Mr John Pierce AO
Chair Australian Energy Market Commission
Level 6, 201 Elizabeth Street
Sydney NSW 2000

31 October 2019

Dear Mr Pierce,

Submission concerning: ERC0274, ERC0263, ERC0277

Thank you for the opportunity to provide a submission regarding these rule changes, I am writing in support of restoring the control of the generation fleet to ensure an appropriate response to changes in frequency. Frequency cannot be separated from active power, the control of active power directly affects the frequency control, the supply of active power to customers is what the power system is for. As Dr Sokolowski has pointed out the rule change that was implemented in 2009 regarding "Ramp Rate" is now in my opinion the largest influence on why the frequency has deteriorated so significantly in the last five years, the ancillary services market coupled with the frequency standards has provided the framework for the frequency deterioration to occur.

The impact of the Ramp Rate rule change is as follows; scheduled generation now receive 4 second dispatch control instructions through the centralised Automatic Generation Control (AGC). This is directing units to follow their dispatch targets and ramp in accordance with the market dispatch despite what is happening in the power system. Such a control method is inappropriate for secure management of the power system. Unit controllers (as documented by John Undrill's report) override local controls forcing units to comply with an inappropriate external control signal.

In power system control theory and to support the system dynamics, a step change on the power system requires <u>a step response</u> from operating plant. The market mechanism described above has replaced the <u>locally controlled step response with a slow ramp in response</u> to an external signal that is what the economic dispatch wants the unit to do. Effectively this has eliminated the dynamic active power from the power system, it forces the error in the dispatch system directly into the frequency. Error in frequency is an error in the supply of active power.

The variation in frequency on the power system is causing issues to precision equipment belonging to customers. This is difficult to quantify as the reason why equipment trips or is damaged may or may not be recorded. Legacy systems operated by HV Customers are affected by the grid when a constant frequency is not maintained. "The grid needs to be resilient against rotor slowing, high dF/dt events reduces the quality of <u>our</u> product as it prevents us running a safe control system." Quote provided by a large HV customer for this submission.

In a power system in which we expect the inertial contribution to reduce over time, it is critical to ensure that sufficient dynamic active power responds to arrest the change in frequency. This must be widespread and as much plant as possible should correctly respond. The synchronous fleet on which the power system was built has the ability to control its input energy, renewable plant does not. It is how the market is controlling <u>the input energy</u> to the synchronous plant that is the cause of the instability, the loss of reliability and the deterioration in the quality of electricity supplied.

Much of AEMO documentation refers to the poor control being in the normal operating band, while true it is only a symptom of the broader problem. Control of regions following a separation event depends the on dynamic active and reactive power that is available within the region. If this is not available within a separated region, it will fall straight through to under frequency load shedding or worse, collapse. The lack of dynamic active power within South Australia was illustrated in the event that occurred on the 1st November 2015. The loss of 200 MW import to the state at 9pm at night caused the region to fall into UFLS. This should not have happened had dynamic active power been present to arrest the fall of frequency.

On the 25 August event the inability of the synchronous units to perform a load rejection was illustrated in the sustained high frequency following the separation. The focus of compliance appears to be on “Continuous uninterrupted operation” rather than whether there was an appropriate control response. The high frequency illustrates over supply of power, without extremely poor control of the region. (See Figure 2 on page 6 of Dr Sokolowski’s submission replicated from the AEMO report into the event)

Such control responses cannot be randomly selected, they must be known and designed into the local generating unit controls, not defeated or eliminated by the desire of the market.

Under Chapter 4 AEMO is obligated to consider whether there is sufficient dynamic active power or dynamic reactive power available within regions. Dynamic response of plant cannot be centrally controlled due to communication latency, the speed of response requires local measurement and local control action that is not over ridden by external unrelated controls such as a market dispatch target. AEMO has stated that FFR could be provided by “centrally controlled signals” this is not true and has not been demonstrated to be true. The Reliability Panel Review of the Frequency Standards (2001) stated:

> “Frequency must be managed on a second by second basis, far faster than any market mechanisms can deliver. Accordingly, as part of its security obligations, NEMMCO is charged with central management of frequency to the defined standards. These should be set so that appropriately designed equipment does not malfunction and will not be damaged.”

This statement recognises the local speed of response is important, it is curious as to why public documents from both AEMO and AEMC continue to make claims that frequency is managed through the FCAS regulation service which is a centrally controlled delayed signal.

I strongly urge the AEMC consider implementing the mandatory control requirements that have been outlined in both Dr Sokolowski and AEMO’s proposed rule changes. The tighter the deadband as proposed by John Undrill will ensure better power system response and improve the ability to withstand large events as the power system used to. The search for “resilience” in the power system will be greatly addressed through reimplementing tight responsive governor systems that are not over ridden by market dispatch instructions.

In must be clear that any deadband range that is written into the rules should not mean that all units only respond at that limit, tuning of the power system requires units to respond efficiently within the capability of their plant. There is significant range of response across the generation fleet that is possible, however, the governor action should occur as soon as possible. For example, some hydro units may not have a deadband at all as the water column takes time to respond. In setting “rules” there must be allowance for a range of responses but not entitle large units who can respond quickly to respond slowly.

As Ryan Jennings and I have demonstrated through charting the various responses of synchronous and asynchronous technologies, renewable energy is largely frequency agnostic. It is stable in the response of frequency variations. This is not a bad thing, but in order to ensure that the power system can withstand events in the future, new renewable plant should in the future provide a dynamic active power response that is sensitive to frequency. Some of the newer existing wind farms may be able to implement such controls, but not all of the plant would have the control capability. Older type 1 and 2 wind turbines for example should not be required to provide this action, their influence on the power system is small. They must not be unduly penalised for this as it was not a requirement at the time they connected and their influence on the system is small.

It is far more important to get the majority of the power system responsive and controlled. The current control methodology which is dominated by unit controllers, responding to the dispatch targets under load control only is not supported in power system control text books, that is we are currently in uncharted waters with respect to how the system is operating. The methods of control that enable this load following method to dominate the response of the system has not be adequately studied, was not predicted and is an unintended consequence due to the culmination of a number of changes made over a long period of time. AEMO has admitted in the report into the 25 August that they can not simulate the frequency response of the power system. This alone places the system at risk as it means that there is an increased uncertainty about the current operating limits used in dispatch.

To use a spring constant analogy, we can represent the strength of a transmission line:

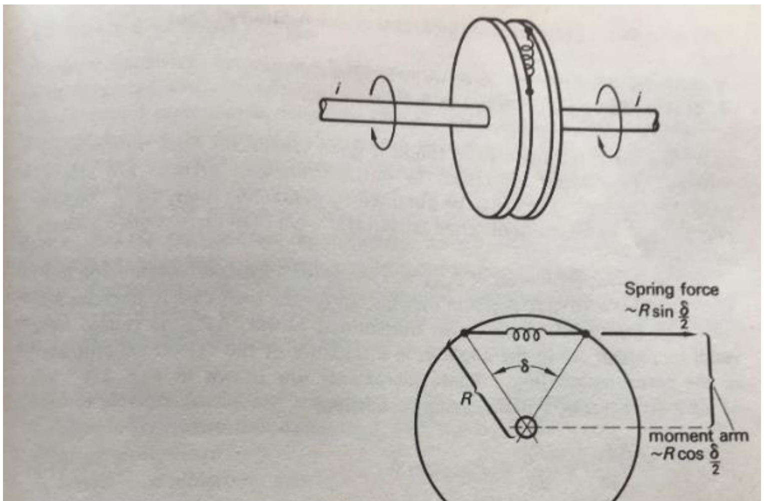
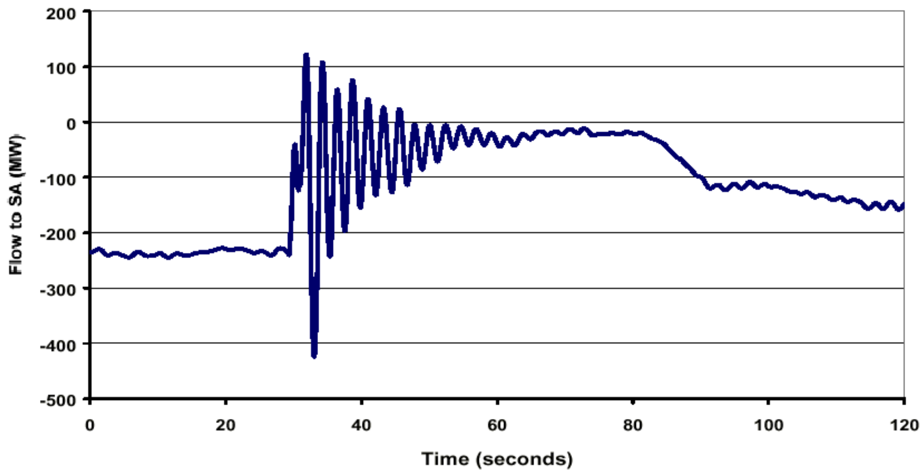


Fig. 3-4 Mechanical analog of electric transmission link.

(Source: Elgerd: Electric Systems Theory: An Introduction)

The constant of the spring dictates how responsive the system will be when it is stretched apart. The type of spring response the system had is illustrated in an actual system event shown below from an event in the early days of the market. Note: this is approximately a 300 MW disturbance on the interconnector flow to SA.



This type of response is required it shows a dynamic active power response from all units in the system. The settling is caused by the rotating masses settling into a new steady state equilibrium. The rules expect this type of response and the technical standards require the system to have a 5 second halving time. Without dynamic active power present in the power system in all areas, the system will suffer greater load shedding, and more severe power system disruptions.

The market has over time, altered the requirements on generators to suit the economic dispatch without consideration of the more complex control requirements associated with the dynamic control necessary for the reliable operation of the power system.

Constant frequency and dynamic active power response, in accordance with power system control theory are pre-requisites for power system security yet the NEM has systematically and unintentionally eliminated them, the response is unpredictable and too slow to be effective.

This contributes a large inaccuracy into the dispatch, the inability to control interconnector flows in accordance with constraints and places regions at risk of collapse.

I highly recommend:

- That the mandatory governor control be restored on all synchronous units in a manner that prioritises frequency sensitivity to their control hierarchy.
- That the obligation to follow a dispatch target be subject to frequency and no penalties apply for responding to frequency as this is a system security requirement.
- Fair consideration must be given to generators that have technologies that are not frequency sensitive and cannot be made to be frequency sensitive, they should not be penalised. Such technologies would be type 1 and type 2 wind turbines.
- Future renewable energy plant and storage must provide a suitably controlled dynamic active power step response to changes in frequency at the connection point.

Your sincerely

(provided electronically)

K. P Summers FIEAust