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November 10, 2017

John Pearce
Chairman, AEMC
Level 6, 201 Elizabeth St
Sydney 2000
Australia

Rule Change: Generator Technical Performance Standards [ERC0222]

Dear Mr Pearce,

General Electric (GE) is pleased to provide our response to the Consultation paper – National Electricity Amendment (Generator Technical Performance Standards) Rule 2017, **[ERC0222]**.

GE is one of the world's leading providers of energy solutions, with over one third of all power across the planet being generated by GE technologies. The electricity industry globally is undergoing significant transformation. Complex interrelationships across the entire energy ecosystem pose challenges to power providers and consumers. GE is uniquely positioned to assist the Australian market as we offer solutions across all forms of generation as well as technologies to the TNSP's and DNSP's.

The current technical performance standards in the National Electricity Rules (NER) for generators have been in force since the last major update in 2007. GE welcomes the review of the technical performance standards given the increased penetration level of newer generation technologies in the power system.

GE is generally supportive of the proposed Technical Performance Standards rule change, however, there are certain aspects of the proposed rule change that we believe require further consideration to avoid the unintentional creation of barriers to entry, as well as avoiding increased generation costs for consumers.

Specific feedback on the proposed rule change is attached. Below is a summary of key areas where GE recommends AEMC consider further refinements to the proposed standards.

Key technical issues

- Further detail is required with respect to a number of the rule changes to ensure least cost generation technologies, which offer significant system support are not inadvertently eliminated. The disturbance ride through, and multiple ride through capability, require further definition. For example, without a boundary limit on the actual low voltage ride through requirements, such as voltage profile vs time, it will not be possible to ascertain the actual requirements on a typical synchronous machine

shaftline, and to identify whether redesign of the synchronous machine shaftline is required.

- The suggested HVRT capability exceeds the current International Electrotechnical Commission (IEC) generator design requirements. This will result in manufactures having to create purpose built solutions for the Australian market, which will increase generation cost.

- With the proposed technical performance standards, the ability to test and validate compliance will become difficult, and add additional costs. The rule change does not currently provide any insight to demonstrating compliance with these requirements. Testing and compliance requirements therefore require further clarification to ensure they are fit for purpose.

Policy issues

- Beyond the rule changes being proposed, there are potentially more cost effective and beneficial solutions for the power system, by exploring changes at a transmission level and generation level to achieve the required outcome at a generator connection point.

- AEMC's stated position of "the proposed access standard should be technology neutral and refrain from being a barrier for entry" may not be achieved given the disproportionate impact of the proposed technical performance standards on a range of generation technologies.

- GE supports the AEMC's view that retroactive transitional arrangements cannot be legally implemented and transitional arrangements can only be enacted from the date they are approved.

- It would be prudent to seek the removal of the ESCOSA licensing conditions for connecting generators in South Australia and avoid the duplication, and potential perpetuation, of such licensing conditions in other States. Given the objective of this rule change is to cater for a power system with higher levels of non-synchronous generation technologies in the grid, duplication of licensing requirements, that seek similar outcomes, adds unnecessary compliance costs.

- Further scope is required for negotiating the technical performance standards depending on where the generator is connecting in the network. Mandating provision for an automatic access standard, does not lead to an efficient investment outcome, especially if such performance requirements are not required at those locations in the network.

Should you have any queries in relation to this response then please do not hesitate to contact Ragu Balanathan (Technical Director) on 0439630289 or ragu.balanathan@ge.com.

GE looks forward to working with the AEMC and AEMO to ensure that we build resilience in the grid and ensure efficient energy security and reliability into the future.

Sincerely,

Max York
Chief Executive Officer
GE Australia

Please refer below for our response with regards to each of the nominated Items from your Appendix B.

Voltage control and reactive power requirements

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 voltage set point range set out in s5.2.5.13 (measured at the connection point).
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).
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.
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.
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.
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 to Item 1	This clause deals with reactive power capability and as such the minimum access standard should specify a requirement for reactive power capability. For example the amount of reactive power required at the connection point to enable the generating system to achieve the continuously controllable voltage set point range is dependent on the fault level at the connection point, therefore unreasonable levels of reactive power may be required if the fault level was high, and this drives significant cost for the generator especially for smaller size projects. If there are multiple generators in close electrical proximity to each other, the proposed standard only exacerbates the cost, whereas defining a reactive power capability for the minimum access standard would be a more effective standard.
Response to Item 2	No comments on proposed change, however the Provision of Information clause in the NER, s5.2.4(b) is only applicable for generating systems with a combined nameplate rating of 30MW or more, hence removing the 30MW threshold in s5.2.5.13 may not provide the required modelling information for AEMO and NSP to assess compliance with the minimum access standard proposed for s5.2.5.13.
Response to Item 3	No comments
Response to Item 4	Reducing the settling time from 7.5s to 5.0s is fine so long as AEMO is able to coordinate and ensure all other voltage controllers in close electrical proximity are appropriately tuned and damped to ensure the reduced settling time could be achieved by the connecting generator. This may be an issue in weak grid areas where the voltage is very sensitive to small changes in reactive power output, hence the flexibility should be available in case a longer settling time is required.
Response to Item 5	Clarification sought with "*Remote control equipment to change the set-point and mode of regulation must be provided*" – is this remote capability required for AEMO and the NSP? If so, what due diligence is required from the generator to accept the set point request and pass through to the controller.
Response to Item 6	No comments

Reactive current injection and reactive support during disturbances

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.
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.
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.
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.
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.
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 to Item 7	The ability to satisfy all the requirements under the automatic access standard is also dependent on the system strength at the connection point, hence there has to be scope for a negotiated access standard in all cases. In a weak grid situation, it will be a deliberate requirement to delay the active power recovery to maintain system stability, hence for example, any attempt to satisfy the following requirement "*from 100 milliseconds after disconnection of the faulted element, active power of at least 95% of the level existing just prior to the fault.*" may lead to instability. Furthermore in a weak grid situation, the voltages will be very sensitive for a small change in reactive power output, hence there will be limitations on the required amount of reactive current during and after the fault is removed.
Response to Item 8	No comment.
Response to Item 9	For reasons as mentioned above (Response to Item 7), there must be scope for negotiating the access standard depending on where the generator is connecting in the network. Mandating provision for an automatic access standard does not lead to an efficient investment outcome, especially if such performance requirements are not required at those locations in the network.
Response to Item 10	No comments.
Response to Item 11	The ratio of negative-sequence to positive-sequence current injection is dependent on technology type between synchronous, doubly fed induction generators, and also full converter machines, therefore with reference to the "…last method….", suggest AEMO and the NSP document a method specific to the technology type.
Response to Item 12	Are there any specific case studies that is driving this requirement of "any reactive power consumption….". An alternative proposal would be to refrain from any positive sequence current consumption upon fault application instead of reference to reactive power consumption. While the introduction of droop control is acceptable, the NER should as a minimum define the reactive current as a function of voltage. ***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 it 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 capacitive 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 positive sequence active current 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

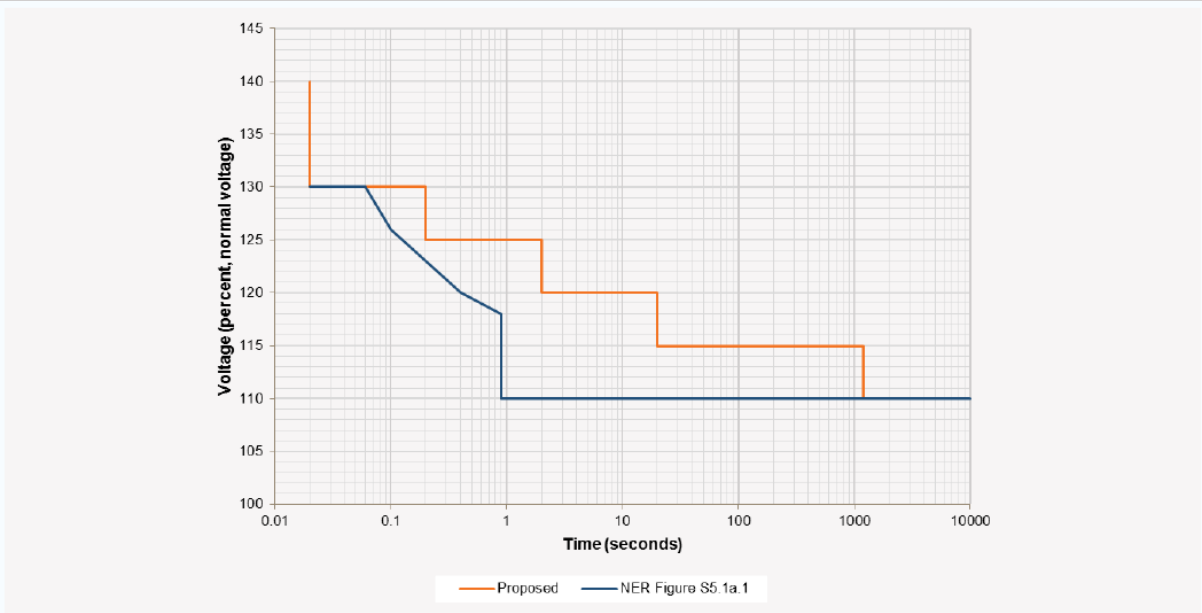
Item 13	AEMO propose amending *S5.2.5.4 Generating system response to voltage disturbances* – **minimum access standard** – by requiring generators to maintain continuous uninterrupted operation where a power system disturbance causes the voltage at the connection point to vary within the following ranges: – 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 to Item 13	No comments.

Multiple low voltage disturbances ride through

Item 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 to item 14 & 15	In general, we agree that generating units need to be resilient against repetitive disturbances however this proposed change appears to create a misalignment between reality and idealised power system operation. The events of 28 September 2016 in South Australia were extreme and pushed the power system to its limits. Therefore, creating standards based on this one isolated event may not be an efficient approach to the design of the NEM for the longer term. For such extreme events, there must be back up special protection schemes/systems in place to preserve the system from collapse, and such designs should take the capability of the power system components into account. Whilst some generators can meet the proposed 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. For example type 3 and type 4 wind turbines will be unlikely to meet this and would require significant redesign to withstand the thermal and mechanical stresses. It would be prudent for AEMO to develop a more realistic requirement considering the probability of different fault types allowing a more realistic design of generation technology without driving an LCOE increase. The fault types to ride through has a direct bearing on design of the generating systems. The proposed rule change and supporting documentation does not distinguish regarding the detailed faults and voltage dips in the different phases. The drafted access standard would need to be read in a way that a sequence of 15 three phase faults within 5 minutes at or close to a generating system's connection point with each fault cleared within say 120ms would need to be withstand. GE is not convinced this is a realistic scenario and the latest system disturbance analysis supports AEMO's conclusion. Without a boundary limit on the actual low voltage ride through requirements, ie. voltage profile vs time, it will not be possible to ascertain the actual requirements on say a typical synchronous machine shaftline, and to identify whether redesign of the synchronous machine shaftline is required.

	Further, it is not apparent that AEMO's proposal has considered the potential impacts on plant life expectancy or thermal withstand capability. The background to this requirement is not an appropriate benchmark, for example the German Connection Requirements are currently going through a review and they have incorporated a similar requirement, however, their proposal allows the generators to trip when thermal limits are exceeded, and/or when mechanical instability is endangered. More info at: https://www.vde-verlag.de/normen/1100438/e-vde-ar-n-4120-anwendungsregel-2017-05.html Based on the above concerns we would caution AEMC in progressing the outcome of this technical requirement 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 say 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 the drive train oscillations with type 3 and type 4 wind turbines; and - Narrow the technology providers for generators in the NEM. 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. GE is concerned that this requirement will be a barrier to entry for many generator technologies. AEMO should propose reasonable technical requirements. **Demonstrating Compliance with this requirement** AEMO have not indicated how grid code compliance would be measured or demonstrated with this requirement. This needs to be defined at the outset such that generator investments can be made efficiently.

High voltage disturbance ride through

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.
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.
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 to Item 16 & 17	The System Standards, Schedule 5.1a, has been in place for a while and the power system is designed and operating to these standards, therefore a change to the System Standards does not necessarily guarantee compliance is met at all locations, and dependent on dispatch scenarios. Whilst a transition is required to increase the HVRT capability of the power system, any rule change must include protections that prevent networks from requiring connecting generators to fund increased network capability to comply with this standard. The proposed rule change does not give any guidance on requirements to withstand relative voltage changes at the connection point which causes a relevant gap, and it is not clear how this requirement is linked with the NSP's obligation NER clause s5.1.5 which deals with voltage fluctuations. With regards to wind farms, the substation transformers connect the MV collector system with the HV or EHV NSP system are equipped with OLTCs. Such OLTC are controlled by AVRs to adjust the WF substation collector bus voltage in the longer term and keep it around nominal voltage. This would for example mean the following: If the steady state voltage at connection point is at 95% OLTCs will be adjusted to achieve nominal voltage at the MV bus. If now the voltage at connection point steps up by 20% to say 115% the MV collector system will be pushed up to around 120%. This example shows that the lower the connection point voltage is at steady state, the less HVRT margin the generating units within the generating system have to withstand HVRT events. IEC compliant generators are designed to withstand 130-140% voltage requirements for 0.02 secs, 131% for 0.6 seconds & 121% for 6 seconds at the generator terminals. Generator protection settings can be set to avoid tripping of the unit but the generator life and safety need to be taken into account. This change could reduce generator and power train life, resulting in higher generation costs to the consumer. ***The case for a changed voltage standard across the NEM has not been clearly stated or investigated***

	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. It is understood similar voltages were only experienced in a remote part of the South Australian power system during a 1 in 100-year storm that led 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 capability and equipment that would not be consistent with the NEM. Further this equipment would be connected to a transmission system that would not be required to perform to the same standard under the same conditions.
Response to Item 19	Please refer to response for Item 7.

Active power recovery

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).
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 to Item 19	Considering the potential weak grid nature at certain locations in the network, an allowance for the recovery time of 1,000ms may not be sufficient. The basis of this proposed recovery time is not clear, ie. have studies concluded this requirement, why not say 1.5s?
Response to Item 20	Transient active power consumption upon fault application can be driven by controls but it is also an intrinsic characteristic of generation system technology. Unfortunately, the proposal does not provide insight to why and how such short-term transients are endangering

	power system stability and security. Alternatively, such requirements should perhaps focus on positive sequence quantities, and is only addressing active current (not mixing power and current).

Response to disturbances

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	No comments.

ROCOF withstand capability

Item 23 and 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 rate of change of frequency requirements proposed as an automatic standard at -4 Hz to 4 Hz per second may have a cost impact associated with the design requirements of state of the art, high efficiency single shaft heavy duty gas turbines that are to be considered as a technology selection. Such a stringent rate of change of frequency requirement could potentially require a single shaft unit to operate very close to its shaftline design characteristics, which may lead reduced life or increased cost. We believe that a better approach to solving the RoCoF concerns is to implement technologies at the transmission and generator level which suppress extreme rates of change of frequency, for example, leveraging fast frequency response technologies such as batteries or synchronous condensers.

System Strength

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	If the proposed metric of Short Circuit Ratio (SCR) is satisfied by a generator consisting of many non-synchronous generating units, it does not necessarily guarantee stable operation. It is necessary to consider the grid strength as seen by all electrically close converters (ie. multiple generators) and such an indicator is referred to as the Composite Short Circuit Ratio (CSCR), more details at this link explaining the CSCR: http://b4.cigre.org/content/download/33958/1481446/version/1/file/Presentation.

Frequency response mode capability

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.
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 to Items 26 →30	The frequency operating standard defines the frequency bands for power system operation. The proposed change requires the performance standard to record the dead-band settings for the generator, does that mean the power system will end up with different dead-bands as applied to various generators. It would have been appropriate to revise the frequency operating standard as set by the Reliability Panel vs specifying a site specific dead-band for individual generators. The NEM has a market for ancillary services - 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. If there is a shortfall in ancillary services capability then the focus should be on the ancillary services markets to resolve this, and not by imposing such capability in the performance standards.

	It is understood AEMO is looking for generators to have this capability but it is at the discretion of the participant to decide if they wish to participate in the ancillary services market. If so compliance with this technical standard should only be required if the generator intends to participate in the FCAS market, the proposal is not clear in this regard.

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

Item 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.
Item 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 to Item 31 & 32	It is worth noting the drafting as proposed by AEMO has consideration for non-scheduled generating unit/system. The requirements pertinent to non-scheduled and semi-scheduled generating units is subject to energy source availability, hence it is understood energy storage devices are not required to comply with the required ramp rate control.

Remote monitoring and control

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 to Items 33-35	No comments.

Response to disturbances

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	No comments.

Revised definition of continuous uninterrupted operation

Item 37	AEMO proposes an amendment to the definition of continuous uninterrupted operation to require additional active power support during fault conditions and remove 'substantially' as a threshold term in respect of a generator's active and reactive power response in accordance with S5.2.5.11, S5.2.5.13 and S5.2.5.14. AEMO proposes adding S5.2.5.5 as an additional standard in respect of continuous uninterrupted operation.

	Proposed definition of continuous uninterrupted operation - 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 the disturbance and after clearance of any electrical fault that caused the disturbance, not varying active power or 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 to Item 37	No comments.

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	No comments.