

# IEEE PES Task Force on Benchmark Systems for Stability Controls

## Simplified 14-Generator Model of the South East Australian Power System:

**DataPackage: AU14GenModel\_SmallSignal\_TimeResponse\_Results\_Ver04**

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The archive file AU14GenModel\_SmallSignal\_TimeResponse\_Results\_Ver04.zip contains small-signal step-response time-series data from the tests described in Appendices III.1 & III.2 of [1]. The time-series data is provided in Matlab (\*.mat) [2] and comma-separated-value (\*.csv) format. Rudimentary Matlab tools are provided to assist the researcher to graphically display time series data contained in these files and to compare these benchmark results with their own simulation results. (The archive file AUTimeSeriesTools\_Ver01.zip contains these tools, including the documentation [3].)

### **1 Results from Appendix III.1 – Generator voltage-reference step-responses of [1]**

As described in Appendix III.1 of [1], for case 1 with all PSSs in service at their design damping gain of 20.0 pu on machine MVA base, a 0.5% step increase in the voltage reference is applied to the AVR of generator HPS\_1 and the *perturbations* in the power output (P), rotor-speed (W), stator-voltage (Vt), reactive-power output (Q), generator field voltage (EFD) and generator field current (IFD) are monitored. This test is conducted in both PSS/E [4] and Mudpack [5].

Similar simulations are performed for each of the other 13 machines in case 1 and then for each of the 14 generator in the remaining cases 2 to 6. The results from each simulation are stored in native Matlab format in sub-folder Appendix3p1\mat; and in CSV format in sub-folder Appendix3p1\csv. Thus, a total of  $6 \times 14 \times 2 \times 2 = 336$  time-response files are provided according to the following naming convention:

IEEE\_Case0<n>\_VrefStep\_<GenName>\_<Package>.<fmt>

where:

- <n> is substituted with the case number 1 to 6;
- <GenName> is the name of one of the 14 power plants listed in [Table 8](#) of [\[1\]](#) (i.e. HPS\_1, BPS\_2, TPS\_4, etc.)
- <Package> is either MP if Mudpack was used to perform the simulation; or PSSE if the PSS/E package was used.
- <fmt> is either mat if the time-series data is stored in native Matlab \*.mat file format; or csv if it is stored in comma-separated-value format.

Within each of these files is stored the *perturbation* from their initial steady-state values of each of the following variables (<GenName> as defined above):

- P.<GenName> – Generator electrical power output (MW)
- W.<GenName> – Generator rotor-speed (pu of synchronous speed)
- Vt.<GenName> – Generator stator voltage (pu)
- Q.<GenName> – Generator reactive-power output (Mvar)
- EFD.<GenName> – Generator field voltage (pu)
- IFD.<GenName> – Generator field current (pu)

The format of these files and simple Matlab tools for loading and graphically-displaying the time-response data are described in [\[3\]](#).

A PDF file [\[6\]](#) generated by Adobe Acrobat [\[7\]](#) called AU14G\_BenchmarkPlots\_GenVref.pdf is provided. It contains for each case and generator a graphical comparison of the Mudpack and PSS/E voltage-reference step responses. (A total of  $6 \times 14 = 84$  plot pages; and each plot page has a comparison between the responses obtained from the two packages for each of the six variables listed above). This file can be read with the freely available Adobe Reader program [\[8\]](#) and possibly other PDF readers.

## 2 Results from [Appendix III.2](#) – Mechanical power step-responses to verify consistency of inter-area modes [\[1\]](#)

As described in [Appendix III.2](#) of [\[1\]](#), for case 1 with all PSSs in service at their design damping gain of 20.0 pu on machine MVA base. For study case 1, a +10 MW step is applied to the mechanical power input of the GPS\_4 machine and a compensating -10 MW step is applied to the NPS\_5 machine. Since these two machines are located at either end of the system the interarea modes of oscillation are excited and the powerflow in the inter-regional tie-lines contain significant inter-area modal components. This test is conducted in both the PSS/E and Mudpack simulation programs and is repeated for cases 2 to 6. The results from each simulation are stored in native Matlab format in sub-folder Appendix3p2\mat; and in CSV format in sub-folder Ap-

pendix3p2\csv. Thus, a total of  $6 \times 2 \times 2 = 24$  result files are provided. The result files are named according to the following convention:

IEEE\_Case0<n>\_DIS01\_<Package>.<fmt>

where:

- <n> is substituted with the case number 1 to 6;
- <Package> is either MP if Mudpack was used to perform the simulation; or PSSE if the PSS/E package was used.
- <fmt> is either mat if the time-series data is stored in native Matlab \*.mat file format; or csv if it is stored in comma-separated-value format.

Within each of these files is stored the perturbation from their initial steady-state values of each of the following generator related variables:

- P.<GenName> – Generator electrical power output (MW)
- W.<GenName> – Generator rotor-speed (pu of synchronous speed)
- Vt.<GenName> – Generator stator voltage (pu)

where <GenName> is from the set of generator names: 'BPS\_2', 'MPS\_2', 'LPS\_3', 'YPS\_3', 'GPS\_4', 'TPS\_4', 'NPS\_5', 'TPS\_5'.

In addition the files contain the perturbation from their initial steady-state values of each of the following inter-regional power flows:

- P.LN42 – Total line-power flow in the circuits from bus 410 to 413 (MW)
- P.LN23 – Total line-power flow in the circuits from bus 217 to 102 (MW)
- P.LN53 – Total line-power flow in the circuits from bus 509 to 315 (MW)

The format of these files and simple Matlab tools for loading and graphically-displaying the time-response data are described in [3].

A PDF file generated by Adobe Acrobat called AU14G\_BenchmarkPlots\_System.pdf is provided. It contains for each case a graphical comparison of the Mudpack and PSS/E mechanical-power step responses. For each case the comparison is shown for the perturbations in the inter-regional power-flow responses. This file can be read with the freely available Adobe Reader program and possibly other PDF readers.

### 3 References

- [1] M. J. Gibbard and D. J. Vowles, "Simplified 14-Generator Model of the South East Australian Power System: (Including implementations in Mudpack for small-signal analysis and PSS/E for transient-stability analysis)", Version 4, Power System Dynamics Group,

School of Electrical and Electronic Engineering, The University of Adelaide, 18 February 2014.

- [2] The Mathworks, Inc. (2010, 23 August 2010). MATLAB®. Available: [www.mathworks.com](http://www.mathworks.com).
- [3] M. J. Gibbard and D. J. Vowles, "Simplified 14-Generator Model of the South East Australian Power System: Matlab tools for displaying time-series results", Version 1, Power System Dynamics Group, School of Electrical and Electronic Engineering, The University of Adelaide, 18 February 2014.
- [4] *PSS/E Version 32, Program Operation Manual*: Siemens, June 2009.  
Siemens-PTI PSS/E web address:  
<http://w3.usa.siemens.com/smartgrid/us/en/transmission-grid/products/grid-analysis-tools/transmission-system-planning/Pages/transmission-system-planning.aspx>
- [5] Vowles, D.J. and Gibbard, M.J., "Mudpack - a software package for the analysis of the small-signal dynamic performance and control of large electric power systems", School of Electrical & Electronic Engineering, The University of Adelaide, South Australia.
- [6] International Organization for Standardization, "ISO 32000-1:2008, Document management -- Portable document format -- Part 1: PDF 1.7," 2008
- [7] Adobe Systems Incorporated. Adobe Acrobat. Available: <http://www.adobe.com/products/acrobat.html>.
- [8] Adobe Systems Incorporated. Adobe Reader XI Available: <http://www.adobe.com/products/reader.html>.