Implementation of RAS Logic and Actions in Transient Stability

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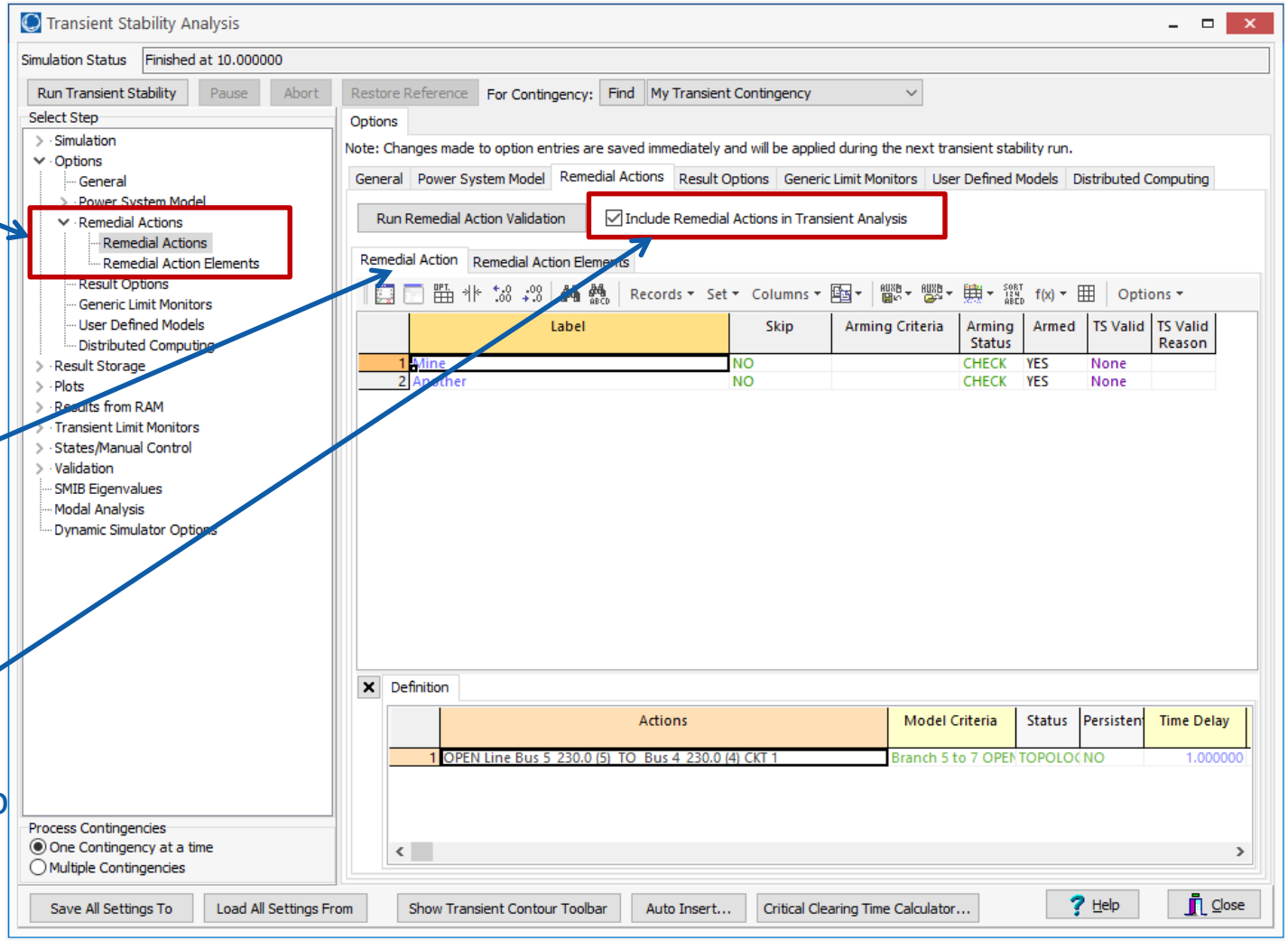
Including RAS with Transient Stability

Remedial Actions options added on the Transient Stability dialog

Same Remedial Action and Remedial Action Elements that are shown on the Contingency Analysis dialog

Include Remedial Actions in Transient Analysis checkbox needs to be checked to include the RAS in a transient stability run



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Logic Translation

- Logic objects that have been translated
  - Model Condition
  - Model Filter
  - Model Expression
- Fields that are translated to the transient realm and monitored during a transient run involve status changes
  - Considered triggering logic
  - As of 6/10/19 only status fields are supported for evaluation during a transient run, but non-status fields will be added in the near future
  - Model Conditions and Model Expressions have options to indicate if a field should be evaluated in the transient realm
- Any fields that are not translated are evaluated for the transient stability initial condition
  - Considered arming logic

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Logic Translation

These are the only fields that are translated for evaluation during a transient simulation (as of 6/10/19)

More fields will be added as necessary – use the **EvalTrans = NO** field to maintain consistency when new fields are included

Object Type	Field
Branch	Status Online Derived Status Derived Online
Bus	Status
Gen	Status Online Derived Status
Load	Status Online Derived Status
Switched Shunt	Status Online Derived Status
Line Shunt	Status Online Derived Status
Model Condition	Meets Condition
Model Filter	Meets Filter
Model Expression	Result

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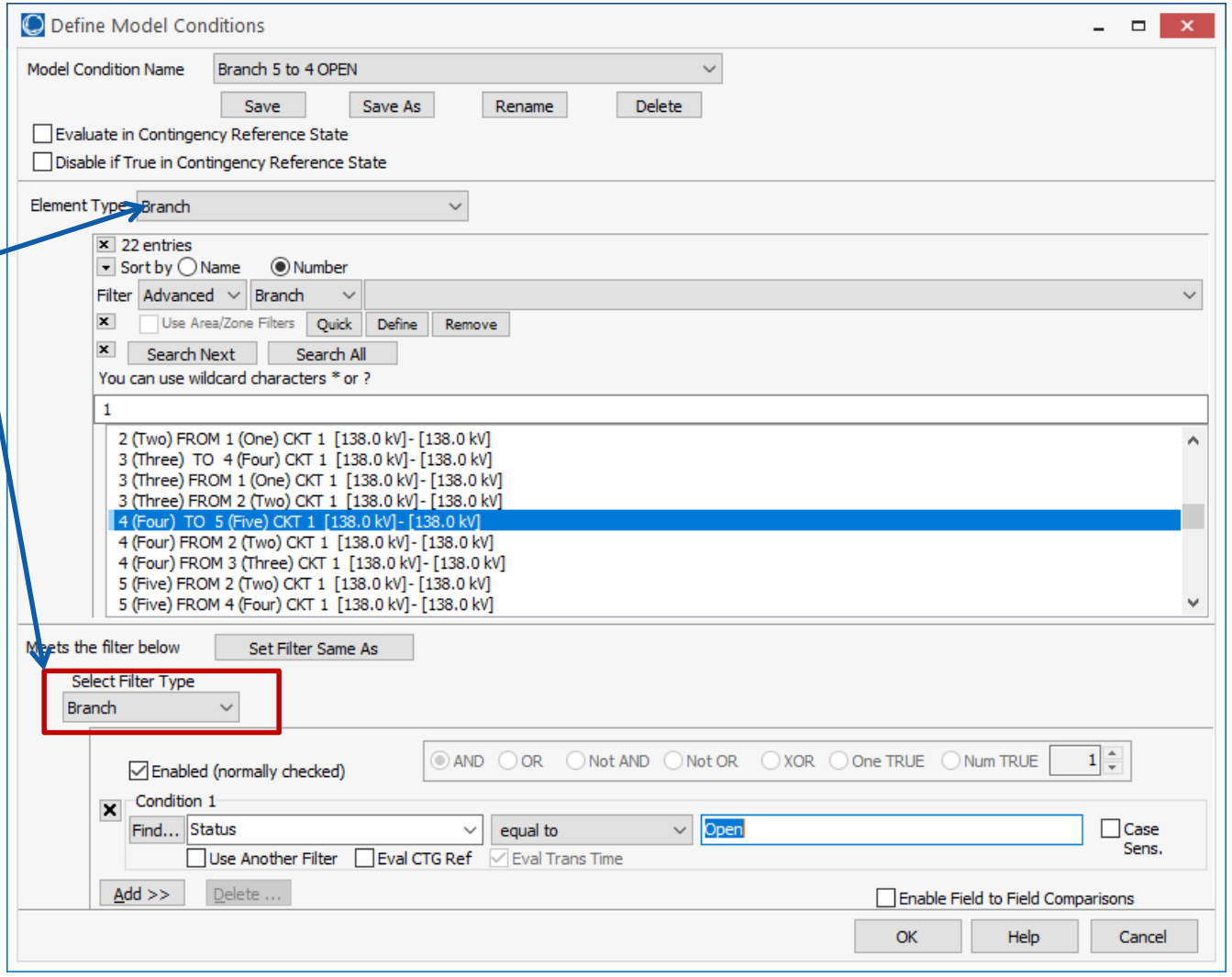
Model Condition Not Translated Features

The **Select Filter Type** field can be set to a different type than the **Element Type** when defining a Model Condition. This is not currently translated to the transient realm, which results in the Model Condition being evaluated for the initial condition. (We have never seen this used when defining RAS.)



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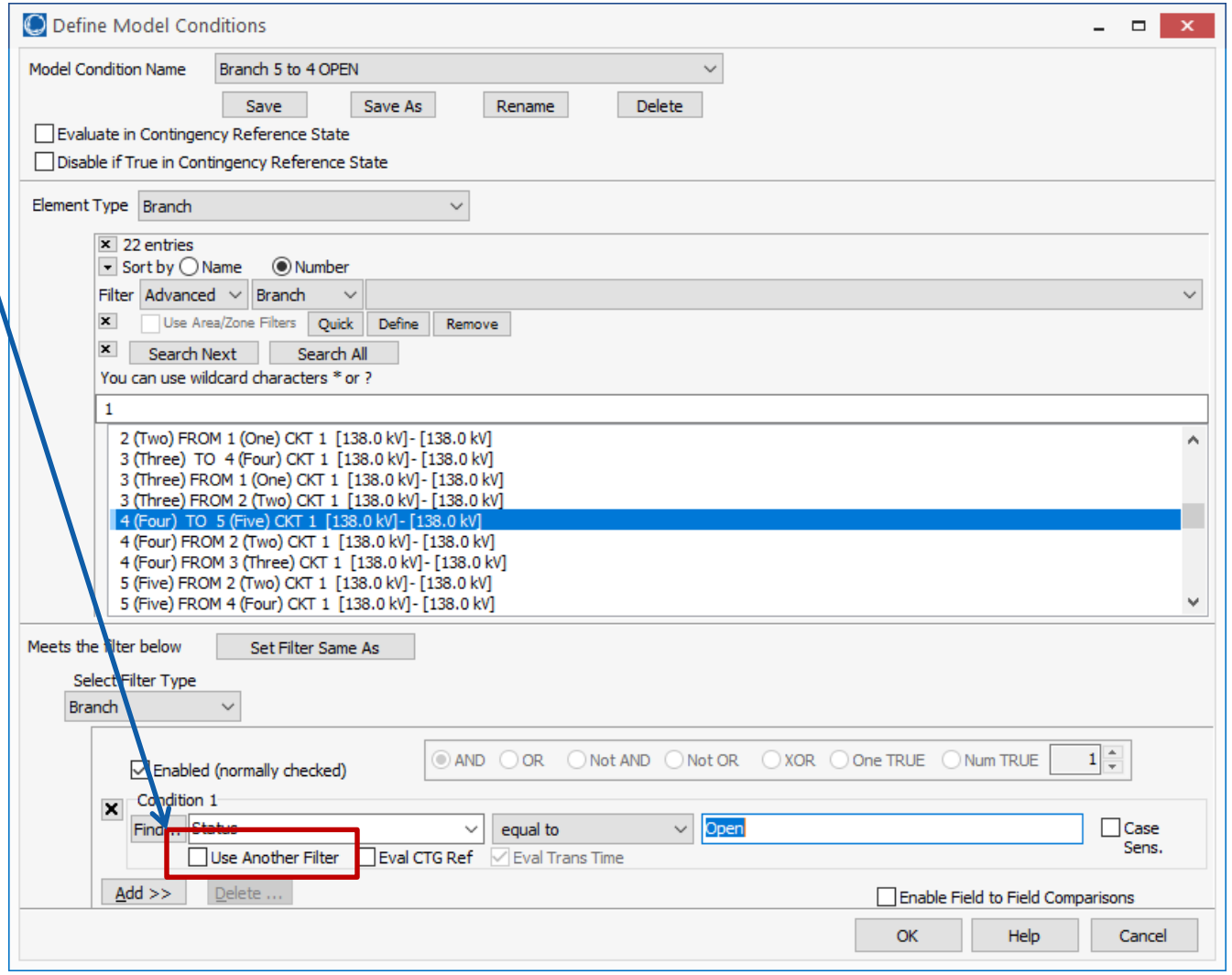
Model Condition
Not Translated Features

An Advanced Filter can be referenced as part of a Model Condition by checking the **Use Another Filter** option. This is not currently translated to the transient realm, which results in the Model Condition Condition being evaluated for the initial condition. (We have never seen this used when defining RAS)



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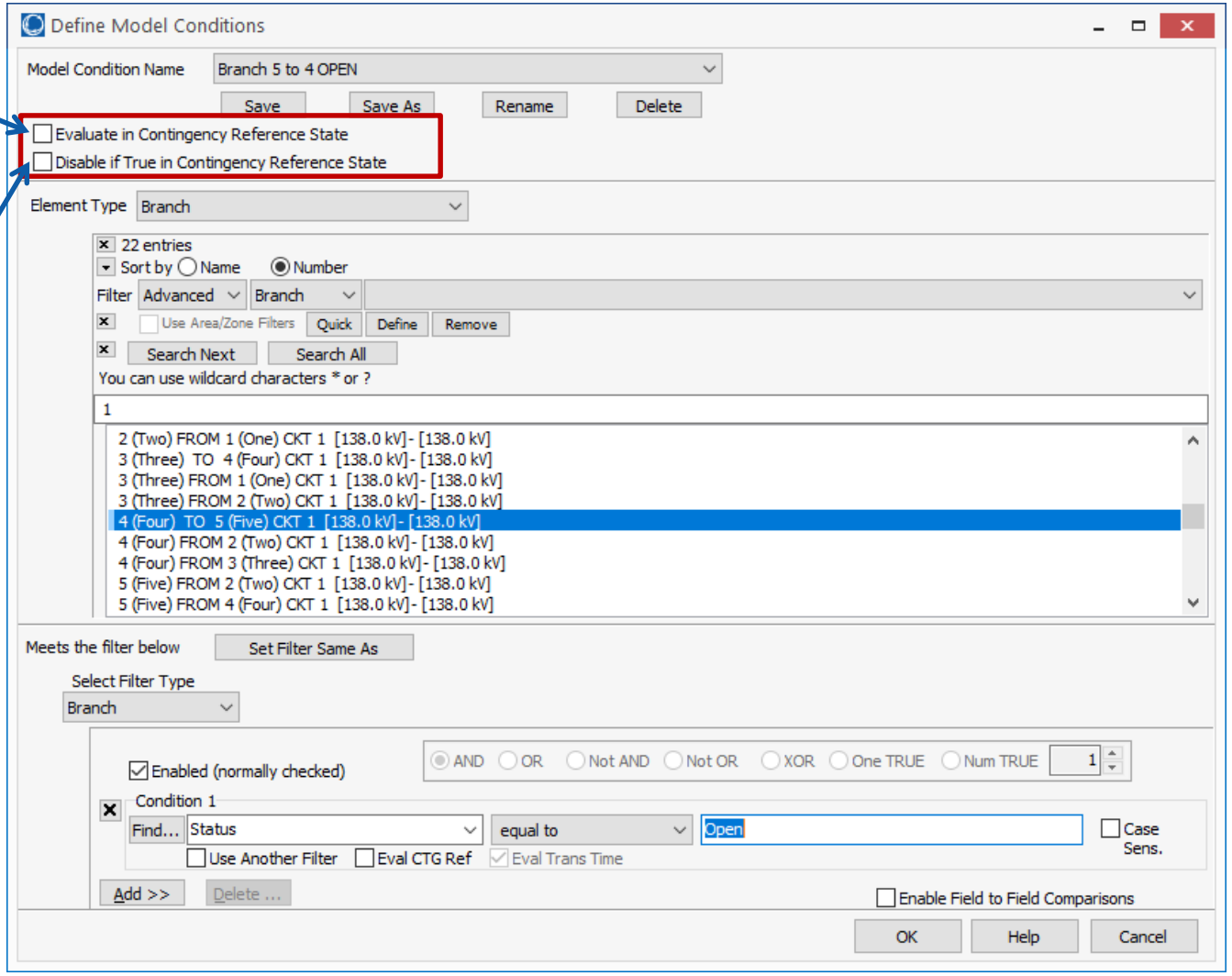
Model Condition Translated Features

Checking **Evaluate in Contingency Reference State** will result in the Model Condition being evaluated for the transient initial condition.

Checking **Disable if True in Contingency Reference State** will result in the Model Condition being ignored if it evaluates to true for the transient initial condition.



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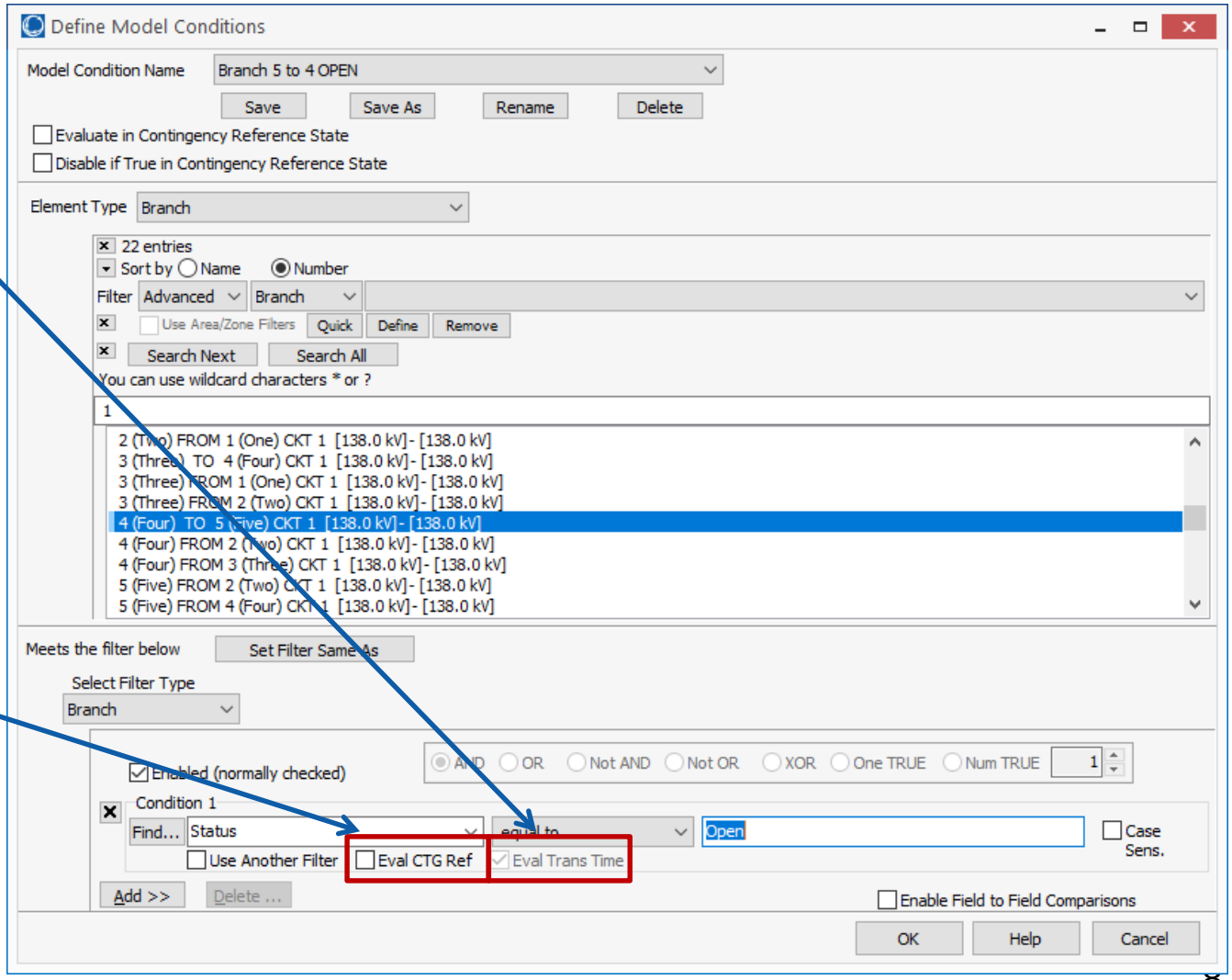
Model Condition Translated Features

Checking **Eval Trans Time** will result in the condition field being evaluated in the transient realm at each time step. If **Eval CTG Ref** is checked, field will always be evaluated for the initial condition. Status fields will ALWAYS be evaluated in the transient realm.

Checking **Eval CTG Ref** will result in the condition field being evaluated for the transient initial condition



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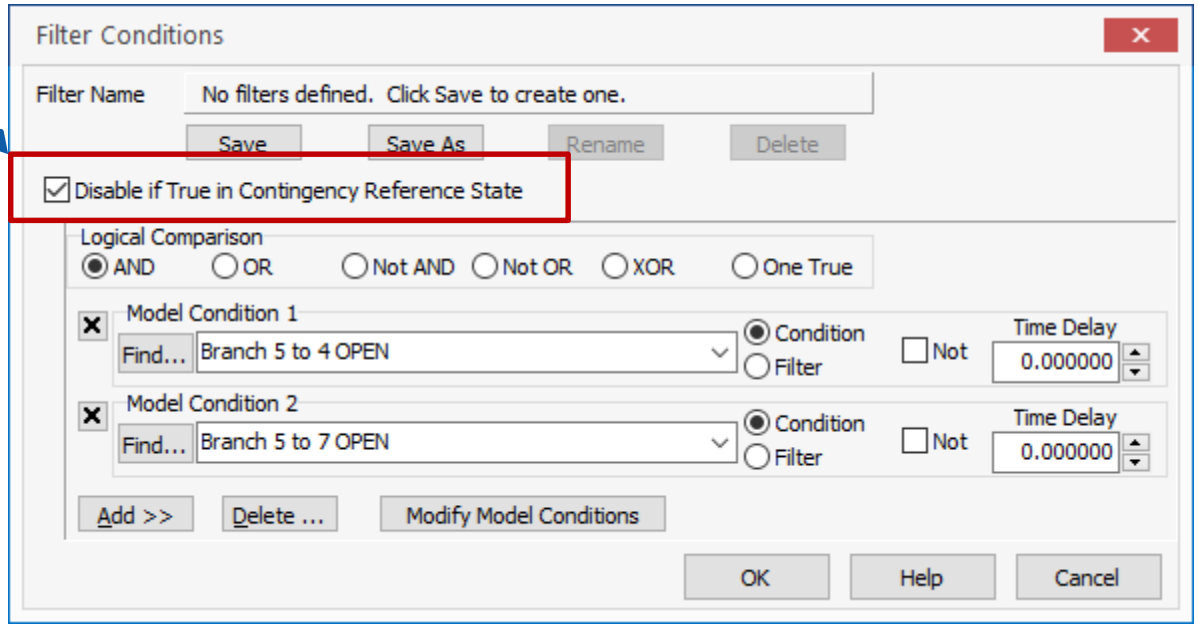
Model Filter Translated Features

Checking **Disable if True in Contingency Reference State** will result in the Model Filter being ignored if it evaluates to true for the transient initial condition.

It will also be ignored if all of its conditions are disabled because they evaluate to true for the initial condition.



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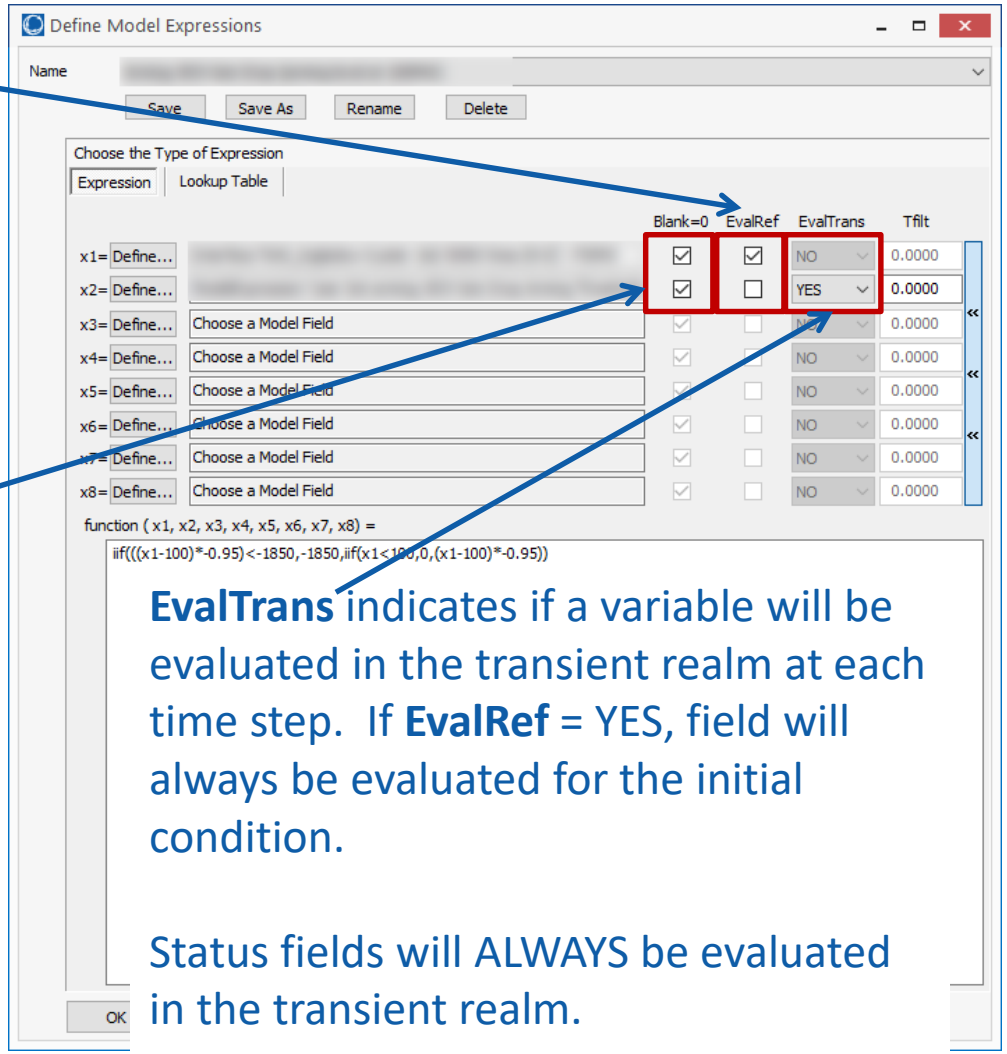
Model Expression Translated Features

Checking **EvalRef** for a variable will result in that variable being evaluated for the transient initial condition

Checking **Blank=0** currently does nothing when a Model Expression is evaluated during a transient run. There are currently no fields that are allowed to be translated where this would matter.



EvalTrans indicates if a variable will be evaluated in the transient realm at each time step. If **EvalRef** = YES, field will always be evaluated for the initial condition.

Status fields will ALWAYS be evaluated in the transient realm.

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Model Result Override

- Model Conditions, Model Filters, and Model Expressions can be overridden by a value specified with a Model Result Override
  - These represent SCADA measurements that are updated very infrequently, so they would not change during the time frame of transient stability
- If a logic object is being overridden, the value of the logic object is a constant and nothing will need to be evaluated during the transient run
- Remedial Action Elements using Model Criteria that is overridden will not be implemented because the model criteria is either not met or is considered met for the initial condition
  - This is true regardless of the action Status

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Logic Translation

- Resulting logic can end up being a combination of parameters that can be evaluated during a transient run and parameters that are evaluated for the transient initial condition
- If a Model Condition or Model Filter that is used as the Model Criteria for a Remedial Action Element results in being completely evaluated in the transient initial condition, that action will never be implemented
  - This includes Model Conditions and Model Filters that are being overridden by a Model Result Override
  - Bad input data could result in RAS logic that evaluates to TRUE in the initial condition. Logic is still ignored in transient stability because this should never happen.

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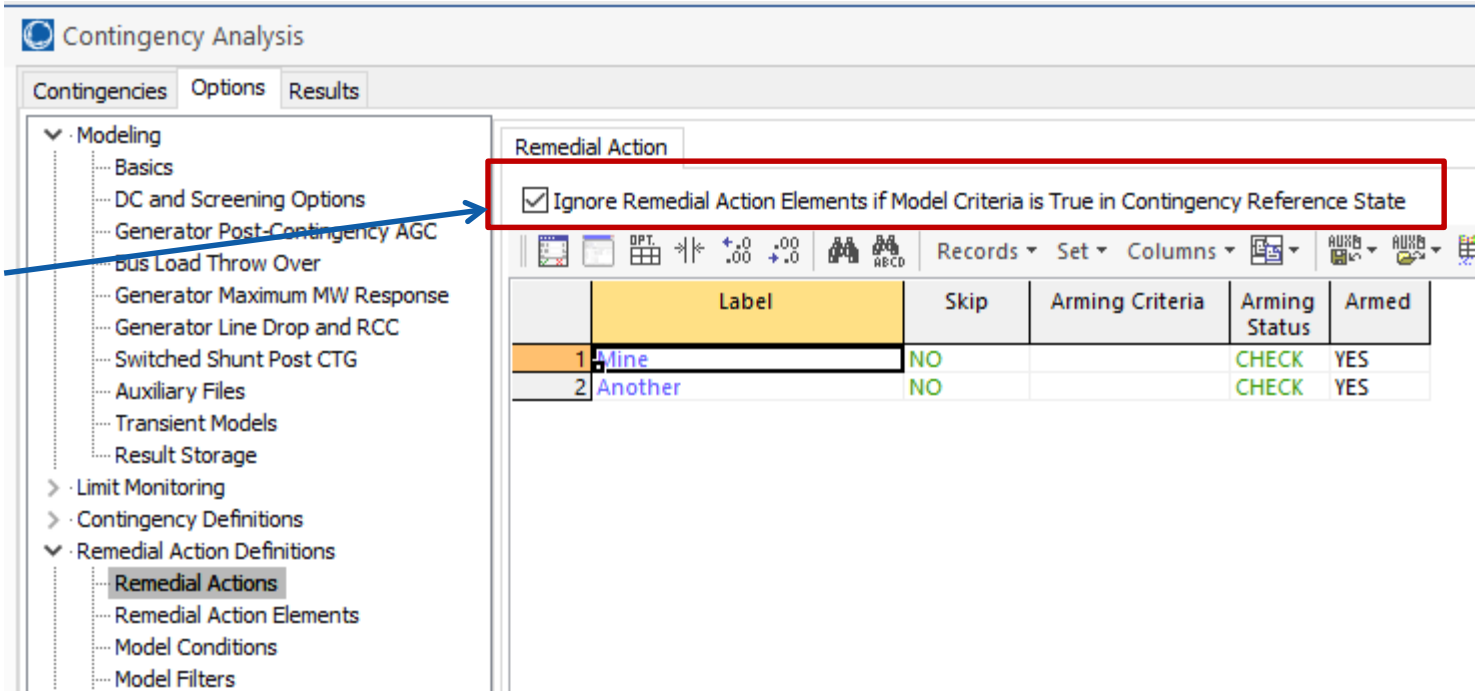
Model Criteria True in Contingency Reference State

Checking **Ignore Remedial Action Elements if Model Criteria is True in Contingency Reference State** will result in the Model Criteria being evaluated for the transient initial condition, and if true the Remedial Action Element will never be implemented.



This is evaluated as part of the arming check and will be considered the same as the Remedial Action Element not being armed.

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Arming Logic

- **Arming Criteria** with Remedial Action and Remedial Action Element determines if an action is armed
  - For a Remedial Action Element to be armed its Remedial Action must also be armed
  - Always evaluated for the transient stability initial condition and never translated to the transient stability realm
- Actions that are not armed can never be implemented
  - Which means they also will not be translated to the transient realm
- How arming is determined

Arming Status	Arming Criteria	Armed
CHECK	Blank	Yes
CHECK	YES for Initial Condition NO for Initial Condition	Yes No
ALWAYS	Ignored	Yes
NEVER	Ignored	No

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Action Translation

- Many different options exist for steady-state remedial actions
- For the most part, only those actions that involve breaker status changes are translated to transient stability
  - These are considered to be the triggering actions
- Any actions that are not translated to transient stability realm are never implemented
  - Even if Model Criteria evaluates to TRUE in the initial condition

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Translated Actions

Object Type	Defined Action	Transient Stability Action
Gen	OPEN	OPEN
Gen	CHANGEBY MW or % SETTO MW or %	Set appropriate transient model parameters to change MW setpoint
Load	OPEN	OPEN
Switched Shunt	OPEN CLOSE (will not be done for continuous shunts or SVCs)	OPEN CLOSE
Branch	OPEN (both ends of line) CLOSE (both ends of line)	OPEN (both ends of line) CLOSE (both ends of line)
Series Cap/Reactor	BYPASS NOTBYPASS	BYPASS NOTBYPASS
Injection Group	OPEN OPEN Number Elements CHANGEBY MERITORDEROPEN MW or % CHANGEBY MWEFFECTOPEN CHANGEBY BESTFITOPEN MW or % SETTO MERITORDEROPEN MW or %	List of devices to open are determined based on the initial condition

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Action Translation
Action Status

- **Status** of an action determines if it can be translated
- Actions that are not translated can never be implemented

Status	Model Criteria	Translated
CHECK	N/A	No
ALWAYS	N/A	No
NEVER	N/A	No
SOLUTIONFAIL	N/A	No
TOPOLOGYCHECK	Defined Blank	Yes No
POSTCHECK	Defined Blank	Yes No

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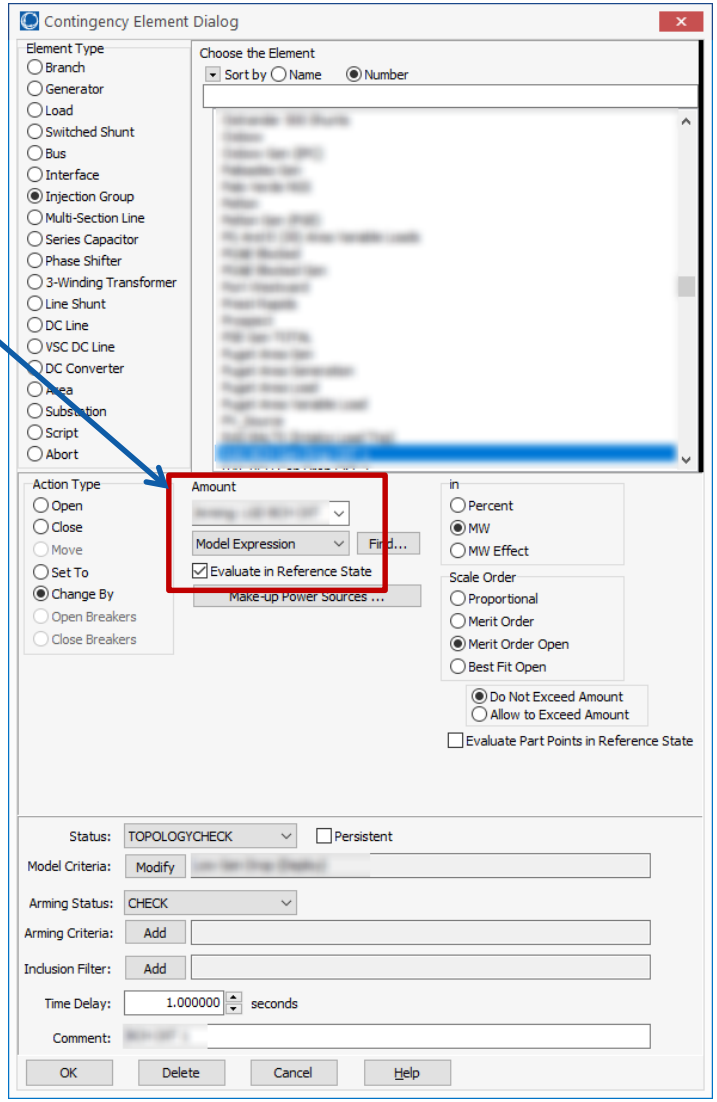
Action Translation Amount

Amount can be specified by a Model Expression or object Field. This will always be determined from the transient initial condition. (**Evaluate in Reference State** option is not relevant.)

For Injection Group actions, the determination of which devices to open will be done based on the transient initial condition.



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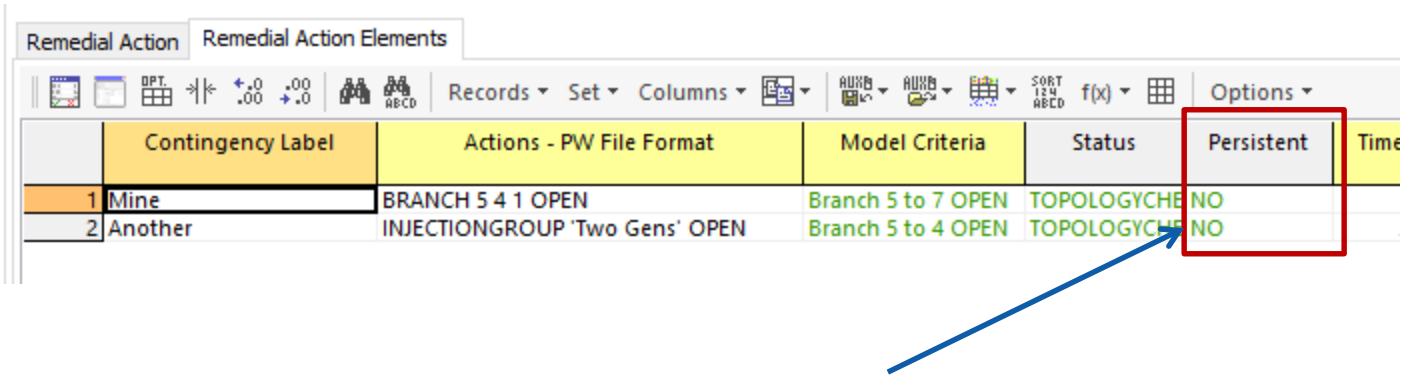
Persistent Actions

- Remedial Action Elements have an option to make them persistent
  - An action can be applied more than once
- This option is currently ignored when translating an action to the transient realm



Persistent option is ignored meaning each action can only occur once

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Breaker Delay

- Once the Model Criteria is met for an action for the pickup time (Time Delay), the action will be implemented after the **Breaker Delay** has been met
  - **Breaker Delay** is specified with Generator, Load, Switched Shunt, and Branch objects
- Only actions that involve breaker actions, i.e. OPEN or CLOSE, will use the **Breaker Delay**

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Breaker Delay

- Branches have a **Breaker Delay From** and **Breaker Delay To**
  - If **Breaker Delay From** <> **Breaker Delay To**, two separate events will occur that open the two ends of the branch at the appropriate times
  - If branch is a switching device (Breaker, Load Break Disconnect, Disconnect, Fuse, or Ground Disconnect) the largest of **Breaker Delay From** and **Breaker Delay To** is used for one event that opens the entire branch

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Breaker Delay

- Injection Group actions will open generators and/or loads or switched shunts
  - Individual events will occur that open the required objects after their own **Breaker Delay**

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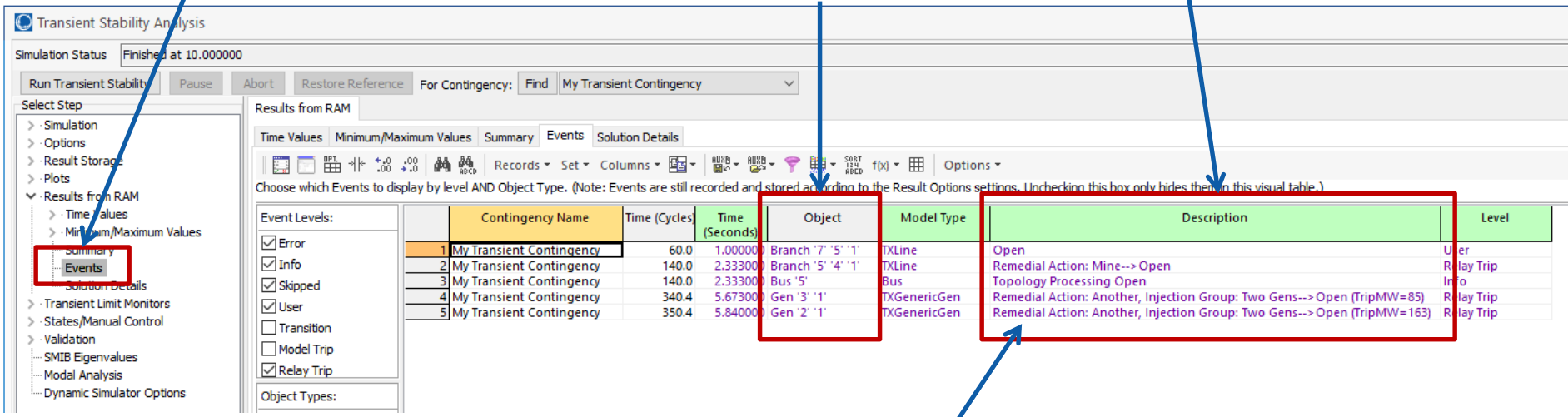
Determining What Happened

Results from RAM → Events will contain the logging of any Remedial Action Elements that are implemented

Description will contain the keyword *Remedial Action* followed by the name of the action from which the action originates

Object contains the description of the action element



Event involving a Remedial Action Element for an Injection Group will also identify the injection group, while the **Object** identifies the specific object that was opened

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Validation

- Done automatically at the start of a transient run if RAS is included
- Can also be done manually
- Indicates if a Remedial Action Element will be translated to be available for implementation during the transient run

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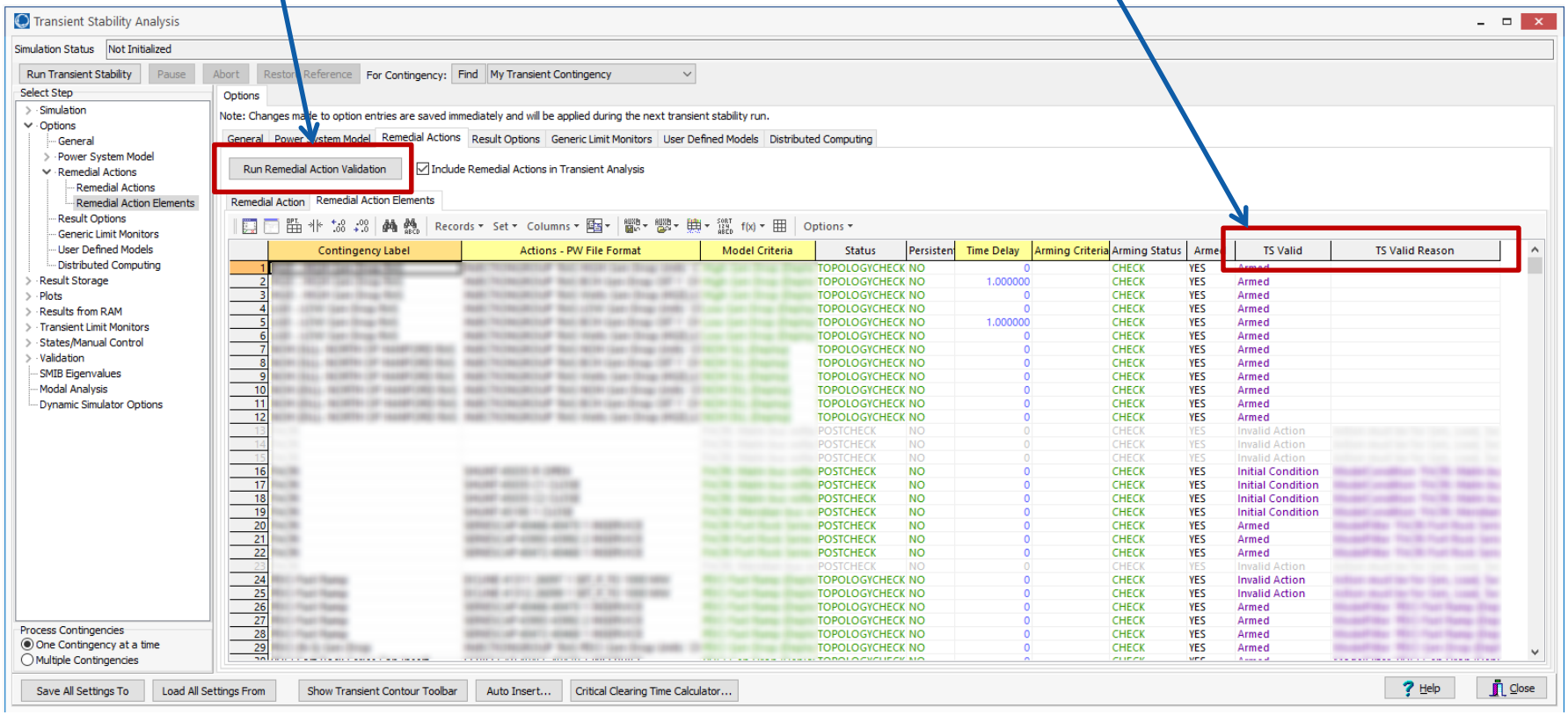
Validation

Click **Run Remedial Action Validation** to run validation

TS Valid and **TS Valid Reason** fields indicate if an action will be translated for use during transient stability



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TS Valid Field
Remedial Action Element

TS Valid Field	Meaning	Translated
Skip	Remedial Action **Skip** = *YES*	No
Armed	**Arming Criteria** is met	Yes
Not Armed	**Arming Criteria** is not met	No
Invalid Status	Action **Status** is not valid for translation (must be TOPOLOGYCHECK or POSTCHECK)	No
Invalid Action	Action is not valid for translation (OPEN/CLOSE or particular SETTO/CHANGEBY)	No
No Model Criteria	**Model Criteria** is not defined	No
Initial Condition	**Model Criteria** is completely evaluated for the transient initial condition	No

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TS Valid Reason

- The **TS Valid Reason** field provides more details about components of the Model Criteria that are evaluated for the transient initial condition
  - If (**TS Valid** = *Armed*) and (**TS Valid Reason** is not blank), some components are evaluated for the transient initial condition and some are evaluated during the transient run

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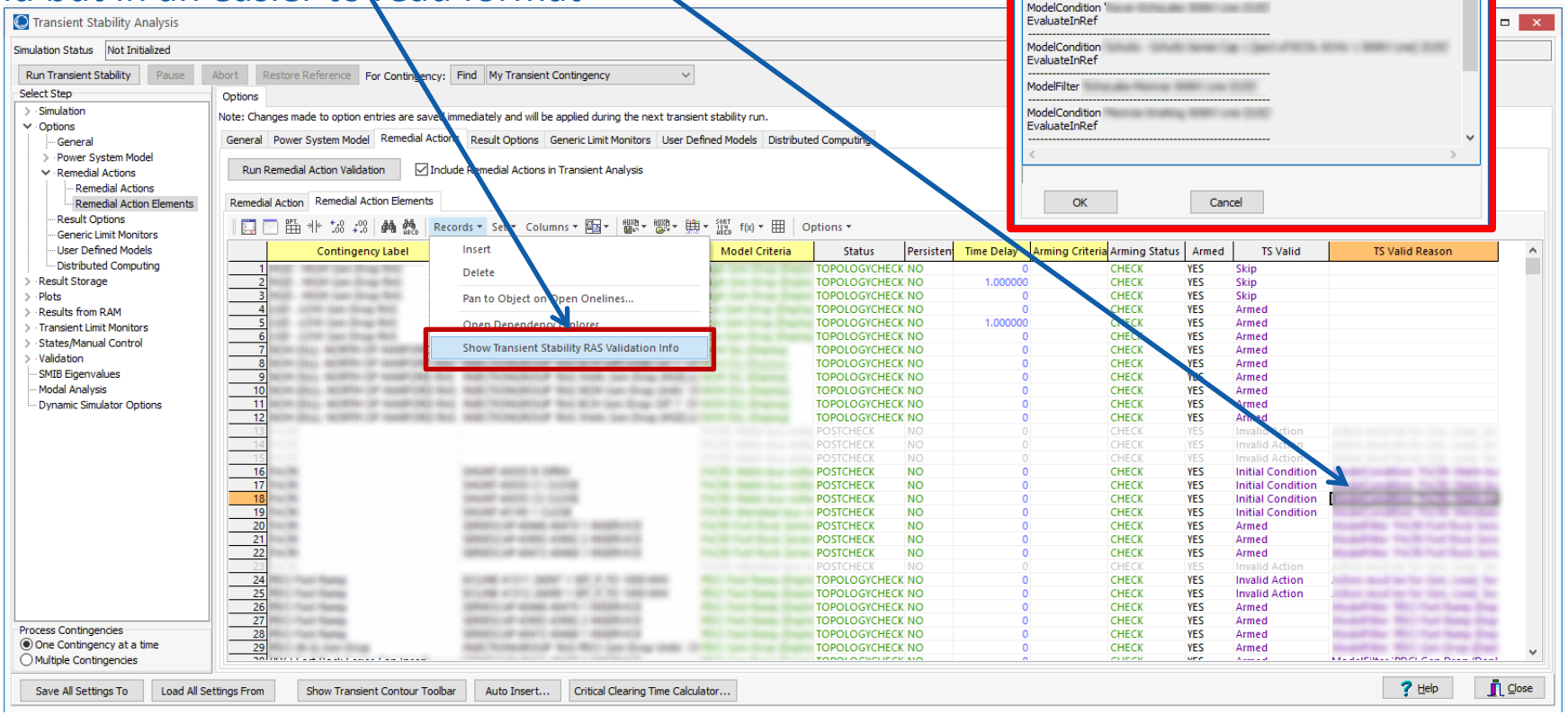
TS Valid Reason

Local menu option to
Show Transient Stability RAS Validation Info
will open a dialog showing the **TS Valid Reason** field but in an easier to read format



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