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Dear Mr Wilson

### **Recommended Technical Standards for Generator License Conditions in South Australia**

As you are aware, South Australia (SA) has the highest level of non-synchronous generation in the National Electricity Market (NEM), both in gross terms and as a proportion of maximum/minimum demand. This unique generation mix affects how the power system in SA operates under normal operating conditions and in response to disturbances. As a result, since 2005 the Essential Services Commission of South Australia (ESCOSA) has applied additional technical performance conditions in licences for grid-scale, wind-powered generators in SA.

In June 2016, ESCOSA requested the Australian Energy Market Operator's (AEMO) advice in relation to two matters:

- The currency of the existing special licence conditions relating to technical standards for wind farms connecting to SA's electricity network, and
- Whether there is merit in additional or amended technical requirements being imposed on other power electronic connected generation technologies.

AEMO developed a comprehensive set of recommendations for generator licence conditions in SA, including modification of ESCOSA's existing licence conditions where appropriate, and the incorporation of a number of new conditions. At the time, in order to maximise the availability of essential system security services in SA, an SA-specific framework that had regard to the current and expected future levels of non-synchronous generation was established. These conditions have been in place since August 2017.

In providing its advice at that time, AEMO noted to ESCOSA that any new licence conditions would ideally be transitional arrangements that could eventually be repealed, in whole or in part, once the generator technical standards in the National Electricity Rules (NER) were updated.

In late 2017, AEMO proposed changes to the NER's generator performance standards, and the Australian Energy Market Commission (AEMC) made a final determination on 27 September 2018 to implement new standards. The rule commenced on 5 October 2018, with transitional arrangements ending on 1 February 2019 for projects that had a connection application submitted by the commencement date.

AEMO has now reviewed ESCOSA's generator licensing conditions against the relevant new NER standards, and is recommending the removal of all standards except three of the ESCOSA requirements. These recommendations and the basis of each are included in **Attachment 1**.

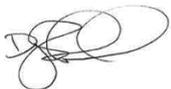
AEMO seeks to maintain a NEM-wide, technology-neutral approach to generator performance standards, and believes the long-term interests of consumers will be best met with a consistent national framework. Participants will also benefit from less duplication.

AEMO makes these recommendations on the understanding that SA's Network Service Providers (NSPs) will fully and effectively enforce the new framework for negotiated access standards as applicable to new generator connections in the National Electricity Market (NEM). Under this framework, connection applicants must aim for the automatic access standard where one exists; and provide reasons and evidence establishing that any proposed lesser standard is as close as possible, taking into account the limited considerations in the NER.

AEMO expects there will be few, if any, new generation connections in SA that will not need to perform at, or very close to, the automatic access standard levels, and that NSPs will be diligent in their assessment of performance requirements in accordance with the SA power system's unique characteristics.

Should you have any questions regarding this advice, please don't hesitate to contact me or Matthew Hyde on 07 3347 5772.

Yours sincerely



Damien Sanford  
**Chief of Operations**

cc:

Attachment 1: Recommended changes to ESCOSA generator licensing conditions

## Attachment 1

### Recommended Changes to ESCOSA Generator Licence Conditions

The ESCOSA Generator Licence conditions were last updated in mid-2017. This 2017 update included a range of new conditions, appropriate to the status of electricity system and market development and the technical conditions applied to generators as specified in the National Electricity Rules (NER).

Subsequent to the licence conditions update process, AEMO proposed a rule relating to Generator Technical Performance Standards for the AEMC to consider. Many of the requirements proposed by AEMO in the rule change were based on the work undertaken to develop the ESCOSA Generator Licence conditions recommended by AEMO. The AEMC rule change process concluded in October 2018, and the new Rules were fully in effect by February 2019. <https://www.aemc.gov.au/rule-changes/generator-technical-performance-standards>

Due to the change in Generator Technical Performance Standards that are defined under the NER, it is appropriate to review the ESCOSA licencing conditions. Upon request from ESCOSA, AEMO has conducted a review, with particular focus on:

- The revised negotiation framework that applies to proposing and agreeing to performance standards for new and altered generation connections;
- The amended technical requirements and how they align with the ESCOSA Generator Licence Conditions.

An objective outcome for the review of ESCOSA Generator Licence Conditions is to achieve a set of criteria that are specifically applicable to South Australia, not already covered by the NER, maintain consistency with the NER, and optimise the assessment and approval process in relation to new generator connections.

Table 1 below, outlines the licence conditions AEMO recommends no longer apply and a description of the basis for these recommendations. In total there are 12 conditions that AEMO consider are now adequately addressed under the NER.

Table 2 outlines the 3 licence conditions AEMO recommends be retained. These conditions remain as specific to the South Australian network conditions and are not specifically defined under the NER.

#### NER Negotiating Framework

AEMO makes these recommendations on the understanding that SA's Network Service Providers (NSPs) will fully and effectively enforce the new framework for negotiated access standards as applicable to new generator connections in the National Electricity Market (NEM). Under this framework, connection applicants must aim for the automatic access standard where one exists; and provide reasons and evidence establishing that any proposed lesser standard is as close as possible, taking into account the limited considerations in the NER.

AEMO expects there will be few, if any, new generation connections in SA that will not need to perform at, or very close to, the automatic access standard levels, and that NSPs will be diligent in their assessment of performance requirements in accordance with the SA power system's unique characteristics.

#### Transitional Arrangements

AEMO recommends that, from the time the Commission makes its determination in regard to AEMO's recommendations, that any applicant with a Generator Performance Standard (GPS) agreed under the NER version 113 or later, these recommendations apply. Applicants with a GPS agreed under the NER version 112 or earlier, shall have the current ESCOSA conditions applied.

Table 1 Special licence conditions recommended to be removed

Licence Condition Number	Focus area	Description of licence condition requirement	Basis for recommendation
2	Disturbance ride-through capability  General requirements	General requirement for the ability of generating systems to maintain continuous uninterrupted operation during and after power system disturbances.	The NER have been amended to include improved voltage disturbance withstand requirements, equivalent to those described under this licence condition. In particular: <ul style="list-style-type: none"> <li>• Clause S5.2.5.5 contains detailed provision for the specific contribution of current by generating units to both low voltage and high voltage disturbances, to mitigate the effect of these disturbances, the provisions include how this functionality will be activated.</li> <li>• Clause S5.2.5.4 contains increased high voltage and low voltage withstand provisions compared with the previous NER.</li> </ul> While the licence conditions current apply to the generator terminals, the NER are primarily applicable at the connection point, with some allowance to consider generator terminals. The NER framework is preferred, this being the interface between the NEM and the connected generation plant. In this manner performance of all equipment connected at a site is included.
3	Disturbance ride-through  Reactive current injection and reactive power support	Requirement for new entrant generators to be able to meet reactive current injection and absorption requirements during and subsequent to contingency events. The reactive current injection must have some defined method of calculation and certain characteristics (such as rise and settling times).	The amended NER include sufficient provisions within clause S5.2.5.5 to cover the provisions described under this licence condition.

Licence Condition Number	Focus area	Description of licence condition requirement	Basis for recommendation
4	<p>Disturbance ride-through</p> <p>Active power injection requirements (active power recovery)</p>	<p>Clause 4.1 requires new generators to return to at least 95% of the pre-fault active power output, after clearance of the fault, within a period of time between 100 msec and 500 msec agreed by the Commission at the time the licence is issued.</p> <p>Clause 4.2 requires the generator's transient active power consumption to not exceed one power frequency cycle (20 msec) and must not exceed 5% of the maximum continuous rated current of the generating system.</p>	<p>The amended NER meets intent of this licence condition with performance requirements defined under clause S5.2.5.5.</p> <p>The minimum access standard for active power recovery under S5.2.5.5 is open (i.e. a 500 msec lower limit is not defined). This difference between the NER and the licence conditions is considered acceptable given that there are some circumstances where a slower recovery time might be the best performance achievable by some technology and the negotiation framework in the NER is specific in terms of when a negotiated standard can be proposed and accepted.</p> <p>The NER does not include the provision relating to active power consumption. This matter is adequately dealt with via the revised definition of <i>continuous uninterrupted operation</i> outlined in Chapter 10 of the NER.</p>
5	<p>Disturbance ride-through</p> <p>Multiple low voltage disturbance ride-through</p>	<p>Requirement for new entrant generators to be able to ride through multiple low voltage disturbances under certain conditions.</p>	<p>The amended NER details a multiple fault ride-through requirement the is more comprehensive than ESCOSA Conditions 5.1 and 5.2. The multiple fault ride-through requirements defined in clause S5.2.5.5 are designed to be more readily adaptable to a range of technology types and includes measures for practical application of the provision, while meeting the objective of improving the resilience of the power system to multiple disturbance events.</p> <p>Further consideration of synchronous machine performance has also been included in the NER.</p>
6	<p>Disturbance ride-through</p> <p>High voltage disturbance ride-through</p>	<p>Requirement for the new generator to withstand a defined over voltage profile and maintain continuous uninterrupted operation for the temporary durations specified in this profile.</p>	<p>The amended NER in clause S5.2.5.4 details performance capabilities for high voltage disturbances that are consistent with this licence condition. This licence condition is therefore now redundant.</p>
7	<p>Disturbance ride-through</p> <p>Partial load rejection</p>	<p>Requirement that non-synchronous generators maintain continuous uninterrupted operation for an event that results in a 30% power system load reduction from its pre-disturbance level in less than 10 seconds.</p>	<p>The amended NER now requires this performance from all plant, previously the requirement applied to synchronous plant only. This licence condition is therefore now redundant.</p>

Licence Condition Number	Focus area	Description of licence condition requirement	Basis for recommendation
8	Disturbance ride-through  Frequency disturbance ride-through	Requirement for generators to be able to meet amended performance requirements for frequency disturbance ride-through for rates of change of frequency of 4 Hz/s for 250 milliseconds and 3 Hz/s for 1 second for all generators (with consideration given to physical limitations for synchronous generators that may require a variation in the condition at the time of issuing the licence).	The amended NER in clause S5.2.5.3 details performance capabilities for frequency disturbances with rates of change of frequency that are consistent with this licence condition. This licence condition is therefore now redundant.
10	Voltage control capability	Requirement that all new generating systems be capable of continuous voltage control with voltage control systems that utilise continuously variable reactive power capability. The generator should be able to be controlled by either a local or remote voltage setpoint, reactive power level or a set power factor. Following a disturbance, any of the control modes should be capable of being overridden according to any of the other disturbance ride-through requirements and automatically reverting to the pre-disturbance mode once the disturbance has ceased.	<p>The amended NER covers the intent of this licence condition via a number of clauses.</p> <p>Clause S5.2.5.13 requires that generating systems be able to be controlled by either a local or remote voltage setpoint, reactive power level or a set power factor.</p> <p>Clause S5.2.5.5 requires that generating systems actively support local voltage during and following disturbances via control of reactive current.</p> <p>Clause S5.2.5.1 is now an AEMO advisory matter. The NER negotiation framework will allow AEMO (and the NSP) to determine an adequate level of reactive power (and voltage control) appropriate for the connection point.</p>

Licence Condition Number	Focus area	Description of licence condition requirement	Basis for recommendation
12	Active power control capability (frequency response mode)	<p>Requirement for generators to provide proportional active power in response to a fall or rise in system frequency (frequency response mode) with the following characteristics:</p> <ul style="list-style-type: none"> <li>• The steady state droop setting of this active power response must be adjustable in the range 2% to 10%.</li> <li>• The frequency dead-band for this response must be adjustable in the range from 0 to +/- 1.0 Hz.</li> <li>• An active power response to changing power system frequency must be provided with no delay beyond that required for stable operation, or inherent in the plant controls, once power system frequency leaves the dead-band.</li> <li>• The response should be sustained for at least 10 minutes (subject to energy resource availability) and the capability of applying different deadband and droop settings for different levels of frequency change should be available.</li> </ul>	<p>The amended NER in clause S5.2.5.11 details performance capabilities for active power response to frequency disturbances that meet the intent of this licence condition.</p> <p>The automatic access standard requires that a generating system must have the capability to provide all of the market ancillary services for frequency contingency events, the minimum access standard requires that a generating system have the capability to provide at least one of these services.</p> <p>The NER negotiation framework will ensure that the active power response to frequency that is delivered by each generating system appropriate for the size and technology of that system.</p> <p>This licence condition is therefore now redundant.</p>

Licence Condition Number	Focus area	Description of licence condition requirement	Basis for recommendation
13	Active power control capability via Automatic Generation Control (AGC)	Requirement for all new entrant generators to have active power control capability and the capability of receiving and automatically responding to the NEM Automatic Generation Control (AGC) signals on a 4-second basis. To facilitate this requirement, under the dispatch rule (3.8.2) and the remote control and monitoring rule (S5.2.6.1), a generating system must provide specific analogue data points to AEMO upon request from AEMO.	<p>The amended NER, under clause S5.2.5.14, requires that all scheduled and semi-scheduled generating systems have Automatic Generation Control (AGC). The NER notes that the AGC signal may be delivered once every 4 seconds or another period specified by AEMO, reflecting the fact that some parts of the NEM operate with alternative AGC signal times.</p> <p>The amended NER, under clause S5.2.6.1, requires that a remote control signal for delivery of AGC is included.</p> <p>These requirements apply to scheduled and semi-scheduled generating systems only as it is not possible to schedule (either via dispatch or AGC non-scheduled systems).</p> <p>Further, the amended NER, under clause S5.2.6.1 automatic access standard require that remote control signals are provided, appropriate to the generating system classification. Scheduled and semi-scheduled generating systems must have active power limit controls (for maximum and minimum power) as well as ramp limit controls (raise and lower), while non-scheduled generating systems require maximum power limit and ramp rate limit controls.</p> <p>The NER negotiation framework enable appropriate arrangements to be agreed for smaller generating systems.</p>
14	Active power control capability (ramp rate of active power)	Requirement for all new entrant generators to have the capability to limit the rate of change of active power both upwards and downwards (unless the reduction is caused by energy resource availability) with different active power rate limits in the normal frequency band and for contingency events. Also, the accuracy of setting the ramp rate must be within 10%. To facilitate this requirement, AEMO also requires amendment to the remote control and monitoring rule (S5.2.6.1) such that a generating system must be able to receive and respond to active power ramp rate limits as well as active power limits.	<p>The amended NER, include a number of measures that meet the intent of this licence condition. Under clause S5.2.5.14, scheduled and semi-scheduled generating systems have Automatic Generation Control (AGC), which effectively manages ramp rate. Further, there are requirements that non-scheduled and semi-scheduled generating systems manage ramp rate within limits set by AEMO.</p> <p>As noted in relation to licence condition 13, the amended NER clause S5.2.6.1 specifies the remote control signals necessary to for AEMO to communicate active power ramp rate limits via SCADA.</p>

Licence Condition Number	Focus area	Description of licence condition requirement	Basis for recommendation
15	Active power control capability (remote monitoring and control)	Requirement for all generating plant to have the capability to provide real-time information about active power control settings to AEMO, including mode of operation, deadband and droop parameters and any other active power control setting that may change during real-time operation.	<p>The amended NER meets the intent of this licence condition.</p> <p>Clause S5.2.5.11 requires that the deadband and droop applied to a generating unit are agreed and documented in the generator performance standards for the plant. As such, real-time changes to dead-band and droop settings cannot be made.</p> <p>Clause S5.2.6.1 requires that a generator provide real-time monitoring information regarding the mode of operation of a generating unit to enable AEMO to predict the active power response to frequency.</p>

Table 2 Special licence conditions recommended to be retained

Licence Condition Number	Focus area	Description of licence condition requirement	Basis for recommendation
9	Disturbance ride-through  Voltage phase angle shift	Requirement that generator does not trip prematurely (by its anti-islanding vector shift or similar protection system) on voltage phase angle changes less than 20 degrees.	<p>AEMO suggests that this licence condition be retained. The requirement that all protection systems and settings be advised to the NSP and AEMO is a provision of the NER under clause S5.2.5.8. However, there is no specific requirement regarding how protection systems such as vector shift or similar systems should be set.</p> <p>Given the risk associated with South Australia in particular where regional separation via interconnector tripping may occur, AEMO considers that the likelihood of large voltage angle shifts that can be seen through the transmission and distribution networks remains high. The consequence of generating systems being sensitive to such events and potentially tripping is also high and therefore should be avoided.</p> <p>The use of highly sensitive vector shift or similar protection settings remains inappropriate within the South Australian network.</p> <p>AEMO recommends to retain this licence condition.</p>

Licence Condition Number	Focus area	Description of licence condition requirement	Basis for recommendation
11	System strength	Requirement for a generating system and each of its generating units to be capable of continuous uninterrupted operation for any short circuit ratio down to a minimum of 1.5 and minimum positive sequence X/R ratio of 2 at the connection point.	<p>Low system strength has already been observed as an operational challenge across the South Australian network. At present, a range of operational measures are put in place by AEMO to manage system strength within the region to acceptable levels. To improve the current situation, a more permanent solution (a synchronous condenser) is being developed by the TNSP.</p> <p>AEMO notes that this permanent measure has been designed to resolve existing issues and ensure stability of the network and its protection systems for the future.</p> <p>However, this solution will not be sufficient to mitigate against all future developments. It is prudent to retain the current measures such that new generating plant is appropriately designed to operate in the South Australian context and as such must be able to operate under a minimum system strength condition.</p> <p>AEMO recommends to retain this licence condition.</p>
16	System restoration	Requirement for generators, where sufficient fault level is available from online synchronous generators, to help with system restoration in terms of providing active and reactive power to auxiliary load for a number of minutes specified by the Commission at the time the licence is issued.	<p>AEMO notes that there has been no change to the NER or NEM guidelines and processes in relation to contribution to network stability by generators during system restart.</p> <p>System restart, particularly in a region such as South Australia which has very low minimum load due to high levels of DER and limited stable load at certain times, is challenging. AEMO considers that it is critical for capable generating plant to be able to contribute steady state and dynamic reactive power support to stabilise voltage, while operating under minimum load to be a significant factor in successful system restart. AEMO recommends to retain this licence condition.</p>