

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

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: 5/21/2010 2:33:04 PM
Errors: 0 Warnings: 99

Validation Errors | Validation Warnings | Informational Messages

	Element Type	General Type	Model Type	Who Am I	Validation Message
1	Generator	Machine Model	GENROU	WPCC4ST1_ 13.8 (14950) #1	Tqop > 5*Tqopp is recommended.
2	Generator	Machine Model	GENROU	SANTAN 1_ 13.8 (15921) #1	Tqop > 5*Tqopp is recommended.
3	Generator	Machine Model	GENROU	SANTAN 2_ 13.8 (15922) #1	Tqop > 5*Tqopp is recommended.
4	Generator	Machine Model	GENROU	SANTAN 3_ 13.8 (15923) #2	Tqop > 5*Tqopp is recommended.

Many time constants must not be too small or they introduce numerical problems.

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 $\frac{1}{sT}$
 - Must be greater than specified multiple of the time step and nonzero
- For a filter block $\frac{1}{1+sT}$
 - Same as above, but allowed to be zero
 - If zero, this becomes an ignored state
- For a lead-lag block $\frac{1+sT_1}{1+sT_2}$
 - T_2 must be greater than specified multiple of time step
 - If T_2 is zero, T_1 must also be zero for causality

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 $X_1 > X_q''$ then $X_1 = 0.8X_q''$
 - If $X_1 > X_d''$ then $X_1 = 0.8X_d''$

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

Number of Errors

Validation Errors Validation Warnings Informational Messages Errors: 832 Warnings: 451

	Validation Object	Validation Message
198	Generator LOW_MON_13.8_1003 (6774) #1, Stabilizer: PSS2A	Parameter Tw3 must be 2.0 times the time step (0 not allowed)
199	Generator LOW_MON_13.8_1005 (6776) #1, Stabilizer: PSS2A	Parameter Tw3 must be 2.0 times the time step (0 not allowed)
200	Generator LOW_MON_13.8_1006 (6777) #1, Machine Model: GENSAL	Parameter Tqopp must be 2.0 times the time step (0 not allowed)
201	Generator LOW_MON_13.8_1006 (6777) #1, Governor: IEEEG3_GE	Parameter Tg must be 2.0 times the time step (0 not allowed)
202	Generator LOW_MON_13.8_1008 (6779) #1, Machine Model: GENSAL	Parameter Tqopp must be 2.0 times the time step (0 not allowed)
203	Generator LOW_MON_13.8_1008 (6779) #1, Governor: IEEEG3_GE	Parameter Tg must be 2.0 times the time step (0 not allowed)
204	Generator LOW_MON_13.8_1009 (6780) #1, Machine Model: GENSAL	Parameter Tqopp must be 2.0 times the time step (0 not allowed)
205	Generator LOW_MON_13.8_1009 (6780) #1, Governor: IEEEG3_GE	Parameter Tg must be 2.0 times the time step (0 not allowed)
206	Generator MAPLE_VL_19_2200 (7004) #1, Machine Model: SVCWSC	SVCWSC model not supported in this version; contact PowerWorld for more information.
207	Generator MCNARY_115_139 (7293) #1, Machine Model: GENTPF	Parameter Xqp must be >= 0.15 (0 not allowed)
208	Generator MCNARY_13.2_8003 (7306) #1, Stabilizer: PSS2A	Parameter Tw3 must be 2.0 times the time step (0 not allowed)

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

Number of Warnings

	Validation Object	Validation Message
75	Generator CHELAN_F_11_1001 (12736) #1, Machine Model: GENTPF	Parameter Tdopp is usually < 1
76	Generator CHELAN_F_11_1001 (12736) #1, Machine Model: GENTPF	Parameter Tqopp is usually < 1
77	Generator NINECNYN_34.5_514 (12784) #1	Generator does not have machine modeled defined; treated as negative load.
78	Generator NINECNYN_34.5_513 (12785) #1	Generator does not have machine modeled defined; treated as negative load.
79	Generator NINECNYN_34.5_512 (12787) #1	Generator does not have machine modeled defined; treated as negative load.
80	Generator NINECNYN_34.5_511 (12788) #1	Generator does not have machine modeled defined; treated as negative load.
81	Generator NINECNYN_34.5_506 (12792) #1	Generator does not have machine modeled defined; treated as negative load.
82	Generator NINECNYN_34.5_501 (12794) #1	Generator does not have machine modeled defined; treated as negative load.
83	Generator ROCKY_RH_15_1003 (12896) #1	bus voltage is equal to zero; generator dynamic models set off
84	Generator ROCKY_RH_15_1001 (12898) #1	bus voltage is equal to zero; generator dynamic models set off
85	Generator ROCK_ISL_13.8_1020 (12939) #1, Machine Model: GENTPF	Parameter Tdopp is usually < 1
86	Generator ROCK_ISL_13.8_1020 (12939) #1, Machine Model: GENTPF	Parameter Tqopp is usually < 1
87	Generator ROCK_ISL_13.8_1020 (12939) #1	bus voltage is equal to zero; generator dynamic models set off

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 impedance 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

Informational Messages

Validation Object		Validation Message
224	Generator CARMEN_S_11.5_1002 (12047) #1, Machine Model: GENTPF	Parameter Xqp must be ≥ 0.15 (0 not allowed); auto-corrected to 0.15
225	Generator TRAILBRG_11.5_1000 (12189) #1, Machine Model: GENTPF	Parameter Xqp must be ≥ 0.15 (0 not allowed); auto-corrected to 0.15
226	Generator WALTVILLE_66_604 (12190) #1, Machine Model: GENTPF	Parameter Xqp must be ≥ 0.15 (0 not allowed); auto-corrected to 0.15
227	Generator CHELAN_F_11_1002 (12735) #1, Machine Model: GENTPF	Parameter Tdopp is usually < 1 ; autocorrected to 1
228	Generator CHELAN_F_11_1002 (12735) #1, Machine Model: GENTPF	Parameter Tqopp is usually < 1 ; autocorrected to 1
229	Generator CHELAN_F_11_1002 (12735) #1, Exciter: EXST4B	Parameter Ta must be 2.0 times the time step; autocorrected to 0.01667
230	Generator CHELAN_F_11_1001 (12736) #1, Machine Model: GENTPF	Parameter Tdopp is usually < 1 ; autocorrected to 1
231	Generator CHELAN_F_11_1001 (12736) #1, Machine Model: GENTPF	Parameter Tqopp is usually < 1 ; autocorrected to 1
232	Generator CHELAN_F_11_1001 (12736) #1, Exciter: EXST4B	Parameter Ta must be 2.0 times the time step; autocorrected to 0.01667
233	Generator ROCKY_RH_15_2001 (12904) #1, Governor: GPWSCC	Parameter Td must be 4.0 times the time step; autocorrected to 0.03333
234	Generator ROCKY_RH_15_2001 (12904) #1, Governor: GPWSCC	Parameter Tf must be 4.0 times the time step; autocorrected to 0
235	Generator ROCKY_RH_15_3003 (12906) #1, Governor: GPWSCC	Parameter Td must be 4.0 times the time step; autocorrected to 0.03333

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