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July 16, 2018

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

**Rule Change: Generator Technical Performance Standards [ERC0222]**

To: Mr. Pearce,

General Electric (GE) is pleased to provide our response to the Draft Rule Determination – National Electricity Amendment (Generator Technical Performance Standards) Rule 2018, **[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 back in 2007. GE welcomes the review of the technical performance standards as it is necessary, considering the increased penetration level of newer generation technologies in the power system.

GE is 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 draft rule is attached. Below is a summary of key areas where GE recommends AEMC consider further refinements to the proposed draft rule.

**Key issues**

- The current drafting of clause 5.3.3 provides high level information and lacks detail around acceptable levels for negotiated access standards and detailed input data for the connection studies. The connection applicant develops a set of access standards using the information provided under clause 5.3.3. The draft rule does not propose any change to clause 5.3.3 with regards to ensuring the appropriate technical information is

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provided for the connection applicant to develop the access standards for the connection.

- The draft rule calls for the connection applicant to propose a standard as close as practicable to the corresponding automatic access standard. Whilst this could be achieved by a connection applicant, some performance standards can lead to a costly connection for other connection applicants to follow since they should not have any adverse impact on existing generators' ability to meet their generator performance standards. However, if there were flexibility to adjust some of the performance standards of the existing generators then a least cost connection could be achieved through coordinating the controls between the existing and proposed connections. One such example is the active power recovery following a fault in weak areas of the network, where the active power recovery post fault should reach at least 95% of the pre-fault active power level within 100ms. If there was flexibility to adjust the 100ms time frame then a least cost connection option could be justified through coordinating controls. The same set of issues (rise time and settling time) are applicable for voltage and reactive power control, and reactive current injection. 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.

- The disturbance ride through and multiple voltage ride through capability require further definition. The time and cost to undertake modelling studies would be significant unless the NSP and AEMO define the scenarios and the combination of disturbances to be investigated. The combination and permutations are significant for a connection applicant to assess if guidance by the NSP and AEMO are not provided. Multiple disturbances will also lead to different network configurations.

- 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.

- GE supports the AEMC's view of a transitional arrangement, ie. when the final rule would apply from the date of the final determination. However, the proposed 8-week period is far too insufficient for a connection applicant to reach an agreed set of access standards for the proposed connection. The process of securing an agreed set of access standard goes through a comprehensive, iterative and lengthy connection process, therefore any impact for re-negotiating access standards would significantly affect the commercial negotiations for project financing and delay the project. The workload of all relevant stakeholders during this transitional period should also be considered. GE recommends the final rule to come into effect at least 20-weeks from the date of the final determination.

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- 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.

- 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.

Should you have any queries in relation to this response then please do not hesitate to contact the undersign via ragu.balanathan@ge.com or mobile 0439630289.

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,

*[Transmitted electronically via email]*

Ragu Balanathan
Technical Director

| | Draft rule | GE response |
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| 5.3.4A Negotiated access standards | When submitting a proposal for a negotiated access standard [...] and where there is a corresponding automatic access standard for the relevant technical requirement, a Connection Applicant must propose a standard that is as close as practicable to the corresponding automatic access standard [...] When proposing a negotiated access standard [...] the Connection Applicant must provide reasons and evidence to the Network Service Provider and AEMO as to why, in the reasonable opinion of the Connection Applicant, the proposed negotiated access standard is appropriate [...] When advising the Network Service Provider [...] to reject a proposed negotiated access standard, [...] AEMO must:<br>(1) provide detailed reasons for the rejection to the Network Service Provider, including:<br>(i) where the basis of AEMO's advice is lack of evidence from the Connection Applicant, details of the additional evidence [...] AEMO requires to continue assessing the proposed negotiated access standard; [...] | Some automatic access standards are already set at a level that is not achievable by synchronous machines (e.g. Automatic access standard for M-FRT or RoCoF or frequency control, etc.) and entering the negotiation process will be unavoidable for some technology. This can substantially increase the amount of work and cost at a tendering stage. More importantly the uncertainty around an acceptable negotiated access standard at the location of the proposed connection unless the NSP could provide valuable information under clause 5.3.3(b1) which is currently not the case.<br><br>With reference to the proposed clause 5.3.4A(b1)(3), the commercial aspects can be sensitive information, therefore only high level basic commercial information could be shared to justify the proposed negotiated access standard. Nonetheless the focus and onus should be on the NSP and AEMO to provide technical evidence as to why the proposed negotiated access standard does not satisfy 5.3.4A(b)(2) - (b)(4).<br><br>It is prudent the NSP takes ownership and provides the required input data for the connection applicant to develop the access standards since a change to these inputs could result in potential delays to the connection process. There is no reference made to how the connection applicant is to source the input data for the connection studies to develop the access standards. |
| S5.2.5.3 Generating System response to frequency disturbance | automatic access standard: unless the rate of change of frequency is outside the range of –4 Hz to 4 Hz per second for more than 0.25 seconds, -3 Hz to 3 Hz per second for more than one second, or such // minimum access standard: unless the rate of change of frequency is outside the range of -2 Hz to 2 Hz per second for more than 0.25 seconds, -1 Hz to 1 Hz per second for more than one second or such other range as determined by the Reliability Panel from time to time | The industry standards for synchronous machines currently cannot match this value. We have to undertake extensive studies to analyze what is a min value that can be handled according to particular grid configuration.<br>This is also site specific and product configuration issue that needs to be analyzed in detail. It can have mechanical impact that needs to be quantified, and the risk needs to be assessed.<br>It is not clear how to address the risk of reverse power for example 3Hz/1s = 1Hz => 100% deload.<br>A value of 1 Hz/s measured over 500ms can be considered based on many studies performed for the EIRGRID case. If higher values are needed, then these should be justified with a detailed study. |
| S5.2.5.4 Generating system response to voltage disturbances | Section (a) (1) to (3) | We recommend a cumulative time above 120% of 2 sec. |
| S5.2.5.4 Generating system response to voltage disturbances | section (a) (6) to (8) | We recommend Text "subject to no other limiters acting" to be added. |

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| S5.2.5.5 Generating system response to disturbances following contingency events | (1A) *in toto* | GE understands that the Automatic access standard is defined around the capability of non-synchronously connected devices such as PV and wind. It is however important to distinguish between PV and wind on one hand and the non-synchronous Hydro on the other hand. Variable speed Hydro pumped storage can be very beneficial to grid stability because of their capability to almost instantaneously inject power, similar to batteries but with higher order of magnitude capacities. They can be used as controlled loads (continuously, not in steps) in pump mode, in such a way that they can do primary frequency control while pumping. They retain a high level of efficiency over their lifetime, and lifetime does not degrade with deep discharging. Having said this, it is important to acknowledge that, mainly for the DFIM, a direct comparison with wind is not always possible. With the much smaller units used in wind turbines, operated at much lower voltage levels, it is common to use converters that allow for a much higher speed variation. Also, the relative sizing of the converter, compared to the generator, is much higher. This, in principle, makes wind technology more resilient to multiple disturbance. In hydro applications the required speed variation is given by the physics of the hydraulic machine. The converter is sized to fulfill this requirement and due care is taken to limit the size of the converter. Oversizing of the converter would lead to economical disadvantages compared to conventional hydro, that would prevent the realization of such systems. With this in mind we are of the opinion that a Variable speed DFIM system can be designed in such a way that it respects the minimum access standard. Note that a similar discussion took place years ago with ENTSO-E in Europe, which ultimately led ENTSO-E to assimilate variable speed hydro pumped storage to synchronous generation technology (please refer Commission Regulation (EU) 2016/631, Article 6.2) |
| S5.2.5.5 Generating system response to disturbances following contingency events | (iii) a two phase to ground, phase to phase or phase to ground fault in a transmission system cleared in:<br>(A) the longest time expected to be taken for a relevant breaker fail protection system to clear the fault; or<br>(B) if a protection system referred to in subparagraph (A) is not installed, the greater of the time specified in column 4 of Table S5.1a.2 (or if none is specified, 430 milliseconds) and the longest time expected to be taken for all relevant primary protection systems to clear the fault; and | 430 ms seems long. Electrical transient study may be performed first with outcomes:<br>* can generaotr stay synchronized;<br>* can all auxiliaries stay connected; and<br>* would the process be affected by speed profile of pumps, fans.<br>We therefore recommend to change this value to maximum 250 ms. |
| S5.2.5.5 Generating system response to disturbances following contingency events | (1A) a generating system and each of its generating units must remain in continuous uninterrupted operation for a series of up to 15 disturbances within any five minute period caused by any combination of the events described in subparagraph (b)(1) where: ...<br>(b) (1A) (v) the minimum clearance from the end of one disturbance and commencement of the next disturbance may be zero milliseconds; | Can the repetition of such event require a Mechanical Integrity study? Process could be to quantify electrical => mechanical constraints (torque profile) and assess the impact.<br>A zero second time difference would result in excessive shaft torsional stress on the shaftline of large synchronous machines probably leading to damage to the shaft-line. Diverse studies of auto-reclose has been dealt extensively with this topic. It is therefore unrealistic to request such a requirement. |
| S5.2.5.5 Generating system response to disturbances following contingency events | (1A) (ii) | Does the term "otherwise" mean where there are no Auto reclosures? Please clarify.<br>We assume the voltage drops below 50% for both [2 x 3-ph faults with AR] and [ 1 x 3-ph fault w/o AR].<br>We understand no single-phase AR is considered. |
| S5.2.5.5 Generating system response to disturbances | (1A) (v) | This would imply no recovery between faults? |

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| following contingency events | | |
| S5.2.5.5 Generating system response to disturbances following contingency events | (2) (iii) | 100 ms is too short. We ask to extend this value to at least 1 second, and add the following statement: Active Power oscillations shall be acceptable provided that:<br>* the total Active Energy delivered during the period of the oscillations is at least that which would have been delivered if the Active Power was constant;<br>* the oscillations are adequately damped.<br><br>This capacity is dependent on the technology limitations. We also ask to add the following "within the technical limitations of the unit or units" |
| S5.2.5.5 Generating system response to disturbances following contingency events | General | How can compliance be tested or demonstrated here? |
| S5.2.5.5 Generating system response to disturbances following contingency events | General, (b) (1A), (c) (1A) | We assume the positive sequence voltage is referred for RMS-type analysis. |
| S5.2.5.5 Generating system response to disturbances following contingency events | (b) (1A), (c) (1A)<br>provided that none of the events would result in:... | We assume 'provided that none of the events alone and none of their combinations would result in:... |
| S5.2.5.5 Generating system response to disturbances following contingency events | (b) (1A) (ix), (c) (1A) (ix)<br>exceeding 1 pu second... | For clarity, 1 pu refers to 100% of normal voltage. |
| S5.2.5.7: Partial load rejection | Section (c) | We need clarification: does this mean the units must decrease their power by 30% in 10 seconds? This is technology dependent and should be taken into consideration. |
| S5.2.5.7 Partial load rejection | Automatic access standard - The automatic access standard is a generating unit system must be capable of continuous uninterrupted operation during and following a power system load reduction of 30% from its pre-disturbance level or equivalent impact from separation of part of the power system in less than 10 seconds, provided that the loading level remains above minimum load generation. | Gas Turbine capability is refer to the islanding capability of the frame. GE Gas Turbines are able to handle both scenarios of Full load rejection and Load rejection to houseload if Plant Auxiliaries load does not exceed 10 % of the Gas Turbine nominal capability. During the event, there is a speed transient, and the frequency can spike up to 108 % speed before stabilizing close to 100 % speed. The time above 104 % speed may be up to 10 seconds and time to stabilization is typically 45 seconds. |
| S5.2.5.7 Partial load rejection | The minimum access standard is a generating unit system must be capable of continuous uninterrupted operation during and following a power system load reduction of 5% or equivalent impact from separation of part of the power system in less than 10 seconds provided that the loading level remains above minimum load generation. | Gas Turbine capability is compliant with the requirement stated in "minimum access standard". |
| S5.5.2.11 Frequency control | the deadband referred to in subparagraph (1) must be set within the range of 0 to ± 1.0 Hz. Different deadband settings may be applied for a rise or fall in the frequency of the power system as measured at the connection point; | GE recommends setting minimum deadband at 10 mHz to avoid unit reacting to grid noise. |

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| S5.5.2.11 Frequency control | Section (b) | Instead of (ii), have the text from (c) (ii) |
| S5.2.5.13 Voltage and reactive power control | Section (2A) | Point from where Remote control is desired is not clear. Within the plant, HMI has this mode selection & setpoint fields. For remote interface from outside the plant, need additional hardwiring/logic modifications. Please consider clarifying the text. |
| S5.2.5.13 Voltage and reactive power control | Section (2B) | Typical point of control in present implementation is Generator bus. Plant Level Voltage control can be implemented in DCS at additional cost, needs additional hardware for feedback from POI. |
| S5.2.5.13 Voltage and reactive power control | Section (4) (v) (A) and (B), as well as (vi) | It makes sense to have different Rise/Settling times for Static Exciter systems vs Brushless Exciter systems.<br><br>For Brushless exciters, GE suggests 7.5 sec instead of 5 sec, and 10 sec instead of 7.5 as settling time, and 3 seconds for rise time. |
| S5.2.5.14: Active power control | Section (2) | * Regarding ramping: going from one level to another (min and max), have different ramp rates. Load variation cannot be demonstrated with only one value.<br>* Add the following "Within limitation of technologies (associated to conditions and load ranges)" |