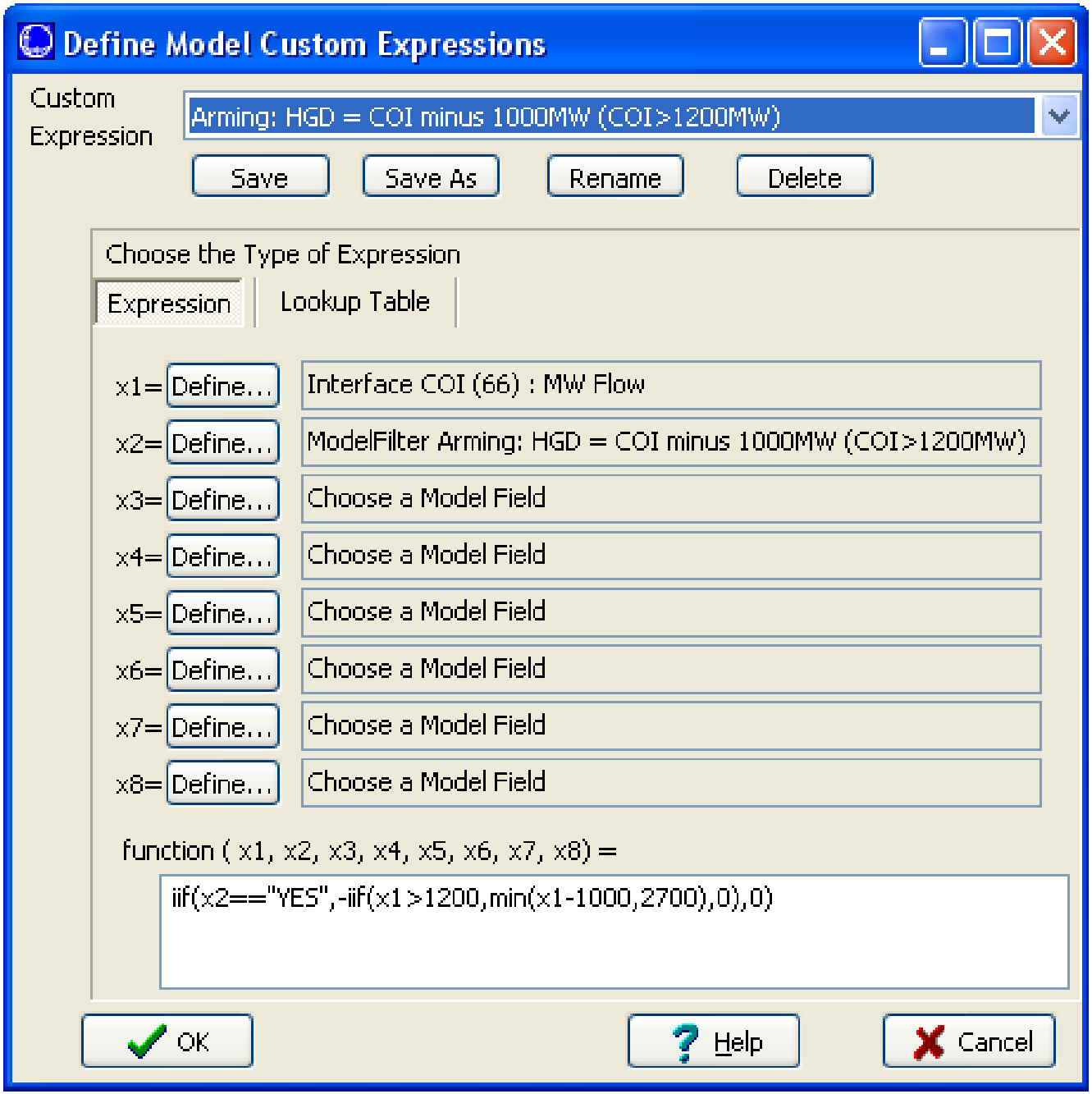

Contingency Element Dialog
Element Type
Branch
Generator
Load
Switched Shunt
Bus
Interface
Injection Group
Series Capacitor
DC Line
DC Converter
Phase Shifter
3-Winding Transformer
Area
Solve Power Flow
Contingency Block
Choose the Element
Sort by Name Number
Paul area load
Pelton
PG&E blocked
Port Westward
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
Action Type
Open
Close
Move
Set To
Change By
Amount
Low Gen Drop Armed
Model Expression
Find...
Evaluate in Reference State
Make-up Power Sources ...
in
Percent
MW
Use Merit Order for Generators
Open Generators in Merit Order
Status:
TOPOLOGYCHECK
Model Criteria:
Modify
Low Gen Drop (Deploy)
Inclusion Filter:
Add
Comment:
Low Gen Drop
OK
Delete
Cancel
Help

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

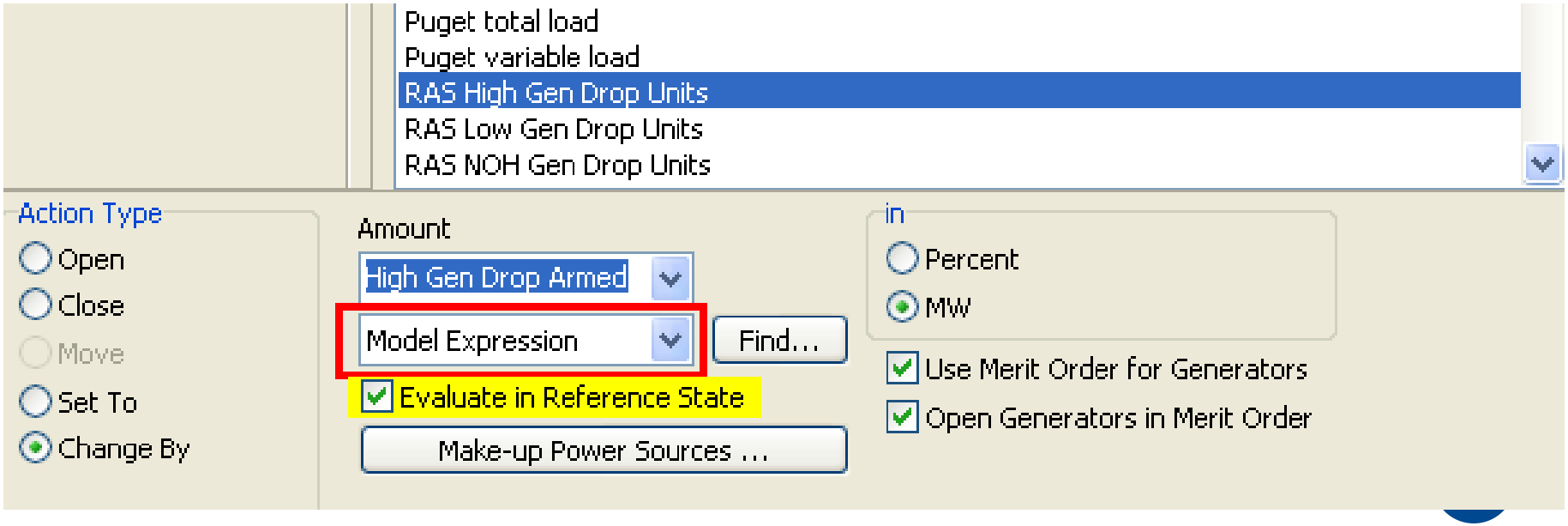
```
If(statement = "True",Output(true),Output(false))
```

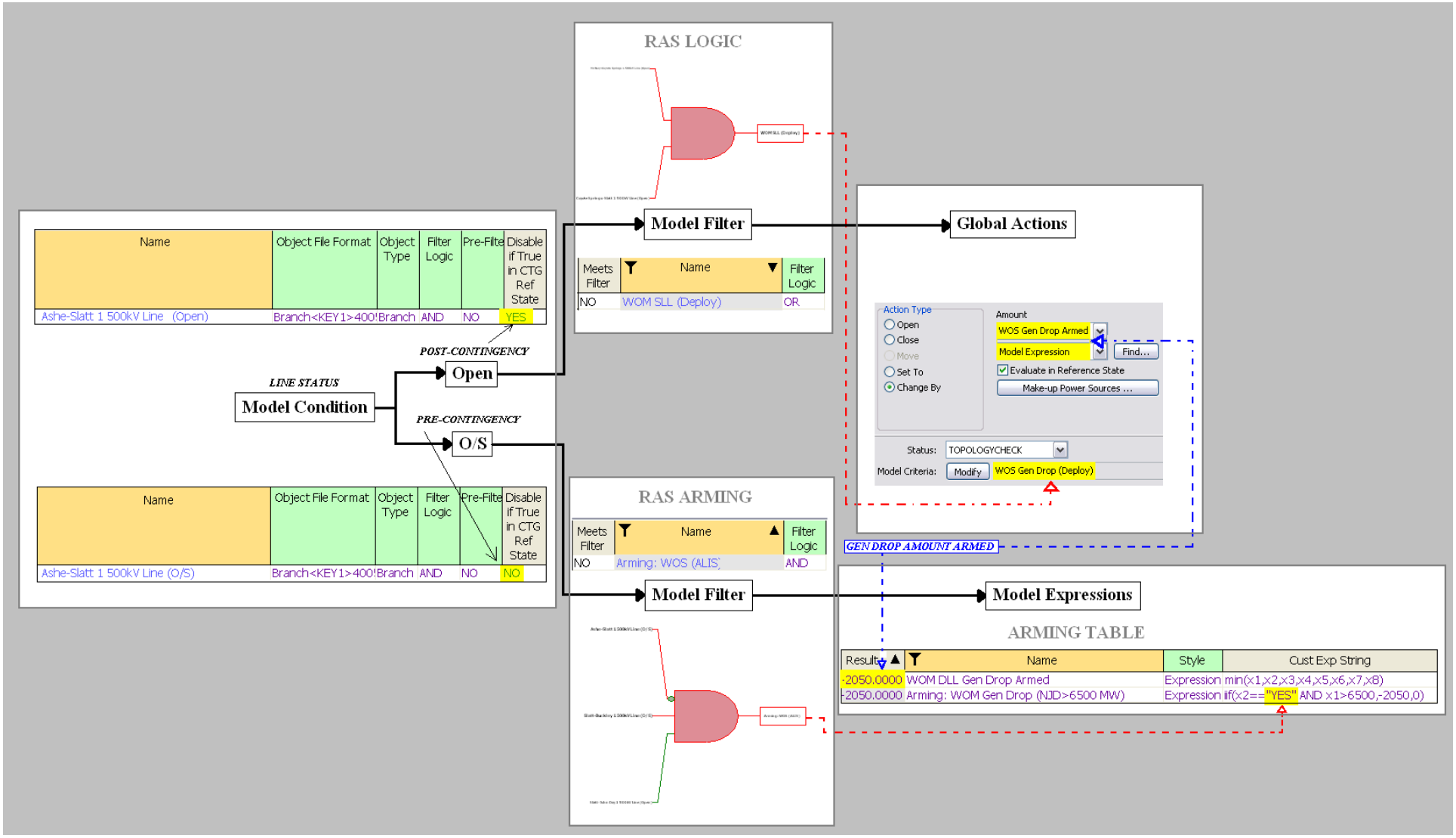

Define Model Custom Expressions
Custom Expression
Arming: HGD = COI minus 1000MW (COI>1200MW)
Save
Save As
Rename
Delete
Choose the Type of Expression
Expression
Lookup Table
x1=
Define...
Interface COI (66) : MW Flow
Model Field
Element Type
Area
Branch
Bus
DC Transmission Line
Generator
Injection Group
Interface
Limit Set
Load
Model Condition
Model Expression
Model Filter
93 entries
Sort by
Name
Number
Filter
Advanced
Interface
Use PreFilters
Define/Find...
Remove
Search Next
Search All
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:
Find...
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




RAS LOGIC
Model Filter
Meets Filter
Name
Filter Logic
NO
WOM SLL (Deploy)
OR
Global Actions
Action Type
Open
Close
Move
Set To
Change By
Amount
WOS Gen Drop Armed
Model Expression
Find...
Evaluate in Reference State
Make-up Power Sources ...
Status:
TOPOLOGYCHECK
Model Criteria:
Modify
WOS Gen Drop (Deploy)
Name
Object File Format
Object Type
Filter Logic
Pre-Filte
Disable if True in CTG Ref State
Ashe-Slatt 1 500kV Line (Open)
Branch<KEY1>400!Branch
AND
NO
YES
POST-CONTINGENCY
LINE STATUS
Model Condition
Open
PRE-CONTINGENCY
O/S
Ashe-Slatt 1 500kV Line (O/S)
Branch<KEY1>400!Branch
AND
NO
NO
RAS ARMING
Meets Filter
Name
Filter Logic
NO
Arming: WOS (ALIS`
AND
Model Filter
GEN DROP AMOUNT ARMED
Model Expressions
ARMING TABLE
Result
Name
Style
Cust Exp String
-2050.0000
WOM DLL Gen Drop Armed
Expression min(x1,x2,x3,x4,x5,x6,x7,x8)
-2050.0000
Arming: WOM Gen Drop (NJD>6500 MW)
Expression iif(x2=="YES" AND x1>6500,-2050,0)