Standard Development Roadmap

This section is maintained by the drafting team during the development of the standard and will be removed when the standard becomes effective.

Development Steps Completed:

1. SAR posted for comment (April 20–May 21, 2007).
2. Revised SAR and response to comments posted.
3. Revised SAR and response to comments approved by SC (June 14, 2007).
4. SDT appointed on (August 18, 2007).

Proposed Action Plan and Description of Current Draft:

This is the first draft of the this standard including Time Horizons, Data Retention, Violation Risk Factors, and Violation Severity Levels. This first posting is for a 30-day comment period.

Future Development Plan:

Anticipated Actions	Anticipated Date
1. Post first draft revision of standard.	April-May 2011
2. Post response to comments and second version draft revision of standard.	July – August 2011
3. Post response to comments and request authorization to ballot the revised standard.	September - October 2011
4. Conduct initial ballot.	November 2011
5. Post response to comments.	December 2011
6. Conduct recirculation ballot.	January 2012
7. BOT adoption.	February 2012
8. File with regulatory authorities.	March 2012

A. Introduction

1. Title: Verification of Models and Data for Turbine/Governor and Load Control or Active Power/Frequency Control Functions

2. Number: MOD-027-1

3. Purpose: To verify that the turbine/governor and Load control or active power/frequency control[1] model and the model parameters used in dynamic simulation that assess Bulk Electric System (BES) reliability accurately represent generator unit real power response to system frequency variations.

4. Applicability:

4.1. Functional entities

4.1.1 Generator Owner

4.1.2 Transmission Planner

4.2. Facilities

For the purpose of this standard, the following Facilities are considered, "applicable units." Units or plants with an average capacity[2] factor greater than 5% over the last three calendar years that meet the following:

4.2.1 Generating units connected to the Eastern or Quebec Interconnections with the following characteristics:

- Each generating unit with a gross nameplate rating greater than 100 MVA, connected at the point of interconnection[3] at greater than 100 kV.
- For each plant with a gross aggregate nameplate rating greater than 100 MVA, connected at the same point of interconnection at greater than 100 kV:
  - Each unit with a gross nameplate rating greater than 20 MVA; and
  - The remainder of the plant as an aggregate.

[1] Turbine/governor and Load control or active power/frequency control:

a. Turbine/governor and Load control applies to conventional synchronous generation.

b. Active power/frequency control applies to variable energy plants.

[2] Once a capacity factor exemption is declared by notifying the Transmission Planner, verification is not required for 10 calendar years from the date eligibility occurs. At the end of this 10 calendar year timeframe, the current average 3 year capacity factor (for years 8, 9, and 10) is examined to determine if the capacity factor exemption can be declared for the next 10 calendar year period. If not eligible for the capacity factor exemption, then model verification must be completed within one year of the date the capacity factor exemption expired with the 10 calendar year periodicity requirement reset based on the verification date.

[3] The common transmission bus voltage level at which the generator step up transformer is connected.

4.2.2 Generating units connected to the Western Interconnection with the following characteristics:

- Each generating unit with a gross nameplate rating greater than 75 MVA, connected at the point of interconnection[3] at greater than 100 kV.
- For each plant with a gross aggregate nameplate rating greater than 75 MVA, connected at the same point of interconnection t greater than 100 kV:
  - Each unit with a gross nameplate greater than 20 MVA; and
  - The remainder of the plant as an aggregate.

4.2.3 Generating units connected to the ERCOT Interconnection with the following characteristics:

- Each generating unit with a gross nameplate rating of greater than 50 MVA, connected at the point of interconnection[3] with rating greater than 100 kV.
- For each plant with a gross aggregate nameplate rating of greater than 75 MVA, connected at the same point of interconnection at greater than 100 kV:
  - Each unit with a gross nameplate greater than 20 MVA; and
  - The remainder of the plant as an aggregate.

5. Effective Date:

5.1. In those jurisdictions where regulatory approval is required:

5.1.1 By the first day of the first calendar quarter, three years following applicable regulatory approval:

- At least 25% of each Generator Owner's applicable units per Interconnection on an MVA basis compliant with Requirement R2.
- 100% compliant with Requirements R1, and R3 through R5.

5.1.2 By the first day of the first calendar quarter, five years following applicable regulatory approval:

- At least 50% of each Generator Owner's applicable units per Interconnection on an MVA basis compliant with Requirement R2.

5.1.3 By the first day of the first calendar quarter, seven years following applicable regulatory approval:

- At least 75% of each Generator Owner's applicable units per Interconnection on an MVA basis compliant with Requirement R2.

5.1.4 By the first day of the first calendar quarter, nine years following applicable regulatory approval:

- 100% of each Generator Owner's applicable units compliant with Requirement R2.

5.2. In those jurisdictions where no regulatory approval is required:

5.2.1 By the first day of the first calendar quarter, three years following Board of Trustees adoption:

- At least 25% of each Generator Owner's applicable units per Interconnection on an MVA basis compliant with Requirement R2.
- 100% compliant with Requirements R1, and R3 through R5.

5.2.2 By the first day of the first calendar quarter, five years following Board of Trustees adoption:

- At least 50% of each Generator Owner's applicable units per Interconnection on an MVA basis compliant with Requirement R2.

5.2.3 By the first day of the first calendar quarter, seven years following Board of Trustees adoption:

- At least 75% of each Generator Owner's applicable units per Interconnection on an MVA basis compliant with Requirement R2.

5.2.4 By the first day of the first calendar quarter, nine years following Board of Trustees adoption:

- 100% of each Generator Owner's applicable units compliant with Requirement R2.

B. Requirements

R1. Each Transmission Planner shall provide its Generator Owner with the following instructions and data within 30 calendar days of receiving a request from its Generator Owner for those instructions and data: *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*

- Instructions on how to obtain the list of acceptable turbine/governor and Load control or active power/frequency control system models for use in dynamic simulation.
- Instructions on how to obtain the Transmission Planner's software manufacturer's dynamic turbine/governor and Load control or active power/frequency control system model library block diagrams and/or data sheets.
- Any of the Generator Owner's existing unit or plant specific turbine/governor and Load control or active power/frequency control system data contained in the Transmission Planner's dynamic database from the current in-use model(s).

R2. Each Generator Owner shall provide a verified turbine/governor and Load control or active power/frequency control model (for each of its applicable Facilities) to its Transmission Planner in accordance with the periodicity specified in MOD-027 Attachment 1 to ensure modeling data is accurate for use in simulation software subject to the following: *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*

2.1. Each Generator Owner shall perform its verifications with one or more models acceptable to its Transmission Planner that collectively include the following information:

2.1.1. Documentation from the turbine/governor and Load control or active power/frequency control model verification activities including the on-line response compared to the recorded response for either a frequency excursion from a system disturbance, or a frequency reference change.

2.1.2. Type of governor and Load control or active power control/frequency control equipment.

2.1.3. A description of the turbine (e.g. for Hydro turbine - Kaplan, Francis, or Pelton; for steam turbine - boiler type, normal fuel type, and turbine type; for gas turbine - the type and manufacturer; for variable energy plant - type and manufacturer).

2.1.4. Turbine/governor and Load control or active power/frequency control model structure and data.

2.1.5. Representation of the real power response effects of outer loop controls (such as operator set point controls, Load control, etc. but excluding AGC control) which would override the governor response (including blocked or nonfunctioning governors or modes of operation that limit Frequency Response), if applicable.

R3. Each Generator Owner shall provide a written response that contains either the technical basis for maintaining the current model, a list of future model changes, or a plan to perform model verification[4] to its Transmission Planner within 90 calendar days of receiving written notice of one of the following: *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*

- Written notification, including a technical description from its Transmission Planner of why the turbine/governor and Load control or active power/frequency control model is not "usable" as identified in Requirement R5, Parts 5.1 through 5.3 criteria, or
- Written comments from its Transmission Planner identifying technical concerns with the verification documentation, or
- Written comments and supporting evidence from its Transmission Planner indicating that the predicted turbine/governor and Load control or active power/frequency control response did not match the recorded response for three or more transmission system events.

R4. Each Generator Owner shall provide revised model data or plans to perform model verification to its Transmission Planner within 180 calendar days of making changes to the turbine/governor and Load control or active power/frequency control system that

[4] If verification is performed, the 10 year period as outlined in Attachment 1 is reset.

alter equipment response [5] characteristic. *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*

R5. Each Transmission Planner shall determine if the model meets the criteria identified in Requirement R5, Parts 5.1 through 5.3 and provide a written response to the Generator Owner indicating whether the model is useable or not useable; including a technical description if the model is not useable. This written response shall be submitted within 90 calendar days of receiving the turbine/governor and Load control or active power/frequency control system verified model information. *[Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*

5.1. The turbine/governor and Load control or active power/frequency control function model can initialize to compute modeling data without error.

5.2. A no-disturbance simulation results in negligible transients.

5.3. For an otherwise stable simulation, a disturbance simulation results in the turbine/governor and Load control or active power/frequency control model exhibiting positive damping.

C. Measures

M1. The Transmission Planner shall have evidence to show that it provided requested instructions and data (such as dated electronic mail messages or mail receipts) within 30 calendar days of receiving a request as specified in Requirement R1.

M2. Each Generator Owner shall have evidence (such as dated electronic mail messages or mail receipts) including the verification report to show that it provided the verified turbine/governor and Load control or active power/frequency control model as specified in Requirement R2.

M3. Each Generator Owner shall have evidence to show that it provided a written response (such as a dated copy of the response, dated electronic mail messages or mail receipts) containing identified information and submitted within 90 calendar days of receiving any written notification as specified in Requirement R3.

M4. Each Generator Owner shall have evidence to show that it provided a written response (such as dated electronic mail messages or mail receipts) submitted within 180 calendar days of making system changes specified in Requirement R4.

M5. Each Transmission Planner shall have evidence to show that it provided a written response (such as dated electronic mail messages or mail receipts) within 90 calendar days of receiving the model as specified in Requirement R5.

D. Compliance

1. Compliance Monitoring Process

1.1. Compliance Enforcement Authority

[5] Control replacement or alteration including software alterations or plant digital control system addition or replacement, plant digital control system software alterations that alter droop, and/or dead band, and/or frequency response and/or a change in the frequency control mode (such as going from droop control to constant MW control, etc).

Regional Entity

1.2. Data Retention

The Generator Owner and Transmission Planner shall each keep data or evidence to show compliance as identified below unless directed by its Compliance Enforcement Authority to retain specific evidence for a longer period of time as part of an investigation:

- The Transmission Planner shall retain the information/data request and provided response evidence of Requirements R1 and R5, Measures M1 and M5 for 3 calendar years from the date the document was provided.
- The Generator Owner shall retain the latest and previous turbine/governor and Load control or active power/frequency control system model verification evidence of Requirement R2, Measure M2.
- The Generator Owner shall retain the information/data request and provided response evidence of Requirements R3, and R4 Measures M3 and M4 for 3 calendar years from the date the document was provided.

If a Generator Owner or Transmission Planner is found non-compliant, it shall keep information related to the non-compliance until found compliant or for the time specified above, whichever is longer.

The Compliance Enforcement Authority shall keep the last audit records and all requested and submitted subsequent audit records.

1.3. Compliance Monitoring and Assessment Processes

Compliance Audits

Self-Certifications

Spot Checking

Compliance Violation Investigations

Self-Reporting

Complaints

1.4. Additional Compliance Information

None

2. Violation Severity Levels

R #	Lower VSL	Moderate VSL	High VSL	Severe VSL
R1	The Transmission Planner provided the instructions and data to the Generator Owner more than 90 calendar days but less than or equal to 120 calendar days of receiving a request.	The Transmission Planner provided the instructions and data to the Generator Owner more than 120 calendar days but less than or equal to 150 calendar days of receiving a request.	The Transmission Planner provided the instructions and data to the Generator Owner more than 150 calendar days but less than or equal to 180 calendar days of receiving a request.	The Transmission Planner failed to provide the instructions and data to the Generator Owner within 181 calendar days of receiving a request.
R2	The Generator Owner provided its verified model(s) to its Transmission Planner after the periodicity timeframe specified in MOD-027 Attachment 1 but less than or equal to 30 calendar days late; OR The Generator Owner provided the Transmission Planner a verified model that omitted one of the five Parts identified in Requirement R2, Parts 2.1.1, through 2.1.5.	The Generator Owner provided its verified model(s) to its Transmission Planner more than 30 calendar days but less than or equal to 60 calendar days late as specified by the periodicity timeframe in MOD-027 Attachment 1. OR The Generator Owner provided the Transmission Planner a verified model that omitted two of the five Parts identified in Requirement R2, Parts 2.1.1, through 2.1.5.	The Generator Owner provided its verified model(s) to its Transmission Planner more than 60 calendar days but less than or equal to 90 calendar days late as specified by the periodicity timeframe in MOD-027 Attachment 1. OR The Generator Owner provided the Transmission Planner verified models that omitted three of the five Parts identified in Requirement R2, Parts 2.1.1, through 2.1.5.	The Generator Owner failed to provide its verified turbine/governor and Load control or active power/frequency control[1] model(s) or failed to provide the verified model(s) no more than 90 calendar days late to its Transmission Planner in accordance with the periodicity specified in MOD-027 Attachment 1. OR The Generator Owner failed to use model(s) acceptable to the Transmission Planner as specified in Requirement R2, Part 2.1. OR The Generator Owner provided the Transmission Planner verified model(s) that omitted four or more of the five Parts identified in Requirement R2, Parts 2.1.1, through 2.1.5.

R3	The Generator Owner provided a written response more than 90 calendar days but less than or equal to 120 calendar days of receiving written notice. (R3)	The Generator Owner provided a written response more than 120 calendar days but less than or equal to 150 calendar days of receiving written notice. (R3)	The Generator Owner provided a written response more than 150 calendar days but less than or equal to 180 calendar days of receiving written notice. (R3)	The Generator Owner failed to provide a written response within 181 calendar days of receiving notice as specified in Requirement R3. OR The Generator Owner's written response was provided within 181 calendar days of receiving written notice however failed to contain either the technical basis for maintaining the current model, or a list of future model changes, or a plan to perform model verification.
R4	The Generator Owner provided revised model data or plans to perform model verification more than 180 calendar days but less than or equal to 210 calendar days of making changes to the turbine/governor and Load control or active power/frequency control[1] system that alter the equipment response characteristic. (R4)	The Generator Owner provided revised model data or plans to perform model verification more than 210 calendar days but less than or equal to 240 calendar days of making changes to the turbine/governor and Load control or active power/frequency control[1] system that alter the equipment response characteristic. (R4)	The Generator Owner provided revised model data or plans to perform model verification more than 240 calendar days but less than or equal to 270 calendar days of making changes to the turbine/governor and Load control or active power/frequency control[1] system that alter the equipment response characteristic. (R4)	The Generator Owner failed to provide revised model data or failed to provide plans to perform model verification within 271 calendar days of making changes to the turbine/governor and Load control or active power/frequency control[1] system that alter the equipment response characteristic as specified in Requirement R3.
R5	The Transmission Planner provided a written response to the Generator Owner indicating whether the model is useable or not useable; including a technical description if the model is not useable, more than 90 calendar days but less than 120 calendar days of receiving verified model information. (R5)	The Transmission Planner provided a written response to the Generator Owner indicating whether the model is useable or not useable; including a technical description if the model is not useable, more than 120 calendar days but less than 150 calendar days of receiving the verified model information. (R5) OR	The Transmission Planner provided a written response to the Generator Owner indicating whether the model is useable or not useable; including a technical description if the model is not useable, more than 150 calendar days but less than 180 calendar days of receiving the verified model information. (R5) OR	The Transmission Planner failed to provide a written response to the Generator Owner within 181 calendar days of receiving the verified model information as specified in Requirement R5. OR The Transmission Planner provided a

		The Transmission Planner provided a written response within 181 calendar days to the Generator Owner however the written response omitted confirmation for one of the specified model criteria listed in Requirement R5, Parts 5.1 through 5.3.	The Transmission Planner provided a written response within 181 calendar days to the Generator Owner however the written response omitted confirmation for two of the specified model criteria listed in Requirement R5, Parts 5.1 through 5.3.	written response within 181 calendar days to the Generator Owner however the written response omitted confirmation for all specified model criteria listed in Requirement R5, Parts 5.1 through 5.3.

E. Regional Variances

None.

F. Associated Documents

Version History

Version	Date	Action	Change Tracking

G. References

The following documents contain technical information beyond the scope of this Standard on turbine/governor and Load control or active power/frequency control system functionality, modeling, and testing.

1) IEEE Task Force on Generator Model Validation Testing of the Power System Stability Subcommittee, “Guidelines for Generator Stability Model Validation Testing,” IEEE PES General Meeting 2007, paper 07GM1307

2) L. Pereira "New Thermal Governor Model Development: Its Impact on Operation and Planning Studies on the Western Interconnection" IEEE POWER AND ENERGY MAGAZINE, MAY/JUNE 2005

3) D.M. Cabbell, S. Rueckert, B.A. Tuck, and M.C. Willis, "The New Thermal Governor Model Used in Operating and Planning Studies in WECC," in Proc. IEEE PES General Meeting, Denver, CO, 2004

4) S. Patterson, "Importance of Hydro Generation Response Resulting from the New Thermal Modeling-and Required Hydro Modeling Improvements," in Proc. IEEE PES General Meeting, Denver, CO, 2004

5) L. Pereira, D. Kosterev, D. Davies, and S. Patterson, "New Thermal Governor Model Selection and Validation in the WECC," IEEE Trans. Power Syst., vol. 19, no. 1, pp. 517-523, February 2004

6) L. Pereira, J. Undrill, D. Kosterev, D. Davies, and S. Patterson, "A New Thermal Governor Modeling Approach in the WECC," IEEE Trans. Power Syst., vol. 18, no. 2, pp. 819-829, May 2003

MOD-027 Attachment 1

Turbine/Governor and Load Control or Active Power/Frequency Control Model Periodicity

Note that local grid codes may specify shorter time frames.

Facility	Condition	Periodicity
	Criteria 1: Verification Frequency Excursion Threshold: ≥ 0.05 hertz for the Eastern Interconnection, or ≥ 0.10 hertz for the ERCOT and Western Interconnections, or ≥ 0.15 hertz for the Quebec Interconnection from scheduled frequency. **Criteria 2:** Establishing the Recurring Ten Year Unit Verification Period Start Date: For each unit, the start date is set to either of the 25%, 50%, 75%, or 100% Standard implementation Effective Dates established as required for compliance in accordance with the nine calendar year transition period. or The start date is set to the actual date unit verification is performed.	
Existing Generating Unit	During each ten year unit verification period as established by Criteria 2 above. **AND** **No exceptions** apply. **AND** While the unit is operating in a control mode with MW output that would result in a turbine/governor and load control or active power/frequency control mode response (or the unit is subjected to a staged frequency reference change test if possible) and is subjected to at least one BES frequency excursion as specified in Criteria 1 above.	A recorded unit Real Power response for a frequency excursion shall be collected during a ten calendar year (January - December) period with the verified model and documentation transmitted to the Transmission Planner no more than 730 days from the date that the recorded response was collected.
Existing Generating Unit	During each ten year unit verification period as established by Criteria 2 above. **AND**	Not Required (however, perform verification on a different unit each ten calendar

Facility	Condition	Periodicity
	The following unit exception applies: 1) Multiple units have the same MVA nameplate rating that are≤ 350 MVA **AND** 2) The same multiple units have identical applicable components and settings **AND** 3) The same multiple units are sited at the same physical location **AND** 4) The model for one of these equivalent units has been verified.	year cycle).
Existing Generating Unit	An acceptable frequency excursion at the generator from scheduled frequency **does not** occur during the ten calendar year (January - December) period and a staged frequency reference test is not performed **AND** The first time after the ten calendar year period while the unit is operating in a control mode with MW output that would result in a turbine/governor and load control or active power/frequency control mode response and is subjected to a BES frequency excursion as specified in Criteria 1 above.	The recorded unit Real Power response for the frequency excursion shall be collected with the verified model and documentation transmitted to the Transmission Planner no more than 730 days from the date that the recorded response was collected.
Existing Generating Unit	Installation of new excitation control system equipment. **AND** The first time the unit is operating in a control mode with MW output that would result in a turbine/governor and load control or active power/frequency control mode response (or the unit is subjected to a staged frequency reference change test if possible) and is subjected to a BES frequency excursion as specified in Criteria 1 above.	The recorded unit Real Power response for the frequency excursion shall be collected with the verified model and documentation transmitted to the Transmission Planner no more than 730 days from the date that the recorded response was collected
Existing Generating Unit	Subjected to an activity resulting in an alteration of the response of the turbine/governor and Load control or active power/frequency control model. **OR** Receive written comments including dated electronic or hard copy evidence indicating that the recorded turbine/governor and Load control or active power/frequency control response for three or more Transmission System event did not match the predicted control system model response..	The recorded unit Real Power response for the frequency excursion shall be collected with the verified model and documentation transmitted to the Transmission Planner no more than 730 days from the date that the recorded response

Facility	Condition	Periodicity
	OR Receive written comments detailing technical concerns with the Generator Owner's turbine/governor and Load control or active power/frequency control model verification documentation. **AND** The Generator Owner has submitted a verification plan. **AND** The first time the unit is operating in a control mode with MW output that would result in a turbine/governor and load control or active power/frequency control mode response (or the unit is subjected to a staged frequency reference change test if possible) and is subjected to a BES frequency excursion as specified in Criteria 1 above.	was collected
New or Existing Generator Unit	Excitation control system model identified as unusable by the Transmission Planner. **AND** The Generator Owner has submitted a verification plan. **AND** The first time the unit is operating in a control mode with MW output that would result in a turbine/governor and load control or active power/frequency control mode response (or the unit is subjected to a staged frequency reference change test if possible) and is subjected to a BES frequency excursion as specified in Criteria 1 above.	The recorded unit Real Power response for the frequency excursion shall be collected with the verified model and documentation transmitted to the Transmission Planner no more than 730 days from the date that the recorded response was collected
New Generating Unit	The first time the unit is operating in a control mode with MW output that would result in a turbine/governor and load control or active power/frequency control mode response (or the unit is subjected to a staged frequency reference change test if possible) and is subjected to aBES frequency excursion as specified in Criteria 1 above.	The recorded unit Real Power response for the frequency excursion shall be collected with the verified model and documentation transmitted to the Transmission Planner no more than 730 days from the date that the recorded response was collected