

Transient Stability Analysis with PowerWorld Simulator



T4: Model Validation



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Model Validation



- It is not uncommon for cases to contain multiple errors or inconsistencies in their input data
- Simulator allows validation and error corrections to be preformed independently of running the simulation
- Validation page of Transient Stability Dialog
 - Validation Options
 - Logging of Error Messages, Warnings, and Informational Messages
- Types of Validation Checks Performed
 - Time constants
 - Machine parameters
 - Limit consistency

Validation Options



The validation tab provides some built-in model validation

Validation: Unsupported Models

Determines what is done with the models which are not fully supported for the transient simulation

Minimum Time Constant Size

A specified multiple of the integration time step, generally between 2 and 4

	Element Type	General Type	Model Type	Who Am I	
9	Generator	Machine Model	GENTPF	CUSHMN2_ 12.6 (46791) #1	Tdop > 5*Tdopp is recommended.
10	Generator	Machine Model	GENTPF	CHELAN_ 11.0 (46803) #A1	Tdop > 5*Tdopp is recommended.
11	Generator	Machine Model	GENTPF	RI SOUTH_ 13.8 (46895) #B9	Tdop > 5*Tdopp is recommended.
12	Generator	Machine Model	GENTPF	RI SOUTH_ 13.8 (46895) #BA	Tdop > 5*Tdopp is recommended.
13	Generator	Machine Model	GENTPF	RI NORTH_ 13.8 (46893) #B6	Tdop > 5*Tdopp is recommended.
14	Generator	Machine Model	GENTPF	RI STUB1_ 13.8 (46889) #B1	Parameter Tdopp is usually < 2

Some time constants introduce numerical problems if they are too small, relative to the time step

Validation Options



- Specify how Simulation should handle unsupported Models
 - Raise Error – Provide an error message and prevents analysis from running
 - Raise Warning – Provide a warning message and set unsupported models to inactive
 - No Error/Warning - Set unsupported models to inactive but provide no message

Validation



- Click “Run Validation” to validate the model
 - “Errors” will list errors with the model data specified
 - “Warnings” will list suggestions about strange or missing data
 - “Information Messages” will report any changes made to the model by the AutoCorrection routine
- Errors prevent the transient stability analysis from being run
- Click “Run AutoCorrection” to automatically correct many data errors
- Note that this may result in changes to the data

Limits on Time Constants



- For an integration block
 - Must be greater than specified multiple of the time step and nonzero
- For a filter block
 - Same as above, but allowed to be zero
 - If zero, this becomes an ignored state
- For a lead-lag block
 - T_2 must be greater than specified multiple of time step
 - If T_2 is zero, T_1 must also be zero for causality

$$\frac{1}{sT}$$

$$\frac{1}{1+sT}$$

$$\frac{1+sT_1}{1+sT_2}$$

Machine Model Reactance Validation



- For synchronous machine models, there are d-axis and q-axis reactance values
- Synchronous reactance - X_d and X_q
- Transient reactance - X_d' and X_q'
- Sub-transient reactance - X_d'' and X_q''
- Leakage reactance - X_l
- The following two relationships must be satisfied (physically impossible to violate)
 - $X_l < X_q'' < X_q' < X_q$ and
 - $X_l < X_d'' < X_d' < X_d$
- These types of model errors are not uncommon

Machine Reactance Auto-Correction



- When machine reactance model errors are found and auto-correction is applied, the following changes will be applied to the data
 - If $X_q' > X_q$ then $X_q' = 0.8X_q$
 - If $X_d' > X_d$ then $X_d' = 0.8X_d$
 - If $X_q'' > X_q'$ then $X_q'' = 0.8X_q'$
 - If $X_d'' > X_d'$ then $X_d'' = 0.8X_d'$
 - If $X_l > X_q''$ then $X_l = 0.8X_q''$
 - If $X_l > X_d''$ then $X_l = 0.8X_d''$

Limit Consistency



- For Min/Max limits, Run Validation checks consistency of the limits – the Min limit must be less than or equal to the Max limit
- Clicking “Run AutoCorrection” when these types of errors are present will swap the Min and Max limit
- Initial limit violations are also indicated and handled using these validation tools

Limit Consistency



- Some limit pairs must *surround* zero
 - Limits on Stabilizer Output (stabilizer output MUST be zero at steady state)
 - Limits on the derivative of a state (derivative must be zero at steady state)
 - Many governors have these types of limits
- Some limit pairs are specified by a single number and the limitation is +/- this limit

Validation: Errors



- Many time constants must be a certain multiple of the integration time step
- Some time constants are not allowed to be zero and will result in an error
- If a model that Simulator can read is not supported, this may list an error

Summary
Tables

Validation

Run Validation Run AutoCorrection

Unsupported Models
☒ Raise Error
☐ Raise Warning
☐ No Error/Warning

Minimum time constant size as multiple of time step 4.0

Last Validation
Time 12/7/2021 12:54:25 PM
Errors: 3207 Warnings: 56

Validation Errors Validation Warnings Informational Messages

	Element Type	General Type	Model Type	Device Status	Who Am I	Validation Message
1	Generator	Machine Model	GENROU	Active	REEVE_G1_ 13.8 (10261) #1	Parameter Tdopp must be 4.0 times the time step
2	Generator	Governor	GGOV1	Active	REEVE_G1_ 13.8 (10261) #1	Parameter Ta must be 4.0 times the time step or zero
3	Generator	Machine Model	GENROU	Active	REEVE_G3_ 13.8 (10263) #1	Parameter Tdopp must be 4.0 times the time step
4	Generator	Governor	GGOV1	Active	REEVE_G3_ 13.8 (10263) #1	Parameter Ta must be 4.0 times the time step or zero
5	Generator	Exciter	EXAC3A	Active	SJUAN_G1_ 22.0 (10318) #1	Parameter Ta must be 4.0 times the time step
6	Generator	Over Excitation Lim	OEL1	Active	SJUAN_G1_ 22.0 (10318) #1	Will not be used, because the Active Exciter is not suitable for thi
7	Generator	Over Excitation Lim	OEL1	Active	SJUAN_G3_ 22.0 (10320) #1	Will not be used, because the Active Exciter is not suitable for thi
8	Generator	Over Excitation Lim	OEL1	Active	SJUAN_G4_ 22.0 (10321) #1	Will not be used, because the Active Exciter is not suitable for thi

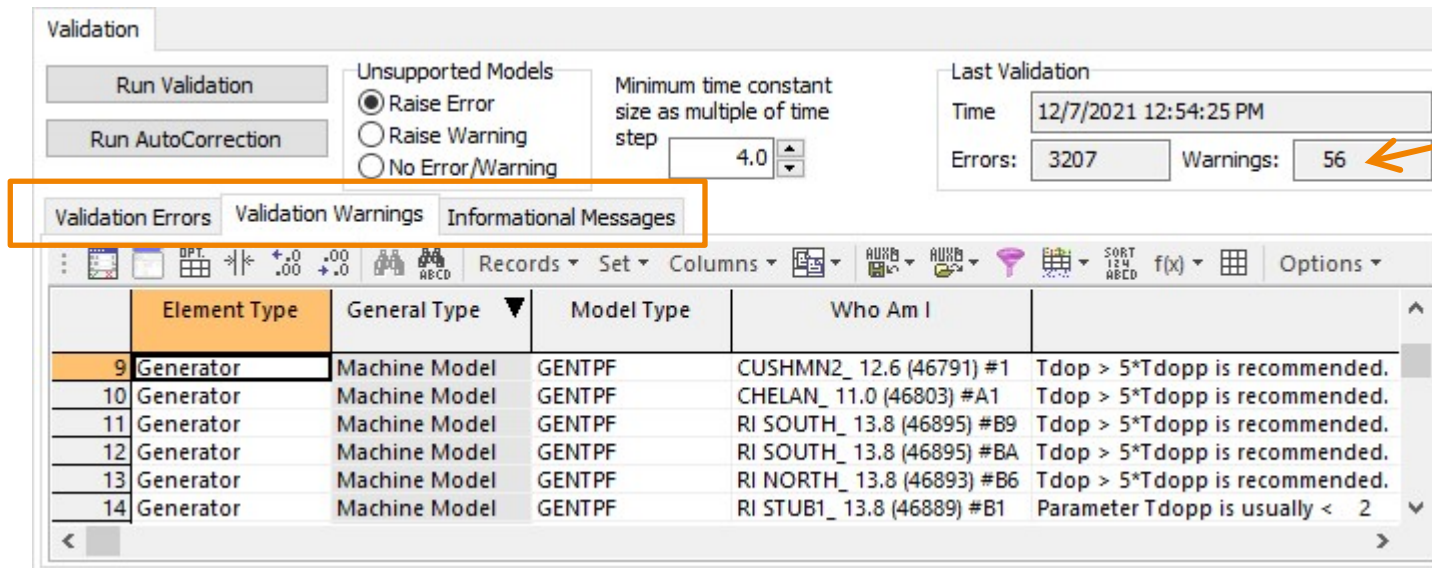
Number of Errors

Validation: Warnings



- Generator may not have a machine model
- Generators may be connected to buses with zero voltage
- Parameters may be outside of their expected range

Summary
Tables



Validation

Run Validation Run AutoCorrection

Unsupported Models
☒ Raise Error
☐ Raise Warning
☐ No Error/Warning

Minimum time constant size as multiple of time step 4.0

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Number of
Warnings

Generator with no Machine Model



- What does Simulator do if a generator has no machine model (or model is inactive)?
 - Ignore exciter, stabilizer, governors, etc...
 - Treat the generators as a constant current based on the initial condition
 - Impedance is calculated from P, Q, and bus voltage from power flow solutions used as initial condition.
 - There is no special command to ask that this be done

Validation: Informational Messages



- Parameters may be outside of their expected range
- Time constants may be increased to multiple of the time step or set to zero if allowed
- Messages will appear regarding any auto-corrections made when using the auto-correction tool

Summary
Tables

Validation

Run Validation

Run AutoCorrection

Unsupported Models

☒ Raise Error

☐ Raise Warning

☐ No Error/Warning

Minimum time constant size as multiple of time step

4.0

Last Validation

Time 12/7/2021 2:32:00 PM

Errors: 0 Warnings: 53

Validation Errors Validation Warnings Informational Messages

	Element Type	General Type	Model Type	Device Status	Who Am I	Validation Message
1	Generator	Machine Model	GENROU	Active	REEVE_G1_ 13.8 (10261) #1	Parameter Tdopp must be 4.0 times the time step; autocorrected to 0.03333
2	Generator	Governor	GGOV1	Active	REEVE_G1_ 13.8 (10261) #1	Parameter Ta must be 4.0 times the time step; autocorrected to 0
3	Generator	Machine Model	GENROU	Active	REEVE_G3_ 13.8 (10263) #1	Parameter Tdopp must be 4.0 times the time step; autocorrected to 0.03333
4	Generator	Governor	GGOV1	Active	REEVE_G3_ 13.8 (10263) #1	Parameter Ta must be 4.0 times the time step; autocorrected to 0
5	Generator	Exciter	EXAC3A	Active	SJUAN_G1_ 22.0 (10318) #1	Parameter Ta must be 4.0 times the time step; autocorrected to 0.03333
6	Generator	Over Excitation Lim	OEL1	Not active	SJUAN_G1_ 22.0 (10318) #1	Status changed to Not Active, because the Active Exciter is not suitable for this
7	Generator	Over Excitation Lim	OEL1	Not active	SJUAN_G3_ 22.0 (10320) #1	Status changed to Not Active, because the Active Exciter is not suitable for this
8	Generator	Over Excitation Lim	OEL1	Not active	SJUAN_G4_ 22.0 (10321) #1	Status changed to Not Active, because the Active Exciter is not suitable for this
9	Generator	Exciter	EXST4B	Active	LEF_G1_ 18.0 (10394) #1	Parameter Ta must be 4.0 times the time step; autocorrected to 0.03333
10	Generator	Exciter	EXST4B	Active	LEF_G2_ 18.0 (10395) #1	Parameter Ta must be 4.0 times the time step; autocorrected to 0.03333
11	Generator	Exciter	EXST4B	Active	LEF_S1_ 18.0 (10396) #1	Parameter Ta must be 4.0 times the time step; autocorrected to 0.03333

Informational Messages

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