MINUTES

MEETING: Annual PMRG Meeting

DATE: Wednesday, 1 May 2013

TIME: 9:00 am – 5:00 pm CST

LOCATION: ElectraNet, Adelaide, SA

ATTENDEES:

NAME	COMPANY / DEPARTMENT
Alfred Li -(AL)	ElectraNet
Sunil Abeyratne -(SA)	ElectraNet
Viet Trinh -(VT)	ElectraNet
Thanh Le -(TL)	ElectraNet
Andrew van Eyk -(AV)	ElectraNet
Wai-Kin Wong -(WK)	ElectraNet
Piya Gammanpila -(PG)	ElectraNet
Babak Badrzadeh -(BB)	AEMO
David Francis -(DF)	AEMO
Michael Redpath –(MR)	AEMO
Tom Anderson -(TA)	Powerlink
Don Geddy -(DG)	Transgrid
Andrew Halley -(AH)	Transend

APOLOGIES:

NAME	COMPANY / DEPARTMENT

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1. TNSP and AEMO feedback session

i. Documents such as *Model Acceptance Guideline* and *AEMO Guideline for R2 Testing* will be beneficial to NSPs as well as to the proponents. For instance, *Guidelines* will be able to direct proponents in terms of what is required, how to report and what to include in the reports. (ALL)

ii. In general, TNSPs and AEMO hold a positive view towards the efforts been taken in order to formalise and release important documents such as *Guidelines*. (ALL)

iii. The inclusion of examples or templates with list of requirements in the *Guidelines* will be helpful, and subsequently will minimise possible conflicts between TNSPs and proponents. (AL, DF & TA)

iv. It has been suggested to include the *Guidelines* as a reference in the NER while maintaining uniform requirements across the NER. (ALL)

v. If a formalised document for standardisation of plant model representation, and a manual can be produced, it can be prudentially utilised as a standard to reduce inconsistencies in model writing. (DF)

vi. Work plan with prioritised works should be raised within the PMRG group as more WF connection proposals are received by TNSPs. (AL)

vii. A question has been raised regarding the ways of convincing the management that the time and money spend on developing, formalising and publishing documents such as *Guidelines* is meaningful and appropriate to do so. (AL)

viii. AEMO has identified production of several *Guidelines* as strategic goals. (BB)

ix. Publishing and releasing of various documents, references, standards and examples on the AEMO website should be encouraged and optimised. (AL)

x. A number of limitations associated with the PSS/E tool were discussed. It is understood that the PSS/E software package is not suitable for analysing power quality related issues such as harmonic analysis. Factors such as but not limited to short circuit ratio (SCR) and the ratio of active power in the area to nominal power of the WF can be used to determine when to use a 3-phase simulation software tool. (BB)

xi. If there is an uncertainty regarding a particular model (for example, when WF SCR<5), proponent is required to supply sufficient additional evidence to AEMO/TNSP to support the fact that merely using PSS/E model is appropriate and 3-phase model is not required, or to demonstrate using measured data and tested data during commissioning that single-phase simulation is adequate enough. (BB)

xii. In the *Guidelines* clearly mention situations where there is a requirement to consider 3-phase analysis, and also in the document make interpretations with respect to what responses are to be expected -e.g., what is to be considered as a stable

response to a voltage dip. This would likely necessitate revising the existing *Stability Guidelines* (MR)

2.0 Model Acceptance Guideline

2.1 General Facts

i. There are two purposes of the *Model Acceptance Guidelines*. Which are:

- To guide and provide criteria on how to accept a model independent of an associated connection project – e.g., accepting a model from a Vendor to be used in the Australian market.
- To guide and provide criteria on how to accept and what is expected from a model which has an associated WF connection project.

ii. It has been suggested to modify the document title to "*Model Acceptance Guideline*" from the existing title "*Model Acceptance Testing Guideline*".

iii. This document is meant to be very generic to cover each and every generating system, dynamic reactive support plant and HVDC link.

iv. This document is not meant to cover small signal models.

v. Model is tested online only. This document only covers online model tests and models are not required to be tested offline. Remove the wording related to offline model testing. (BB)

vi. This document is for standalone model testing only. Once a model is accepted and reach a connection project, then the model will be evaluated and tested accordingly. If additional requirements are required to be met at the connection project level, TNSP and AEMO have the right to ask the proponent to meet those requirements.

2.2 Scope

2.2.1 Scope of tests

i. Rewording is necessary to convey the meaning "testing the model of the item" rather than mentioning "testing the item" (DG)

ii. **Bullet point 2:** Also incorporate other coordinated systems such as frequency controller, voltage controller and the like.

iii. Include wordings for various WF operating modes such as voltage control mode, power factor control mode and reactive power control mode associated with the central park level controller.

iv. Mechanical controllers, pitch controllers, turbine speed controllers and the like are not required to be tested individually but as a lump. (DF)

2.2.2 Relationship with connection projects

i. The model acceptance tests are to determine the robustness of the model for defined test conditions, but are not intended to provide any assessment of compliance for performance or access standards for any particular connection point.

ii. Once a model is accepted it can be used in future projects without having to undergo the model acceptance process, provided that there hasn't been any changes done to the model.

iii. Include a provision or a paragraph mentioning AEMO/TNSPs have the right to warrant for additional requirements.

iv. Remove the existing example and instead include more generalised statement (e.g., model will be tested independently however aggregated model must also be tested if deemed required).

2.2.3 Power system study applications

i. **Bullet point 2:** Remove the wording "Phenomena" and "frequency" (to avoid possible confusions regarding assessments of protection functions)

ii. **Bullet point 3:** Remove the wording "Phenomena" and "frequency" " (to avoid possible confusions regarding assessments of protection functions).

2.3 Model documentation and structure

i. TNSPs only get the functional block diagrams but not the source code. Checking the accuracy of the source code with respect to the functional block diagram should be an obligation of AEMO. (ALL)

ii. Include the necessity of clearly mentioning what external files and library files are required to run dynamic simulation. Also point out the importance of maintaining a consistent renaming convention of external library files after a modification or a change is made. (DF)

iii. Mention that all the provided documentations must be consistent (for example there shouldn't be any conflicting data for a particular turbine model where the type and the manufacturer of the underlying turbine is identical).

iv. How long the dynamic simulation should be able to run for a particular model? It has been agreed not to include an exact time duration regarding how long a model should be able to run to be considered as a robust model. However, there have been situations where some models became unstable after 30 seconds during the simulation. (AH & BB)

v. Time constant requirement is covered in the *Generating Systems Model Guideline*, therefore it is not required to include in this document. (BB and VT)

vi. **Bullet point 14:** Highlight the fact that parameters and set-points are applicable to each generating unit and generating systems. Some wind turbine manufacturers haven't been providing details of the lower voltage side (such as 0.69kV level) which is considered as insufficient. Instead they tend to lump the models and provide the connection level terminal information which is not acceptable anymore. (BB)

vii. **Bullet point 15:** Design value of the SCR. What should be mentioned as the minimum short circuit ratio? (During the meeting participants were not able to come up with a minimum SCR value)

viii. **Bullet point 17:** The reason for requesting not to include full feeder representation for one or more feeders is to maintain the download speed and to retain integration complexity at a lower level when integrating those models into AEMO OPDMS and DSA tools. It was agreed to leave this bullet point as it is.

ix. Wind turbine which support the voltage at the turbine level (for example SIEMENS machines), at the connection point what is seen as Mvar support is the one developed across all the wind turbines. The accumulated Mvar support of all the wind turbines should meet the required Mvar support at the connection point. If possible incorporate this in to the bullet point 17. (SA)

x. **Bullet point 19 – dot point 3:** The use of models which includes calls into either of the CONEC or CONET subroutines is not acceptable. This is because in PSSE V32 would imply the need for the user to make a fresh compilation each and every time the network configuration changes.

xi. Switching off the generator model in the PSS/E may not necessarily work in every situation. In PSS/E V29 it is required to comment out the model in the dynamic data file if the WF model is switched off in the PSS/E study file.

2.4 Model Initialization

i. **Bullet point 1:** It has been agreed that the derivative of all state variables should be close to zero during the initialization and therefore it is ok to mention as "close to zero" given the fact PSS/E default tolerance 0.0001 is used.

ii. **Bullet point 2:** Rephrase to clearly reflect the idea that initialization suspect conditions are not acceptable. However, if these messages can't be eliminated explanations to a great extend including reasons and the possible impact will be required. If initial suspect conditions are ignored, it can make debugging much tougher. (AL)

iii. **Bullet point 3:** Operating range is underpinned by the vendor of the equipment. Some wind turbines' operating range can be a percentage of the manufacturer defined range. Provided that the equipment operating range is consistent, it will be acceptable. (BB)

2.5 Acceptance Criteria during Dynamic Simulation

i. **Bullet point 1:** It has been argued that dynamic simulation should be able to run indefinitely with no disturbance if the model is robust. (AH)

ii. **Bullet point 1**: How constant the voltage, frequency, active and reactive power should remain during the simulation is to be clearly addressed using an example.

iii. **Bullet point 3:** Rephrase to emphasise the idea that numerically robust model should be able to run indefinitely (take out "30 s"). (AH)

iv. **Bullet point 6:** Replace "reasonably consistent" with "consistent". (AH)

v. **Bullet point 10:** Rephrase this point to be more specific. (AL)

2.6 Model Acceptance Tests

i. This section has already been applied to some of the connection projects by AEMO. (BB)

2.7 Additional case studies for synchronous generators

i. There was a question raised whether the limiter should be tested. Provide your comments to AEMO (BB) within two weeks' time.

3. AEMO Guideline for R2 Testing

i. **Section 3:** Change the wording to AEMO and TNSP rather than just mentioning "AEMO's interest in generator testing include..."

ii. **Section 5.2.1:** Include the point that data acquisition process by itself has to be validated. For example, use of some built-in data recording devices with low sampling rate would not be acceptable. (TA)

iii. **Section 5.2.1:** Specifically mention that the data recording device should be able to record with a high sampling rate during a fault. (WK)

iv. **Section 5.2.2:** Data obtained via long-term monitoring equipments can be used to compare simulated behaviour against the actual behaviour of the wind farm following a pre-contingency as well as a post-contingency event.

v. **Section 5.2.3:** As a principle every wind farm connection will require a brand new R2 Testing irrespective of the manufacturer, turbine type and technology. This is because of the variable requirements at different connection points.

vi. **Section 5.3 (paragraph 2):** Allowing an output power level tolerance is useful because it is unlike that all the turbines in a WF subject to the same wind speed. It has been requested that rewording is required for this paragraph in particular include "network performance". (ALL)

vii. This document does not intend to supersede any existing document. (BB)

viii. **Section 5.4:** It has been agreed that the R2 data must be able to be used to derive model parameters of a wind turbine.

ix. **Section 6.3:** Make reference to the *Generator Performance Standards* in this section. (TA)

x. **Section 7:** There can be some exclusion zones for synchronous generators in this section.

xi. **Section 7:** Divide this section into two main sections: on-site testing and off-site testing. Mention on-line testing prior to off-site testing. (DF)

xii. **Section 7.3:** Put a reference to the provision of *Variation Request* in the NER. (AL)

xiii. **Section 7.3.3:** It has been agreed that overseas factory tested plant should closely represents the plant installed at the site. Consequently, no amendments are required for this section. (ALL)

4. Mudpack R&D Agreement

4.0.1 Continuing work from previous work

i. Continuing work from previous report.

ii. Testing of Mudpack with PSS/E V32 & V33 loadflow files has been undertaken, including with 6 digit bus numbers and 12 character bus names and including with raw data files in extended bus name format.

iii. Testing of Mudpack with PSS/E V32 OPDMS snapshot loadflow data provided by AEMO has been undertaken.

iv. Workarounds for several anomalies in the snapshot loadflow formats and some anomalies due to the PSS/E loadflow converters have been implemented.

v. The description of the Mudpack RPTI has been updated in the *User Manual.*

vi. A tool to automatically generate the FORTRAN code required by Mudpack to read PSS/E loadflow data files was developed. Therefore moving to later versions of PSS/E (beyond V33) should be straightforward.

4.0.2 Extended Eigenvectors

i. A MATLAB prototype to compute and graphically display left- and right-eigenvector components for user selected state and algebraic variables has been implemented and tested.

ii. This tool will be integrated in to Mudpack which will be able to plot eigenvectors graphically and superimpose eigenvector components from different case into a one plot.

4.0.3 Book on "small signal stability, control and dynamic performance of power systems"

i. A book is being developed which is intend to provide the theoretical and practical background for the application of Mudpack. The book will fulfil the objectives of the incomplete chapter 4-9 of the Mudpack User Manual.

ii. This book has isolated any control system references as it includes information of control systems to understand Mudpack even for a beginner.

iii. Adelaide Uni currently pursuing publishing options for the book which are yet to be confirmed.

4.0.4 Mudpack Maintenance

i. Mudpack update 10S-02 released on 29 April 2013. An e-mail giving instructions on how to access the update and listing the new facilities in the update was sent to the parties. Areas of the updates are as follows.

- Updated Mudpack to handle PSS/E V32 & V33 loadflow raw data files.
- Updated Mudpack User Manual to omit incomplete chapters dealing with the theoretical background to power system small-signal stability analysis.
- Updated PSS/E IPLANs which append extra HVDC link solution data to the PSS/E loadflow raw data file. The update handles PSS/E V32 & V33 loadflow cases. The HVDC link solution data which is required by Mudpack is not included in by PSS/E in the loadflow raw data file.

ii. Continuing implementation in Mudpack of a basic STATCOM model to which users can connect their own controller models. This avoids the need to implement the STATCOM using PSSE2Mudpack.

iii. A tool for the automatic identification of key electromechanical modes on the Mainland system was previously developed in conjunction with AEMO. This tool, called AUModeID, has been packaged and documented and provided to the parties according to the R&D agreement (an e-mail has been sent to relevant parties on 30/04/2013)

iv. Miscellaneous assistance to Mudpack users at AEMO and ElectraNet is available.

4.0.5 PSSE2Mudpack maintenance

i. PSSE2Mudpack (V2), update 1.7 released. This release has been bundled with the updates mentioned in 4.4 above. This update is suitable for use with PSS/E V32 & V33 study cases. A new example case, illustrating that PSSE2Mudpack operates with PSS/E loadflow cases with six digit bus numbers, has been included.

ii. PSSE2Mudpack speed issue: Adelaide Uni investigations show that the memory leak in Perl which required splitting of the PSSE2Mudpack application into several executables components exists in Perl 5.14 (the latest version attempted). An attempt will be made to determine if the problem also exists in Perl 5.16 (the latest version). A number of modifications to existing Adelaide Uni

Perl tools are being undertaken to address incompatibilities between Perl versions 5.14 & 5.16.

iii. Investigation is carried out to search for possibilities in saving compiled form of model descriptors so as to avoid the need to recompile the descriptor file for every instance of the model.

4.0.6 Computation of frequency responses in PSS/E

i. Software tool (to calculate the frequency response of turbine) is complete and documentation is nearing completion.

ii. This tool is capable of calculating the equivalent admittance for a part of the network.

iii. Revised target release date from end of March to end of May 2013.

4.0.7 Modelling tool to analyse the effect of signal quantization and quantization on PSS performance

i. In-house testing of the software is continuing (target release date is end of September 2013)

4.0.8 Updating of Mudpack User Manual

i. Mudpack User Manual has been upgraded to FameMaker version 11.

ii. Obsolete chapter 2 as well as incomplete chapters 4-9 have been removed from the manual. The latter chapters will be included in the book *"Small-signal stability, control and dynamic performance of power systems"*. Description of the RPTI activity has also been updated. The revised Mudpack User Manual has been included in the Mudpack release of 24/9)

iii. Adelaide Uni is commencing work of incorporating descriptions of activities SLAB, ELAB, RLAB into new chapter 3 (*Activity Reference*) of the Manual.

iv. Adelaide Uni is commencing writing of descriptions of TCSC model parameters and induction motor parameters into the Manual. Moreover, writing descriptions for power, current and admittance is being commenced.

4.0.9 Proposed Immediate Priorities

i. A generic model is more likely to represent reasonably the small signal behaviour of range of different turbines given the parameters are set correctly, rather than using large signal models for those turbines. (David Vowles)

ii. It has been requested by AEMO to wait until the latest generic models are to be released. Nevertheless Adelaide University has already implemented generic models in Mudpack to a greater extent.

iii. In terms of work priority, Adelaide University has been asked to get the turbine model representations (model descriptor for internal models) completed ASAP. (DF & BB)

iv. Work towards improving PSSE2Mudpack computation speed. Complete profiling and implementation (if possible) of a scheme to save compiled model descriptors (target May / June 2013). A clear solution to the speed issue has not been identified. Time to implement any solution that is identified will need to be determined in due course. Depending on the time needed the target dates rely on this milestone may need to be adjusted.

v. Release of tool for computing frequency response in PSS/E (target May / June 2013)

vi. Implement extended eigenvector computation and graphical display in Mudpack, including documentation (target August/September 2013)

vii. Complete implementation of STATCOM model in Mudpack, including documentation (target September/ October 2013)

viii. Complete implementation of generic wind turbine models in Mudpack, including documentation (target October / November 2013)

ix. Update Mudpack User Manual Appendices to include new and missing models (target October / November 2013)

x. Release Mudpack update (target December 2013/ January 2014)

4.1 Related consulting activities

i. Adelaide University have been conducting consulting activities with ElectraNet in the following areas:

- Auditing of Mudpack and PSS/E dynamics data records of key plant (generators and SVCs) in the SA network.
- Reviewing the performance of a PSS fitted to a generator in SA. An interesting aspect of this review is that magnitude errors in rotor-speed estimators based on measurements of electrical quantities can produce very significant unintended phase-shifts in the output signal from the pre-filter of integral-of-accelerating power PSSs.
- Tunning of the speed signal is required and use of algorithms (e.g., using rotor angle, bus frequency etc.) to reduce the error in the output signal.
- ABB has used synthesised speed signal derivation by using σ, P, Q and V. ABB has sent basic block diagrams to AEMO which aren't detailed enough to fully understand how the synthesised mode can be derived. (DF)

4.2 General

i. Studies need to be carried out to assess the impact on the damping performance caused by wind turbines. (AL & DF)

ii. Presently, there are anomalies in the voltage control of CSSTAT models as they use wide dead bands. AEMO is working towards getting the CSSTAT models superseded with more accurate models as an initiative of the modelling strategy improvement. (AL & DF)

iii. Having a composite Dvar model with Dvars and capacitor banks including embedded switching would be beneficial which in turn will comfort day to day studies. (AL)

iv. One of the notions of using black box models is that it can verify whether it is ok to use a particular wind turbine generic model for small signal studies for a given small disturbance signal. (David Vowles)

v. Black box approach has worked well for the synchronous generator models. Therefore, it is convincing to represent a particular wind farm as a black box at the connection point. (DG)

vi. Until the Lake Bonney wind farm is R2 tested, it would be reasonable to wait before coming up with a strategy for assessing revisions of wind turbine models. (BB, SA & AH)

vii. Each and every wind farm owner must provide R2 pack to AEAMO and TNSP. (ALL)

viii. Providing a rigorous finite list of tests that are required to be endured in the *R2 Testing Guideline* can be chancy as it can constitute a legal liability towards AEMO and TNSP. As a result it has been agreed to provide a universal list of tests as examples (if required) in the appendix in *R2 Guidelines*. (AL, BB & DG)

ix. Include a summarised and tabulated segment in the *R2 Guidelines* for 7.4.2 and 7.4.3 sections. (AL & BB)

x. Load modelling is not feasible at this stage due to various complications and limitations associated with studies and simulation speeds. As far as a wind integration project is concerned, it is a high level study to assess the impact of wind generation regardless of voltage control and other control characteristics of dynamic loads. (DG & BB)

5. Wind Integration Project

i. The purpose of this document is to demonstrate the impact of larger scale of wind farm integration into the network.

ii. This document proposes various wind farm and solar models.

iii. Work is in progress to produce a report for future models of various machines, reactive capability, AVR capability etc. (BB)

iv. No public consultation will be conducted for this report. (BB)

v. It has been suggested that QLD, VIC, TAS, NSW should perform studies to identify the minimum number of synchronous generators to be online with the intension of maintaining small signal stability. (AL)

vi. South Australia's *Heywood Interconnector Series Compensation* Project can necessitate ElectraNet to reconsider scenarios such as sub-synchronous interaction, inter-area oscillation, damping issues and small signal stability. (AL)

vii. In order to consider using of SVCs to control damping issues is not viable as the SVC function depends on the dynamic load model. Hence, dynamic models need to be created prior addressing this proposal. (TA & DF)

viii. David Francis will be grateful if he is assisted to integrate wind farm models into PSS/E and Mudpack. (DF)

6. Action items

Item	Action Item
1	Should the 3-phase model acceptance be formalised?
2	Should PSS/E to be used for scenarios SCR is 5 or more, whereas PSCAD to be used for SCR between 3 and 5? It is in question if WF SCR<5, can the actual equipment will be able to operate under that situation?
3	What are the advantages of using a 3-phase power system modelling software package (such as PSCAD) over the existing single-phase modelling software (PSS/E)?
4	If a 3-phase modelling software package to be used, what will be the criteria which will determine when to use the 3-phase modelling? AEMO is required to consider whether to replace or accept other simulation packages such as PSACD and PowerFactory. If three-phase models are to be accepted then what changes are required to be applied

	to the existing systems?
5	How to convince the management that the time and money spent in the direction of developing, formalising and publishing documents such as the *Guidelines* is meaningful and appropriate to do so? (AL & BB)
28	**Section 5.2.1:** Include the message that data acquisition process by itself has to be validated. For example, use of some built-in data recording devices with low sampling rate would not be acceptable. (TA) (AEMO Guideline for R2 Testing)
29	**Section 5.3 (paragraph 2):** Allowing an output power level tolerance is useful because it is unlikely that all the turbines in a WF subject to the same wind speed. It has been requested that rewording is required for this paragraph in particular consider "network performance". (ALL) (AEMO Guideline for R2 Testing)
30	This document does not intend to supersede any existing document. Please clearly differentiate the application of this document for conventional and non-conventional generators. (BB and DG) (AEMO Guideline for R2 Testing)
31	**Section 6.3:** Make a reference to the *Generator Performance Standards* in this section. (TA) (AEMO Guideline for R2 Testing)
32	**Section 7:** Divide this section into two main sections: on-site testing and off-site testing. Mention on-line testing prior to off-site testing. (DF) (AEMO Guideline for R2 Testing)
33	**Section 7.3:** Place a reference to the provision of *Variation Request* in the NER. (AL) (AEMO Guideline for R2 Testing)
34	Adelaide University is currently pursuing publishing options for the book which are yet to be confirmed. (4.3: Book on *"small signal stability, control and dynamic performance of power systems"*)
35	Modelling tool to analyse the effect of signal quantization and quantization on PSS performance is scheduled to be released on end of September 2013
36	Adelaide Unit to release software tool for computing frequency response by end of May 2013.
37	In terms of work priority, Adelaide Uni has been asked to get the turbine model representations (model descriptor for turbines rather than using generic models) completed ASAP. (Adelaide Uni)
38	Work towards improving PSSE2Mudpack computation speed. Complete profiling and implementation (if possible) of a scheme to save compiled model descriptors (target May / June 2013). A clear solution to the speed issue has not been identified. Time to implement any solution that is identified will need to be determined in due course. Depending on the time needed the target dates rely on this milestone may need to be adjusted.
39	Release of tool for computing frequency response in PSS/E (target May / June 2013)
40	Implement extended eigenvector computation and graphical display in Mudpack, including documentation (target August/September 2013)
41	Complete implementation of STATCOM model in Mudpack, including documentation (target September/ October 2013)
42	Complete implementation of generic wind turbine models in Mudpack, including documentation (target October / November 2013)
43	Update Mudpack User Manual Appendices to include new and missing models (target

	October / November 2013)
44	Release Mudpack update (target December 2013/ January 2014)
45	Mudpack training is to be held in September 2013. Location is to be confirmed. Andrew Halley to confirm that he has no problems if the training is to be held in Brisbane. Number of participants from each organization is to be confirmed with Adelaide University.
46	Include a summarised and tabulated segment in the *R2 Guidelines* for 7.4.2 and 7.4.3 sections. (AL & BB)
47	Consolidate and finalise *Model Acceptance Guidelines* and *Guideline for R2 Testing*. (ALL)