9 June 2017

Mr Con Carellas
Principal Advisor
Essential Services Commission
GPO Box 2605
Adelaide SA 5001

Submitted electronically: escosa@escosa.sa.gov.au

Dear Mr Carellas

INQUIRY INTO LICENSING ARRANGEMENTS FOR SA GENERATORS – DRAFT REPORT

Origin Energy Limited (Origin) welcomes the opportunity to comment on the Essential Services Commissions' (ESCOSA) draft report into the licensing arrangements for generators within South Australia.

Origin currently operates approximately 500MW of gas fired generation within South Australia, has a number of wind farm power purchase agreements (PPAs) and recently announced a 220MW PPA for the Bungala Solar Farm development at Port Augusta. Origin draws on its extensive experience developing and operating generation assets within the SA market and across the NEM when considering the technical standards that should apply to both synchronous and asynchronous generation.

Origins key points are:

- Origin does not support the retrospective application of the increased licensing conditions to existing plant. The costs for existing generators to meet all potential licencing conditions will be prohibitive. Origin has further detailed the likely impact in the attached submission that includes information on generator technical limitations and the risk of damage to units when complying with increased licence requirements they were not originally designed for.
- The incorporation of additional technical standards for new generators should only be considered appropriate where there is a net benefit, after weighing the costs of providing this additional service against any incremental benefits to system security. Origin further suggests that ESCOSA should make clear the point at which new generation will have to comply with increased licencing obligations. Origin believes that this should occur before generators have reached the Detailed Planning Data Submission (D) stage of development. Any time past this point of construction will result in higher costs to generators, similar to those that would be imposed on existing assets.
- Participants are ultimately seeking investment certainty when developing projects and operating generation assets. The proposal for a regular review mechanism should detail what the appropriate review threshold is, including clarity around timeframes and trigger mechanisms.
- Origin maintains that additional, State based, generation licence requirements adds to the regulatory burden for all participants. Origin supports clarity around generation licencing obligations across the NEM and supports ESCOSA transitioning quickly to a national scheme should AEMO's anticipated rule change proposal be successfully introduced by the AEMC. ESCOSA should also take into account any recommendations that arise from the Finkel Review in regards to national system security issues. A national approach to generator performance standards will provide increased regulatory certainty.
- Multiple contingency event ride through capabilities should be capped at an agreed level. It is both impractical and expensive to design systems that can ride through unlimited levels of faults. This is due to both energy recovery times and potential unit stresses causing reliability issues.
- Altering frequency control settings including higher RoCoF levels should be carefully considered as there is an increased risk of plant damage to synchronous generators with the increased tolerances proposed.

Overall the impact of additional licencing conditions and costs should be examined against the benefits to system security and reliability. Every mandatory requirement to a new unit should be seen as both a cost to the initial development and ongoing operation of the unit. Costs will increase through a lack of clarity in the requirements and Origin would seek definitive requirements that allows the development of additional generation assets to continue with certainty.

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
Manager, Wholesale Regulatory Policy

SUMMARY OF ORIGINS RESPONSE

ESCOSA Proposal – General	**Origin Response**
Requirements for Existing Generators	Origin does not support requiring existing SA generation assets to meet the increased level of standards due to the prohibitive costs involved and potential for unit damage resulting from retrofitting units to meet increased generator performance standards or licence conditions.
New Generators / Generators Under Construction	Origin would expect that the license conditions and performance requirements that were agreed to during the design phase would be the requirements the plant is commissioned and registered to. Unless significant technical risk is identified, changing these requirements once construction has started can lead to significant variation costs and risks. ESCOSA should clearly define at what point a new generator is required to meet increased licencing conditions. Origin would suggest that an appropriate point should be at the Detailed Planning Data Submission (D) stage.
ESCOSA/AEMO TECHNICAL REQUIREMENTS	
General	Origin seeks clarification that the technical standards would be applied to either an individual generating unit or the plant as a whole.
Static and Dynamic Reactive Power	Origin supports the need to provide guidance around the recovery requirements for reactive power requirements
Voltage Control	
Performance during and subsequent to system contingencies	Origin does not support the widening of the frequency tolerance requirements for all generation types. There is a greater risk to unit damage as a result of increased frequency tolerances. Additionally any changes to frequency tolerance requirements should not be implemented until the findings of AEMO's technical advisory group on frequency are finalised. Origin conditionally supports voltage ride through capabilities where there is a limit to the amount of voltage ride through events a unit is required to withstand. Unlimited voltage ride through is both costly and risks plant as well as other protection elements.
Active Power	Origin supports: - all new generators requiring AGC if costs are not overly onerous; - limits on maximum ramp rates across 5 minute periods to prevent contingency events from occurring by sudden increases in generation. The requirement for registration in all FCAS Markets should be contingent on the outcomes of AEMO's technical advisory group on frequency control in the NEM. Other considerations – a limit on the number of frequency events a generator is required to satisfy. Unlimited numbers of frequency events can risk system security through damaged plant and inability to provide further frequency control once energy levels are depleted.
Ability to assist in system restart	ESCOSA should assess the costs and benefits of generators providing voltage support during the restart process, especially where some generators are at risk of damage.

Simulation Models	Origin conditionally supports the EMT models provided the responsibilities and processes are made clear between affected parties. This should lead to cost efficient outcomes because all parties will be aware of the information they are required to provide and prevent duplication of work.

DETAILED TECHNICAL INFORMATION – ESCOSA LICENCING ARRANGEMENTS FOR SA GENERATORS

Existing Generators

Existing plant may not be capable of meeting many of the proposed elements due to technology limitations that were not required at the time of commissioning or the prohibitive cost of retrofitting.

Origin is concerned that if all the technical changes advised by AEMO for new generators are retrospectively applied to existing generators there is potentially a greater risk to system security due to:

- Physical damage from units operating outside, or being exposed to grid conditions beyond their physical design conditions.
- Unreliable operation and increased potential for tripping of unit due to instability of control and protection systems.
- Inability to perform changes to obsolete control and protection system to accommodate performance changes
- Inability to cover the costs of refurbishments required to meet the performance standards due to remaining asset life.

Origin strongly believes that any proposed changes imposed on existing plant should not deteriorate or impair a generators performance beyond its current capability. These changes will risk damage to the physical assets, especially aging plant, and potentially will result in cascading energy security issues. This is especially important for aged assets where the physical resilience to voltage and frequency variations has deteriorated.

Any expected performance and information requirements of existing plant need to accept the limitations in their design. Examples of this will include frequency response capabilities and modeling data that is not readily available to the participant as in some cases the developers of the assets are no longer able to supply modeling data.

There is also the consideration that any costs of retrofitting and upgrading plant to meet increased licencing conditions will ultimately be passed onto consumers. It is appropriate that the costs versus benefits of this potential action are examined thoroughly and the implications for system security are considered before applying retrospective action.

New Generators / Generators Under Construction

Origin suggests that ESCOSA make explicit the point at which additional licence conditions for new generators would apply. Origin contends that a new generator is one that has progressed no further than the Detailed Planning Data Submission phase in the development cycle and that after this point the cost of imposing the requirements becomes prohibitive, with costs similar to that of an existing generator.

A construction project may take anywhere from six months to four years from when design and performance requirements are first agreed between AEMO, the connecting proponent and a TNSP, until the plant has completed its R2 validation requirements. Additionally for multiple unit sites, the performance requirements may change between the first and last unit being commissioned. If the

performance criteria are required to change as a result of regulatory change or at the request of the owner, the changes can be costly due to the amount of variation work that is required to occur.

Origin's experience with even minor changes between design and commissioning stages has resulted in increased costs to an overall project. If, for example, licencing conditions require changes in control systems to handle increased protection settings, these can have significant consequences for commissioning costs and meeting the performance criteria. Other items such as frequency and voltage ride-through capability will be affected by the design of the physical assets and modifying this performance requirement may prove impractical or place additional operational risks on the unit.

AEMO SPECIFIC TECHNICAL REQUIREMENTS

Additional Consideration - Assessment at the Connection Point or the Generator

In order to try and promote technology neutrality and deliver the most efficient outcome, many characteristics may be considered based on a site capability, not by individual unit.

This is common where multiple small units of the same type are aggregated together, but not as common where different technologies or large units are used. A current example is that of a combined cycle unit where the performance requirements are enforced on gas turbines and steam turbines individually. As the steam turbine is dependent on the gas turbine for energy, there is a direct correlation in the performance of one to the other, and any services provided should be considered as a combined performance of all the units involved. This would utilize the best of each technology with minimal additional costs or risks. Another example would be a battery hybrid plant, where batteries are connected alongside a conventional turbine.

ESCOSA and AEMO should consider how a connection point assessment would demonstrate a level of co-dependence or co-ordination between the various units and take that into consideration when setting the performance standards for the site as a whole, especially in situations where there is a co-dependency between units.

PERFORMANCE DURING AND SUBSEQUENT TO CONTINGENCY EVENTS

Clarity of ride-through requirements

Origin supports having separate performance assessment criteria for synchronous and asynchronous generators in order to simplify how operators interpret generator performance standards for that unit. This will aid in the design phase where operators are able to quickly identify the correct standards for their potential unit and assess the costs of meeting those generator performance standards

Multiple Fault Ride-Through

Every contingency event has an impact on generation plant and the type of technology will dictate how these events are handled. Generally ride-through events put significant mechanical and thermal stress on components such as transformers, discharge/ride-through resistors, rotor forgings, retaining rings and stator windings. Neither the quantity of events nor a size of a disturbance alone can be used to quantify a generators ability to handle multiple fault ride through, rather it is a combination of time and value of the event that determines a units fault ride through capability.

An example of existing requirements that meet this criteria are items such as fault current of 100kA for 3 seconds, or 30% unbalance currents for 8 seconds. The criterion is similar for multiple voltage dips or frequency events on both synchronous and asynchronous units. Each event will either heat components or utilise stored energy therefore having an unlimited number of ride-through events is not practical. In other words, all ride through events come at an energy cost, and once that energy is

depleted it impairs a unit's ability to continue to respond to further faults. A requirement for unlimited fault ride through would result in significant capital for under-utilised equipment.

Traditional requirements of thermal performance have been adequate, provided protective systems operate as required. Many protection relays have suitable thermal and cumulative models that can be programmed to monitor the impact of contingency events. Examples in practice include generator or motor thermal overload, negative sequence and over-excitation thermal protection. Origin contends that there needs to be an acceptable design limit that can be quantified and measured to ensure damage to plants does not occur.

Origin supports a practical limitation on the number of ride through events that units would be expected to perform against.

Withstanding Frequency Changes Over and Above Existing Requirements

Currently frequency control in the NEM is being reviewed by an AEMO technical forum which is examining better frequency response throughout the NEM and gathering input from stakeholders. At this stage, changing the frequency withstand characteristics will add additional cost and risk to both generation plant and the system generally which may not be necessary if the frequency control concerns are addressed in other forums. Origin suggests that frequency withstand characteristics are addressed at a later date when the deliberations from these forums have been finalised.

As with fault ride through, every technology is different in how it responds and its limitations. For frequency withstand, there are three elements to look at:

1 – Main plant capability and physical withstand ratings – ROCOF or Hz/s changes, stability of energy source, V/Hz limits
2 – Changes to plant characteristics and reactions – Changes in reactance, windup, pressure oscillations, reductions in output
3 – Auxiliary plant behavior – Motors, transformers, UPS and chargers

Increasing overall frequency limits may result in a reduction in energy generated or voltage constraint issues (V/HZ), but through control systems, these changes could be predictable and managed for most plant. Single shaft synchronous plant are more susceptible to damage operating away from 50Hz for excessive periods and careful attention at auxiliary systems will be required to ensure ongoing operation under these scenarios.

Two significant risks of allowing higher RoCoF rates, as suggested by AEMO[1], have the potential for pole slipping and shaft/coupling damage on synchronous generators. This is an unstable situation that has the potential to damage units or result in multiple units tripping. It would be almost impossible to have the existing fleet of generation increase its withstand capability hence there would be a significant contingency risk if a higher Hz/s were to be accepted. With shaft and coupling limits there are concerns if frequency control is not managed that the torsion stress on a turbines shaft from a sudden vector or RoCoF change would permanently damage the generation unit requiring it to be out of service until rectified. Origin questions if a better approach would be to review the frequency control mechanisms through AEMO's technical forum first, before implementing higher withstand requirements on generators.

[1] AEMO Recommended Technical Standards, Page 32 (+-4Hz/s for 250ms & +-3Hz/s for 1 second)

Active Power

The provision of AGC being made for all new connections should be considered if the costs are not overly onerous to new generators. Origin understands that these costs should be minimal if they are undertaken early on in the design phase of a generators life. Origin would expect that under certain circumstances a generator may choose not to be connected to the AGC system if there is a suitable technical reason.

In regards to the provision of all FCAS services by new generators, certain technologies will be limited in their ability to either sustain long periods of support, or risk plant damage with frequent short changes. Frequency control is currently being assessed by a technical AEMO working group and there is merit in assessing the outcomes of this group before mandating FCAS registration in all markets.

A potential alternative frequency control method that could be considered for generators would see three frequency control characteristics being introduced.
1 – A proportional controller based on frequency change,
2 – A proportional controller based on rate of frequency change (or inertia) and
3 – A switched controller providing a ramped output to a frequency change.

Items 1 and 3 would be settable for all generation types and item 2 would also be settable for non-synchronous and optional for synchronous for values above that of inertia. This would allow flexibility of operation for potential changes in the future but still provide AEMO with the ability to call on a variety of frequency control mechanisms during times of scarcity.

Concurrent Frequency Events

A concern not raised by AEMO and ESCOSA in a low inertia environment is the behavior of units during multiple concurrent contingency FCAS events.

Contingency FCAS events in the same direction may utilize stored energy or energy volume. This will have a limited capacity and may require recovery time between events to provide full capacity again. This is an obvious consideration for batteries, but also steam systems using a sliding pressure or boiler follow mode where the drum level may need to recover after an event. The recovery time would depend on the quantity and duration of the event.

Likewise, events that reverse direction can put significant stress on high inertia machines. Depending on the logic used there may also be delays or recovery times required before FCAS can operate in the reverse direction after the first event, i.e. swing from Lower to Raise services or vice versa.

FCAS response may also put stress on electrical components, especially during times of low voltages or high reactive power demands. Protection systems may operate due to thermal limits of machines or on auxiliary plant where multiple events are experienced.

Origin would encourage both ESCOSA and AEMO to examine the limits of concurrent frequency events and availability of contingency reserves following multiple changes in contingency FCAS events.

Regulation services, as currently installed, do not have the same concerns as contingency services due to slower control loops.

Ability to assist in system restart

For some systems, providing voltage control at low or zero load may be cost prohibitive. Damage to the units may occur if this condition is sustained for longer than half an hour. In addition, thermal units often have environmental constraints, such as NOx and SOx levels, which may limit their minimum load and run times. Provided these limitations are accepted and understood, all technologies should be able to provide some voltage support services during a restart process.

The ability for units to have a continuous droop and/or isochronous control would also help during islanding and restart events. A restart with all units being on continuous droop (apart for the frequency control units) will dampen any MW change (planned or unplanned) and prevent units oscillating against each other. This will also limit the need to procure or source frequency control services during the initial stages of the restart process.

System Models

Origin recognises the value of modeling as an important tool in assessing system parameters and conditions. Origin believes that any requests for additional modeling data should only be requested where there is a clear understanding by all parties (generator, AEMO, TNSP) on the specific data that is required from each participant, a clear explanation is provided by AEMO as to why additional modeling data is required and any request should clearly identify the benefits to system security as a result of increased modeling data against the cost to provide these services. Origin contends that by providing this information up front it would reduce the duplication of data requests that currently exists and subsequently lower modeling costs overall.

Currently modeling a new generator can cost between $300,000 and $1,000,000 and can take over 6 months to complete. It is very hard to quantify the type and amount of modeling at the outset of a project because of uncertain data requests which require a significant contingency budget due to potential variations.

Much of the process is iterative and the sharing of information is poor, resulting in significant rework and time lost. If modeling requirements are clearly outlined at the start of the process it would reduce decision timeframes and should prevent any excessive costs.