Electromagnetic Transient (EMT) Model Requirements

A EMT model compatible with PSCAD is required. The model requirements include:

A. Represent the full detailed inner control loops of the power electronics. The model cannot use the same approximations classically used in transient stability modeling, and must fully represent all fast inner controls, as implemented in the real equipment.

B. Represent all control features pertinent to the type of study being done. Examples include external voltage controllers, customized PLLs, ride-though controllers, SSCI damping controllers, and others. As in point A, actual hardware code is required to be used for most control and protection features. Operating modes that require system specific adjustment must be user accessible.

C. Represent plant level control. Power Plant Control (PPC) representation must be included which represents the specific controllers used in the plant. Plant controllers must be represented in sufficient detail to accurately represent short term performance, including specific measurement methods, communication time delays, transitions into and out of ride-through modes, settable control parameters or options, and any other specific implementation details which may impact plant behavior. Generic PPC representation are not acceptable unless the final PPC controls are designed to exactly match the generic PPC model. If multiple plants are controlled by a common controller, or if the plant includes multiple types of IBRs (e.g., Hybrid BESS/PV) this functionality must be included in the plant control model. If supplementary or multiple voltage control devices (e.g., STATCOM) are included in the plant, these should be coordinated with the PPC.

D. Represent all pertinent electrical and mechanical configurations. This includes any filters and specialized transformers. There may be other mechanical features such as gearboxes, pitch controllers, or others which must be modeled if they impact electrical performance within the timeframe and electrical purview of the study. Any control or dynamic features of the actual equipment which may influence behavior in the simulation period which are not represented, or which are approximated, must be clearly identified.

E. Have all pertinent protections modeled in detail for both balanced and unbalanced fault conditions. Typically, this includes various OV and UV protections (individual phase and RMS), frequency protections, DC bus voltage protections, converter overcurrent protections, and often other inverter specific protections. Any protections which can influence dynamic behavior or plant ride-through in the simulation period must be included. Actual hardware code is recommended to be used for these protection features.

F. Be configured to match expected site-specific equipment settings. Any user-tunable parameters or options must be set in the model to match the equipment at the specific site being evaluated, as far as they are known. Default parameters are not appropriate unless these will match the configuration in the installed equipment.

G. Have control or hardware options which are pertinent to the study accessible to the user. Although plant must be configured to match site specific settings as far as they are known, parameters pertinent to the study must be accessible for use by the model user. Examples of this could include protection thresholds, real power recovery ramp rates, frequency or voltage droop settings, voltage control response times, or SSCI damping controllers. Diagnostic flags (e.g. flags to show control mode changes or which protection has been activated) should be visible to aid in analysis.

H. Be accurate when running at a simulation time step of 10 μs or higher.

I. Operate at a range of simulation time steps. The model must not be restricted to operating at a single time step but must be able to operate withing a range (e.g., 10 μs – 20 μs).

J. Include documentation and a sample implementation test case. Test case models must be configured according to the site-specific real equipment configuration up to the Point of Interconnection. This would include (for example): aggregated generator model, aggregated generator transformer, equivalent collector branch, main plant transformers, gen-tie line, power plant controller, and any other static or dynamic reactive resources. Test case must use a single machine infinite bus representation of the system, configured with an appropriate representative SCR.

K. Have an identification mechanism for configuration. The model documentation must provide a clear way to identify the specific settings and equipment configuration which will be used in any study, such that during commissioning the settings used in the studies can be checked. This may be control revision codes, settings files, or a combination of these and other identification measures.

L. Accept external reference variables. This includes real and reactive power ordered values for Q control modes, or voltage reference values for voltage control modes. Model must accept these reference variables for initialization and be capable of changing these reference variables mid-simulation, i.e., Dynamic signal references.

M. Be capable of initializing itself. Once provided with initial condition variables, the model must initialize and ramp to the ordered output without external input from simulation engineers. Any slower control functions which are included (such as switched shunt controllers or power plant controllers) must also accept initial condition variables if required. Note that during the first few seconds of simulation (e.g., 0-2 seconds), the system voltage and corresponding terminal conditions may deviate from nominal values due to other system devices initializing, and the model must be able to tolerate these deviations or provide a variable initialization time.

N. Initialize quickly. Model must reach its ordered initial conditions as quickly as possible (for example < 5 seconds) to user supplied terminal conditions.