

A FREQUENCY OPERATING STANDARD — MARKUP

Note: This appendix provides a markup of the revised FOS with respect to the FOS that came into effect from 1 January 2020.

The *frequency operating standard* forms part of the *power system security standards*.

The Panel has determined to amend the frequency operating standard, in accordance with clause 8.8.3(a)(1) of the *Rules* with effect from ~~1 January 2020~~ 9 October 2023.

In this document:

- Appendix A.1 — specifies the *frequency* bands for the purpose of the *frequency operating standard* and the *Rules*
- Appendix A.2 — specifies the required **system frequency** outcomes following specified events
- Appendix A.3 — contains the definitions used in this document.

A.1 Frequency bands

The frequency bands are shown in Table A.1.

Column 4 during **supply scarcity** system restoration in the mainland and Column 2 in all other conditions (**Normal**).

Table A.1: Frequency bands

COLUMN 1	COLUMN 2		COLUMN 3		COLUMN 4
	NORMAL (HZ)		ISLAND (HZ)		SUPPLY SCARCITY <u>SYSTEM RESTORATION</u> (HZ)
	MAINLAND	TASMANIA	MAINLAND	TASMANIA	MAINLAND
<u>primary frequency control band</u>	49.985 – 50.015				
<i>normal operating frequency band</i>	49.85 – 50.15		49.5 – 50.5	49.0 – 51.0	49.5 – 50.5
<i>normal operating frequency excursion band</i>	49.75 – 50.25		49.5 – 50.5	49.0 – 51.0	49.5 – 50.5
<i>operating frequency tolerance band</i>	49.0 – 51.0	48.0 – 52.0	49.0 – 51.0	48.0 – 52.0	48 49.0 – 52 51.0
<i>extreme frequency excursion tolerance limit</i>	47.0 – 52.0	47.0 – 55.0	47.0 – 52.0	47.0 – 55.0	47.0 – 52.0

Note: 1. The Reliability Panel has not determined separate frequency bands for periods of **supply scarcity** system restoration in Tasmania. ~~Where a state of supply scarcity exists for the Tasmanian power system, the frequency bands set out in column 2 of table A.1 apply for an intact power system, and the frequency bands set out in column 3 of table A.1 apply for an island with the Tasmanian power system.~~

A.2 Required frequency outcomes

The target **system frequency** for the mainland and Tasmania is 50 Hz.

The *power system* is expected to experience a range of different operating conditions. Table A.2 — Table A.7 detail the required **system frequency** outcomes following the occurrence of the events specified in each Table.

Table A.2: System frequency outcomes following specified conditions

	REQUIREMENT	MAINLAND	TASMANIA
1	Accumulated time error limit. Accumulated time error limit...	no limit <15 seconds, except for an island or during supply scarcity	no limit <15 seconds, except for an island or following a multiple contingency event
2	Except as a result of a <i>contingency event</i> (which may be a generation event , a load event or a network event), system frequency : a) shall must be maintained within the applicable normal operating frequency excursion band, and b) shall must not be outside of the applicable normal operating frequency band for more than 5 minutes on any occasion and not for more than 1% of the time over any 30-day period.		
3	Following a generation event or a load event , system frequency must be maintained within the applicable generation and load change band , and must not be outside of the applicable <i>normal operating frequency band</i> for more than...	...5 minutes	...10 minutes
4	Following a network event , system frequency must be maintained within the applicable <i>operational frequency tolerance band</i> , and must not be outside ofthe applicable generation and load change band for more than 1 minute, or be outside of the applicable <i>normal operating frequency band</i> for more than 5 minutes.	...the applicable <i>normal operating frequency band</i> for more than 10 minutes.
5	Following a separation event , system frequency must be maintained within the applicable island separation band, and must not be		

	REQUIREMENT	MAINLAND	TASMANIA
	outside of the applicable generation and load change band for more than 2 minutes, or be outside of the applicable <i>normal operating frequency band</i> for more than 10 minutes.		
6	Following a <i>protected event</i> , system frequency must be maintained within the applicable extreme frequency excursion tolerance limit, and must not be outside of the applicable generation and load change band for more than 2 minutes while there is no <i>contingency event</i> , or be outside of the applicable <i>normal operating frequency band</i> for more than 10 minutes while there is no <i>contingency event</i> .		
7	Following a non-credible contingency event or multiple contingency event that is not a protected event, AEMO should use reasonable endeavours to: (a) maintain system frequency within the applicable <i>extreme frequency excursion tolerance limits</i> ; and (b) avoid system frequency being outside of the applicable generation and load change band for more than 2 minutes while there is no <i>contingency event</i> , or being outside of the applicable <i>normal operating frequency band</i> for more than 10 minutes while there is no <i>contingency event</i> .		
8	<u>Following a <i>credible contingency event</i> (which may be a generation event, a load event or a network event), the rate of change of frequency must not be greater than</u>	<u>... $\pm 1\text{Hz/s}$ (measured over any 500ms period)</u>	<u>... $\pm 3\text{Hz/s}$ (measured over any 250ms period).</u>
9	<u>Following a <i>non-credible contingency event</i> or multiple contingency events that is not a <i>protected event</i>, AEMO should use reasonable endeavours to maintain the rate of change of frequency within...</u>	<u>... $\pm 3\text{Hz/s}$ (measured over any 300ms period)</u>	<u>... $\pm 3\text{Hz/s}$ (measured over any 300ms period).</u>
10	The size of the largest single generation event , load event or network event is limited to...	N/A	...144 MW measured a) at the connection point for a generating system; b) at the connection point for one or more generating systems in an identified user group

	REQUIREMENT	MAINLAND	TASMANIA
			<p>which share a dedicated connection asset.</p> <p>This limit can be implemented <u>for an event greater than 144MW by automatic load shedding or any other arrangements approved by AEMO that would effectively reduce the impact of the event to 144MW or below.</u>¹—in relation to any generating system with a capacity greater than 144 MW, or to one or more generating systems with a combined capacity greater than 144MW which are connected to the transmission network by a single dedicated connection asset, by automatic load shedding or any other arrangements approved by AEMO that would effectively reduce any generation event in relation to the relevant generating system(s) to 144MW or below.</p>

Note: 1. Under clause 4.8.9(a)(1) of the *Rules*, AEMO may require a *Registered Participant* to do any act or thing if AEMO is satisfied that it is necessary to do so to maintain or re-establish the *power system* to a *secure operating state*, a *satisfactory operating state* or a *reliable operating state*. Using this power, AEMO may direct a *Generator* to exceed the 144MW limit following a *contingency event* if AEMO reasonably believes this would be necessary to maintain a *reliable operating state*.

Table A.3: Summary of mainland system frequency outcomes for an interconnected system

CONDITION	CONTAINMENT BAND (HZ)	STABILISATION BAND (HZ)	RECOVERY BAND (HZ)	RATE OF CHANGE OF FREQUENCY
No contingency event or load event	49.75 – 50.25 49.85 – 50.15 ¹	49.85 – 50.15 within 5 minutes		±1Hz/s (measured over any 500ms period)
Generation event or load event	49.5 – 50.5	49.85 – 50.15 within 5 minutes		
Network event	49.0 – 51.0	49.5 – 50.5 within 1 minute	49.85 – 50.15 within 5 minutes	
Separation event	49.0 – 51.0	49.5 – 50.5 within 2 minutes	49.85 – 50.15 within 10 minutes	As per the protected event declaration
Protected event	47.0 – 52.0	49.5 – 50.5 within 2 minutes	49.85 – 50.15 within 10 minutes	
Multiple contingency event	47.0 – 52.0 (reasonable endeavours)	49.5 – 50.5 within 2 minutes (reasonable endeavours)	49.85 – 50.15 within 10 minutes (reasonable endeavours)	

Note: 1. ~~99% of the time~~ System frequency must not be outside the NOFB for more than 1% of the time over any 30-day period.

Table A.4: Summary of Mainland system frequency outcomes for an island within the Mainland other than during [system restoration](#)⁵

CONDITION	CONTAINMENT BAND (HZ)	STABILISATION BAND (HZ)	RECOVERY BAND (HZ)	RATE OF CHANGE OF FREQUENCY
No <i>contingency event</i> or load event	49.5 – 50.5	N/A		±1Hz/s (measured over any 500ms period)
Generation event, load event or network event	49.0 – 51.0	49.5 – 50.5 within 5 minutes		
The separation event that resulted in the island	49.0 – 51.0 ¹	49.0 – 51.0 within 2 minutes	49.5 – 50.5 within 10 minutes	
<i>Protected event</i>	47.0 – 52.0	49.0 – 51.0 within 2 minutes	49.5 – 50.5 within 10 minutes	As per the protected event declaration
Multiple contingency event including a further separation event	47.0 – 52.0 (reasonable endeavours)	49.0 – 51.0 within 2 minutes (reasonable endeavours)	49.5 – 50.5 within 10 minutes (reasonable endeavours)	±3Hz/s (measured over any 300ms period) (reasonable endeavours)

Note: 1. Or a wider band as notified to AEMO by a JSSC for a region.

Table A.5 applies in the **Mainland** during **supply scarcity system restoration** if:

1. Following a *contingency event*, the *frequency* has reached the **Recovery Band** set out in Table A.3¹, and *AEMO* considers the *power system* is sufficiently secure to begin *reconnection of load*.
2. The estimated *load* available for *under frequency schemes* within the **island** is more than the amount required to ensure that any subsequent *frequency excursion* would not go below the **Containment Band** and **Stabilisation Band** set out in Table A.5 as a result of a subsequent **generation event, load event, network event** or a **separation event** during *reconnection of load*.
3. The *generation reserve* available for *frequency regulation* is consistent with *AEMO's* current practice.

Table A.5: Summary of Mainland system frequency outcomes during **supply scarcity system restoration**

CONDITION	CONTAINMENT BAND (HZ)	STABILISATION BAND (HZ)	RECOVERY BAND (HZ)	RATE OF CHANGE OF FREQUENCY
No <i>contingency event</i> or load event	49.5 – 50.5	N/A		±1Hz/s (measured over any 500ms period) (reasonable endeavours)
Generation event, load event or network event	Qld and SA: 48.0 – 52.0 NSW and Vic.: 48.5 – 52.0 ¹	49.0 – 51.0 within 2 minutes	49.5 – 50.5 within 10 minutes	
<i>Protected event</i>	47.0 – 52.0	49.0 – 51.0 within 2 minutes	49.5 – 50.5 within 10 minutes	As per the <i>protected event declaration</i>
Multiple contingency event or separation event	47.0 – 52.0 (reasonable endeavours)	49.0 – 51.0 within 2 minutes (reasonable endeavours)	49.5 – 50.5 within 10 minutes (reasonable endeavours)	±3Hz/s (measured over any 300ms period) (reasonable endeavours)

Note: 1. For the operation of an **island** that incorporates *power system* elements from more than one *region*, the Containment Band for a **generation event**, a **load event** or a **network event** is the narrower of the Containment Bands for the affected *regions*. For example, following a **generation event, load event** or **network event** during **supply scarcity system restoration** for an **island** that is partly within the *Victoria region* and partly within the *South Australia region*, the Containment band would be 48.5 – 52.0Hz.

¹ Note: In the FOS that came into effect on 1 January 2020, the Table was incorrectly listed as Table A.2.3.

The frequency outcomes for Tasmania during system restoration are equivalent to the requirements set out in Table A.6 for an intact *power system* and in Table A.7 for an island within the Tasmanian *power system*.

Table A.6: Summary of Tasmania system frequency outcomes where the Tasmanian power system is intact

CONDITION	CONTAINMENT BAND (HZ)	STABILISATION BAND (HZ)	RECOVERY BAND (HZ)	RATE OF CHANGE OF FREQUENCY
No contingency event or load event	49.75 – 50.25 49.85 – 50.15 ¹	49.85 – 50.15 within 5 minutes		±3Hz/s (measured over any 250ms period)
Generation event, load event or network event	48.0 – 52.0	49.85 – 50.15 within 10 minutes		
Separation event	47.0 – 55.0	48.0 – 52.0 within 2 minutes	49.85 – 50.15 within 10 minutes	
Protected event	47.0 – 55.0	48.0 – 52.0 within 2 minutes	49.85 – 50.15 within 10 minutes	As per the protected event declaration
Multiple contingency event	47.0 – 55.0 (reasonable endeavours)	48.0 – 52.0 within 2 minutes (reasonable endeavours)	49.85 – 50.15 within 10 minutes (reasonable endeavours)	±3Hz/s (measured over any 300ms period) (reasonable endeavours)

Note: : 1. ~~99% of the time~~ System frequency must not be outside the NOFB for more than 1% of the time over any 30-day period.

Table A.7: Summary of Tasmania system frequency outcomes where an island is formed within Tasmania

CONDITION	CONTAINMENT BAND (HZ)	STABILISATION BAND (HZ)	RECOVERY BAND (HZ)	RATE OF CHANGE OF FREQUENCY
No contingency event or load event	49.0 – 51.0	N/A		±3Hz/s (measured over any 250ms period)
Generation event, load event or network event	48.0 – 52.0	49.0 – 51.0 within 10 minutes		
Separation event	47.0 – 55.0	48.0 – 52.0 within 2 minutes	49.0 – 51.0 within 10 minutes	
Protected event	47.0 – 55.0	48.0 – 52.0 within 2 minutes	49.0 – 51.0 ¹ within 10 minutes	As per the protected event declaration
Multiple contingency event	47.0 – 55.0	48.0 – 52.0 within 2 minutes (reasonable endeavours)	49.0 – 51.0 within 10 minutes	±3Hz/s (measured over any 300ms period) (reasonable endeavours)

Note: ~~1. In the FOS that came into effect on 14 November 2017, the Recovery band following a protected event for an island within Tasmania was incorrectly listed as 49.85 Hz — 50.15 Hz.~~

A.3

Definitions

In this document:

- *Italicised* terms are defined in the National Electricity Rules.
- **Bold** terms are defined in Table A.8.

Table A.8: Definitions

TERM	DEFINITION
accumulated time error	For a measurement of system frequency that AEMO uses, the integral over time of the difference between 20 milliseconds and the inverse of that system frequency , starting from a time <i>published</i> by AEMO.
generation and load change band	<p>For the Mainland:</p> <ol style="list-style-type: none"> 1. 49.0 – 51.0 Hz for an island 2. during supply scarcitysystem restoration: <ol style="list-style-type: none"> a. 48.0 – 52.0 Hz in an island incorporating South Australia or Queensland; and b. 48.5 – 52.0 Hz in an island incorporating Victoria or New South Wales 3. 49.5 – 50.5 Hz otherwise. <p>For Tasmania: 48.0 – 52.0 Hz.</p>
generation event	<ol style="list-style-type: none"> 1. a synchronisation of a generating unit of more than 50 MW<u>a synchronisation of a generating unit of more than the generation event threshold of:</u> <ol style="list-style-type: none"> a. <u>for the Mainland: 50MW</u> b. <u>for Tasmania: 20MW.</u> 2. an event that results in the sudden, unexpected and significant increase or decrease in the <i>generation</i> of one or more <i>generating systems</i> totalling more than 50MW<u>the generation event threshold for the region</u> in aggregate within no more than 30 seconds; or 3. the <i>disconnection</i> of <i>generation</i> as the result of a <i>credible contingency</i> event (not arising from a load event, a network event, a separation event or part of a multiple contingency event), in respect of either a single <i>generating system</i> or a single <i>dedicated connection asset</i> providing <i>connection</i> to one or more <i>generating systems</i>.
island	A part of the <i>power system</i> that includes <i>generation</i> , <i>networks</i> and <i>load</i> , for which all of its alternating current <i>network connections</i> with other parts of the <i>power system</i> have been <i>disconnected</i> , provided that the

TERM	DEFINITION
	<p>part:</p> <ol style="list-style-type: none"> 1. does not include more than half of the combined <i>generation</i> of each of two <i>regions</i> (determined by available capacity before <i>disconnection</i>); and 2. contains at least one whole <i>inertia sub-network</i>.
island separation band	<p>For the Mainland:</p> <ol style="list-style-type: none"> 1. for a part of the <i>power system</i> that is not an island, the <i>operational frequency tolerance band</i>; 2. for an island that includes a part of the <i>power system</i> to which no notice under paragraph (3) applies, the <i>operational frequency tolerance band</i>; and 3. otherwise in respect of an island, the <i>frequency band</i> determined by the most restrictive of the high limits and low limits of <i>frequency ranges</i> outside the <i>operational frequency tolerance band</i> notified by a JSSC to AEMO with adequate notice to apply to a nominated part of the island within the JSSC's region. <p>For Tasmania: the <i>extreme frequency excursion tolerance limits</i>.</p>
JSSC	<i>Jurisdictional System Security Coordinator</i>
load event	<p>For the Mainland: <i>connection or disconnection</i> of more than 50 MW of <i>load</i> not resulting from a network event, generation event, separation event or part of a multiple contingency event.</p> <p>For Tasmania: either a change of more than 20 MW of <i>load</i>, or a rapid change of flow by a <i>high voltage direct current interconnector</i> to or from 0 MW to start, stop or reverse its power flow, not arising from a network event, generation event, separation event or part of a multiple contingency event.</p>
multiple contingency event	Either a <i>contingency event</i> other than a <i>credible contingency event</i> , a sequence of <i>credible contingency events</i> within 5 minutes, or a further separation event in an island .
mainland	The Queensland, New South Wales, Victoria and South Australia <i>regions</i> .
network event	A <i>credible contingency event</i> other than a generation event , load event , separation event or part of a multiple contingency event .
rate of change of frequency (RoCoF)	The change in <i>frequency</i> over a period of time (Hz/second).
separation event	A <i>credible contingency event</i> affecting a <i>transmission element</i> that results in an island .
system frequency	The <i>frequency</i> of the <i>power system</i> , or an island (as applicable).

TERM	DEFINITION
<u>system restoration</u>	<u>Where <i>load</i> has been <i>disconnected</i> other than in accordance with <i>dispatch instructions</i> or a <i>direction</i> or <i>clause 4.8.9 instruction</i>, or the provision of a <i>market ancillary service</i>, and not yet restored.</u>
Tasmania	The Tasmania <i>region</i> .