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John

Dear Mr Pierce

Managing power system fault levels and rate of change of power system frequency

AEMO welcomes the opportunity to provide comments on the draft determinations published for managing power system fault levels and the rate of change of power system frequency which form part of the Commission's work program of the System Security Market Frameworks Review.

AEMO has provided its submission for the two draft determinations as a consolidated package. We believe there are synergies between the fundamental principles that must be applied to the framework designed for managing fault levels (system strength) and the framework for managing rate of change of power system frequency (inertia and other services).

AEMO supports market and regulatory frameworks that are flexible under changing market conditions, so that the most efficient outcomes can be delivered to consumers. It has been evident over recent years that the dynamic behaviour of the market and technological advancements must be factored into the design of our frameworks to encourage outcomes that are complementary and adaptable to a range of conditions. It is also necessary to ensure adequate clarity is provided on the roles and responsibilities of market bodies for the frameworks to be successful.

AEMO broadly supports the Commission's recommendations as an interim policy for addressing these issues, one that is suitable at least in the short term to resolve existing power system issues. In considering the detail of the proposed interim arrangements, AEMO believes there are certain measures that should be taken to enhance the frameworks proposed in the draft determinations.

AEMO believes the principles of the frameworks developed for the two work streams must be simple and consistent and its design practical to implement.. Although AEMO acknowledges that the detailed design of the frameworks for each work stream will be different, we believe that there are common solutions to manage these (and other) power system security issues. Therefore the frameworks must not be so prescriptive that they exclude the benefits that can be delivered to consumers from the co-optimisation of such solutions.

In the long term, there may be merit in considering a more holistic planning process to determine the services required, alternative processes to procure, dispatch and price those services and different arrangements to recover the costs of those services.

Impact on Victorian arrangements

Under section 50C of the National Electricity Law (NEL), AEMO is the provider of shared transmission services by means of, or in connection with, the declared shared network (DSN) in Victoria and is responsible to plan, authorise and direct augmentations of the DSN. In accordance with the NEL, AEMO supports the AEMC's proposal that we are the party to determine, contract for, and maintain system strength and inertia within Victoria.

Timing of the application of the Rules

It is critical that any framework allow for a rapid response to emerging system security issues. AEMO has proposed some minor amendments to the Commission's draft recommendations relating to implementation timeframes and transitional measures. We believe that the amendments help ensure that power system security issues can be addressed at the appropriate time, in accordance with the severity of the identified need.

Future reviews

While AEMO supports the AEMC's proposed allocation of responsibility to Network Service Providers (NSPs) at least in the short term, the generation mix and character of the power system is continuing to change and this will require further changes in the market design and regulatory arrangements. The Finkel Review has recommended a range of measures to assist in managing the transition. AEMO considers that these arrangements should be reviewed in the medium to long term, to ensure they drive efficient investment in, and optimal usage of the resources required to deliver system security and that the arrangements for system security services fit with the overall market design.

We strongly believe that the frameworks designed must reflect the current and emerging market conditions. This means that they must be flexible enough to allow for future reviews so that the optimal mechanism for the provision of system services is selected for the long-term interests of consumers.

If you would like to discuss our submission please contact Chris Davies, Manager Strategy & Coordination, on 03 9609 8000.

Yours sincerely

Cameron Parrotte
Executive General Manager, Strategy & Innovation

SUBMISSION TO AEMC CONSULTATION ON DRAFT RULE DETERMINATIONS

ERC0211 - MANAGING POWER SYSTEM FAULT LEVELS &

ERC0214 - MANAGING THE RATE OF CHANGE OF POWER SYSTEM FREQUENCY

Published: **August 2017**

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

CONTENTS

1 MANAGING POWER SYSTEM FAULT LEVELS

System strength across the network is an important consideration for power system security under normal and contingency conditions. As the generation mix continues to change, system strength (fault level) is diminishing in certain locations in the NEM. Further, the connection of multiple asynchronous generating systems in close electrical proximity to one another can result in insufficient fault current being available to some generating systems, leading to stability issues for some. Together, these issues make maintaining power system security at some locations an increasingly difficult operational challenge.

AEMO supports the underlying principles of the AEMC's Draft Determination on Managing Power System Fault Levels as a solution, at least in the short term, to address existing system strength issues. In the long term, there may be merit in considering a more holistic planning process for the management of such issues, ideally through an integrated, efficient market mechanism.

As an interim solution for the NEM's immediate needs, the proposed framework provides clarity on participant obligations and provides a transparent and consistent methodology for specifying the technical requirements.

AEMO considers, however, that some changes should be made to the Draft Rule so that system operation and investment decisions are better aligned with consumers' best interests.

While AEMO has suggested some significant changes, the outcome still aligns with the AEMC's objectives, with additional benefits that include:

1. a more efficient and deterministic implementation; and
2. an outcome that incorporates guidelines that reflect the evolving power system conditions, and associated phenomena.

The recommended changes will allow the most appropriate mechanisms to be developed to support the secure, reliable and affordable delivery of electricity to consumers.

This submission focusses on recommendations for improvement to the four key themes of the Draft Determination that would deliver more efficient outcomes for consumers in the longer term.

1.1 Maintaining system stability as local system strength reduces

As an interim policy solution, AEMO supports the proposal that Network Service Providers (NSPs) be responsible for maintaining system strength in their networks, as this will allow immediate system strength issues to be addressed . In the longer term, it may be more efficient to address system security as part of a holistic process that takes into account the full range of power system needs.

We also agree that AEMO should continue to be responsible for maintaining power system security and stability in real-time. We believe however, that the following amendments to the AEMC's draft determination would deliver an improved outcome.

1.1.1 Specification of the system strength requirement

AEMO considers that the NSP requirement to maintain a minimum system strength by maintaining a short circuit ratio (SCR) above an agreed level at each connection point has the following practical limitations:

- The SCR is suboptimal as a metric for understanding a number of key aspects of power system security. Specifically:
    - Synchronous machine stability: The stability of a synchronous machine or asynchronous generating system cannot be adequately determined with the use of

SCR alone. Other factors such as a synchronous generating unit's operational impedance, inertia, synchronising torque, and protection systems are more relevant for safeguarding against instability or disconnection.

  - Protection system adequacy: protection systems detect faults and disconnect faulted elements within clearance times specified in the System Standards. These protection systems operate based on measuring fault currents or a combination of fault currents and voltages. The use of SCR is not appropriate for evaluating any susceptibility the protection systems may exhibit as the system strength declines.

- Evaluation and operational implementation at every connection point would be onerous and potentially unachievable.
  - AEMO acknowledges that the SCR is a useful metric for high level screening of asynchronous generator stability issues, however this would have to be benchmarked against appropriate full-scale electromagnetic transient (EMT) simulations.
  - Such analysis to the level of every generator connection point is neither practical nor effective: in terms of the need for detailed, computationally-intensive EMT modelling and operational implementation.

AEMO considers the following amendments would allow the AEMC's objectives to be more practically implemented:

- Use the fault current (in MVA) as the measure of local system strength, with the relevant Transmission Network Service Providers (TNSPs) obliged to plan their networks to maintain this above a minimum level specified by AEMO.
- This minimum fault current should be maintained through a requirement specified only at major power system nodes rather than at every connection point. These nodes would be representative of connection points within a certain electrical distance.
- Responsibility for specifying minimum fault levels and triggering any TNSP obligation should be allocated to AEMO, guided by high level principles in the Rules and supported by consultation.

The assumptions and requirements that are used to calculate minimum fault levels should be specified in a guideline outside of the Rules. This is considered in Section 1.1.2.

AEMO's rationale for these recommendations is set out below.

Appropriate metric for system strength

Guaranteeing a particular SCR will be maintained at any point in the network might not meet the underlying objectives of the proposed Rule, and could create unintended inefficiencies. Specifically:

- It creates a moving target because the SCR at any point in the network varies dynamically with real-time system conditions. That is, it will change depending on the number of asynchronous generating units operating within a certain electrical proximity of the connection point.
- The SCR at any point in the network might only be at its lowest point for a small period of time in any year. This is because the SCR is dependent on the number of asynchronous generating units that are online, and the output of these units.

As an alternative, AEMO considers that the AEMC's proposal could be improved by specifying the necessary security obligation in terms of maintaining a specified minimum fault current at major power system nodes:

- This would be a static value that could be planned and delivered in a way that is consistent with existing NSP obligations in clause S5.1.10 of the National Electricity Rules (NER) and obligations on AEMO as the Victorian planner in clause S9.3A of the NER relating to maximum fault levels.

- The metric also provides a higher level of operational certainty regarding downstream system strength compared to the SCR. Absolute fault levels are more straightforward to calculate and manage in real-time as generation commitment and output varies.

AEMO's alternative proposal to use minimum fault levels instead of minimum SCR will establish a baseline, however, AEMO acknowledges that even a minimum fault level metric does not capture all sources of instability, and the determination of minimum fault levels must be appropriately baselined in dynamic power system analysis.

Furthermore, assessing whether the minimum fault current requirement is met, broader stability issues must be considered to ensure that the final solution delivers a stable power system outcome. AEMO has proposed the use of a guideline to guide this process for NSPs (see Section 1.1.2).

Location of system strength requirement

AEMO considers the proposed requirement that NSPs maintain system stability (in terms of the SCR) at each connection point to be impractical for the following reasons:

- Analysis, reporting and implementation of this requirement at the connection point level would be an onerous task, and the benefits would not be commensurate with the effort required.
- Operationally, it would be logistically impossible to monitor and maintain SCR in real-time at every connection point. This is considered in Section 1.3.
- Simplistic assumptions would need to be applied in regional/NEM-wide consideration down to the connection point level. This introduces the risk of compromised real-time operational considerations and can lead to inefficient investment decisions.

Instead, AEMO proposes that the minimum system strength levels are specified at major power system nodes. Reasons for this recommendation are as follows:

- Fault level at certain nodes in the power system can serve as sufficient indicators of fault levels at other points within the system, based on their relative proximity. Specifying these key nodes and assessing the minimum required operational fault levels at these locations is a more practical means of addressing the underlying objectives of the proposed requirement.
- It facilitates coordinated planning consideration of system strength investment needs between downstream network locations and at the power system node at which the minimum fault current requirement is specified – through joint-planning between the relevant NSPs and AEMO where necessary. The fault level metric allows for this, as it encapsulates downstream fault levels – the same does not apply for the SCR.

How the minimum fault level will be specified

The Draft Rule specifies that minimum system strength levels would be determined based on an agreed SCR at each connection point. Under AEMO's proposal, an alternative arrangement must be used for specifying minimum system strength. AEMO recommends that obligations for identifying minimum fault current levels be as follows:

- The NER set out guiding principles AEMO should follow in determining minimum fault level requirements.
- AEMO engages with NSPs and other relevant stakeholders on its approach to determining minimum system strength levels through the National Transmission Network Development Plan (NTNDP) consultation process, in coordination with the inertia requirement determination, and publishing relevant inputs and assumptions where appropriate.

AEMO considers this approach allows for improvements in the process to be incorporated in a timely manner to reflect current or emerging conditions and lessons learned, while still achieving the level of transparency envisaged by the AEMC. This approach would be in addition to the development of, and consultation on, the proposed System Services Guidelines, discussed below.

This is consistent with the following provisions in the NER on the development and publication of the NTNDP:

- Clauses 5.20.2 and 5.20.3 set out the high level requirements AEMO must consider and provide.
- AEMO publishes a database of inputs considered (clause 5.20.4) and a methodology document on our website.
- AEMO consults with participants on material issues and inputs during the year (clause 5.20.1) and is required to explain how this feedback has been taken into account, or why it has not, in the analysis (clause 5.20.2(c)(12)).

The specification of the minimum system strength requirements by AEMO, including key inputs and methodology on this process, would easily fit within the NTNDP consultation structure.

1.1.2 System Services Guideline

AEMO agrees there is a need for guidelines to provide clarity and transparency on how minimum system strength levels are calculated, including when assessing the potential impacts of new connections on the stability of existing generating systems. However, if the minimum system strength obligation is specified as a minimum SCR at the connection point level, as currently proposed, the SCR guidelines imply that a simple SCR calculation is sufficient to identify where system strength challenges are likely to arise. While SCR is a useful metric to screen for potential stability issues, it cannot be used on its own to guarantee a stable power system.

Accordingly, AEMO recommends that the guidelines be reframed more broadly, with the Rules specifying the principles that AEMO should consider when developing the guidelines, but that the content of the guidelines be allowed to develop in consultation with stakeholders.

AEMO recommends reframing the proposed rule requiring AEMO to develop and maintain 'SCR Calculation Guidelines', broadening the scope to allow consideration of related matters such as inertia, and renaming the guidelines as the **System Services Guidelines**. The Guidelines would provide transparency on these new power system strength and inertia obligations and, specifically, how NSPs must meet the new requirements as part of the short term solution.

Broadening the scope also allows for the development of more informative guidelines that can be used to reflect the dynamic behaviour of the power system resulting from changing market conditions. This would ultimately lead to better outcomes for consumers.

AEMO notes there are synergies between the proposed scope of these guidelines with the existing Power System Stability Guidelines AEMO is required to develop under clause 4.3.4(h) of the NER. AEMO recommends merging the proposed System Services Guidelines with the Power System Stability Guidelines.

AEMO recommends that the NER specify the intent of the guidelines in a broad manner, to allow for improvements over time. The guidelines should specify, but not be limited to, the following:

- A common definition of stability issues and screening criteria (such as minimum fault level)
- How to assess and demonstrate compliance with obligations for maintaining minimum fault levels, including assumptions to be considered
- How to assess and demonstrate compliance with obligations for maintaining minimum inertia, including assumptions to be considered
- The modelling processes that may be required
- How to demonstrate compliance with all related obligations, including ensuring that the solutions proposed will deliver secure power system outcomes for all necessary scenarios
- Guidance on how to undertake preliminary screening to identify potential system security issues accounting for both system strength and inertia in the case of a new connection application

- How to model the impacts of generating systems on each other or on nearby non-generating system plant, in order to comply with the 'do no harm' requirement for new connections.

The guidelines would be updated as necessary in accordance with the Rules consultation procedures in NER clause 8.9 to remain fit-for-purpose over time.

AEMO believes the proposed amendments to the guidelines aligns with the AEMC's objectives, particularly with providing transparency, consistency and clarity on the process to determine system strength requirements.

1.1.3 Efficient NSP compliance with system strength obligations

The Draft Rule requires the NSPs to use existing planning and regulatory arrangements when acquiring or providing system strength services. This would involve ongoing assessment over the planning horizon summarised in NSP annual planning reports, with appropriate triggers for investment as needs arise (e.g. commencement of a RIT-T process).

It is also important that the proposed rule and its implementation involve co-optimised consideration of interrelated decisions across the energy supply chain. This includes:

- Jurisdictional renewable energy objectives: These will have implications for how security in parts of the system can be managed most efficiently and how the costs of doing so will be recovered.
- NSPs' overall network investment plans: This involves integration of security management initiatives into the annual network planning frameworks, cost-benefit tests and revenue determination processes.
- Other security-related requirements and rule change processes: This includes the power system frequency risk review and protected events as well as generator performance standards.

AEMO supports the encouragement of innovative solutions to deliver and maintain power system security in the most cost-effective manner. This means not restricting the obligation on NSPs to maintain system strength through network investment only so that the best outcome can be provided to customers. In the long run, we consider that there is merit in establishing an integrated, efficient market mechanism that is able to weigh all potential solutions in a competitively neutral fashion. The mechanism should make available the right information at the right time to allow the full range of potential service providers to put forward optimal solutions taking into account whole of system needs.

In the short term, AEMO recommends that the AEMC ensure clarity in the framework that allows for solutions other than network options to be considered on equal grounds to resolve power system security issues.

1.2 Maintaining system stability as additional non-synchronous generators connect to the system

AEMO considers that the "do no harm" obligation on new connecting generation is consistent with existing clauses in the NER:

- Clause S5.2.5.5 can already be applied to ensure new connecting generators remain online for disturbances caused by credible contingency events
- Clause S5.2.5.13 can already be applied to ensure new connecting generators 'do no harm'

AEMO agrees that new connecting generators should be required to manage the impact of their connection on existing Network Users. Such a requirement provides a strong locational signal for new generators to connect to stronger parts of the network.

AEMO acknowledges that the draft Rule clarifies roles and responsibilities by specifying:

- New connecting generators negotiate the minimum SCR (required by the generator to maintain stable operation) with the NSP, which is to be disclosed in their connection agreement
- The SCR for the new connecting generator is registered with AEMO
- The process for the connecting party to propose a remediation scheme as an alternative to NSP works to maintain system stability
- New connecting generators are to fund the work undertaken by the NSP to maintain system strength services

In providing this additional clarification, AEMO considers these additions enhance their effectiveness in practice.

1.2.1 Minimum SCR requirements to be registered with AEMO for new connecting generating systems only

While there is value in requiring new non-synchronous generating systems to register their minimum stable SCR, which is starting to occur already during some connection processes, AEMO believes a mandatory requirement for existing non-synchronous generating systems to have their SCR registered is unnecessary.

By specifying system strength by reference to the minimum fault current required at key power system nodes (as proposed above), the minimum SCR requirements for the majority of existing generators are likely to be provided inherently and, therefore, not required to be registered separately. This reduces the reporting burden while still providing the relevant information required for new non-synchronous generating systems seeking to connect.

The SCR requirements for existing non-synchronous generating systems could be added to AEMO's SCR register as required.

1.2.2 Clarifying the intention of obligations on new connecting generating systems

The AEMC proposes new connecting generators be required to pay for the remediation of degradation in local system strength their connection may cause, below the minimum requirement. AEMO believes the language in the draft rule implies that the obligation on new generating systems to 'do no harm' infers some form of capital expenditure to remediate the problem even where alternative, more efficient, solutions might be available. The range of possible remediation measures might include:

- Connecting to a higher voltage section of the network (if available)
- Capital expenditure solutions such as building synchronous condensers or connecting at a different voltage.
- Contracting with another generator or an NSP to provide fault current.
- Specification of technical characteristics, such as reduced active power rating, or low impedance transformers.

To be consistent with other current market initiatives promoting mechanisms to reduce capital expenditure, AEMO considers that rather than a network solution, any 'harm' may be more efficiently addressed using non-network solutions, especially if the 'harm' has a low probability of occurrence.

The obligations on connecting generators should, therefore, be clear that the cost associated with remediating any harm is not limited to a network solution.

1.3 Managing system strength in real-time

The draft Rule requires AEMO to manage low fault levels in real-time using the SCR at connection points as a metric. As mentioned in Section 1.1.1, AEMO believes the AEMC's proposal can be

improved by specifying such obligations using fault current at major power system nodes. This recommendation should be extended to AEMO's real-time obligations as well for the following reasons:

- Currently, AEMO monitors maximum fault levels to ensure stability and security of supply in accordance with clause 4.6.1 of the NER. NSPs have historically planned their networks on the basis of guaranteed maximum fault levels at an interface point, and the impact on downstream fault levels. On this basis, it would seem logical to include compliance with minimum fault level requirements in their planning and operational processes.
- Absolute fault level is more easily calculated and managed, both operationally and in a planning context, than SCR.
- Managing system strength in real-time is primarily related to maintaining minimum levels of synchronous capacity online. The use of fault level provides a simpler metric to manage operationally than SCR, as generation commitment and output varies. This would provide AEMO and NSPs a more predictable and simple baseline but, is not expected to address all power system stability problems. Development of additional screening methods would be necessary as will be set out in AEMO's proposed System Services Guidelines.

1.4 Proposed transitional rules

The Draft Rule proposes a series of transitional measures to facilitate the timely commencement of the proposed Rule in July 2018.

As discussed in Section 1.1.1, AEMO does not believe it is necessary for a minimum SCR to be determined for every existing connection point.

AEMO also believes it is important that the proposed System Services Guidelines be properly considered and consulted upon prior to coming into effect. This is important work that should not be rushed. AEMO, therefore, recommends that the AEMC not include provision for transitional guidelines in the Final Rule.

In the 2016 NTNDP, AEMO identified a system strength gap in South Australia. Further analysis has been undertaken to quantify this gap, and information about this system strength gap is expected to be published by AEMO as an update to the 2016 NTNDP.

This gap will need to be addressed ahead of this proposed Rule taking effect in July 2018 and the proposed System Services Guidelines being finalised.

In its 2017 Transmission Annual Planning Report, ElectraNet noted the studies which AEMO was undertaking and said that should a gap "be identified we will consider appropriate measures, which could include contracting large synchronous generators to remain in service when needed, or installing synchronous condensers, to maintain a required level of system strength".[1] ElectraNet has identified addressing this gap as a contingent project in both its revenue proposal to the AER for the 2018-2023 regulatory period[2] and in the 2017 TAPR.[3]

AEMO is concerned that the usual planning processes under the NER will not enable ElectraNet to consider the most efficient solutions quickly enough once AEMO quantifies the gap. In particular, the time required to conduct a full RIT-T assessment in accordance with the NER may in itself create a less efficient outcome (if the costs incurred by consumers in the interim are substantial and an earlier decision could have prevented these).

[1] ElectraNet, South Australian Transmission Annual Planning Report, June 2017, paragraph 3.5.3
[2] ElectraNet – Revenue Proposal 2018-23 – Attachment 6 – Capital Expenditure – March 2017. Available here: https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/electranet-determination-2018-23/proposal Accessed on 10 August 2017.
[3] Ibid 1, paragraph 8.33

Accordingly, AEMO supports the development of appropriate transitional rules that will allow a regional TNSP to respond appropriately should AEMO identify a 'system strength gap' in a particular region through its NTNDP process before the processes contemplated by the new Rule are in place.

Further, AEMO supports the development of appropriate transitional arrangements allowing a case to be made to the AER to expedite decisions that balance the costs to consumers of managing system strength in the short term (using operational or contractual solutions) against any longer term solutions.

The transitional arrangements will need to address:

- the obligation on a regional TNSP to take action to remediate an identified 'system strength gap';
- a provision that deems any action taken by a regional TNSP in response to the identified 'system strength gap' as an 'urgent and unforeseen network issue' for the purposes of clause 5.16.3 of the NER;
- a streamlined joint planning process between AEMO and the TNSP to develop the most timely, effective and efficient solution (replacing the need for a guideline in the transition period);
- a streamlined process for the regional TNSP to obtain regulatory approval for cost recovery in respect of the remedial action undertaken to implement the most timely, effective and efficient solution identified as a result of its joint planning process with AEMO.

AEMO looks forward to working with the AEMC and other stakeholders to address these issues.

2 MANAGING THE RATE OF CHANGE OF POWER SYSTEM FREQUENCY

AEMO supports the AEMC's two-staged approach to implementing changes to the NER: addressing the minimum levels of inertia or other frequency management services (such as Fast Frequency Response (FFR)) required for managing power system security in this proposed new Rule, with a subsequent new Rule (late 2017) to develop a mechanism for delivering inertia and other services.

This approach is consistent with AEMO's submission to the Draft Determination, which proposed a two-tier inertia requirement: a minimum level required for power system security that must be available (though not necessarily enabled) at all times, plus an additional level of inertia providing market benefits through relaxing system constraints.

Obligation on NSPs

AEMO supports the AEMC's proposal that, in at least the short term, NSPs are best placed to manage the minimum inertia required for their networks as this will allow immediate inertia issues to be resolved. In the longer term, it may be more efficient to allocate this responsibility centrally to AEMO, ideally through an integrated market mechanism.

Furthermore, given the strong link between delivering inertia and providing system strength, tat least in the short term, the NSP should manage these two requirements simultaneously, taking into account the proposed System Services Guidelines that will consider broader issues of power system security. In parallel it is critical that NSPs work closely with AEMO to ensure AEMO can maintain power system security at all times.

AEMO agrees that it is appropriate to initially align these *inertia sub-networks* with the existing regions, with AEMO to undertake further analysis over time and specify smaller *inertia sub-networks* if appropriate.

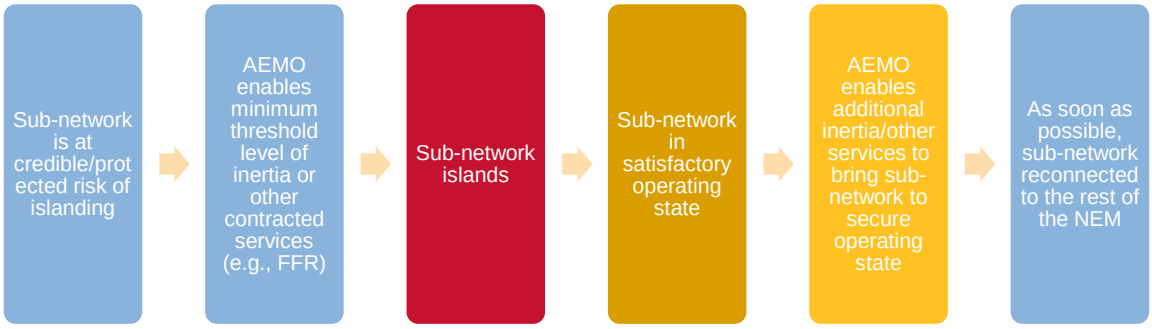
Improved power system security

AEMO agrees these changes will improve power system security. They also represent a further step towards unbundling energy market services, which will allow more flexibility in operating parts of the NEM vulnerable to islanding in secure operating states both before and after islanding.

2.1 Defining minimum and secure operating levels of inertia

The draft Rule states that the minimum threshold/secure operating level of inertia is "the minimum level of inertia required to operate the inertia sub-network in a satisfactory/secure operating state when the inertia sub-network is islanded" (clause 5.20B.2).

The following chart represents AEMO's understanding of how an inertia sub-network would be operated before and after islanding:



Operating the network in a satisfactory operating state after islanding would require any contingency event associated with the separation event to be minimised. AEMO, therefore, expects to have to curtail interconnectors at times when separation is a credible contingency or a relevant protected event. Therefore, developing an effective mechanism for valuing and procuring additional inertia or other services at such times will be important for the efficient operation of the NEM (and will be addressed in the second proposed Rule).[4]

2.2 Determining the secure operating level of inertia

The AEMC proposes three matters that AEMO must take into account in determining the *secure operating level of inertia* (clause 5.20B.2(c)):

1. the capabilities and expected response times provided by generating units providing market ancillary services (other than the regulating raise service or regulating lower service) in the inertia sub-network;
2. the maximum load shedding or generation shedding expected to occur on the occurrence of any credible contingency event affecting the inertia sub-network when the inertia sub-network is islanded; and
3. additional inertia needed to account for the possibility of a reduction in inertia if the contingency event that occurs is the loss of a scheduled generating unit.

AEMO agrees that these are key inputs into determining the inertia requirement, but proposes the following enhancements:

Broader consideration of contingency events

AEMO notes that the third matter should be broadened to consider the loss of any synchronous generating unit in the contingency, or the loss/unavailability of any service that is material to managing the RoCoF in the islanded network. This could include scheduled or non-scheduled synchronous generation, synchronous condensers, or other services (clause 5.20B.5, such as FFR providers) that can be used to reduce the inertia requirement.

Constraining the system to reduce inertia requirements

AEMO also expects to need to consider the level of constraints that would or could be placed on the sub-network before islanding, immediately after separation, and in a secure operating state if required. For example, this could involve curtailing generation to reduce the maximum contingency and reduce overall inertia requirements. These factors may also be related; for example, if generation needs to be constrained to reduce the size of an overall contingency, this may limit the maximum demand that can be served in the islanded sub-network.

Applying more significant constraints to the islanded network would reduce the *minimum threshold* and *secure operating levels of inertia*. However, applying significant constraints may extend restoration time (e.g., if a thermal generating unit has been shut down, it may take several hours to restore it).

AEMO, therefore, recommends an additional matter should be included in clause 5.20B.2(c) for AEMO's consideration:

4. any constraints that could be reasonably applied to the islanded sub-network to achieve a secure operating state, and any unserved energy that might result from these constraints

[4] See opening paragraph of this submission.

Defined response time for secure level of inertia

When the power system is not secure, including after a separation event, AEMO should use all reasonable actions with a view to returning the system to a secure operating state as soon as it is practical to do so, and in any event within 30 minutes (clause 4.2.6(b)). Therefore, the inertia required to meet the *secure operating level of inertia* (in particular, the difference between the minimum and secure levels) would either need to be able to be activated within 30 minutes of a credible contingency or protected event that led to the islanding of the region, or be already enabled.

AEMO recommends that this requirement be explicitly stated in the proposed Rule. This would allow AEMO to enable more than the *minimum threshold level of inertia* to ensure the *secure operating level of inertia* could be made available, if required. More importantly, as part of the requirement to seek least-cost solutions, it would allow NSPs to give preference to services that could be activated quickly, or with low short-run marginal costs if they were to be enabled pre-contingency.

Minimum threshold level of inertia

AEMO must take all reasonable steps to ensure that, after a credible or protected separation event, the power system will remain in a satisfactory operating state within the technical envelope determined by the NER and in accordance with the FOS.

With very low levels of inertia even small movements in load or generation under islanding conditions might result in significant frequency movements. If the frequency moves too quickly for the available regulation service or contingency FCAS to operate, the islanded region might not remain in a satisfactory state – even in the absence of future contingency events. Therefore, sufficient inertia would be required to ensure that available regulation and contingency FCAS would be sufficient to manage the normal variations in demand and generation. Analysis by AEMO indicates that a minimum level of inertia would be required even to ensure that other activities, such as FFR, have sufficient time to operate.

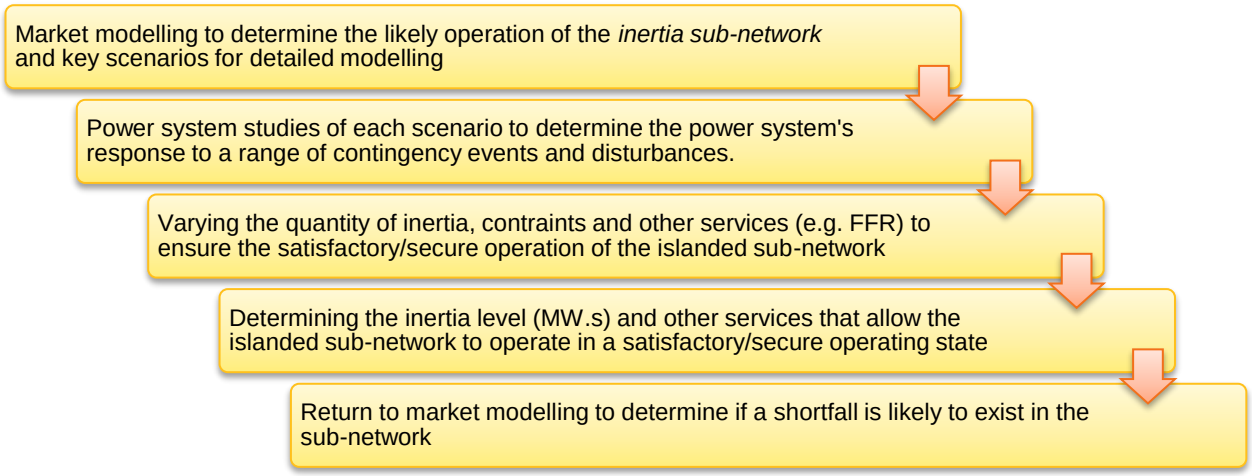
This is distinct from the transition to the secure operation of the island, where the possibility a further contingency event must be allowed for.

The draft Rule does not explicitly provide for the factors that AEMO must consider in determining this level. AEMO proposes to determine those factors in the Guideline, and agrees that it is appropriate not to include that level of technical detail in the NER. AEMO expects that this would require consideration of other factors contributing to the secure operating level, but without the need to consider contingency events. AEMO would again use a combination of modelling and previous operational experience to set an appropriate requirement.

AEMO notes that in the existing FOS, a (contingency) load event is classed as “an identifiable connection or disconnection of more than 50 MW of customer load” not arising from another contingency event. Implicitly, this may indicate the size of load events that would need to be managed, but is unlikely to be appropriate for a specific islanded sub-region. It may be appropriate to consider adjusting this definition for islanded sub-networks, and this could be considered as part of the current Review of the Frequency Operating Standard.

2.3 Procedure for determining inertia requirements

At a high level, AEMO expects that the process for determining the *minimum threshold* and *secure operating levels of inertia* can be depicted as follows:



As part of this process, AEMO would consider other activities proposed by a TNSP as alternatives to procuring inertia (and which might therefore reduce the inertia requirement). For example, FFR that can quickly restore the supply-demand balance after a contingency in the islanded sub-region may allow for a larger RoCoF for a briefer period and, hence, require less inertia.

Streamline development of procedure

If updating the *inertia requirements procedure* is a lengthy process, it would need to be less detailed and leave enough scope to flex the methodology and parameters outside the procedures. Given the requirements already outlined in the draft Rule, the procedure is unlikely to do more than repeat the factors that AEMO will take into account, and will not be a useful document.

Consistent with AEMO's proposal for system strength (Section 1.1.1), AEMO proposes that the development and updating of processes for determining the inertia requirements could be managed through the existing NTNDP consultation process. This requires AEMO to consult on material issues and inputs during the year and to explain why these have or have not been included in the analysis. This would be in addition to the matters related to inertia presented and consulted on in the System Services Guidelines (discussed in section 1.1.2).

In this framework, the procedure could be amended outside of the Rules consultation procedures and on a more regular basis, if required (for example, where an additional parameter or different circumstances arise). This ensures that AEMO is not compelled to continue to apply out-dated methodologies as the market's technical understanding and potential solutions evolve. This is a real and present challenge in today's rapidly transforming power system.

Timelines for identifying inertia requirements and shortfalls

AEMO notes that in the current proposal, there could be a two-year delay between identifying a physical inertia shortfall and the delivery of inertia: changes to the power system occurring close to the NTNDP publication might not be captured or analysed in time. Coupled with the requirement for a 12-month notice period for the *Inertia Service Provider*, this could lead to a delay of over two years before a potential *inertia shortfall* could be remedied. AEMO, therefore, proposes a number of enhancements to improve the speed and flexibility of inertia procurement.

Time between shortfall and remedy

The AEMC have proposed that if AEMO identifies a shortfall, the date by which the relevant *Inertia Service Provider* must provide those services must not be earlier than 12 months after the publication of the NTNDP. In contrast, the Network Support and Control Ancillary Services (NSCAS) Tender Guidelines[5] expect that NSCAS can be procured in five months. AEMO also notes that new synchronous condensers are unlikely to be able to be constructed even within 12 months, while contracts with Generators for the provision of services that a generating system might be able to provide could be procured in shorter timeframes. AEMO, therefore, recommends that the timeframe for addressing a shortfall be reduced to 6 months.

Under the draft Rule, *Inertia Service Providers* might not be required to deliver inertia until July 2019. AEMO recommends that this restriction be removed, and allow inertia to be requested and procured earlier, subject to the proposed timeframes above. In addition, AEMO recommends that transitional measures for inertia be aligned with those for system strength, as discussed in Section 1.4.

Responding to unexpected events

AEMO considers it important that the *inertia requirements* and any *inertia shortfall* can be reviewed in response to major changes to the power system. Clause 5.20B.2(d)(2) requires AEMO to make a determination of *inertia requirements* in response to major changes to the power system, with the retirement of a synchronous generating unit given as an example.

AEMO notes that the exit of a synchronous generating unit might not, on its own, affect the *inertia requirements.* AEMO expects the requirements would more typically be driven by the size of potential contingency events in the islanded system and the available FCAS response. The retirement of generation could, however, have an impact on the presence of an *inertia shortfall* (e.g., if the retirement was earlier than expected, and AEMO's modelling had included a contribution from that generator in providing inertia).

AEMO recommends that the draft Rule be amended to include consideration of changes affecting either the *inertia requirements* or the presence of an *inertia shortfall.* This would give AEMO and NSPs greater ability to ensure the security of networks when conditions change unexpectedly. This should also include events with unpredictable timing.

Out of cycle notifications

AEMO also recommends that the NTNDP not be the only mechanism available to give notice of an *inertia shortfall*. The NTNDP is currently conceived of as a multipurpose document that is produced following a process set out in the NER. As such, it cannot be produced quickly. AEMO, therefore, recommends that the interim rules proposed by the AEMC allowing notification of the *Inertia Service Provider* outside of the NTNDP cycle (as per clause 11.99.4(c)) be extended to the ongoing operation of the proposed Rule. Notification would still be provided in AEMO's NTNDP and relevant Transmission APRs and be published on AEMO's website.

Developing standard contracts and streamlining procurement

AEMO proposes to work closely with NSPs to agree on a framework for developing and approving sources of inertia to be applied under proposed clause 5.20B.6(d). This would allow NSPs to negotiate with service providers for services with reasonable confidence, and ensure that the services made available to AEMO through the NSPs' priority order have consistent characteristics. This will allow AEMO to follow the priority order where possible, and reduce the analysis required for operational decisions close to real-time.

[5] Page 7, https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Ancillary_Services/Network-Support-And-Control-Ancillary-Services-Tender-Guidelines.pdf

2.5 Alternatives to inertia procurement

AEMO considers it important that the NER remain technology neutral and do not mandate inertia as the only option for managing the RoCoF. Alternative options for managing frequency include special protection schemes, generator runback schemes and FFR, including from distributed energy resources and demand response.

AEMO supports the AEMC's approach to allow other services to be considered by AEMO, the NSP or other suitable party and to be procured if they represent a least-cost option.

Given the diversity of potential solutions, AEMO agrees that it is appropriate to require potential solutions to be approved by AEMO to reduce the inertia requirement where they are operating. This is preferred to prescribing specific alternatives to inertia that might preclude some potential service providers.

It may be valuable, however, to establish trials of new technology to develop sufficient experience to justify investment, and to develop practical demonstrations as a basis for AEMO to confirm their effectiveness. It may also be appropriate to require consideration of, or expressions of interest for, non-inertia solutions (e.g., an FFR response that could reduce the inertia requirement).

It may also be necessary to impose requirements for new generating units to have **the ability** to offer services such as active power control and FFR to ensure that such services are available in the future. AEMO has previously provided similar advice on the merits of mandatory active power controls (although not FFR at this stage) for all new generators to Essential Services Commission of South Australia[6].

Other services

AEMO notes that the proposed clause 5.20B.5 (and related clauses, such as clause 5.20B.4(b)(2)) do not allow for other services to effect a reduction in the *minimum threshold level of inertia*. AEMO recommends that the proposed Rule allows for this, and for AEMO and the *Inertia Service Provider* to consider the capabilities of each proposed service.

2.6 NEM-wide inertia requirements

AEMO notes that the Draft Rule only provides for inertia to manage sub-networks that are at risk of islanding (e.g., South Australia when the loss of the Heywood Interconnector is a credible contingency or, if applicable in the future, a protected event). Preliminary projections developed by AEMO suggest that mainland inertia levels could decline over time so that the FOS might not be met without curtailing the largest generating units and thereby reducing the size of the largest contingency events[7]. These projections depend on many factors, including future contingency sizes and the development of new services, such as FFR, and could initially be managed through network constraints. However, AEMO recommends that the AEMC consider potential NEM-wide inertia requirements in a subsequent rule change proposal that will investigate the procurement of inertia and other services to deliver market benefits.

2.7 Clarification of drafting

AEMO has identified some other potential clarifications that could be made to the drafting of the proposed Rule, and has provided these to the AEMC for its consideration.

[6] https://www.aemo.com.au/Media-Centre/AEMOs-recommendations-on-ESCOSA-report
[7] Slide 17, https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Reports/FPSS-2017-01-27a.pdf