

**Indicative mark up of changes made by Schedule 1 of the National Electricity Amendment
(Efficient reactive current access standards for inverter-based resources) Rule 2023**

Note:

This is an indicative version of the changes to the National Electricity Rules made by Schedule 1 of the *National Electricity Amendment (Efficient reactive current access standards for inverter-based resources) Rule 2023*. It comprises clause S5.2.5.5 from chapter 5 and a short extract from chapter 10, in each case from version 196 of the National Electricity Rules.

This document is provided for information purposes only. The actual amendments are set out in the *National Electricity Amendment (Efficient reactive current access standards for inverter-based resources) Rule 2023*. That Rule also inserts transitional rules and makes amendments commencing in 2024 that are not shown in this mark up.

The Australian Energy Market Commission does not guarantee the accuracy, reliability or completeness of this indicative mark up of the National Electricity Rules.

5. Network Connection Access, Planning and Expansion

Schedule 5.2 Conditions for Connection of Generators

S5.2.5.5 Generating system response to disturbances following contingency events

- (a) In this clause S5.2.5.5 a fault includes a fault of the relevant type having a metallic conducting path.

Automatic access standard

- (b) The *automatic access standard* is:
- (1) for a *generating system* and each of its *generating units*, the requirements of paragraphs (c) and (d);
 - (2) for a *generating system* comprised solely of *synchronous generating units*, the requirements of paragraph (e);
 - (3) for a *generating system* comprised solely of *asynchronous generating units*, the requirements of paragraphs (f) to (i); and
 - (4) for a *generating system* comprised of *synchronous generating units* and *asynchronous generating units*:
 - (i) for that part of the *generating system* comprised of *synchronous generating units*, the requirements of paragraph (e); and
 - (ii) for that part of the *generating system* comprised of *asynchronous generating units*, the requirements of paragraphs (f) to (i).

All generating systems

- (c) A *generating system* and each of its *generating units* must remain in *continuous uninterrupted operation* for any disturbance caused by:
- (1) a *credible contingency event*;
 - (2) a three phase fault in a *transmission system* cleared by all relevant *primary protection systems*;
 - (3) a two phase to ground, phase to phase or phase to ground fault in a *transmission system* cleared in:
 - (i) the longest time expected to be taken for a relevant *breaker fail protection system* to clear the fault; or
 - (ii) if a *protection system* referred to in subparagraph (i) is not installed, the greater of the time specified in column 4 of Table S5.1a.2 (or if none is specified, 430 milliseconds) and the longest time expected to be taken for all relevant *primary protection systems* to clear the fault; or
 - (4) a three phase, two phase to ground, phase to phase or phase to ground fault in a *distribution network* cleared in:

- (i) the longest time expected to be taken for the *breaker fail protection system* to clear the fault; or
- (ii) if a *protection system* referred to in subparagraph (i) is not installed, the greater of 430 milliseconds and the longest time expected to be taken for all relevant primary *protection systems* to clear the fault,

provided that the event is not one that would *disconnect the generating unit* from the *power system* by removing *network elements* from service.

- (d) A *generating system* and each of its *generating units* must remain in *continuous uninterrupted operation* for a series of up to 15 disturbances within any five minute period caused by any combination of the events described in paragraph (c) where:
 - (1) up to six of the disturbances cause the *voltage* at the *connection point* to drop below 50% of *normal voltage*;
 - (2) in parts of the *network* where three-phase automatic reclosure is permitted, up to two of the disturbances are three phase faults, and otherwise, up to one three phase fault where *voltage* at the *connection point* drops below 50% of *normal voltage*;
 - (3) up to one disturbance is cleared by a *breaker fail protection system* or similar back-up *protection system*;
 - (4) up to one disturbance causes the *voltage* at the *connection point* to vary within the ranges under clause S5.2.5.4(a)(7) and (a)(8);
 - (5) the minimum clearance from the end of one disturbance and commencement of the next disturbance may be zero milliseconds; and
 - (6) all remaining disturbances are caused by faults other than three phase faults,

provided that none of the events would result in:

- (7) the islanding of the *generating system* or cause a material reduction in *power transfer capability* by removing *network elements* from service;
- (8) the cumulative time that *voltage* at the *connection point* is lower than 90% of *normal voltage* exceeding 1,800 milliseconds within any five minute period; or
- (9) the time integral, within any five minute period, of the difference between 90% of *normal voltage* and the *voltage* at the *connection point* when the *voltage* at the *connection point* is lower than 90% of *normal voltage* exceeding 1 pu second.

Synchronous generating systems

- (e) Subject to any changed *power system* conditions or energy source availability beyond the *Generator's* reasonable control, a *generating system* comprised of *synchronous generating units*, in respect of the types of fault described in subparagraphs (c)(2) to (4), must supply to or absorb from the *network*:
 - (1) to assist the maintenance of *power system voltages* during the fault, capacitive reactive current of at least the greater of its pre-disturbance

- reactive current and 4% of the ~~maximum continuous current~~ maximum continuous current of the *generating system* including all operating *synchronous generating units* (in the absence of a disturbance) for each 1% reduction (from the level existing just prior to the fault) of *connection point voltage* during the fault;
- (2) after clearance of the fault, *reactive power* sufficient to ensure that the *connection point voltage* is within the range for *continuous uninterrupted operation* under clause S5.2.5.4; and
 - (3) from 100 milliseconds after clearance of the fault, *active power* of at least 95% of the level existing just prior to the fault.

Asynchronous generating systems

- (f) Subject to any changed *power system* conditions or energy source availability beyond the *Generator's* reasonable control, a *generating system* comprised of *asynchronous generating units*, in respect of the types of fault described in subparagraphs (c)(2) to (4), must have *facilities* capable of supplying to or absorbing from the *network*:
 - (1) to assist the maintenance of *power system voltages* during the fault:
 - (i) capacitive reactive current in addition to its pre-disturbance level of at least 4% of the ~~maximum continuous current~~ maximum continuous current of the *generating system* including all operating *asynchronous generating units* (in the absence of a disturbance) for each 1% reduction of *voltage* at the *connection point* below the relevant range in which a reactive current response must commence, as identified in subparagraph (g)(1), with the *performance standards* to record the required response agreed with *AEMO* and the *Network Service Provider*; and
 - (ii) inductive reactive current in addition to its pre-disturbance level of at least 6% of the ~~maximum continuous current~~ maximum continuous current of the *generating system* including all operating *asynchronous generating units* (in the absence of a disturbance) for each 1% increase of *voltage* at the *connection point* above the relevant range in which a reactive current response must commence, as identified in subparagraph (g)(1), with the *performance standards* to record the required response agreed with *AEMO* and the *Network Service Provider*,

during the disturbance and maintained until *connection point voltage* recovers to between 90% and 110% of *normal voltage*, or such other range agreed with the *Network Service Provider* and *AEMO*, except for *voltages* below the relevant threshold identified in paragraph (h); and
 - (2) from 100 milliseconds after clearance of the fault, *active power* of at least 95% of the level existing just prior to the fault.
- (g) For the purpose of paragraph (f):
 - (1) the *generating system* must commence a response when the *voltage* is in an under-voltage range of 85% to 90% or an over-voltage range of 110% to 115% of *normal voltage*. These ranges may be varied with the

agreement of the *Network Service Provider* and *AEMO* (provided the magnitude of the range between the upper and lower bounds remains at $\Delta 5\%$); and

- (2) the reactive current response must have a *rise time* of no greater than 40 milliseconds and a *settling time* of no greater than 70 milliseconds and must be *adequately damped*.
- (h) Despite paragraph (f), a *generating system* is not required to provide a capacitive reactive current response in accordance with subparagraph (f)(1)(i) where:
- (1) the *generating system* is directly connected to the *power system* with no step-up or *connection transformer*; and
 - (2) *voltage* at the *connection point* is 5% or lower of *normal voltage*.
- (i) Subject to paragraph (h), despite the amount of reactive current injected or absorbed during *voltage* disturbances, and subject to thermal limitations and energy source availability, a *generating system* must make available at all times:
- (1) sufficient current to maintain rated apparent power of the *generating system* including all operating *generating units* (in the absence of a disturbance), for all *connection point voltages* above 115% (or otherwise, above the over-voltage range agreed in accordance with subparagraph (g)(1)); and
 - (2) the ~~maximum continuous current~~*maximum continuous current* of the *generating system* including all operating *generating units* (in the absence of a disturbance) for all *connection point voltages* below 85% (or otherwise, below the under-voltage range agreed in accordance with subparagraph (g)(1)),

except that *AEMO* and the *Network Service Provider* may agree limits on active current injection where required to maintain *power system security* and/or the quality of *supply* to other *Network Users*.

Minimum access standard

- (j) The *minimum access standard* is:
- (1) for a *generating system* and each of its *generating units*, the requirements of paragraphs (k) and (l);
 - (2) for a *generating system* comprised solely of *synchronous generating units*, the requirements of paragraph (m);
 - (3) for a *generating system* comprised solely of *asynchronous generating units*, the requirements of paragraphs (n) to (p); and
 - (4) for a *generating system* comprised of *synchronous generating units* and *asynchronous generating units*:
 - (i) for that part of the *generating system* comprised of *synchronous generating units*, the requirements of paragraph (m); and
 - (ii) for that part of the *generating system* comprised of *asynchronous generating units*, the requirements of paragraphs (n) to (p).

All generating systems

(k) A *generating system* and each of its *generating units* must remain in *continuous uninterrupted operation* for any disturbance caused by:

- (1) a *credible contingency event*; or
- (2) 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,

provided that the event is not one that would *disconnect* the *generating unit* from the *power system* by removing *network elements* from service.

(l) A *generating system* and each of its *generating units* must remain in *continuous uninterrupted operation* for a series of up to six disturbances within any five minute period caused by any combination of the events described in paragraph (k) where:

- (1) up to three of the disturbances cause the *voltage* at the *connection point* to drop below 50% of *normal voltage*;
- (2) up to one disturbance causes the *voltage* at the *connection point* to vary within the ranges agreed by *AEMO* and the *Network Service Provider* under clause S5.2.5.4(a)(7), (a)(8), (b)(4) or (b)(5) (as appropriate);
- (3) the time difference between the clearance of one disturbance and commencement of the next disturbance exceeds 200 milliseconds;
- (4) no more than three of the disturbances occur within 30 seconds; and
- (5) all disturbances are caused by faults other than three phase faults,

provided that none of the events would result in:

- (6) the *islanding* of the *generating system* or cause a material reduction in *power transfer capability* by removing *network elements* from service;
- (7) the cumulative time that *voltage* at the *connection point* is lower than 90% of *normal voltage* exceeding 1,000 milliseconds within any five minute period; or
- (8) the time integral, within any five minute period, of the difference between 90% of *normal voltage* and the *voltage* at the *connection point* when the *voltage* at the *connection point* is lower than 90% of *normal voltage* exceeding 0.5 pu second,

and there is a minimum of 30 minutes where no disturbances occur following a five minute period of multiple disturbances.

Synchronous generating systems

(m) Subject to any changed *power system* conditions or energy source availability beyond the *Generator's* reasonable control after clearance of the fault, a

generating system comprised of *synchronous generating units*, in respect of the types of fault described in subparagraph (k)(2) must:

- (1) deliver *active power* to the *network*, and supply or absorb leading or lagging *reactive power*, sufficient to ensure that the *connection point voltage* is within the range for *continuous uninterrupted operation* agreed under clause S5.2.5.4; and
- (2) return to at least 95% of the pre-fault *active power* output, after clearance of the fault, within a period of time agreed by the *Connection Applicant*, *AEMO* and the *Network Service Provider*.

Asynchronous generating systems

(n) Subject to any changed *power system* conditions or energy source availability beyond the *Generator's* reasonable control, a *generating system* comprised of *asynchronous generating units* must:

- (1) for the types of fault described in subparagraph (k)(2), and to assist the maintenance of *power system voltages* during the fault, have *facilities* capable of supplying to or absorbing from the *network*:
 - (i) capacitive reactive current in addition to its pre-disturbance level of a percentage greater than 0% of the maximum continuous current of the at least 2% of the maximum continuous current of the generating system including all operating *asynchronous generating units* (in the absence of a disturbance) for each 1% reduction of *voltage* at the *connection point* below the relevant point at range in which a reactive current response must commence, as identified in or agreed under paragraph (o)(1), ~~with the performance standards to record the required response agreed with AEMO and the Network Service Provider;~~ and
 - (ii) inductive reactive current in addition to its pre-disturbance level of a percentage greater than 0% of the maximum continuous current of the at least 2% of the maximum continuous current of the generating system including all operating *asynchronous generating units* (in the absence of a disturbance) for each 1% increase of *voltage* at the *connection point* above the relevant point at range in which a reactive current response must commence, as identified in or agreed under paragraph (o)(1), ~~with the performance standards to record the required response agreed with AEMO and the Network Service Provider;~~

during the disturbance and maintained until *connection point voltage* recovers to between 90% and 110% of *normal voltage*, or such other range agreed with the *Network Service Provider* and *AEMO*, except for *voltages* below the relevant threshold identified in paragraph (p); and

- (2) return to at least 95% of:
 - (i) the pre-fault active power output; or
 - (ii) during a frequency disturbance, a level of active power output consistent with the generating system's performance standard under clause S5.2.5.11,

after clearance of the fault and recovery of positive sequence voltage at the connection point to remain between 90% and 110% of normal voltage, within a period ~~of time~~ agreed by the *Connection Applicant*, *AEMO* and the *Network Service Provider*, which period may differ according to the type of fault.

(o) For the purpose of paragraph (n):

(1) ~~the generating system must commence a response when the voltage is in an under voltage range of 80% to 90% or an over voltage range of 110% to 120% of normal voltage. These ranges may be varied with the agreement of the Network Service Provider and AEMO (provided the magnitude of the range between the upper and lower bounds remains at $\Delta 10\%$);~~

~~(i) falls to a threshold of 80% of normal voltage or other percentage threshold agreed with AEMO and the Network Service Provider;~~
~~or~~

~~(ii) increases to a threshold of 120% of normal voltage or other percentage threshold agreed with AEMO and the Network Service Provider,~~

~~and in each case may commence a response before the threshold is reached;~~

(2) ~~[Deleted]; where AEMO and the Network Service Provider require the generating system to sustain a response duration of 2 seconds or less, the reactive current response must have a rise time of no greater than 40 milliseconds and a settling time of no greater than 70 milliseconds and must be adequately damped; and~~

~~(2A) the response initiating conditions must be agreed with AEMO and the Network Service Provider;~~

(3) ~~the reactive current rise time must be no longer than 80 milliseconds or a longer time agreed to by the Network Service Provider and AEMO; where AEMO and the Network Service Provider require the generating system to sustain a response duration of greater than 2 seconds, the reactive current rise time and settling time must be as soon as practicable and must be adequately damped.~~

~~(4) the reactive current response must be adequately controlled;~~

~~(5) the reactive current response must commence within a period after the response initiating condition of:~~

~~(i) 40 milliseconds; or~~

~~(ii) a longer time agreed to by the Network Service Provider and AEMO; and~~

~~(6) the time when the reactive current response commences may be measured at either:~~

~~(i) the connection point; or~~

(ii) if agreed by the *Network Service Provider* and *AEMO*, the *generating unit* terminals or a point between the *generating unit* terminals and the *connection point*.

(o1) For the purposes of paragraphs (n) and (o), the *performance standards* must record:

- (1) the range applicable for subparagraph (n)(1);
- (2) the period agreed for subparagraph (n)(2), where applicable for each type of fault;
- (3) for subparagraph (o)(1), the percentage thresholds;
- (4) for subparagraph (o)(2A), the response initiating condition;
- (5) for subparagraph (o)(3), the reactive current *rise time*;
- (6) for subparagraph (o)(5), the required response time; and
- (7) for subparagraph (o)(6), where the time of commencement is to be measured.

(p) Despite paragraph (n), a *generating system* is not required to provide a capacitive reactive current response in accordance with subparagraph (n)(1)(i) where:

- (1) *voltage* at the *connection point* is 15% or lower of *normal voltage*; or
- (2) where the *generating system* is directly connected to the *power system* with no step-up or *connection transformer*, *voltage* at the *connection point* is 20% or lower of *normal voltage*.

Provision of minimum access standard

(p1) For the purposes of providing *minimum access standards* under clauses 5.3.3(b1)(4) and S5.4B(b)(2) in respect of reactive current response, and for the purposes of clause 5.3.4A(b), a *Network Service Provider* may provide the times in paragraphs (o)(3) and (o)(5)(i) or other longer times it may be prepared to agree.

(p2) For the purposes of clause 5.3.4A, and subject to clauses 5.3.4A(b1) and (b2), when proposing a *negotiated access standard* in respect of reactive current response, the *Connection Applicant* may propose the times in paragraphs (o)(3) and (o)(5)(i) or other longer times it is seeking to agree.

(p3) A *negotiated access standard* with a lower standard or longer time agreed to by the *Network Service Provider* and *AEMO* in accordance with paragraph (o) is taken to satisfy the requirements of clause 5.3.4A(b)(1) for a *negotiated access standard* to be no less onerous than the corresponding *minimum access standard* provided by the *Network Service Provider* under clauses 5.3.3(b1)(4) or S5.4B(b)(2).

Negotiated access standard

(q) In carrying out assessments of proposed *negotiated access standards* under this clause S5.2.5.5, the *Network Service Provider* and *AEMO* must take into account, without limitation:

- (1) the expected performance of:

- (i) existing *networks* and *considered projects*;
 - (ii) existing *generating plant* and other relevant projects; and
 - (iii) *control systems* and *protection systems*, including auxiliary systems and *automatic reclose equipment*; and
- (2) the expected range of *power system* operating conditions.
- (r) A proposed *negotiated access standard* may be accepted if the *connection* of the *plant* at the proposed access level would not cause other *generating plant* or *loads* to trip as a result of an event, when they would otherwise not have tripped for the same event.
- (r1) In carrying out assessments of proposed *negotiated access standards* under this clause S5.2.5.5 where the *Connection Applicant* has elected in accordance with clause 5.3.4B(b1) to pay the *system strength charge* in relation to the *connection*, the *Network Service Provider* and *AEMO* must take into account the performance required to be provided by the *System Strength Service Provider* at the relevant *system strength node* in accordance with clause S5.1.14.

General requirement

All generating systems

- (s) The *performance standard* must include any operational arrangements to ensure the *generating system* including all operating *generating units* will meet its agreed performance levels under abnormal *network* or *generating system* conditions.
- (t) When assessing multiple disturbances, a fault that is re-established following operation of *automatic reclose equipment* shall be counted as a separate disturbance.

Asynchronous generating systems

- (u) For the purpose of paragraphs (f) and (n):
 - (1) the reactive current contribution may be limited to the *maximum continuous current* ~~*maximum continuous current*~~ of a *generating system*, including its operating *asynchronous generating units*;
 - (1A) the reactive current contribution must not contribute excessively to voltage rise on unfaulted phases during unbalanced faults;
 - (2) the reactive current contribution and *voltage* deviation described may be measured at a location other than the *connection point* (including within the relevant *generating system*) where agreed with *AEMO* and the *Network Service Provider*, in which case the level of injection and absorption will be assessed at that agreed location;
 - (3) the reactive current contribution required may be calculated using phase to phase, phase to ground or sequence components of *voltages*. The ratio of the negative sequence to positive sequence components of the reactive current contribution must be agreed with *AEMO* and the *Network Service Provider* for the types of disturbances listed in this clause S5.2.5.5; and

- (4) the *performance standards* must record:
- (i) all conditions (which may include temperature) considered relevant by *AEMO* and the *Network Service Provider* under which the reactive current response is required. and
 - (ii) the maximum reactive current contribution to each phase.

Synchronous generating systems and units

- (v) For a *generating system* comprised solely of *synchronous generating units*, the reactive current contribution may be limited to 250% of the *maximum continuous current* ~~*maximum continuous current*~~ of the *generating system*.
- (w) For a *synchronous generating unit* within a *generating system* (other than a *generating system* described in paragraph (v)), the reactive current contribution may be limited to 250% of the *maximum continuous current* ~~*maximum continuous current*~~ of that *synchronous generating unit*.

10. Glossary

maximum allowed revenue

For a *Transmission Network Service Provider*: the amount calculated as such for a *regulatory year* of a *regulatory control period* in accordance with rule 6A.3.

For *AEMO*: the amount calculated as such for a *regulatory year* of a *regulatory control period* in accordance with clause S6A.4.2(c)(4).

maximum continuous current

In respect of a *generating system*:

(a) where assessed at the *connection point*, the current at the *connection point* corresponding to the largest amount of *apparent power* required by the *generating system's performance standard* under S5.2.5.1, at the *normal voltage*; and

(b) where assessed at any other point, the current at that point assessed in the manner agreed by the *Network Service Provider* for the *transmission system* or *distribution system* to which the *generating system* is connected and recorded in the *connection agreement*.

maximum demand

The highest amount of electrical power delivered, or forecast to be delivered, over a defined period (*day*, week, month, season or year) either at a *connection point*, or simultaneously at a defined set of *connection points*.