

# NERC

NORTH AMERICAN ELECTRIC  
RELIABILITY CORPORATION

# Industry Webinar

Project 2020-06 Verification of Data and Models for  
Generators

April 24, 2023

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- Notice of Open Meeting
  - Participants are reminded that this webinar is public. The access number was widely distributed. Speakers on the call should keep in mind that the listening audience may include members of the press and representatives of various governmental authorities, in addition to the expected participation by industry stakeholders.

- Project Background
- Summary of Changes (Draft 1)
- Summary of Changes (Draft 3)
- Requirement Language
- Implementation Plan
- Project Timeline
- Questions & Answers

Name	Company
Brad Marszalkowski (chair)	ISO-New England
Katie Iverson (vice-chair)	S Power (AES Corporation)
Andrew Arana	Florida Power & Light
Jonathan Rose	ERCOT
William Casey Harman	Puget Sound Energy
Ebrahim Rahimi	California ISO
Jason MacDowell	GE Energy Consulting
Sam Li	BC Hydro
Wes Baker	Southern Company
Michael (Bing) Xia	Powertech Labs
Jerry L Thompson	Kestrel Power Engineering
Robert J. O’Keefe	American Electric Power

- 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

- Increased emphasis on IBR performance, modeling, and supporting programs
- IRPTF becomes Inverter-Based Resource Performance Subcommittee (IRPS)
- EMT Task Force formed under IRPS
- [NERC Reliability Guideline: EMT Modeling](#) published March 2023

- 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 (R1)
- Update model required if impact to dynamic performance
- Synchronous condenser, FACTS devices, HVDC Facilities

- Clarification of models associated with Facilities in R1.1, R1.2
- Trimmed list of Protection Systems of R2.3
- Merged footnotes of R6.1, R6.3, and R6.4 into requirement language
- Footnote describing large signal disturbance added to R6.2
- Reorganized R7 to similar structure of R8/R9
- Added footnote to R7 describing which in-service equipment changes are included
- All mentions of timeframes moved to Attachment 1 (R8/R9)
- Added dispute resolution phrase to R9
- Implementation Plan: effective date increase from 1 to 2 years (R1, R8, R9), 5 years total to implement R2-R6, R7 (R7 timing aligned with R2-R6)
- R6 exemption date: commissioning date before January 1, 2023



Common comments which were not incorporated as changes:

- Transmission Planner specifies when EMT models are required in R1
- Specific voltage/frequency values for large signal disturbance
- OEM is not a functional entity (R6.1, R6.2); burden placed on GO
- Requirement R6 exemption date should be the effective date\*

## **4.1. Functional Entities:**

**4.1.1. Generator Owner**

**4.1.2. Transmission Planner**

**4.1.3. Planning Coordinator**

**4.1.4. Transmission Owner that owns a Facility listed in Section 4.2.4 or 4.2.5**

- 4.2. Facilities:** For the purpose of this standard, the term “applicable Facility” or “Facility” shall mean any one of the following:
- 4.2.1** Individual generating unit meeting the criteria set by Inclusion I2 of the BES definition.
  - 4.2.2** Generating plant/Facility meeting the criteria set by Inclusion I2 of the BES definition.
  - 4.2.3** Generating plant/Facility of dispersed power producing resources meeting the criteria set by Inclusion I4 of the BES definition.
  - 4.2.4** Dynamic reactive resources meeting the criteria set by Inclusion I5 of the BES definition with a gross (individual or aggregate) nameplate rating greater than 20 MVA including, but not limited to:
    - 4.2.4.1** Synchronous condenser; and
    - 4.2.4.2** Flexible alternating current transmission system (FACTS) devices.
  - 4.2.5** High-voltage direct current (HVDC) terminal equipment including:
    - 4.2.5.1** Line commutated converter (LCC); and
    - 4.2.5.2** Voltage source converter (VSC).
  - 4.2.6** Facilities meeting an exclusion of the BES definition are exempt as an applicable Facility.

- R1.** Each Transmission Planner and its Planning Coordinator, shall jointly develop dynamic model verification<sup>1</sup> requirements and processes. The dynamic model verification 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~~Long-term Planning*]
- 1.1. Acceptable positive sequence dynamic models, format, and level of detail for Facilities specifically identified within Requirement R2-R5;
  - 1.2. Acceptable electromagnetic transient (EMT) models, format, and level of detail for Facilities specifically identified within Requirement R6;<sup>2</sup>
  - 1.3. Acceptance criteria used by the Transmission Planner to determine disposition under Requirement R8 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.<sup>3</sup>
  - 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 Coordinator, 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 data from the Transmission Planner's database for an existing Facility owned by the Generator Owner or Transmission Owner within 90 calendar days of receiving a written request.

<b>MOD-026-1 (R2) and MOD-027-1 (R2)</b>	<b>MOD-026-2</b>
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

- R2.** For synchronous generation identified in Section 4.2.1 or 4.2.2 or a synchronous condenser identified in Section 4.2.4.1, each asset owner (Generator Owner or Transmission Owner) shall provide a verified positive sequence dynamic model(s) with associated parameters, and accompanying information that represent the in-service equipment of the Facility to its Transmission Planner, ~~in accordance with~~ within the timeframe in MOD-026-2 Attachment 1. The verified model(s) and accompanying information 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/synchronous condenser, excitation system hardware, and Protection System(s) specified in Part 2.3;
  - 2.2. Model(s) representing the generator/synchronous condenser, and associated excitation system including voltage regulator, impedance compensation, power system stabilizer, and outer-loop controls which impact dynamic volt/volt-ampere reactive (VAR) performance;
  - 2.3. Model(s) representing enabled excitation limiters and model(s) representing enabled Protection Systems that ~~directly~~ trip the prime mover or generator/synchronous condenser either directly or via lockout or auxiliary tripping relays. Protection Systems that shall be modeled include phase over- and under-voltage, ~~stator-phase overcurrent, voltage restrained time overcurrent, field overcurrent, loss of field,~~ out-of-step, ~~phase-distance,~~ and volts per hertz protection; and
  - 2.4. Validation<sup>4</sup> of the positive sequence dynamic model(s) of Part 2.2 response using the recorded response for a dynamic reactive power or voltage event from either a staged test or a measured system disturbance.

- R3.** For synchronous generation identified in Section 4.2.1 or 4.2.2, each Generator Owner shall provide a verified positive sequence dynamic model(s) with associated parameters, and accompanying information that represent the in-service equipment of the Facility to its Transmission Planner, ~~in accordance with~~ within the timeframe in MOD-026-2 Attachment 1. The verified model(s) and accompanying information 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 prime mover, type of governor, type of control, and Protection System(s) of Part 3.3;
  - 3.2. Model(s) representing the prime mover, governor control system, and any other controls which impact the dynamic active power or frequency performance due to a system disturbance (e.g. load controller), but excluding automatic generation control;
  - 3.3. Model(s) representing enabled Protection Systems that ~~directly~~ trip the prime mover or generator either directly or via lockout or auxiliary tripping relays. Protection Systems that shall be modeled include over- and under-frequency elements. In addition, model(s) representing enabled prime mover over- and under-speed trip functions that directly trip the prime mover/generator; and
  - 3.4. Validation<sup>5</sup> of 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.



- R4.** For inverter based resources (IBRs) identified in Section 4.2.3, FACTS devices identified in Section 4.2.4.2, and VSC HVDC identified in Section 4.2.5.2, each asset owner (Generator Owner or Transmission Owner) shall provide a verified positive sequence dynamic model(s) with associated parameters, and accompanying information that represent the in-service equipment of the Facility to its Transmission Planner, ~~in accordance with~~ within the timeframe in MOD-026-2 Attachment 1. The verified model(s) and accompanying information 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 IBR unit(s)<sup>56</sup> and power plant controller;
  - 4.2. Model(s) representing the IBR unit(s), and associated reactive power control system<sup>67</sup> including the IBR unit's electrical control, power plant controller, auxiliary reactive resources, and other equipment which impacts ~~plant~~ Facility voltage and reactive power dynamic response;
  - 4.3. Model(s) representing enabled protections<sup>78</sup> and limiting functions,<sup>89</sup> that either directly trip IBR unit(s) or ~~plant~~ Facility, or limit active/reactive output of the IBR unit or ~~plant~~ Facility; and
  - 4.4. Validation<sup>910</sup> of the positive sequence dynamic model(s) of Part 4.2 response using the recorded response for a dynamic reactive power or voltage event from either a staged test or a system disturbance.



- R5. For inverter based resources (IBRs) identified in Section 4.2.3, LCC HVDC identified in Section 4.2.5.1, and VSC HVDC identified in Section 4.2.5.2, each asset owner (Generator Owner or Transmission Owner) shall provide a verified positive sequence dynamic model(s) with associated parameters, and accompanying information that represent the in-service equipment of the Facility to its Transmission Planner, ~~in accordance with~~ within the timeframe in MOD-026-2 Attachment 1. The verified model(s) 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), and 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~~ Facility active power or grid frequency dynamic response;
  - 5.3. Model(s) representing enabled protections<sup>4911</sup> and limiting functions, that either directly trip IBR unit(s) or ~~plant~~ Facility, or limit active/reactive output of the IBR unit or ~~plant~~ Facility; and
  - 5.4. Validation of 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.

R6. For inverter based resources (IBRs) identified in Section 4.2.3, FACTS devices ~~per~~identified in Section 4.2.4.2, LCC HVDC identified in Section 4.2.5.1, and VSC HVDC identified in 4.2.5.2, each asset owner (Generator Owner or Transmission Owner) shall provide a verified EMT model(s) with associated parameters and accompanying information that represent the in-service equipment of the Facility to its Transmission Planner, ~~in accordance with~~within the timeframe in MOD-026-2 Attachment 1. The verified model(s) and accompanying information 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 structure of IBR unit model(s), power plant controller model, and auxiliary control devices model(s) represent the equipment supplied by the OEM.<sup>11</sup> The attestation shall include the equipment make, model number, software/firmware version number, and confirmation that all inverter control modes, control blocks, and protections are represented in the model. If an attestation from an OEM is not obtainable, the Generator Owner or Transmission Owner shall document the reason;
- 6.2. Device test<sup>12</sup> 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;
- 6.3. Facility EMT model with associated parameters representing the IBR unit(s), collector system, auxiliary devices, power plant controller, main transformer(s), and enabled protections and controls that ~~either~~act on voltage, frequency, and/or current, or act on quantities derived from voltage, frequency, and/or current, which directly trip the IBR unit(s) or ~~plant~~Facility, or limit active/reactive output of the IBR unit or ~~plant~~Facility.<sup>13</sup>

<sup>12</sup> A device test that is hardware specific may include a factory type test, hardware in the loop test, or other manufacturer test to ensure the EMT model's large signal response emulates the supplied equipment to the extent possible.

<sup>13</sup> In the context of MOD-026-2, a large signal disturbance is typically the result of a fault on the transmission system, the loss of generation, the loss of a large load, or the switching of a heavily loaded transmission line.

**6.4.** Validation of the Facility EMT model response using the recorded response ~~for of~~ a dynamic reactive power or voltage event;<sup>14</sup> ~~and for a~~ from either a staged test or a measured system disturbance (LCC HVDC Facility is excluded from the dynamic reactive power or voltage event validation);

**6.5.** Validation of the Facility EMT model response using the recorded response of a dynamic active power or frequency event from either a staged test or a system disturbance 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

**6.6.** ~~6.5.~~ Documentation comparing the response of the positive sequence dynamic model(s) of Requirement R4 and R5 to the response of the Facility EMT model of Requirement R6 for large signal disturbances.

**R7.** Each Generator Owner or Transmission Owner ~~shall provide an updated verified model(s), or a plan to verify the model(s), in accordance with one or more of Requirements R2, R3, R4, R5, or R6<sup>15</sup> to its Transmission Planner within 180 calendar days of, upon~~ making a hardware, software, firmware, control mode, or setting change to in-service equipment specified in Part 2.2, 2.3, 3.2, 3.3, 4.2, 4.3, 5.2, 5.3, or 6.3 that alters the equipment response characteristic, ~~in accordance with<sup>15</sup> shall~~ provide its Transmission Planner one of the following, within the timeframe in MOD-026-2 Attachment 1. [Violation Risk Factor: Lower] [Time Horizon: Operations Planning]

- An updated verified model(s) in accordance with each Requirement R2, R3, R4, R5, or R6 applicable to the change being made, or
- A plan to verify the model(s) in accordance with Requirement R2, R3, R4, R5, or R6.

<sup>15</sup> The changes in scope for Requirement R7 include, but are not limited to, (a) exciter, voltage regulator, plant volt/var, power system stabilizer, or governor control replacement including software alterations, (b) addition or replacement of protection systems that deploy under- and over- voltage and/or under- and over- frequency elements, (c) plant digital control system addition or replacement, (d) plant volt/var function equipment addition or replacement (such as static var systems, capacitor banks, individual unit excitation systems, etc), (e) software, firmware or setting change in the equipment (such as exciter, voltage regulator, power system stabilizer, excitation limiter, governor, plant controller, FACTS devices or IBR unit, etc.) that alters the equipment response characteristics, (f) a change in the voltage or frequency control mode (such as manually switching the voltage regulator from power factor control to automatic voltage control, etc). Automatic change of control mode or a control setting that is implemented in the plant control systems do not apply to Requirement R7.

- R8.** Each Transmission Planner shall review materials submitted under Requirement R2-R7 or R9, and provide written response to the submitter ~~within 120 calendar days~~ from after receiving each submission, within the timeframe in MOD-026-2 Attachment 1. 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.



- R9.** Each Generator Owner or Transmission Owner shall provide a written response to its Transmission Planner after receiving a notification of denial under Requirement R8 or a request from its Transmission Planner for a model review due to identified model or accompanying information deficiencies ~~shall provide a written response to its Transmission Planner within 90 calendar days of receiving a notification or request, in accordance with the periodicity,~~ within the timeframe in MOD-026-2 Attachment 1. The written response shall contain one of the following: *[Violation Risk Factor: Lower]* *[Time Horizon: Operations Planning]*
- An updated verified model and accompanying information in accordance with Requirements R2–R6,
  - A plan to verify the model in accordance with Requirements R2–R6, or
  - Technical justification and supporting evidence for maintaining the current model, which is agreed upon by its Transmission Planner.

MOD-026-2 Attachment 1 Model Verification Periodicity		
Row Number	Verification Condition	Required Action
5	For an existing applicable Facility with a change to in-service equipment as described under Requirement R7.  (Applies to Requirement R7)	Transmit the verified model and accompanying information or a plan to verify the model to the Transmission Planner within 180 calendar days after making the change to in-service equipment. If a plan to verify the model is provided to the Transmission Planner, then Row 6 also applies.  <a href="#"><u>In order for the transmittal to reset the 10-year anniversary transmittal date for Requirement R2-R6 as described in Row 3, all model(s) and model parameters must be verified according to the applicable requirement(s) and included in the transmittal.</u></a>
6	The Generator Owner or Transmission Owner has provided a plan to verify the model.  (Applies to Requirements R7 and R9)	Transmit the updated verified model and accompanying information to the Transmission Planner within 365 calendar days after the submittal of the plan to verify the model.
<a href="#"><u>7</u></a>	<a href="#"><u>The Transmission Planner has review materials submitted under Requirement R2-R7 or R9.</u></a>  <a href="#"><u>(Applies to Requirements R8)</u></a>	<a href="#"><u>Transmission Planner provides written response to the submitter within 120 calendar days from receiving each submission, per Requirement R8.</u></a>
<a href="#"><u>8</u></a>	<a href="#"><u>The Generator Owner or Transmission Owner receives a notification of denial under Requirement R8 or a request for model review from its Transmission Planner.</u></a>  <a href="#"><u>(Applies to Requirements R9)</u></a>	<a href="#"><u>Provide a written response to its Transmission Planner within 120 calendar days of receiving a notification or request for model review, per Requirement R9.</u></a>

11	<p>Commissioning date of the applicable Facility is before January 1, <del>2020</del><u>2023</u>; OR</p> <p>OEM is no longer doing business in North America; OR</p> <p>OEM no longer supports model(s) for in-service equipment at the Facility.</p> <p>(Requirement R6 exemption)</p>	<p>Requirement R6 is met with a written statement to that effect transmitted to the Transmission Planner.</p> <p>If the OEM that commissioned the Facility was acquired, merged, or operating under a different name, the new company would be considered the OEM.</p>
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		Date
FERC approval date (example only)		12/31/2023
Effective Date of MOD-026-2 (R1, R8, R9)	+ 2 years	01/01/2026
Compliance Date (R2-R3, R4-R5, R6, R7) <b>(for newly applicable units)</b>	+ 3 years	01/01/2029

### Initial Performance of Periodic Requirements:

Applicable Entities shall initially comply with the periodic requirements (Requirements R2, R3, R4, and R5) in **MOD-026-2 based upon the periodic timeframes (before the 10-year anniversary)** 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 MOD-026-2 Requirement R4 or performance of MOD-026-2 Requirement R5, whichever is sooner.

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	<b>2029</b>
2016	10	2026	<b>2029</b>
2017	10	2027	<b>2029</b>
2018	10	2028	<b>2029</b>
2019	10	2029	<b>2029</b>
2020	10	2030	2030
2021	10	2031	2031
2022	10	2032	2032
2023	10	2033	2033
2024	10	2034	2034
2025	10	2035	2035

## **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.

- 45-day initial ballot and comment period
  - Scheduled for late May to early July 2023
- Subsequent ballot
  - Scheduled for October 2023
- NERC Board Adoption
  - Scheduled for February or May 2024



# Questions and Answers