



Power System Operations Working Group –  
Meeting 1:

# Ancillary Services and Frequency Operating Standards

September 26<sup>th</sup> 2018

# Agenda

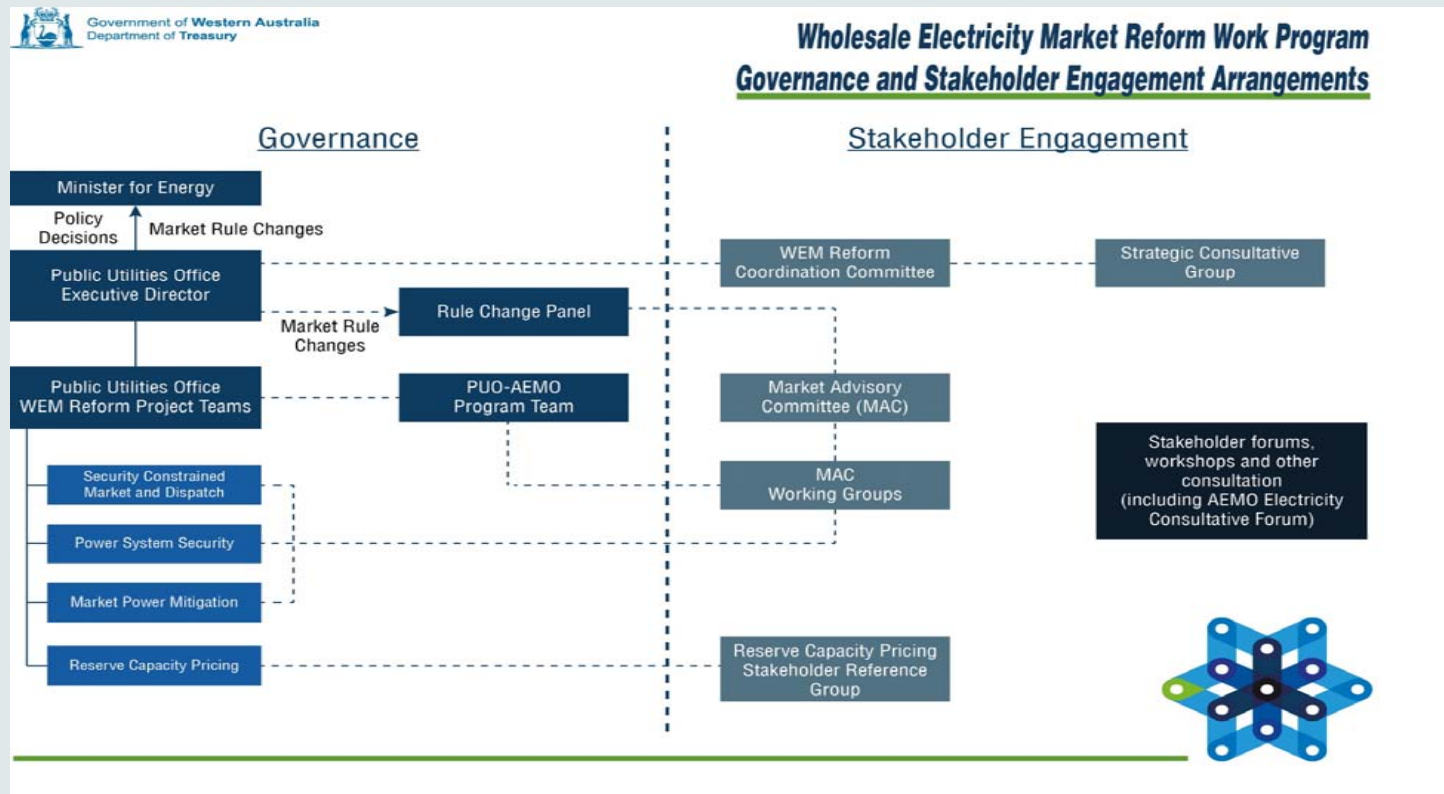
1. Introduction & PSOWG terms of reference review
2. PSSR scope and topics overview
3. AS issues
4. 5-min break
5. WEM FOS
6. General discussion

# Ground Rules

## A few ground rules to get us started

- There is a large amount of material to work through in the workshop today, and the session chair will try to keep us on time in order to have sufficient time for discussion
- It is assumed that attendees have pre-read the papers that have been circulated and so in the interests of time, the slides will focus on the key items to discuss and conversations may need to be captured off-line in order to move onto the next item
- Should it not be possible to get through all the material within the available workshop time, a second session may be scheduled depending on the amount of material remaining and availability of attendees, or alternatively feedback may be provided out-of-session
- We will attempt to capture all questions/answers discussed during the session today, for circulation after the workshop along with these slides and any revisions to the papers as a result of the workshop discussions
- All feedback/discussion is relevant, if attendees do not have a chance to ask a question or raise an issue, please feel free to make use of the PSOWG mailbox: [WARPSO@aemo.com.au](mailto:WARPSO@aemo.com.au)

# PSOWG and Wider Engagement



# Context of the Reform

# Aim of Electricity Sector Reforms

Manage transformation  
of the energy sector



Remove barriers to  
investment



Optimise  
grid use



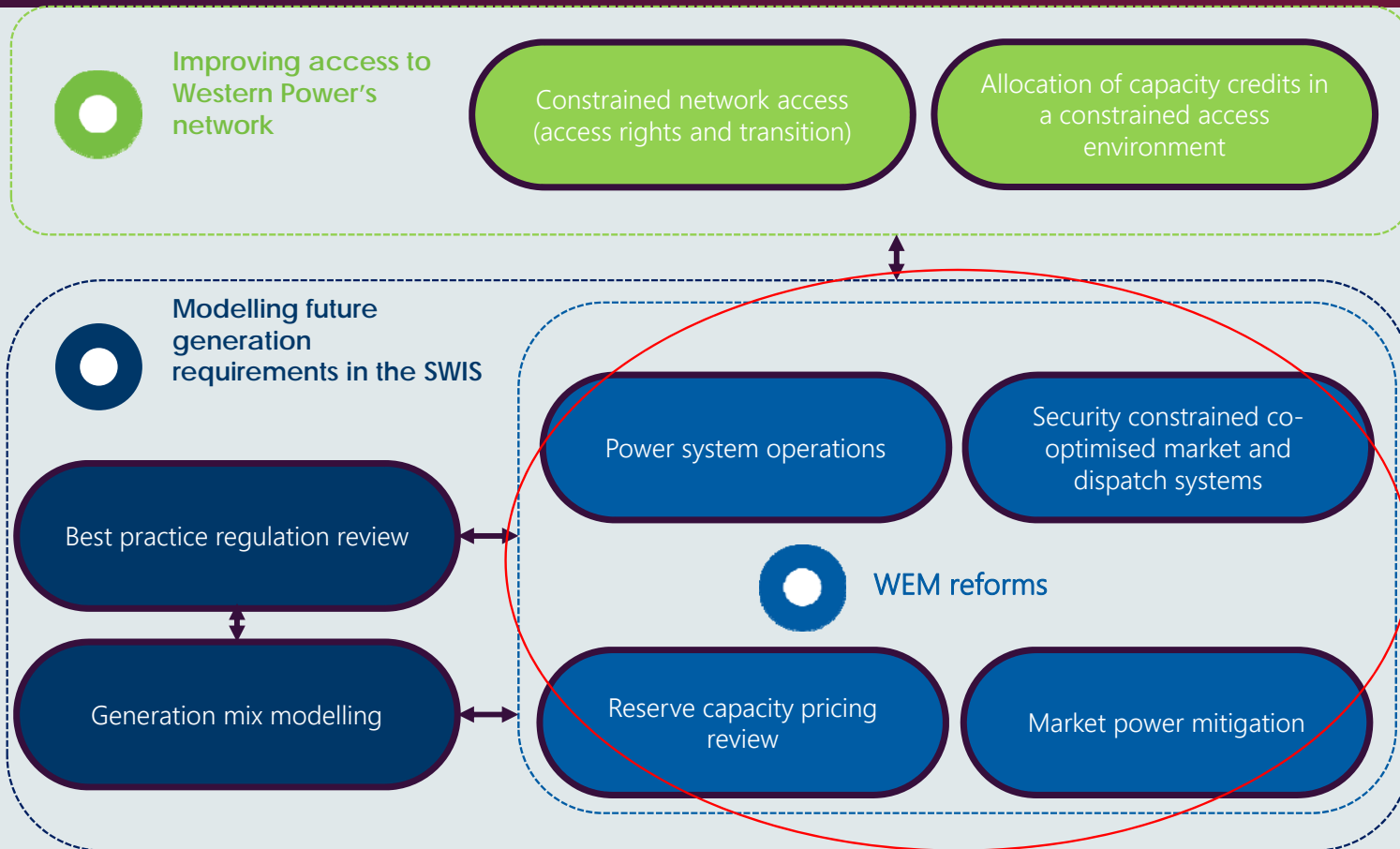
Improve  
operation of  
the WEM



Put downward  
pressure  
on prices



# Reform Initiatives



# PSO scope items

## Key items of scope for the PSOWG:

- Ancillary Services
  - Analysis and review
  - Framework options
- Power System Security and Reliability
  - Frequency Operating Standards
  - Operating States
  - Credible Contingency Events
  - Power System Reliability
  - Coordination between NSPs and AEMO
- Constraints
  - Frameworks, definitions and processes
  - Library (location, form, etc)
- Planning and Forecasting
  - PASA arrangements (timeframes, forecasts, information)
  - Load and non-scheduled generation forecasting arrangements
- Outage Management
  - Outage framework
  - Outage processes
  - Commissioning
- Dispatch
  - Structure of dispatch (form of instructions, etc)
  - Signal requirements
  - Fast start inflexibility



# Ancillary services

Presentation from David  
Bones (GHD) on Ancillary  
Services work

## Frequency Operating Standards for the WEM

# WEM FOS - recap

## Why does the WEM FOS need to be reviewed?

- The structure and settings of the FOS are important factors when determining what Ancillary Services are required and what quantities are required.
- With the removal of the Synergy portfolio, and introduction of competitive Ancillary Service markets, clearly defined and linked standards are required in order to define the ancillary service requirements, and ultimately the mechanisms for procuring and dispatching them.
- In addition to this, with structures and roles evolving within the SWIS it is timely to review the governance arrangements for this (review and change process), and to review the applicability of the FOS under different scenarios (e.g. island-able networks).

# WEM FOS – design principles

Some suggested design principles are provided below:

- The design of the revised WEM/FOS should:
- Be consistent with a move towards co-optimised security constrained ancillary services and economic dispatch.
- Adopt a simplified approach where possible.
- Maintain consistency with the current TR frequency settings, adapted to fit within the proposed FOS structure.
- Be clear in how it must apply to the power system and any islands in the SWIS.
- Ensure definitions are technology neutral to the extent possible.

**The PSOWG is asked to review and consider the proposed design principles**

# WEM FOS – recommendations

## Nominal frequency and Normal Band:

Per the proposed design principles, and noting that moving to a tighter normal operating band would notionally require a greater level of frequency regulation Ancillary Services, the recommendation for the PSOWG to consider here is to retain the existing TR settings for the SWIS:

### Recommendation 1

- Retain the current normal frequency operating band 49.8Hz to 50.2Hz (i.e. 50Hz +/- 0.2Hz)

## Containment, recovery and stabilisation settings:

The PSWOG should consider whether for the WEM/SWIS FOS there is benefit in having similar terminology:

### Recommendation 2

- Adopt the 'containment', 'stabilisation', and 'recovery' frequency terms to provide consistency of terminology and simplify the current TR FOS (currently similar concepts but not explicitly worded).
- Adapt the current TR FOS settings to the extent necessary to enable their mapping across to the frequency terms (i.e. no change to the actual frequency numbers in the current TR FOS).

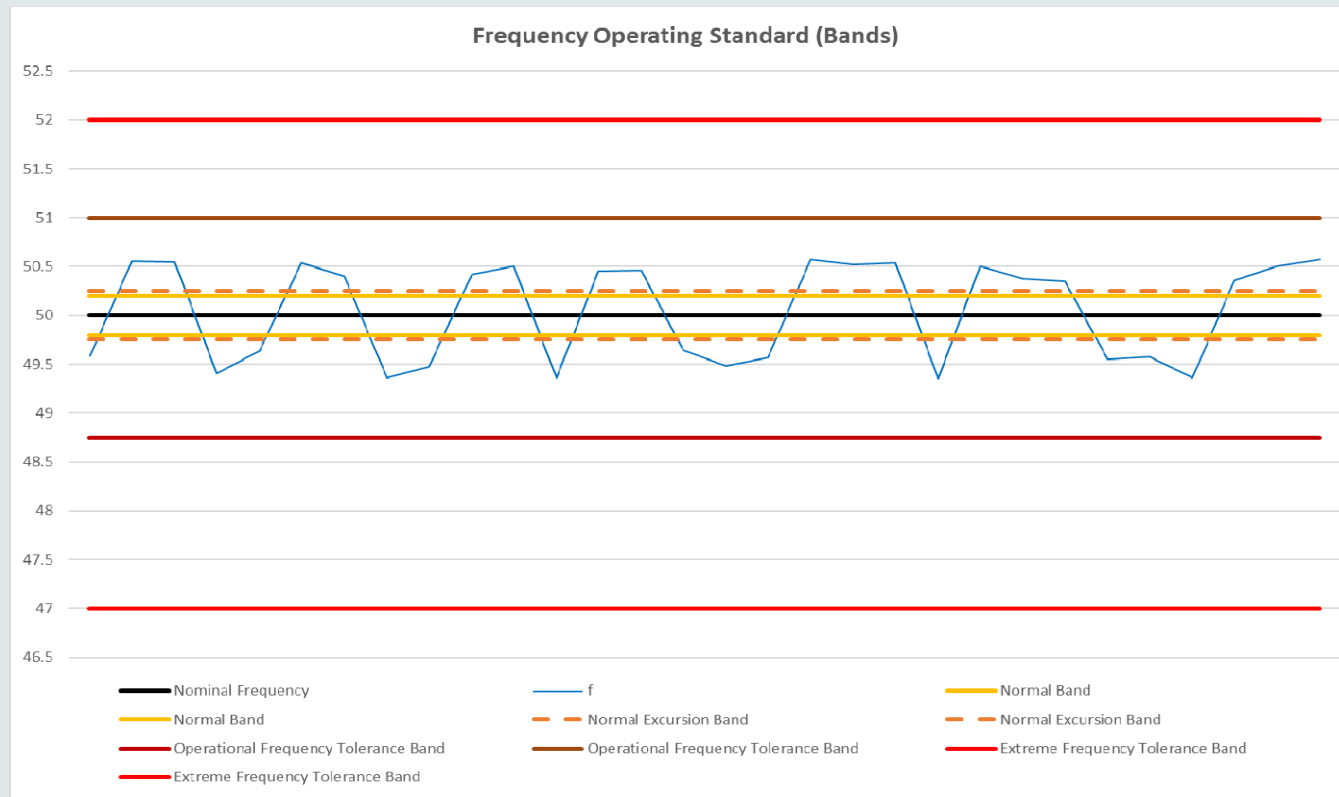
# WEM FOS – recommendations

## Defined rule terms:

- The following defined terms are used in the NEM:
  - *Normal operating frequency band*: represents the normal frequency operating range (currently equivalent to 50Hz +/- 0.2Hz in the TR FOS).
  - *Normal operating frequency excursion band*: this is a very small deadband around the normal frequency operating band that allows for infrequent/momentary excursions outside of the normal operating band (**there is currently no equivalent in the TR FOS**).
  - *Operational frequency tolerance band*: represents the allowable frequency operating range for credible contingencies (currently equivalent to 48.75Hz/+51Hz in the TR FOS).
  - *Extreme frequency excursion tolerance limit*: represents the allowable frequency operating range for more extreme non-credible contingency events (currently equivalent to 47Hz/52Hz in the TR FOS).

# WEM FOS – recommendations

Defined rule terms:



# WEM FOS – recommendations

## Defined rule terms:

These settings within the defined rule terms are used to provide the allowable frequency ranges for various events. They are analogous to the current TR FOS settings with the exception of the 'normal operating frequency excursion band' – this term provides an absolute target or reporting level for normal operations when we are not operating within the 'normal operating frequency band' 99% of the time (i.e. the remaining 1%). This also allows us to specify performance targets around the remaining 1%.

The initial recommendation for the PSOWG to consider is:

### Recommendation 3

- Create new WEM/SWIS definitions for 'normal operating frequency band', 'normal operating frequency excursion band' and 'extreme frequency excursion tolerance limit' such that these can be referred to in other security related rules and procedures. **The term 'operational frequency tolerance band' and some other frequency bands embedded within other FOS definitions in the NEM will be discussed in later recommendations**
- Adopt settings from the current TR FOS for these with the exception of new values for the currently non-existent 'normal operating frequency excursion band'. As such, a preliminary 'normal operating frequency excursion band' has been proposed for discussion/further assessment of 49.7 to 50.3Hz (i.e. +/- 0.1Hz from the 'normal operating frequency band')



# WEM FOS – recommendations

Accumulated time error:

**Recommendation 4**

Retain the TR FOS setting but specify a rolling 30-day period to provide clarity on the measurement criterion.

# WEM FOS – recommendations

## Events:

- Due to the emergence of new technology which can act as both a load or a generator, and the fact that the TR FOS currently does not prescribe any “different” frequency limits for generator/load or network/non-network single contingency events, there may be an opportunity to simplify these definitions to link to the broader ‘credible contingency event’ definition instead. This definition would cover all non-planned events that AEMO considers to credibly occur and which could result in a frequency disturbance.

### **Recommendation 5**

Adopt the definition of ‘credible contingency event’ in relation to the WEM/SWIS FOS as a replacement for the NEM FOS ‘generator event’ and ‘load event’.

- As a corollary to the above, the recommendation for the PSOWG to consider in relation to the relevant allowable frequency band is:

### **Recommendation 6**

Adopt a definition of ‘credible contingency event frequency tolerance band’ with the following settings based on the WEM/SWIS FOS “Single Contingency” settings: 48.75Hz to 51Hz.

- And similarly in relation to the network event concept:

### **Recommendation 7**

Align with the ‘credible contingency event’ definition and frequency settings to simplify the WEM/SWIS FOS.

# WEM FOS – recommendations

## Events:

- In relation to the *extreme frequency excursion tolerance limits* referred to in Recommendation 3, these represent the most extreme frequency limits of the power system that should only be reached under the most onerous of conditions
- In the TR FOS, these are captured as the “Multiple Contingency” limits (47.0 to 52.0Hz)

### **Recommendation 8**

Per Recommendation 3, adopt the term and align with TR FOS definitions, being essentially the same as the TR multiple credible contingency limits (47.0 to 52.0 Hz).

# WEM FOS – recommendations

## Performance (non-island):

- In addition to the bands themselves, there is also a need to define some performance parameters associated with each of those bands (i.e. the number of allowable excursions timeframe to remain in the normal band, etc). Both the NEM FOS and the TR FOS have these performance parameters
- There are some deficiencies in the NEM performance definitions both the NEM FOS and the current TR FOS (e.g. timeframes for measurement and definitions around stabilisation and recovery), but generally the NEM FOS definition provides greater clarity overall than the TR FOS definition, including what types of events to include/exclude

The recommendation for the PSOWG to consider is:

### **Recommendation 9**

- Create new WEM performance definitions for each of the frequency bands based on the structures previously recommended, amending wording where necessary to create greater clarity
- Adopt settings from the current TR FOS for these with the exception of new values for the currently non-existent 'normal operating frequency excursion band'.

# WEM FOS – recommendations

## Proposed WEM FOS Performance Standards (Recommendation 9)

Item	Performance Requirements
Accumulated Time Error	except in an island or during a system restart, the accumulated time error should not exceed 10 seconds for 99% of the time over any 30-day period
Normal Operating and Excursion Band	except as a result of either a credible contingency event or non-credible contingency event, system frequency should not exceed the applicable normal operating frequency excursion band (49.7 to 50.3 Hz) and should not exceed the applicable normal operating frequency band (49.8 to 50.2 Hz) for more than five minutes on any occasion and not for more than 1% of the time over any 30-day period
Credible Contingency Event Frequency Tolerance Band	as a result of a credible contingency event (e.g. generator fault or load trip), system frequency should not exceed the applicable credible contingency event frequency tolerance band (48.75 to 51 Hz), should stabilise below 50.5Hz within two minutes and should recover within the applicable normal operating frequency band (49.8 to 50.2 Hz) within fifteen minutes
Island Separation Band	as a result of any separation event (e.g. system splitting into multiple sections), system frequency should not exceed the applicable island separation band (48.75 to 51 Hz), should stabilise below 50.5Hz within two minutes and should recover within the applicable normal operating frequency band (49.8 to 50.2 Hz) within fifteen minutes  Note – definitions of separation event, island separation band and alternative performance parameters for island scenarios are discussed in further detail later.
Extreme Frequency Tolerance Band	as a result of any multiple credible contingency event or non-credible contingency event, system frequency should not exceed the extreme frequency excursion tolerance limits (47 to 52 Hz), should stabilise above 47.5Hz within ten seconds, stabilise below 51.5Hz within one minute, stabilise below 51Hz within two minutes, stabilise within 48 and 50.5Hz within five minutes and should recover within the applicable normal operating frequency band (49.8 to 50.2 Hz) within fifteen minutes

In terms of how to measure against these performance criteria, it is important to have a common, consistent understanding of when the events commence and complete.

For the purposes of the above:

- the timing of a *credible contingency event*, *separation event* or *multiple contingency event* commences at the time AEMO records the *system frequency* in its SCADA system going outside of the *normal operating frequency excursion band* and is completed at time at which the frequency has recovered (see below)
- stabilise means when the *system frequency* has remained above or below the required level **for at least 20 seconds**
- recover means when the *system frequency* has remained above or below the required level **for at least 1 minute**

# WEM FOS – recommendations

## Islands - definition:

- The TR FOS **does not define an “island”**, but includes a single setting for an island in Table 2.1 of the Technical Rules and an accompanying explanatory note (see *Appendix A - Frequency Operating Standards in the Technical Rules*):

“An island is formed when the *interconnection* between parts of the *interconnected transmission system* is broken, for example if the *interconnection* between the Goldfields region and remainder of the power system is broken”

- **No other standards are specifically identified for an “island” in the TR FOS other than the normal operating frequency band (49.5 to 50.5Hz)**

### Recommendation 10

Create a new definition of an ‘island’ as follows:

“*Island*: means a part of the SWIS that includes *generation systems* (or other energy sources), *networks* and *load*, for which all of its alternating current network connections with other parts of the SWIS have been disconnected, provided that the part:

is smaller than the rest of the SWIS that it has disconnected from, i.e. does not include more *generation* (or other energy sources) and *load* (determined by on-line quantities before dis-connection); and

contains active *generation* (or other energy sources) capable of supplying the *load* within the part of the SWIS that has been disconnected.

Provide separate prescription on the frequency operating standards that are to apply to an island containing only distribution networks, where the island was formed by a contingency event in relation to a distribution element. See Recommendation 13 below.

Provide a recommendation to the Public Utilities Office that consideration is given as to how Ancillary Service provisions may need to be modified to cater for *Islands*

# WEM FOS – recommendations

## Islands – events and bands:

- The TR FOS **does not define a “separation event”**, which describes the types of events that can result in the formation of an island, **or the concept of a “separation band”** which describes the frequency the system must remain operating within following one of these events
- The NEM FOS **only contemplated separation events resulting from a ‘credible contingency event’ in relation to a transmission element**

It is proposed for the WEM FOS that there would be merit in ensuring the definition of ‘separation event’ is sufficient to cater for as many as possible types of conditions that can result in the formation of an island where it is desirable for frequency standards to apply:

### **Recommendation 11**

Adopt a definition of ‘separation event’ as follows:

*“Separation event: means either a contingency event or planned switching that results in the formation of an island”.*

The recommendation for the resulting frequency band to apply in both the island that is formed following the event and in the rest of the SWIS is:

### **Recommendation 12**

- Adopt a definition for ‘island separation band’ as follows:

*“Island separation band: means the credible contingency event frequency tolerance band”.*

# WEM FOS – recommendations

## Islands – performance:

- The TR FOS has **very limited specification** around the frequency performance requirements within an island, only a single entry
- However even though for the SWIS the separation frequency requirements are recommended to be the same as other types of events, there is merit in maintaining a separate definition such that this could be modified in the future to be a different range if need be

The recommendation for the resulting frequency band to apply in both the island that is formed following the event and in the rest of the SWIS is:

### **Recommendation 13**

No accumulated time error to apply within an island.

**Retain the 99% / 5-minute obligation for the normal frequency range within an island**

Relax timeframe to return to normal frequency operating range within the island following initial formation

Maintain contingency event frequency band within the island but relax timeframes to return to normal frequency operating range following credible and multiple contingency events (from 2 to 5 minutes for high frequency recovery with best endeavours).

Within a sub-island of the SWIS, a multiple contingency event would be fairly extreme and difficult to cater for practically in terms of ancillary service provisions. Propose that the multiple contingency event frequency band within the island remains the same, but with relaxed stabilisation timeframes (from 1 to 2 mins, from 2 to 5 mins, from 5 to 10 mins) as soon as practicable timeframes to return to normal frequency operating range following a multiple contingency event.



# WEM FOS – recommendations

## Islands – autonomous islands:

- There are several locations within the SWIS that have historical arrangements in place whereby they are able to operate autonomously within their own islands under certain network conditions.
- Examples of this are the TransAlta network in the goldfields and large refinery operations in the South West and around Kwinana.
- In these cases, AEMO has no direct control of frequency in the island, and ongoing supply may be based on contractual arrangements (where other market customers are involved).

The recommendation is to recognise that these types of islands are not intended to be covered by the frequency operating standards:

### **Recommendation 15**

Make it clear that the revised WEM/SWIS FOS does not apply to *Autonomous Islands*

Discuss and provide options for the consideration of the Public Utilities Office in regard to reporting and governance arrangements on *Autonomous Islands*, including:

- How an *Autonomous Island* is identified
- How an *Autonomous Island* is authorised (if required)
- The possible use of s.25 of the Electricity Act 1945 as the reference form of words for the frequency obligations that apply in an *Autonomous Island*.
- Reporting arrangements for *Autonomous Islands* (if required)

# WEM FOS – recommendations

## Islands – autonomous islands, other thoughts:

- In terms of frequency standards that might apply in these islands, the Electricity Act does have a simple form of frequency requirement that could apply to “network operators” covered by the Act:

### *25. Duties as to supply of electricity*

*(1) A network operator shall*

*.....*

*declare the system pressure and/or frequency at which the network operator proposes to supply electricity to the premises of a consumer at the position thereon where the electricity will pass beyond the service apparatus of the network operator, and maintain constantly the said pressure within the limit of  $\pm 6\%$  and the said frequency within the limit of  $\pm 2\frac{1}{2}\%$ .*

- Other considerations:
  - Identifying where these autonomous islands are authorised to exist (and which network operator is responsible for operating them)
    - perhaps a register on the ERA website?
  - What reporting arrangements should exist
    - perhaps an annual report outlining any “significant” deviations? E.g. where the frequency went outside of the 2.5% limit for an extended period of time, or the number of times the limit was exceeded in a year/month/etc.
    - possibly limit reporting requirements for only where there are market customers being supplied, i.e. not for companies supplying their own load (e.g. refinery sites)

# WEM FOS – recommendations

## Protected events:

- A 'protected event' is defined as:

*"A protected event means a non-credible contingency event that the Reliability Panel has declared to be a protected event under clause 8.8.4, where that declaration has come into effect and has not been revoked. Protected events are a category of non-credible contingency event"*

- These are intended to be very specific, non-credible contingency event that has been categorised as high enough impact by the AEMC Reliability Panel to warrant special treatment.

Within the SWIS, looking at both the non-island and islanded WEM FOS recommendations covering multiple contingencies, and taking into consideration the additional work to be done around the classification framework for *credible contingencies*, it is perhaps difficult to see where there would be a need for a protected event definition currently

### **Recommendation 14**

At this time, do not proceed with the definition of *protected event* and associated frequency settings. However, recommend that once the appropriate governance framework is established, that this be one of the first items to review and include if deemed necessary in the future.

# WEM FOS – recommendations

## Scarcity of supply - NEM:

- The NEM FOS defines 'supply scarcity' as:
 

“...the condition where load has been disconnected either manually or automatically, other than in accordance with dispatch instructions or service provision, and not yet restored to supply”.
- The NEM FOS uses this definition to apply a separate set of frequency settings under this condition
- During these types of events the table effectively reduces the frequency standards to widest possible range to cater for further contingency events.

**Table A.1.3 NEM Mainland Frequency Operating Standards – during supply scarcity**

Condition	Containment	Stabilisation	Recovery
No contingency event or load event	49.5 to 50.5 Hz		
Generation event, load event or network event	48 to 52 Hz (Queensland and South Australia) 48.5 to 52 Hz (New South Wales and Victoria)	49 to 51 Hz within 2 minutes	49.5 to 50.5 Hz within 10 minutes
Protected event	47 to 52 Hz	49.0 to 51.0 Hz within 2 minutes	49.5 to 50.5 Hz within 10 minutes
Multiple contingency event or separation event	47 to 52 Hz (reasonable endeavours)	49.0 to 51.0 Hz within 2 minutes (reasonable endeavours)	49.5 to 50.5 Hz within 10 minutes (reasonable endeavours)

# WEM FOS – recommendations

## Scarcity of supply – WEM Rules:

A similar principle currently applies in the WEM in relation to the way that Ancillary Service requirements are defined:

WEM Rule 3.10.2 currently allows for the Spinning Reserve Service to be relaxed by up to 12% where there is a shortfall in SRAS that is anticipated to last less than 30 minutes. If this relaxation were not allowed, System Management could be faced with a situation requiring it to issue load shed directions to enable capacity from energy to be re-allocated for frequency Ancillary Services (which is not an effective outcome).

WEM Rule 3.10.2 also allows for the Spinning Reserve Service to be relaxed by up to 100% where all reserves are exhausted. If the relaxation were not allowed, System Management could be faced with a situation in which a multiple contingency event has exhausted all available frequency Ancillary Services, requiring it to issue load shed directions to recover Ancillary Services before the system has re-stabilised. Again, this is not an effective outcome.

Similarly, the WEM Rules currently cater for reduced LFAS quantities during supply scarcity conditions. WEM Rule 3.10.5 allows for the level of LFAS, SRAS and LRAS to be reduced following relevant contingencies, or when System Management considers the standard cannot be met without shedding load

# WEM FOS – recommendations

## Scarcity of supply:

- Rather than describing a new set of frequency standards, it could be possible to allow for “scarce” conditions within the WEM Rule drafting, e.g.
  - Link the quantities of Ancillary Services to meeting the Frequency Operating Standards
  - Allow for this to be relaxed under “scarce” conditions (adding appropriate definitions), instead providing a best endeavours approach (similar to current WEM rules)

The recommendation for the PSOWG to consider is:

### **Recommendation 16**

Do not adopt a ‘scarcity of supply’ **table** for the FOS.

Ensure the WEM rules are drafted appropriately to allow for scarcity conditions and to ensure there is not an undue trade-off in these conditions between energy and frequency Ancillary Services.

# WEM FOS – other thoughts

## RoCoF

- Per discussion in the Ancillary Service slides, there may be merit in introducing a “Frequency Rate of Change Limit” to the WEM FOS to allow for, and guide, Ancillary Service provisions into the future. The need for this will be guided by some of the GHD analysis and will be discussed at future PSOWG sessions.

Any other thoughts?

# Thank you

Thank you very much for your attendance and thoughtful contribution

- We will endeavour to send a copy of these slides, along with notes from today's workshop out to attendees and interested parties within the next 5 business days
- Please feel free to send any other questions or thoughts to the PSOWG email inbox:

[WARPSO@aemo.com.au](mailto:WARPSO@aemo.com.au)



## Summaries

# WEM FOS – SUMMARY

## Part A – Summary of Standards:

The resultant Wholesale Electricity Market *frequency operating standards* based on the recommendations above (also set out in Part B below), are summarised in the following tables for convenience. To the extent of any inconsistency between these tables and Part B below, Part B prevails.

The following table applies to the South West Interconnected System, including within an *island* and during periods of supply scarcity during load restoration.

### Wholesale Electricity Market Frequency Operating Standards – interconnected system

Condition	Containment	Stabilisation	Recovery
Accumulated Time Error	<10 seconds for 99% of the time over any 30 day period		
No Credible contingency event	[49.70 to 50.30 Hz] 49.8 to 50.2 Hz 99% of the time over any 30 day period	49.8 to 50.2 Hz within 5 min	
Credible contingency event	48.75 to 51 Hz	Below 50.5 Hz within 2 min	49.8 to 50.2 Hz within 15 min
Separation event	48.75 to 51 Hz	Below 50.5 Hz within 2 min	49.8 to 50.2 Hz within 15 min
Multiple contingency event	47 to 52 Hz	Above 47.5 Hz within 10 seconds	49.8 to 50.2 Hz within 15 min
		Below 51.5 Hz within 1 min	
		Below 51Hz within 2 min	
		48.0 Hz to 50.5 Hz within 5 min	

# WEM FOS – SUMMARY

## Part A – Summary of Standards:

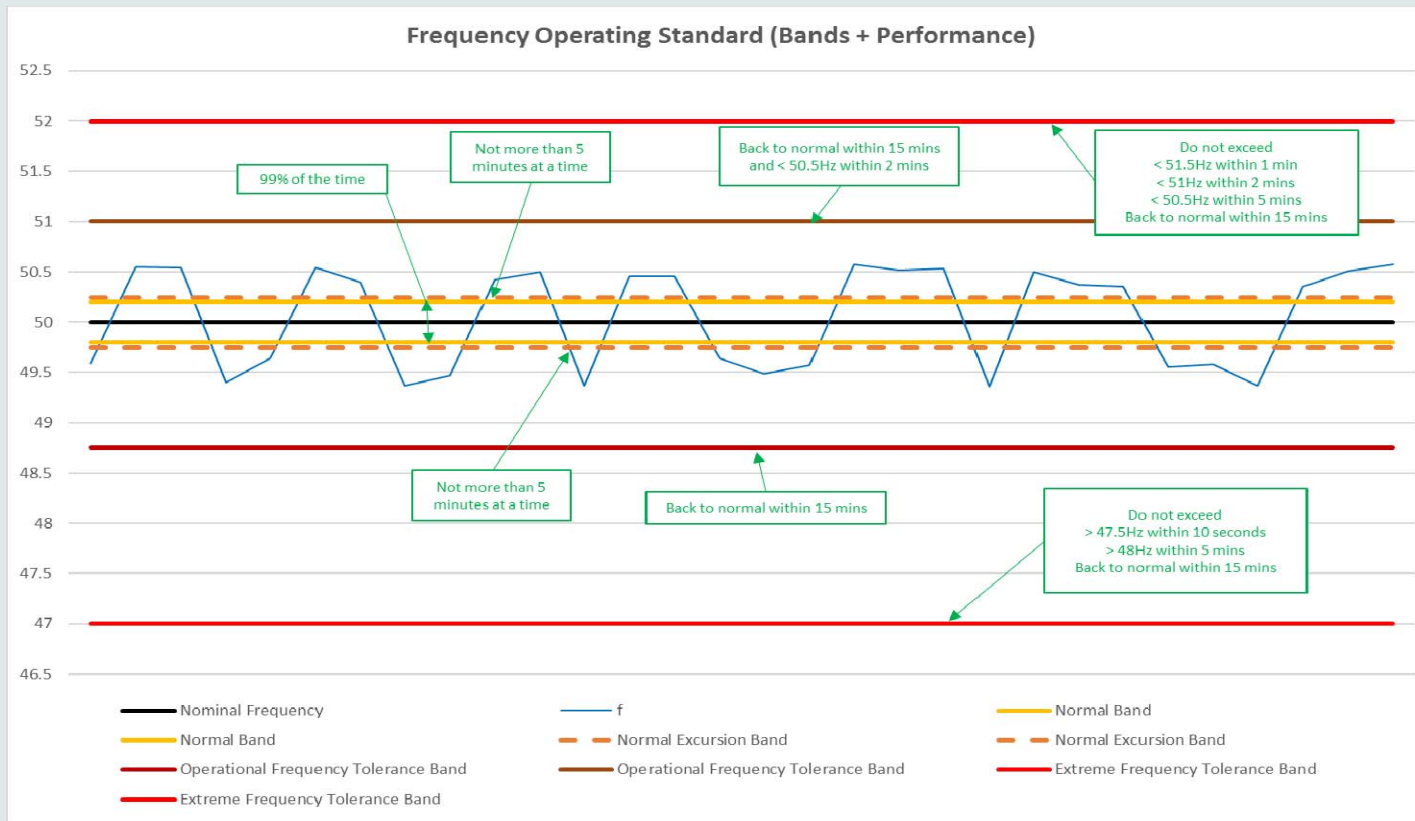
### Wholesale Electricity Market Frequency Operating Standards – island

These *frequency operating standards* for an *island* system are not intended to apply to an *island* containing only distribution networks. The *Electricity Act 1945* specifies the frequency obligations that apply to the *island* formed under these condition

Condition	Containment	Stabilisation	Recovery
No Credible contingency event	49.5 to 50.5 Hz 99% of the time over any 30 day period		
Credible contingency event	48.75 to 51 Hz	Below 50.5 Hz within 5 min	49.5 to 50.5 Hz as soon as practicable
Separation event that formed the island	48.75 to 51 Hz	Below 50.5 Hz within 5 min	49.5 to 50.5 Hz as soon as practicable
Multiple contingency event or separation event	47 to 52 Hz	Above 47.5 Hz within 10 seconds Below 51.5 Hz within 2 min Below 51Hz within 5 min 48.0 Hz to 50.5 Hz within 10 min  Best endeavours	49.5 to 50.5 Hz as soon as practicable

# WEM FOS – SUMMARY

Proposed WEM FOS Performance Standards:



# WEM FOS – Complete

## Part B – The Frequency Operating Standards:

For the purposes of the Wholesale Electricity Market (WEM) Rules, the *frequency operating standards*, for the operation of the SWIS (excluding *autonomous islands*) are:

- a) except in an *island* or during a *system restart*, the *accumulated time error* should not exceed 10 seconds for 99% of the time over any 30-day period;
- b) except as a result of a *credible contingency event*, *separation event*, or *multiple contingency event*, *system frequency* should:
  - a. not exceed the applicable *normal operating frequency excursion band*; and
  - b. not exceed the applicable *normal operating frequency band* for more than five minutes on any occasion; and
  - c. not exceed the applicable *normal operating frequency band* for more than 1% of the time over any 30-day period;
- c) as a result of a *credible contingency event*, *system frequency* should:
  - a. not exceed the *credible contingency event frequency tolerance band*; and
  - b. stabilise lower than 50.5 Hz within 2 minutes, or within 5 minutes in an *island*; and
  - c. recover to within the *normal operating frequency band* within 15 minutes, or as soon as practicable in an *island*;
- d) as a result of any *separation event*, *system frequency* should:
  - a. not exceed the *island separation band*; and
  - b. stabilise lower than 50.5Hz within two minutes, or within 5 minutes in an *island*; and
  - c. recover to within the applicable *normal operating frequency band* within fifteen minutes, or as soon as practicable in an *island*;
- e) as a result of any *multiple contingency event*, *system frequency* should:
  - a. not exceed the *extreme frequency excursion tolerance limits*; and
  - b. stabilise above 47.5 Hz within 10 seconds; and
  - c. stabilise lower than 51.5 Hz within 1 minute, or with *best endeavours* within 2 minutes in an *island*; and
  - d. stabilise lower than 51 Hz within 2 minutes, or with *best endeavours* within 5 minutes in an *island*; and
  - e. stabilise within 48Hz to 50.5 Hz within 5 minutes, or with *best endeavours* within 10 minutes in an *island*; and
  - f. recover to within the *normal operating frequency band* within 15 minutes, or as soon as practicable in an *island*.

# WEM FOS – Complete

## Part B – The Frequency Operating Standards:

For the purposes of the above:

- the timing of a *credible contingency event*, *separation event* or *multiple contingency event* commences at the time AEMO records the *system frequency* in its SCADA system going outside of the *normal operating frequency excursion band* and is completed at time at which the frequency has recovered (see below)
- stabilise means when the *system frequency* has remained above or below the required level for at least 20 seconds
- recover means when the *system frequency* has remained above or below the required level for at least 1 minute

# WEM FOS – Complete

## Part C – Application of Rules Terms:

For the purpose of these *frequency operating standards* the following frequency band settings apply:

Frequency operating band	Interconnected (Hz)	Island (Hz)
normal operating frequency band	49.8 to 50.2	49.5 to 50.5
normal operating frequency excursion band	[49.7 to 50.3]	[49.5 to 50.5]
credible contingency event frequency tolerance band	48.75 to 51	48.75 to 51
extreme frequency excursion tolerance limit	47.0 to 52.0	47.0 to 52.0

# WEM FOS – Complete

## Part D – Definitions:

Words and phrases shown in *italics* in this document have a defined meaning associated with them. The intention is to re-use existing WEM Rule definitions where possible, however some of these terms will need to be added, and some terms are used within the WEM Rules for other similar purposes but are not defined terms within the WEM Rules. The following table lists each of the items that require definition:

Term	Meaning
accumulated time error	means, in respect of a measurement of system frequency that AEMO uses for controlling system frequency, the integral over time of the difference between 20 milliseconds and the inverse of that system frequency as recorded by AEMO via its SCADA system.
AEMO	has the meaning given to it currently in the WEM Rules: AEMO or Australian Energy Market Operator: Means the Australian Energy Market Operator Limited (ACN 072 010 327)
contingency event	has the meaning given to it in the WEM Rules (Note that this is yet to be defined in the WEM Rules but will be as part of future PSSR work)
credible contingency event	has the meaning given to it in the WEM Rules (Note that this is yet to be defined in the WEM Rules but will be as part of future PSSR work)
credible contingency event frequency tolerance band	has the meaning given to it in the WEM Rules (will have the values assigned as per the table in Part C)
distribution system	has the meaning given to it in the WEM Rules (Note that this is currently used in the WEM Rules but is not yet defined)
extreme frequency excursion tolerance limit	has the meaning given to it in the WEM Rules (will have the value assigned as per the table in Part C)
frequency operating standards	are the standards set out in Part B of this document (relocated to a relevant section in the WEM Rules)



# WEM FOS – Complete

## Part D – Definitions:

Term	Meaning
generation system	has the meaning given to it in the WEM Rules  (Note that this is currently used in the WEM Rules but is not yet defined)
Island	means a part of the SWIS that includes generation systems (or other energy sources), networks and load, for which all of its alternating current network connections with other parts of the SWIS have been disconnected, provided that the part: <ul style="list-style-type: none"> <li>a) is smaller than the rest of the SWIS that it has disconnected from, i.e. does not include more generation (or other energy sources) and load (determined by on-line quantities before dis-connection); and</li> <li>b) contains active generation (or other energy sources) capable of supplying the load within the part of the SWIS that has been disconnected.</li> </ul>
island separation band	means in respect of an island, the credible contingency event frequency tolerance band.
Load	has the meaning given to it currently in the WEM Rules:  Load: Has the meaning given in clause 2.29.1(d).
multiple contingency event	means either a contingency event other than a credible contingency event, a sequence of credible contingency events within a period of 5 minutes, or a further separation event in an island.
network	means either a transmission system or distribution system, or a combination of both a transmission system and a distribution system
normal operating frequency band	has the meaning given to it in the WEM Rules  (will have the value assigned as per the table in Part C)

# WEM FOS – Complete

## Part D – Definitions:

Term	Meaning
normal operating frequency excursion band	has the meaning given to it in the WEM Rules (will have the value assigned as per the above table)
autonomous islands	means identified islands that are not covered by the frequency operating standards
power system security	has the meaning given to it in the WEM Rules: Power System Security: The ability of the SWIS to withstand sudden disturbances, including the failure of generation, transmission and distribution equipment and secondary equipment.
reliability standards	has the meaning given to it in the WEM Rules (Note that this is yet to be defined in the WEM Rules but will be as part of future PSSR work)
separation event	means either a contingency event or planned switching that results in the formation of an island
system frequency	means the frequency of a part of the power system, including the frequency of an island as recorded by AEMO via its SCADA system.
system restart	has the meaning given to it in the WEM Rules (Note that this is currently used in the WEM Rules but is not yet defined)
transmission system	has the meaning given to it in the WEM Rules (Note that this is currently used in the WEM Rules but is not yet defined)