NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Field Tested Version of MOD-026 Mapped to Proposed MOD-026-1 — Verification of Models and Data for Generator Excitation System Functions

Field Tested Version of MOD-026	Comment	Proposed MOD-026-1
2. Number: MOD-026-1	Proposed standard will only cover MOD-026-1 content and will not be merged with any other standard	**2. Number:** MOD-026-1
1. Title: Verification of Models and Data for Generator Excitation System Functions	Title is unchanged	**1. Title:** Verification of Models and Data for Generator Excitation System Functions
3. Purpose: To ensure accurate information on generator excitation system functions (including voltage regulator controls, limiters, compensators, and power system stabilizers, if applicable) is available for models used to assess bulk electric system reliability.	The Purpose has been modified to emphasize verification of models, as opposed to data reporting already covered in MOD-012 and MOD-013.	**3. Purpose:** To verify that the excitation system model (including power system stabilizer model and impedance compensator model if so installed) and the model parameters used in dynamic simulations that assess Bulk Electric System (BES) reliability accurately represent generator excitation system behavior.
4. Applicability: **4.1.** Regional Reliability Organization. **4.2.** Generation Owner.	Regional Reliability Organization applicability is eliminated. Transmission Planner is added as this functional entity is involved in the iterative process of validating dynamic models. Additionally, generating facilities have been limited to those that have significant	**4. Applicability:** **4.1. Functional entities** **4.1.1** Generator Operators of generating facilities: **4.1.1.1** Connected to Eastern or Quebec Interconnections with the following characteristics**:** Each unit (including synchronous condensers) ≥ 100 MVA, connected at the point of interconnection at 100 kV or above and with an average Capacity Factor greater than 5% over the last three calendar years. Each unit (including synchronous condensers) ≥ 20 MVA within a plant ≥ 200 MVA, connected at the

Field Tested Version of MOD-026	Comment	Proposed MOD-026-1
	impact to BES reliability as they consist of approximately 80% of the connected MVA in each Interconnection	point of interconnection at 100 kV or above and with an average Capacity Factor greater than 5% over the last three calendar years. **4.1.1.2** Connected to Western Interconnection with the following characteristics**:** Each unit (including synchronous condensers) ≥ 75 MVA, connected at the point of interconnection at 100 kV or above and with an average Capacity Factor greater than 5% over the last three calendar years. Each unit (including synchronous condensers) ≥ 20 MVA within a plant ≥ 150 MVA, connected at the point of interconnection at 100 kV or above and with an average Capacity Factor greater than 5% over the last three calendar years. **4.1.1.3** Connected to ERCOT Interconnection with the following characteristics: Each unit (including synchronous condensers) ≥ 50 MVA, connected at the point of interconnection at 100 kV or above and with an average Capacity Factor greater than 5% over the last three calendar years. Each unit (including synchronous condensers) ≥ 20 MVA within a plant ≥ 100 MVA, connected at the point of interconnection at 100 kV or above and with an average Capacity Factor greater than 5% over the last three calendar years. **4.1.2** Transmission Planners**.**
R1. The regional reliability organization shall establish and maintain procedures to address	Regional applicability is eliminated and functional entity	**Requirements R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, & R12** define the model verification process which would have been

Field Tested Version of MOD-026	Comment	Proposed MOD-026-1
verification of models and data associated with generator excitation system functions including voltage regulator controls, limiters, compensators, and power system stabilizers. These procedures shall include the following:	responsibility is defined Verification, including reporting, is addressed throughout proposed Standard. Voltage regulator controls are inherent to excitation models. Some generators include power system stabilizer equipment that has an associated individual model and model data. Under and over excitation limiter static set points will be addressed in MOD-025 and/or PRC-019. Any reactive compensation settings are to be provided to the Transmission Planner so that the Transmission Planner can model these set points and settings as appropriate (reference IEEE 421.5-2005 for additional information).	addressed by regional procedures. Following is a high level summary of each of the Requirements: **R1.** Statement of the GOP Schedule (periodicity, extensions, exceptions) for verifying the excitation system model **R2.** TP provides a set of model data sheets to the GOP within 30 days of a request **R3**. TP provides the current unit specific excitation system dynamics data to the GOP within 30 days of a request **R4.** GOP provides the verified unit information to the TP **R5.** TP confirms that the provided models (R4) runs on its software **R6.** TP informs GOP if the provided model ran on the TP software, and if not, provides details. **R7**. If the model did not run on the TP software, the GOP provides the TP a written response with proposed solutions or a reason why no solution is offered **R8.** GOP provides TP information regarding the correlation of actual equipment to model simulated response **R9.** GOP provides RCs, TOs, and PCs information regarding the correlation of actual equipment to model simulated response within 60 days of a request **R10**. GOP responds within 90 days to a technical concern if initiated by the TP/PC **R11.** Within 90 days of receiving evidence by the TOP or RC that the equipment's response to a due to a transmission system event did not match the predicted model response, the GOP reviews its model(s) and provides the TOP or RC and applicable TP either an explanation or a re-verification of the model(s). **R12.** List of activities that potentially alter equipment response and thus could trigger a re-verification within a 10 year cycle

Field Tested Version of MOD-026	Comment	Proposed MOD-026-1
R1.1. Generating unit exemption criteria including documentation of those units that are exempt from a portion or all of these procedures.	Exemption criteria are addressed by **Applicability Section 4.1 and its sub-sections** by stating which generators are applicable to this Standard. Two criteria are utilized in specifying applicability: MVA and capacity factor. Unit MVA and plant MVA cutoffs for each NERC Interconnection are based on a total connected MVA of 80% being subjected to model verification.	**Sections 4.1 and sub sections are mapped above**
R1.2. Acceptable methods for model and data verification, including any applicable conditions under which the data should be verified. Such methods can include use of manufacturer data, commissioning data, performance tracking, engineering analysis, field verification of equipment settings, testing, simulation and comparison with test results or disturbance monitoring data, etc.	**Requirement R8** requires the Generator Operator to provide to the Transmission Planner documentation verifying that the provided model response matches the recorded response. Rather than establishing rigorous testing details, the Standard simply requires that the verification methodology chosen shall result in good correlation between model response and a recorded response. The recorded response could be from a staged test or ambient event. Additionally, **R9** requires the	**R8.** The Generator Operator shall provide to the Transmission Planner documentation demonstrating that the excitation system model's response matches the recorded response for a voltage excursion at the generator from either a staged test or a measured system disturbance (i.e., an ambient event) within 90 calendar days of completion of the excitation system model verification. **R9.** The Generator Operator shall make documentation demonstrating that the excitation system model's response

Field Tested Version of MOD-026	Comment	Proposed MOD-026-1
	Generator Operator to make the documentation available to its Transmission Planner (R9) and others (RC, TO, PC) which have responsibility for the area where the generator is located. This replaces part of a "catch-all" requirement of the Field Tested Version R3 mapped below.	matches the recorded response for a voltage excursion at the generator from either a staged test or a measured system disturbance (i.e., an ambient event) available for inspection and technical review to the Reliability Coordinators, Transmission Operators, and Planning Coordinators that have responsibility for the area in which the associated unit is located, within 60 calendar days after receipt of a request.
R1.3 Periodicity and schedule of verification and reporting, including schedules associated with field changes to existing units, and refurbished units.	Requirements **R1** and its sub requirements and **R10** address periodicity and schedules The intent of **R1 Item 1** is to provide ample time to perform verification for new equipment. Prior to verification, models and data would be made available to the Transmission Planner via Interconnection agreements and the process detailed in MOD-012 and 013. **R1 Item 2** specifies a 10 year recurring verification cycle and defines allowable opportunities to reuse the results of the validation of a unit's model for other units that meet the criteria listed in Item 2. A 250 MVA cutoff results in the inclusion of one of the most logical and likely beneficiaries of this	**R1.** The Generator Operator shall verify the excitation system model (including power system stabilizer model and impedance compensator model if so installed) which represents generator excitation system behavior in dynamic simulations per the following schedules: 1) For a new or existing unit with a new excitation system, within 180 days of the commercial operation date or new equipment commissioning date, whichever occurs first. 2) For an existing unit, once in a ten calendar year period. If multiple units have the same MVA rating that is ≤ 250 MVA and if they have identical applicable components and settings and are sited at the same physical location, verification of one unit is sufficient for all units. Verification shall be performed on a different unit each ten calendar year cycle.

Field Tested Version of MOD-026	Comment	Proposed MOD-026-1
	"proxy" unit philosophy - relatively new Combined Cycle and multiple Combustion Turbine plants (i.e., a "CT farm") with digital excitation systems **R1.3** details allowable time delays beyond the standard 10 year verification cycle for units that have not been on-line. **R1 Item 4** addresses verification schedules for units that were exempt due to a low capacity factor, but transition to having a capacity factor of greater than 5% R11 requires the Generator Owner to review the model when notified by the Transmission Operator or Reliability Coordinator that the actual equipment response observed during a transmission system event deviated from what was predicted by the model. Upon such notification, the GO must either provide an explanation or re-verify the model. The Requirement is written in such a manner to	3) If verification cannot be performed within the ten year period because a unit has not been on-line, the ten year period shall be extended. It is permissible to wait until the unit is scheduled to operate in order to conduct verification so that sufficient advance notice to make arrangements for verification is available. After verification is performed, the subsequent ten year schedule for the next verification will start. 4) For units that reach an average Capacity Factor greater than 5% over the last three calendar years, and have not been verified within the last ten calendar years, verification shall be performed within the next calendar year. The subsequent ten year schedule will start upon a successful verification. **R11.** The Generator Operator shall perform a review of its current excitation system model when its Transmission Operator or Reliability Coordinator provides the Generator Operator dated electronic or hard copy evidence that the recorded excitation control system response to a Transmission system event did not match the predicted excitation system model response. Upon review the Generator Operator shall either: • Provide a dated electronic or hard copy explanation detailing why the current excitation system model is still appropriate within 90 days to the commenter and the Transmission Planner whose area the generating facility is located in, or • Perform a re-verification in accordance with R4, and R8 within 180 days. Once the re-verification is

Field Tested Version of MOD-026	Comment	Proposed MOD-026-1
	ensure the applicable Transmission Planner has up to date information regarding the model. **R12** lists activities that could result in an alteration of equipment response which necessitates the need for model re-verification due to field changes.	performed, the 10 year period as outlined in R1 will be reset. **R12.** The Generator Operator shall perform a review of its current excitation system model and model parameters each time an activity that may alter the equipment response is performed. An activity that potentially alters the response of the excitation system and/or power system stabilizer includes but is not limited to: • Exciter, voltage regulator or power system stabilizer control replacement including software alterations that could alter excitation system equipment response • Plant Digital Control System addition or replacement • Plant Digital Control System software alterations that could alter excitation system equipment response • Exciter, voltage regulator, impedance compensator or power system stabilizer settings change The Generator Operator shall either: • Provide documentation that the response has not changed to the Transmission Planner within 90 days of completion of an activity that could have altered equipment response, or • Perform a re-verification in accordance with Requirements R4 and R8 within 180 days. Once the re-verification is performed, the ten year period as outlined in Requirement R1 is reset.
R1.4. Information to be reported related to generator excitation system functions:	**Requirements R2, R3, R4, R7, and R8** addresses information to be reported from the Generator Operator, and associated	

Field Tested Version of MOD-026	Comment	Proposed MOD-026-1
	interactions between the Generator Operator and the Transmission Planner.	
R1.4.1. Verified manufacturer and type of excitation system/voltage regulator control system (static, brushless, rotating, etc.).	Field Test Ver. R1.4.1 is covered by proposed R4.	**R4.** The Generator Operator shall provide to the Transmission Planner the following unit specific information within 90 calendar days of completion of the excitation system model verification: **1)** Manufacturer, model number if available, and type of excitation system (for example: static, ac brushless, dc rotating). **2)** Generator model structure and data (reactances, time constants, saturation factors, rotational inertia) **3)** Excitation system model structure and data for the closed loop voltage regulator (including main exciter if so equipped). **4)** Reactive compensation settings (for example: reactive droop, line drop, differential compensation), if utilized. **5)** Model structure and data for power system stabilizer, if so equipped.
R1.4.2. Verified model for each excitation system/voltage regulator control system with associated gains, time constants, and limits.	Field Test Ver. R1.4.2 is covered by proposed R4. The model data is specified as part of the list in R4. In additional to providing additional specificity, the current draft Standard's R4 contains specific reference to Generator model data that was not part of the Field Test Version of the Standard. This is because the generator and excitation system data are all included in the closed loop system being verified.	
R1.4.3. Verified static set points for under and over excitation limiters.	The information on verified static set points in Field Test Ver. R1.4.3 has been removed.	

Field Tested Version of MOD-026	Comment	Proposed MOD-026-1
	Static set points for UEL and OELs will be addressed in MOD-025 and/or PRC-019.	
R1.4.4. Verified line drop compensator settings.	R1.4.4 is covered by R4. See additional comments above for NERC Field Test Ver. R1.	
R1.4.5. Open circuit test response data showing generator field voltage and generator terminal voltage (exciter field voltage and current data for brushless units).	Additional options beyond the specific Open circuit test referenced in Field Test R1.4.5 have been included in R8.	**R8 is mapped above**
	R10 is a new requirement which provides the opportunity for a technical exchange between the GO and the TP and/or PC regarding the verified documentation specified in R8.	**R10.** The Generator Operator shall provide a written response within 90 calendar days after receipt of a Transmission Planner's or a Planning Coordinator's written comments detailing technical concerns with the Generator Operator's excitation system model verification documentation. That written response shall either: • Indicate what changes will be made to the excitation system model, or • Provide the technical basis why no changes will be made.
R1.4.6. Verified model for each power system stabilizer with associated gains, time constants, and limits.	Same comments apply to Field Test Ver. R1.4.6 as noted directly above for Field Test Ver. R1.4.2.	

Field Tested Version of MOD-026	Comment	Proposed MOD-026-1
R1.4.7. Method of verification, including the date of verification, with the voltage regulator in the automatic voltage control mode.	Field Test R1.4.7 is covered in R8 Reference to "the voltage regulator in the automatic voltage control mode" in the Field Test Version Standard was removed in this draft Standard as it is a statement of the obvious.	**R8 is mapped above**
R2. The regional reliability organization shall provide its generator excitation system data verification and reporting procedures, and any changes to those procedures, to the generator owners, generator operators, transmission operators, planning authorities, and transmission planners affected by the procedure within 30 calendar days of the approval.	Regional Reliability Organization applicability is eliminated and functional entity responsibility is defined. This proposed Reliability Standard in its entirety (**R1 – R12**) specifies continent-wide verification and reporting procedures.	**R1 – R12 are mapped above**
R3. The generator owner shall follow its regional reliability organization's procedures for verifying and reporting its models and data associated with the generator excitation system functions per requirement 1.	Regional Reliability Organization applicability is eliminated and functional entity responsibility is defined. **R1, R4, R7, R8, R9, R10, R11, and R12** defines the procedures to be followed by the Generator Operator for verifying and	**R1, R4, R7, R8, R9, R10, R11, and R12 are mapped above**

Field Tested Version of MOD-026	Comment	Proposed MOD-026-1
	reporting its model and data.	
	R2 and R3 are new requirements which, upon request of the Generator Operator: 1) Ensures the Transmission Planner provides a list of acceptable excitation system model data sheets 2) Ensures the Transmission Planner provides unit specific excitation system model data currently being utilized in the Transmission Planner's dynamic database	**R2.** The Transmission Planner shall provide the Generator Operator a set of model data sheets for the acceptable excitation system models (models cannot be confidential or proprietary) for use in dynamic simulation software, with each data sheet including the excitation system model block diagram structure and data requirements, within 30 calendar days of a request from the Generator Operator. **R3.** The Transmission Planner shall provide the Generator Operator the unit specific data contained in the Transmission Planner's dynamic database from the current in-use excitation system model, within 30 calendar days of a request from the Generator Operator.
	R5, R6 and R7 are new requirements which: 1) Ensures that the Transmission Planner tests the developed model to assess if the model is useable in the dynamic simulation software 2) Ensures the Generator Operator is promptly notified that the model is useable or not 3) Provides a process for the Generator Operator and Transmission Planner to work together to resolve usability issues.	**R5.** The Transmission Planner shall determine if the excitation system model is useable by including the excitation system model in dynamic simulation software and substantiating that: 1) A no-disturbance simulation contains no transients. 2) For an otherwise stable simulation, a disturbance simulation results in the equipment exhibiting positive damping. **R6**. The Transmission Planner shall inform the Generator Operator whether the excitation system model is useable or not within 90 calendar days of receipt (R4). If the excitation system model is not useable, the Transmission Planner shall provide the Generator Operator with a description of the problem and any relevant details. **R7**. The Generator Operator shall provide a written response within 90 calendar days following notification by the Transmission Planner that the excitation system model is not useable. The Generator Operator's response shall either:

Field Tested Version of MOD-026	Comment	Proposed MOD-026-1
	It is stressed that a "useable" model is simply a model which does not unexpectedly negatively impact otherwise stable dynamic simulation. An example might be a model which contains a parameter that has been incorrectly scaled thus causing dynamic simulation solution convergence issues. A model can be "useable", but it may or may not be representative of the installed equipment performance.	• Indicate what changes will be made to the excitation system model, or • Provide the technical basis why no changes will be made. .