NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Industry Webinar

Project 2020-06 Verification of Data and Models for Generators

April 20, 2022

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Webinar Agenda

- Project Background
- Summary of Changes
- Why combine MOD-026-1 and MOD-027-1?
- Requirement Language
- Project Timeline
- Questions & Answers

Project Background

- Model accuracy is essential in transmission planning
- Increased penetration of IBR
- Standard Authorization Request (SAR) prepared by the Inverter-Based Resource Performance Task Force (IRPTF)
- Initial SAR accepted by SC – September 2020
- SAR Drafting Team formed – March 2021
- May & June 2021 TX events – Odessa Disturbance Report recommended EMT models quality and fidelity checks
- Revised SAR with dynamic reactive resources accepted by SC – July 2021

Summary of Changes

- MOD-026 and MOD-027 are merged
- TP to provide clear requirements and processes (R1)
  - Acceptance criteria, types of models, format, etc.
  - Process for submittal
- EMT Model requirements (R6)
  - Provisions for legacy equipment
  - More detailed package of information required
  - Verify documentation with model
  - Validate with testing (OEM device testing & field test)
- TP reviews submittal package and provides written response
  - Reviews in alignment with developed acceptance criteria
- Update model required if impact to dynamic performance
- Synchronous condenser, FACTS devices, HVDC Facilities

Why combine MOD-026/027?

- Nearly identical process and language for MOD-026/027-1 Requirements R1, R3, R4, R5, and R6
- Only Requirement R2 of MOD-026/027-1 has specific wording for each standards
  - MOD-026-1: excitation control or plant volt/var control
  - MOD-027-1: turbine/governor and load control or active power/frequency control
- Allows for consolidation of process related requirements
- Verification of EMT models for Facility is a new Requirement R6, which would have been a new requirement in both standards

Applicable Entities

4. Applicability:

4.1. Functional Entities:

- **4.1.1.** Generator Owner
- **4.1.2.** Transmission Planner
- **4.1.3.** Planning Authority
- **4.1.4.** Transmission Owner that owns Facilities listed in Section 4.2.4 or 4.2.5

Facilities

4.2. Facilities:

For the purpose of this standard, the term "applicable units" shall mean any one of the following:

- **4.2.1** Individual generating resource per BES Inclusion I2.
- **4.2.2** Generating plant/Facility per BES Inclusion I2.
- **4.2.3** Generating plant/Facility per BES Inclusion I4.
- **4.2.4** Dynamic reactive resources per BES Inclusion I5 with a gross nameplate rating greater than 20 MVA
  - **4.2.4.1** Synchronous condenser
  - **4.2.4.2** Flexible alternating current transmission system (FACTS) devices
- **4.2.5** HVDC terminal equipment
  - **4.2.5.1** Line commutated converter (LCC)
  - **4.2.5.2** Voltage source converter (VSC)

Requirement R1

R1. Each Transmission Planner and its Planning Authority shall jointly develop model requirements and processes. The model requirements and processes shall be made available to the Generator Owner and Transmission Owner by the Transmission Planner, and include at a minimum the following: *[Violation Risk Factor: Lower] [Time Horizon: Operations Planning]*

1.1. Acceptable positive sequence models, format, and level of detail;

1.2. Acceptable electromagnetic transient (EMT) models, format, and level of detail[1];

1.3. Acceptance criteria used by the Transmission Planner to determine disposition in Requirement R7 including at a minimum the following:

1.3.1. model parameterization checks;

1.3.2. model usability, initialization, and interoperability; and

1.3.3. model submittal requirements.[2]

1.4. Process for Generator Owner or Transmission Owner to provide verified models to the Transmission Planner;

1.5. Process by which verified model(s) are submitted to the applicable Planning Authority, after the model(s) meets acceptance criteria of Part 1.3; and

1.6. Process for Generator Owner or Transmission Owner to obtain the model(s) contained in the Transmission Planner's database for an existing Facility owned by the Generator Owner or Transmission Owner.

Requirement Mapping

MOD-026-1 (R2) and MOD-027-1 (R2)	MOD-026-2
MOD-026-1 R2 (synchronous) generator excitation	R2
MOD-027-1 R2 (synchronous) turbine/governor and load control	R3
MOD-026-1 R2 (IBR) volt/var control	R4
MOD-027-1 R2 (IBR) active power/frequency control	R5
EMT model (new requirement)	R6

Requirement R2

R2. For applicable units of synchronous generation per Section 4.2.1 or 4.2.2 or a synchronous condenser per Section 4.2.4.1, each Generator Owner or Transmission Owner shall provide a verified positive sequence dynamic model(s) and accompanying information to its Transmission Planner, in accordance with periodicity in MOD-026-2 Attachment 1. The generator/synchronous condenser, excitation system, and protection system model(s) and associated parameters shall represent in-service equipment of the Facility. The verified model shall include at a minimum the following: *[Violation Risk Factor: Medium] [Time Horizon: Long-term Planning]*

2.1. Manufacturer, model number (if available), and type of generator or synchronous condenser, excitation system hardware, and protection system(s);

2.2. Model(s) representing the generator or synchronous condenser, and associated excitation system including voltage regulator, impedance compensation, power system stabilizer, excitation limiters, and outer-loop controls which impact dynamic volt/var performance;

2.3. Model(s) representing enabled protection systems that directly trip the generating resource. Protection systems that shall be modeled include over- and under-voltage, stator and field overcurrent, loss of field, out-of-step, and volts per hertz protection; and

2.4. Validate the positive sequence dynamic model(s) of Part 2.2 response using the recorded response for a dynamic volt or var event from either a staged test or a measured system disturbance.

Requirement R3

R3. For applicable units of synchronous generation per Section 4.2.1 or 4.2.2, each Generator Owner shall provide a verified positive sequence dynamic model(s) and accompanying information to its Transmission Planner, in accordance with periodicity in MOD-026-2 Attachment 1. The turbine-governor, load control, and protection system model(s) and associated parameters shall represent in-service equipment of the Facility. The verified model shall include at a minimum the following: *[Violation Risk Factor: Medium] [Time Horizon: Long-term Planning]*

3.1. Manufacturer, model number (if available), type of turbine, type of governor, mode of operation, and protection system(s);

3.2. Model(s) representing the turbine, governor control system, load controller, and other outer loop controls that override the governor response or modes of operation that limit frequency response, but excluding automatic generation control;

3.3. Model(s) representing enabled protection systems that directly trip the turbine-generator. Protection systems that shall be modeled include over- and under-speed, and over- and under-frequency; and

3.4. Validate the positive sequence dynamic model(s) of Part 3.2 response using the recorded response for a dynamic active power or frequency event from either a staged test or a measured system disturbance in which perceived frequency deviates per Attachment 1, Note 1.

Requirement R4

R4. For applicable units of inverter based resources (IBRs) per Section 4.2.3, FACTS devices per Section 4.2.4.2, and VSC HVDC per section 4.2.5.2, each Generator Owner or Transmission Owner shall provide a verified positive sequence dynamic model(s) and accompanying information to its Transmission Planner, in accordance with periodicity in MOD-026-2 Attachment 1. The reactive power control model(s) and associated parameters shall represent in-service equipment of the Facility. The verified model shall include at a minimum the following: *[Violation Risk Factor: Medium] [Time Horizon: Long-term Planning]*

- **4.1.** Manufacturer, model number, and software/firmware version number of the inverter(s) and power plant controller;
- **4.2.** Model(s) representing the IBR unit(s)[3], and associated reactive power control system[4] including the IBR unit's electrical control, power plant controller, auxiliary reactive resources, and other equipment which impacts plant voltage and reactive power dynamic response;
- **4.3.** Model(s) representing enabled protections[5] and limiting functions[6], that either directly trip IBR unit(s) or plant, or limit active/reactive output of the IBR unit or plant; and
- **4.4.** Validate the positive sequence dynamic model(s) of Part 4.2 response using the recorded response for a dynamic volt or var event from either a staged test or a system disturbance.

Requirement R5

R5. For applicable units of inverter based resources per Section 4.2.3, LCC HVDC per Section 4.2.5.1, and VSC HVDC per 4.2.5.2, each Generator Owner or Transmission Owner shall provide a verified positive sequence dynamic model(s) and accompanying information to its Transmission Planner, in accordance with periodicity in MOD-026-2 Attachment 1. The active power/frequency control model and associated parameters shall represent in-service equipment of the Facility. The verified model shall include at a minimum the following: *[Violation Risk Factor: Medium] [Time Horizon: Long-term Planning]*

5.1. Manufacturer, model number, and software/firmware version number of the IBR unit(s), power plant controller;

5.2. Model(s) representing the IBR unit(s), and associated active power/frequency control including the IBR unit's electrical control, power plant controller, and other equipment which impacts plant active power or grid frequency dynamic response;

5.3. Model(s) representing enabled protections[7] and limiting functions, that either directly trip IBR unit(s) or plant, or limit active/reactive output of the IBR unit or plant; and

5.4. Validate the positive sequence dynamic model of Part 5.2 response using the recorded response for a dynamic active power or frequency event from either a staged test or a measured system disturbance in which the power plant controller's or other Facility active power controller's, perceived frequency deviates per Attachment 1, Note 1;

Requirement R6

R6. For applicable units of inverter based resources per Section 4.2.3, FACTS devices per Section 4.2.4.2, LCC HVDC per Section 4.2.5.1, and VSC HVDC per 4.2.5.2, each Generator Owner or Transmission Owner shall provide a verified EMT model(s) and accompanying information to its Transmission Planner, in accordance with periodicity in MOD-026-2 Attachment 1. The verified EMT model and associated parameters shall represent in-service equipment of the Facility. The verified model shall include at a minimum the following: *[Violation Risk Factor: Medium] [Time Horizon: Long-term Planning]*

6.1. Attestation from respective original equipment manufacturer(s) (OEM) stating the IBR unit model(s), power plant controller model, and auxiliary control devices model(s) represent the equipment supplied by the OEM.[8] If an attestation from an OEM is not obtainable, the Generator Owner or Transmission Owner shall document the reason;

6.2. Device test[9] results demonstrating a comparison of the IBR unit's response and the IBR unit's EMT model response for large signal disturbances. If device test results are not obtainable, the Generator Owner or Transmission Owner shall document the reason;

Requirement R6 continued

6.3. Facility EMT model and associated parameters representing the IBR unit(s), collector system, auxiliary devices, power plant controller, main transformer(s), and enabled protections and controls that either directly trip IBR unit(s)[10] or plant, or limit active/reactive output of the IBR unit or plant;

6.4. Validate the Facility EMT model response using the recorded response for a dynamic voltage or var event[11], and for a dynamic active power or frequency event in which the power plant controller's or other Facility active power controller's perceived frequency deviates per Attachment 1, Note 1, resulting from either a staged test or a system disturbance; and

6.5. Documentation comparing the response of positive sequence dynamic model(s) of Requirement R4 and R5 to the response of Facility EMT model of Requirement R6 for large signal disturbances.

Requirement R7

R7. Each Generator Owner or Transmission Owner shall provide an updated verified model(s) or a mutually agreed upon plan with its Transmission Planner to verify the model in accordance with Requirements R2-R6[12] to its Transmission Planner within 180 calendar days of making a change to in-service equipment specified in Part 2.2, 3.2, 4.2, 5.2, or 6.3 that alters the equipment response characteristic.[13] *[Violation Risk Factor: Lower] [Time Horizon: Operations Planning]*

Requirement R8

R8. Each Transmission Planner shall review the verified model and accompanying information, an updated verified model per Requirement R7, or a written response per Requirement R9, provided by Generator Owner or Transmission Owner, and provide a written response to the submitter within 90 calendar days from receiving the verified model information. The written response shall include one of the following: *[Violation Risk Factor: Lower] [Time Horizon: Operations Planning]*

- Notification of acceptance: the model and accompanying information meet the acceptance criteria established in Requirement R1, or
- Notification of denial: the model and accompanying information does not meet acceptance criteria established in Requirement R1, or information submitted is incomplete. The notification of denial shall include an explanation and supporting evidence.

Requirement R9

R9. Each Generator Owner or Transmission Owner receiving a notification of denial per Requirement R8 or a technical justification for model review[14] shall provide a written response to its Transmission Planner within 90 calendar days of receiving a notification. The written response shall contain one of the following: *[Violation Risk Factor: Lower] [Time Horizon: Operations Planning]*

- An updated verified model and accompanying information per Requirement R2-R6,
- A mutually agreed upon plan with its Transmission Planner to verify the model in accordance with Requirement R2-R6, or
- Technical justification and supporting evidence for maintaining the current model.

Implementation Plan

		Date
FERC approval date (example only)		12/31/2023
Effective Date of MOD-026-2 (R1, R7, R8, R9)	+ 1 years	01/01/2025
Compliance Date (R2-R3, R4-R5, R6) **(newly applicable units)**	+ 2 years	01/01/2027

Initial Performance of Periodic Requirements:

Applicable Entities shall initially comply with the periodic requirements (Requirements R2, R3, R4, and R5) in MOD-026-2 **within the periodic timeframes of their last performance** under the respective requirement in the Requested Retired Standards (MOD-026-1 R2 or MOD-027-1 R2). Applicable Entities shall initially comply with MOD-026-2 Requirement R6 by the periodic timeframe associated with the performance of Requirement R4 or performance of Requirement R5, whichever is sooner.

Implementation Plan

Date of Last Verified Model (MOD-026-1/MOD-027-1)	Periodicity	Compliance with R2 (MOD-026-1/027-1)	Compliance with R2, R3, R4, R5, and R6 (MOD-026-2)
2015	10	2025	***2027***
2016	10	2026	***2027***
2017	10	2027	***2027***
2018	10	2028	2028
2019	10	2029	2029
2020	10	2030	2030
2021	***10***	***2031***	***2031***
2022	10	2032	2032
2023	10	2033	2033
2024	10	2034	2034
2025	10	2035	2035

Implementation Plan

Initial Performance of Periodic Requirements:
For applicable units commissioned after the Effective Date of MOD-026-2, Applicable Entities shall comply with periodic requirements of MOD-026-2 by the later of (i) the Compliance Date for the respective Requirement or (ii) 365 calendar days after the commissioning date in accordance with MOD-026-2 Attachment 1.

Project Timeline

- 45-day initial ballot and comment period
  - Scheduled for May 20 to July 5, 2022
- Subsequent ballot
  - Scheduled for October 2022
- NERC Board Adoption
  - Scheduled for February or May 2023

Questions and Answers