8 November 2017

John Pearce
Chairman
Australian Energy Market Commission
PO Box A2449
Sydney South NSW 1235

Submitted online: www.aemc.gov.au

REF: ERC0222

Dear Mr Pearce

GENERATOR TECHNICAL PERFORMANCE STANDARDS – INITIAL CONSULTATION

Origin Energy Limited (Origin) welcomes the opportunity to respond to the Australian Energy Market Commission's (AEMC) consultation paper on changes to the generator technical performance standards for the National Electricity Market (NEM).

Overall, this rule change proposal sets minimum connection standards at an unreasonably high level, which places an undue cost burden on connecting generators. This could have the unintended consequence of impeding generation investment. Ensuring the operation of the system in a secure manner is rightly a key priority for the market operator, however the performance standards outlined need to strike an appropriate balance between the expected benefits and the costs of implementing the changes.

Origin's views on the main recommendations are summarised below. Additional detail on the proposed changes including estimated system costs are provided in Appendix A.

Continuous uninterrupted operation during faults
Changes to the continuous uninterrupted operation settings will have the largest impact for connecting generators. This is because under the proposed minimum settings there is a marked increase in the level of faults that generators are required to withstand. Additionally, the requirements span multiple technical settings under the Rules including voltage, frequency, and active power provision.

The proposal to maintain operation during an increased number of faults comes at a cost to generators in terms of both system design and the risks in permanently damaging a unit that doesn't disconnect early enough to prevent a catastrophic failure. A catastrophic failure would further undermine system security by removing its output for an extended period of time. Thus, both of these costs, that a generator would incur to meet these increased performance standards, must be considered by the AEMC when evaluating if the minimum levels proposed by AEMO are acceptable or excessive.

AEMO proposes that generators must be able to withstand up to 15 faults/disturbances in a 5-minute period following a contingency event (S5.2.5.5). Origin considers that this level is unreasonably high and the costs of meeting this level would be significant enough to warrant re-examination of the investment. For example, a large scale solar farm would likely be required to increase the capability of their inverter specifications which could add ~$1 million for this component alone. Additionally, if a new generator utilises an existing connection point it would likely be required to upgrade or replace the existing transformer which could be in the order of $5 million.

Depending on the type of fault, it may also be impossible for a generator to remain connected over this period. For example, a generator would be unable to stay connected through 15, 3 phase faults. Origin suggests that the fault tolerances a generator is required to withstand needs to be better defined by

Origin Energy Limited ABN 30 000 051 696 • Level 45, Australia Square, 264-278 George Street, Sydney NSW 2000
GPO Box 5376, Sydney NSW 2001 • Telephone (02) 8345 5000 • Facsimile (02) 9252 9244 • www.originenergy.com.au

AEMO. In other words, all faults are not equal and have differing impacts on a generators ability to remain connected to the NEM and 'ride through' these faults. Origin does not know of any generator currently available that could remain connected to a grid if a circuit breaker recloses 15 times on its terminals within 5 minutes. The proposed settings place the onus on the generator to withstand all faults equally. AEMO can better define which faults have a greater impact on a generator and the number of faults that they are required to withstand. This could include an upper limit that defines the types or combinations of faults that a generator should be able to withstand as opposed to a blanket 15 faults in 5 minutes.

High and low voltage ride through settings

The high and low voltage settings proposed also set at an unreasonably high level which will result in high costs for generators to meet minimum standards. The level of continuous operation through both high and low voltage scenarios requires more reactive power from units, risks transformer damage, affects generator auxiliary systems and will impact existing generators at the same connection point. Additional reactive support would be required to influence the node at which the generator is connected. For example, this can consist of additional capacitors, reactors and static VAR compensators, the latter of which starts at $20 million regardless of the size of the unit.

Additionally, the AEMC should also consider the impact that changing the technical performance standards of newly connecting generators will have on existing generators. There is an unintended effect which will require existing generators, at the same connection point, to also meet the increased standards. This is especially true of the proposed voltage settings which will require extensive retrofitting of existing generators to ensure they meet the standard.

Origin believes that these are unintended costs of these proposed changes, especially if a generator is thinking of upgrading or adding units to existing sites. The cost impact on existing generators should be considered before extensive changes are adopted, alternatively separate arrangements may be warranted for generators upgrading or adding assets at an existing connection point with exemptions put in place to lower the cost impact. Origin notes that ESCOSA chose not to require existing assets to meet increased technical requirements due to the costs involved in retrofitting assets that were previously not designed for higher connection standards.

Mandatory droop control requirements

The consultation paper outlines that mandatory droop control should be required for all new generators connecting to the NEM. The AEMC Frequency Control Frameworks Review will be examining the fundamental role of frequency across the NEM. This has the potential to adjust how frequency services are provided including the level of ancillary services and the role of automatic governor control. Origin would suggest that a requirement for mandatory droop control for new generators through this rule change process is premature and would pre-empt the Frameworks Review.

Should mandatory droop control be required by new generators, Origin would prefer that units are only required to have the capability to provide droop control, not mandatory participation. Generators should be free to determine the percentage of droop control they provide to the market. This is similar to the requirement for ancillary services (S5.2.5.14) that requires generators to be enabled for the service, but are not required to participate in the FCAS market unless they make the decision to do so. Origin notes that mandatory droop control would limit the maximum output that a generator can provide the NEM, this presents a cost to a generator by limiting the potential revenue stream from the energy market.

Finally, the AEMC state in the consultation paper that under the NEL, section 104 prevents the AEMC from making a rule that commences operation before the day the rule is published[1]. Origin supports

[1] Generator Technical Standards Consultation Paper, AEMC, p.44

this course of action, as retroactively applying rules to connecting generators will undermine confidence in the regulatory regime, negatively impacting future investment.

Should you have any questions or wish to discuss this information further, please contact James Googan on james.googan@originenergy.com.au or (02) 9503 5061.

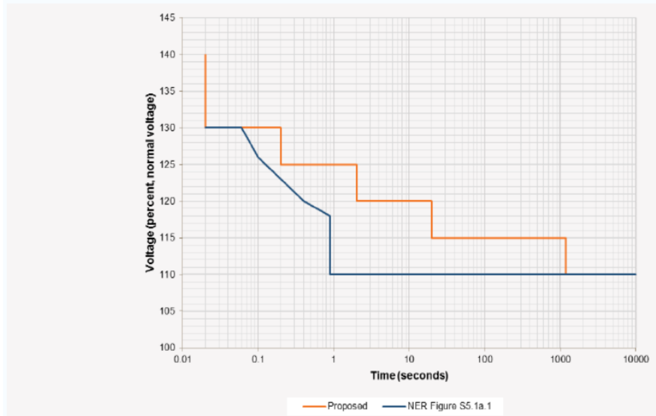
Yours sincerely,

Steve Reid
Group Manager, Regulatory Policy

APPENDIX A

General Category	Section	Title	AEMO Rule Page Reference	Affects	Existing Issues Summary	Changes Proposed by AEMO	Origin Position
Non Technical Matters	5.3.4A	Negotiated Access Standards	19-20	S5.2.5.3; S5.2.5.4; S5.2.5.5; S5.2.5.7	Not adversely affect power system security; Not adversely affect the quality of supply for other Network Users In respect of generating plant, meet the requirements applicable to a negotiated access standard in clauses S5.2.5, S5.2.6, S5.2.7 and S5.2.8.	Where possible, aim to meet the automatic access standards. Must provide AEMO sufficient evidence as to why it cannot meet the automatic access standards. The agreed performance standard must not fall below the minimum access standard and should be as close as practicable to the automatic access standard. **Min Std**: Any level of active power output **greater than 10% of its max operating level**... must be capable of supplying and absorbing continuously at its connection point an amount of reactive power of at least the amount required to enable the generating system to achieve the continuously controllable voltage setpoint range specified in the performance standard agreed under clause S5.2.5.13, and **within the limits in the automatic access standard.**	Origin has always considered aiming for the automatic access standards for new generators to be the best starting position as it reduces the negotiations that must take place between the proponent, an NSP and AEMO. This has a direct impact on project costs incurred. Origin considers that the number of applicants aiming for the minimum technical standards has been overstated by AEMO with only one cited at the recent Technical Forum. This is counter to the claim by AEMO that connecting generators are aiming for the minimum connection standards. Origin believes that the vast majority of our industry peers actively aim for automatic access standards as a start for negotiations. Origin is not opposed to the change presented for new generators to aim for automatic access standards which should not fall below minimum standards. For existing generators, the aim of negotiations should not be to bring these up to Automatic Standards, rather it must be a pragmatic discussion between all parties to come to a reasonable agreement on what the unit can perform to, within reasonable costs. The impact of this will be to hasten the retirement of plant who are looking to upgrade and continue service. It may be an impossible request or extremely cost prohibitive to meet increased standards, for example: - Additional reactive support (capacitors or reactors which can cost >>$2M per set) - Partial upgrades would not be possible for key components e.g. AVR – may be pushed into replacing governor and control system as well with total costs $>>6M

Origin Energy Limited ABN 30 000 051 696 • Level 45, Australia Square, 264-278 George Street, Sydney NSW 2000
GPO Box 5376, Sydney NSW 2001 • Telephone (02) 8345 5000 • Facsimile (02) 9252 9244 • www.originenergy.com.au

							"Reasonable" assessment will need to specify criteria to enable existing generators to continue operating. For example: doesn't impact other standards; doesn't change fundamental operation; doesn't impact system security beyond existing; costs (e.g. additional relays + training etc.); doesn't risk physical damage to unit; provides technological improvement (e.g. predictive PSS). A pragmatic approach would be to design and utilise a set of standards that considers a generators location.
System Standards	S5.1a.4	Power Frequency Voltage and Fig S5.1.a.1	33			Figure 5 Proposed *system standard* for power frequency over voltage 	Origin does not support the proposed frequency over voltage curve. Meeting this proposal would have unintended consequences of requiring existing generators to adjust their voltage ride through settings. Origin would need to review each of our generators to ensure that this curve could be met. Should the Generator Performance Standards (GPS) be modified it would represent a significant and unexpected cost which could hasten retirement of plant. Existing units require investigation – as well as capability of the connecting transformer. The older assets will need thinking as to impacts on auxiliary plant. The higher speed voltage is an issue for the transformers, but the slower speed voltages are the issue for the balance of the plant. This will remain an issue for older plant and cannot be updated without significant works. If the changes are small (depends on site arrangements), the additional costs would be per transformer ~$500k, but auxiliary impacts are extremely hard to quantify. If we had to replace transformers, this is $5M per transformer at Eraring plus the loss of production. AEMO need to maintain the consistency in language between normal and nominal voltage by nominating one or the other in their

							documentation. Switching between these two terms can result in increased requirements, sometimes from 10% to 18%. This makes it difficult to design a system that can meet these needs and increased costs.
Voltage Control	S5.2.5.1	Reactive Power Capability	23-24	S5.2.5.1, S5.2.5.5	Sufficient dynamic reactive power support close to each connection point prevents the propagation of voltage dips across the network and reduces the risk of consequential voltage instability or widespread generation disconnections. Auto Stds: capacity reactive current of up to 4% of the max continuous current of the gen system (in the absence of a disturbance) for each 1% reduction of connection point voltage. Min Std: Does not require a generating system to provide any form of reactive power support during a disturbance.	**Auto Std**: 4% max continuous current for each 1% reduction of connection point voltage below 90% of normal voltage. **Min Std**: must supply additional capacitive reactive current (reactive injection) of 2% for each 1% reduction below 90% of normal voltage. **All access stds** require: - reactive current injection may be limited to 100% of the rated current of an asynchronous generator, and 250% of a synchronous. Must be maintained within 90-110% of normal voltage until the connection point voltage returns. - a rise time of no greater than 30ms and a settling time no greater than 60ms. - Reactive power consumption upon application of a fault must not exceed 5% of max continuous rated current.	Not of significant concern, there could be some technical issues around achieving this but likely will not require an excessive outlay.
	S5.2.5.13	Voltage and Reactive Power Control	21-22	S5.2.5.13, S5.2.5.1	The minimum access standard requires no capability to supply or absorb reactive power at the connection point. (S5.2.5.1) S5.2.5.13 presently allows some generating systems to be connected with only power factor or reactive power control and no voltage control.	**Min Std:** requires a generating system must have facilities to regulate voltage regardless of connection point voltage or capacity of the generating system. Must be capable of supply and absorbing continuously at its connection point an amount of reactive power of at least the amount required to enable the generating system to achieve the continuously controllable voltage setpoint range. Remote control facilities to change the setpoint and mode of regulation must be provided. Must be able to be switched to voltage or excitation control at any time.	Origin does not support the requirement that generators must have voltage regulation capabilities regardless of the connection point voltage or the capacity of the generating system. This change gives no consideration of the location and strength of the connection point. The amount of reactive power required varies with connection point strength (fault current). By not taking these values into account it may become impossible for small units to connect to some nodes. It would be impossible to design a unit that meets these requirements without excessive costs. Additional reactive support would be required to influence the node – which can consist of capacitors/reactors/static VAR compensators among others.
Disturbance Ride Through	S5.2.5.3	Generating System Response to Frequency Disturbances	36	S5.2.5.3		Stabilisation and recovery time mean the longest times allowable for **power system frequency at the connection point** to remain outside the operational frequency tolerance band and the normal operating frequency band.	Origin is ok with the limits proposed here.

						Synchronous generators must be capable of continuous uninterrupted operation for frequencies in the ranges listed in Subparagraphs 1-6, unless the rate of change of frequency is outside the **range of -2Hz to 2Hz per second for more than 0.25 seconds, -1Hz to 1Hz per second for more than 1 second** or as determined by the Reliability Panel. **Auto Std:** -3Hz to 3Hz per second for more than 1 second. **Min Std**: -2Hz to 2Hz per second for more than 0.25 seconds, -1Hz to 1Hz per second for more than 1 second.	
	S5.2.5.4	Generating System Response to Low and High Voltage Disturbances	27-28, 30-33	S5.2.5.4, S5.1a.4 (graph), S5.2.5.5	**Low Voltage**: Requirement to withstand multiple LV events is not explicitly stated. Min std only required to maintain continuous operation down to 90% of normal voltage. **High Voltage**: voltage should not rise above 120% for more than 0.42seconds following a credible contingency event.	**LV Auto Std**: gens and reactive plant must maintain continuous uninterrupted operation for up to 15 voltage disturbances in any 5 minute period causing the connection point voltage to drop below 90% of normal voltage for a duration of 1,800ms. **LV Min Std**: 15 voltage disturbances in 5 mins, 90% of normal voltage for a total duration of 1,000ms. 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. **HV:** Required over-voltage withstand capability 110-115 (1,200 secs); 115-120 (20s); 120-125 (2s); 125-130 (0.2s); 130-140 (0.02s) As shown in the graph under S5.1.a4	Origin does not support the current definition of continuous uninterrupted operation in response to high and low voltage disturbances for new generators. The definition around 15 voltage disturbances is too general and does not take into account the magnitude that different disturbances have on a generator. For example 15 x 3 phase to ground voltage disturbances would cause a generator to trip regardless of the protection systems that were put in place. The capability of the machine and auxiliary plant will vary greatly depending on the length, size and time between each disturbance. The definition the 15 faults over 5 minutes needs to be better defined and could include cool down; depth of fault; recovery (under to overvoltage). A definition (for this purpose) of a “fault” or “voltage disturbance” could be of benefit. AEMO should reassess these settings with the view of lowering the amount of disturbances that generators must withstand. They should also define which combination of disturbances would form an upper limit that units should be capable of withstanding. There are no units anywhere in the world that could deal with a CB reclosing 15 times on its terminals inside 5 minutes – there is no viable technical solution.

							As noted above AEMO need to maintain the consistency in language between normal and nominal voltage by nominating one or the other in their documentation.
	S5.2.5.5	Generating System Response to Disturbances Following Contingency Events (Active Power Recovery)	34	S5.2.5.5	If a large proportion of generators have slow active power recovery this can cause: - transient instability leading to voltage instability - Increased power swings across interconnectors - restricting operation of asychronous gens in regions at risk of islanding A min active power recovery level and associated time period should be a mandatory component of all generators	**Auto Std:** generating units must remain in continuous uninterrupted operation for **up to 15** disturbances **within any five-minute period** caused by **any combination of the following events:** credible contingency, three phase fault, two phase to ground, a three phrase (two phase to ground), protection system to clear the fault. That the total time that the voltage at the connection point is less than 90% of normal voltage for 1,800ms. **Min Std**: restore active power to 95% of the level prior to a fault within 1 sec following disconnection of a faulted element. AEMO proposes acceptable criteria regarding transient active power consumption upon application of a fault. These requirements are such that a generating system's response should not exceed one power frequency cycle and must not exceed 5% of the max continuous rated current of the generating system. **Negotiated Access Std:** Each generating unit must be capable of: 1) continuous uninterrupted operation for the range of disturbances; and 2) supplying and absorbing the active power, reactive power and reactive current specified in the automatic access standards, except where AEMO and the NSP agree that the total reduction of generation in the power system due to that fault would not exceed 100MW.	Like the High/Low voltage above, Origin does not support this change as it is significantly different than previous interpretations from AEMO - i.e. use of tap changers for voltage control after event. No recognition has been given of the existing plants. Modification to the existing GPS based upon the current access standards may result in significant expense to bring existing plant up to the newer access standards. This is unreasonable and should be reflected accordingly in the Rules including any impacted definitions. Additionally a cool down period should be made mandatory. This was recommended and adopted in the ESCOSA technical standards. A 30 minute cool-down period after any 5 minute fault event period.
	S5.2.5.7	Partial Load Rejection	35	S5.2.5.7	Auto Std: requires continuous operation for an event that results in a 30% load reduction but excludes application of the partial load rejection requirements to asynchronous generators.	Ensure that all generators including asynchronous units are required to provide partial load rejection.	Origin seeks clarity on the maximum amount of load rejection that may be required. Previous interpretations allowed trip to house load or sync idle. Frequency values may also be of concern and require clarity as this will likely be a droop based function. This change may not represent a significant upfront cost (~$50k), requiring a minor control system update. However, the larger issue is if a generator is expected to run in droop mode continuously. This could result in a 5% loss

							against a generators operational dispatch maximum limit. This is because a unit cannot maintain maximum output while in droop control mode.
Active Power Control	S5.2.5.11	Frequency Control	42-44	S5.2.5.3	A generator must be able to withstand and maintain continuous uninterrupted operation of +-4Hz for 0.25 seconds (auto) and 1Hz/s for 1 second (Min) for RoCoF.	New settings that a generator must maintain continuous uninterrupted operation for: **Async**: +-4Hz/s for 250ms and +-3Hz/s for 1 second. Auto Std must be met. **Sync Auto**: +-4Hz/s for 250ms and +-3Hz/s for 1 second. **Sync Min**: +-1Hz/s for 1 second.	The requirement of 3Hz/s for 1 second appears to be quite aggressive. Origin would recommend that these settings are maintained according to international standards. This is because generators will be sourced internationally and it will align generator specifications. At 47/53Hz we have moved outside normal operating parameters – and we would be into the Under/Over Frequency Load Shed scheme. We would also likely have pole slip protection operated at this point. Secondly it is difficult to test for this requirement and generators rely on manufacturer guarantees to meet the standards. The AEMC should clarify the penalty provisions if a generator holds an assurance certificate from a manufacturer and a subsequent event shows that it doesn't meet the ride through standard.
	S5.2.5.14	Active Power Control	40-41		Not all generators are currently able to offer active power control (FCAS) to the market which could help to increase system security by allowing AEMO to direct units to provide this service, and potentially increase the level of FCAS providers thereby creating greater competition.	AEMO proposes that all new generation have active power control facilities with the capability to provide: - Automatic active power response to frequency changes - AGC - Controlled rate of change of active power - Enhanced remote monitoring requirements to provide real-time information regarding active power control.	Origin generally supports the requirement to be able to supply active power control facilities. Origin would welcome some more detailed definitions around what is required for active power control, e.g. droop control specs, proportional controllers or time responses. Detailing these specifications early will lower costs for connecting generators.
System Strength	S5.2.5.15	System Strength	39	S5.2.5.15	The AEMC's ruling on system strength requires any new connecting generators to 'do no harm' and contribute towards minimum system strength levels. AEMO wishes to increase minimum short circuit ratios so the burden of late connecting generators is not as large.	Min Std: generators must be capable of continuous uninterrupted operation for a short circuit ratio to a minimum of 3.0 at the connection point.	Origin is ok with a minimum short circuit ratio of 3.0 at the connection point.

Monitoring and Control	S5.2.6.1	Remote Control and Monitoring	48			A *generating system* must have remote monitoring equipment and control equipment to transmit to, and receive from, AEMO's control centres in real-time. May include switching devices, tap changing transformer positions, active and reactive power, voltage control setpoint and mode. Also max/min active power limits and max/min power ramp rates.	AEMO should only receive enough data points to safely operate the network. This would prevent excessive costs being incurred by generators who must supply data. The replacement of legacy control systems can be >$5M per unit. Again, should the access standards be required to be updated on older plant, this may prove to be highly expensive in retrofitting equipment.
Glossary Changes	Amended Definitions	Continuous uninterrupted operation		S5.2.5.3, S5.2.5.4, S5.2.5.5, S5.2.5.8, S5.2.5.9, S5.2.5.11, S5.2.5.13, S5.2.5.14, S5.2.5.15		Must maintain operation of the unit **during the disturbance** and not **vary the unit's reactive power unless** required by its performance standards. **S5.2.5.5 (b)**: During the disturbance contributing reactive current as required by its performance standards established under S5.2.5.5.	It is hard to guarantee predictable performance during all types of disturbances with no active or reactive changes. Unit performance depends significantly on where the unit is operating at the time of the event and what it is capable of achieving. Again this is hard to test and will require modelling of the unit performance standards against a number of scenarios. A clear definition of 'disturbance' would be valuable as it will better define the limits a generator is expected to perform at certain parameters. AEMO should make an allowance for units to vary their reactive power, if the changed definition requires units maintain operation **during the disturbance**, rather than after it.
		Rise Time	Appendix 1, Page 25	S5.2.5.13	**Rise time** means in relation to a step response test or simulation of 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.	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.	No Changes
		Settling Time	Appendix 1, Page 25	S5.2.5.13	**Settling time** means in relation to a step response test or simulation of 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: (1) 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	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: (1) 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 (2) the sustained change induced in that output quantity.	No Changes

					(2) the sustained change induced in that output quantity.		