A FREQUENCY OPERATING STANDARD

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 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.

For the purpose of the *frequency operating standard* and the *Rules*, a term in Column 1 means the *frequency* range in Column 3 for an **island**, Column 4 during **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)		SYSTEM RESTORATION (HZ)
	MAINLAND	TASMANIA	MAINLAND	TASMANIA	MAINLAND
primary frequency control band	49.985 – 50.015				
normal operating frequency band	49.85 – 50.15		49.5 – 50.5	49.0 – 51.0	49.5 – 50.5
normal operating frequency excursion band	49.75 – 50.25		49.5 – 50.5	49.0 – 51.0	49.5 – 50.5
operating frequency tolerance band	49.0 – 51.0	48.0 – 52.0	49.0 – 51.0	48.0 – 52.0	49.0 – 51.0
extreme frequency excursion tolerance limit	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 **system restoration** in Tasmania.

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…	no limit	no limit.
2	Except as a result of a *contingency event* (which may be a **generation event**, a **load event** or a **network event**), **system frequency**: a) must be maintained within the applicable normal operating frequency excursion band, and b) 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 *normal operating frequency band* for more than…	…5 minutes	…10 minutes.
4	Following a **network event**, **system frequency** must be maintained within the applicable *operational frequency tolerance band*, and must not be outside of…	…the applicable **generation and load change band** for more than 1 minute, or be outside of the applicable *normal operating frequency band* for more than 5 minutes.	...the applicable *normal operating frequency band* 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 outside of the applicable **generation and load change band** for more than 2 minutes, or be outside of the applicable *normal operating frequency band* for more than 10 minutes.		

	REQUIREMENT	MAINLAND	TASMANIA
6	Following a *protected event*, **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 *contingency event*, or be outside of the applicable *normal operating frequency band* for more than 10 minutes while there is no *contingency event*.		
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 *extreme frequency excursion tolerance limits*; and (b) avoid **system frequency** being outside of the applicable **generation** and **load change band** for more than 2 minutes while there is no *contingency event*, or being outside of the applicable *normal operating frequency band* for more than 10 minutes while there is no *contingency event.*		
8	Following a *credible contingency event* (which may be a **generation event**, a **load event** or a **network event),** the **rate of change of frequency** must not be greater than…	… ±1Hz/s (measured over any 500ms period)	… ±3Hz/s (measured over any 250ms period).
9	Following a *non-credible contingency event* or **multiple contingency events** that is not a *protected event*, AEMO should use reasonable endeavours to maintain the **rate of change of frequency** within…	… ±3Hz/s (measured over any 300ms period)	… ±3Hz/s (measured over any 300ms period).
10	The size of the largest single **generation event, load event** or **network event** is limited to...	N/A	...144 MW. This limit can be implemented 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.[1]

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	
Protected event	47.0 – 52.0	49.5 – 50.5 within 2 minutes	49.85 – 50.15 within 10 minutes	As per the protected event declaration
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)	±3Hz/s (measured over any 300ms period) (reasonable endeavours)

Note: 1. 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

CONDITION	CONTAINMENT BAND (HZ)	STABILISATION BAND (HZ)	RECOVERY BAND (HZ)	RATE OF CHANGE OF FREQUENCY
No *contingency event* 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	
Protected event	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 for the *power system* or an **island** within the **Mainland** during **system restoration** if:

1. Following a *contingency event*, the *frequency* has reached the **Recovery Band** set out in Table A.3[1], and *AEMO* considers the *power system* is sufficiently secure to begin *reconnection* of *load.*
2. The estimated *load* available for *under frequency schemes* 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 system restoration

CONDITION	CONTAINMENT BAND (HZ)	STABILISATION BAND (HZ)	RECOVERY BAND (HZ)	RATE OF CHANGE OF FREQUENCY
No *contingency event* 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	
Protected event	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 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 **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. 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)

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 *published* by *AEMO*.
generation and load change band	For the **Mainland**: 1. 49.0 – 51.0 Hz for an **island** 2. during **system restoration:** 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. For **Tasmania:** 48.0 – 52.0 Hz.
generation event	1. a *synchronisation* of a *generating unit* of more than the generation event threshold of: (a) for the **Mainland**: 50MW (b) for **Tasmania**: 20MW. 2. an event that results in the sudden, unexpected and significant increase or decrease in the *generation* of one or more *generating systems* totalling more than the generation event threshold for the region in aggregate within no more than 30 seconds; or 3. the *disconnection* of *generation* as the result of a *credible contingency* 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 *generating system* or a single *dedicated connection asset* providing *connection* to one or more *generating systems*
island	A part of the *power system* that includes *generation*, *networks* and *load*, for which all of its alternating current *network connections* with other parts of the *power system* have been *disconnected*, provided that the part:

TERM	DEFINITION
	1. does not include more than half of the combined *generation* of each of two *regions* (determined by available capacity before *disconnection*); and 2. contains at least one whole *inertia sub-network*.
island separation band	For the **Mainland**: 1. for a part of the *power system* that is not an **island**, the *operational frequency tolerance band*; 2. for an **island** that includes a part of the *power system* to which no notice under paragraph (3) applies, the *operational frequency tolerance band*; and 3. otherwise in respect of an **island**, the *frequency* band determined by the most restrictive of the high limits and low limits of *frequency* ranges outside the *operational frequency tolerance band* notified by a **JSSC** to *AEMO* with adequate notice to apply to a nominated part of the **island** within the **JSSC's** *region*. For **Tasmania**: the *extreme frequency excursion tolerance limits.*
JSSC	*Jurisdictional System Security Coordinator*
load event	For the **Mainland**: *connection* or *disconnection* of more than 50 MW of *load* not resulting from a **network event**, **generation event**, **separation event** or part of a **multiple contingency event.** For **Tasmania**: either a change of more than 20 MW of *load*, or a rapid change of flow by a *high voltage* direct current *interconnector* 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**.
multiple contingency event	Either a *contingency event* other than a *credible contingency event*, a sequence of *credible contingency events* within 5 minutes, or a further **separation event** in an **island**.
mainland	The Queensland, New South Wales, Victoria and South Australia *regions*.
network event	A *credible contingency event* 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 *frequency* over a period of time (Hz/second).
separation event	A *credible contingency event* affecting a *transmission element* that results in an **island**.
system frequency	The *frequency* of the *power system*, or an **island** (as applicable).

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