Australian Energy Market Commission

RULE CHANGE

CONSULTATION PAPER

National Electricity Amendment (Generator Technical Performance Standards) Rule 2017

Rule Proponent
Australian Energy Market Operator

19 September 2017

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About the AEMC

The AEMC reports to the Council of Australian Governments (COAG) through the COAG Energy Council. We have two functions. We make and amend the national electricity, gas and energy retail rules and conduct independent reviews for the COAG Energy Council.

Executive summary

On 11 August 2017, the Australian Energy Market Operator (AEMO) submitted a rule change request to the AEMC seeking changes to:

- the access standards for generating systems in the National Electricity Rules (NER), and
- the negotiating framework that translates those access standards into the standard of performance required of the physical equipment that makes up and connects to the power system.

The last decade has seen a rapid rise in the penetration of new generation technologies, such as wind and solar farms. In the past, these technologies accounted for only a small fraction of total electricity supply. Now they are a critical part of our power system, and their significance is continuing to grow. Changes to the NER are required to keep pace with this transition and maintain the security of the power system.

Forming part of the AEMC's broader work program focused on the security of the power system, this rule change request also covers part of recommendation 2.1 made by the Finkel Panel in its Independent review into the future security of the National Electricity Market. The rule change relates primarily to the connection standards for generators, and not for other equipment such as market network service providers and certain large customers.

Background

Equipment that makes up and connects to the power system must perform to certain levels of technical capability. This helps AEMO to maintain the power system in a secure and safe operating state and manage the risk of major supply disruptions.

The levels of performance for equipment connecting to the power system are set out in performance standards for each connection. These performance standards are reached through a negotiating framework that is set out in the NER. Under this framework:

- access standards in the NER define the range of the technical requirements for the operation of equipment when negotiating the connection of generators, market network service providers and certain end use customers. These access standards include a range from the minimum to the automatic access standard.
- for each technical requirement defined by the access standards a connection applicant must either:
  - meet the automatic access standard, in which case the equipment will not be denied access because of that technical requirement, or
  - negotiate a standard of performance with the local network service provider (and AEMO for access standards that are AEMO advisory matters) that is at or above the minimum access standard and below the automatic access standard, and

- equipment that does not at least meet the minimum access standard will be denied access because of that technical requirement.

As noted above, this rule change request relates primarily to the access standards that apply to generators. Generator access standards cover a range of technical capabilities for connecting generators, including, among other things, reactive power capability, quality of electricity, response to frequency and voltage disturbances during and following contingency events, frequency control, protection systems, and monitoring and control systems.

Issues raised and changes proposed to address them

AEMO considers that the current access standard settings in the NER and the negotiating framework to set performance standards are not adequate to ensure ongoing security in an evolving power system. AEMO also considers that the security of the power system may be impacted if the connection applications currently before them, as well as those applications expected to be made in the near future, are processed on the basis of the current access standards and negotiating framework.

To address these issues, AEMO proposes:

- amending or introducing a number of access standards for connecting generators, including those relating to voltage control and reactive power provision, disturbance ride through, system strength, active power control and remote monitoring and control
- amending the process for negotiating performance standards for equipment connecting to the power system, and
- implementing transitional arrangements applying the changes to performance standards agreed on or after 11 August 2017.

Assessment framework

The Commission's assessment of this rule change will consider how performance standards can be set in a way that supports system security at the lowest cost to consumers in the long term. This will include considering:

- the appropriate allocation of costs and risks to parties involved in the process of setting performance standards for equipment connecting to the power system
- regulatory certainty and flexibility for parties involved in the connection process
- the existence of any barriers to entry, including technical and cost barriers, for particular technologies, scales or locations, and
- whether the overall benefits of any changes outweigh the costs.

Consultation processes

This consultation paper has been prepared to facilitate stakeholder comment on the issues raised by the rule change request. Stakeholders are invited to provide written submissions by 31 October 2017.

In addition to consultation on this paper the Commission will be holding stakeholder workshops to facilitate input on the issues and potential solutions in this rule change. Further information on these workshops will be provided as assessment of the rule change progresses.

Contents

1 Introduction

On 11 August 2017, the Australian Energy Market Operator (AEMO) submitted a rule change request to the Australian Energy Market Commission (AEMC or Commission). The request seeks changes to the access standards for generating systems in the National Electricity Rules (NER) and changes to the negotiating framework that translates those access standards into the standard of performance required of the physical equipment that makes up and connects to the power system.[1]

This consultation paper has been prepared to facilitate public consultation on the rule change request. The paper sets out:

- a summary of, and a background to, the rule change request (Chapters 2 and 3)
- the proposed approach to assessing the rule change request (Chapter 4)
- a number of questions and issues to facilitate consultation (Chapters 5 and 6), and
- the process for making submissions (Chapter 7).

1 The power system is the electricity power system of the national grid including associated generation and transmission and distribution networks for the supply of electricity, operated as an integrated arrangement, as defined in Chapter 10 of the NER.

2 Background

The sections below provide relevant background on:

- the context for this rule change request
- the current arrangements for managing power system security and setting performance standards for equipment connecting to the power system
- the types and roles of access standards in the NER, and
- the relevant AEMC and other projects and processes that relate to this rule change request.

2.1 Context

The power system has historically been comprised of large synchronous generators.[2] The last decade has seen a rapid rise in the penetration of new asynchronous generation technologies, such as wind and solar farms.[3] In the past, these asynchronous technologies accounted for only a small fraction of total electricity supply. Now they are a critical part of our power system, and their significance is continuing to grow.

As synchronous generation that innately provides some system security services exits the power system and is replaced by asynchronous generation with different characteristics, there has been an increased focus on the appropriate market and regulatory frameworks to maintain system security. The AEMC's System security market frameworks review and the Independent review into the future security of the national electricity market,[4] both recommended further consideration of changes to technical standards for equipment connecting to the power system as part of a broader suite of potential policy measures to maintain a secure and resilient power system throughout its transition.

In this context AEMO has submitted a rule change request proposing changes to the technical standards in the NER for generators connecting to the power system,[5] as well as changes to the negotiating framework that translates those technical standards into

2 Synchronous generators are large spinning units that have turbines that spin at the same speed as the frequency of the power system. As a result there is an electro-mechanical "link" between the mechanical energy of the generator and the electrical frequency of the power system.

3 Asynchronous generators are those that connect to the power system using inverters.

4 See AEMC, *System security market frameworks review*, final report, 27 June 2017 and Expert Review Panel, *Independent review into the future security of the national electricity market: blueprint for the future*, final report, June 2017.

5 Note the term "technical standards" is an industry term and is not defined in the NER. The term loosely refers to the rules that set the level of performance required of the equipment that makes up, and is connected to, the power system. More detail on this is provided in section 2.1.2 below.

the standard of performance required of the physical equipment that makes up and connects to the power system.

2.2 Current arrangements

This section provides an overview of technical standards in the NER and how they are used to set the performance standards that apply to equipment connecting to the power system.

2.2.1 Power system security and reliability

Power system security refers to maintaining the power system in a secure and safe operating state to manage the risk of major supply disruptions. It deals with the technical parameters of the power system such as voltage, frequency, the rate at which these might change and the ability of the system to withstand transient faults. System security is necessary for the efficient functioning of the National Electricity Market (NEM).[6]

System security is distinct from reliability. The reliability of supply has a consumer focus and describes the likelihood of supplying all consumer needs with the existing generation capacity and network capability. Security of supply is a measure of the power system's capacity to continue operating within defined technical limits, even in the event of the disconnection of a large generator, load or major network element such as an interconnector. A secure operating system is a necessary condition for meeting consumer electricity needs.

2.2.2 Management of power system security

AEMO is required under the NEL and the NER to operate and maintain the power system in a secure operating state. In order for the power system to remain in a secure operating state, there are a number of physical parameters that must be maintained within a defined operating range. An electricity system that operates outside of these parameters may become unstable, jeopardise the safety of individuals, risk damage to equipment, and lead to the possibility of blackouts.

To manage power system security AEMO has a range of tools available to it, including:

- the operation of the power system, particularly through applying constraints to the dispatch of generation
- the utilisation of market and non-market ancillary services (such as frequency control ancillary services (FCAS) and network support control ancillary services), and

6 Note the NEM refers to the wholesale exchange operated and administered by AEMO as well as the national electricity system, as defined in the NEL. The term "national electricity system" in the NEL is consistent with the term "power system" defined in the NER, which is the term used throughout this document.

- instructions and directions to market participants, including load and generation shedding instructions.

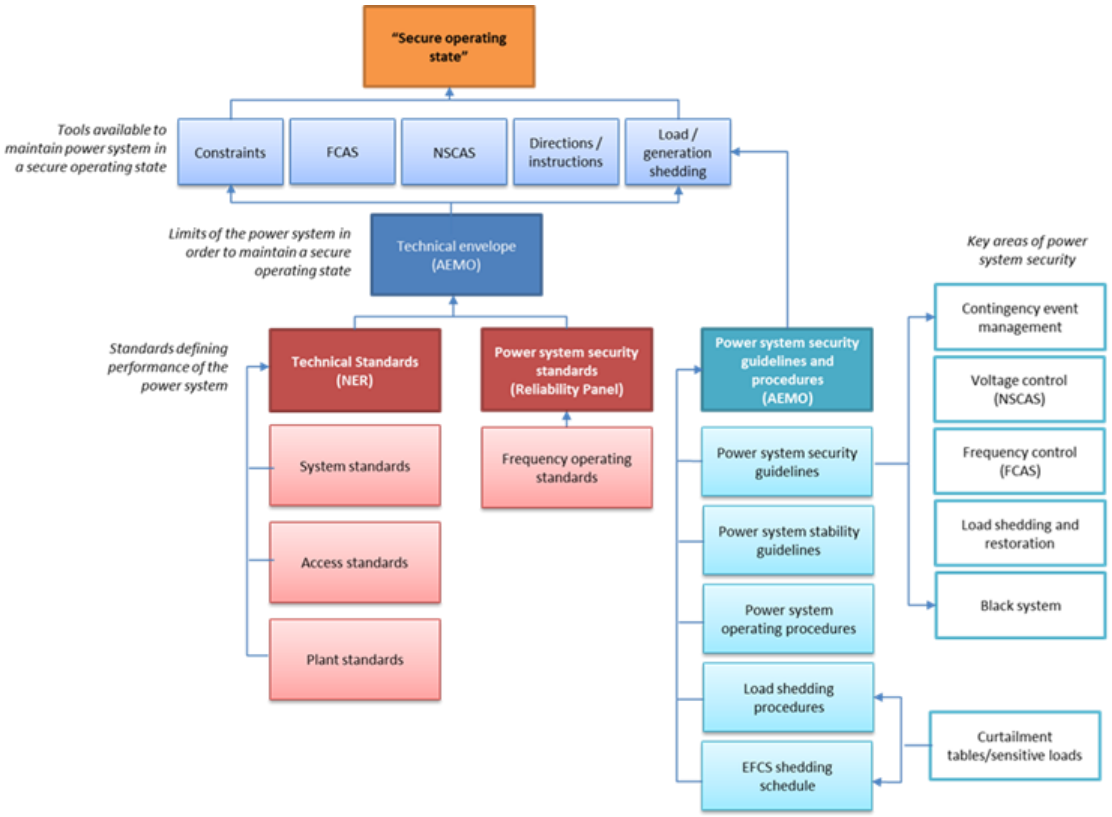
AEMO's management of power system security is influenced by a number of variables. These include the performance of electricity networks and equipment that is connected to the power system that are determined by the "technical standards" in the NER. It also includes the power system security standards set by the Reliability Panel, and the power system security guidelines and procedures set by AEMO.

This rule change concerns the process of setting standards for equipment connecting to the power system, particularly generating equipment, and in this way is directly related to AEMO's ability to manage power system security.

Network businesses also play an important role in the general operation of the power system, including functions that are relevant to the maintenance of system security. This includes meeting requirements to take a number of actions to deliver minimum levels of capability in their networks, including power transfer capability, minimum function of equipment and management of voltage.[7] Networks also have responsibilities related to emergency frequency control, including working with AEMO in the design and implementation of emergency frequency control schemes.

Figure 2.1 below shows the overarching framework for managing power system security.

Figure 2.1 Framework for managing power system security



7 See Schedule 5.1 of the NER.

2.2.3 Overview of technical standards

The term "technical standards" is not defined in the NER, but broadly refers to the rules that set the level of performance required of the equipment that makes up, and is connected to, the power system. The overall power system is operated to these standards which allows AEMO to effectively manage the power system securely.

The "technical standards" are the provisions in the NER that:

- define power system security and quality standards (known as system standards),[8] and
- define ranges of standards for different kinds of equipment that may connect to the power system (known as access standards).[9]

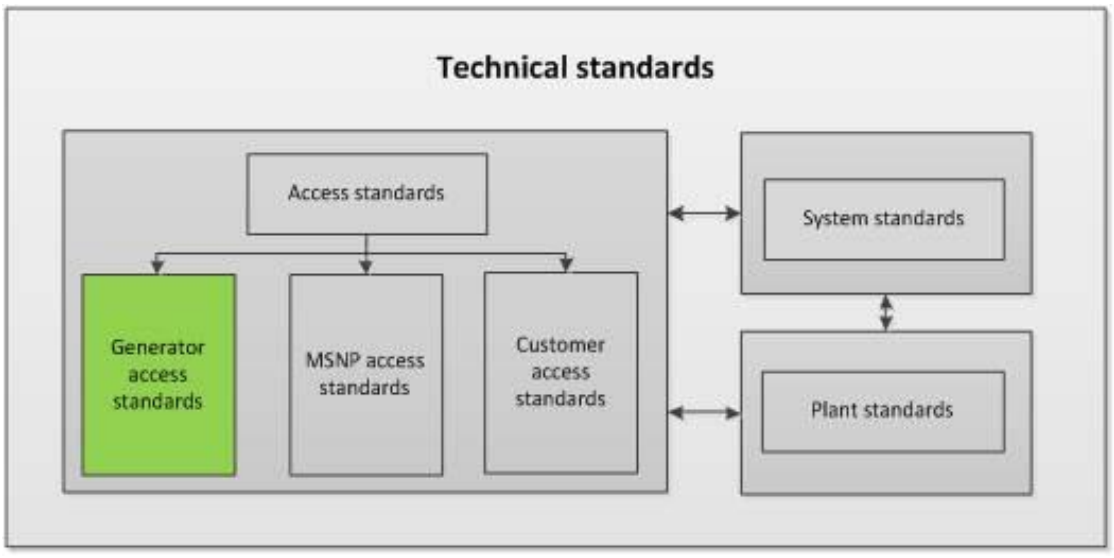
The NER also define the process to negotiate performance standards for specific equipment connecting to the power system.

Together these rules define the required performance of the power system and the equipment connecting to it. They allow parties to invest in and operate equipment with reasonable assurance of the quality and performance of the network and other parties connected to it.

It is the *access standards*, and the way that they are translated into the required performance of particular equipment through a negotiating framework, that among other tools, enables the power system to meet the *system standards*.

Figure 2.2 below shows the types of technical standards in the NER and how they relate to each other.

Figure 2.2 Overview of technical standards



8 These are contained in Schedule 5.1(a) of the NER.

9 These are contained in Schedules 5.1, 5.2, 5.3 and 5.3a to Chapter 5 of the NER.

2.2.4 System standards

The *system standards* set the targets for the performance of the power system. The purpose outlined in the NER is to establish *system standards* that:[10]

- are necessary or desirable for the safe and reliable operation of facilities of registered participants and equipment that makes up and is connected to the power system[11]
- could be reasonably considered good electricity industry practice, and
- seek to avoid the imposition of undue costs on the industry or registered participants.

The system standards establish the security, reliability and quality parameters of the power system. They define specific technical operating standards for the power system, such as the frequency operating standard,[12] the requirements for the power system to remain in synchronism and be stable, a range of voltage requirements and fault clearance requirements.

2.2.5 Access standards

The *access standards* define the parameters of the technical obligations for the operation of equipment owned by network users and network owners when negotiating the connection of certain types of equipment. Access standards relate to the connection of generators, market network service providers (MNSPs) and end use customers. For each technical requirement, the corresponding *access standard* is generally comprised of:

- an *automatic access standard* - equipment that meets this standard would not be denied access because of that technical requirement
- a *minimum access standard* - equipment that does not at least meet this standard will be denied access because of that technical requirement, and
- a *negotiated access standard* - equipment that does not meet the automatic access standard can connect at a level of performance that is at or above the level of the minimum access standard following a process of negotiation between the

10 See clause S5.1a.1 of the NER.

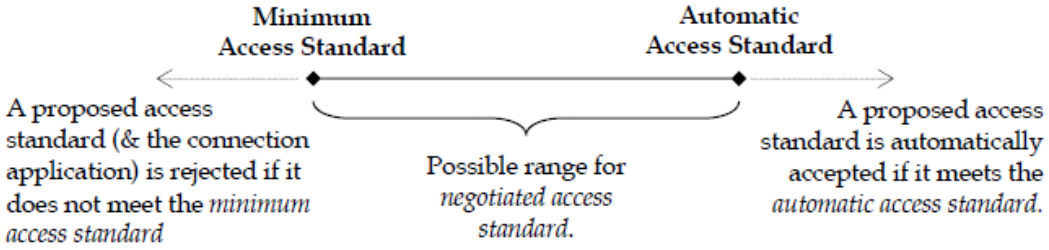
11 A registered participant is a person registered by AEMO under Chapter 2 of the NER. They include certain generators, purchasers of electricity (customers), aggregators of small generating units, transmission and distribution network service providers, traders and market participants (which is in essence any of the preceding persons that participates in markets or trading activities conducted by AEMO).

12 The frequency operating standard defines maximum acceptable frequency deviations for different types of operating states or following events that can occur within the power system. It is incorporated into the system standards by reference, but is defined by the Reliability Panel periodically. The Panel is currently reviewing the frequency operating standard for Tasmania and the mainland power system.

connection applicant and the relevant network service provider (NSP) (and with AEMO for those access standards that are AEMO advisory matters).[13]

Figure 2.3 below shows the range between an *automatic* and *minimum access standard* for any given technical requirement.

Figure 2.3 Access standards ranges



The Reliability Panel can also declare technology-specific standards (called "plant standards") which, if met, would assure compliance with the access standards. Plant owners may request that the Panel approve particular standards for this purpose. To date, no *plant standards* have been declared by the Reliability Panel.

2.2.6 Negotiation of performance standards

The access standards in the NER are the reference points used for negotiations between a connection applicant, a NSP and, where relevant, AEMO, to set the specific levels of technical performance of equipment that a connection applicant is seeking to connect to the power system. Once the technical performance of the equipment is agreed, the specific levels agreed become the *performance standards* for that connection and form part of the connection agreement between the parties.[14]

The process for the negotiation of *performance standards* is set out in the NER and is part of the overall connection process in Part A in Chapter 5 of the NER.[15] Under this process the connection applicant lodges a connection enquiry with the Local NSP setting out the type, magnitude and timing of a proposed connection. The Local NSP must then:

- provide details to the connecting party of all the other parties that will need to be involved in the negotiations (for example, other NSPs), and

13 An AEMO advisory matter is a matter that relates to AEMO's functions under the NEL and a matter in which AEMO has a role in Schedules 5.1a, 5.1, 5.2, 5.3 and 5.3a, being the assessment of negotiated access standards.

14 See clause 5.3.4A(i) of the NER.

15 See rule 5.3 of the NER. Chapter 5, Part A effectively deals with three connection processes: connection of embedded generation (to the distribution network only); connection of generation (for both transmission and distribution); and connection of load (for both transmission and distribution).

- provide details of each of the access standards relevant to the equipment to be connected (automatic, minimum and plant) and the negotiated access standards that will require input from AEMO.[16]

The connection applicant may then make an application to connect. In that application, for each technical requirement where the proposed equipment will not meet the *automatic access standard*, the applicant must propose a *negotiated access standard*. A *negotiated access standard* must be:[17]

- no less onerous than the *minimum access standard*
- set at a level that will not adversely affect power system security[18]
- set at a level that will not adversely affect the quality of supply for other network users, and
- for generating plant, meet specific requirements for *negotiated access standards* set out in the NER.[19]

The NSP must consult with AEMO regarding those negotiated access standards for which AEMO has an advisory role.[20] The NSP must then respond to the connecting party either accepting or rejecting each of the proposed negotiated access standards. A negotiated access standard must be rejected if it would not, in the reasonable opinion of the NSP (or AEMO in respect of its advisory matters) meet the requirements listed above.

Where a proposed negotiated access standard is rejected, the NSP must advise the connecting party of a negotiated access standard that the NSP will accept.[21] The connecting party can then either accept the negotiated access standard that the NSP has proposed or propose another negotiated access standard that must be assessed by the NSP (and AEMO in respect of its advisory matters) again in the process outlined above. This process can continue until the access standards are agreed. The NSP and connecting party are required to negotiate in good faith.[22]

This framework applies to new connections, as well as alterations to existing connections.

16 See clauses 5.3.3(b) and (b1) of the NER.

17 See clause 5.3.4A of the NER.

18 Power system security refers to AEMO scheduling and operating the power system in a secure and safe operating state, and returning the system to such a state following supply disruptions.

19 Including those matters set out in clauses S5.2.5 to S5.2.8 of the NER.

20 As noted above an AEMO advisory matter is a matter that relates to AEMO's functions under the NEL and a matter in which AEMO has a role in Schedules 5.1a, 5.1, 5.2, 5.3 and 5.3a, being the assessment of negotiated access standards.

21 See clause 5.3.4A(g) of the NER.

22 See clause 5.3.6(f) of the NER.

The framework is relatively prescriptive and follows a staged negotiation process with defined timeframes for key steps in the process. However, it is understood that, in practice, it can be a more fluid iterative process as parties exchange relevant information to finalise negotiations.

As noted above, once this process is finalised, the agreed standards are set out in the connection agreement.[23] These agreed standards are called *performance standards*. The NSP must then notify AEMO of the performance standards set out in the connection agreement.[24] AEMO uses these performance standards to help it operate the power system in a safe and secure state.

2.3 Generator performance standards

As noted in section 2.2.2 above, the performance standards for equipment connecting to the power system are one of the inputs relevant to AEMO's management of the security of the system. As the generation mix evolves, the performance of new generators connecting to the system is an important source of capabilities available to AEMO to be used to achieve a secure power system.

The access standards in the NER, as well as the framework for negotiations, complement and in many cases enable the range of other tools (such as FCAS and system constraints) that are available to AEMO to meet the system standards. For example, mandating active power control capabilities may impact the number of generators that are then able to make offers in FCAS markets. This would then be relevant to AEMO's ability to procure FCAS to manage system frequency. Higher or lower standards for generators connecting to the power system can therefore influence the costs and effectiveness of those other tools.

The sections below provide an overview of capabilities that generator performance standards can provide that are relevant to this rule change request. We have not included an overview of capabilities provided by access standards that are not impacted by AEMO's rule change request, such as quality of electricity generated and impact on network reliability.

Voltage and reactive power control – Voltage control is required to maintain power system stability and maximise power transfer capability within transmission and distribution networks. Voltage control is inherently related to the provision of reactive power which is utilised for the formation of magnetic and electric fields in devices such as motors, transformers and transmission lines. The capabilities of connecting generators to provide reactive power not only influence the power transfer capability of the power system but also its stability and ability to recover from disturbances.

Disturbance ride through – Maintaining the security of the power system requires robustness and resilience on the part of the system as a whole as well as the individual components that make up the system. Disturbance ride-through capabilities required

23 See clause 5.3.6(b) of the NER.

24 See clause 5.3.6(g) of the NER.

from connecting generators involve robustly maintaining continuous operation in the face of power system fault and contingency events and the resilient capacity to recover quickly and return the power system to standard operating conditions immediately following power system disturbances.[25]

Active power control – Control of power system frequency requires continuous matching of supply and demand for active power. In the power system, frequency control is managed through a combination of FCAS, primary frequency control through automated governor response, and synchronous inertia. Future power system needs are likely to see an increase in requirements for the management of changes in frequency in shorter timeframes in the form of fast frequency response (FFR). Whether a connecting generator has active power control capability will determine its ability to assist in balancing supply and demand of active power on a number of different time scales. This is necessary to support system security by maintaining system frequency within acceptable limits, and potentially acting as a source of future FFR.

System strength – System strength is an inherent characteristic of any power system and is usually measured by the available fault current or by the short circuit ratio (SCR) at a given location. Fault currents vary throughout the network and are higher in areas close to synchronous generation. As levels of synchronous generation decline, the consequent reduction in system strength may result in power system security issues. Particular areas of concern are asynchronous and synchronous plant stability, incorrect operation of protection systems, and voltage control. The ability to maintain stable operation in a low system strength environment will therefore be an important capability from connecting generators.

Remote monitoring – The increasing complexity of the power system, and the necessity for faster operational actions, leads to the need for greater automation and coordination of many different power system elements. The capability for a generator to provide real-time information allows AEMO to specify the technical envelope, and to better understand the real-time ancillary services requirements and capabilities, to maintain power system security with more precision.

2.4 Related policy processes

A range of policy processes have recently considered the role of generator performance standards in maintaining power system security. This includes a broader system security work program that has been undertaken by the AEMC. A summary of these processes is set out at Appendix A.

25 These requirements are specified in clauses S5.2.5.3, S5.2.5.4, S5.2.5.5, and S5.2.5.7 of the NER, and specify requirements for the, reactive output of generating systems during fault conditions, the ability of generating systems to remain in service through multiple low voltage disturbances, requirements for managing the risk of transient asynchronous generator reduction due to a single credible fault, and generator over-voltage ride through capability.

3 Details of the rule change request

In its rule change request, AEMO provides its rationale for the rule change, which included the following issues:

- the current access standard settings in the NER are not adequate to ensure the ongoing security of an evolving power system
- the negotiating framework allows connecting generating systems to use the minimum access standard as a default setting when entering the negotiation of performance standards, which risks impacting the ongoing security of an evolving power system, and
- the ongoing security of the power system may be impacted if the large number of connection applications currently before AEMO, as well as those applications expected to be made in the near future, are processed on the basis of the current access standards and negotiating framework rather than the potential new arrangements.

To address these issues, the rule change request from AEMO proposes to:

- change the levels of certain automatic and minimum access standards for generators, as well as introduce new access standards
- change the process for negotiating performance standards, and
- implement transitional arrangements applying the changes to performance standards agreed on or after 11 August 2017.

The rule change request includes a proposed rule. Copies of the rule change request and proposed rule are on the AEMC website, www.aemc.gov.au.

3.1 Technical issues

The sections below set out the issues raised by AEMO in its rule change request for each category of technical performance and, at a high level, the solutions it proposes. Specific details of AEMO's proposed rule changes are set out in Appendix B.

3.1.1 Voltage control

Voltage control is required to maintain power system stability and maximise power transfer capability within transmission and distribution networks. It is inherently related to the provision of reactive power that is utilised for the formation of magnetic and electric fields in devices such as motors, transformers, and the transmission lines.

AEMO considers the current requirements for the provision of reactive power by connecting generators are insufficient. It considers that these arrangements will potentially lead to the proliferation of new generation with limited voltage control

capabilities that, when combined with the withdrawal of existing generation with voltage control capability, places both power system security and quality of supply at risk. This is because the minimum access standard allows for generators without reactive power capability or voltage control capabilities to connect to the power system. AEMO also notes the expression of the minimum and automatic access standards are inconsistent and ambiguous in areas.

AEMO proposes amendments to the voltage and reactive power control requirements in the generator access standards to require all generating systems to have facilities to regulate voltage, regardless of the connection point voltage or capacity of the generating system.[26] Details of AEMO's proposed amendments to address this issue are set out at Items 1 to 6 in Appendix B.

AEMO also proposes changes to generator access standards for the provision of reactive power during and immediately following power system disturbances, which are discussed in section 3.1.2 below.

3.1.2 Disturbance ride through

AEMO proposes amendments to generator access standards related to the ability of generating systems to provide capabilities supporting the security of the power system when faced with disturbances such as faults and contingency events. The proposals relate to:

- reactive current injection and reactive power support
- multiple low voltage disturbance ride through
- high voltage disturbance ride through, and
- partial load rejection.

Reactive current injection and reactive power support

Reactive power support helps the power system to recover from disturbances and helps reduce risks to local voltage levels from transient voltage instability. Sufficient dynamic reactive power support close to each connection point helps to prevent the propagation of voltage dips across the network and reduces the risk of consequential voltage instability or widespread generation disconnections.

AEMO considers that the current minimum generator access standard for responding to disturbances following contingency events is inadequate as the standard does not require the provision of reactive power support during disturbances.[27] AEMO argues

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26 That is, amendments to clauses S5.2.5.1 and S5.2.5.13 of the NER. AEMO, *Generator technical performance standard rule request*, p. 22.

27 See clause S5.2.5.5 of the NER.

this increases the risk of voltage instability and loss of synchronism with the remainder of the power system.[28]

To address this issue AEMO proposes amending the minimum generator access standard for responding to disturbances following contingency events to require all generators to provide additional capacitive reactive current when voltage at the connection point dips below 90 per cent of normal levels. AEMO proposes different limits for reactive current injection requirements for synchronous and asynchronous generators due to their different physical capabilities. Details of AEMO's proposed amendments are set out at Items 7 to 12 in Appendix B.

Multiple low voltage disturbance ride-through

The ability of generators to maintain continuous uninterrupted operation during and following power system disturbances helps maintain the power system in a secure state. The greater the ability of generating systems to "ride-through" multiple disturbances, the greater the ability of the overall system to overcome faults and disturbances without cascading failures causing blackouts, such as that experienced in South Australia in September 2016.

AEMO considers that the current generator access standards for response to voltage disturbances during and following contingency events are inadequate to support the ongoing needs of the power system. The requirement to withstand multiple low voltage events is not explicitly set out in the automatic access standards for generator response following contingency events.[29] AEMO considers that without a clear obligation with respect to multiple disturbance events there is a risk of uncoordinated disconnection of generation, potentially exacerbating a disturbance to the power system. AEMO also considers the minimum access standard for generator response during voltage disturbances is insufficient because it does not set out obligations to maintain continuous uninterrupted operation at voltages below 90 per cent of normal voltage. AEMO notes in its rule change request that low voltage disturbances are becoming more common as the proportion of asynchronous generation in the power system increases and system strength declines.[30]

To address these issues, AEMO proposes amendments to the generator access standards to increase the length of time a generating system is required to be capable of continuous uninterrupted operation[31] for voltages below 90 per cent of normal,[32] and to add a new requirement for generators to maintain continuous uninterrupted operation for up to 15 voltage disturbances in any 5-minute period for a defined length

28 AEMO, *Generator technical performance standard rule request*, p. 24.

29 See clause S5.2.5.5 of the NER.

30 AEMO, *Generator technical performance standard rule request*, p. 27.

31 AEMO proposes an amendment to the definition of continuous un-interrupted operation for which further detail is provided in Chapter 5 of the NER.

32 This would amend the minimum access standard in clause S5.2.5.4 of the NER.

of time.[33] Details of AEMO's proposed amendments to address these issues are set out at Items 13 to 15 in Appendix B.

High voltage disturbance ride through

The changing nature of connected plant and control and operational strategies impact a NSP's ability to manage power system voltages. AEMO considers this is leading to an increasing risk of temporary over voltages under extreme operational outcomes.[34] This risk particularly relates to voltage outcomes as a result of fast acting load shedding schemes for protected events. Such events are relevant to the development and implementation of special protection schemes to maintain power system security, particularly during islanding events. AEMO notes that measured responses obtained from the five recent islanding events that have occurred in the South Australian power system indicate high temporary over-voltages beyond the capabilities specified in existing technical standards.

The generator access standards for responding to high voltage disturbances are specified by reference to the system standard for power frequency voltage. As a result, the requirements of the system standard directly flow through to the access standards.[35] The system standard specifies the length of time and degree to which, as a consequence of a credible contingency event, the voltage of supply at a connection point is able to rise above normal levels. AEMO considers that this system standard is not adequate because it specifies withstand periods that are substantially shorter than the duration of simulated temporary over-voltages in South Australia following network separation.[36]

AEMO proposes addressing this by amending the high voltage withstand requirements in the system standard so that the requirements in the corresponding generator access standards require connecting generators to maintain continuous uninterrupted operation for temporary over-voltages for greater magnitudes and longer durations. It should be noted that the system standard for power-frequency voltage applies to all elements of the power system, not just generators. AEMO believes the system standard for temporary over-voltages could be raised as proposed without affecting existing elements of the transmission and distribution systems.[37]

AEMO also proposes amendments to require generating systems to supply additional inductive reactive current (reactive absorption) during over voltage events. Details of AEMO's proposed amendments to address these issues are set out at Items 16 to 18 in Appendix B.

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33 This includes amending both the automatic and minimum access standards in clause S5.2.5.5 of the NER, to include a form of this requirement.

34 AEMO, *Generator technical performance standard rule request*, p. 30.

35 See clauses S5.2.5.4 and S5.1a.4 of the NER.

36 AEMO, *Generator technical performance standard rule request*, p. 31.

37 AEMO, *Generator technical performance standard rule request*, p. 31.

Active power recovery

The ability for generators to quickly recover active power output following contingency events contributes to several aspects of power system security. The restoration of active power to the level existing just prior to a fault helps restore network power transfer to pre-contingency conditions, restore voltages to within the normal operating envelope and reduce reliance on the provision of voltage control.

While most synchronous generating plant can normally recover active power output within a few hundred milliseconds of a disturbance, asynchronous generating plant can take between 100 milliseconds and over a second to fully recover active power output. AEMO states that a large proportion of generating systems with slow active power recovery could cause:

- transient instability (leading to voltage instability)
- increased power swings across interconnectors (increasing their risks of failing and islanding a region), and
- require AEMO to apply operating constraints that limit the asynchronous generation that can be online in a region at risk of islanding.[38]

AEMO considers the minimum access standard for generating system response to disturbances following contingency events as not sufficient to deal with the risks outlined above because the standard does not specify a requirement for active power recovery time.[39] AEMO therefore proposes to amend the minimum standard to specify that a generating system must restore active power within 1 second following disconnection of a faulted element. Details of AEMO's proposed amendment are set out at Items 19 and 20 in Appendix B.

Partial load rejection

Partial load rejection refers to the ability of generators to maintain continuous uninterrupted operation in the event of a loss of a significant amount of end use load. Partial load rejection is related to other disturbance withstand requirements because the loss of a large proportion of load leads to voltage and frequency disturbances that a generator is required to withstand under related standards.

AEMO notes that asynchronous generation is exempted from the existing generator access standard requirements applying to partial load rejection.[40] AEMO considers this is not sufficient to maintain the power system in a secure state as the system evolves to include higher proportions of asynchronous generation. AEMO therefore proposes to amend existing arrangements to extend the requirements for synchronous

38 AEMO, *Generator technical performance standard rule request*, p. 34.

39 See clause S5.2.5.5 of the NER.

40 See clause S5.2.5.7 of the NER.

generators to all generating systems (including asynchronous generators).[41] Details of AEMO's proposed amendment are set out at Items 21 and 22 in Appendix B.

Rate of change of frequency withstand capability

As synchronous generators exit the power system, rapid changes in frequency may become more common, particularly following the separation of a region, or a major load or generation shedding event. This has been experienced in South Australia recently.[42] The ability for generators to remain connected to the power system following a rapid change in frequency is typically limited to a given rate of change of frequency (RoCoF).

While the existing generator access standards for newly connecting generators include a requirement to withstand certain levels of RoCoF,[43] AEMO considers these requirements are insufficient to cope with the increasing RoCoF levels in the power system, which over time could lead to an increased risk of cascading failure as generating units disconnect from the system following a major disturbance and a rapid change in power system frequency.[44]

While AEMO notes that a technology-neutral approach is preferred, it also considers that there are fundamental differences in the ability of different types of generation to withstand high levels of RoCoF. Synchronous generation is susceptible to severe damage and must be able to disconnect in order to protect itself, whereas asynchronous generation is less susceptible to this kind of damage. AEMO considers that this difference needs to be recognised in order to achieve the most efficient use of plant and maintain a secure power system, without creating an un-reasonable barrier to entry.[45]

AEMO proposes addressing this issue by amending the generator access standards to require asynchronous generating systems to be able to withstand high levels of RoCoF, while providing synchronous generating systems with flexibility to negotiate a performance standard that reflects their physical plant capabilities.[46] Details of AEMO's proposed amendments are set out at Items 23 and 24 in Appendix B.

3.1.3 System Strength

System strength is a characteristic of electrical power systems that relates to the size of the change in voltage for a change to the load or generation at a connection point. The

41 AEMO, *Generator technical performance standard rule request*, p. 35.

42 AEMO, *Generator technical performance standard rule request*, p. 37.

43 See clause S5.2.5.3 of the NER.

44 AEMO, *Generator technical performance standard rule request*, p. 37.

45 AEMO, *Generator technical performance standard rule request*, p. 37.

46 For example, asynchronous generators will be required to meet the automatic access standard of ±4 Hz/s for 250 milliseconds, or ±3 Hz/s for 1 second, which synchronous generators will be able to negotiate over a range down to ±1 Hz/s for 1 second.

system strength at the connection point of a particular generating system can be measured by the SCR, which is the ratio of the system strength in mega-volt amp (MVA), to the capacity of the generating unit in megawatts (MW).

The exit of large thermal synchronous generation, together with an increasing proportion of asynchronous generation like wind and solar, has contributed to decreases in system strength in some areas of the power system. AEMO considers that reductions in system strength may create generation stability issues, as well as issues with voltage control and incorrect operation of protection systems. AEMO states that if left unmanaged, low system strength issues could contribute to additional generation tripping during power system disturbances, posing a threat to the stability of the power system.[47]

To address this issue, AEMO proposes a new access standard be specified covering system strength.[48] The minimum access standard would require a connecting generating system to be capable of continuous uninterrupted operation for any SCR to a minimum of 3.0 at the connection point. AEMO does not propose a corresponding automatic access standard for system strength.[49] Details of AEMO's proposed new minimum access standard for system strength are set out at Item 25 in Appendix B.

On 27 June 2017 the AEMC published a draft determination on the *Managing power system fault levels rule change* that recommended introducing requirements that connecting generators "do no harm" to the minimum level of system strength being provided to any nearby generating system connection points. It also proposed an obligation for NSPs to maintain system strength, measured in terms of SCR, at nominated points in the network above an agreed minimum level under a defined range of conditions.[50] The AEMC has published, on the same day as this consultation paper, its final determination on the *Managing power system fault levels rule change*. This final determination includes a "do no harm" requirement and technical obligations on AEMO and NSPs that differ materially from the position in the draft determination.[51] The implications of this shift on the formulation of AEMO's proposed access standard for system strength are further explored in section 5.2.1.

3.1.4 Active power control requirements

To help maintain power system frequency through the supply and demand of active power, AEMO proposes amendments to the generator access standards for the following active power control requirements:

- frequency response mode capability

47 AEMO, *Generator technical performance standard rule request*, p. 39.

48 In its proposed rule, AEMO included this standard as a new clause S5.2.5.15 of the NER.

49 AEMO notes that the defined term short circuit ratio is used in the Draft National Electricity Amendment (Managing Power System Fault Levels) Rule 2017 and recommends that this new defined term be included in this provision.

50 AEMC, *Managing power system fault levels rule change*, Draft determination, 27 June 2017.

51 AEMC, *Managing power system fault levels rule change*, Final determination, 19 September 2017.

- capability for active power control via automatic generation control
- capability to limit active power and ramp rate, and
- enhanced remote monitoring requirements to provide real-time information regarding active power control.

While AEMO acknowledges the frequency control framework for the power system is currently under review,[52] it considers there is a need to ensure that new generators are equipped and have the capability to deliver frequency control services at least cost to consumers under any future frameworks.

Frequency response mode capability

Primary frequency control is typically provided by generating systems providing a proportional response to a local frequency measurement. AEMO expects the availability of this frequency control capability to decline as synchronous generation retires as it considers there is little incentive for generators to install these capabilities in new generating systems.[53]

AEMO considers the current generator access standards for frequency control are inadequate because the minimum access standard does not include a requirement for an active power response to frequency deviation.[54]

To address this issue AEMO proposes amending the automatic access standard for frequency control to require a connecting generator to provide a proportional increase or decrease in power transfer to the power system in response to a change in power system frequency, with the response being sufficiently rapid and sustained for the generator to be in a position to offer measurable amounts of services to the spot market for each of the market ancillary services. AEMO also proposes amending the minimum access standard to substantially reflect the automatic access standard with the exception that it only applies the generators over 30 MW and requires the generator to be in a position to offer measurable amounts of services to the spot market for at least one of the market ancillary services.

AEMO also proposes a number of other general requirements for frequency response. Details of AEMO's proposed amendments are set out at Items 26 to 30 in Appendix B.

Capability for active power control via automatic generation control

Regulation market ancillary services are used to continually adjust power system frequency within the normal operating frequency band. Raise and lower frequency regulation services are provided by increasing or decreasing active power output in

52 AEMC, *Frequency control frameworks review*, initiated on 7 July 2017.

53 AEMO, *Generator technical performance standard rule request*, p. 43.

54 See clause S5.2.5.11 of the NER; AEMO, *Generator technical performance standard rule request*, p. 44.

response to signals sent to generating systems by AEMO's automatic generation control (AGC) approximately every 4 seconds.

Requirements relevant to the ability to respond to AGC signals are contained in some of the generator access standards.[55] AEMO considers existing requirements to be insufficient as they do not specifically require generating systems to have the capability to respond to AGC signals. Only generating units that are classified as ancillary services generating units typically have this capability for the purpose of providing regulation FCAS.

AEMO considers the inclusion of AGC response capability from more connected generation is needed to ensure the continued efficient operation of the power system.[56] AEMO therefore proposes to amend the generator access standards that relate to the ability of scheduled and semi-scheduled generating systems to receive, and automatically respond to, signals delivered remotely from the AGC, as updated at a typical rate of once every four seconds. Details of AEMO's proposed amendment are set out at Item 31 in Appendix B.

Capability to limit active power and ramp rate

Uncontrolled active power ramping by generators has the potential to present significant challenges to the secure operation of the power system. This is because rapid and large changes (rapid ramping) to supply and/or demand affect power system frequency. On a local scale, rapid changes in power transfer can affect transmission and distribution voltages. AEMO considers the capability to dispatch generating systems with appropriate ramp rates will become a critical factor in managing the supply and demand balance of the power system in the future.[57]

AEMO considers the existing generator access standards for active power control and remote monitoring are insufficient because they currently allow the connection of generating systems whose active power output cannot be directly controlled over short timeframes.[58] The access standards also do not set minimum standards to provide for active power limits, or to require that limits to rate of change of active power can be set.[59]

AEMO therefore proposes to add a new requirement that brings semi scheduled generators into line with scheduled generators in terms of being capable of limiting the rate of change of active power, subject to energy source availability, by not changing their active power output within five minutes by more than specified in instructions from AEMO. This change is further supported by amendments to the generator access standard for remote monitoring that requires a generator to have the capability to

55 See clause S5.2.5.14 and S5.2.6.1 of the NER.

56 AEMO, *Generator technical performance standard rule request*, p. 45.

57 AEMO, *Generator technical performance standard rule request*, p. 47.

58 See clause S5.2.5.14, and S5.2.6.1 of the NER.

59 AEMO, *Generator technical performance standard rule request*, p. 47.

provide and respond to AEMO in real-time about its generating system's active power control systems.

Details of AEMO's proposed amendments are set out at Item 32 in Appendix B.

3.1.5 Remote monitoring and control

AEMO considers the increasing complexity of the power system and the need for faster operational actions as leading to a requirement for greater automation and co-ordination of many different power system elements. Real time information allows AEMO to specify the technical envelope to maintain power system security more precisely, and to understand better the ancillary service requirements and capabilities for the management of power system security.

The requirements for remote monitoring and control are specified in the generator access standards for remote monitoring.[60] AEMO considers that these access standards do not effectively capture the capabilities of modern technology and proposes amendments as helping to develop a more advanced, automated and efficient power system. AEMO also considers it requires more detailed information to facilitate the integration of storage systems into the power system.

To address these issues, AEMO proposes amending the access standards for remote monitoring to require additional monitoring and control capabilities from connecting generators. Details of AEMO's proposed amendments are set out at Items 33 to 35 in Appendix B.

3.2 Process issues

3.2.1 Negotiation of performance standards

For each access standard in the NER, the current framework requires that the connecting equipment either meets the automatic access standard, or is set at a level negotiated within a range between the automatic and minimum access standards. The negotiating process is set out in further detail in Chapter 2.

AEMO considers there are a range of issues with the current negotiating process that risk negotiations taking place in a manner that is not in the long term interests of consumers.[61]

The access standards in the NER generally will provide a set of guidance criteria to be followed in the process of reaching an acceptable negotiated access standard on particular technical matters. This guidance covers matters that NSPs and AEMO must specifically consider in their assessment, such as the level of impact on the ability of NSPs to meet their obligations under the system standards or on the quality of supply

60 See clause S5.2.6.1 of the NER.

61 AEMO, *Generator technical performance standard rule request*, p. 19.

to be provided to other network users. AEMO considers that, over time, amendments to these specific guidance criteria have resulted in inconsistencies and has introduced ambiguity and uncertainty in the negotiation of performance standards.[62]

The negotiating framework in the NER provides some guidance on the overarching principles that should govern the negotiation, as noted in section 2.2.6 above. It appears that some of the proposed amendments are designed to harmonise some of the negotiating criteria by applying them in overarching principles, rather than in specific guidance criteria.

AEMO states that in its experience many connection applicants aim for the lowest level of performance standards when entering negotiations, regardless of the needs of the power system.[63] AEMO argues that this risks negotiations taking place in a manner that is not consistent with system security and the long term interests of consumers. AEMO considers that this approach to negotiations may lead to the connection of generating systems that cannot perform to the levels that are required to meet the future needs of the power system as it evolves.

AEMO also states that an approach to negotiating performance standards that uses the minimum standard as the starting point is not consistent with the requirement that a negotiated access standard must be set at a level that will not adversely affect power system security.[64]

3.2.2 Proposed solution

AEMO considers that the role of the automatic access standard should be to act as a "safe harbour" for a connecting generator.[65] That is, if the proposed performance standards meet the automatic access standard, no further analysis of its impact on the power system is required because the automatic access standard should be set at a level that ensures the secure operation of the power system. AEMO considers that the role of the minimum access standard should be to provide the flexibility to allow the connection of generating systems that are relatively insignificant and whose potential impact on the power system and other network users is likely to be small.[66]

AEMO notes that, in general, the closer a proposed negotiated standard is to the automatic access standard, the lower its impact on power system security.[67] To maintain a robust and secure power system, AEMO considers that negotiated

62 AEMO, *Generator technical performance standard rule request*, p. 19.

63 AEMO, *Generator technical performance standard rule request*, p. 19.

64 See AEMO, *Generator technical performance standard rule request*, p. 19, and see also clause 5.3.4A(b)(2) of the NER.

65 AEMO, *Generator technical performance standard rule request*, p. 19.

66 AEMO, *Generator technical performance standard rule request*, p. 19.

67 AEMO, *Generator technical performance standard rule request*, p. 19.

performance standards should be as close as reasonably practicable to the automatic access standard.[68]

AEMO states that the automatic access standard, rather than the minimum access standard, should therefore be specified as the default starting point for negotiations for connections. To reflect this in the NER, AEMO proposes amending the provisions in the NER guiding the process for negotiating access standards. The proposed amendments include:

- removing the requirement specifying that a negotiated access standard must be no less onerous than the corresponding minimum access standard, and replacing it with a requirement specifying that the negotiated access standard must "be as close as practicable to the automatic access standard and no less than the corresponding minimum access standard", and

- providing that a connection applicant submitting a proposal for a negotiated access standard must "provide with that proposal evidence (to AEMO and the NSP's reasonable satisfaction) that it is not practicable for the applicable plant to achieve the relevant automatic access standard (including where there is a material risk that the applicable plant will be damaged if the level is set any higher than a specified level)".

3.3 Transitional issues

3.3.1 Impact of existing and new connection applications

AEMO states that the number of connection applications currently before it for assessment is "an order of magnitude" greater ever before. These applications largely relate to asynchronous generating systems. AEMO also expects that more asynchronous connection applications are likely to emerge in the near future driven by jurisdictional policies.[69]

AEMO considers that absent its proposed transitional arrangements, NSPs and AEMO will come under pressure to finalise negotiations on performance standards and connection agreements before the new requirements take effect.[70] AEMO argues this would mean that generating systems with long life-cycles may be connected under outdated standards that do not ensure the capabilities required of the future power system.

AEMO has not detailed the specific negative system security and other implications that it is concerned could result from the connection of these generating systems. The Commission asks for stakeholder input to help explore this issue further in section 6.2 below.

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68 AEMO, *Generator technical performance standard rule request*, p. 19.

69 AEMO, *Generator technical performance standard rule request*, p. 54.

70 AEMO, *Generator technical performance standard rule request*, p. 7.

Relevant to the level of urgency in changing the NER and applying those changes from the earliest point in time, AEMO notes that South Australia already has separate jurisdictional technical performance requirements for connecting generators and some other jurisdictions, including Victoria and Tasmania, are considering their own requirements.[71]

3.3.2 Proposed solution

AEMO proposes to apply the new technical standards and negotiating process changes to all performance standards that were not agreed by the date the rule change request was submitted (11 August 2017), even if the agreed performance standards result from a connection application that was made before any new rule comes into effect.[72]

The proposed rule accompanying AEMO's rule change request appears to be proposing:

1. applying the final rule from 11 August 2017 for all connection applications made before the date the new rule is made, where the performance standards were not finalised by 11 August 2017; and

2. for any performance standard finalised on or after 11 August 2017 that is below the level of the minimum access standard set out in the new rule:

    (a) applying the new minimum access standard to the exclusion of the agreed performance standard from the date the new rule commences, and

    (b) requiring the NSP and the connection applicant to negotiate an amendment to the performance standard to ensure it is consistent with the new rule, with AEMO to provide advice to the NSP on any relevant AEMO advisory matters.

AEMO also proposes allowing it to provide exemptions from the requirements in (2) above where it considers that the performance standard will not adversely affect power system security.

Section 6.2.1 discusses the extent of the Commission's rule making power as it relates to the rule change requested by AEMO.

71 AEMO, *Generator technical performance standard rule request*, p. 15.

72 AEMO, *Generator technical performance standard rule request*, p. 54.

4 Assessment framework

The Commission's assessment of this rule change request must consider whether the proposed rule promotes the National Electricity Objective (NEO).[73]

4.1 Rule making test and the NEO

The Commission may only make a rule if it is satisfied that the rule will, or is likely to, contribute to the achievement of the NEO.[74] This is the decision making framework that the Commission must apply.

The NEO is:[75]

> "To promote efficient investment in, and efficient operation and use of, electricity services for the longer term interests of consumers of electricity with respect to -
>
> (a) price, quality, safety, reliability and security of supply of electricity, and
>
> (b) the reliability, safety and security of the national electricity system."

The Commission may make a rule that is different (including materially different) to a proposed rule (a more preferable rule) if it is satisfied that, having regard to the issue or issues raised in the rule change request, the more preferable rule will or is likely to better contribute to the achievement of the NEO.[76]

4.2 Proposed assessment framework

The Commission uses an assessment framework to evaluate whether the proposed rule, if made, is likely to promote the NEO. The framework may be refined during the rule change process. At this stage the Commission is seeking stakeholder views on the proposed assessment framework, which includes the following factors.

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73 From 1 July 2016, the NER, as amended from time to time, apply in the Northern Territory, subject to derogations set out in Regulations made under the NT legislation adopting the National Electricity Law (NEL). Under those Regulations, only certain parts of the NER have been adopted in the NT. The proposed rule relates to parts of the NER that will apply in the Northern Territory from 1 July 2019. The Commission is not required to consider the draft rule against certain additional elements required where the NER apply in the Northern Territory, but will consult with relevant Northern Territory government stakeholders given that the relevant sections will apply from 1 July 2019.

74 Section 88 of the NEL.

75 Section 7 of the NEL.

76 Section 91A of the NEL.

Maintaining system security at lowest costs to consumers

There is a trade-off between setting generator performance standards at a "tighter" level that provides further capability and provides an additional degree of security in the system, and the costs of achieving that additional security, that are ultimately passed through to consumers as higher prices. In other words, if the standards are set at levels that are too high, while there is a greater probability that system security will be maintained, consumers may also end up paying higher prices that could exceed the relative additional security benefit enabled by those higher prices.

Setting standards that are too high could affect the reliability of the system if it impacts the ability of generators to connect and meet the level of supply required to meet consumer demand, leading to load shedding or blackouts. This also imposes significant costs on consumers. Equally, setting the standards too low may increase the risk that the system is not able to be maintained in a secure state, which may lead to load-shedding or blackouts, again imposing costs on consumers.

The objective of this rule change is therefore to promote efficient investment in the power system, striking a reasonable balance between system security and the price paid by consumers for that security.

Mandating capabilities for new generators using access standards in the NER may result in investment in capabilities that are underutilised or not required to maintain system security. This could result in stranded assets that are ultimately paid for by consumers. The stranded asset risk and associated costs needs to be weighed against any benefits from lower costs of operating the network and the contribution these capabilities may make to system security.

In assessing the trade-offs in costs and benefits the Commission may also consider the potential impact of the generator performance standards on existing and new ancillary services markets. Higher performance standards imposed on generators now may increase the supply in ancillary service markets in the future as more generators may have the capability to provide services to these markets. This may cause the price of such services to fall over the longer term, reducing costs and providing improved system security outcomes for consumers in the longer term. The Commission understands that these longer term cost savings and security benefits may be difficult to quantify at this stage.

Appropriate allocation of costs and risks

Regulation should seek to allocate costs and risks on the parties that are best placed to bear and manage them. The costs associated with generator performance standards are borne by connecting generators. AEMO must manage the security of the power system. In this rule change the Commission will consider how costs and risks are allocated between parties, having regard to the roles and functions of AEMO, generators and networks.

Generators are best placed to make investment decisions regarding the costs of meeting performance standards and the potential revenues that are available from

wholesale markets, and from providing services in ancillary service markets. AEMO is best placed to manage system security risks, and performance standards should reflect the current risks posed to system security. Transmission and distribution network businesses are also best placed to make investment and operational decisions to meet their obligations regarding the secure and reliable operation of their networks.

Increasing generator performance standards may increase capital costs of new generation but this must be balanced against the value these standards bring to the power system now and in the future. AEMO notes that imposing costs at the time of connection, through generator access standards, may involve low overall increases in marginal costs. The Commission will consider the increase in costs related to increased generator access standards relative to the contribution these standards are likely to make to maintaining system security.

There may also be a trade-off between imposing costs on generators connecting to the network and the cost of operating the network, which is borne by transmission and distribution networks, and ultimately consumers. Higher access standards for connecting generators may allow for less conservative planning and operation of the power system, which could reduce costs across the system. On the other hand lower access standards for connecting generators may have the opposite effect. As a result, in addition to considering the system security implications of any changes it proposes to make to the NER, consideration will be given to whether the changes could result in any appreciable reductions in costs in other parts of the power system, putting downward pressure on prices for consumers.

Regulatory certainty and flexibility

Regulation should provide market participants with certainty regarding their respective roles and responsibilities. This certainty needs to be balanced with the need for flexibility to account for uncertain future outcomes. Regulatory certainty will be considered in three ways in this rule change.

First, there is a need for certainty with respect to ongoing performance standards. Connection applicants seeking to connect generators should have a clear idea of what standards they will be expected to meet. This will allow generators to fully factor in the cost of connection when making the decision to enter the market.

AEMO and NSPs also need certainty that there will be sufficient power system capabilities to allow them to operate the system in accordance with the system standards.

Second, there is a trade-off between the certainty of imposing strict performance standards that must be met with the flexibility to negotiate standards on a case-by-case basis. The access standard regime should not pose an unnecessary barrier to entry, where a generator who could connect to the network with minimal system security implications is prevented from doing so because of a particular access standard that cannot be altered. The negotiating framework for performance standards provides some flexibility which may lead to lower-cost connections in cases where the system

security implications of that connection are small. The Commission will consider the importance of these trade-offs as part of this rule change process.

Third, AEMO notes that there are a large number of connection requests currently being processed. It is important to balance the need for these applicants to have certainty regarding the connection process and the access standards they will be expected to meet with the risks posed to the security of the system by allowing a large number of connections to occur under the existing access standards.

Technology neutrality

The access standards for connecting generators should be, to the greatest extent possible, technology neutral. That is, they should not present an unnecessary barrier to entry for any technology type.

Technical obligations could have materially different implications (including cost implications) for different types of technology, or different classes of participants. This could form a barrier to entry for those technologies or participants. In some cases, for example where meeting these obligations is fundamental to maintaining a basic level of system security, these costs may be unavoidable. In this case, while they may still form a barrier to entry for a particular technology type or participant, this may be a necessary condition of connecting to the power system. However, to the extent possible, these costs (and the barriers to entry they may create) should be no higher than is absolutely necessary to maintain the security of the system. Unnecessary barriers to entry may lead to inefficient investment outcomes and higher future power system costs that are ultimately borne by consumers.

The rule change request notes that the energy market is undergoing a transition. The technologies and capabilities of new generators have changed in recent years. It is important that generator access standards are fit-for-purpose and reflect the capabilities of the current and, to the extent possible, future generation fleet that is seeking to connect to the network.

Question 1 Assessment framework

Do you agree with the Commission's proposed approach to assessing whether the rule change request will, or is likely to, contribute to the achievement of the national electricity objective? If not, how should it be assessed?

5 Technical issues

Taking into consideration the assessment framework, a number of "technical" issues have been identified for initial consultation.

The sections below are provided to help inform stakeholder responses on this rule change request. Stakeholders are invited to raise and comment on any other technical issues they consider relevant to AEMO's rule change request.

5.1 Role of access standards

The assessment framework outlines that the Commission's core task is to consider whether AEMO's proposed changes are likely to meet the NEO in terms of the extent to which they maintain, or enhance, system security at the lowest cost.

The challenge of maintaining system security in the absence of significant levels of synchronous generation is described by AEMO as the task of procuring a set of 'system services' formerly provided as a by-product of the synchronous generation of electricity.[77] One option for procuring these services to maintain system security is to mandate additional capabilities from connecting generators through amendments to access standards. The cost to consumers associated with maintaining the security of supply is likely to be minimised by AEMO's proposed rule if changes in generator access standards are the least cost option to achieve this outcome.

AEMO's rule change request acknowledges that it is not efficient to require generating systems to solve all technical issues arising as a result of the energy transition and identifies that there are a range of alternative solutions, including establishing market frameworks and amending the access standards for distribution network service providers (DNSPs) and Market Customers.[78] AEMO states that it has only proposed changes to the generator access standards where it considers the change is likely to be the most efficient way of addressing an identified issue.

The Commission also understands that changes to the access standards may play a role in enabling alternative solutions to provide improved system security outcomes in the future. AEMO states that it "is important to consider the role that performance standards can have in supporting any future frameworks to deliver the most efficient long term outcomes for consumers." For example, AEMO proposes a number of changes to active power capabilities that are specifically intended to allow for the future development of other frequency control arrangements.[79]

As such, the Commission will also consider the role of the access standards and their relationship to the establishment of other solutions, including market solutions, for the provision of system security services. In this regard, the Commission will consider:

77 AEMO, *Generator technical performance standard rule request*, p. 10.

78 AEMO, *Generator technical performance standard rule request*, p. 51.

79 AEMO, *Generator technical performance standard rule request*, p. 41.

- the trade-off between setting generator access standards at a level that maintains the system in a secure state and minimising costs to consumers
- any implications for existing and future alternative methods for delivering system security outcomes, including ancillary service markets and network obligations, and
- whether risks are allocated to the parties that are best able to manage them.

Question 2 Role of access standards

- **Do the current generator access standards require changes to help maintain power system security?**
- **Would making changes to generator access standards represent the lowest cost approach to maintaining system security relative to other options?**
- **Will mandating certain capabilities in generator access standards enable and support the establishment of ancillary services in future?**

5.2 Proposed changes to generator access standards

The generator access standards were last reviewed in 2007.[80] Since then, the power system has evolved, with expectations of significant change still to come. AEMO considers the black system event in South Australia in September 2016 exposed the weaknesses in the current settings of generator access standards. AEMO considers these access standards are no longer adequate to maintain the security and reliability of the power system.[81] AEMO therefore presents a set of specific recommendations for changes to the access standards, at least in part, as a means of maintaining system security in light of the changing generation mix. Each of these specific proposals is set out in the detailed summary presented in Appendix B.

AEMO suggests that its proposed changes represent an appropriate balance between the need to maintain system security and the cost implications for connecting generators. AEMO presents its proposed changes as being aligned with international standards and justifiable given technical capabilities of generation equipment available on the international market. AEMO also states that its proposed changes take advantage of the capabilities of modern asynchronous generation technologies, arguing that it is making use of the higher levels of performance that can be provided at little or no cost increase.[82]

80 National Electricity Amendment (Technical Standards for Wind and other Generator Connections) Rule 2007.

81 AEMO, *Generator technical performance standard rule request*, p. 6.

82 AEMO, *Generator technical performance standard rule request*, p. 52.

AEMO's recommendations make changes to access standards that also impose higher requirements on connecting generators and could present a challenge to the connection of certain generation types in certain circumstances. The Commission will consider whether each of AEMO's proposed access standards are reasonable and do not represent an unnecessary barrier to entry for new generation. In assessing whether AEMO's proposals are reasonable, any additional costs borne by connecting generators, and the technical and commercial practicality of complying with AEMO's proposed access standards will be taken into account.

Question 3 Proposed changes to generator access standards

For each of AEMO's technical recommendations set out in Appendix B:

- **Do you agree with AEMO's analysis of the issue in relation to the proposed change to the access standard?**
- **Would the proposed change address the issue raised by AEMO? If not, what alternative solutions are there?**
- **Does the proposed change represent an unnecessary barrier to entry, having regard to the costs imposed by the change and the technical capabilities of different technologies?**
- **Can you provide an indication of the costs associated with the proposed change?**

5.2.1 Specific Issues regarding AEMO's proposed access standards

In addition to the questions posed in section 5.2, which seek stakeholder feedback across the range of AEMO's proposed access standard changes, the Commission has also identified a set of specific issues relating to one, or more, of AEMO's proposals on which it seeks stakeholder feedback.

System strength

AEMO proposes a new system strength access standard to make generators able to deal with lower future levels of system strength even if they are connecting in an area of the system which is currently strong.[83] In considering the application of a new access standard in this regard, the Commission will consider:

- the extent to which such an obligation may impose upfront costs on connecting participants, to account for a future scenario that may not eventuate, thereby representing a potential barrier to entry for connecting generators, and
- the manner in which AEMO's proposed system strength access standard interacts with other Commission rule changes.

83 AEMO, *Generator technical performance standard rule request*, p. 40.

For example, AEMO considers this proposed access standard to complement the Commission's draft determination for the *Managing power system fault levels rule change* as published on 27 June 2017. The Managing power system fault levels draft determination provided an enhanced framework that requires NSPs to maintain system strength, measured in terms of SCR at nominated points in the network above an agreed minimum level under a defined range of conditions.[84]

On 19 September 2017, the Commission published a final determination for the *Managing power system fault levels rule* which has changed the metric used to measure system strength away from the requirement to maintain SCR to determine minimum fault levels at generator connection points.[85] SCRs were viewed as potentially placing an onerous burden on generators, NSPs and AEMO. For many existing generators, determining a minimum SCR was considered to be expensive, particularly if it required the involvement of the original equipment manufacturer.[86]

Instead, the final rule obliges AEMO to develop 'system strength impact guidelines' that will set out a methodology and model to be used by an NSP when undertaking a system strength impact assessment in relation to what harm, if any, a new generator will need to remediate as a result of its connection.

The Commission is also aware of interactions between system strength and a generator's ability to meet its performance standards in other areas, such as reactive power and disturbance ride through. In particular, the reactive power injection requirements for voltage regulation will depend on the system strength conditions faced by the generator. As the generation mix in the power system changes, and the penetration of asynchronous generation increases, system strength may vary significantly across the day. Therefore, generating systems may need capabilities that take into account a range of system strength conditions. Accordingly, the Commission will also consider how an access standard for system strength interacts with access standard settings in other areas, particularly in respect of the range of potential system strength conditions a generator may face.

AEMO's proposal relevant to system strength is set out in Item 25 in Appendix B.

Question 4 System strength access standard

- **Do you agree with AEMO's analysis of the issue related to system strength?**
- **Would the proposed changes address these issues, particularly in light of the Commission's *Managing system fault levels rule change final determination*? If not, what alternative solutions are there?**

84 AEMC, *Managing power system fault levels Draft determination*, 27 June 2017, p. 13.

85 SCRs are an alternative measure for system strength where the SCR is the system strength in MVA to the capacity of the associated generating systems in MW.

86 AEMC, *Managing power system fault levels Final determination*, 19 September 2017, Summary p. V.

- **Would the proposed changes relating to system strength represent an unnecessary barrier to entry, having regard to the costs imposed by the change and the technical capabilities of different technologies?**

Mandating active power control

AEMO states it has purposefully designed its active power control proposals to be consistent with a wide range of possible future frequency control mechanisms. AEMO views mandated active power control capabilities as aiding the transition to market-based solutions for FFR, where such standards are low cost and may deliver long-term efficiencies for consumers.[87]

AEMO notes that while contingency and regulation FCAS markets are open to asynchronous generation, no asynchronous generator has yet been registered as a Market Participant in any of the power system's FCAS markets.[88] AEMO considers asynchronous generators could face high costs to build the capability to provide FCAS unless the capability is built into the project at a very early stage.[89]

AEMO states in its rule change request that the proposed rule seeks to remove any such potential barriers by requiring the capability to provide FCAS to be installed on all new generating plant at the time of connection. Importantly, AEMO's rule change does not require generators to participate in FCAS markets, but simply to have the capability to do so.[90]

The Commission will consider how mandated active power control capabilities may interact with the potential for provision of ancillary services, including FCAS. A foundation principle behind the implementation of FCAS markets is that commercial incentives should drive any decision to invest in new capabilities. This should in theory produce more efficient outcomes that minimise the potential for over-investment, ultimately paid for by consumers, that is inherent in some regulatory approaches.[91]

By mandating active power control capability, more generators may be capable of participating in FCAS markets. This may have an immediate system security benefit, if it means that there is more FCAS available to help manage power system frequency. To the extent that it increases supply of these services, a mandated requirement for active power control may also enhance competitive pressure in FCAS markets and help keep downward pressure on FCAS prices, potentially reducing costs for consumers.

87 AEMO, *Generator technical performance standard rule request*, p. 41.

88 There is an ARENA funded study at Hornsdale wind farm that is trialling a wind farm providing FFR.

89 AEMO, *Generator technical performance standard rule request*, p. 42.

90 AEMO, *Generator technical performance standard rule request*, p. 42

91 NECA, *Review of technical standards*, December 2001.

However, this approach also risks mandating investment in capabilities that end up not being used, resulting in less efficient investment and potentially increasing costs for consumers, to the extent that the costs of these inefficient investments are passed through as higher wholesale costs.

This stranded asset risk therefore needs to be weighed against the potential for any system security benefits, or potential competition benefits in FCAS markets.

AEMO's proposals relevant to mandating active power control are set out Items 26 to 30 in Appendix B.

Question 5 Mandating active power control

- **Do you agree with AEMO's analysis of the issue related to active power control?**
- **Would the proposed changes address these issues? If not, what alternative solutions are there?**
- **Would the proposed changes relating to active power control represent an unnecessary barrier to entry, having regard to the costs imposed by the change and the technical capabilities of different technologies?**
- **What are the risks associated with mandating active power control capabilities?**
- **What impacts would a mandated active power control capability have on competition in FCAS markets, and therefore FCAS prices?**

5.2.2 Reduction in system size thresholds

AEMO suggests that in general, access standards should not consider generating system size in their application. They therefore propose removing or adjusting the existing 30MW threshold for a number of standards including voltage and reactive power control, frequency control and active power control.[92] The effect of this change would be to extend generator access standards to smaller generating systems that are currently not subject to these requirements.

AEMO considers that the 30MW threshold was imposed at a time when the number of smaller scale utility generating systems was low enough that their combined connection would not have a material impact on the operation of the power system. AEMO considers the growing trend of generating system projects less than 30 MW, when considered in aggregate, has a material impact on the power system that requires their inclusion in a wider range of connection standards.

92 Thresholds are removed or adjusted in respect of clauses S5.2.5.13 , S5.2.5.11 and S5.2.5.14 of the NER.

Irrespective of system size, all parties seeking to connect generation are obliged to engage with the relevant NSP in relation to applicable connection requirements. For generating systems smaller than 5 MW an NSP may, on a case-by-case basis, elect not to apply performance requirements.[93] By proposing to make connection standards generally apply irrespective of generating system size AEMO is effectively extending the application of some access standards to connecting generators between 5 MW and 30 MW that previously did not apply. It is important to understand the implications of these changes on smaller generation units and whether they may constitute an unnecessary barrier to entry.

The Commission will therefore consider whether this change poses challenges to smaller generators in meeting AEMO's proposed technical standards and whether there is a trade-off between the costs this requirement may impose for small generators, as measured against the increasing impacts these smaller generators are likely to have on system security.

AEMO's proposals relevant to a reduction in system size thresholds are set out Items 2, 31, 33, and 34 in Appendix B.

Question 6 Reduction in system size thresholds

- **Do you agree with AEMO's view that standards should not consider generating system size in their application appropriate? If not, what alternatives are there?**
- **Would the proposed changes to the thresholds for certain generator access standards represent an unnecessary barrier to entry, having regard to the costs imposed by the change and the technical capabilities of different technologies?**
- **Can you provide an indication of the costs associated with the proposed changes?**

5.2.3 Definition of continuous uninterrupted operation

"Continuous uninterrupted operation" refers to the ability of a generating system to remain connected to support the power system during a disturbance, and in its recovery and return to normal operation once the disturbance has passed. AEMO's rule change request notes there is a need to review the definition of continuous uninterrupted operation for disturbance ride through requirements.[94] AEMO's recommendation to amend the definition would apply to all relevant access standards.

AEMO's proposed new rule provides a specific change to the definition of continuous uninterrupted operation. The proposed change would require a generator to not vary its active or reactive power output both during and following the clearance of any fault

93 AEMO, *Generator technical performance standard rule request*, p. 16.

94 AEMO, *Generator technical performance standard rule request*, p. 25.

causing the relevant power system disturbance.[95] The current definition of continuous uninterrupted operation under the NER only requires active power output following (and not during) clearance of the fault that caused the disturbance.[96]

AEMO's proposed definition also removes the requirement that, after the clearance of any electrical fault, a generator should only 'substantially' vary its active power and reactive power as required by its performance standards. The threshold term 'substantially' has been replaced with a requirement to not vary active or reactive power unless required by its performance standards. This change may represent a reduction in the level of flexibility available to a generator to manage unavoidable variation in active and reactive power under such conditions.

The Commission will consider whether there are technical challenges for certain technologies associated with maintaining active power output during fault conditions, and whether a materiality threshold is appropriate for active and reactive power recovery following fault conditions.

AEMO's proposed definition of continuous uninterrupted operation is set out as Item 37 in Appendix B.

Question 7 Definition of continuous uninterrupted operation

- **Do you think the current definition of continuous uninterrupted operation raises issues for maintaining power system security?**
- **Would the proposed change to the definition of continuous uninterrupted operation address the issues raised by AEMO? If not, what alternatives are there, for example what materiality thresholds should apply?**
- **Would the proposed change to the definition of continuous uninterrupted operation represent an unnecessary barrier to entry, having regard to the costs imposed by the change and the technical capabilities of different technologies?**

5.2.4 Negotiated access standard requirements under specific clauses

In addition to the general principles applying to the negotiation of performance standards, most access standards also provide specific guidance and criteria, applying to that standard, for parties when determining a negotiated access standard. Some of these restrict the ability of connecting generators to negotiate a performance standard and require connection at the automatic access standard.

AEMO's proposed rule includes amendments to the negotiated access standard guidance for a number of standards including those relating to generating unit

95 AEMO, *Generator technical performance standard rule request*, p. 25.

96 See NER, Glossary, p. 1181.

response to voltage and frequency disturbances, contingency events, and frequency control.[97] The proposed amendments include requiring generators to meet the automatic access standards for those technical requirements in certain circumstances.

The Commission will consider the extent to which AEMO's proposed changes are reasonable and the implications for flexibility available to generators, NSPs and AEMO to align generator performance standards with the localised power system security needs of the power system.

AEMO's proposals regarding negotiated access standard requirements under specific clauses are set out at Items 5, 9, and 28 in Appendix B.

Question 8 Negotiated access standard requirements under specific clauses

- **Do you agree with AEMO's analysis of the issues in relation to negotiated access standard requirements?**
- **Would the proposed changes address the issues raised by AEMO? If not, what alternatives are there?**
- **Would the proposed changes represent an unnecessary barrier to entry, having regard to the costs imposed by the change and the technical capabilities of different technologies?**

5.2.5 Inclusion of new technical standards for alteration of generating plant/system

In addition to changes to generator access standards, AEMO proposes to amend the list of access standards in relation to which the corresponding performance standards will need to be renegotiated where a generator proposes to alter a connected generating system. AEMO proposes to add the following to the list:

- partial load rejection in respect of an alteration of equipment making up the generator's voltage control system,[98] and
- protection to trip plant for unstable operation in respect of an alteration of equipment making up the generator's protection system.[99]

In assessing AEMO's proposal, the Commission will consider whether the proposed changes are necessary for system security and whether any benefits to systems security

97 AEMO propose amendments to requirements for negotiated access standards for: S5.2.5.3 Generating system response to frequency disturbances; S5.2.5.4 Generating system response to voltage disturbance; S5.2.5.5 Generating system response to disturbance following contingency events; and S5.2.5.11 Frequency control.

98 See clause S5.2.5.7 of the NER, relating to partial load rejection.

99 See clause S5.2.5.10 of the NER relating to protection to trip plant for unstable operation.

are reasonable and appropriate in light of the likely costs of compliance and any alternative options to achieve the same outcome.

AEMO's proposals regarding inclusion of new technical standards for alteration of generating plant or system are set out as Item 36 in Appendix B.

Question 9 Technical standards relevant to the alteration of generating plant/system

- **Do you agree with AEMO's analysis of the issues related to the technical standards for alteration of generating plants or system?**
- **Would the proposed change address the issues identified by AEMO? If not, what alternatives are there?**
- **Would the proposed changes to standards relevant to the alteration of generating systems or plant represent an unnecessary barrier to investment, having regard to the costs imposed by the change and the technical capabilities of different technologies?**

5.3 Jurisdictional issues and harmonisation

AEMO seeks to maintain a NEM-wide, technology-neutral approach to establishing connections, and believes the long-term interests of consumers will be best met with a consistent national framework. AEMO views different requirements across regions as presenting an unnecessary barrier to the efficient investment in electricity infrastructure that will ultimately lead to less economical outcomes for consumers. AEMO argues that the existence of state-based performance requirements indicates that the technical requirements in the NER require updating to reflect the needs of the changing power system.[100]

South Australia has imposed state based technical standards applying to connecting generators since 2005, which were justified on the basis that the generator access standard framework in the NER was insufficient to protect the security of the South Australian power system given the high penetration of asynchronous generation, particularly wind. In implementing requirements specific to South Australia, ESCOSA recognised that a state-based licensing solution is a second-best outcome and that these technical matters ought to be addressed at the national level (through the NER). In that sense, ESCOSA has always regarded these licence conditions as transitional.[101]

In addition to South Australia, AEMO considers the urgency to review technical requirements as further indicated by other participating jurisdictions' reportedly seeking their own requirements over and above those in the NER. In order to allow South Australia to remove its existing technical licence conditions, and avoid other

100 AEMO, *Generator technical performance standard rule request*, p. 15.

101 ESCOSA, *Inquiry into the licensing conditions for generators in South Australia*, final report, August 2017, p. 10.

jurisdictions imposing their own, any changes under this rule change will need to be sufficient to manage system security across all areas of the power system.

There are some differences between the access standards proposed in AEMO's rule change request, AEMO's recommendations to ESCOSA's 2017 inquiry into the licensing arrangements for generators in South Australia, and the technical requirements ultimately determined in ESCOSA's final report. The Commission will have regard to these differences, and any reasons for them, when considering the interactions between this rule change request and specific arrangements in South Australia and other jurisdictions.

Question 10 Jurisdictional issues and harmonisation

- **How important is a consistent approach to generator access standards across regions?**
- **Are AEMO's proposed changes sufficient to manage system security across all areas of the power system so that jurisdictional arrangements (such as ESCOSA's licensing conditions for connecting generators in South Australia) are not required?**
- **Are there changes in addition to those proposed by AEMO that stakeholders consider necessary to avoid the need for jurisdictional specific arrangements?**

6 Other issues for consultation

Taking into consideration the assessment framework, a number of other "non-technical" issues have been identified for initial consultation. These include issues related to AEMO's proposed changes to the process for negotiating performance standards as well as AEMO's proposed transitional arrangements for its proposed rule.

The sections below are provided to help inform stakeholder responses on this rule change request. Stakeholders are also invited to raise and comment on any other issues they consider relevant to AEMO's rule change request.

6.1 Process issues

6.1.1 Issues with the current framework

Parties seeking to connect equipment to the power system must either connect at the automatic access standard (accepting the level of performance associated with the standard) or enter a negotiation to set the levels of performance for that equipment. Connection applicants must negotiate with NSPs (and for matters relevant to system security, AEMO) to set the performance standards of their equipment, using the automatic and minimum access standards in the NER as a guide. The process is described in section 2.2.

AEMO considers the current negotiating framework for equipment connecting into the electricity network risks negotiations taking place in a manner that is not consistent with the NEO. AEMO states that many connection applicants aim for the lowest level of performance, regardless of the needs of the power system, and that this may, over time, negatively impact power system security.[102]

In assessing the materiality of the issues raised by AEMO, the Commission will focus on how the incentives created for market participants under the current negotiating framework may impact on power system security. It will also be important to consider the costs imposed on parties from the negotiating framework, and how these costs may ultimately impact on electricity prices for consumers.

The current negotiating framework may impact power system security where AEMO is not able to effectively require a connection applicant to raise a proposed negotiated access standard to a level AEMO reasonably considers is required to maintain system security. This question relates both to AEMO's powers under the current negotiating framework in the NER, and to whether in practice the framework is difficult to administer or enforce, resulting in negative impacts on system security.

A NSP must reject a proposed negotiated access standard if the connection or alteration of the generating plant at the proposed standard would, on AEMO's reasonable advice,

102 AEMO, *Generator technical performance standard rule request*, p. 19.

adversely affect power system security.[103] Stakeholders are invited to comment on whether this and other tools available to AEMO and NSPs are adequate to require connection applicants to set performance standards at levels that do not affect power system security (assuming the standards themselves are set at appropriate levels).

However, even if such tools are adequate, other factors may be present that may affect the effectiveness of the negotiating process. For example, NSPs and AEMO may face significant administrative burdens in negotiating generator performance standards proposed by connection applicants. This may cause difficulties in the processing of adequate performance standards, which may have implications for system security.

The Commission is interested in understanding whether existing powers are being utilised effectively in all instances by AEMO and NSPs. This is important to consider, as the effectiveness of existing institutional governance and enforcement arrangements may have a significant impact on the overall effectiveness of the negotiating processes.

The Commission is also seeking stakeholder views on the costs of the current negotiating framework; specifically, whether the costs involved in the process to negotiate performance standards present any unnecessary barriers to entry for specific generation technologies, or vary significantly by project scale or location. More generally, the Commission will be interested to understand how the benefits of having a negotiation framework for performance standards compares with the costs imposed on AEMO and participants to comply with this negotiation framework.

In order to be able to consider the costs and benefits of the proposed changes, where possible the AEMC would appreciate responses that include quantitative data on the costs of the current negotiating framework. This could be expressed as total costs incurred as a direct result of the process to negotiate performance standards or as a proportion of total project costs. Costs may be made up of the direct costs of negotiations (such as legal fees and technical experts) as well as indirect costs (such as impacts on project timelines). Further high level discussion of the trade-offs between cost, security and flexibility, is included in section 6.1.2.

It is important to clarify that there may be a difference between an issue with the negotiating process and an issue with the levels of the technical standards. For example, difficulties in negotiations resulting in cost increases may be caused by the levels of, and guidance in, the generator access standards, rather than the overarching negotiating processes set out in the NER

In order to fully assess the materiality of this issue, the AEMC is seeking information from a range of industry participants on how the negotiating process operates in practice, including the incentives they face within this process. The perspective that AEMO has set out in its rule change request may vary from that experienced by NSPs and connection applicants.

103 See clause 5.3.4A(f)(1) of the NER.

Question 11 Issues with the current negotiating framework

- **Do AEMO and NSPs have adequate powers under the NER to require connection applicants to set performance standards at levels that do not negatively impact power system security? Are there other factors that may impact the effectiveness of the negotiating process?**
- **How does the negotiating process operate in practice for participants? Is AEMO's view that connection applicants generally aim for the minimum access standards, and negotiate away from that position, an accurate representation of most negotiations?**
- **What are the costs of the current negotiating framework for market participants and AEMO?**

6.1.2 Rationale for a negotiating framework

The aim of a framework to negotiate the standards of performance for equipment connecting into the power system is to set performance standards at a level that maintains system security (as part of a broader suite of system security tools) at the lowest cost in the long term. The underlying rationale for a negotiating framework is to set those performance standards in a way that meets system security requirements and also provides the flexibility to reduce costs and barriers to entry for connection applicants, where appropriate. The process needs to be timely, practical and efficient so that the costs of the negotiating process do not outweigh the benefits.

AEMO notes in its rule change request that it considered proposing the removal of the negotiating framework and relying solely on the automatic standards, as occurs in international jurisdictions.[104] However, AEMO determined that there was still a need for flexibility in the process to set performance standards, and therefore did not recommend removal of the negotiating process.[105]

There may be other drawbacks to removing the negotiating framework and therefore the ability to set more tailored performance standards reflecting the circumstances of individual generators. For example, complete removal of the ability to negotiate performance standards could result in the potential need to develop a range of more technology specific access standards that may not be able to be applied flexibly to reduce costs, may not be technology neutral, and may not be able to be altered easily over time as technologies develop.

The Commission is seeking stakeholder views on whether the underlying rationale for a negotiating framework remains relevant and that a negotiating framework is still the most appropriate way to meeting the ongoing needs of the power system.

104 AEMO, *Generator technical performance standard rule request*, p. 20.

105 AEMO, *Generator technical performance standard rule request*, p. 20.

Whether a negotiating framework is fit for purpose to maintain the security of the power system as it transitions over the longer term, and whether it can achieve this at lowest cost while providing sufficient flexibility to facilitate generator access, depends on a range of factors:

- whether the transaction costs of negotiating performance standards are outweighed by potential reductions in overall costs for equipment seeking to connect to the power system

- whether a negotiating framework appropriately allocates to connection applicants the costs and risks of determining whether or not to negotiate performance standards, and

- whether the overall benefits of flexibility and potential cost reductions are impacted by the realities of an evolving power system, as it transitions from a system with a few connections of large synchronous generators to one with many connections of smaller asynchronous generators.

We note that any negotiating framework must work hand in hand with the levels that are set for the automatic and minimum access standards. The policy objective of meeting the required levels of system security at the lowest long term cost to consumers is a product of both the levels of access standards as defined in the NER and the process to negotiate to the appropriate levels for any given equipment that is seeking to connect. Achieving this goal with a negotiating framework approach will require a high degree of certainty and clarity regarding the negotiating process to allow parties to efficiently negotiate to an appropriate position. This is likely to require a clear understanding for all participants of the role of the automatic and minimum access standards, as well as the role of the negotiating process.

The Reliability Panel's first stage review of technical standards in the power system conducted in 2009 developed a range of principles for a then proposed broader review of the levels of technical standards.[106] It included proposed definitions for the roles of the automatic and minimum standards as follows:

- **Automatic Access Standard** - The automatic access standard must denote the performance level, considering the size, technology and location of likely connection applicants in the foreseeable future, where there would be no harm done to other network users or the system, and which would be unlikely to degrade the power system. A performance standard proposed by a connection applicant that meets the level of the automatic access standard must be accepted.

- **Minimum Access Standard** - The minimum access standard must denote the lowest level of performance, considering the size, technology and location of likely connection applicants in the foreseeable future, such that there is minor influence in the network, but no harm done to others or the power system. A performance standard proposed by a connection applicant that is below the level of the minimum access standard must be rejected.

The AEMC is seeking views from stakeholders on the appropriate role of the automatic and minimum access standards within the broader negotiating framework. This includes considering whether the above objectives proposed by the Reliability Panel in 2009 remain appropriate or whether there are other potential objectives for negotiating access standards between the automatic and minimum standards. Stakeholders should consider the tradeoffs between flexibility and cost reductions on the one hand, and security of supply on the other. Some questions to help prompt stakeholder engagement are:

- Whether the role of negotiating access standards should be to reduce the costs of connecting to the power system and allow for the flexibility to incorporate a range of technologies into the power system, while maintaining the security of the system?

- Whether the role of negotiations should be to ensure the highest level of system security and only depart from the automatic standard where a particular connecting technology cannot physically meet the level of performance required by the automatic standard?

- Are there other more appropriate roles for the negotiation of generator performance standards?

Question 12 Rationale for a negotiating framework

- **Given the changing nature of connections to the power system, does the rational for a negotiating framework governing the connection process remain appropriate? Do you value the ability to negotiate and why?**

- **What are the appropriate respective roles of the automatic, minimum and negotiated access standards?**

6.1.3 AEMO's proposed changes

As outlined in section 3.2, AEMO proposes changes to the negotiating framework to include a requirement that a negotiated access standard be as close as practicable to the automatic access standard and to require the connection applicant to provide evidence (to AEMO and the NSP's reasonable satisfaction) that it is not practicable for their proposed connection to meet an automatic access standard.

The changes would fundamentally alter the way negotiations of performance standards occur. Connection applicants may currently propose a negotiated access standard, so long as it is between the automatic and minimum standards.[107] Under

106 Reliability Panel, *Stage 1, Comprehensive technical standards review*, 2009.

107 Note that clause S5.2.1(g) of the NER states that Schedule 5.2 "provides for automatic access standards and the determination of negotiated access standards derived from minimum access standards, which once determined must be recorded ... and registered with AEMO as performance standards."

AEMO's proposal this would shift to a process where a negotiated access standard may only be proposed by a connection applicant where it is not practicable to meet the automatic standard (that is, where they are not able to meet it). The proposed threshold required to depart from the automatic access standard is therefore relatively higher than the current arrangements, which arguably allow negotiation to commence from the minimum access standard. The Commission is interested in stakeholder feedback on the implications of this change.

The proposed changes also shift the onus onto the connection applicant to produce evidence proving that it is not able to meet an automatic access standard. In addition NSPs and AEMO would be allowed a reasonable discretion as to whether or not they are satisfied with the evidence produced. This may increase the costs (including through project completion delays) faced by a connection applicant, in terms of producing the evidence necessary to support its claim, and responding to any challenges or requests for additional data from AEMO and the relevant NSP.

The overarching principle in assessing this rule change proposal is to strike a reasonable balance between system security and the cost of maintaining that security. That is, to maintain the power system in a secure state at the lowest long term cost to consumers. Stakeholders are invited to provide feedback on whether the proposed changes to the negotiating framework strike the appropriate balance between security and costs, specifically as this relates to:

- any increase or reduction in transaction costs (including the cost of project completion delays), such as the internal and external costs of engaging in the negotiating process
- any increase or reduction in the capital costs of connecting equipment to the power system, and
- any impacts on the level of system security over time.

The Commission is also interested in stakeholder views on whether the proposed changes might present unnecessary barriers to entry for particular technologies, scales or locations.

The proposed changes to the negotiating framework should be considered in light of the proposed changes to the generator access standards. As noted in section 6.1.2 above, any negotiating framework must work together with the levels that are set for the automatic and minimum standards.

Stakeholders should also take into account that the proposed changes to the negotiating framework would operate in respect of all connection applications, which includes the connection of major loads and MNSPs as well as connecting generators. On the other hand, AEMO has only proposed changes to the levels of the access standards for generator connections.

Question 13 AEMO's proposed changes to the negotiating framework

- **AEMO proposes changing the negotiations so that the onus is on the connection applicant to prove that they cannot practicably meet an automatic access standard. Does this change strike the appropriate balance between security and costs?**
- **Would the proposed changes present unnecessary barriers to entry for particular technologies, scales or locations?**
- **Would the proposed changes have any unintended adverse consequences for connecting MNSPs or large customers?**

6.2 Transitional issues

AEMO has requested changes to the access standards in Chapter 5 of the NER for generators connecting to the power system, as well as changes to the process for negotiating performance standards for equipment connecting to the system. AEMO has included transitional arrangements for its proposed rule, which provide that:

1. the amending rule applies to all connection applications where the performance standards have not been finalised by 11 August 2017, being the date that AEMO submitted its rule change request, and

2. the minimum access standards apply to any performance standards agreed after 11 August 2017 that are below the level that is the new minimum access standard. For each affected performance standard, the connecting generator, NSP and where relevant, AEMO,[108] would then need to renegotiate a new performance standard.

As noted in section 3.3, AEMO considers that applying the amending rule to all negotiations from 11 August 2017 is imperative to ensure the ongoing security of the power system.[109] AEMO argues that failing to do so would mean that assets with long life-cycles may be connected under outdated standards that do not ensure the capabilities required for the future power system.[110] Developing an appropriate response to the issues raised by AEMO will require a more detailed understanding of the nature of the issues and potential impacts on system security that could arise from the connection of new equipment under existing arrangements. This includes considering:

- whether any impacts on system security vary by technology type, scale or location

108 AEMO has a role in advising on negotiated access standards that are AEMO advisory matters, as defined by clause 5.3.4A(a) of the NER.

109 AEMO, *Generator technical performance standard rule request*, p. 7.

110 AEMO, *Generator technical performance standard rule request*, p. 7.

- whether any impacts on system security relate to:
  - the levels of specific access standards, and if so do some standards present greater risks than others, and/or
  - the powers available to NSPs and AEMO to require connection applicants to set performance standards at levels that do not negatively impact power system security, and
- the relevant details (including number, scale, location and technology type) of connection applications that could negatively impact system security.

The Commission will also consider what other options may be available to address the issues raised, once the specific nature of those issues has been assessed.

Question 14 Nature of the issues raised

- **What are the potential negative impacts on system security that could arise from the connection of new equipment under existing arrangements?**
- **What other options may be available to address the issues raised, taking into account the limitations set out in section 6.2.1 below?**

The transitional arrangements proposed by AEMO could have significant impacts on investments already planned or committed. This highlights the need to carefully consider both legal and policy implications of the transitional arrangements that apply for any amending rule that is made.

6.2.1 Limits to AEMC rule making powers

The AEMC does not have the power to make *retroactive* rules.[111] That is, rules that commence on a date before the rule is made and gazetted. It appears that this is the intended effect of the transitional arrangements proposed by AEMO and described in paragraph (1) in section 6.2 above.

In addition, rules made by the AEMC that have certain types of retrospective effect (*retrospective* rules) will be invalid. That is, rules that repeal or amend an existing rule in a manner that affects existing rights and liabilities in any of the ways described in paragraphs (a)-(e) of clause 33(1) of Schedule 2 to the NEL. The central consideration for retrospective rules is identifying which existing rights are protected from being affected by the repeal or amendment of an existing rule. While it is clear that a rule that affects existing rights or liabilities in the ways described in paragraphs (a)-(e) of clause 33(1) of Schedule 2 to the NEL will be invalid, it is not always clear whether a particular amendment to the NER has such an effect. It will depend on the

111 Section 104 of the National Electricity Law (NEL) provides that a rule made commences operation on the day the relevant notice is published or on any day after that day. This prevents the AEMC from making a rule that commences operation before the day the rule is published.

circumstances of each case, and in particular on the precise nature of the rule and the nature of the rights and liabilities it affects. These considerations are relevant to the transitional arrangements proposed by AEMO and described in paragraph (2) in section 6.2 above.

The AEMC must also take into account the constitutional limitations on making laws in the Northern Territory and the ACT under the Commonwealth self-government Acts that apply to those territories.[112] If a provision of the NER affects an acquisition of property otherwise than on just terms,[113] that provision will be invalid and not operate as a law of the Northern Territory and the ACT. For example, a rule change that affects contractual rights without provision for compensation could amount to an acquisition of property other than on just terms and be invalid in the Northern Territory and the ACT on that basis.

When making any new rule the AEMC carefully considers the implications of any transitional arrangements, including whether such arrangements could operate retroactively, retrospectively or have the effect of acquiring property rights other than on just terms.

6.2.2 Policy considerations for transitional arrangements

The Commission will consider the issues raised by AEMO and the policy measures appropriate to deal with material issues to further the NEO. This process ultimately may result in changes to the NER. After the policy measures and rule changes are settled, the AEMC will consider the appropriate way to implement any new rules.

If the AEMC makes a rule to amend the generator access standards and associated negotiating processes in the NER, a range of policy considerations will be important for assessing the appropriate transitional arrangements. These would include considering:

- the number and size of pending investments in new generating systems and other equipment that may be captured by the changes, and how progressed those investments are
- the range of options available, in light of relevant legal restrictions, from immediate transition through to full grandfathering, and
- for each option, considering:
    - the nature and extent of the implications for system security of negotiating performance standards for those pending connection applications that have been made or assessed in accordance with the current rules, and

112 Electricity (National Scheme) Act 1997 (ACT), s 5; National Electricity (Northern Territory) (National Uniform Legislation) Act (NT), s 6.

113 In this sense, "property" is a broad term that encompasses more than just tangible real property (land) and personal property, but also extends to contractual rights: Mutual Pools & Staff Pty Ltd v The Commonwealth (1994) 179 CLR 155 at 172.

– the nature and extent of the impact on prices for consumers, including through potentially increasing capital costs and transaction costs for some connecting generators.

The AEMC has the power to make a more preferable rule if it is satisfied that, having regard to the issues raised by AEMO, the more preferable rule will or is likely to better contribute to the achievement of the NEO.[114] Given this, the Commission may make a rule that operates in a different way to AEMO's proposed rule. If this occurs, the Commission would need to consider the range of relevant policy and legal considerations to determine the appropriate transitional arrangements to implement that different rule.

Question 15 AEMO's proposed transitional arrangements

- **What is the nature of the system security implications of an immediate transition to a new rule, as against a grandfathered transition?**
- **What is the nature of the cost implications of an immediate transition to a new rule, as against a grandfathered transition, and could this vary for different technology types, or depending on the stage a project has reached?**

114 Section 91A of the NEL.

7 Lodging a submission

The Commission has published a notice under s. 95 of the NEL for this rule change proposal inviting written submissions. Submissions should be lodged online or by mail by 31 October 2017.

Where practicable, submissions should be prepared in accordance with the Commission's Guidelines for making written submissions on rule change requests[115] The Commission publishes all submissions on its website subject to a claim of confidentiality.

All enquiries on this project should be addressed to Dominic Adams on (02) 8296 7800.

7.1 Lodging a submission electronically

Electronic submissions must be lodged online via the Commission's website, www.aemc.gov.au, using the "lodge a submission" function and selecting the project reference code "ERC0222". The submission must be on letterhead (if submitted on behalf of an organisation), signed and dated.

7.2 Lodging a submission by mail

The submission must be on letterhead (if submitted on behalf of an organisation), signed and dated. The submission should be sent by mail to:

Australian Energy Market Commission
PO Box A2449
Sydney South NSW 1235

The envelope must be clearly marked with the project reference code "ERC0222".

115 This guideline is available on the Commission's website, www.aemc.gov.au.

Abbreviations

AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AGC	automatic generation control
Commission	See AEMC
ESCOSA	Essential Services Commission of South Australia
FCAS	frequency control ancillary services
FFR	fast frequency response
MNSP	market network service providers
MVA	mega-volt amp
MW	megawatts
NEM	national electricity market
NEO	National Electricity Objective
NER	National Electricity Rules
NSP	network service provider
RoCoF	rate of change of frequency
SCADA	supervisory control and data acquisition
SCR	short circuit ratio

A Related policy processes

There are three principal policy processes that have informed AEMO's rule change request, including:

- the *Review of the black system in South Australia report: system event of 28 September 2016*, AEMO, March 2017 (the "AEMO black system event review")
- the *Inquiry into the licensing arrangements for generators in South Australia*, Essential Services Commission of South Australia (ESCOSA) (the "ESCOSA licensing inquiry"), and
- the *Independent review into the future security of the national electricity market: blueprint for the future* (Finkel review), Dr Alan Finkel and the Expert Review Panel, June 2017 .

The AEMO black system event review considered the events leading to the statewide blackout in South Australia on 28 September 2016 as well as the performance of the system restart processes, the power system and market operations during market suspension and provided recommendations for further action.[116] The recommendations included, relevantly, that AEMO would propose changes to generator licensing conditions in South Australia to ESCOSA, and would also request similar changes to the NER, to address deficiencies in performance standards identified through the investigation.

The ESCOSA licensing inquiry considered whether or not there should be any changes to ESCOSA's technical licensing conditions for electricity generators.[117] The inquiry specifically considered whether the current conditions for grid-scale wind generators should be removed, retained or varied, and whether any additional or amended conditions should be imposed on other grid-scale generators, such as solar generators or conventional synchronous generators. The final report was published in August 2017. Its conclusions were reached having considered technical advice from AEMO and with other stakeholder input. Relevant findings include that the access standards in the NER do not yet cater for the efficient integration of a changing mix of generation in South Australia and therefore transitional technical conditions on licenses should remain and new conditions should apply to require new generators to perform to a higher standard in a range of areas.

The Finkel review was commissioned to develop a blueprint for the transformation of the NEM, taking into account the need to reduce emissions, to keep the system safe, secure and reliable, and to do so at lowest cost to consumers.[118] The review

116 AEMO, *Review of the black system in South Australia report: system event of 28 September 2016*, final report, March 2017.

117 ESCOSA, *Inquiry into the licensing arrangements for generators in South Australia*, final report, 17 August 2017.

118 Expert Review Panel, *Independent review into the future security of the national electricity market: blueprint for the future*, final report, June 2017.

recommended, among many other things, that the AEMC review and update the access standards for all equipment in their entirety, including addressing system strength, reactive power and voltage control capabilities, the performance of generators during and subsequent to contingency events and active power control capabilities. The Finkel review also recommended a comprehensive review of the connection standards should occur every three years.

The AEMC has also been progressing a broad work programme on system security issues, including its System security market frameworks review and associated rule change projects. Final determinations are being published for three of those rule changes on the same day as the publication of this consultation paper, 19 September 2017.[119] Some of the processes that make up the AEMC's system security work programme relate to the issues raised in AEMO's rule change request. They include:

- the *System security market frameworks review* - This review included some analysis and recommendations on system strength outcomes. The specific recommendations in the system security review informed the more detailed changes proposed in the *managing power system fault levels rule change* noted below.[120]

- the *Managing power system fault levels rule change* - This Rule amended technical requirements for connecting generators to impose a new requirement to "do no harm" to system strength.[121] The Rule directly intersects with AEMO's proposal for access standards related to system strength.

- the *Managing the rate of change of power system frequency rule change* – This Rule places an obligation on Transmission Network Service Providers (TNSPs) to procure minimum required levels of inertia or alternative frequency control services.[122] This change is relevant to AEMO's proposal regarding generator technical standards for active power capability and generator frequency change withstand.

- the *Generating system model guidelines rule change* – This Rule clarified the scope and detail of model data that are provided to AEMO and NSPs.[123] There is some relationship between this rule change and the system strength requirements proposed by AEMO, in that it established that participants may be required to provide AEMO and NSPs with additional model data for the purpose of assessing whether equipment owned by registered participant may have an adverse impact on power system strength.

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119 These are the *managing power system fault levels rule change*, the *managing the rate of change of power system frequency rule change*, and the *generating system model guidelines rule change*.

120 AEMC, *System security market frameworks review*, final report, 27 June 2017.

121 National Electricity Amendment (Managing power system fault levels) Rule 2017.

122 National Electricity Amendment (Managing the rate of change of power system frequency) Rule 2017.

123 National Electricity Amendment (Generating System Model Guidelines) Rule 2017.

- the *Frequency control frameworks review* - This review is considering, among other things, how to best integrate faster frequency control services offered by new technologies into current and future market arrangements.[124] AEMO's proposed changes to active power capabilities for connecting generators relates to this review because this capability is relevant to the ability of generators to provide existing and future frequency control services, including FFR.

- the *Transmission connection and planning arrangements rule change* - This Rule changes the arrangements for parties connecting to the transmission network, and enhances the arrangements for transmission businesses to plan their networks.[125] The changes provide for a comprehensive and coherent transmission connection and planning framework. The changes relate to the process to connect and the economic regulation of the provision of certain connection and transmission assets and services. The changes are relevant to this rule change proposal because the process to negotiate the technical performance of equipment connecting into the power system occurs alongside the broader connection process that was considered and altered in this rule change.

124 AEMC, *Frequency control frameworks review*, initiated on 7 July 2017.

125 National Electricity Amendment (Transmission Connection and Planning Arrangements) Rule 2017.

B Detailed summary of AEMO's rule change proposal

This table provides a summary of AEMO's proposed rule changes. The summary is not an exhaustive list of AEMO's proposed changes. Stakeholders should carefully review AEMO's rule change request and proposed rule in considering their response to this rule change proposal. This table also excludes AEMO's proposals regarding process and transitional arrangements that are addressed in sections 3.2 and 3.3 of the consultation paper.

Capability	Issue	Proposal	Item No
Voltage control	Reactive power capability	*Clause S5.2.5.1 Reactive power capability* – **minimum access standard** - AEMO proposes requiring all generating systems to be capable of continuously supplying and absorbing reactive power. AEMO therefore proposes amending the minimum access standard in S5.2.5.1 to: • remove the provision specifying that no capability is required to supply or absorb reactive power at the connection point. And add a new clause requiring a generating system operating at any level of active power output, greater than 10% of its maximum operating level, and any voltage at the connection point (within the limits specified by S5.1a.4) to:[126] • 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 set-point range specified in the performance standard agreed under clause S5.2.5.13.	1

[126] There is a material difference between the position set out in the rule change request and the position in the draft rule proposed by AEMO in respect of the active power requirement of the minimum access standard in S5.2.5.1. AEMO's draft rule indicates that the 10% threshold for reactive power supply and absorption is a feature of the automatic access standard while its rule change request indicates this to be a proposal in respect of the minimum access standard. AEMO have clarified that the position set out in the body of the rule change request is to be preferred, and that the 10% active power threshold is an intended feature of the minimum access standard.

	Voltage and reactive power control	*Clause S5.2.5.13 Voltage and reactive power control* – **minimum access standard** – AEMO proposes amending the minimum access standard to remove the 30MW threshold and require all connecting generators to have facilities to regulate voltage irrespective of connection voltage or generator capacity. AEMO proposes that all generating systems (except embedded generating units) must: • regulate voltage at the connection point, or at another agreed location on the power system or within the generating system, to within 2% of the set-point • regulate voltage in a manner that helps to support network voltages during faults and does not prevent the NSP from achieving the requirements of clause S5.1a.3 and S5.1a.4 • allow the voltage set-point to be continuously controllable in the range of at least 98% to 102% of normal voltage at the connection point or the agreed location, without reliance on a tap-changing transformer, and • have limiting devices to ensure that a voltage disturbance does not cause the generating unit to trip at the limits of its operating capability. For generators that are embedded generating units connecting to the distribution network, AEMO proposes to amend the **minimum access standard** to remove the 100kV connection threshold and specify: • that the embedded generating units may have facilities to regulate reactive power or power factor in a manner that does not prevent the Network Service Provider from achieving the requirements of clauses S5.1a.3 and S5.1a.4, and sufficient to achieve the performance agreed in respect of clauses S5.2.5.1, S5.2.5.2, S5.2.5.3, S5.2.5.4, S5.2.5.5, S5.2.5.6 and S5.2.5.12;	2
		Clause S5.2.5.13 Voltage and reactive power control – **minimum access standard** – AEMO proposes to amend requirements in respect of the settling time for a synchronous generator of over 30MW with an excitation voltage control system to include a new requirement that the generating system: • operate the stator continuously at 102% of nominal voltage with rated active power output	3

		• have a settling time for a step change of voltage set-point or voltage for active power, reactive power and voltage a settling time of less than: — 5.0 seconds for a 5% voltage disturbance with the generating unit synchronised, from an operating point where such a voltage disturbance would not cause any limiting device to operate — in respect of each limiting device, 25 seconds for a 5% voltage disturbance with the generating unit synchronised, when operating into a limiting device from an operating point where a voltage disturbance of 2.5% would just cause the limiting device to operate	
		Clause S5.2.5.13 Voltage and reactive power control – **minimum access standard** – AEMO proposes additional requirements to reduce the settling time for asynchronous generating units of over 30MW. These requirements bring the standard applying to asynchronous generators into line with those applying to synchronous generators. AEMO proposes a settling time for active power, reactive power and voltage due to a step change of voltage set point or voltage of less than: • 5.0 seconds (previously 7.5 seconds) for a 5% voltage disturbance with the generating unit connected to the power system from an operating point where such a voltage disturbance would not cause any limiting device to operate • also requires such systems to have reactive power rise time, for a 5% step change in the voltage setpoint, of less than 5 seconds.	4
		Clause S5.2.5.13 Voltage and reactive power control – **negotiated access standard** – AEMO proposes the addition of a new requirement: • Where power factor or reactive power regulation modes are included, these are in addition to voltage control or excitation control. The generating system may operate in any control mode as agreed with the NSP and AEMO and must be able to be switched to voltage control or excitation control at any time. Remote control equipment to change the set-point and mode of regulation must be provided.	5
	Definitions	*Clause S5.2.5.13 Voltage and reactive power control* - Definitions for **settling time** and **rise time** have been revised and moved to the Glossary. AEMO's proposed definitions in respect of these	6

		parameters are: • **Rise time** - 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 • **Settling time** - 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: — 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 — the sustained change induced in that output quantity.	
Disturbance ride through – Reactive current injection requirements	Reactive current injection	*Clause S5.2.5.5 Generating system response to disturbances following contingency events* – **automatic access standard** – AEMO proposes amending the automatic access standard reactive current injection requirements to:[127] • require capacitive reactive current of 4% of the maximum continuous current of the generating system for each 1% reduction in connection point voltage below 90% of normal voltage. AEMO's amendment requires this capacitive reactive current injection to be in addition to its pre-disturbance level rather than the greater of its pre-disturbance level and 4% reactive current injection requirement. AEMO's proposal also requires that capacitive reactive current injection be in respect of voltage below 90% of normal rather than from the pre-fault level. AEMO also proposes a new provision requiring a generator to maintain the reactive current injection during the disturbance and until the connection point voltage recovers to between 90% and 110% of normal voltage.	7
		Clause S5.2.5.5 Generating system response to disturbances following contingency events –	8

[127] Please note that AEMO's proposal in respect of inductive reactive current injection under clause s5.2.5.5 of the NER is introduced under high voltage disturbance ride through.

		minimum access standard – AEMO proposes to add a new requirement for reactive current injection under the minimum access standard. By proposing this change to the minimum access standard, all generators will be required to have capacitive reactive current injection capabilities. AEMO proposes requiring: • a capacitive reactive current injection in addition to its pre-disturbance level of 2% of the maximum continuous current of the generating system and each of its generating units (in the absence of a disturbance) for each 1% reduction of connection point voltage below 90% of normal voltage during the fault. AEMO also proposes a new provision in line with the automatic access standard requiring a generator to maintain the reactive current injection during the disturbance and until the connection point voltage recovers to between 90% and 110% of normal voltage.	
		Clause S5.2.5.5 Generating system response to disturbances following contingency events – **negotiated access standard** – AEMO proposes amending the conditions on which a generator can negotiate an access standard different to the automatic access standard. AEMO proposes requiring a connecting generator to meet the automatic access standard for continuous uninterrupted operation and the supply and absorption of active power, reactive power, and reactive current: • except where AEMO and the NSP agree that the total reduction of generation in the power system due to an applicable fault would not exceed 100MW. This requirement replaces a provision under the minimum access standard. The existing requirement was however solely in respect of continuous uninterrupted operation and didn't extend to requiring automatic access standard levels in respect of active power, reactive power, or multiple fault ride-through.	9
		Clause S5.2.5.5 Generating system response to disturbances following contingency events – **general requirements** – AEMO proposes a new clause which limits the level of reactive current required from asynchronous and synchronous generators under fault conditions: • the reactive current contribution may be limited to: — the maximum continuous current of an **asynchronous** generating system including all	10

		operating generating units; or — 250% of the maximum continuous current of a synchronous generating system including all operating generating unit.	
		Clause S5.2.5.5 Generating system response to disturbances following contingency events – **general requirements** – AEMO proposes an additional clause specifying the manner in which reactive current contribution under fault conditions is measured and calculated: • the reactive current contribution and voltage deviation may be measured at the applicable low voltage terminals of the generating units or reactive plant within a generating system • the reactive current contribution required may be calculated using phase to phase, phase to ground, or sequence components of voltage. When using sequence components, the ratio of negative-sequence to positive-sequence current injection must be agreed with AEMO and the NSP for various types of voltage disturbances.	11
		Clause S5.2.5.5 Generating system response to disturbances following contingency events – **general requirements** – AEMO proposes a set of additional clauses specifying rise and settling time and reactive and active power consumption upon the occurrence of a fault: • the reactive current response must have a rise time of no greater than 30 milliseconds, a settling time of no greater than 60 milliseconds and must be adequately damped • any reactive power consumption immediately upon the occurrence of a fault must not exceed 5% of the maximum continuous current of the generating system and is limited to the duration of rise time	12
Disturbance ride through - Multiple low voltage	Low voltage ride through - withstand	*Clause S5.2.5.4 Generating system response to voltage disturbances* – **minimum access standard** – AEMO proposes new requirements for low voltage ride through/withstand by requiring generators to maintain continuous uninterrupted operation where a power system disturbance	13

disturbance ride through		causes the voltage at the connection point to vary within the following ranges: • 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. This mirrors requirements under the automatic access standard except with a lower withstand duration for voltages between 80% to 90% of normal.	
	Multiple low voltage disturbance withstand	*Clause S5.2.5.5 Generating system response to disturbances following contingency events* – **automatic access standard** – AEMO proposes the following new requirement for generators to withstand multiple low voltage disturbances under the automatic access standard: • a generating system and each of its generating units and reactive plant must maintain in continuous uninterrupted operation for up to 15 voltage disturbances in any 5-minute period and that the total time that the voltage at the connection point is less than 90% of normal voltage is 1,800ms.	14
		Clause S5.2.5.5 Generating system response to disturbances following contingency events – **minimum access standard** – AEMO proposes new requirements covering multiple low voltage disturbances withstand under the minimum access standard. AEMO proposes minimum access standard requirements that mirror those of the automatic access standard except that it requires a total withstand period of 1,000ms (rather than 1,800ms): • a generating system and each of its generating units and reactive plant must maintain continuous uninterrupted operation for up to 15 voltage disturbances in any 5-minute period and that the total time that the voltage at the connection point is less than 90% of normal voltage is 1,000ms.	15
Disturbance ride through - High voltage disturbance ride	High voltage withstand requirements	*Clause S5.2.5.4 Generating system response to voltage disturbances* – **automatic and minimum access standards** – access standards in respect of disturbances leading to voltages over 110% of normal reference the system standard S5.1a.4 Power frequency voltage withstand requirements. AEMO therefore recommends amending S5.1a.4 to require continuous uninterrupted operation for	16

through		the following durations as a function of the degree of over-voltage: • voltages within 110% to115% of normal – 1,200 seconds • voltages within 115% to120% of normal – 20 seconds • voltages within 120% to125% of normal – 2 seconds • voltages within 125% to130% of normal – 0.2 seconds • voltages within 130% to140% of normal – 0.02 seconds. Increasing the requirements of the system standard s5.1a.4, automatically increase the requirements in respect of high voltage disturbance ride through under the automatic and proposed new minimum access standard of S5.2.5.4	
		Clause S5.2.5.4 Generating system response to voltage disturbances – **minimum access standard** – AEMO proposes adding a new requirement to bring the minimum access standard into line with the automatic access standard by referencing the requirements of the system standard S5.1a.4 in respect of withstand requirements for voltages above 110% of normal.	17
	Over voltage - Inductive reactive current injection	*Clause S5.2.5.5 Generating system response to disturbances following contingency events* – **automatic and minimum access standards** – AEMO recommends a new requirement under both the automatic and minimum access standards applying to inductive reactive current injection in respect of over-voltage events. This new provision requires a generator to supply:: • inductive reactive current in addition to its pre-disturbance reactive current of 6% of the maximum continuous current of the generating system, including all operating generating units, for each 1% increase of connection point voltage above 110% of normal voltage. • reactive current injection maintained until the connection point voltage recovers to between 90% and 110% of normal voltage.	18

Disturbance ride through - Active power recovery	Active power recovery	*Clause S5.2.5.5 Generating system response to disturbances following contingency events* – **minimum access standard** – AEMO proposes a new requirement under the minimum access standard which covers the speed of active power recovery following the clearance of a fault event. AEMO's proposal involves requiring a generator to recover active power: • from 1,000ms after disconnection of the faulted element, to at least 95% of the level existing immediately prior to the fault. This requirement effectively mirrors the existing requirement under the automatic access standard except with an allowable recovery time of 1,000ms (rather than 100ms).	19
	Transient active power consumption	*Clause S5.2.5.5 Generating system response to disturbances following contingency events* – **general requirement** – As asynchronous generating systems generally require time to measure data, detect a disturbance and produce an appropriate response, AEMO proposes adding the following criteria regarding transient active power consumption upon application of a fault: • any active power consumption immediately upon the occurrence of a fault must not exceed 5% of the maximum continuous current of the generating system and is limited to 20 milliseconds.	20
Disturbance ride through – Partial load rejection	Extension to asynchronous generation	*Clause S5.2.5.7 Partial load rejection* – **automatic and minimum access standard** – AEMO proposes to remove the clause which limits s5.2.5.7 to synchronous generating units. This removal would extend application of the automatic and minimum access standards to all generators both synchronous and asynchronous.	21
	Clarification of terminology	*Clause S5.2.5.7 Partial load rejection* – AEMO proposes a minor amendment to clarify the terminology used in S5.2.5.7 such that the term generating unit is replaced by generating system.	22
Disturbance ride through – RoCoF withstand	RoCoF withstand requirements for synchronous and asynchronous	*Clause S5.2.5.3 Generating system response to frequency disturbances* – **automatic access standard** – AEMO proposes to amend the automatic access standard for generating system response to frequency disturbance to increase withstand capabilities to higher rates of change of frequency (RoCof). AEMO proposes:	23

	generation	• A generating system and each of its generating units must be capable of continuous uninterrupted operation unless the rate of change of frequency is outside the range of -4 Hz to 4 Hz per second for more than 0.25 seconds, -3Hz to 3Hz per second for more than one second, or such range as determined by the reliability panel from time to time.	
		Clause S5.2.5.3 Generating system response to frequency disturbances – **minimum access standard** – AEMO recommends amending the minimum access standard to increase the required RoCoF withstand applying to **synchronous** generators. Asynchronous generators will therefore be required to meet the automatic access standard. AEMO proposes: • a **synchronous** generating system and each of its generating units must be capable of continuous uninterrupted operation unless the rate of change of frequency is outside the range of -2 Hz to 2 Hz per second for more than 0.25 seconds, -1Hz to 1Hz per second for more than one second, or such range as determined by the reliability panel from time to time.[128]	24
System Strength	Addition of a new access standard	*Proposed new clause S5.2.5.15 System strength* – **minimum access standard** - AEMO proposes the addition of a new access standard covering system strength that would represent a minimum requirement for all connecting generators. AEMO proposes: • the minimum access standard is a generating system and each of its generating units must be capable of continuous uninterrupted operation for any short circuit ratio to a minimum of 3.0 at the connection point.	25
Active power	Proportional response	*Clause S5.2.5.11 Frequency control* – **automatic access standard** – AEMO proposes simplifying	26

[128] Please note that there is a difference between AEMO's rule change request and its proposed rule regarding RoCoF withstand for synchronous generators. AEMO's draft rule includes a requirement under the minimum access standard for synchronous generating systems to be capable of continuous uninterrupted operation unless the rate of change of frequency is outside the range of -2Hz to 2 Hz for more than 0.25 seconds. AEMO has clarified that its policy intent is for RoCoF withstand requirements to be as proposed in the draft rule (and not as set out in the rule change request), requiring continuous uninterrupted operation unless the rate of change of frequency is outside the range of -2Hz to 2 Hz for more than 0.25 seconds.

control requirements – Frequency response mode capability	to frequency change	the language specifying the automatic access standard requirements for providing a proportional active power response to frequency change. The requirements under AEMO's proposed amendment provide a more generic description of the required response capability from the connecting generator than is currently the case. AEMO proposes that a generating system must be capable of automatically providing a proportional: • decrease in power transfer to the power system in response to a rise in power system frequency at the connection point, and • increase in power transfer to the power system in response to a fall in power system frequency at the connection point. This response must be sufficiently rapid and sustained for a sufficient period for the generator to be in a position to offer measurable amount of market ancillary services to the spot market **for each of** the market ancillary services.	
		Clause S5.2.5.11 Frequency control – **minimum access standard** – AEMO proposes imposing a new minimum access standard requirement on generators with a nameplate rating of 30MW in respect of frequency control capabilities. AEMO recommends that a generating system with a nameplate rating of 30MW or above must be capable of automatically providing a proportional: • decrease in power transfer to the power system in response to a rise in power system frequency at the connection point, and • increase in power transfer to the power system in response to a fall in power system frequency at the connection point. This response must be sufficiently rapid and sustained for a sufficient period for the generator to be in a position to offer measurable amount of market ancillary services to the spot market for **at least one of** the market ancillary services.	27
	Negotiated access standard requirements	*Clause S5.2.5.11 Frequency control* – **negotiated access standard** – AEMO proposes amending the negotiated access standard requirements to remove the need for a connecting generator to "demonstrate" to AEMO and the NSP that the proposed increase in active power transfer capability (in response to a fall in power system frequency) is as close as practicable to the automatic access standard. Generators would need to "satisfy" AEMO and the NSP that their capability to decrease	28

		power transfer (in response to an increase in power system frequency) is as close as practicable to the automatic access standard.	
	Definition of droop	*Clause S5.2.5.11 Frequency control* – AEMO proposes to add a definition of 'droop' in S5.2.5.11 as follows: • **Droop** – means in relation to frequency response mode, the percentage change in power system frequency at the connection point required to produce a change in power transfer equal to the maximum operating level of the generating system.	29
	General requirements	*Clause S5.2.5.11 Frequency control* – **general requirements** – AEMO proposes including a set of new general requirements regarding the active power response to frequency disturbance: • the change in power transfer to the power system must occur with no delay beyond that required for stable operation, or inherent in the plant controls, once power system frequency at the connection point leaves the dead-band around 50 Hz • the dead band must be set within the range 0 to ±1.0 Hz. Different dead-band settings may be applied for a rise or fall in power system frequency at the connection point • the frequency droop must be set within the range of 2% to 10%, and • a generating system is not required to operate below its minimum operating level in response to a rise in power system frequency at the connection point, or above its maximum operating level in response to a fall in power system frequency at the connection point.	30
Active power control requirements – Automatic generation control	Ability to receive and respond to AGC signal	*Clause S5.2.5.14 Active power control* – **automatic and minimum access standards** – AEMO proposes amending S5.2.5.14 to remove the 30MW threshold and require generators connecting under both the automatic and minimum access standards to have the capability to: • **Scheduled generators** - receive and automatically respond to signals delivered from the AGC, as updated at a rate of one every four seconds • **Semi-scheduled generators** – <u>subject to energy source availability</u>, receive and automatically	31

		respond to signals delivered from the AGC, as updated at a rate of one every four seconds.	
Active power control requirements – Capability to limit active power and ramp rate	Ramp rate limitation	*Clause S5.2.5.14 Active power control* – **minimum access standard** – AEMO proposes amending the minimum access standard to add a new requirement that brings semi-scheduled generators into line with scheduled generators in being capable of limiting the rate of change of active power. AEMO proposes: • for a **semi-scheduled** generating unit or system, subject to energy source availability, is capable of not changing its active power output within five minutes by more than the raise and lower amounts specified in an instruction electronically issues by a control centre.	32
Remote monitoring and control	Remote monitoring capabilities	*Clause S5.2.6.1 Monitoring and control requirements* – **automatic access standard** – AEMO proposes to include the following **remote monitoring** capabilities for generating systems which it can request under the automatic access standard irrespective of capacity of the generating system: • status of all switching devices that carry the generation, tap positions and voltages, active and reactive power, voltage control set-point and mode - *Formerly remote monitoring capabilities in respect of these parameters were only required in respect of generators with capacity of >30MW* AEMO proposes adding the following additional remote monitoring requirements that it may request under the automatic access standard: • in respect of scheduled or semi-scheduled generators, active power limits and ramp rates • the available energy in an energy storage system (MWh) • runback scheme parameters, and • mode of operation of the generating unit including turbine control limits, and other information required to predict the active power response of the generating system to changes in power system frequency	33

		Clause S5.2.6.1 Monitoring and control requirements – **minimum access standard** - AEMO proposes to require under the minimum access standard the same **remote monitoring** capabilities for generating systems as are required under the automatic access standard, however with the 30MW capacity threshold retained in some areas. AEMO proposes that the remote monitoring requirements AEMO may request include: In respect of generators with a capacity of 30MW or more: • status of switching devices, tap positions and voltages, active and reactive power, voltage control set-point and mode and, in respect of reactive power equipment that is part of the generating system but not part of a particular generating unit, reactive power – **for generators that are connected to the transmission system** • current, voltage, active power and reactive power in respect of generating unit stators or power conversion systems (as applicable) • active and reactive power in respect of an auxiliary supply system with a capacity of >30MW associated with a generator In respect of all generators irrespective of capacity: • in respect of scheduled or semi-scheduled generators, active power limits and ramp rates, and AGC • the available energy in an energy storage system (MWh) • runback scheme parameters • mode of operation of the generating unit including turbine control limits, and other information required to predict the active power response of the generating system to changes in power system frequency • any other quantity that AEMO reasonably requires to discharge its market and power system security functions set out in Chapters 3 and 4.	34

	Remote control capabilities	*Clause S5.2.6.1 Monitoring and control requirements* – **automatic and minimum access standards** – In respect of the **remote control** quantities, AEMO proposes the following new requirements for both the automatic and minimum access standards: • voltage control set point and, where applicable, mode • AGC control in respect of scheduled or semi-scheduled generating systems • active power limit and active power ramp limit in respect of non-scheduled generating systems	35
Procedure to be followed by a generator proposing to alter a generating system	Addition of standards for re-assessment	*Clause 5.3.9 Procedure to be followed by a generator proposing to alter a generating system* – AEMO proposes the following as additional standards where re-assessment will be necessary if a generating system is altered: • Alteration of a voltage control system – *S5.2.5.7 Partial load rejection* • Alteration of a protection system – *S5.2.5.10 Protection to trip plant for unstable operation* Please note that AEMO is not proposing any changes to access standards under *s5.2.5.10 Protection to trip plant for unstable operation*.	36
Definition of continuous uninterrupted operation	Removal of threshold term and maintaining active power output during a power disturbance	AEMO proposes an amendment to the definition of continuous uninterrupted operation to require additional active power support during fault conditions and remove 'substantially' as a threshold term in respect of a generator's active and reactive power response in accordance with S5.2.5.11, S5.2.5.13 and S5.2.5.14. AEMO proposes adding S5.2.5.5 as an additional standard in respect of continuous uninterrupted operation. **Proposed definition of continuous uninterrupted operation -** • In respect of a generating system or operating generating unit operating immediately prior to a power system disturbance, not disconnecting from the power system except under its performance standards established under clauses S5.2.5.8 and S5.2.5.9 and, **during the**	37

			disturbance and after clearance of any electrical fault that caused the disturbance, **not** varying active power or reactive power unless required by its performance standards established under clauses **S5.2.5.5**, S5.2.5.11, S5.2.5.13 and S5.2.5.14, with all essential auxiliary and reactive plant remaining in service, and responding so as not to exacerbate or prolong the disturbance or cause a subsequent disturbance for other connected plant.	