

# GENERATOR CONNECTION APPLICATION CHECKLIST

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## PURPOSE

This document has been prepared by AEMO to provide guidance to Network Service Providers and Connection Applicants and Generators about the minimum information and documents to be submitted with a connection application or proposal to alter generating plant (as applicable), to enable AEMO to undertake its assessment of those under Chapter 5 of the National Electricity Rules.

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## VERSION RELEASE HISTORY

Version	Effective Date	Summary of Changes
1.0	27 July 2019	First Issue
2.0	18 December 2020	Various updates
3.0	3 May 2021	Updated document links and model benchmarking requirements

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## 1. INTRODUCTION

### 1.1. Purpose and scope

This document contains a number of checklists designed to assist *Connection Applicants* in ensuring that an *application to connect* under clause 5.3.4 of the National Electricity Rules (NER), and *Generators* proposing to alteration of *generating plant*, under clause 5.3.9 of the NER (Applicants) contains all relevant and necessary information to enable AEMO to complete its assessment for the purposes of assessing the application or alteration, as applicable.

The NER and the National Electricity Law (NEL) prevail over this document to the extent of any inconsistency.

### 1.2. Definitions and interpretation

#### 1.2.1. Glossary

Terms defined in the NEL and the NER have the same meanings in this document unless otherwise specified.

Terms defined in the NER are intended to be identified in this document by italicising them, but failure to italicise a defined term does not affect their meaning.

The words, phrases and abbreviations in the table below have the meanings set out opposite them when used in these Procedures.

Term	Definition
Applicant	Either a <i>Connection Applicant</i> submitting an <i>application to connect</i> a proposed <i>generating system</i> under clause 5.3.4 of the NER, or a <i>Generator</i> seeking to alter its <i>generating plant</i> under clause 5.3.9 of the NER.
Application	An <i>application to connect</i> a proposed <i>generating system</i> under clause 5.3.4 of the NER, or a <i>Generator</i> seeking to alter its <i>generating plant</i> under clause 5.3.9 of the NER.
AVR	Automatic voltage regulator.
FRT	Fault ride-through.
GPS	<i>Performance standards</i> applicable to a <i>generating system</i> .
HVRT	High <i>voltage</i> ride-through.
LVRT	Low <i>voltage</i> ride-through.
NEL	<i>National Electricity Law</i>
NER	National Electricity Rules
NSP	<i>Network Service Provider</i> . Used in this document to denote the <i>connecting Network Service Provider</i> .
OPDMS	Operations and Planning Data Management System
PIA	Preliminary impact assessment carried out under the <u><a href="#">System Strength Impact Assessment Guidelines</a></u> .
PSCAD™/EMTDC™	Power Systems Computer Aided Design / Electromagnetic Transient with Direct Current.
PLL	Phase locked loop.
PSS®E	Power System Simulator for Engineering.
PPC	Power plant controllers.

PSS	Power system stabiliser.
RUG	<i>releasable user guide.</i>
SCR	Short circuit ratio.
SLD	Single line diagram.
SMIB	Single machine and infinite bus (simplified network model).
X/R ratio	The ratio of the system reactance to the system resistance.

### 1.2.2. Interpretation

This document is subject to the principles of interpretation set out in Schedule 2 of the National Electricity Law.

### 1.3. Related documents

This document does not supersede or replace any other documents published by AEMO in accordance with the NER that relate its subject matter. The table below lists these and other related documents that Applicants should be familiar with when submitting their Applications.

Title	Location
Access Standard Assessment Guidelines	<a href="https://www.aemo.com.au/-/media/Files/Electricity/NEM/Network_Connections/Access-Standard-Assessment-Guide-20190131.pdf">https://www.aemo.com.au/-/media/Files/Electricity/NEM/Network_Connections/Access-Standard-Assessment-Guide-20190131.pdf</a>
Dynamic Model Acceptance Test Guideline	<a href="https://www.aemo.com.au/-/media/files/electricity/nem/network_connections/model-acceptance-test-guideline-feb-2021.pdf">https://www.aemo.com.au/-/media/files/electricity/nem/network_connections/model-acceptance-test-guideline-feb-2021.pdf</a>
GPS Template	<a href="https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Network-connections/Transmission-and-distribution-in-the-NEM--process-overview/Stage-3---Application">https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Network-connections/Transmission-and-distribution-in-the-NEM--process-overview/Stage-3---Application</a>
Guideline for Preparation of a Releasable User Guide and RUG Template	<a href="https://www.aemo.com.au/-/media/Files/Electricity/NEM/Network_Connections/Transmission-and-Distribution/Guideline-and-Template-for-preparation-of-a-Releasable-User-Guide.pdf">https://www.aemo.com.au/-/media/Files/Electricity/NEM/Network_Connections/Transmission-and-Distribution/Guideline-and-Template-for-preparation-of-a-Releasable-User-Guide.pdf</a>
Power System Design and Setting Data Sheets	<a href="https://www.aemo.com.au/-/media/files/electricity/nem/security_and_reliability/system-security-market-frameworks-review/2018/power_system_design_and_setting_data_sheets_published.xlsx">https://www.aemo.com.au/-/media/files/electricity/nem/security_and_reliability/system-security-market-frameworks-review/2018/power_system_design_and_setting_data_sheets_published.xlsx</a>
Power System Model Guidelines	<a href="https://aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/System-Security-Market-Frameworks-Review/2018/Power_Systems_Model_Guidelines_PUBLISHED.pdf">https://aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/System-Security-Market-Frameworks-Review/2018/Power_Systems_Model_Guidelines_PUBLISHED.pdf</a>
System Strength Impact Assessment Guidelines	<a href="https://aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/System-Security-Market-Frameworks-Review/2018/System_Strength_Impact_Assessment_Guidelines_PUBLISHED.pdf">https://aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/System-Security-Market-Frameworks-Review/2018/System_Strength_Impact_Assessment_Guidelines_PUBLISHED.pdf</a>

## 2. USING THIS DOCUMENT

Each Appendix contains a checklist for the use of Applicants when submitting an *application to connect*, or proposing an alteration to *generating plant*, as applicable.

The purpose of the checklists is to ensure that all necessary and relevant information and data is submitted to AEMO and the NSP to facilitate the timely assessment of the application or proposal.

### **3. THE CHECKLISTS**

Applicants must complete all relevant checklists and submit them at the appropriate time during the submission or assessment of an Application.

The listed documents and other information to be submitted is the minimum that must be submitted. Where an Applicant considers that more information would assist in the assessment of their Application, they should provide it.

Applicants should copy each Appendix they wish to complete into a new document, complete it and submit it with their Application.

#### **3.1. Documentation Completeness**

This checklist is in Appendix A and is designed to ensure that an Application is complete.

#### **3.2. Information Consistency and Quality Check**

It is incumbent on the Applicant to ensure that high quality information and documents are submitted and that the results and conclusions included with reports are appropriate. This checklist is included in Appendix B and is designed to assist Applicants in determining whether these quality standards are met.

#### **3.3. Initial Model Check**

This checklist is included in Appendix C to assist Applicants in determining whether the models they submit with their Application are appropriate for the use of the NSP and AEMO in assessing their Application.

#### **3.4. PSCAD Study Guidance**

This checklist is included in Appendix D and is designed to assist Applicants to ensure the completeness of their PSCAD™/EMTDC™ studies and other documents submitted to AEMO.

### **4. CONFIDENTIALITY**

AEMO will manage the model, data and information provided by Applicants for AEMO to assess their Application in accordance with the confidentiality requirements in clauses 5.3.8, 3.13.3 and 4.6.6 of the NER.

### **5. ADDITIONAL INFORMATION REQUESTS**

Either AEMO, or the NSP, may request further or additional information at any time during the assessment of an *application to connect* or request to alter *generating plant*, and the Applicant is required to respond within the time specified by the request.

### **6. TRANSMITTAL**

Applicants must accompany any models, data or other information submitted to AEMO with a transmittal describing the model, data or other information submitted and include a date, model number or version number, as applicable.

## APPENDIX A. DOCUMENTATION COMPLETENESS CHECKLIST

Requirement	Provided by	Comment / file name / reference [Applicant to complete]
Proposed GPS in AEMO's <a href="#">GPS Template</a> .	Applicant	
Connection studies report(s) detailing and demonstrating how the Applicant intends to meet each proposed GPS in accordance with the <a href="#">Access Standard Assessment Guidelines</a> .	Applicant	
Preliminary impact assessment (PIA) has been completed and results provided to AEMO by the NSP.  Where the results of the NSP's preliminary impact assessment under the <a href="#">System Strength Impact Assessment Guidelines</a> indicate that the proposed <i>plant</i> is likely to have an <i>adverse system strength impact</i> , full impact assessment.	NSP	
For <i>asynchronous plant</i> , confirmation from the <i>plant</i> manufacturer of the minimum SCR and X/R ratio at which: <ul style="list-style-type: none"> <li>• it can operate satisfactorily (at the <i>connection point</i> and at <i>generating unit</i> terminals); and</li> <li>• PSS<sup>®</sup>E and PSCAD<sup>™</sup>/EMTDC<sup>™</sup> models have been validated.</li> </ul> Evidence demonstrating ability to operate at the nominated SCR and X/R ratio, such as factory acceptance test reports.	Applicant	
Complete set of site-specific PSS <sup>®</sup> E software simulation models (in .DLL and .obj/.lib in V34.5 format) representing the <i>generating system</i> that meet the requirements specified on AEMO's <a href="#">Modelling Requirements</a> webpage, especially the <a href="#">Power System Model Guidelines</a> .  For <i>synchronous generating systems</i> , governor, excitation system, <i>power system</i> stabiliser, limiters and protection models will be required. The following excitation system design reports will be required: <ul style="list-style-type: none"> <li>• Automatic <i>voltage</i> regulator (AVR).</li> <li>• Excitation limiters.</li> <li>• <i>Power system</i> stabiliser (PSS).</li> </ul> For <i>asynchronous generating systems</i> power plant controllers (PPC) must be modelled as a controller.  PSS <sup>®</sup> E model files must include .sav, .raw, .dvr files and sequence component data and connection numbers for transformer vector group orientation. <i>Generating system</i> impedance data must be consistent with the <a href="#">Power System Design and Setting Data Sheets</a> and clause S5.2.8 of the NER, and facilitate calculation of short circuit currents (e.g. using 'IEC' method as defined in the PSS <sup>®</sup> E software).	Applicant	
PSS <sup>®</sup> E and PSCAD <sup>™</sup> /EMTDC <sup>™</sup> Model Acceptance Test Report complies with the <a href="#">Dynamic Model Acceptance Guideline</a> . The report should also include benchmarking and a completed checklist from Appendix A1 of the <a href="#">Dynamic Modal Acceptance Guideline</a> .	Applicant	

<p>PSS®E RUG, incorporating details on how to use all site-specific PSS®E simulation models, including load flow setup of the <i>generating system</i>, <i>generating system voltage</i> control scheme details, model control modes, dynamic setup with details of the model’s integer constants (ICONS), constants (CONs), STATEs and variables (VARs).</p> <p>RUG complies with the <a href="#">Guideline for Preparation of a Releasable User Guide and RUG Template</a> and <a href="#">Power System Model Guidelines</a>.</p>	<p>Applicant</p>	
<p>A complete set of site-specific PSCAD™/EMTDC™ software simulation models including user guides representing the <i>generating system</i> that meet the requirements specified on AEMO’s <a href="#">Modelling Requirements</a> webpage, especially the <a href="#">Power System Model Guidelines</a>.</p> <p>PSCAD™/EMTDC™ RUG complies with the <a href="#">Guideline for Preparation of a Releasable User Guide and RUG Template</a>.</p> <p>PSCAD™/EMTDC™ model settings files and PSS®E to PSCAD™/EMTDC™ mapping MS Excel spreadsheet provided, including, all parameters related to fault ride-through (FRT), high <i>voltage</i> ride-through (HVRT), protection settings, fault recovery, active and reactive current (including limitations for balanced and unbalanced faults, converter gains and phase locked loop (PLL) settings).</p>	<p>Applicant</p>	
<p>PSS®E to PSCAD™/EMTDC™ <i>generating system</i> model benchmarking report based on a Single Machine Infinite Bus (SMIB) case setup taking into consideration the lowest SCR condition at the <i>connection point</i> in accordance with the <a href="#">Dynamic Model Acceptance Guideline</a> or minimum SCR level nominated by the NSP.</p> <p>PSCAD™/EMTDC™ responses overlaid against each other to demonstrate the accuracy requirements in the <a href="#">Power System Model Guidelines</a>.</p> <p>Signals taken into consideration for model accuracy overlays are <i>active power</i>, <i>voltage</i> and <i>reactive power</i> at the <i>connection point</i> of the <i>generating system</i>.</p>	<p>Applicant</p>	
<p>Voltage control strategy document (and explanation of how the <i>generating system</i> complies with clauses S5.2.5.13 and S5.2.5.1 of the NER, primary, secondary and tertiary control and equipment responses (switching logic where used) including examples for achieving Max and Min <i>power factor</i> ranges).</p> <p>If harmonic filters/capacitor banks can be switched on/off remotely, the process by which AEMO can switch the equipment needs to be included in the voltage control strategy document.</p>	<p>Applicant</p>	



<p>Single line diagrams (SLD) of the proposed:</p> <ul style="list-style-type: none"> <li>• <i>Connection</i> arrangement and <i>generating system</i> clearly showing the <i>connection point</i>, including primary electrical SLD for all collector circuits showing switching arrangements for each <i>generating unit</i>.</li> <li>• Revenue <i>meters</i> and <i>power quality meters</i> (complete to the extent details are available).</li> <li>• Auxiliary supply arrangement.</li> </ul>	Applicant	
<p><u>Power System Design and Setting Data Sheets</u>, including all referenced documents within each data sheet (See Schedule 5.5 of the NER).</p> <p>Note: Inapplicable data sheets should be greyed out and not removed from the document prior to AEMO’s review and acceptance as “not applicable”.</p>	Applicant	
<p><i>Generating system</i>’s continuous (and if any short term) reactive capability (PQ) curve, taking into account any dependency of temperature, <i>voltage</i> etc.</p> <p>Capability curve points in MS Excel.</p>	Applicant	
<p>Protection and control scheme details, including those required to be modelled to assess the impact of the proposed <i>generating system</i> (complete to the extent details are available).</p>	Applicant	
<p>A set of functional and control block diagrams, including all functions between feedback signals and <i>generating system</i> output.</p> <p>The parameters of each functional block, including all settings, gains, time constants, delays, deadbands and limits, should be represented in standard Laplace block diagram.</p> <p>The characteristics of non-linear elements.</p> <p>The model functional block diagram illustrates all derivative states, including derivative state variable names consistent with the block diagrams and the model settings/parameters. The block diagrams must comply with the <u>Power System Model Guidelines</u>.</p>	Applicant	
<p>Additional information requested by the NSP in its response to the Applicant’s <i>connection enquiry</i>.</p>	Applicant	

## APPENDIX B. INFORMATION CONSISTENCY AND QUALITY CHECK

Requirement	Provided by	Comment / file name / reference
PSS®E and PSCAD™/EMTDC™ models are consistent in the physical representation of the <i>generating system</i> .	Applicant	
Details of model aggregation methodology for PSSE and PSCAD™/EMTDC™ models in relevant RUGs, if applicable.	Applicant	
PSS®E and PSCAD™/EMTDC™ models comply with the <u>Power System Design and Setting Data Sheets</u> and the representation in the connection studies report(s).	Applicant	
<p>PSS®E and PSCAD™/EMTDC™ models – a map of parameters is provided including conversion process, where applicable, consistent with the following items:</p> <ul style="list-style-type: none"> <li>• <i>Protection systems – over-voltage, over-frequency, under-voltage and under-frequency settings.</i></li> <li>• Any limitations or <i>protection systems</i> that would otherwise limit accuracy of one of the models, e.g. multiple low <i>voltage ride-through</i> (LVRT) capability and protection settings for overspeed or oscillatory protection.</li> <li>• Disturbance ride-through logic and performance is consistent for the application of balanced disturbances, where models are consistent during and after the applied disturbance, e.g. look-up tables, gains for active-reactive current injections, activation and deactivation thresholds (depending on the control logic) for LVRT or HVRT etc.</li> </ul>	Applicant	
SLDs align with the model representation of the <i>generating system</i> .	Applicant	
Protection settings report does not overrule any other requirement in the GPS (i.e. quality check to ensure that protection settings design (complete to the extent details are available) does not impede any GPS or stated capability).	Applicant	

## APPENDIX C. INITIAL MODEL CHECK

Requirement	Provided by	Comment / file name / reference
<p>PSS®E model and model version complies with the requirements specified on AEMO's <a href="#">Modelling Requirements</a> webpage, especially the <a href="#">Power System Model Guidelines</a>.</p> <p>When the PSS®E model is executed with the PSS®E software version used by AEMO, the model:</p> <ul style="list-style-type: none"> <li>• Does not result in unstable initialisation or initialisation that requires settling.</li> <li>• Does not result in initialisation or run-time errors, including non-convergence or suspect state errors.</li> <li>• Is dynamically stable for all possible ranges of SCR and X/R ratio where the <i>generating system</i> would be in operation.</li> <li>• Allows <i>active power, voltage, power factor, and reactive power</i> reference changes to be performed.</li> </ul>	Applicant	
<p>PSCAD™/EMTDC™ model and model version complies with the requirements specified on AEMO's <a href="#">Modelling Requirements</a> webpage, especially the <a href="#">Power System Model Guidelines</a>.</p> <p>When the PSCAD™/EMTDC™ model is executed, it:</p> <ul style="list-style-type: none"> <li>• Is dynamically stable for all possible ranges of SCR and X/R ratio, up to SCR of 3 or the lowest SCR determined following a PIA, whichever is smaller, where the <i>generating system</i> would be in operation, and the model presented in the SMIB case is representative of the lowest SCR for the <i>generating system</i>.</li> <li>• Initialises and remains stable at rated output and prior to application of any disturbance.</li> <li>• Runs through a balanced fault application in the SMIB case and achieves stable operating condition upon removal of the fault/disturbance.</li> <li>• Runs through an unbalanced single phase and phase-to-phase-to-ground disturbance application in the SMIB case and achieves stable operation upon removal of the disturbance.</li> <li>• Complies with all requirements for <i>continuous uninterrupted operation</i>.</li> <li>• Allows <i>active power, voltage, power factor, and reactive power</i> reference changes to be performed.</li> </ul>	Applicant	

## APPENDIX D. PSCAD STUDY GUIDANCE CHECKLIST

NER Requirement	Provided by	Comment / file name / reference
<p>Clause S5.2.5.3 - to test the boundaries of <i>frequency</i> limitations and rate of change of <i>frequency</i> (df/dt) capability, including <i>frequency</i> protection operation.</p> <p>Playback of <i>frequency</i> change performed and compared overlay of PSS<sup>®</sup>E and PSCAD™/EMTDC™ responses against the accuracy requirements in the <u>Power System Model Guidelines</u>.</p>	Applicant	
<p>Clause S5.2.5.4 - to test the boundaries of the <i>voltages</i>, including <i>voltage</i> protection operation.</p> <p>Playback of over-<i>voltage</i> curve defined in Figure S5.1a.1 and overlay comparison of PSS<sup>®</sup>E and PSCAD™/EMTDC™ responses against the accuracy requirements in the <u>Power System Model Guidelines</u>.</p> <p>Playback of under-<i>voltage</i> profile in clause S5.2.5.4 and overlay comparison of PSS<sup>®</sup>E and PSCAD™/EMTDC™ responses against the accuracy requirements in the <u>Power System Model Guidelines</u>.</p>	Applicant	
<p>Clause S5.2.5.5 - to include balanced and unbalanced faults at various fault locations.</p> <p>In particular, performance during a fault (such as <i>reactive power</i> injection capability) and post-fault recovery (<i>active power</i> recovery and <i>voltage</i> recovery) have been investigated.</p> <p>Studies have been conducted in the network equivalent case as discussed with the NSP and AEMO.</p> <p>Applicable fault locations and inclusion of any runback and trip schemes have been considered and presented.</p> <p>For balanced system events, PSS<sup>®</sup>E and PSCAD™/EMTDC™ responses are overlaid against the accuracy requirements in the <u>Power System Model Guidelines</u>. As a minimum, one close and one remote balanced event has been considered.</p>	Applicant	
<p>Clause S5.2.5.8 – Studies to demonstrate capability to reduce power by half within 3 seconds on occurrence of <i>frequency</i> excursion (emulated via <i>frequency</i> playback).</p> <p>Applicable fault locations and inclusion of any runback and trip schemes have been considered and presented.</p>	Applicant	
<p>Clause S5.2.5.11 – Studies to include injection of <i>frequency</i> disturbances to the <i>generating system</i> that could be studied in a SMIB case.</p>	Applicant	
<p>Clause S5.2.5.12 – Studies as applicable.</p> <p>Fault locations and inclusion of any runback and trip schemes, where applicable, have been considered and presented.</p>	NSP?	

<p>Clause S5.2.5.13 – Studies to include step responses in control setpoint and 5% <i>voltage</i> disturbance at the <i>connection point</i>.</p> <p>Studies performed for <i>voltage, power factor and reactive power</i> controller depending on the operating modes of the <i>plant</i> where agreed with the NSP and AEMO for the required operating system mode(s).</p>	Applicant	
<p>Clause S5.2.5.14 – Studies to include curtailment of <i>active power</i> simulating a <i>dispatch instruction</i> or runback instruction.</p>	Applicant	

**Notes:**

- Signals taken into consideration for model accuracy overlays are (as a minimum) *active power, voltage* and *reactive power* at the *connection point* of the *generating system*.
- Studies for clauses S5.2.5.3, S5.2.5.8 and S5.2.5.11 may complement each other where so related.
- Assessment of each requirement must be conducted using the network representative cases as discussed with the NSP and AEMO. The assessments for the purpose of the PSCAD™/EMTDC™ study and its PSS®E model overlays cannot be treated as replacement tests for the compliance assessments to be carried out in the PSS®E models based on AEMO's OPDMS data.