



Requirements for Model Validation Reporting

for Generators and Generator Control
Systems

Revision 0

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1.0 Scope of work

This document defines the format of a Generator and Generator Controls Model Validation Report and also defines which data must be presented therein. These requirements are applicable to two versions of the Machine Model Validation Report:

- 1) An initial test report, required from every generator upon energization, and
- 2) Regular re-test reports, required every five years.

2.0 Requirements for the test report

Test reports shall be submitted electronically in Adobe Portable Document Format (PDF) format. Every test report must comprise:

- 1) A cover page
- 2) A Table of Contents
- 3) Generator description, and parameters for modelling the generator
- 4) Control-System Description and parameters for every control system operating on the generator: governor, compensator, excitation, and power system stabilizer (PSS), and any other related control systems such as limiters.
- 5) A valid model of each control system complete with parameters and block diagram as follows:
 - a) The model of the control-system as provided by the manufacturer
 - b) A valid PSS/E model
 - c) A valid PSLF model
- 6) Plots showing the actual tests performed on the control systems, overlaid with the simulated performance of the submitted models
- 7) Appendices containing manufacturer's nameplates and data sheets for the generator, prime-mover, and control systems.
- 8) An accompanying data-file containing all numerical test data and model simulation data in machine-readable tabular form (such as a comma-separated-variable text file), with appropriate column headings.

Details regarding each of these requirements follow.

2.1 The Cover Page

Each test report must have a Cover page displaying the following

- 1) A unique identifier for the unit being tested, that is the "element code". This is the name by which the unit is referenced on diagrams and in AESO databases, for example, "Horseshoe 1". This name will have been established during the initial data-submission process for new interconnections.
- 2) The name, stamp and signature of the Professional Engineer licensed to practice engineering in the Province of Alberta, who takes the engineering responsibility for the Model Validation Report.
- 3) The date on which the tests were performed.
- 4) The report date.

2.2 The Table of Contents

Each test report must have a table of contents similar to that shown in Figure 1 - "Example Table of Contents"

Figure 1 - Example Table of Contents

TABLE OF CONTENTS	
1.0	UNIT DESCRIPTION.....
2.0	GENERATOR PARAMETERS.....
2.1	Description
2.2	Manufacturer's Model
2.2.1	<i>Block Diagram</i>
2.2.2	<i>Parameters</i>
2.2.3	<i>Validation</i>
2.3	PSS/E Model
2.3.1	<i>Block Diagram</i>
2.3.2	<i>Parameters</i>
2.3.3	<i>Validation</i>
2.4	PSLF Model
2.4.1	<i>Block Diagram</i>
2.4.2	<i>Parameters</i>
2.4.3	<i>Validation</i>
3.0	EXCITATION SYSTEM
3.1	Description
3.2	Manufacturer's Model
3.2.1	<i>Block Diagram</i>
3.2.2	<i>Parameters</i>
3.2.3	<i>Validation</i>
3.2	PSS/E Model
3.3.1	<i>Block Diagram</i>
3.3.2	<i>Parameters</i>
3.3.3	<i>Validation</i>
3.3	PSLF Model
3.4.1	<i>Block Diagram</i>
3.4.2	<i>Parameters</i>
3.4.3	<i>Validation</i>
4.0	GOVERNOR SYSTEM.....
4.1	Description
4.2	Manufacturer's Model
4.2.1	<i>Block Diagram</i>
4.2.2	<i>Parameters</i>
4.2.3	<i>Validation</i>
4.3	PSS/E Model
4.4.1	<i>Block Diagram</i>
4.4.2	<i>Parameters</i>
4.4.3	<i>Validation</i>
4.4	PSLF Model
4.4.1	<i>Block Diagram</i>
4.4.2	<i>Parameters</i>
4.4.3	<i>Validation</i>
5.0	PSS SYSTEM
5.1	Description
5.2	Manufacturer's Model
5.2.1	<i>Block Diagram</i>
5.2.2	<i>Parameters</i>
5.2.3	<i>Validation</i>
5.3	PSS/E Model
5.3.1	<i>Block Diagram</i>
5.3.2	<i>Parameters</i>

2.3 Generator Description

This section of the report must include¹, but is not limited to, the following:

- i) Unit name
- ii) Manufacturer
- iii) Date of manufacture
- iv) Model number
- v) Serial Number (assigned by the generator manufacturer)
- vi) Client Name Tag or equipment Number (assigned by the generator owner)
- vii) Fuel source
- viii) Prime Mover rating
- ix) Inertia of generator
- x) Inertia of turbine including shaft
- xi) Generator winding resistance, impedances and time constants (X_d , X_q , X'_d , X'_q , X''_d , X''_q , X_l , T'_{do} , T'_{qo} , T''_{do} , T''_{qo} , T_a and Saturation Factors)
- xii) Zero-sequence impedances
- xiii) Generator maximum continuous rating (MCR)
- xiv) Generator rated MVA
- xv) Generator station-service load (also known as 'house load')
- xvi) Capability curve
- xvii) Air-gap saturation curve
- xviii) exciter time constant
- xix) exciter and field resistance
- xx) exciter and field ceiling current and voltage
- xxi) exciter and field rated current and voltage
- xxii) exciter and field saturation curve

The preferred source for this data is the prime mover and generator name plates and manufacturer's data sheets which shall be attached to the model testing report as appendices. Units of measure shall be provided for every datum submitted. Where data are submitted in per-unit the base value shall be explicitly stated.

2.4 Control System Description

This section of the report must include the following:

- i) Manufacturers of the control system components
- ii) Model numbers of the control system components

The preferred source for this data is the control system name plates and manufacturer's data sheets which shall be attached to the model testing report as appendices

2.5 Models (Parameters and block diagram)

For the machine itself, and for each control system, the report must include:

¹ If any item on the list is not applicable (as for example with induction machines having no exciter), the report must explicitly state why the item is not applicable.

- a) Block diagrams representing each of:
 - i) The model as provided by the manufacturer.
 - ii) A standard PSS/E model, run with quarter-cycle time step
 - iii) A standard PSLF model, run with a quarter-cycle time step
- b) A tabular listing of the parameters for each block diagram. The PSS/E and PSLF models must include the validated values for all parameters, with no parameters left blank. Where a parameter chosen for the block diagram conflicts with manufacturer's datum for that parameter, an explanation must be provided as to why the manufacturer's datum was not used.
- c) A description of every test that was performed to determine or to validate the parameters. The text describing each test must include
 - i) A summary paragraph identifying how the test or tests meet AESO and WECC testing requirements.
 - ii) A plot of the performance of each model except the manufacturer's model, overlaid on the test result for the same conditions.

NOTE: The model used to produce the performance plot must be exactly the model being submitted. No specific software package is mandated for performing the plot, but regardless of the software used to plot the model performance, it must implement one of the standard block diagrams and test it with the specified step size. In the case of a re-test report, the model parameters and model plot submitted may be taken directly from a prior test report, provided that the test data matches the test data from the prior test report.
 - iii) The actual test data, in electronic tabular form.

A description of the deficiencies and or limitations of each model when compared to the test data, including an assessment of the "quality of fit" between the test data and modelled data (see Figure 2 - Example of a good fit

- iv) and Figure 3 - Example of a poor fit.).

Figure 2 - Example of a good fit

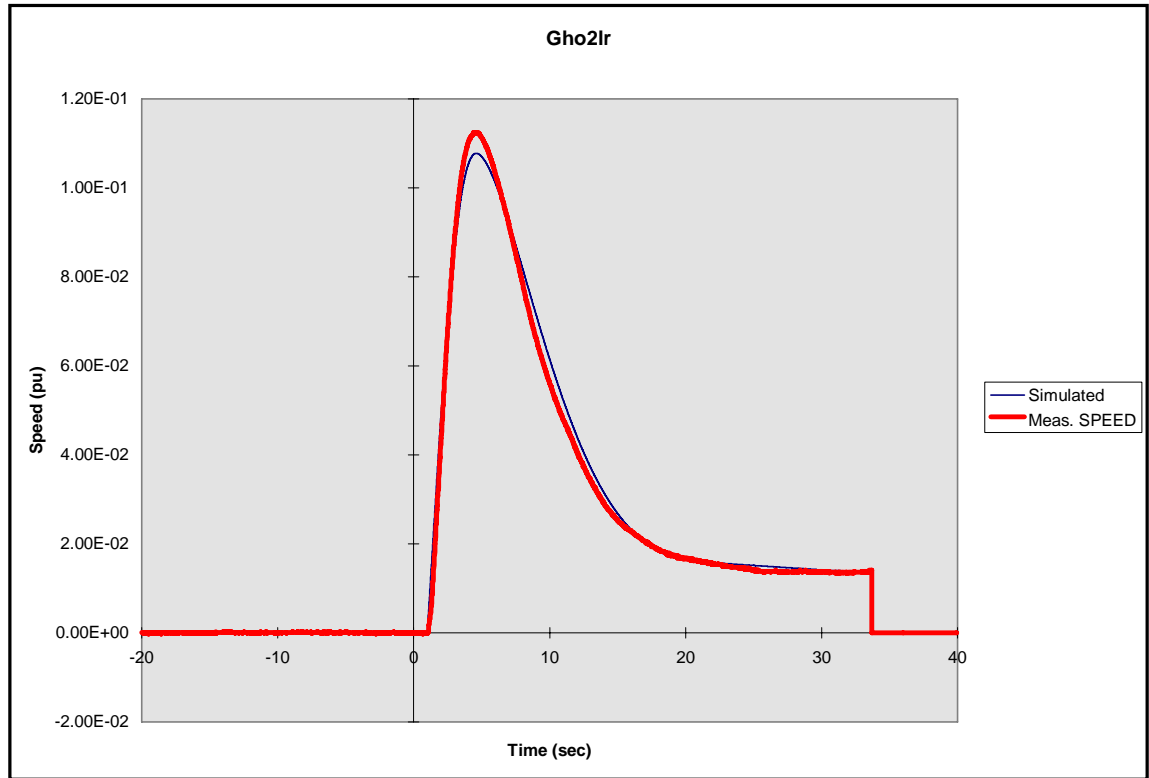
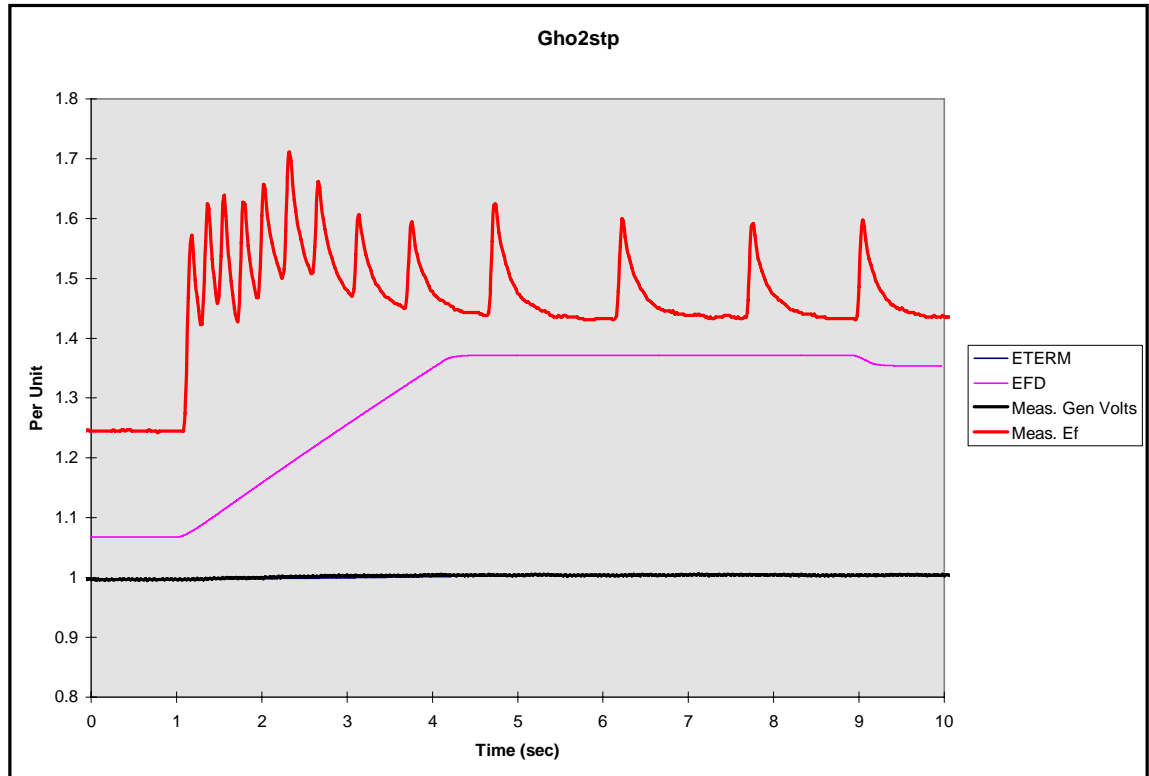


Figure 3 - Example of a poor fit



The information provided in the report, along with any data accompanying the report, must be sufficient that any competent engineer should be able to replicate the validation.

2.5.1 *PSS validation reporting*

The Power System Stabilizer must be shown to have a positive effect on system stability. At a minimum, you must include plots of:

- i) System performance measured response without PSS in service overlaid on system performance measured response with PSS in service, showing effective damping.
- ii) System simulated response without PSS in service overlaid on system performance measured response without PSS in service.
- iii) System simulated response with PSS in service overlaid on system performance measured response with PSS in service.

2.6 **Plots**

All plots included in the report must include the following features:

- a) Detailed and precise labels for the axes and traces
- b) Traces distinguishable in a black-and-white printed copy
- c) Clear titles for each graph indicating the test that was performed
- d) Appropriate scales for both axes

- e) The measured response of the test over an adequate period to confirm the modelled results, typically 15 seconds for an exciter and 40 seconds for a governor.

2.7 Manufacturer's nameplates and data sheets

Each test report shall include manufacturer's nameplates, test reports and data sheets for the generator, prime-mover, and control systems. Where manufacturer's data is not available the report shall explain the circumstances resulting in the omission and the assumptions made to compensate for the missing data.

2.8 Raw data for test and simulated traces

Each test report shall include an accompanying data-file containing all test data and model simulation data in machine-readable tabular form (such as a comma-separated-variable text file).

3.0 Retest report requirements

Up-to-date Model Validation Reports must be resubmitted every five years. Retest reports must conform to the requirements for initial Model Validation Reports with the following exceptions:

3.1 Invariant previously-submitted data

Where retesting demonstrates that the control-system response is the same as the control-system response previously submitted, and where the previously-submitted test report conformed to the requirements detailed in section 2.0, the re-test report may be reduced to:

- i) A plot of the test result for each test performed, overlaid on the test result from the previous testing cycle.
- ii) The previous test report, included as an appendix.