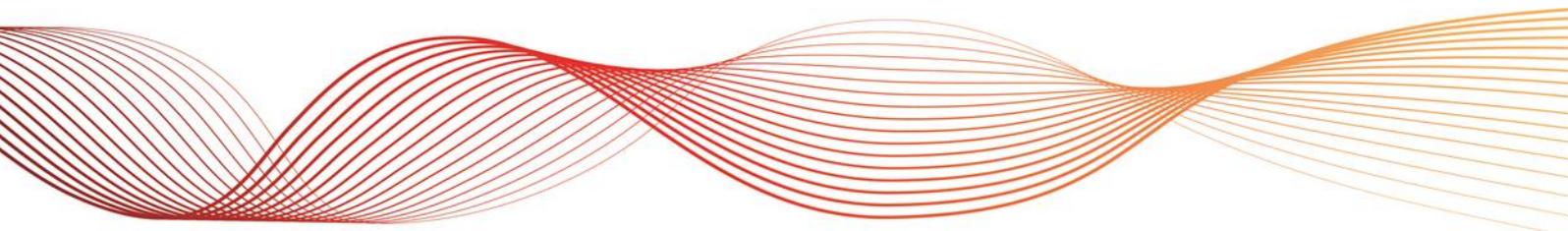




ELECTRICITY RULE CHANGE PROPOSAL

GENERATOR TECHNICAL REQUIREMENTS:
SUPPLEMENTARY MATERIAL TO RULE CHANGE PROPOSAL

October 2017







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1 PURPOSE OF THIS DOCUMENT

In response to preliminary feedback from stakeholders and a number of questions raised by the AEMC, the Australian Energy Market Operator (AEMO) provides the following clarifications to its Electricity Rule Change Proposal: Generator Technical Requirements. AEMO thanks stakeholders for the feedback provided to date on AEMO's Rule change proposal and will continue to work with the Australian Energy Market Commission (AEMC) and stakeholders during the AEMC's consultation process.

2 SPECIFIC QUESTIONS FROM THE AEMC

2.1 Procedures to be followed by a Generator proposing to alter a generating system

2.1.1 Are all proposed changes intended to apply to alterations to existing plant under 5.3.9?

Yes. AEMO considers the proposed changes to clause 5.3.9 to be very minor; these being amendments to include two additional clauses listed for review under clause 5.3.9(d). The first of these is likely to be a mistaken omission in the past, the other is consequential to the proposed amendments in AEMO's proposed Rule change relating to the application of clause S5.2.5.7 to asynchronous plant. AEMO does not intend any procedural changes to clause 5.3.9 and considers that in its proposed amended form should be applied to any altered plant in the same manner as it is currently being applied.

2.1.2 Are there any changes where grandfathering is intended (i.e. where the changes are not intended to apply on alteration of an existing plant)?

AEMO does not intend any explicit or altered grandfathering provisions, the application and process of clause 5.3.9 remains unchanged.

2.2 Voltage and reactive power

2.2.1 Is it intended that the proposed requirement for the minimum access standard in S5.2.5.1, given its relationship with S5.2.5.13, may result in a standard higher than the automatic access standard (i.e. is the automatic access standard intended to be the upper limit, and the minimum will not go above this level)?

Yes, the automatic access standard represents the upper limit. AEMO has now included an additional note to clarify this in the proposed Rule, this can be found in Section 3.1.

2.2.2 Are there any changes proposed related to the difficulty in assessing compliance with the requirements under S5.2.5.13 under variable levels of system strength?

This is an existing issue. The Generator and Network Service Provider will need to agree on appropriate settings to suit the characteristics of a connection point based on the maximum and minimum fault levels as agreed in a connection agreement.

2.2.3 Is the requirement under S5.2.5.13, to provide remote control (to AEMO) for switching to voltage control at any time, intended to operate as a capability or a mandated requirement?

AEMO expects that most plant will normally operate in voltage control mode, but that in some circumstances a Distribution Network Service Provider and Generator may agree to operate a generator in alternative modes. Where this is the case, the need for a capability to switch to voltage control mode is required. Utilisation of such mode changing will need to be coordinated between AEMO and the Network Service Provider, as per normal operational arrangements. The main control functionality proposed is the voltage set point control. AEMO will utilise this in meeting its obligations

under clause 4.5 and can consider alternative means, such as tap change control to suit each Generator – as is current practice. It should be noted that provision and participation in voltage support are effectively mandatory requirements for all Registered Participants, as there are no market mechanisms for voltage support. Voltage set point control would be managed in accordance with the system standards, normally at the connection point, and AEMO does not consider there is increased risk for any participant. Unusual voltage control schemes would require discussion and operational protocols to be agreed with the Generator and Network Service Provider.

2.2.4 Is it intended that any generators will be able to operate in power factor or reactive control modes (as agreed by the Network Service Provider and AEMO)?

AEMO had only intended such control be an option for embedded generating plant and cannot identify what else is implied in AEMO's proposed rule. Such arrangements are optional and may be agreed between a Network Service Provider and a Generator / Connection Applicant.

2.3 Reactive injection / absorption

2.3.1 Is the reactive current injection / absorption requirement during a disturbance, specified in S5.2.5.5, intended to operate as a mandated requirement or a capability (noting the ESCOSA decision for reactive power injection of up to 6%, rather than 6%)?

AEMO has proposed additional paragraphs within S5.2.5.5 that allow the exact injection to be agreed with the Network Service Provider. Refer to Section 3.4.

2.3.2 In the general requirements proposed in S5.2.5.5 – (in respect of the reactive current response, 30ms response rise time and settling time of 60ms) is the reactive current response 100% in 30ms, or is a different response step size proposed?

AEMO has proposed a definition of *rise time* to be included in Chapter 10 (Glossary). This is consistent with the definition currently under clause S5.2.5.13 and is as follows:

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.

2.3.3 Are the rise time and settling time for reactive injection intended to apply to synchronous machines, noting that the Essential Services Commission of South Australia (ESCOSA) determination only applied these requirements to non-synchronous generating systems?

It should be noted that the term *settling time* does not apply to synchronous machines in the context of fault current contribution because:

- *Settling time* as defined in the Glossary (as proposed by AEMO) relates to the time taken for an output quantity of a *control system* to be within an error margin of its final value following a step change in an input quantity.
- Unlike *asynchronous* plant, the fault current contribution of synchronous generators is provided through an intrinsic and uncontrolled response.
- The fault current contribution of synchronous generators does not settle during the fault due to the presence of large DC components in the fault current. This is unlike a power electronic controlled system such as a power electronic interface wind turbine or solar inverter where the DC component is practically eliminated.

2.4 System strength access standard

2.4.1 Is Short Circuit Ratio (SCR) still proposed as the metric used in specifying a system strength access standard (and if so, how defined), or is a different approach proposed in light of the final determination of the managing fault level rule change?

AEMO has reviewed the Managing Power System Fault Levels Determination and will propose an amended system strength access standard as a consequence. Its original recommendations were developed based on the principles in the Draft Determination. AEMO plans to use SCR and X/R ratio seen by the generating system at the connection point to specify the required plant minimum capability in the proposed system strength access standard and will develop and propose a definition for SCR.

2.4.2 Is SCR (or some other metric AEMO intends to use in an altered proposal) to be measured at the connection point or at the terminals?

The SCR will be measured at the connection point. In this way, AEMO considers that Generators have flexibility to design their generating system – which includes generating units and any associated support plant and reticulation systems to meet this requirement.

The connection point is also the most appropriate location to reference the minimum fault level to be maintained by Transmission Network Service Providers at fault level nodes to (referring to the recently finalised Managing Power System Fault Levels Rule change).

2.4.3 Is an X/R requirement intended to operate as part of the proposed access standard for system strength (noting this was a requirement in ESCOSA's final decision)?

AEMO will develop a recommended X/R requirement in conjunction with the SCR. It had been omitted from AEMO's original Rule change proposal for consistency with the metrics proposed in the Managing Power System Fault Levels Draft Determination.

2.5 Continuous Uninterrupted Operation

2.5.1 For what range of voltages is it proposed that a generator is required to maintain active power during a disturbance?

Active (and reactive power) must be maintained between 90% and 110% of normal voltage, which is the continuous operating range under clause S5.1a.4 of the system standard, and as further clarified in S5.2.5.4, so as not to exacerbate, prolong or cause a subsequent disturbance for other connected plant.

A disturbance is considered to be outside of this range i.e. less than 90% or greater than 110% of normal voltage. AEMO had proposed a change to the definition of *continuous uninterrupted operation* to ensure that the reactive current injection requirement proposed under the amendment of clause S5.2.5.5 is captured. AEMO acknowledges the proposal as made requires clarification. AEMO has now proposed a more transparent definition of *continuous uninterrupted operation*, in Section 3.6.

AEMO notes that the revised *minimum access standard* in clause S5.2.5.4 and definition of *continuous uninterrupted operation* has been interpreted by some to require that active power not vary for disturbances that cause the voltage to reduce to 70 % of normal voltage. This is not AEMO's intention - a generating system may respond to disturbances that cause voltage to go outside the normal operating



range (90 – 110 % of normal voltage) in accordance with its performance standards. AEMO has amended the proposed definition for *continuous uninterrupted operation* to clarify this matter.

2.5.2 The rule change proposal requires a generator to ‘not vary its active power or reactive power unless required by performance standards’. Are there any access standards that require additional amendment to explicitly specify requirements for active or reactive power performance during or following a disturbance? In particular: S5.2.5.4, S5.2.5.5, S5.2.5.7 and other potentially affected clauses not currently subject to this rule change request including S5.2.5.10; S5.2.5.6; and S5.2.5.8. Should any other clauses be specified as exemptions under the definition of *continuous uninterrupted operation*?

AEMO does not consider additional clauses need to be explicitly exempted:

- Clause S5.2.5.8(a) provides the conditions whereby *continuous uninterrupted operation* would be considered to not be met.
- Clause S5.2.5.10 relates to protection to trip a generating system when it becomes unstable, the allowable operation for such protection is addressed in clause S5.2.5.8.
- Clause S5.2.5.6 does not require *continuous uninterrupted operation*, only that a generating system must not disconnect within the network quality of supply limits specified in clause S5.2.5.6.

2.6 Multiple fault ride through

2.6.1 Are the multiple fault ride through requirements (as currently proposed) intended to apply to synchronous generators, including synchronous condensers?

Yes, this clause is proposed to equally apply to all generation technologies, including synchronous condensers, which are fundamentally synchronous generators without a prime mover.

Further, it is AEMO’s intention that the proposed multiple fault ride through requirements are consistent with equipment capabilities of all generation technologies. AEMO welcomes stakeholder feedback where there are concerns with equipment’s capability to meet the recommended standards.

2.6.2 Are there any limits or conditions to be applied to the proposed multiple disturbance ride through requirements, noting the forum discussion on the combination, depth and timing of disturbances, as well as ESCOSA’s final decision including a 30 minute cool-down period after any 5 minute fault event period?

The objective of this proposal is to limit implementation of controls (e.g. simple fault counters), and to establish capabilities to ride-through successive disturbances.



2.7 Active power control

2.7.1 Are the proposed active power control and remote monitoring and control requirements a capability or mandated requirements to provide services?

Remote monitoring is required for all electrical, environmental measurement, and control signal quantities requested by AEMO and as agreed in each generator performance standard. Active power control capabilities will be utilised in accordance with the classification of each facility.

Refer to section 2.2.3 for discussion of voltage control.

2.7.2 Are there any limits to required contributions in respect of generator capabilities to provide active power response to frequency events?

AEMO's proposed amendments to clause S5.2.5.11 require a proportional (droop) response to frequency events. AEMO's proposed rule included a definition for droop, 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*.

In general, the required active power response will be consistent with the combined requirements of clause S5.2.5.11, the classification of generating units for the delivery market ancillary services, dispatch outcomes and the Market Ancillary Services Specification – no change to current processes is intended.

3 PROPOSED RULE DRAFTING CLARIFICATIONS

AEMO proposes the following changes to the Draft Rule.

3.1 S5.2.5.1

AEMO notes a drafting error in the proposed draft Rule and proposes to add a clarifying note that the *automatic access standard* represents the upper bound for any negotiated standard. The revised draft rule is as follows:

Automatic access standard

(a) The *automatic access standard* is a *generating system* operating at:

- (1) any level of *active power* output ~~greater than 10% of its maximum operating level~~; and
- (2) any *voltage* at the *connection point* within the limits established under clause S5.1a.4 without a *contingency event*,

must be capable of supplying and absorbing continuously at its *connection point* an amount of *reactive power* of at least the amount equal to the product of the *rated active power* of the *generating system* and 0.395.

Minimum access standard

(b) The *minimum access standard* is a *generating system* operating at:

- (1) any level of *active power* output ~~greater than 10% of its maximum operating level~~; and
- (2) any *voltage* at the *connection point* within the limit established under clause S5.1a.4 without a *contingency event*,

must be capable of supplying and absorbing continuously at its *connection point* an amount of *reactive power* of at least the amount required to enable the *generating system* to achieve the continuously controllable *voltage* setpoint range specified in the *performance standard* agreed under clause S5.2.5.13, and within the limits in the *automatic access standard*.

3.2 S5.2.5.3

In section 5.9.3 of AEMO's Rule change proposal, a withstand requirement for *synchronous generating systems* under the *minimum access standard* of ± 1 Hz/s for 1 second is noted. This was a drafting error.

The correct recommendation is detailed in AEMO's draft clause S5.2.5.3.

The correct recommendation is that a *synchronous generating system* and each of its *generating units* must be capable of *continuous uninterrupted operation* for *frequencies* in a number of ranges listed under sub-paragraphs (1) to (6), 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.

3.3 S5.2.5.4 and S5.2.5.5

AEMO notes that in aligning the negotiation principles specified under clauses S5.2.5.4 and S5.2.5.5 some previous flexibility within clause S5.4.5.4 has been lost. AEMO proposes to restore this flexibility to clause S5.2.5.4 and add it to clause S5.2.5.5 by making the following amendments to draft clauses S5.2.5.4(c) and S5.2.5.5(c)(1)(ii):

S5.2.5.4 (c) In negotiating a *negotiated access standard*, a *generating system* and each of its operating *generating units* must be capable of *continuous uninterrupted operation* for the range of *voltages* specified in the *automatic access standard* except where AEMO and the *Network Service Provider* agree that the total reduction of *generation* in the *power system* as a result of any *voltage* excursion within levels specified by the *automatic access standard*, would not exceed 100 MW, or a greater limit based on what AEMO and the *Network Service Provider* both consider to be reasonable in the circumstances.

S5.2.5.5(c)(1)(ii) a single phase to ground, phase to phase or two phase to ground fault in a *transmission system*, or *distribution network*, cleared in the longest time expected to be taken for all relevant primary *protection systems* to clear the fault unless AEMO and the *Network Service Provider* agree that the total reduction of *generation* in the *power system* due to that fault would not exceed 100 MW, or a greater limit based on what AEMO and the Network Service Provider both consider to be reasonable in the circumstances.

3.4 S5.2.5.5

AEMO has noted stakeholder concerns raised regarding establishing acceptable levels of reactive current injection and active power recovery for various connection points and proposes to amend the proposed Rule such that the required reactive current injection levels and active power recovery must be coordinated with the NSP.

Insert paragraphs (j) and (k) to draft Rule S5.2.5.5 as follows:

- (j) The Network Service Provider may require that the actual reactive current contribution under subparagraphs (b)(2)(i)(A) and (b)(2)(i)(B) and/or the active power recovery time under subparagraph (b)(2)(iii) be agreed with the Network Service Provider in order to manage any potential adverse impacts on the Network Service Provider and other Network Users.
- (k) The actual reactive current contribution settings and active power recovery time agreed with the Network Service Provider under paragraph (j) must be recorded in the performance standard.

3.5 S5.2.5.11

AEMO acknowledges there will be benefit in clarifying the necessity to coordinate droop¹ settings for frequency response and propose to amend the subparagraph (i)(3) as follows:

- (3) The *frequency* droop must be set within the range of 2% to 10% or as agreed with the Network Service Provider and AEMO and must be recorded in the performance standard; and

3.6 Continuous uninterrupted operation definition

AEMO notes concerns raised regarding lack of clarity in the proposed amendments to the definition of *continuous uninterrupted operation*. AEMO therefore proposes a revision to clarify that the required performance during a disturbance only applies to reactive power requirements, specifically the requirements under clause S5.2.5.5. The revised definition is as follows:

In respect of a *generating system* or operating *generating unit* operating immediately prior to a *power system* disturbance:

- (a) not *disconnecting* from the *power system* except under its *performance standards* established under clauses S5.2.5.8 and S5.2.5.9 ~~and~~;
- (b) during the disturbance contributing reactive current as required by its performance standards established under clause S5.2.5.5; and
- (c) after clearance of any electrical fault that caused the disturbance, not only substantially varying its active power or and 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*.

¹ Refer to Section 2.7.2 discussion regarding definition of droop and its relationship with the maximum operating level of the generating system