Generator and Load Model Guidelines and Change Management Requirements

Response to Stakeholder Submissions

PowerWater

1 Introduction

The Network Technical Code and Network Planning Criteria (NTC) requires that Power and Water ensure that computer modelling data used for planning, design and operational purposes is complete and accurate. As required by Clause 3.3.4(f) of the NTC, Power and Water has developed a document containing Model Guidelines 'Generator and Load Model Guidelines and Model Change Management Requirements'. The model guidelines are intended to provide guidance to assist Users to provide models meeting their obligations in clause 3.3.4 of the NTC.

When developing the model guidelines the Network Operator is required to consult with Users and the Utilities Commission. To meet this requirement, Power and Water Corporation published proposed model guidelines on 31 July 2020. Consultation was held over a four-week period, with submissions due by Friday 28 August 2020. To assist stakeholders, Power and Water Corporation also held an information session on Wednesday 19 August 2020.

Submissions addressing the model guidelines were received from:

- ENI
- DigSILENT
- TGen
- NT Solar
- EDL

2 Key issues raised in submissions

The issues raised by stakeholders can be grouped into the following key themes:

1. The choice of modelling software
2. EMT modelling requirements
3. Load modelling requirements and
4. Model encryption and
5. Access to modelling information

The following sections explore the concerns raised in relation to each theme. The concerns raised are presented, their relevance to the model guidelines discussed and any revisions to the guidelines that Power and Water believe are warranted are identified. All other feedback received from stakeholders through their submissions has been addressed in the detailed responses to submissions provided in Section 3.

2.1 Choice of modelling software

The consultation impact statement released with the draft guidelines noted that Power and Water was considering which software platform should be adopted for EMT analysis. The consultation impact statement sought feedback regarding whether there was a clear preference for either of the two approaches being considered by Power and Water and whether requiring either a PSCAD or

DIgSILENT Powerfactory EMT model meeting the accuracy requirements specified in the Model Guidelines present materially different costs or risks for Users.

A number of submissions addressed this topic. Some submissions identified the potential for reduced costs if Power and Water requires the provision of DIgSILENT Powerfactory EMT models. This was particularly true for generators that could leverage the DIgSILENT RMS model to produce an EMT model. None of the submissions identified material different costs advantages in requiring the provision of a PSCAD EMT model. Some stakeholders identified that OEMs who are active in the NEM may have a preference to provide PSCAD EMT models as they can leverage their NEM experience. Those same stakeholders generally recognised that in other power system around the world, OEMs have been able to provide acceptable DIgSILENT EMT models.

Power and Water has considered the submissions and decided to adopt DIgSILENT Powerfactory as the preferred software for EMT modelling. This decision will be reflected in the Generator and Load Model Guidelines and Model Change Management Requirements (Model Guidelines). It will mean that generators will need to provide RMS and EMT DIgSILENT models for generating systems.

Given the potential for savings from use of the same platform for RMS and EMT models and the lack of any quantified material issues with this approach Power and Water believes that adopting DIgSILENT for both RMS and EMT analysis is appropriate.

2.2 EMT Modelling

Stakeholders raise a concern that the grandfathering provisions in the NTC may reduce the accuracy of the EMT model for the power system due to the absence of accurate models for legacy plant and the timeframes addressing these modelling gaps might add to the connection process.

Power and Water would like to acknowledge these concerns and reassure stakeholders that an EMT model is currently being developed for its regulated network which includes models for legacy generators. The provisions in clause 3.3.4 of the NTC require connection applicants to provide EMT models for new generating systems. Collectively these activities should ensure EMT models are available as needed to support the assessment of generator connection applications.

Stakeholders also raised concerns that developing accurate EMT models for a power system can be a time consuming exercise and suggested that Power and Water consider other options such as the appropriate tuning of inverter controls prior requiring the development of an EMT model. Power and Water acknowledges that the development of EMT models is time consuming, but Power and Water also recognise that with increasing levels of inverter based resources utilising grid following technology, EMT modelling is often required to study the performance of the power system and assessing the ability to maintain secure operation of the power system. Experience in the north west of Victoria has demonstrated that the availability of EMT models can enable the coordinated tuning of inverter controls to address poorly damped oscillations that emerged during periods of low system strength. In this situation the EMT models facilitated the effective tuning of inverter controls, by enabling the effectiveness of proposed control settings to be evaluated[1].

[1] Further details on the north west Victoria system strength issues and the role of EMT studies in tuning inverter controls to address the issue is provided in the AEMO report https://www.aemo.com.au/-/media/Files/Electricity/NEM/Network_Connections/Power-System-Limitations-December.pdf

The scale of the Power and Water regulated networks compared with the NEM power system should also reduce the complexity and cost of developing and maintaining EMT models for the power systems in the Northern Territory.

2.3 Load Modelling

A number of submissions included suggested refinements to the modelling requirements for loads including:

- refinement of the modelling of the frequency dependence
- clarifying the thresholds and criteria specifying when detailed modelling of motors is required
- clarifying the when detailed harmonic distortion information is required.

Power and Water agrees that the suggested refinement to include the modelling of load frequency dependence will add value. This additional information is included in the revised model guidelines. Furthermore, Power and Water notes that some loads that are proposed to connect to Power and Water's regulated networks include power electronic equipment that provide frequency conversion. The model guidelines have also been revised to provide sufficient advice regarding the modelling requirements for these types of facilities.

Power and Water recognises that the revisions proposed concerning the requirement for detailed motor models provide additional clarity and lead to treating all motors of a particular size consistently. However, the motor modelling criteria also needs to balance the cost involved with adding more detail to modelling and the benefit received from it. The model guideline as currently drafted provide sufficient discretion for Power and Water to require more detailed modelling of larger motors, if necessary. In exercising this discretion Power and Water can assess whether the more detailed motor model justifies the added expense involved in extending the network model to utilise the detailed motor model.

Power and Water agrees that there is value in clarifying the harmonic modelling requirements and the revised modelling guidelines now limit the requirement for harmonic models to motors supplied by variable speed drives or which utilise power electronic converters for slip energy recovery. The revised model guidelines require that the harmonic emissions must be assigned in the part of the model relevant for network power quality analysis (via harmonic load flow), across the range of partial load set-point to full load, as may apply in normal operation.

2.4 Encryption

The model guidelines include a requirement that models are provided to the Network Operator in an unencrypted version. Power and Water agrees with stakeholders that OEMs are sometimes reluctant to release a model that is unencrypted. Power and Water is willing to work with all parties to execute agreements regarding the release of unencrypted models to the Network Operator.

2.5 Access to modelling information

Stakeholders have identified that timely provision of modelling information to connection applicants is required and suggested that the model guideline specify timeframes for provision of modelling information that the Network Operator should meet.

The model guidelines are intended to the Network Operator's approach to developing and maintaining accurate computer models, and *User* requirements for the provision of computer models and associated information for new connections or modifications to existing facilities. The Guidelines do not specifically address the processes by which Network Users and developers of generating systems can access network modelling information. Those arrangements are defined in clause 3.3.4 of the NTC.

While reviewing the adequacy of the process described in clause 3.3.4 of the NTC is beyond the scope of the consultation on the guidelines, Power and Water note that clause 3.3.4(h) does require that the *Network Operator* provides information requested by connection applicants via clause 3.3.4(g) as soon as practicable subject to meeting the requirements in that clause. That framework should provide connection applicants with sufficient access to power systems modelling information.

3 Detailed Responses to Submissions Received

Please note that the words used in Issue/Comment column in the table below are in general our summarised interpretation of the issues raised by stakeholders and are not a verbatim quote from individual submissions. The submissions are available on our website (other than those identified as confidential). The Reference Number (Ref#) in the table is an internal tracking number to ensure all issues have been addressed. The comments made by stakeholders have, where possible, been grouped into themes so that similar issues can be addressed together. Where our response has recommended a change in the draft Procedure, this has been noted in the response.

Ref#	Theme	Stakeholder	Issue/Comment	Power and Water Response
1	EMT Modelling	ENI	It is not clear how the grandfathering arrangements for the Network Technical Code (NTC) overlap with the proposed methodologies in these guidelines. Electromagnetic Transient (EMT) models do not appear to be required from legacy / grand-fathered plant. In order to properly conduct the proposed modelling for adjacent new plant, how will they be sourced? If existing plant is non-compliant with these guidelines, how will this be resolved?	As EMT model provide a more accurate representation of how the power system will react in various situations, including the fast acting controls and protection systems, EMT models as well as RMS models are required. To support this clause 3.3.4 of the NTC now requires all new generators connecting to Power and Water's regulated networks to provide both RMS and EMT models. Power and Water is developing an EMT model for its regulated networks, which includes models for legacy generating systems. These measures should provide a sufficiently accurate EMT model for Power and Water's regulated networks to enable undertaking any EMT studies required to assess adverse system strength impacts.
2	EMT Modelling	ENI	Power and Water should acknowledge that EMT modelling of both networks and generators is very time consuming and expensive to conduct and will be of limited use and accuracy until the models of all relevant system elements are accurate, which may potentially take many years to achieve. They should only be used when reasonable alternative methods have been exhausted, such as simply ensuring the control system tuning of neighbouring inverter based generators are complimentary, to ensure positive feedback effects on voltage levels do not occur. Or changing protection settings to accommodate a reduction in fault levels on parts of the power system.	Power and Water acknowledges that the development of EMT models is time consuming, but this has become standard practice to ensure the network remains in a stable state after new connections into the network. As stated above, Power and Water is developing an EMT model for its regulated networks.

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3	Access to information	ENI	Reasonable time limits must be imposed on Power and Water for providing core information to project owners and proponents on technical information and agreed assumptions for the various studies. Power and Water's agreement on basic information such as the assumed fault levels at a connection point should be provided before signing a Generator User Agreement (GUA), at a minimum. At present it appears this type of information has not been specified or provided by Power and Water for projects that have already been constructed.	The Model Guidelines has been developed to clarify Power and Water's approach to developing and maintaining accurate computer models, and *User* requirements for the provision of computer models and associated information for new connections or modifications to existing facilities. The Guidelines do not specifically address the processes by which Network Users and developers of generating systems can access network modelling information. Those arrangements are defined in clause 3.3.4 of the NTC. While reviewing the adequacy of the process described in clause 3.3.4 of the NTC is beyond the scope of the consultation on the guidelines, it is noted that clause 3.3.4(h) does require that the *Network Operator* provides information requested by connection applicants via clause 3.3.4(g) as soon as practicable subject to meeting the requirements in that clause. That framework should provide connection applicants with sufficient access to power systems modelling information.
5	Load Modelling	DIgSILENT	**2.1.4.1 Model configuration requirements** *"Where various loads are represented as a single lumped (static) load, they must be modelled with complex load parameters based on the constituent loads (VSD's, induction machines and other loads), and with suitable voltage dependent parameters.* *Simplification of load model representation should be consistent with the requirements of AS 3851 and good electricity industry practice to ensure that equipment fault level contributions are appropriately represented."* We suggest adding frequency in addition to voltage dependency. Furthermore, the term '*good electrical industry practice*' is presented in italics but is not defined in the document. Given the term has only been used once in the Modelling Guidelines, rather than apply a definition, a focus should be on the required outcomes given that the use of this legal term will likely not lead to consistency across submitted models.	Power and Water agrees that the frequency dependence of loads is an important characteristic to represent when studying the behaviour of Power and Water's regulated power systems. The sections of the Model Guidelines addressing load modelling requirements have therefore been revised to include the requirement to provide information on both voltage and frequency dependent parameters. Furthermore some loads have been proposed to connect to Power and Water's regulated networks that include power electronic equipment to provide frequency conversion. The guidelines will be reviewed to ensure they provide sufficient advice regarding the modelling requirements for these types of facilities. Power and Water agrees with the suggest to un-italicise the phrase "*Good electrical industry practice".* That change will be made in the revised version of the Model Guidelines.

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6	Load Modelling	DIgSILENT	**2.1.4.2 Modelling motor starting** *"Explicitly modelled motors connected at 11 kV or more must have starting method parameters defined in the model (e.g. direct online, soft-starter)"* It is unclear why only motors at the 11kV voltage level must be explicitly modelled with their starting method defined however DIgSILENT assumes the intent is to assess the starting impact (i.e. flicker) of large motors on the Power and Water network. If so, the classification threshold of Large Motors should be defined as an appropriate ratio of system fault level to motor apparent power rather than as a voltage threshold.	Section 2.1.4.1 of the Model Guidelines specify that explicit models are only required for large motors (>1 MW) that are connected at 11 kV and higher voltages. Smaller motors and those connected at lower voltage levels can be represented by appropriate lumped equivalents. This approach is intended to balance the accuracy of system studies and the complexity involved in extending the power system model to provide explicit and detailed of voltage levels below 11 kV. Power and Water agrees that there may be exceptional situations where a motor connected at voltages below 11 kV, is of sufficient size that it needs to be represented explicitly. The sentence in Section 2.1.4 is intended to provide an appropriate opportunity to depart from the guidance provided in the subsection when necessary. The concern raised by DIgSILENT has been addressed by revising section 2.1.4 to read as follows," These requirements are intended as a guide and should be agreed with Power and Water prior to model preparation. They may need to be varied for large motors connected at voltages below 11 kV."
7	Load Modelling	DIgSILENT	**2.1.4.3 Other model requirements** "*Explicitly modelled motors connected at 11 kV or higher must have harmonic current emissions modelled."* As per our prior comment in 2.1.4.2 this should apply to Large Motors not just 11kV motors. In practice however only motors supplied by variable speed drives will have any adverse impact on network power quality due to harmonics. We suggest that wording of the paragraph is adjusted as follows: *"Where Large Motors are supplied by variable speed drives or utilise power electronic converters for slip energy recovery, the harmonic emissions must be assigned in the part of the model relevant for network power quality analysis (via harmonic load flow), across the range of partial load set-point to full load, as may apply in normal operation"*	As noted above Power and Water believes it is important to balance the costs involved in more detailed modelling of the lower voltage networks with the benefits obtained. Power and Water therefore prefers retaining the original wording limiting the requirement for motors connected at 11 kV or higher, but agrees that there is value in adding the qualifications suggested by DIgSILENT limiting the requirement for harmonic models to those motors "*supplied by variable speed drives or utilise power electronic converters for slip energy recovery, the harmonic emissions must be assigned in the part of the model relevant for network power quality analysis (via harmonic load flow), across the range of partial load set-point to full load, as may apply in normal operation*

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14	Unencrypted Models		**2.2.1 RMS model format** – unencrypted version– The ability of OEMs to provide unencrypted version of the model is a significant issue. Some OEM's models are developed in the form of a fully encrypted model using DLL files. OEMs implement a single-root model approach to maintain model consistency across various simulation platforms, e.g. PSSE, PowerFactory. The entire Firmware is developed in MATLAB/SIMULINK and the DLL files directly generated from that model. Hence, this ensures a high level of consistency, regardless of which platform will be used for power system studies. Models are not individually developed in and for each platform. Hence, to fulfil the definition of an unencrypted model requires access to the modelling source code which is considered as the OEM's intellectual property.	Clause 3.3.4(c) of the NTC requires that *Generators* provide models in both encrypted and unencrypted form. Power and Water recognises that OEMs can be reluctant to disclose unencrypted models due to concerns over confidentiality and the protection of intellectual property. Power and Water recognised that addressing such issues may require specific agreements regarding the use of unencrypted models to be executed with OEMs and is willing to work with Generators and OEMs to establish required agreements.