# Template for proposed Generator or Integrated Resource Provider Performance Standards

This is a template to assist *Connection Applicants* to submit proposed *access standards* for a *generating system* or *integrated resource system* to be assessed under clause 5.3.4A of the National Electricity Rules (**NER**). It contains three tables:

* **Table 1** – *Connection Applicants* should complete Table 1 to specify the proposed *production units* and *generating system* or *integrated resource system* to which the proposed *access standards* are intended to apply.
* **Table 2** – AEMO has drafted Table 2 to reflect the structure of the technical requirements in Schedule 5.2 of the NER for the *connection* of new *generating systems* and *integrated resource systems*. *Connection Applicants* must complete columns 4 and 5 and indicate in the 4th column whether it is proposing an *automatic* *access standard* (**A**), or a *negotiated* *access standard* (**N**). As a guide for *Connection Applicants*, AEMO has completed the 5th column to indicate how a proposed *access standard* should be drafted. For these purposes AEMO has used the relevant *automatic access standard* (or *minimum access standard*, where the NER do not specify automatic). *Connection Applicants* should amend Table 2 as necessary and respond to the comments in square brackets ([], including making the appropriate selection in dropdown fields and completing variables highlighted in yellow). Other changes to the text should be minimised. The ‘Track Changes’ function should be used to highlight changes. AEMO uses the International System of Units to identify quantities.
* **Table 3** – *Connection Applicants* and AEMO should complete Table 3 to track changes made to the registered performance standards following the formal acceptance of the *access standards* by the relevant Network Service Provider (**NSP**) (subject to AEMO’s advice).

Where a *Connection Applicant* proposes a *connection* arrangement that does not meet the *automatic access standards*, the information submitted with this document will be used by AEMO and the *connecting* NSP to assess their feasibility in accordance with clause 5.3.4A of the NER. *Connection Applicants* are reminded that proposed *access standards* must be as close as practicable to the *automatic access standards* – see NER clause 5.3.4A(b1). Any proposed *negotiated access standards* may need to be revised and resubmitted during the assessment process under clause 5.3.4A.

Once formally accepted by the relevant NSP (subject to AEMO’s advice), the *access standards* agreed in the *Connection Agreement* will become the registered performance *standards* for the *generating system* or *integrated resource system*. For convenience, this document is therefore titled ‘Generator or Integrated Resource Provider Performance Standards’.

All technical enquiries should be directed to NEM.Connections@aemo.com.au.

GPS template updates:

|  |  |
| --- | --- |
| Date | Descriptions |
| 18/12/2020 | Updated S5.2.5.11 for PFR Rule change and Table 1: Background. Added a new Revision table for version control. |
| 31/3/2021 | General update to S5.2.6.1 and updated S5.2.5.3 frequency ranges for continuous uninterrupted operation to be consistent with the frequency operating standard and considering the "Supply Scarcity" system condition. |
| 15/3/2023 | Updated for *National Electricity Amendment (Efficient management of system strength on the power system) Rule 2021* (commences 15 March 2023) and *National Electricity Amendment (Integrating energy storage systems into the NEM) Rule 2021* (commences 3 June 2024)*,* including interim implementation effective 15 March 2023. |

**How to fill in this template:**

* Text highlighted in grey indicates a dropdown menu for selecting appropriate text – click on the down arrow for options.
* Highlighted grey text indicates a content field for inserting text – click on the field and type in the box.
* Highlighted black text provides additional instructions or context to support the template.
* Turn on track changes enable changes to be easily identified.

**Please delete the above instructions when submitting the proposed *access standards*.**

# Performance standards for [select participant type]

1. Background

|  |  |
| --- | --- |
| **Name of Applicant & ABN:** | [insert company name and ABN of *Connection Applicant* who will, ultimately, apply for registration as a Generator or Integrated Resource Provider] |
| **Name of Network Service Provider & ABN:** | [insert company name and ABN of NSP] (**NSP**) |
| **Name of *[select system type]*:** | [insert name of power station / generating system / integrated resource system] |
| **Production unit designations:** | [insert unit designations e.g. Units 1 to 4] |
| **Production unit make(s) and model(s):** | [insert unit make and model name/version] |
| **Reactive plant:** | [insert make and model name/version, *nameplate rating*]  |
| **Connection point:** | [insert *connection point/s*] (**Connection Point**) |
| **Connection point nominal voltage:** | [insert *connection point* *nominal voltage*]kV (**Nominal Voltage**) |
| **Connection point normal voltage:** | [insert *connection point* *normal voltage*] pu or kV (**Normal Voltage**) |
| **Nameplate rating:** | [insert the *nameplate rating* of all *production units* this document applies to] MW ([insert the number of units] x [insert unit rating, equipment make(s) and model(s)]) |
| **Maximum capacity:** | [insert maximum *generation* of the *generating system* or *integrated resource system*, that is, the total capacity at the connection point of all *production units* this document applies to] MW. [Please enter a whole number only.] |
| **System strength remediation scheme:** | [insert a description of the system strength remediation scheme or ‘Not applicable’] |
| **Date of acceptance:** | [to be completed by the NSP once final] |

1. Performance Standards[[1]](#footnote-1)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NER version | NER reference  | Description | Automatic or Negotiated Access Standard (A/ N) | Detailed description of performance standard  |
|  | S5.2.5.1 | Reactive Power Capability | A | *[Select system type] rated active power* = [insert] MW as measured at the Connection Point, determined by [insert determination method or delete if not applicable]While operating at any level of *active power* output and at any *voltage* at the Connection Point within the limits of ±10% of Normal Voltage*,* the *[select system type]* is capable of supplying and absorbing at the Connection Point an amount of *reactive power* of at least equal to the product of the *rated active power* of the *[select system type]* and 0.395, as reflected in Figure 1.Figure 1: *Reactive Power* Capability[Insert *reactive power* capability diagram]The *[select system type]*, while not generating *active power* and not supplying or absorbing *reactive power* under an *ancillary services agreement*, will:* When the *production* *units* are *connected* and the ambient temperature is less than [50]OC, follow the *voltage* regulation control requirement specified in the *performance standard* under clause S5.2.5.13 with a *reactive power* capability of ± [insert] MVAr for each *production* *unit*; and
* When the *production units* are not *connected*, not supply at its Connection Point *reactive power* of more than 0 MVAr and not draw more electricity than [insert] kW of *active power* and [insert] kVAr of *reactive power*;

If the *reactive power* supplied or absorbed at the Connection Point falls outside the range that applies when the *production units* are not *connected*, the *[select system type]* must, where required by the NSP in order to maintain satisfactory *voltage* levels at the Connection Pointor to restore *intra-regional* or *inter-regional* *power transfer capability*, take action to ensure that the *reactive power* falls within that range within 30 min. |
|  | S5.2.5.2 | Quality of Electricity Generated | A | When *generating* and when not *generating*, the *[select system type]* does not produce at the Connection Point:1. *Voltage* fluctuations greater than the limits specified in Table 2.1 by the NSP under clause S5.1.5(a) of the NER, where flicker will be measured in accordance with AS/NZS 61000.3.7:2001:

Table 2.1: Voltage Fluctuation Limits

|  |  |
| --- | --- |
| Pst | Plt |
| [insert] | [insert] |

1. Harmonic *voltage* distortion greater than the limits specified in Table 2.2 by the NSP under clause S5.1.6(a) of the NER and will be measured at the Connection Point in accordance with AS/NZS 61000.3.6:2001:

Table 2.2: Harmonic Voltage Distortion Limits

| Harmonic Order (h) | Harmonic Voltage Limits (%) | Harmonic Order (h) | Harmonic Voltage Limits (%) | Harmonic Order (h) | Harmonic Voltage Limits (%) |
| --- | --- | --- | --- | --- | --- |
| 2 |  | 19 |  | 36 |  |
| 3 |  | 20 |  | 37 |  |
| 4 |  | 21 |  | 38 |  |
| 5 |  | 22 |  | 39 |  |
| 6 |  | 23 |  | 40 |  |
| 7 |  | 24 |  | 41 |  |
| 8 |  | 25 |  | 42 |  |
| 9 |  | 26 |  | 43 |  |
| 10 |  | 27 |  | 44 |  |
| 11 |  | 28 |  | 45 |  |
| 12 |  | 29 |  | 46 |  |
| 13 |  | 30 |  | 47 |  |
| 14 |  | 31 |  | 48 |  |
| 15 |  | 32 |  | 49 |  |
| 16 |  | 33 |  | 50 |  |
| 17 |  | 34 |  | THD(1) |  |
| 18 |  | 35 |  |  |  |

Notes: (1) THD is calculated considering the complete spectrum of harmonic *voltage* distortion at the Connection Point. 1. *Voltage* unbalance greater than the limits specified in Table 2.3 by the NSP under clause S5.1.7(c) of the NER and will be measured in accordance with AS/NZS 61000.3.6:2001:

Table 2.3: Voltage Unbalance Limits

|  |  |
| --- | --- |
| Nominal Supply Voltage (kV) | Maximum Negative Sequence Voltage (% of Nominal Voltage) |
| No *contingency event* | *Credible contingency event* | General | Once per hour |
| 30-min average | 30-min average | 10-min average | 1-min average |
|  |  |  |  |  |

 |
|  | S5.2.5.3 | Response to Frequency Disturbance | A | Unless the rate of change of *frequency* is outside the range of ±4 Hz/s for more than 0.25 s, ±3 Hz/s for more than 1.00 s, the *[select system type]* and each of its *production units* is capable of *continuous uninterrupted operation* for *frequencies* in the ranges indicated in Table 2.4:Table 2.4: Frequency Limits for Continuous Uninterrupted Operation

|  |  |  |
| --- | --- | --- |
| **Frequency range(1) (Hz)**[Mainland, delete column if not applicable] | **Frequency range(1) (Hz)**[Tasmania, delete column if not applicable] | **Duration(1)** |
| 47 to 48 | 47 to 48 | 2 min |
| 48 to 49.5 | 48 to 49 | 10 min(2) |
| 49.5 to 50.5 | 49 to 51 | continuous |
| 50.5 to 52 | 51 to 52 | 10 min(3) |
| [delete row if not applicable] | 52 to 55 | 2 min |

Notes: (1) Based on the *frequency operating standard* effective 1 January 2020. (2) 10 min, including any time spent in the range 47-48 Hz. (3) 10 min, including any time spent in the range 52-55 Hz [Tasmania, delete if not applicable]. |
|  | S5.2.5.4 | Response to Voltage Disturbances | A | The *[select system type]* and each of its *production units* is capable of *continuous uninterrupted operation* where a *power system* disturbance causes the *voltage* at the Connection Pointto vary within the ranges indicated in Table 2.5:Table 2.5: Voltage Limits for Continuous Uninterrupted Operation

|  |  |
| --- | --- |
| **Voltage range (% of Normal Voltage)** | **Duration** |
| > 130% | 0.02 s(1)  |
| 125% to 130% | 0.2 s(1) |
| 120% to 125% | 2.0 s(1) |
| 115% to 120% | 20 s(1)  |
| 110% to 115% | 20 min(1) |
| 90% to 110% | continuous |
| 80% to 90% | 10 s(2) |
| 70% to 80% | 2 s(2) |

Notes: (1) After the Connection Point *voltage* first varied above 110% of Normal Voltage before returning to between 90% and 110% of Normal Voltage. (2) After the Connection Point *voltage* first varied below 90% of Normal Voltage before returning to between 90% and 110% of Normal Voltage.[Insert any operational arrangements necessary to ensure the generating system or integrated resource system and each of its production units will meet these levels under abnormal network or generating system (or integrated resource system where applicable) conditions.] |
|  | S5.2.5.5 | Response to Disturbances following Contingency Events | A | For the purposes of this *performance standard,* a **fault** includes a fault of the relevant type having a metallic conducting path. *Fault clearance times* for relevant equipment are specified in Table 2.6:Table 2.6: Fault Clearance Times for Specified Equipment

|  |  |  |
| --- | --- | --- |
|  | **Transmission system fault clearance time(1)** | **Distribution system fault clearance time(1)** |
| **Primary protection system** | [insert time] ms | [insert time] ms |
| **Breaker fail protection system** | [insert time] ms | [insert time] ms |
| **Automatic reclose equipment** | [insert characteristics (single phase and three phase, if fitted), dead time in seconds, number of reclose shots, reclaim time in seconds, specifying if not greater than] | [insert characteristics (single phase and three phase, if fitted), dead time in seconds, number of reclose shots, reclaim time in seconds, specifying if not greater than] |

[Note: (1) Specify clearance times as per Table S5.1a.2 of the NER, or as applicable in the local *network*, whichever is the longest.]**Single disturbance** (reflects clause S5.2.5.5(c) of the NER):Provided that the event is not one that would *disconnect* the *[select system type]* from the *power system* by removing *network elements* from service, the *[select system type]* and each of its *production units* will 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 the *transmission system* cleared in:
			1. the longest time expected to be taken for a relevant *breaker fail protection system* to clear the fault; or
			2. if a *breaker fail protection system* is not installed, the greater of the time specified in Table 2.7

Table 2.7: Fault Clearance Times

|  |  |
| --- | --- |
| **Nominal voltage at fault location (kV)** | **Time (ms)** |
| ≥ 400kV | 175 |
| ≥ 250kV and < 400kV | 250 |
| > 100kV and < 250kV | 430 |
| ≤ 100kV | 430 |

and the longest time expected to be taken for all relevant primary *protection systems* to clear the fault; or* + 1. a three-phase, two-phase-to-ground, phase-to-phase or phase-to-ground fault in a *distribution network* cleared in:
			1. the longest time expected to be taken for a relevant *breaker fail protection system* to clear the fault; or
			2. if a *breaker fail protection system* is not installed, the greater of 430 ms and the longest time expected to be taken for all relevant primary *protection systems* to clear the fault.

**Multiple disturbances** (reflects clause S5.2.5.5(d), (s) and (t) of the NER):When assessing multiple disturbances, a fault that is re-established following operation of *automatic reclose equipment* is counted as a separate disturbance.The *[select system type]* and each of its *production units* will remain in *continuous uninterrupted operation* for a series of up to 15 disturbances within any 5-min period caused by any combination of the events described above where: * + 1. up to 6 of the disturbances cause the Connection Point *voltage* 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 the Connection Point *voltage* 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 Connection Point *voltage* to vary within the ranges under clause S5.2.5.4(a)(7) and (8) of the NER;
		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: * + 1. the islanding of the *[select system type]* or cause a material reduction in *power transfer capability* by removing *network* *elements* from service;
		2. the cumulative time that the Connection Point *voltage* is lower than 90% of Normal Voltage exceeding 1,800 milliseconds within any 5-min period; or
		3. within any 5-min period, the time integral of the difference between 90% of Normal Voltage and the Connection Point *voltage* when the Connection Point *voltage* is lower than 90% of Normal Voltage exceeding 1 pu second.

The *[select system type]* will not, as a consequence of its *connection*, 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.[Insert any operational arrangements or conditions necessary to ensure the *generating system* or *integrated resource system* and each of its *production units* will meet its agreed performance levels under abnormal *network* or *generating system* (or *integrated resource* system where applicable) conditions]For ***synchronous* *generating systems*** or ***integrated resource systems*** or ***synchronous production units*** (reflects clause S5.2.5.5(e), (v) and (w) of the NER):[Delete any inapplicable paragraph]Subject to any changed *power system* conditions or energy source availability beyond the *[select participant type]* reasonable control, in respect of the fault types described in clause S5.2.5.5(c)(2) to (4) of the NER, the *[select system type],* including all operating *synchronous* *production units* (in the absence of a disturbance), will supply to, or absorb from, the *network*:* + 1. capacitive reactive current of at least the greater of its pre-disturbance reactive current and 4% of its maximum continuous current for each 1% reduction (from the level existing just prior to the fault) of Connection Point *voltage* during the fault, to assist the maintenance of *power system voltages* 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 the *performance standard* under clause S5.2.5.4 of the NER; and
		3. from 100 ms after clearance of the fault, *active power* of at least 95% of the level existing just prior to the fault.

For ***asynchronous* *generating systems*** or ***integrated resource systems*** (reflects clause S5.2.5.5(f)-(i) and (u) of the NER):Subject to any changed *power system* conditions or energy source availability beyond the *[select participant type]* reasonable control, the *[select system type],* including all operating a*synchronous production units* (in the absence of a disturbance), in respect of fault types described in clause S5.2.5.5(c)(2) to (4) of the NER, will supply to, or absorb from, the *network*:* + 1. during the disturbance and maintained until the Connection Point *voltage* recovers to between 90% and 110% of Normal Voltage, to assist the maintenance of *power system voltages* during the fault:
			1. capacitive reactive current in addition to its pre-disturbance level of at least 4% of its maximum continuous current for each 1% reduction of the Connection Point *voltage* below the range of 85% to 90% of Normal Voltageup toits maximum continuous current*.* [If the *generating system* or *integrated resource system* is directly *connected* to the *power system* with no step-up or *connection transformer*, insert next sentence: The *[select participant type]* may cease capacitive reactive current injection if the Connection Point *voltage* <[0-5%, please specify] of Normal Voltage];
			2. inductive reactive current in addition to its pre-disturbance level of at least 6% of its maximum continuous current for each 1% increase of the Connection Point *voltage* above the range of 110% to 115% of Normal Voltage up to [sufficient current, please specify if possible] to maintain its rated apparent power;
			3. the reactive current response will have a *rise time* of no greater than 40 ms and a *settling time* of no greater than 70 ms and will be *adequately damped*; and
			4. the reactive current contribution is calculated using [insert as applicable: [phase-to-phase], [phase-to-ground] or [sequence components, the ratio of positive to negative sequence components must be agreed with AEMO and the NSP for the types of disturbances listed in clause S5.2.5.5]].
		2. from 100 ms after clearance of the fault, *active power* of at least 95% of the level existing just prior to the fault.
 |
|  | S5.2.5.6 | Quality of Electricity Generated and Continuous Uninterrupted Operation | N | The *[select system type]* and each of its operating *production units* and *reactive plant*, will not *disconnect* from the *power system* for *voltage* fluctuation, harmonic *voltage* distortion and *voltage* unbalance at the Connection Point within the levels specified:1. For *voltage* fluctuations at the Connection Point*,* in the "compatibility levels" set out in Table 1 of AS/NZS 61000.3.7:2001.
2. For harmonic *voltage* distortion at the Connection Point*,* in the “compatibility levels” defined in Table 1 of AS/NZS 61000.3.6:2001.
3. a negative sequence *voltage* at the Connection Point*,* in Table S5.1a.1 of the NER and shown in Table 2.8:

Table 2.8: Negative Sequence Voltages

|  |  |
| --- | --- |
| **Nominal Supply Voltage (kV)** | **Maximum Negative Sequence Voltage (% of Nominal Voltage)** |
| **No Contingency Event** | **Credible Contingency Event** | **General** | **Once Per Hour** |
| **30-Minute Average** | **30-Minute Average** | **10-Minute Average** | **1-Minute Average** |
| **> 100**  | 0.5 | 0.7 | 1.0 | 2.0 |
| **> 10 and ≤ 100**  | 1.3 | 1.3 | 2.0 | 2.5 |
| **<10**  | 2.0 | 2.0 | 2.5 | 3.0 |

[Delete rows for voltage levels not applicable] |
|  | S5.2.5.7 | Partial Load Rejection | A | For the purposes of this *performance standard*:**Minimum generation** means the minimum *sent out generation* for continuous stable operation, PMIN = [insert] MW.The *[select system type]* is capable of *continuous uninterrupted operation* during and following a *power system load* reduction of 30% from its pre-disturbance level or equivalent impact from separation of part of the *power system* in less than 10 s, provided that the *loading level* remains above PMIN. |
|  | S5.2.5.8 | Protection from Power System Disturbances |  | 1. Subject to paragraphs (b) [delete reference to (b) if *generating system* or *integrated resource system* is <30MW or distribution connected] and (e) where the *[select system type]* or any of its *production units* that is required by the NSP, *Generator* or *Integrated Resource Provider* to be automatically *disconnected* from the *power system* in response to abnormal conditions arising from the *power system*, the relevant *protection system* or *control system* does not *disconnect* the *[select system type]* for:
2. conditions for which it must remain in *continuous uninterrupted operation*; or
3. conditions it must withstand under the NER.
4. [Delete all of paragraph (b) if *generating system* or *integrated resource system* is <30MW or distribution connected] The *[select system type]* has *facilities* to automatically and rapidly reduce its *generation*:

[Delete non-applicable paragraphs below (either (i) or (ii)), include any limitations e.g. minimum generation level]1. by at least half, if the *frequency* at the Connection Point exceeds [a level nominated by *AEMO* (not less than the upper limit of the *operational frequency tolerance band*)] and the duration above this *frequency* exceeds a value nominated by *AEMO* where the reduction may be achieved by [delete (A) or (B)]:
	1. reducing the power level of the *[select system type]* within 3 s, and holding at the reduced power level until the *frequency* returns to within the *normal operating frequency band*; or
	2. *disconnecting* the *[select system type]* from the *power system* within 1 s; or
2. in proportion to the difference between the *frequency* at the Connection Point and a level nominated by *AEMO* (not less than the upper limit of the *operational frequency tolerance band*) such that the *generation* is reduced, by at least half, within 3 s of the *frequency* reaching the upper limit of the *extreme frequency excursion tolerance limits*.
3. [Delete paragraph (c) if *AEMO* or the NSP do not require it.] The *[select system type]* must be automatically *disconnected* by a local or remote control scheme whenever the part of the *network* to which it is *connected* has been *disconnected* from the *national grid* and has formed an island that *supplies load.*
4. The conditions for which the *[select system/unit type]* must trip and must not trip are: [specify the conditions to facilitate AEMO and NSP maintaining power system security].
5. Notwithstanding the *performance standards* under clauses S5.2.5.3, S5.2.5.4, S5.2.5.5, S5.2.5.6 and S5.2.5.7 of the NER the *[select system type]* may be automatically *disconnected* from the *power system* under any of the following conditions [delete inapplicable sub-paragraphs]:
	1. in accordance with the *ancillary services agreement* dated [insert date] between the *[select participant type]* and *AEMO* for the provision of [insert type of ancillary services] [delete if no *ancillary services agreement* exists]
	2. where a *load* that is not part of the *[select system type]* has the same *connection point* as the *[select system type]* and *AEMO* and the NSP agree that the *disconnection* would in effect be under-frequency *load shedding*; [delete if none exists]
	3. where the *[select system type]* is automatically *disconnected* under paragraphs (a), (b) [deleted reference to (b) if *generating system* is <30MW or distribution connected] or the *performance standard* under clause S5.2.5.9 of the NER;
	4. where the *[select system type]* is automatically *disconnected* under the *performance standard* under clause S5.2.5.10 of the NER; or
	5. in accordance with an agreement between the *[select participant type]* and the NSP (including an agreement in relation to an emergency control scheme under clause S5.1.8 of the NER) to provide a service that *AEMO* agrees is necessary to maintain or restore *power system* *security* in the event of a specified *contingency* *event*. [delete if none exists]
	6. Where the *[select system type]* is automatically *disconnected* from the *power system* via an *emergency frequency control scheme* (EFCS) in accordance with an *EFCS settings schedule* as maintained by AEMO and notified to the *[select participant type]* from time to time.
 |
|  | S5.2.5.9 | Protection Systems that Impact on Power System Security | A | 1. The *[select system type]* has primary protection systems to *disconnect* from the *power system* any faulted element within the *[select system type]* and in the protection zones that include the Connection Point, within the *fault clearance times* specified in Table 2.9 [insert fault clearance times determined under clause S5.1.9(a)(1) of the NER, but subject to clauses S5.1.9(k) and (l) in the table below].
2. Each *primary protection system* has sufficient redundancy to ensure that a faulted element within its protection zone is *disconnected* from the *power system* within the applicable *fault clearance time* with any single protection element (including any communications *facility* on which that *protection system* depends) out of service.
3. *Breaker fail protection systems* are provided to clear faults that are not cleared by the circuit breakers controlled by the primary *protection system*, within the *fault clearance times* in Table 2.9: [insert fault clearance times determined under clause S5.1.9(a)(1) of the NER].

Table 2.9: Protection and Breaker Fail System Fault Clearance Times

|  |  |  |
| --- | --- | --- |
|  | **[Insert voltage level] kV** | **[Insert voltage level] kV** |
| **Primary *protection systems*** | [insert time] ms | [insert time] ms |
| ***Breaker fail protection systems*** | [insert time] ms | [insert time] ms |

1. The *protection system* design will be coordinated with other *protection systems*, avoid consequential *disconnection* of other *Network Users’ facilities* and take into account the NSP’s existing obligations under their *connection agreements* with other *Network Users.*
 |
|  | S5.2.5.10 | Protection to Trip Plant for Unstable Operation | A | [If the *generating system* or *integrated resource system* is *synchronous*, paragraph (A) applies; if it is *asynchronous*, paragraph (B) applies. Delete the inapplicable paragraph and then complete the applicable one by specifying the type of *protection system* installed.](A) Each *production* *unit* has the following *protection system* to *disconnect* it promptly when a condition that would lead to pole slipping is detected, to prevent pole slipping or other conditions where a *production unit* causes *active power, reactive power* or *voltage* at the Connection Point to become unstable as assessed in accordance with AEMO’s Power System Stability Guidelines (established under clause 4.3.4(h) of the NER): * [Specify the type of *protection system* installed, e.g. loss of field, reverse power, etc.]

(B) Each *production unit,* or where this is impractical, the *[select system type]* has the following *protection system* to *disconnect* its *production units* promptly for conditions where the *active power, reactive power* or *voltage* at the Connection Point becomes unstable as assessed in accordance with AEMO’s Power System Stability Guidelines (established under clause 4.3.4(h) of the NER): * [Specify the type of *protection system* installed and the corresponding operating time]
 |
|  | S5.2.5.11 | Frequency Control | A | For the purposes of this *performance standard*:**‘Maximum operating level’** = [insert] MW.**‘Minimum operating level’** = [insert] MW.**‘droop’** means, in relation to *frequency response mode*, the percentage change in *power system frequency* as measured at the Connection Point, divided by the percentage change in *power transfer* of the *[select system type],* expressed as a percentage of the maximum operating level of the *[select system type].* Droop must be measured at *frequencies* that are outside the deadband and within the limits of *power transfer.*[For ***generating systems*** use paragraph (1) and (2) below and for ***integrated resource systems*** use (3). Delete any inapplicable paragraph.]*Power system frequency* is measured at the Connection Point*.** + 1. The *generating system’s power* transfer to the *power system* will not:

(i) increase in response to a rise in *power system* *frequency*; or(ii) decrease in response to a fall in *power system* *frequency*; and* + 1. The *generating system* is capable of operating in *frequency response mode* such that it automatically provides a proportional:

(i) decrease in *power transfer* to the *power system* in response to a rise in *power system* *frequency*; and(ii) increase in *power transfer* to the *power system* in response to a fall in *power system* *frequency,*sufficiently rapidly and sustained for a sufficient period for the *Generator* to be in a position to offer measurable amounts all *market ancillary services* for the provision of *power system frequency* control. * + 1. an *integrated resource system*, to the extent it comprises *production units,* must be capable of operating in *frequency response mode* such that it automatically provides a proportional:
1. decrease in *power transfer* to the *power system,* with a continuous shift from one to the other mode, in response to a rise in the *frequency* of the *power system* as measured at the *connection point* accompanied by a smooth change in *bidirectional unit* operating mode between production and consumption; and
2. increase in *power transfer* to the *power system* in response to a fall in the *frequency* of the *power system* as measured at the *connection point* accompanied by a smooth change in *bidirectional unit* operating mode between production and consumption,

sufficiently rapidly and sustained for a sufficient period for the *Integrated Resource Provider* (as relevant) to be in a position to offer measurable amounts of all *market ancillary services* for the provision of *power system frequency* control.* + 1. Nothing in paragraph (2) or (3) requires the *[select system type]* to operate below its minimum operating level in response to a rise in *power system frequency*, or above its maximum operating level in response to a fall in *power system frequency.*
		2. The change in *power transfer* to the *power system* will occur with no delay beyond that required for stable operation, or inherent in the *plant* controls, once *power system* *frequency* leaves a deadband around 50 Hz.
		3. The *[select system type]*:

(i) deadband can be set within the range of 0 to ± 1.0 Hz [different deadband settings may be applied for a rise or fall in the *frequency* of the *power system* as measured at the Connection Point– delete if one deadband applies for rise and fall]; and (ii) droop can be set within the range of 2% to 10% [For *bidirectional unit*, reflect the recommended droop as outlined in the BESS guide for contingency FCAS registration[[2]](#footnote-2)].* + 1. Each control system used to satisfy this performance standard is adequately damped.
		2. The amount of relevant *market ancillary service* for which the *plant* is registered will not exceed the amount that would be consistent with this *performance standard*.
 |
|  | S5.2.5.12 | Impact on Network Capability | A | The *[select system type]* has *plant* capabilities and *control systems* that are sufficient so that when *connected* to the *power system* it does not reduce any *inter-regional* or *intra-regional power transfer capability* below the level that would apply if the *[select system type]* were not *connected*. |
|  | S5.2.5.13 | Voltage and Reactive Power Control | A | 1. The *[select system type]* has *plant* capabilities and *control systems* sufficient to ensure that:

(i) *power system* oscillations, for the frequencies of oscillation of the *production unit* against any other *production unit* or *system*, are *adequately damped*;(ii) operation of the *[select system type]* does not degrade the damping of any critical mode of oscillation of the *power system*; and(iii) operation of the *[select system type]* does not cause instability (including hunting of *tap-changing transformer control systems*) that would adversely impact other *Registered Participants*.1. The *control systems* used with this *[select system type]* have:

(i) for the purposes of disturbance monitoring and testing, permanently installed and operational, monitoring and recording *facilities* for key variables including each input and output; and(ii) *facilities* for testing the *control system* sufficient to establish its dynamic operational characteristics.1. The *[select system type]* has *facilities* with a *control system* to regulate *voltage*, *reactive power* and *power factor*, with the ability to operate in any control mode and to switch between control modes, as shown in [specify the manufacturer’s and/or design specifications of the relevant equipment and demonstrated to the reasonable satisfaction of the NSP and AEMO][delete if not applicable].
2. The *[select system type]* has a *voltage control system* that:

(i) regulates *voltage* at [the Connection Pointor [specify agreed location in the *power system* (including within the *generating system* or *integrated resource system*)]] [delete if not applicable, or if applicable, delete reference to Connection Point] to within 0.5% of the setpoint [where that setpoint is adjusted to incorporate any *voltage* droop or reactive current compensation agreed with *AEMO* and the NSP, delete if not applicable];(ii) regulates *voltage* in a manner that helps to support *network voltages* during faults and does not prevent the NSP from achieving the requirements under clause S5.1a.3 and S5.1a.4 of the NER;(iv) allows the *voltage* setpoint to be continuously controllable in the range of at least 95% to 105% of the target *voltage* at [the Connection Point(as recorded in the *connection agreement*) or the agreed location in the *power system*] [adjust to align with sub-paragraph (i)], without reliance on a *tap-changing transformer* and subject to the *reactive power* capability referred to in the *performance standard* under clause S5.2.5.1;(v) has limiting devices to ensure that a *voltage* disturbance does not cause the *production unit* to trip at the limits of its operating capability. The limiting devices:1. do not detract from the performance of any power system stabiliser or power oscillation damping capability; and
2. are co-ordinated with all *protection systems*.

[If the *generating system* or *integrated resource system* is ***synchronous***, paragraph (5) applies; if it is ***asynchronous***, paragraph (6) applies. Delete the inapplicable paragraph and then complete the applicable one by specifying the type of *voltage and reactive power control system* installed.]1. the *[select system type]* has an *excitation control system* that:

(i) can operate the stator continuously at 105% of Nominal Voltagewith *rated active power* level;(ii) has an excitation ceiling *voltage* of at least: [delete whichever not applicable](A) for a static excitation system, 2.3 times; or(B) for other *excitation control systems*, 1.5 times, the excitation required to achieve transfer of power at the *nameplate rating* for rated *power factor*, rated speed and Nominal Voltage;(iii) has *settling times* for a step change of *voltage* setpoint or *voltage* at the location agreed in paragraph (4)(i) of:(A) generated *voltage* less than 2.5 s for a 5% *voltage* disturbance with the *production unit* not *synchronised*;(B) *active power*, *reactive power* and *voltage* less than 5.0 s for a 5% *voltage* disturbance with the *production unit synchronised*, from an operating point where the *voltage* disturbance would not cause any limiting device to operate; and(C) in respect of each limiting device, *active power*, *reactive power* and *voltage* less than 7.5 s for a 5% *voltage* disturbance with the *production 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;(iv) can increase field *voltage* from rated field *voltage* to the excitation ceiling *voltage* in less than:(A) 0.05 s for a static excitation system; or(B) 0.5 s for other *excitation control systems*; and(ix) has a *power system* stabiliser with sufficient flexibility to enable damping performance to be maximised, with characteristics as described in paragraph (7); and1. The *[select system type]* has a *voltage control system* that:

(i) with the *[select system type]* *connected* to the *power system*, has *settling times* for *active power*, *reactive power* and *voltage* due to a step change of *voltage* setpoint or *voltage* at [insert the location agreed under subparagraph (4)(i)], of less than:(A) 5.0 s for a 5% *voltage* disturbance with the *[select system type]* *connected* to the *power system*, from an operating point where the *voltage* disturbance would not cause any limiting device to operate; and(B) 7.5 s for a 5% *voltage* disturbance with the *[select system type] connected* to the *power system*, when operating into any limiting device from an operating point where a *voltage* disturbance of 2.5% would just cause the limiting device to operate;(ii) for a 5% step change in the *voltage* setpoint, has *reactive power* rise time, of less than 2 s;(iii) has power oscillation damping capability with sufficient flexibility to enable damping performance to be maximised with characteristics as described in paragraph (7).1. The *power system* stabiliser or power oscillation damping device has [delete paragraph (7) if power system stabiliser is not provided]:
2. [For a *synchronous production unit*] measurements of rotor speed and *active power* level of the *production unit* as inputs, and otherwise, measurements of *power system frequency* and *active power* level of the *production unit* as inputs [delete for *asynchronous production unit*];
3. two washout filters for each input, with ability to bypass one of them if necessary;
4. [Insert number not less than two] lead-lag transfer function blocks (or equivalent number of complex poles and zeros) with adjustable gain and time-constants, to compensate fully for the phase lags due to the *generating plant*;
5. an level limiter, which for a *synchronous production unit* is continually adjustable over the range of ±10% of stator *voltage* [delete for *asynchronous production unit*];
6. monitoring and recording *facilities* for key variables including inputs, level and the inputs to the lead-lag transfer function blocks; and
7. *facilities* to permit testing of the *power system* stabiliser in isolation from the *power system* by injection of test signals, sufficient to establish the transfer function of the *power system* stabiliser.
8. A *reactive power* or *power factor control system* provided under paragraph (3) will:
9. *regulate* *reactive power* or *power factor* at [the Connection Pointor [specify agreed location in the *power system* (including within the *generating system* or *integrated resource system*)], to within:
10. for a *[select system type]* operating in *reactive power* mode, 2% of the *generating system’s* rating (expressed in MVAr); or
11. for a *[select system type]* operating in *power factor* mode, a *power factor* equivalent to 2% of the *[select system type]* rating (expressed in MVAr);
12. allow the *reactive power* or *power factor* setpoint to be continuously controllable across the *reactive power* capability range established under the *performance standard* under clause S5.2.5.1; and
13. with the *[select system type]* *connected* to the *power system*, and for a step change in setpoint of at least 50% of the *reactive power* capability agreed with *AEMO* and the NSPunder clause S5.2.5.1 of the NER, or a 5% *voltage* disturbance at the location agreed under subparagraph (i):
14. have *settling times* for *active power*, *reactive power* and *voltage* of less than 5.0 s from an operating point where the *voltage* disturbance would not cause any limiting device to operate; and
15. have *settling times* for *active power*, *reactive power* and *voltage* of less than 7.5 s when operating into any limiting device from an operating point where a *voltage* disturbance of 2.5% would just cause the limiting device to operate.

[Include any requirements for the design and operation of the *control systems* of the *production unit*, *generating system* or *integrated resource system* tobe coordinated with the existing NSP *voltage control systems* of and those of other *Network Users* and any requirements relating to inclusion in AEMO’s Var Dispatch Schedule system] |
|  | S5.2.5.14 | Active Power Control | A | [Delete paragraph (1), (2) or (3), as applicable – (1) applies to *scheduled production units/systems*, (2) applies to *non-scheduled production units/systems* and (3) applies to *semi-scheduled production units/systems*.] (1) The *[select system/unit type]* has an *active power control system* that is *adequately damped* and capable of:(i) maintaining and changing its *active power* level in accordance with its *dispatch instructions*; (ii) ramping its *active power level* linearly from one *dispatch* level to another; and(iii) receiving and automatically responding to signals delivered from the *automatic generation control system*, as updated at a rate of once every 4 s [or insert other period specified by *AEMO*].(2) Subject to the energy source availability, the *[select system/unit type]* has an *active power control system* that is *adequately damped* and capable of: (i) automatically reducing or increasing its *active power* level within 5 min at a constant rate, to or below the level specified in an instruction electronically issued by a *control centre*, subject to subparagraph (iii),(ii) automatically limiting its *active power* level, to below the level specified in subparagraph (i); and(iii) not changing its a*ctive power* level within 5 min by more than the raise and lower amounts specified in an instruction electronically issued by a *control centre*.(3) Subject to energy source availability, the *[select system/unit type]* has an *active power control system* that is *adequately damped* and capable of:1. automatically reducing or increasing its *active power* level within 5 min at a constant rate, to or below the level specified in an instruction electronically issued by a *control centre*;
2. automatically limiting its *active power* level to or below the level specified in subparagraph (i);
3. not changing its *active power* level within 5 min by more than the raise and lower amounts specified in an instruction electronically issued by a *control centre;*
4. ramping its *active power* level linearly from one level of *dispatch* to another; and
5. receiving and automatically responding to signals delivered from the *automatic generation control system*, as updated at a rate of once every 4 s [or insert other period specified by *AEMO*].
 |
|  | S5.2.5.15 | Short circuit ratio | N | [Highlighted text below is for reference only and is not part of S5.2.5.15 clause description] This standard:* applies to a *generating system* or *integrated resource system* that is comprised solely of *asynchronous production units*;and
* for a *generating system* or *integrated resource system* that is comprised of both *synchronous* and *asynchronous production units,* applies only to the *asynchronous production units* and to the *generating system* or *integrated resource system* to the extent it relates to its *asynchronous production units.*

The *[select system type]* comprised of *asynchronous generating units* must have plant capability sufficient to operate stably and remain connected at a short circuit ratio (SCR) of [insert number not higher than 3.0 (representing SCR withstand capability of plant)], assessed in accordance with the methodology prescribed in the system strength impact assessment guidelines, where:1. the rated *active power* for calculating the SCR value is [insert number] [;and]
2. [Delete if not applicable] the agreed arrangements under S5.2.5.15(e) to achieve this performance standard are:
* [If applicable, record details of arrangements necessary for plant to operate stably and remain *connected* at agreed SCR value]
 |
|  | S5.2.5.16 | Voltage phase angle shift | N | [Highlighted text below is for reference only and is not part of S5.2.5.15 clause description]This standard:* applies to a *generating system* or *integrated resource system* that is comprised solely of *asynchronous production units*;and
* to a *generating system* or *integrated resource system* that is comprised of both *synchronous* and *asynchronous production units.*

 The *[select system type]* and each of its *asynchronous production units* must not include any vector shift or similar relay or protective function that acts upon *voltage* phase angle which might operate for phase angle changes less than 20 degrees at the *connection point*.[The agreed value of the settings of any protection system must be recorded in the performance standards]. |
|  | S5.2.6.1 and 4.11.1 | Remote Monitoring | A | [Delete rows in Table 2.10 where the type of plant is not applicable]The *[select system/unit type]* has *remote monitoring equipment* and *remote control equipment* to transmit to, and receive from, *AEMO’s control centres* the quantities specified in Table 2.10 in real-time in accordance with clause 4.11 of the NER:Table 2.10: Remote Monitoring Equipment and Remote Control Equipment Quantities required by AEMO

| **Type of Plant** | **Remote Monitoring Quantities** | **Remote Control Quantities** |
| --- | --- | --- |
| ***Generating systems*** **or *integrated resource systems*** | 1. the status of all switching devices that carry the *generation* or *load*;
2. *tap-changing transformer* tap position(s) and *voltages*;
3. *active power* and *reactive power* aggregated for groups of identical *production units*;
4. either the number of identical *production units* operating or the operating status of each non-identical *production unit*;
5. either the number of identical *production units* available or the available status of each non-identical *production unit*;
6. *active power* and *reactive power* for the *generating system* or *integrated resource system*;
7. *voltage, reactive power* and *power factor control system* setpoint and mode (as applicable);
8. the mode of operation of each *production* *unit*, turbine control limits, or other information required to reasonably predict the *active power* response of the *generating system* or *integrated resource system* to a change in *power system frequency* at the Connection Point;
9. any quantities reasonably required by AEMO for the Var Dispatch Scheduling (VDS) system.
10. any quantities reasonably required by AEMO to discharge its *market* and *power system security* functions as set out in Chapters 3 and 4 of the NER.
 | 1. *voltage, reactive power* and *power factor* control *setpoint* (delta) (as applicable);and
2. *voltage*, *reactive power* and *power factor* controlmode (where applicable);
3. [for a non-scheduled *generating system* or *integrated resource system* only – delete if inapplicable] to the extent required to manage *network* flows:

(i) *active power* limit; and(ii) *active power* ramp limit. |
| ***Generating units* with *nameplate rating* of 30 MW or more, or *bidirectional units* with *nameplate rating* of 5 MW or more, in respect of *generating unit* or *bidirectional unit* stators or power conversion systems (as applicable)** | 1. Current;
2. *Voltage*; and
3. *Active power* and *reactive power*
 |  |
| ***Automated generation control system (AGC) – scheduled generating systems, semi-scheduled generating systems* and *scheduled integrated resource systems*** | 1. *AGC* control mode (remote or local);
2. *AGC* availability status;
3. maximum *active power* limit;
4. minimum *active power* limit;
5. maximum *active power* raise ramp rate; and
6. maximum *active power* lower ramp rate;
 | 1. *AGC* *active power* setpoint
 |
| **Auxiliary supply system with a capacity of 30 MW or more associated with the *generating unit,* or *generating system, bidirectional unit* or *integrated resource system*** | *Active power* and *reactive power* |  |
| ***Reactive power* equipment that is part of the *generating system* or *integrated resource system* but not part of a *production unit*** | *Reactive power* |  |
| ***Semi-scheduled* *generating system* or a *semi-scheduled generating unit* in an *integrated resource system*** | All data specified as mandatory in the relevant *energy conversion model* applicable to that type of *semi-scheduled generating system,* especially the standing and metered data requirements (see the [Semi-Scheduled Energy Conversion Model Guidelines](http://www.aemo.com.au/Stakeholder-Consultation/Consultations/Energy-Conversion-Model-Guidelines-Consultation---Wind-and-Solar-Farms) for wind and solar *generating systems*) |  |
| **Runback scheme agreed with the NSP** | 1. Runback scheme status (enabled/disabled);
2. Runback scheme operated status; and
3. *active power, reactive power* or other control limit, as applicable.
 |  |

 |
|  | S5.2.6.2 and 4.11.3 | Communications Equipment | A | The *[select participant type]* has provided and will maintain:(1) two separate telephone *facilities* using independent telecommunications service providers, for the purposes of operational communications between the *[select participant type]* responsible operator under clause 4.11.3(a) of the NER and *AEMO’s control centre*; and(2) electricity supplies for *remote monitoring equipment* and *remote control equipment* installed in relation to its *[select system type]* capable of keeping such equipment available for at least 3 hours following total loss of *supply* at the *connection point* for a relevant *production unit*. |
|  | S5.2.7 | Power Station Auxiliary Supplies | Not applicable | [Only required if the *generating system* or *integrated resource system* takes its auxiliary *load* via a *connection point* through which its *generation* is not transferred to the *network,* in which case,specify *performance standard* under clause S5.3.5 of the NER as if the *Generator* or *Integrated Resource Provider* were a *Market Customer*]The *[select system type]* takes its auxiliary supplies via [insert connection point and Nominal Voltage] . The *power factor* of the *[select system type]* *auxiliary loads will be between 0.9 leading to 0.9 lagging* [or *insert power factor* requirement as agreed with NSP].[Delete as appropriate] |
|  | S5.2.8 | Fault Current | A | The *[select system type]* *limits its contribution to the fault current at the Connection Point to:** + - 1. *three-phas*e fault current, [insert value] kA;
			2. single-phase-to-ground fault current, [insert value] kA;
			3. phase-to-phase-to-ground fault current, [insert value] kA.

 [Specify calculation basis as necessary]The *[select system type] connected plant* is capable of withstanding fault current through the Connection Point up to:* + - 1. three-phase fault current [insert value] kA;
			2. single-phase-to-ground fault current [insert value] kA;
			3. phase-to-phase-to-ground fault current [insert value] kA,

for [insert time] ms.The circuit breaker provided to isolate the *[select system/unit type]* from the *network* is capable of breaking, without damage or restrike, the maximum fault current of [insert value] kA expected to flow through the circuit breaker for any fault in the *network* or in the *[select system/unit type]*, as specified in the *connection agreement*.  |

1. Revision history [to track changes to registered Generator or Integrated Resource Provider Performance Standards]

|  |  |  |
| --- | --- | --- |
| Revision number | Date | Revision description |
|  |  |  |
|  |  |  |

1. Capitalised terms are defined in Table 1. Italicised terms are defined in the NER. [↑](#footnote-ref-1)
2. BESS guide for contingency FCAS registration: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security\_and\_Reliability/Ancillary\_Services/Battery-Energy-Storage-System-requirements-for-contingency-FCAS-registration.pdf [↑](#footnote-ref-2)