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8 November 2017

John Pierce, Commissioner
Australian Energy Market Commission
Lodged Electronically

Dear John,

RE: AEMC Consultation on Generator Technical Standards Rule Change

The Clean Energy Council (CEC) is the peak body for the clean energy industry in Australia. We represent and work with hundreds of leading businesses operating in solar, wind, energy efficiency, hydro, bioenergy, energy storage, geothermal and marine along with more than 4,000 solar installers. We are committed to accelerating the transformation of Australia's energy system to one that is smarter and cleaner.

We welcome the opportunity to provide this submission to the Australian Energy Market Commission (AEMC). As the penetration of renewables and energy storage increases in the NEM, we can appreciate the need to consider an evolution of the technical standards for generator connections. In general the CEC is supportive of the need to improve the technical performance standards. However, we are deeply concerned that the drafting of some of the proposed rules will limit the scope of technologies that can be connected. As a result this will limit the market and stifle competition.

While it may be appropriate to increase standards to improve system security, applying blanket requirements for excessively high performance standards and excluding the options to negotiate for a number of changed standards is likely to exclude entire technology sectors from the market. The AEMC needs to ensure that there is scope for negotiations to identify efficient technology design that suits the needs of the power system. However, the rule change proposal sets excessively high performance standards and inappropriately assumes that the needs of the power system will be met by imposing unnecessary requirements for capability at locations in the network where it is not needed forcing inefficient investment outcomes for uncertain system security benefits.

The CEC believes the following general considerations are relevant to any revision of the generator connection standards:

- A number of the proposed changes appear to be related to the operation of the network and not the operation of generators. The AEMC should be clear on where

the boundaries lie in the connection process. Once the boundary is clarified, generators that can meet reasonable levels of performance will readily meet reasonable connection standards.

- The AEMC should take care to ensure there is a clear distinction between connections occurring under do-no-harm expectations and under system supporting expectations. The automatic access standards should not seek to exceed doing no harm to the power system and existing connection agreements. Performance levels above this that are intended to support the power system's needs at present, or some arbitrary time in the future should be rewarded as services to the power system.

With these points in mind the CEC also provides the following overarching views on the rule change.

Questionable sense of urgency

In the rule change request, the AEMO notes that it has registered over 20,000 MW of proposed renewable energy projects via its connection application process[1]. This appears to be contradictory to AEMO's work in other areas suggesting that far lower connection volumes will materialise, including

- The key messages coming from AEMO in its 2017 Electricity Statement of Opportunities (ESOO), released on September 9, were that increased risk of unserved energy (USE) was forecasted in New South Wales and Victoria if Liddell Power Station closes as planned in 2022. The ESOO outlook concedes that renewable generation could reduce USE if it does not cause additional thermal generator retirements, based on the best case scenario of approximately 12,000 MW of renewable deployments by 2027.
- AEMO's draft least cost generation outlook as part of the Integrated Grid Plan development work also shows approximately 5,000 MW of new cumulative capacity in 2019, with no additional capacity developed beyond this (beyond meeting the current Renewable Energy Target).
- AEMO's support for the National Energy Guarantee also suggests that AEMO expects a far lower volume of connections to actually materialise.

This difference between the modelled outlooks of renewable deployment underpinning the ESOO and the draft generation outlooks, and the number of renewable projects currently applying for connections demonstrates that AEMO appears to have the view that the majority

[1] Australian Energy Market Operator, Electricity rule change proposal: Generator technical requirements, August 2017.

of projects currently in its connection application process will not actually materialise. This brings AEMO's sense of urgency into question.

Jurisdictional considerations of AEMO's advice

The AEMC cite AEMO's statement that the NEM's state governments are looking at implementing ESCOSA-like requirements. Such an approach would have a negative impact on investments in the NEM. For example a new generator connection in South Australia now goes through four bodies (OTR, ESCOSA, AEMO and ElectraNet) increasing risk, cost and complexity for each and every project.

While such an approach is not consistent with the NEO, the CEC understands that the pressure to take this action has come from AEMO, not unilaterally by the state governments. The CEC expects a far more efficient outcome can be realised if the jurisdictions look towards this rule change to resolve this issue. The CEC supports this approach as being more consistent with the NEO.

Alignment to the Finkel Review

The proposed rule change does not appear to take into consideration Recommendation No. 5.1 of the Finkel Review, which requires AEMO and NSPs to plan the transmission network in such a way as to enable more renewable generator connections to the NEM (e.g. by extending the transmission network to high solar/wind resource areas, and developing renewable energy "hubs"). CEC believes this recommendation – which has been accepted by the federal and state governments – places sufficient onus on AEMO and NSPs to provide any required plant/technologies that support reasonable generator connection standards. However, it appears that the rule change request is placing this obligation on generators instead.

Implications for existing plant

While the proposed rule change is being made to primarily address issues associated with asynchronous generation, the proposed standards would also apply to existing plant that undergoes a modification or upgrade (as per section 5.3.9 of the NER). The CEC wishes to highlight that the application of the proposed rule may be technically inconsistent or require unnecessary investment for existing generation that may seek to make changes to its performance standards (including low and zero emission technologies). The CEC suggests that the AEMC consider the efficient treatment of plant modifications under the proposed standards by considering the advantages of grandfathering arrangements or similar.

The remainder of this submission sets out the CEC's specific responses to each of AEMO's proposed changes. We trust that this submission assists the AEMC in its deliberations and welcome continued discussion of important issue. Please contact the undersigned or Emma White (03 9919 4107) for any queries regarding this submission.

Sincerely,

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Transitional arrangements

Issue	AEMO proposes retroactive transitional arrangements to apply these changes to GPS' not 'finalised' by 11 August 2017. AEMC note that they cannot make retroactive changes to generator performance standards, although AEMO has requested this. The AEMC needs to consider the 'rights of those impacted' in planning their transitional requirements. This includes the generator's place in the negotiation process and costs imposed on projects. A rapid transition can impact these rights.
Response	The CEC supports the AEMC's understanding that retroactive transitional arrangements cannot be legally implemented; transitional arrangements can only be implemented from the date a rule change is made. This approach is specifically designed to allow for changes that support investor confidence. Pre-emptive or retroactive changes to generator performance standards undermine this confidence and not in accordance with the NEO, NER or NEL. Despite this the CEC is aware that connection applicants are already being asked to demonstrate compliance with the revised rules (for example with regards to riding through multiple LVRT events) or that they should aim for performance levels set out in the rule change request, not the current rules. Further, the CEC is aware that AEMO has in some cases sought to change the terms under which generator performance standards have been agreed to for construction. This is concerning as progressing a connection relies on AEMO to commit to an accepted performance level and the process can face significant delays if AEMO does not accept this. Delays of this nature at this stage in the process can easily result in investors simply abandoning the project. The commercial implications of demanding performance above the current rules requirements and proposing retroactive transitional requirements has not been considered. Project finance is negotiated around the specific yield expectations that are based on the design agreed to in the generator performance standards. Late changes to previously agreed standards or retroactive changes to standards will significantly undermine agreed finance terms, ultimately leading to the harms the AEMC needs to avoid. The CEC also notes that the language used in the proposed transitional arrangements is ambiguous. It is not clear whether 'finalised' means registered with AEMO (upon commissioning), or agreed to by AEMO to allow construction to commence. The transitional rules need to be precise about the point at which the new rules would apply. CEC suggests that the transitional arrangements should simply apply to connection applications lodged after the rule is made. [Note: TBC AEMC requested that the CEC map out the generator connection process, proposed GPS, GPS negotiation and registration,

	and relationship to financing as this would enable the AEMC to have better vision of the transition impacts.]

Amendments to the negotiating framework to reverse the onus of proof of being as close as practicable to the Automatic Access Standards

Proposed rule change	AEMO proposes to change the process for negotiating performance standards (Clause 5.3.4A) so that connection applicants are required to aim for the automatic access standard, only falling below that standard if it is not practicable to meet it and providing evidence of this. Loads would also have to comply with the automatic access standards.
Response	The CEC agrees that generators should strive to provide a level of performance which is above the minimum, and where readily achievable the automatic access standard may be appropriate. However, the CEC is of the view that it is not efficient, necessary or always on the interest of power system security for all generators to achieve all the automatic access standards in all circumstances. This approach runs counter to the intent of the NEO. ***AEMO's powers are sufficient to negotiate appropriate performance levels*** The underlying assumptions for this change appears to be that AEMO does not have a sufficient negotiating position to persuade a generator to lift its performance towards the automatic access standards where this is needed to support power system security. There are a number or counter-arguments for this view: - Firstly, AEMO holds the information and is the ultimate decision-maker on the generator performance standards that are required to ensure a secure system. Its role as a gate-keeper provides it with all the power in these negotiations. Conversely generators have no countervailing power against AEMO's view of what is required for a secure power system. - Second, AEMO has demonstrated its power over negotiated outcomes through its recent change in interpretation of clause S5.2.5.4 and application of its revised interpretation to projects that may have been under construction but had not yet *registered* their GPS with AEMO (undergone commissioning). Some of these projects have had to undertake major redesign and new site works to achieve the revised level of performance demanded by AEMO's revised interpretation of this clause. - Third, AEMO's has demonstrated its powers to impact on a generator's commercial returns where it believes non-compliance is

present. The response to the Black System event in South Australia showed that, upon finding new information on wind turbine protection settings that acted during the event, AEMO constrained a number of wind farms until they complied with a demand to adjust protection settings that are not present in the NER.

This framework is consistent with most electricity markets around the world, where system operators have the power to act unilaterally to ensure system security. The CEC finds it hard to see how generators have any power to demand performance standards lower than AEMO expects.

Automatic access standards do not imply system security is achieved

Applying the automatic access standard ignores tolerances in the real system which power system modelling does not account for. The modelling used to identify the performance standards is not perfect so the assumption that the establishing generator performance at the automatic access standard alone creates a more secure system is not valid. Further, the reversal of the onus onto generators to prove compliance with the automatic access standard has the potential to reverse the perception of liability for a secure power system onto generators. This approach therefore imposes significant new risks on generators and appears to absolve AEMO of making sensible planning decisions that ensure the secure operation of the system.

Language around performance needs to be concise

The current approach to negotiating performance standards assumes that 'practicable' is determined by AEMO's demonstration of the level of performance needed for the secure operation of the power system. This approach creates an objective and measurable benchmark which can be justified against the NEO.

The proposed rule change introduces subjective language by stating 'as close as practicable to the automatic access standard'. The CEC notes that while the term 'practicable' is used in the NER it generally relates to timing of actions or publication of information, not to enforcing performance requirements that haves subsequent implications for investment. There appears to be an overarching view that pushing every generator towards the automatic access standards will mean the system is operating perfectly securely. This is unlikely to be the case as the capability required for system security is very closely linked to the characteristics of any particular location in the network.

Pushing all generators towards the automatic access standards will have significant economic impacts for generation projects and lead to unnecessary investments in ancillary plant and equipment in locations where it is not needed. This issue is dramatically influenced by the language in the rules. For example a network might apply the term practicable by requiring an asynchronous generator to install a reactive

	capability commensurate to that of a synchronous generator on the basis that because it's practicable for one it should be practicable for both. This view is entirely subjective and the asynchronous generator would not have any success arguing that the excessive costs that result are not practicable for its business case. A further level of subjectivity is introduced by the lack of boundary around what future the generator is meant to be planning for. AEMO suggests this rule change is needed to plan for the future with more renewable energy but a generator has no visibility over what future exactly AEMO views to be practicably planned for. Indeed confidentiality rules prevent AEMO from sharing even the slightest insights for this. The picture of the future could only ever be entirely subjective and a generator would never be able to demonstrate they were 'as close as practicable to the automatic access standard' because views of the likely future would never align. Investments made under this framework could never be consistent with the NEO. The CEC argues that the current approach is necessary to achieve efficient investment in line with a secure power system. The locational characteristics are critical to identifying what is required for system security, and applying the automatic access standards to all generators runs counter to this outcome. Further, applying the automatic access standard from the commencement of negotiations will push generators towards on-site solutions when there could be reasonable solutions that meet power system security needs and can be located remotely on the network. These options would be more consistent with the NEO and could align to a broader network support opportunities, but would never be revealed should the generator pursue the automatic access standard from the outset. ***Potential amendment to ensure efficient investments are made*** While the CEC does not support the proposed changes to clause 5.3.4A a further consideration for the AEMC is whether this clause can be amended to ensure that investments are made commensurate with reasonable performance levels expected by the NEO. The CEC is aware of examples where performance levels have been demanded by networks that go well above the reasonable needs of the network. These additional costs are unnecessarily borne by the generator, but appear to be required to provide a potential but undefined network support role. The CEC believes the rules should be amended to ensure *only* efficient investments are incurred for the generator. This could be achieved by inserting a sub-clause into clause 5.3.4A (b) along the lines of "*A negotiated access standard must be set at a level that is commensurate to the identified performance needs of the network and power system*".

Commissioning program for distribution network connected generators

Proposed rule change	AEMO proposes to apply clause 5.8.4 to distribution network connected generators rated above 30 MW.
Response	The acceptability of this change will depend on the transitional arrangements applied by the AEMC as it will introduce new procedural steps for sub-transmission or distribution network connected registered generation (such as a longer lead time for application submission) that need to be planned and accounted for.

Voltage control and reactive power requirements

Proposed rule change	ITEM 1 - AEMO propose amending *S5.2.5.1 Reactive power capability* **minimum access standard** to require generating systems to be able to continuously supply and absorb reactive power sufficient to achieve the continuously controllable set point range set out in s5.2.5.13 (measured at the connection point).
Proposed rule change	ITEM 2 - AEMO propose amending *S5.2.5.13 Voltage and reactive power control* **minimum access standard** to require all generators to have facilities to regulate voltage meeting a set of new accuracy and controllability requirements (measured at the connection point).
Proposed rule change	ITEM 3 – AEMO proposed amending *S5.2.5.13 Voltage and reactive power control* **minimum access standard** in respect of the settling time for a synchronous generator of over 30MW with an excitation voltage control system.
Proposed rule change	ITEM 4 – AEMO propose amending *S5.2.5.13 Voltage and reactive power control* **minimum access standard** for voltage and reactive power control to require asynchronous generating units, >30 MW, to have specific settling times for active power, reactive power, and voltage measured at the connection point.
Proposed rule change	ITEM 5 – AEMO propose amending *S5.2.5.13 Voltage and reactive power control* **negotiated access standard** AEMO proposes the addition of a new requirement stating that where power factor or reactive power regulation modes are included, these are in addition to voltage control or excitation control. The generating system may operate in any control mode as agreed with the NSP and AEMO and must

	be able to be switched to voltage control or excitation control at any time. Remote control equipment to change the set-point and mode of regulation must be provided.
Proposed rule change	ITEM 6 – *S5.2.5.13 Voltage and reactive power control* related definitions for settling time and rise time have been revised and moved to the Glossary. AEMO's proposed definitions in respect of these parameters are: • Rise time - In relation to a control system, the time taken for an output quantity to rise from 10% to 90% of the maximum change induced in that quantity by a step change of an input quantity • Settling time - In relation to a control system, the time measured from initiation of a step change in an input quantity to the time when the magnitude of error between the output quantity and its final settling value remains less than 10% of: - if the sustained change in the quantity is less than half of the maximum change in that output quantity, the maximum change induced in that output quantity; or - the sustained change induced in that output quantity.
Response	CEC considers that these changes in relation to the control of voltage are achievable however, will come at a high cost to some generators, especially those that are located in strong network locations, or in remote parts of the network where X/R ratios are low, where large amounts of reactive power would be required to control voltage. These costs would be exacerbated with smaller project sizes at these locations indicating that the changes will create new barriers to entry by smaller generators. In particular the proposed minimum access standard for all generators to continuously control voltage between 98% and 102% is not reasonable. Depending on the size of the generator and the strength of the network at its connection point, this requirement could add unnecessary costs to some projects by increasing the already stringent requirements on generator reactive capability. Ironically, this will increase the cost of new generation in good, strong areas of the network where it can be accommodated most cost-efficiently by requiring the most amount of reactive power support in locations where it is simply not needed. CEC members have also noted that in strong network locations it is highly likely that the minimum access standard for S5.2.5.1 will exceed the automatic access standard. This case creates a contradiction in the definition of these standards – that is that a standard cannot be agreed which is less than the minimum access standard and that the standard cannot exceed the automatic access standard. The minimum access standard should not demand voltage control capability that would force the generator to exceed the automatic reactive capability requirements and this proposed change must be refined to be acceptable.

	The CEC also argues that requiring multiple generators to have voltage control capability to individually control voltage at the same location would lead to significant over-investment in capability (especially in high fault level areas). Further, there are likely to be connection point locations where voltage is readily controlled by network elements (such as tap-changing transformers) where it would also be undesirable and unnecessary to require the automatic access standard capability because the voltage would not vary across the full +/- 10% range and the network would not desire two overlapping voltage control schemes. Lower performance standards would be more appropriate and more consistent with the NEO in these circumstances (also see previous comments indicating how the term 'practicable' introduces subjectivity in these requirements and increases the likelihood of inefficient investment). The CEC's view is that these requirements are likely to create barriers to entry by most plant unless they invest in ancillary plant that is likely to be unnecessary and potentially undesirable for some locations. AEMO should propose a more responsible set of standards that allow technologies to perform within their capabilities or invest in additional plant *only* where this is needed to ensure the local network can accept the generation. This approach should be aimed within the capability of available technology, not far above it. ***Information held by NSPs is critical to efficient setting of access standards*** As the NSP holds all the requisite information to determine efficient voltage control requirements the rules should ensure clear obligations on NSPs to demonstrate the minimum needs for efficient voltage control schemes and systems early in the connection process. This approach would lead to more informed and efficient investment decisions by generators (as expected by the NEO) when compared to the current and proposed arrangements under which the generator proposes a solution without knowing the requisite network information to inform the performance standard to be proposed. ***Alternative options to the rule change request*** Alternative options for the AEMC to consider include - Creating a market-based solution to control voltage in the magnitude and locations that are efficient - Ensure that NSPs have sufficient obligations to control voltage within a 'do no harm' framework. NSPs have traditionally had this role and effective delivery against it implies that there should be no need for excessive obligations on generators. Further, efficient voltage control by NSPs would reduce technical uncertainties and time/cost burdens on generators, leaving operational matters to those with the knowledge and power to act and appropriate risk exposure (ensuring supply quality is already a risk NSPs manage)

	The CEC suggests that the AEMC should investigate the second option in lieu of the proposed rule changes. ***Clarification sought*** A clarification is also sought for the text in subclause 5.2.5.13 b.2. Here the minimum access standard sets up a logical paradox: if the voltage is 0.9pu (which is within the range given in S5.1a.4) then it cannot be simultaneously be at 0.98 (i.e.: within the continuously controllable voltage set point range specified in S5.2.5.13).

Reactive current injection and reactive support during disturbances

Proposed rule change	ITEM 7 – *Clause S5.2.5.5 Generating system response to disturbances following contingency events* **automatic access standard** AEMO proposes amending the automatic access standard reactive current injection requirements to: • require capacitive reactive current of 4% of the maximum continuous current of the generating system for each 1% reduction in connection point voltage below 90% of normal voltage. AEMO's amendment requires this capacitive reactive current injection to be in addition to its pre-disturbance level rather than the greater of its pre-disturbance level and 4% reactive current injection requirement. AEMO's proposal also requires that capacitive reactive current injection be in respect of voltage below 90% of normal rather than from the pre-fault level. AEMO also proposes a new provision requiring a generator to maintain the reactive current injection during the disturbance and until the connection point voltage recovers to between 90% and 110% of normal voltage.
Proposed rule change	ITEM 8 – *Clause S5.2.5.5 Generating system response to disturbances following contingency events* **minimum access standard** AEMO proposes to add a new requirement for reactive current injection under the minimum access standard. By proposing this change to the minimum access standard, all generators will be required to have capacitive reactive current injection capabilities. AEMO proposes requiring: • a capacitive reactive current injection in addition to its pre-disturbance level of 2% of the maximum continuous current of the generating system and each of its generating units (in the absence of a disturbance) for each 1% reduction of connection point

	voltage below 90% of normal voltage during the fault. AEMO also proposes a new provision in line with the automatic access standard requiring a generator to maintain the reactive current injection during the disturbance and until the connection point voltage recovers to between 90% and 110% of normal voltage.
Proposed rule change	ITEM 9 – *Clause S5.2.5.5 Generating system response to disturbances following contingency events* **negotiated access standard** AEMO proposes amending the conditions on which a generator can negotiate an access standard different to the automatic access standard. AEMO proposes requiring a connecting generator to meet the automatic access standard for continuous uninterrupted operation and the supply and absorption of active power, reactive power, and reactive current: • except where AEMO and the NSP agree that the total reduction of generation in the power system due to an applicable fault would not exceed 100MW. This requirement replaces a provision under the minimum access standard. The existing requirement was however solely in respect of continuous uninterrupted operation and didn't extend to requiring automatic access standard levels in respect of active power, reactive power, or multiple fault ride-through.
Proposed rule change	ITEM 10 – *Clause S5.2.5.5 Generating system response to disturbances following contingency events* **general requirements** AEMO proposes a new clause which limits the level of reactive current required from asynchronous and synchronous generators under fault conditions: • the reactive current contribution may be limited to: - the maximum continuous current of an **asynchronous** generating system including all operating generating units; or - 250% of the maximum continuous current of a synchronous generating system including all operating generating unit.
Proposed rule change	ITEM 11 – *Clause S5.2.5.5 Generating system response to disturbances following contingency events* **general requirements** AEMO proposes an additional clause specifying the manner in which reactive current contribution under fault conditions is measured and calculated: • the reactive current contribution and voltage deviation may be measured at the applicable low voltage terminals of the generating units or reactive plant within a generating system • the reactive current contribution required may be calculated using phase to phase, phase to ground, or sequence components of

	voltage. When using sequence components, the ratio of negative-sequence to positive-sequence current injection must be agreed with AEMO and the NSP for various types of voltage disturbances.
Proposed rule change	ITEM 12 – *Clause S5.2.5.5 Generating system response to disturbances following contingency events* **general requirements** AEMO proposes a set of additional clauses specifying rise and settling time and reactive and active power consumption upon the occurrence of a fault: • the reactive current response must have a rise time of no greater than 30 milliseconds, a settling time of no greater than 60 milliseconds and must be adequately damped • any reactive power consumption immediately upon the occurrence of a fault must not exceed 5% of the maximum continuous current of the generating system and is limited to the duration of rise time • any active power consumption immediately upon the occurrence of a fault must not exceed 5% of the maximum continuous current of the generating system and is limited to 20 milliseconds
Response	***Plant capability*** While the introduction of droop control is acceptable the CEC is concerned that the proposed changes introduce new requirements that expect different slope capabilities of plant for inductive or capacitive operation. This capability is above that of state of the art plant and is inconsistent with international best practice and will likely require significant testing and compliance to demonstrate capability. Typically reactive current injection setting pickups are further outside the continuous operating band than this (ie +/- 15% or more). There needs to be some gap to allow for transition and hysteresis between the continuous operating mode (typically voltage control but not always) and inverter ride-through/grid support modes. Some inverter technologies will stop injecting active power completely once they enter grid support mode whereas others have the option to keep delivering as much active current as is left available – this needs to be taken into account when setting the activation level for the reactive current operating during disturbances suggested by the revised minimum access standard. Different Inverter products have differing degrees of customisability on their reactive injection curves during ride through. As a result it would be more appropriate to define these standards as minimum amounts of reactive injection so that inverter products are not unnecessarily prohibited from meeting the minimum and automatic standards. As previously set out the NEO expects efficient investment and this requires performance to be assessed against the characteristics of the connection point. Onerous and uniform technical requirements introduce unnecessary costs and capabilities. AEMO and the NSPs have all the knowledge and should guide generator proponents to select any plant/technology required to meet the level of performance expected at

	the respective location. The CEC is concerned that some of these proposed changes will create barriers to entry for some inverter technologies. AEMO should propose reasonable technical requirements that identify and address these barriers. ***Clarification sought*** It is unclear whether the reactive current support as described in S5.2.5.5 (2) will apply to voltage levels as described in S5.2.5.4 or if any other reactive current infeed requirements with regard to voltage levels result out of S5.2.5.5(b)(1) would also apply. Further, during a contingency event is very unlikely to have a clear voltage step event at the point of connection and hence further clarification is requested about the future assessment of compliance with the rise and settling time requirements. ***Suggested change*** Only one slope setting should be required for both capacity and inductive modes of operation. Regarding the 5% consumption of both active and reactive power, it is advised to split the general requirement in an automatic access standard and a minimum access standard being the automatic as the general requirement and the minimum as follows: (v) any reactive power consumption exchange immediately upon the occurrence of a fault must not exceed 5% of the maximum continuous current of the generating system to support the network and is limited to the duration of rise time; and (vi) any active power consumption exchange immediately upon the occurrence of a fault must not exceed 10% of the maximum continuous current of the generating system to support the network and is limited to 60 milliseconds.

Low voltage disturbance ride through

Proposed rule change	ITEM 13 - AEMO propose amending *S5.2.5.4 Generating system response to voltage disturbances* – **minimum access standard** – by requiring generators to maintain continuous uninterrupted operation where a power system disturbance causes the voltage at the connection point to vary within the following ranges: – 80% to 90% of normal voltage for a period of at least 5 seconds – 70% to 80% of normal voltage for a period of at least 2 seconds. AEMO's proposed **minimum access standard** mirrors requirements under the **automatic access standard** except with a lower withstand duration for voltages between 80% to 90% of normal. The automatic access standard is 10 seconds rather than 5 seconds for the minimum. AEMO propose LV/HV voltage disturbance ride through requirements as being for 'normal' voltage rather than 'nominal' voltage established at the connection point.
Response	The CEC's view is that the performance standards should be considered in light of plant capability. CEC members have advised that operating at these lower voltages within the expectations of the revised definition is continuous uninterrupted operation may not be achievable as a minimum access standard. The key issue being that the proposed change to the definition of CUO provides no room for a generator to alter its voltage control scheme, such as through tap-changing transformers. Further, to apply this clause AEMO would have to declare the 'normal voltage'. As it has historically been challenging to get AEMO to provide and commit to normal voltage a clear framework is needed to ensure this can be provided. The AEMC's Final Determination of the 2013 Rule Change on Technical Standards for Wind and Other Generator Connections provides some guidance: "Normal voltage' is always to be regarded as 'nominal voltage' except where the NSP has requested a different voltage level to be applied, and has written approval from NEMMCO for the application of that different voltage level." (P 40) Given this the AEMC should include a respective change in the information that is provide to connection applicants to ensure that a normal voltage is provided and committed to by the NSP and AEMO such that an appropriate assessment can be made of the respective performance standards.

Multiple low voltage disturbances ride through

Proposed rule change	ITEMS 14,15 - AEMO propose the following new requirement in *S5.2.5.5 Generating system response to disturbances following contingency events* – **automatic and minimum access standards** – for generators to withstand multiple low voltage disturbances: – a generating system and each of its generating units and reactive plant must maintain continuous uninterrupted operation for up to 15 voltage disturbances in any 5-minute period. The automatic and minimum access standards differ by the total withstand duration required over that 5 minute period: – **Automatic access standard** requires a total of 1,800ms – **Minimum access standard** requires a total of 1,000ms AEMO is also seeking that negotiated access standards comply with the conditions of the automatic access standard, unless AEMO and the TNSP agree that a total reduction in generation in the entire power system will be less than 100 MW.
Response	This proposed change appears to create a misalignment between the real and idealised power system operation. The events that occurred on September 28 2016 in South Australia were extreme and pushed the power system to its limits. However, creating standards based on this one event may not be an efficient approach to the design of the NEM. While some generators can meet these requirements this is not a uniform capability. Generators require significant testing in order to demonstrate this capability and there are no ancillary plant options available to increase the capability of a generator to meet this requirement. Further, it is not apparent that AEMO's proposal has considered the potential impacts on plant life expectancy or equipment damage. Major redesign works will likely be required for many generator types, such as synchronous machines, to withstand the thermal and mechanical stresses. ***The background to this requirement is not an appropriate benchmark*** Firstly, the AEMC should keep in mind that AEMO's approach to enforcing compliance with multiple LVRT events on wind generators in South Australia was to create a new technical performance criterion (multiple LVRT events) and apply it to these wind generators or constrain their operation until they agreed to accept it. As such the AEMC should take caution in progressing the outcome of this situation as the status-quo. Factors that AEMO has not considered in proposing this requirement include:

- Power system performance during an event that creates multiple LVRT events is highly unpredictable and could lead to N-3 or higher network configurations. This requirement could literally mean the assets in the network are tripping off all around the generator to ensure they are protected and that the community is protected, but that generators would keep operating irrespective of potential damage.
- The potential implications this requirement has on thermal generators which might see oscillations between the boiler and generator occurring, or that might pole-slip should a fault occur as the rotor angle is recovering from a previous fault.
- The scope for this new requirement to narrow the market of equipment providers for generators in the NEM.

The multiple LVRT requirements are being prioritised above plant capability

An appropriate balance should be struck in the rules as it is unreasonable for a generation asset to be facing damage and continuing to operate. For example, a generator should be able to adhere to thermal or mechanical stress protection alarms during multiple events and trip off accordingly to prevent damage or life reduction resulting. This new performance standard should include sufficient scope for thermal and mechanical protection and/or recovery. It should allow plant to override if damage is foreseeable, and allow time for cooling. For example, the ESCOSA Licence conditions allow 30 minutes from the first five minute period starting before a generator has to comply with this standard again.

Compliance expectations with multiple LVRT events is not clearly indicated

AEMO have not indicated how compliance with this requirement would be measured or demonstrated. This needs to be clarified such that generator investments can be made efficiently. The CEC suggest that compliance could only be achieved through factory testing and a statement of compliance from the OEM. Actual performance would never be certain until an event occurs whilst the generator is operating.

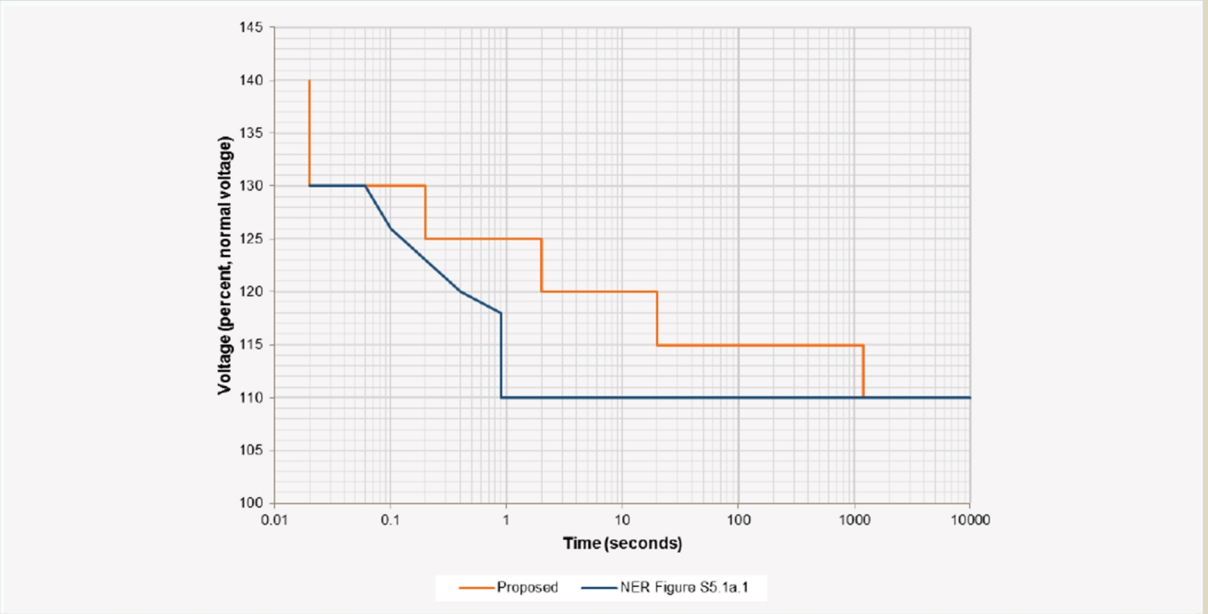
Maximum generator unit sizes are introduced in the proposed rules

The draft rule seeks to limit the amount of generation that can be shed from the power system to 100 MW for a negotiated access standard to be accepted. The CEC notes that the definition of 'generation' does not distinguish between embedded generation or registered generation. During periods of high output from distributed generators operation multiple LVRT events would likely trigger active or passive anti-islanding protection and could easily lead to over 100 MW being shed. This scenario requires further investigation by AEMO. Further, as noted earlier generators that include units with capacity above 100 MW would only have the choice of the automatic access standard.

	Clarification sought It is not clear whether these faults are intended to be spread out across the period or could occur one after the other. In the latter situation, no opportunity is given for the unit to recover after the previous fault and hence the ability to comply could be significantly changed, depending on the profile of the faults.

High voltage disturbance ride through

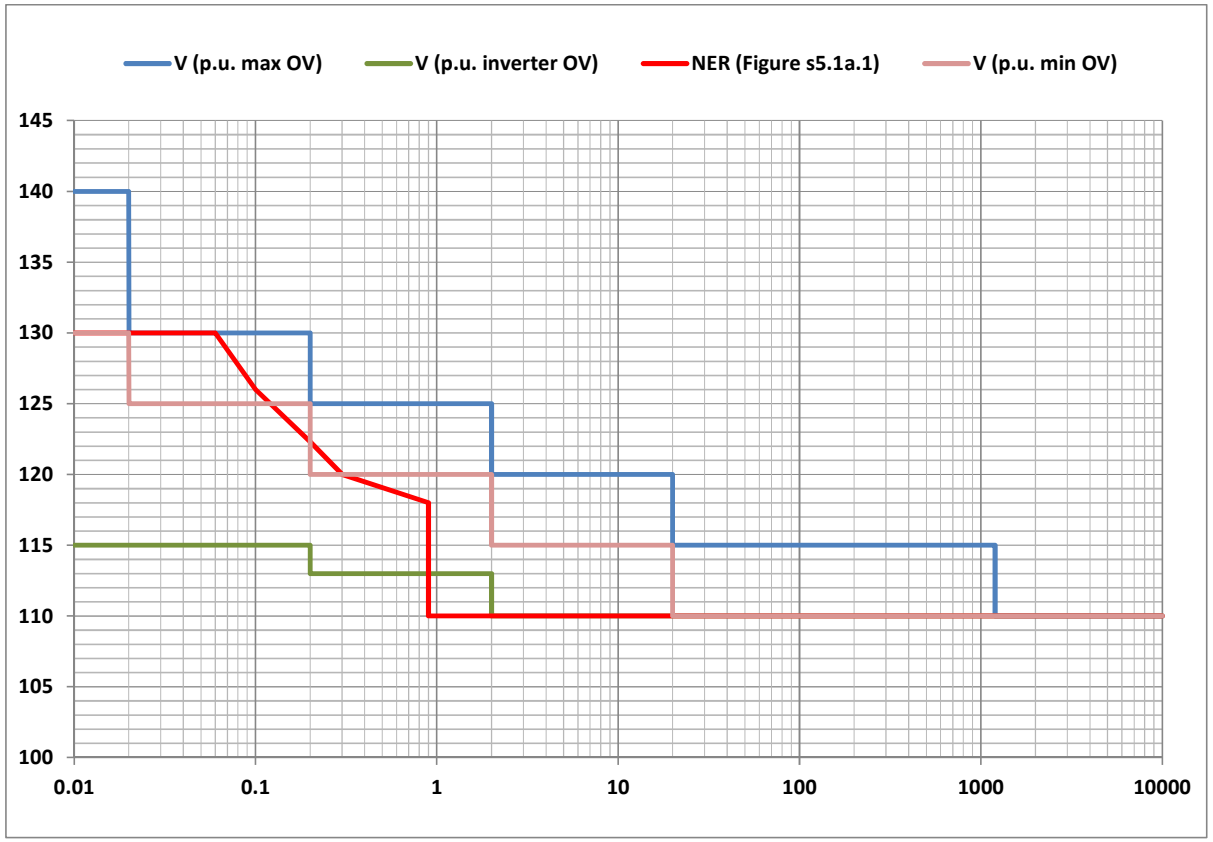
Proposed rule change	ITEM 16 - AEMO propose increasing high voltage withstand requirements for voltages over 110% of normal under both the **automatic and minimum access standards**, by amending the system standard *s5.1a.4 Power frequency voltage* which AEMO proposes to apply to both standards in *s5.2.5.4*



	AEMO's proposal aligns the minimum and automatic access standards.
Proposed rule change	ITEM 17 - *Clause S5.2.5.4 Generating system response to voltage disturbances* – **minimum access standard** – AEMO proposes adding a new requirement to bring the minimum access standard into line with the automatic access standard by referencing the requirements of the system standard S5.1a.4 in respect of withstand requirements for voltages above 110% of normal. AEMO has also requested the removal of caveats that allow tripping when voltages are within these ranges, should another clause in the generator performance standards require this.
Proposed rule change	ITEM 18 – Reactive current injection during over-voltage disturbances: *Clause S5.2.5.5 Generating system response to disturbances following contingency events* – **automatic and minimum access standards** – AEMO recommends a new requirement under both the automatic and minimum access standards applying to inductive reactive current injection in respect of over-voltage events. This new provision requires a generator to supply: • inductive reactive current in addition to its pre-disturbance reactive current of 6% of the maximum continuous current of the generating system, including all operating generating units, for each 1% increase of connection point voltage above 110% of normal voltage. • reactive current injection maintained until the connection point voltage recovers to between 90% and 110% of normal voltage.
Response	Note that the introduction to Scheduled 5.1 of the NER allows room to move and does not guarantee that the system standard is met at all times and in all locations. Changes to the system standard for voltage needs broader consideration. When examining the connection and assessing the performance standards the settings in S5.1 and the network characteristics provide feedback on the need to perform at the Automatic Access Standard, and the parameters to negotiate on for Negotiated Access Standards. ***Plant capability to comply across the transmission and distribution network is unlikely*** The system standard and S5.2.5.4 reference connection point voltages and normal voltage. This implies the potential for significantly higher voltages at the generator terminals, perhaps referencing from a normal connection point voltage of 110%. AEMO's suggestion that generators can deploy dynamic reactive plant if generator units cannot meet this would lead to major investment in ancillary plant which in

	the majority of cases may never be used. Further, the minimum access standards are set at a level which has not been justified and would require significant investment to comply with. The CEC expects that many gas turbines will struggle to meet the proposed revised system standard. AEMO noted in the September 28 workshop they expect that the 'majority' of OEM's plant can meet these requirements, highlighting that they are aware of some plant that would not be able to do so. However, the CEC note that this standard exceeds the IEC standards for equipment, for example there could be issues with cable isolation requirements within generator reticulation systems that may require redesign. The main issue with over-voltage withstand is that the voltages at generator terminals tend to be naturally higher than the voltages at the connection point. So a voltage of 120% at a connection point would be translated to a voltage above this at the generator terminals. As a result there are likely to be many existing generators that could not comply with the proposed new voltage standard, in particular a requirement to comply with voltages at just below 120% for 20 seconds will be problematic. The AEMC should consider relaxing this longer term requirement to below 115%. The CEC suggests that managing power system voltages appropriately is the responsibility of NSPs, as suggested above. A change in the voltage standard to this extent would imply significant network investment to comply. Any rule change must include protections that prevent networks from requiring connecting generators to fund increased network capability to comply with the revised standard. In respect of insulation coordination these proposed changes would create requirements for generators that are far above the capability of the associated network. There is the potential for transfer of the risk for voltage performance onto generators. Concurrently, the voltages suggested by the revised system standard could have major ramifications for the distribution network and small embedded generation connected in the distribution network. ***Small scale embedded generation would not tolerate operating under the proposed voltage conditions*** For example the inverter standard AS 4777.2 requires that all LV-connected inverter energy systems rated at below 200 kVA include passive anti-islanding protection that disconnects the inverter for voltages above 265 V (115%) within 0.02 seconds or for voltages above 260 V (113%) within two seconds with a one second delay to align to the current system standard. Although there are consistent predictions for increased deployment of small-scale embedded generation AEMO's revised high voltage standards would not be consistent with keeping these generators in operation through high voltage disturbances. The figure below compares the current and proposed changes against the AS4777.2 standard's inverter overvoltage protection settings indicating that high volumes of embedded generation would be tripped off if the

system was operated at the revised system standards.



The case for a changed voltage standard across the NEM has not been clearly stated

The proposed changes to the system standard has originated from experience in South Australia which is unique in terms of both system and event characteristics. The CEC understands that similar voltages were only experienced in a remote part of the South Australian power system during a 1 in 100 year storm that lead to major damage to the transmission system. These new requirements are premised on a view that the entire NEM power system is certain to face equivalent conditions in the future. This is unrealistic and will lead to major

	overinvestment in generator and equipment capability that would not be consistent with the NEO. This equipment would also be connected to a transmission system that would not be required to perform to the same standard under the same conditions. Further, there does not appear to be a precedent in international standards for the proposed requirements, suggesting much work would be required across the power system to manage the proposed new standard. ***The scope for negotiation has been overly restricted*** This change narrows the distinction between the minimum and automatic access standards to one of timing only, and therefore removes most of the ability to negotiate on clause S5.2.5.4. In regards to the negotiated access standard of clause S5.2.5.4 AEMO also proposes removing caveats that allow generator tripping when voltages are within these ranges, should another clause in the generator performance standards expect the generator to trip. The incident of generator tripping when RMS voltages are within this range can be in response to peak voltage transients that far exceed the transient withstand capability of the plant and its auxiliary systems. All generators should have the right to ensure they can trip to protect plant and transient peak voltages can be a source of this damage. Caveats are required under clause S5.2.5.8 to prevent this damage. Ignoring plant limitations could prolong network restart after some contingencies if plant is damaged due to unnecessarily onerous requirements. Transient ride-through capability should be negotiated based on generator capability, size, and the system security requirements of the network, not set arbitrarily high for every plant. ***The proposed reactive current injection requirements are inconsistent with high renewable energy penetrations*** Most central inverters have the ability to set custom reactive injection curves for voltage ride through. However the specific amount of injection requested under the proposed rule change may not be achievable in all cases, for example if the gains in injection curves have to be equivalent for over-voltage and under-voltage which is the case in some firmware settings – therefore a minimum amount of response needs to be defined rather than an exact amount to ensure generators can comply with both the over-voltage and under-voltage requirements. It's also unclear what modeling has been done to show how this requirement will impact the network as more renewable generators come online. CEC members have raised concern that in some overseas cases inverter OEM's have reported that setting reactive current injection too aggressively has resulted in instability in the local network, and its unclear how this fixed percentage requirement would impact the network in areas where there are large concentrations of renewable generators. Members have also noted that they have been requested to

	disable this capability by TNSP's in the past due to a concern it might interfere or compete with the control systems for their existing reactive plant. It would make more sense to require that the inverter firmware allows reactive current injection to be adjusted within a particular range, and that it is set for each project's GPS based on achieving a desired response in negotiation with the NSP. ***Maximum generator unit sizes are introduced in the proposed rules*** Further, the proposed limitation of a total reduction of 100 MW of generation from the entire power system during a disturbance is unworkable. Firstly, it prevents all new generators with unit sizes above 100 MW from negotiating. Secondly, it references a compliance regime which is entirely out of the connecting generator's control and creates a compliance liability on the new generator which depends on the performance of other generators in the power system.

Active power recovery

Proposed rule change	ITEM 19 – *Clause S5.2.5.5 Generating system response to disturbances following contingency events* – **minimum access standard** – AEMO proposes a new requirement under the minimum access standard which covers the speed of active power recovery following the clearance of a fault event. AEMO's proposal involves requiring a generator to recover active power: • from 1,000ms after disconnection of the faulted element, to at least 95% of the level existing immediately prior to the fault. This requirement effectively mirrors the existing requirement under the automatic access standard except with an allowable recovery time of 1,000ms (rather than 100ms).
Proposed rule change	ITEM 20 – *Clause S5.2.5.5 Generating system response to disturbances following contingency events* – **general requirement** – transient active power consumption. As asynchronous generating systems generally require time to measure data, detect a disturbance and produce an appropriate response, AEMO proposes adding the following criteria regarding transient active power consumption upon application of a fault: • any active power consumption immediately upon the occurrence of a fault must not exceed 5% of the maximum

Response	***Limited energy*** The CEC notes that the revised rules would expect that generators that have ridden through distribution network faults distribution – which may have clearance times up to 10s (for remote end) – and then recover up to 95% of its pre-disturbance operating level within 1 second. This is not possible where energy sources are limited. Finding an appropriate balance for this situation will require a trade-off against performance for one or the other and the standard should allow for negotiation over which is more important for the power system. ***Forced minimum performance could lead to unstable network conditions*** The proposed changes are note consistent with the needs of the network as there will be connection point locations where a slower recovery time is preferred. Mandating a fast recovery time could actually create network instability challenges (such as overvoltage or transient voltage collapse). Further, the inherent torsional oscillations in some two-mass model generators cause variations in recovery that make the one second time very challenging to comply with. These issues are exacerbated where there are number of generators connected closely together. A slower recovery time is expected under the NEO in this circumstance. However, the solution would only be revealed if the negotiations are set within a reasonable range. The proposed changes do not strike this balance, but an extended recovery time of up to 1.5 seconds would be acceptable for a minimum access standard.

Response to disturbances

Proposed rule change	ITEM 21 & 22 – *Clause S5.2.5.7 Partial load rejection* – **automatic and minimum access standard** – AEMO proposes to remove the clause which limits s5.2.5.7 to synchronous generating units. This removal would extend application of the automatic and minimum access standards to all generators both synchronous and asynchronous. AEMO also proposes a minor amendment to clarify the terminology used in S5.2.5.7 such that the term generating unit is replaced by generating system.
Response	Further analysis and demonstration from AEMO is required before this proposal can be accepted. For example AEMO should provide modelling that shows this requirement would not extend the revised continuous uninterrupted operation changes to beyond 90-110%

	voltage range for some projects.

ROCOF withstand capability

Proposed rule change	ITEM 23 & 24 – AEMO propose amending *S5.2.5.3 Generating system response to frequency disturbances* to add additional requirements under both the **automatic access and minimum access standards** to require CUO except where the rate of change of frequency (RoCoF): – **automatic access standard** -4 Hz to 4 Hz per second for more than 0.25 seconds**,** -3Hz to 3Hz per second for more than one second – **minimum access standard** -2 Hz to 2 Hz per second for more than 0.25 seconds, -1Hz to 1Hz per second for more than one second – AEMO propose that the **minimum access standard** be available to **synchronous generators only**. Asynchronous generators will be required to meet the automatic access standard.
Response	The CEC is unclear of the benefit of splitting this requirement between synchronous and asynchronous generators. Should the NEM end up with a mix of asynchronous generators performing at the automatic access standard and a fleet of synchronous generators rated close to the minimum access standard there are no guarantees that the system would withstand an event more severe than that applied to synchronous generators. If AEMO is expecting ROCOF events more severe than the minimum access standard and obliging generators to ride through them then this should be applied to all generators to have meaningful benefit.

System Strength

Proposed rule change	ITEM 25 – *Proposed new clause S5.2.5.15 System strength* **minimum access standard** AEMO proposes the addition of a new access standard covering system strength that would represent a minimum requirement for all connecting generators. AEMO proposes: • the minimum access standard is a generating system and each of its generating units must be capable of continuous uninterrupted operation for any short circuit ratio to a minimum of 3.0 at the connection point.
Response	The definition of Short Circuit Ratio in this context is as proposed by the Draft Determination of the AEMC's Managing Power System Fault Levels rule change (p.14): "*the ratio of the three phase fault level (in MVA) at the connection points for the generating system to*

	the active power output of the generating system (in MW)"[2]. CEC notes that some Original Equipment Manufacturers (OEMs) may not be able to meet this requirement so it may lead to a narrowing of the market (note: at the 28 September workshop AEMO suggested this could impact around 15-20 % of the market). Challenges will arise in compliance with this performance standard. The only material evidence will be the generating plant OEM's equipment specifications for the short circuit ratio that applies to the each generating unit, and that of other ancillary plant. As a result this proposed change must also clearly articulate the compliance approach expected and testing methodology applied for each generator which needs to be formed in the draft rule. The CEC notes that the NER should also align to the revised ESCOSA licence conditions, including the inclusion of the X/R ratio as this would make the NER requirements more meaningful and easier to assess.

Frequency response mode capability

Proposed rule change	ITEM 26 - *Clause S5.2.5.11 Frequency control* – **automatic access standard** – AEMO proposes simplifying the language specifying the automatic access standard requirements for providing a proportional active power response to frequency change. The requirements under AEMO's proposed amendment provide a more generic description of the required response capability from the connecting generator than is currently the case. AEMO proposes that a generating system must be capable of automatically providing a proportional: • decrease in power transfer to the power system in response to a rise in power system frequency at the connection point, and • increase in power transfer to the power system in response to a fall in power system frequency at the connection point. This response must be sufficiently rapid and sustained for a sufficient period for the generator to be in a position to offer measurable amount of market ancillary services to the spot market **for each of** the market ancillary services.

[2] http://www.aemc.gov.au/getattachment/7cc0370d-7447-4618-a181-f5216cef89b7/Draft-determination.aspx

Proposed rule change	ITEM 27 – *Clause S5.2.5.11 Frequency control* – **minimum access standard** – AEMO proposes imposing a new minimum access standard requirement on generators with a nameplate rating of 30MW in respect of frequency control capabilities. AEMO recommends that a generating system with a nameplate rating of 30MW or above must be capable of automatically providing a proportional: • decrease in power transfer to the power system in response to a rise in power system frequency at the connection point, and • increase in power transfer to the power system in response to a fall in power system frequency at the connection point. This response must be sufficiently rapid and sustained for a sufficient period for the generator to be in a position to offer measurable amount of market ancillary services to the spot market for at least one of the market ancillary services.
	ITEM 28 - *Clause S5.2.5.11 Frequency control* – **negotiated access standard** – AEMO proposes amending the negotiated access standard requirements to remove the need for a connecting generator to "demonstrate" to AEMO and the NSP that the proposed increase in active power transfer capability (in response to a fall in power system frequency) is as close as practicable to the automatic access standard. Generators would need to "satisfy" AEMO and the NSP that their capability to decrease power transfer (in response to an increase in power system frequency) is as close as practicable to the automatic access standard.
	ITEM 29 - *Clause S5.2.5.11 Frequency control* – AEMO proposes to add a definition of 'droop' in S5.2.5.11 as follows: • Droop – means in relation to frequency response mode, the percentage change in power system frequency at the connection point required to produce a change in power transfer equal to the maximum operating level of the generating system.
	ITEM 30 - *Clause S5.2.5.11 Frequency control* – **general requirements** – AEMO proposes including a set of new general requirements regarding the active power response to frequency disturbance: • the change in power transfer to the power system must occur with no delay beyond that required for stable operation, or inherent in the plant controls, once power system frequency at the connection point leaves the dead-band around 50 Hz • the dead band must be set within the range 0 to ±1.0 Hz. Different dead-band settings may be applied for a rise or fall in power system frequency at the connection point • the frequency droop must be set within the range of 2% to 10%, and • a generating system is not required to operate below its minimum operating level in response to a rise in power system frequency at

	the connection point, or above its maximum operating level in response to a fall in power system frequency at the connection point.
Response	***Requirements to participate could amount to significant unnecessary investments in storage*** The proposed requirements require under-frequency response via an increase in active power. Since most renewable generators are always supplying the most power possible with the available energy options available to increase active power include • constant derating of the power plant • battery storage Given that that plant may already be derating by ~20% to comply with the proposed reactive capability and continuous uninterrupted operation requirements the most logical conclusion is that the combination of the revised performance standards leads to some level of storage being required. However, the wording in the proposed changes to this clause is ambiguous. It requires that the generator must provide a "meaningful" amount of ancillary service market participation, capped only at the maximum operating level of the generator. The actual level of investment in storage is subsequently impossible to determine and would be subjective. AEMO needs to demonstrate that the proposed rule change to require participation in an ancillary service is consistent with a reasonable commercial operating environment that permits efficient investment in the NEM. ***Requirements to participate do not clearly provide benefits*** Requirements to enforce a capability to provide an ancillary service to the market appear to be at odds to the objective of the ancillary service markets. While it may be possible to build in the capability to participate in FCAS market, this provides no guarantee of increased participants in the FCAS market. Generators have other commercial and technical drivers – such as contracting full energy volumes as part of their power purchase agreements or the availability of wind or solar resources – that would prevent them from actively participating in the ancillary services markets. Given that an investor would always be attracted to the certainty that a full-volume offtake arrangement presents them with, there would be little incentive to allow some 'headroom' for an uncertain revenue stream from an ancillary services opportunity. Obliging a new plant to have this ancillary services capability would do nothing, and appears to go against the AEMC's view that market-based solutions are consistent with the NEO. Applying requirements to participate in one ancillary service will only drive significant capability in the service with the lowest barriers to entry. AEMO and the AEMC should focus their efforts on the ancillary services markets to resolve this, not the generator performance

	standards. The CEC notes the work being undertaken by AEMO for the Ancillary Services Technical Advisory Group which demonstrates that the NEM's synchronous generators are failing to control frequency inside the normal operating band. Further, the AEMC's Frequency Control Frameworks Review is in its early stages and will be examining this issue. It may be premature to oblige this capability through this rule change and these further pieces of work will likely reveal the most efficient and effective means to control frequency in the NEM.

Capability for active power control via automatic generator control and to limit active power and ramp rate

Proposed rule change	ITEMS 31 – *Clause S5.2.5.14 Active power control* – **automatic and minimum access standards** – AEMO proposes amending S5.2.5.14 to remove the 30MW threshold and require generators connecting under both the automatic and minimum access standards to have the capability to: • **Scheduled generators** - receive and automatically respond to signals delivered from the AGC, as updated at a rate of one every four seconds • **Semi-scheduled generators** - subject to energy source availability, receive and automatically respond to signals delivered from the AGC, as updated at a rate of one every four seconds.
Proposed rule change	ITEMS 32 – *Clause S5.2.5.14 Active power control* – **minimum access standard** – AEMO proposes amending the minimum access standard to add a new requirement that brings semi-scheduled generators into line with scheduled generators in being capable of limiting the rate of change of active power. AEMO proposes: • for a **semi-scheduled** generating unit or system, subject to energy source availability, is capable of not changing its active power output within five minutes by more than the raise and lower amounts specified in an instruction electronically issues by a control centre.
Response	The CEC is supportive of the move towards AGC as this capability is technically possible and is consistent with the needs of the power system. However, we consider that the following points are relevant when considering the implementation of these changes: • While it is technically possible to include AGC and ramp rate control there is a tendency within AEMO to preference using the Market

	Management System (MMS) to provide dispatch instructions to semi-scheduled generators, rather than the SCADA system. The MMS is inadequate to meet these requirements so AEMO will have to change its preference. • The requirement for ramp rate control needs to be clarified. While the CEC understand this would be made subject to resource availability so would not automatically be a requirement to deploy energy storage, commercial drivers for plant design need to have clarity on the operational limitations of the plant. This is particularly true for the selection of equipment that may be tailored for a five minute settlement regime the market expects to be implemented. The rules need to clearly set out the ramp-rate limitations that might be applied. • A further consideration relates to the treatment of generators rated below 30 MW. The CEC expects that AEMO intends for application of these requirements applies depending on the registration class, not capacity. Thus non-scheduled generators are exempted. The CEC requests this is clarified by the AEMC.

Remote monitoring and control

Proposed rule change	ITEM 33 – *Clause S5.2.6.1 Monitoring and control requirements* – **automatic access standard** – AEMO proposes to include the following **remote monitoring** capabilities for generating systems which it can request under the automatic access standard irrespective of capacity of the generating system: • status of all switching devices that carry the generation, tap positions and voltages, active and reactive power, voltage control set-point and mode - *Formerly remote monitoring capabilities in respect of these parameters were only required in respect of generators with capacity of >30MW* AEMO proposes adding the following additional remote monitoring requirements that it may request under the automatic access standard: • in respect of scheduled or semi-scheduled generators, active power limits and ramp rates • the available energy in an energy storage system (MWh) • runback scheme parameters, and • mode of operation of the generating unit including turbine control limits, and other information required to predict the active power response of the generating system to changes in power system frequency
	ITEM 34 – *Clause S5.2.6.1 Monitoring and control requirements* – **minimum access standard** - AEMO proposes to require under the minimum access standard the same **remote monitoring** capabilities for generating systems as are required under the automatic access

	standard, however with the 30MW capacity threshold retained in some areas. AEMO proposes that the remote monitoring requirements AEMO may request include: In respect of generators with a capacity of 30MW or more: • status of switching devices, tap positions and voltages, active and reactive power, voltage control set-point and mode and, in respect of reactive power equipment that is part of the generating system but not part of a particular generating unit, reactive power – **for generators that are connected to the transmission system** • current, voltage, active power and reactive power in respect of generating unit stators or power conversion systems (as applicable) • active and reactive power in respect of an auxiliary supply system with a capacity of >30MW associated with a generator In respect of all generators irrespective of capacity: • in respect of scheduled or semi-scheduled generators, active power limits and ramp rates, and AGC • the available energy in an energy storage system (MWh) • runback scheme parameters • mode of operation of the generating unit including turbine control limits, and other information required to predict the active power response of the generating system to changes in power system frequency • any other quantity that AEMO reasonably requires to discharge its market and power system security functions set out in Chapters 3 and 4.
	ITEM 35 – *Clause S5.2.6.1 Monitoring and control requirements* – **automatic and minimum access standards** – In respect of the **remote control** quantities, AEMO proposes the following new requirements for both the automatic and minimum access standards: • voltage control set point and, where applicable, mode • AGC control in respect of scheduled or semi-scheduled generating systems • active power limit and active power ramp limit in respect of non-scheduled generating systems
Response	While the CEC expects that the proposed remote monitoring requirements are reasonably achievable we are concerned about the validity of some of the information. For example, the energy available in a battery tells AEMO nothing informative as there may be a range of applications for this energy and capacity. Its discharge or charging cycles would dictate its impact on AEMO's market operations, but may be driven by non-market factors like network support or ancillary services.

	The changes proposed to the remote control capability create some concerns around liability implications and how insurances are to capture scenarios where AEMO is controlling plant. AEMO and NSPs currently have control of generator transformer tap changers that control the medium voltage busbar voltages which then flow on into the generator reticulation systems. CEC members have raised serious concerns about AEMO's setting of taps creating excessively high voltages within wind farm reticulation systems. Thus there is a need to balance this capability with the potential for commercial risks. The CEC suggests any increase in control by AEMO should be balanced with an appropriate commercial arrangement that manages this risk. Another consideration with AEMOs request to allow changes to the voltage control mode is how the interface may be managed with the NSPs, who have traditionally dictated the control mode. The interfaces and NSP acceptance of any AEMO-led control mode need to be clearly understood and negotiated with the NSP, with the appropriate arrangements and protocols established in NSP connection agreements. A further consideration relates to the treatment of generators rated below 30 MW. The CEC expects that AEMO intends for application of these requirements applies depending on the registration class, not capacity. Thus non-scheduled generators are exempted from some of the above changes. The CEC requests this is clarified by the AEMC as applying onerous monitoring and control requirements to smaller generators (say in the 5-10 MW range) would likely lead to high and unnecessary costs.

Response to disturbances

Proposed rule change	ITEM 36 – *Clause 5.3.9 Procedure to be followed by a generator proposing to alter a generating system* – AEMO proposes the following as additional standards where re-assessment will be necessary if a generating system is altered: • Alteration of a voltage control system – *S5.2.5.7 Partial load rejection* • Alteration of a protection system – *S5.2.5.10 Protection to trip plant for unstable operation* Please note that AEMO is not proposing any changes to access standards under *s5.2.5.10 Protection to trip plant for unstable operation*.
Response	The current structure of clause cl 5.3.9 discourages incremental improvements to plant, even when they may benefit the secure operation of the power system. Where a generator proposes a minor improvement, they open their plant to complete reconsideration and renegotiation

	of entire generator performance standards. This approach discourages plant from making sensible and beneficial improvements as it can create the opportunity for subjective and unrelated changes to be forced onto the generator. It is not clear why this treatment is in place for connection agreements, and the clause should be amended to focus only on equipment being upgraded. The CEC refers the AEMC to consider the treatment of extending the operating life of thermal plant, for which connection agreements are not re-opened.

Revised definition of continuous uninterrupted operation

Proposed rule change	ITEM 37 – Proposed changes to the definition of **Continuous Uninterrupted Operation** Continuous uninterrupted operation (CUO) is a foundation term in respect of access standards for disturbance ride through. Relevant access standards require generators to maintain CUO except under specified conditions. AEMO's rule change request recommends a 'review' of the definition of CUO and their drafting proposes the following changes: In respect of a *generating system* or operating *generating unit* operating immediately prior to a *power system* disturbance: (a) not *disconnecting* from the *power system* except under its *performance standards* established under clauses S5.2.5.8 and S5.2.5.9 ~~and~~; (b) during the disturbance contributing reactive current as required by its *performance standards* established under clause S5.2.5.5; and (c) after clearance of any electrical fault that caused the disturbance, not ~~only substantially~~ varying ~~its~~ *active power* or ~~and~~ *reactive power* unless required by its *performance standards* established under clauses ~~S5.2.5.5,~~ S5.2.5.11, S5.2.5.13 and S5.2.5.14, with all essential auxiliary and *reactive plant* remaining in service, and responding so as not to exacerbate or prolong the disturbance or cause a subsequent disturbance for other *connected plant*.

Response	AEMO has clarified this drafting to remove the obligation to not vary real and reactive power during a disturbance. The references are now to specific clauses including a new reference to clause S5.2.5.5, which refers to performance during a disturbance. AEMO's revised text remains ambiguous as it appears to have confused the sequencing: prior, during and after clearance not sequenced logically. Further, the CEC notes that the rule change request makes no reference to the need for this definition to be changed to this extent. Other than the inclusion of clause S5.2.5.5 no other basis is provided for substantial change to this definition, nor are there other proposed changes to the rules which lead to a consequential need for changes to this definition. Considering that this clause is simply referring to the generator remaining in service and performing as expected by the agreed performance standards the CEC expects that only minor amendment is needed to incorporate clause S5.2.5.5. Further, as the clauses which permit changes in generator operating point are clearly set out the definition of 'substantially' is implicitly agreed in the referenced clauses. Its removal is therefore unwarranted. The CEC argues that each of the referenced clauses set out *expected* performance not 'required' performance. Recovery times for example are not requirements but agreed performance levels that can be exceeded. As a result the use of 'required' in this definition should be replaced with a reference to the agreed performance under the referenced performance standards. Applying this approach retains consistency and avoids confusion. AEMO's draft rule also seeks to remove the flexibility needed to negotiate reasonable technical outcomes. Specifying that there must be no change to real and reactive power in the definition of continuous uninterrupted operation limits the scope for negotiation under the negotiated access standards. For example, a tap changing transformer could be used to adjust connection point voltage relative to generation point where voltage is depressed for a period of time the step in voltage would result in a real and reactive power change, but would maintain constant voltage. The present definition of continuous uninterrupted operation would permit this solution to be negotiated under the performance standards, while AEMO's revision explicitly prevents this. A reduction of flexibility and options to make efficient investment decisions will result from AEMO's proposed restrictions. Further evidence that AEMO does not require these proposed new restrictions to be included can be seen in AEMOs re-interpretation of clause S5.2.5.4 which effectively achieves the desired outcome without changing the definition of continuous uninterrupted operation. The CEC suggests the following definition is a clearer representation of AEMO's requested changes and is commensurate with AEMO's

	intent to include S5.2.5.5. The below should be applied in the AEMC's draft rule: In respect of a *generating system* or operating *generating unit* operating immediately prior to a *power system* disturbance, not *disconnecting* from the *power system* except under its *performance standards* established under clauses S5.2.5.8 and S5.2.5.9 and, during and/or after clearance of any electrical fault that caused the disturbance, only substantially varying its *active power* and/or *reactive power* under~~required by~~ its *performance standards* established under clauses S5.2.5.5, S5.2.5.11, S5.2.5.13 and S5.2.5.14, with all essential auxiliary and *reactive plant* remaining in service, and responding so as to not exacerbate or prolong the disturbance or cause a subsequent disturbance for other *connected plant*. Keeping the definition as close as the original intent as possible will avoid any unintended consequences. The revision proposed above is consistent with the intent of the definition of continuous uninterrupted operation which was stated in the AEMC's Final Determination of the Rule Change on Technical Standards for Wind and Other Generator Connections (2013): "The Commission also notes that the definition of continuous uninterrupted operation … means that a generating system or unit is in-service prior to a disturbance, and continues to operate (within its performance standards) during that disturbance and after the disturbance has subsided." (p. 41)

Glossary

Proposed rule change	AEMO is proposing changes and additions to the definitions of - Maximum operating level (new) - Rise time (new) - Settling time (new)
Response	CEC has no comment on these proposed changes