

# MARKET ANCILLARY SERVICE SPECIFICATION

PREPARED BY: AEMO Systems Performance ~~and Commercial~~  
DOCUMENT REF: ESOPP\_12  
VERSION: 6.3  
EFFECTIVE DATE: N/A  
STATUS: SECOND DRAFT DETERMINATION VERSION – October 2021

Approved for distribution and use by:

APPROVED BY: TBC

TITLE: TBC

DATE: TBC

## VERSION RELEASE HISTORY

Version	Effective Date	Summary of Changes
1.0	Sep 2001	Initial document issued at the commencement of the market ancillary services
1.5	27 Feb 2004	Revised to include the Tasmania region
2.0	5 May 2009	Revised to align with the revised Tasmania frequency operating standards
3.0	1 Jul 2010	Revised after consultation
4.0	30 Mar 2012	Revised after consultation
5.0	30 Jun 2017	Revised after consultation
6.0	1 Jun 2020	<ul style="list-style-type: none"> <li>Revised following consultation on relationship with the draft Primary Frequency Response rule change (ERC0274).</li> <li>Minor drafting updates, corrections and clarifications.</li> </ul>
6.1	<a href="#">19 Jan 2021</a> <a href="#">[remove on final]</a>	Draft for consultation following a restructure of the document to remove unnecessary duplication and improve readability.
<a href="#">6.2</a>	<a href="#">14 Jun 2021</a> <a href="#">[remove on final]</a>	<a href="#">Updated draft issued with draft determination and report.</a>
<a href="#">6.3</a>	<a href="#">28 Oct 2021</a> <a href="#">[remove on final]</a>	<a href="#">Updated draft issued with second draft determination and report.</a>

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## 1. INTRODUCTION

### 1.1. Purpose and scope

This is the *market ancillary service specification (MASS)* made under clause 3.11.2(b) of the National Electricity Rules (NER). It includes the monitoring and recording standards referred to in clause 3.11.2(g).

The MASS has effect only for the purposes set out in the NER. The NER and the *National Electricity Law* prevail over the MASS to the extent of any inconsistency.

### 1.2. Definitions and interpretation

#### 1.2.1. Glossary

Terms defined in the *National Electricity Law* or the NER have the same meanings in the MASS unless otherwise specified in this section 1.2.1. NER defined terms are intended to be identified in the MASS by italicising them, but failure to italicise a defined term does not affect its meaning.

The words, phrases and abbreviations in Table 1 have the meanings set out opposite them when used in the MASS.

**Table 1 Definitions**

Term	Definition
Aggregated Ancillary Service Facility	The <i>ancillary service generating units</i> or <i>ancillary service loads</i> aggregated by an FCAS Provider under clause 3.8.3 of the NER for the purpose of providing FCAS.
Aggregated Generation Amount	The aggregate <del>Generation a</del> <del>Amounts of active power flow</del> through one or more <i>connection points</i> of an Aggregated Ancillary Service Facility <del>comprised of ancillary service generating units, in MW.</del>
Aggregated Load Amount	The aggregate <del>Load a</del> <del>Amounts of active power flow</del> through one or more <i>connection points</i> of an Aggregated Ancillary Service Facility <del>comprised of ancillary service loads, in MW.</del>
Ancillary Service Facility	An <i>ancillary service generating unit</i> or <i>ancillary service load</i> used to deliver FCAS.
Contingency Event Time	The time at which a <i>contingency event</i> occurred, which is determined as follows: <ul style="list-style-type: none"> <li>(a) Where the initial <i>frequency</i> change that led to a Frequency Disturbance is clear, there was a single rapid and significant change in <i>frequency</i>, the Contingency Event Time is the starting point of that <i>frequency</i> change.</li> <li>(b) If there was a series of step changes in <i>frequency</i> or a slow ramp in <i>frequency</i>, the Contingency Event Time will be at the start of the greatest rate of change of <i>frequency</i>, as measured by AEMO.</li> <li>(c) If neither paragraph (a), nor (b), applies, AEMO will take into account the circumstances of the <i>contingency event</i> and select a time that, in AEMO's opinion, represents the start time of the <i>frequency</i> disturbance, against which the FCAS response to it can reasonably be measured.</li> </ul>
Contingency FCAS	A term used to refer to <i>fast raise service, fast lower service, slow raise service, slow lower service, delayed raise service</i> and <i>delayed lower service</i> collectively.

Term	Definition
<u>Control Response Delay or CRD</u>	<u>Applies to Regulation FCAS Providers; defines the maximum time in seconds an Ancillary Service Facility takes to achieve at least 63.2%<sup>1</sup> of a step change in output following instructions via AGC.</u>
<u>Control Request Feedback</u>	<u>Applies to Regulation FCAS Providers; the latest AGC-issued control signal request (in MW) as known by an Ancillary Service Facility. This value excludes any change in output from frequency controller action including PFR. For setpoint controlled facilities, this is simply an echo back of the control signal request. For raise/lower controlled facilities, this is the MW value of the stream of raise/lower controls as accumulated internal to the plant controller or equivalent.</u>
Controlled Quantity	A quantity of <i>generation</i> or <i>load</i> that is: (a) controlled by Raise Signals and Lower Signals; and (b) measured at the relevant <i>connection point</i> .
Delayed FCAS	<i>delayed raise services</i> and <i>delayed lower services</i> .
Fast FCAS	<i>fast raise services</i> and <i>fast lower services</i> .
FCAS	<i>market ancillary services</i> , commonly referred to as “frequency control ancillary services”.
FCAS Provider	<u>An <del>Market Ancillary Service Provider</del> or Ancillary Service Provider, as applicable. The term can be combined with ‘Regulation’, ‘Delayed’, ‘Slow’ or ‘Contingency’ or a combination of these to indicate an FCAS Provider providing a particular type of FCAS.</u>
FCASVT	Frequency Control Ancillary Service Ancillary Service Verification Tool: An Excel spreadsheet used to verify the delivery of Contingency FCAS.
FOS	<i>frequency operating standard</i> .
Frequency Deadband	The range of Local Frequency through which a Variable Controller will not operate.
Frequency Deviation Setting	The setting allocated to an Ancillary Service Facility by AEMO within the range shown in Table 5 for the Mainland and Table 6 for the Tasmania region.
Frequency Disturbance	An occasion when System Frequency is outside the NOFB.
Frequency Disturbance Time <sup>2</sup>	The time <sup>3</sup> when Local Frequency is outside the NOFB following a Frequency Disturbance, as determined by AEMO.
Frequency Ramp Rate	0.125 Hz/s for the Mainland or 0.4 Hz/s for Tasmania.
Frequency Rate of Change Multiplier	See Table 5 for the Mainland, and Table 6 for Tasmania.
Frequency Recovery	The first change in Local Frequency to occur after a Frequency Disturbance from above 50.15 Hz to below 50.1 Hz, or below 49.85 Hz to above 49.9 Hz.
Frequency Setting	The level of <i>frequency</i> or a combined level of <i>frequency</i> and <i>frequency</i> rate of change determined by AEMO in accordance with section 6 for use by an Ancillary Service Facility’s Switching Controller.
Generation Amount	The amount of <i>active power</i> flow through the <i>connection point</i> of an <u>Ancillary Service Facility into the transmission network or distribution network to which it is connected, expressed as a positive value <del>ancillary service generating unit</del>, in MW, with flow from the ancillary service generating unit being positive.</u>

<sup>1</sup> This value is specific to AEMO’s AGC.

<sup>2</sup> Referred to as occurring at t=0 in the equations used in the MASS.

<sup>3</sup> Australian Eastern Standard Time.

Term	Definition
Generation Event	As defined in the FOS.
Inertial Response	The change in Generation Amount or Load Amount due to the impact of an Ancillary Service Facility's <i>inertia</i> .
Initial Value	The Generation Amount or Load Amount immediately prior to a Contingency Event Time.
Load Amount	The amount of <i>active power</i> flow through the <i>connection point</i> of an <u>Ancillary Service Facility from the transmission network or distribution network to which it is connected, expressed as a negative value in MW, ancillary service load, in MW, with flow towards the ancillary service load being negative.</u>
Load Event	As defined in the FOS.
Local Frequency	The <i>frequency</i> measured by an FCAS Provider at the <i>connection point</i> of the FCAS Provider's Ancillary Service Facility or Aggregated Ancillary Service Facility, in Hz.
Lower Control Limit	The lowest level to which a Controlled Quantity can be controlled in response to Lower Signals, <u>subject to the enablement amount.</u>
Lower Rate Limit	The highest rate at which a Controlled Quantity can be controlled in response to Lower Signals, <u>subject to the enablement amount.</u>
Lower Reference Frequency	The upper value in the 'containment band' for Load Events, as specified in Section A.1 of the FOS (A.2.1 for Tasmania).
Lower Response	The decrease in Generation Amount or increase in Load Amount as compared with its Initial Value.
Lower Signal	An AGC control signal sent by or on behalf of AEMO to request delivery of a Regulating Lower Response.
Mainland	All <i>regions</i> other than Tasmania.
MASS	This document, namely, the <i>market ancillary service specification</i> .
NER	National Electricity Rules.
NOFB	<u>The normal operating frequency band that applies under normal operating conditions, namely the values in Column 2 of Table A.1 in the FOS.</u>
OFTB	<i>operational frequency tolerance band.</i>
<u>Online/Offline Status</u>	<u>Applies to Regulation FCAS Providers; a binary status flag indicating whether their Ancillary Service Facility is connected and ready to produce power.</u>
<u>PFR</u>	<u>primary frequency response.</u>
Raise Control Limit	The highest level to which a Controlled Quantity can be controlled in response to Raise Signals, <u>subject to the enablement amount.</u>
Raise Rate Limit	The highest rate at which a Controlled Quantity can be controlled in response to Raise Signals, <u>subject to the enablement amount.</u>
Raise Reference Frequency	The lower value in the 'containment band' for Generation and Load Events, as specified in Section A.1 of the FOS (A.2.1 for Tasmania).
Raise Response	The increase in Generation Amount or decrease in Load Amount as compared with its Initial Value.
Raise Signal	An AGC control signal sent by or on behalf of AEMO to request the delivery of a Regulating Raise Response.
<u>Reference Trajectory</u>	<u>A linear trajectory between two consecutive energy market dispatch values.</u>

Term	Definition
Regulating Lower Response	The decrease in Generation Amount or increase in Load Amount delivered in response to one or more Lower Signals.
Regulating Raise Response	The increase in Generation Amount or decrease in Load Amount delivered in response to one or more Raise Signals.
<u>Remote/Local Status</u>	<u>Applies to Regulation FCAS Providers; a binary status flag. Remote indicates the local plant controller or equivalent for aggregated is ready to receive AGC-issued control signal requests.</u>
SCADA	Supervisory control and data acquisition system.
<u>Setpoint Change Deadband</u>	<u>A value set for an Ancillary Service Facility in AEMO's AGC that indicates the minimum change in MW output AGC may request from that Ancillary Service Facility.</u>
Slow FCAS	<i>Slow raise services and slow lower services.</i>
Standard Frequency Ramp	A linear change in Local Frequency from one level to another at the applicable Frequency Ramp Rate and then sustained, as <u>shown in per</u> Appendix A.
Switching Controller	A control system that delivers a specific amount of FCAS by either switching generation or load on or off (as applicable) <u>or rapidly and automatically altering an Ancillary Service Facility's output in response to parameters specified by AEMO when its Frequency Settings are detected.</u>
System Frequency	The <i>frequency</i> of the power system, as measured by AEMO.
Time Average	For a Raise Response or Lower Response and a time interval, the average value of that Raise Response or Lower Response over that time interval, determined as the integral of the Raise Response or Lower Response over the time interval divided by the duration of the time interval.
Trigger Range	The <i>frequency</i> range for which an Ancillary Services Facility with one or more switching controllers must record and store data regarding its performance, commencing 0.2 Hz either side of 50 Hz for the Mainland, and 0.8 Hz for Tasmania.
Trigger Rate	0.05 Hz/s for the Mainland and 0.15 Hz/s for Tasmania.
Variable Controller	A control system that <u>is used by an Ancillary Service Facility to</u> delivers FCAS upon the commencement of a Frequency Disturbance <u>corresponding in proportion</u> to the size of the <i>frequency</i> excursion <u>outside the NOFB.</u>

### 1.2.2. Interpretation

The following principles of interpretation apply to the MASS unless otherwise expressly indicated:

- (a) The MASS is subject to the principles of interpretation set out in Schedule 2 of the *National Electricity Law*.
- (b) Units of measurement are in accordance with the International System of Units.

### 1.3. Related documents

**Table 2 Title and Location of Related Documents**

Title	Location
Application for Registration as a Customer in the NEM	<a href="http://aemo.com.au/Electricity/National-Electricity-Market-NEM/Participant-information/New-participants/Application-forms-and-supporting-documentation">http://aemo.com.au/Electricity/National-Electricity-Market-NEM/Participant-information/New-participants/Application-forms-and-supporting-documentation</a>



Title	Location
Application for Registration as a Generator in the NEM	<a href="http://aemo.com.au/Electricity/National-Electricity-Market-NEM/Participant-information/New-participants/Application-forms-and-supporting-documentation">http://aemo.com.au/Electricity/National-Electricity-Market-NEM/Participant-information/New-participants/Application-forms-and-supporting-documentation</a>
Application for Registration as a Market Ancillary Service Provider and Classification of Load	<a href="http://aemo.com.au/Electricity/National-Electricity-Market-NEM/Participant-information/New-participants/Application-forms-and-supporting-documentation">http://aemo.com.au/Electricity/National-Electricity-Market-NEM/Participant-information/New-participants/Application-forms-and-supporting-documentation</a>
Dispatch Procedure SO_OP_3705	<a href="http://aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Power_System_Ops/Procedures/SO_OP_3705---Dispatch.pdf">http://aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Power_System_Ops/Procedures/SO_OP_3705---Dispatch.pdf</a>
FCAS Verification Tool User Guide	<a href="http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Ancillary-services/Market-ancillary-services-specifications-and-FCAS-verification">http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Ancillary-services/Market-ancillary-services-specifications-and-FCAS-verification</a>
Generator Exemption and Classification Guide	<a href="http://aemo.com.au/-/media/Files/Electricity/NEM/Participant_Information/New-Participants/Generator-Exemption-and-Classification-Guide.pdf">http://aemo.com.au/-/media/Files/Electricity/NEM/Participant_Information/New-Participants/Generator-Exemption-and-Classification-Guide.pdf</a>
Generator Registration Guide	<a href="http://aemo.com.au/-/media/Files/Electricity/NEM/Participant_Information/Application-forms-and-supporting-documentation/NEM_GENERATOR_REGISTRATION_GUIDE.pdf">http://aemo.com.au/-/media/Files/Electricity/NEM/Participant_Information/Application-forms-and-supporting-documentation/NEM_GENERATOR_REGISTRATION_GUIDE.pdf</a>
Guide to Ancillary Services in the National Electricity Market	<a href="http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Ancillary-services">http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Ancillary-services</a>
MASS 4.0 FCAS Verification Tool_v2.08	<a href="http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Ancillary-services/Market-ancillary-services-specifications-and-FCAS-verification">http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Ancillary-services/Market-ancillary-services-specifications-and-FCAS-verification</a>
NEM Market Ancillary Service Provider and Classification of Load Registration Guide	<a href="http://aemo.com.au/Electricity/National-Electricity-Market-NEM/Participant-information/New-participants/Application-forms-and-supporting-documentation">http://aemo.com.au/Electricity/National-Electricity-Market-NEM/Participant-information/New-participants/Application-forms-and-supporting-documentation</a>
Pre-Dispatch Procedure SO_OP_3704	<a href="http://aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Power_System_Ops/Procedures/SO_OP_3704---Predispatch.pdf">http://aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Power_System_Ops/Procedures/SO_OP_3704---Predispatch.pdf</a>
Interim Primary Frequency Response Requirements	<a href="https://aemo.com.au/-/media/files/initiatives/primary-frequency-response/2020/interim-pfrr.pdf">https://aemo.com.au/-/media/files/initiatives/primary-frequency-response/2020/interim-pfrr.pdf</a>

## 2. MASS PRINCIPLES

### 2.1. Open access

When specifying the requirements for participation, the MASS is designed to permit open access to the FCAS *spot markets*.

### 2.2. No priority in delivery of different FCAS types~~Priority of Contingency FCAS over Regulation FCAS~~

If an Ancillary Service Facility is enabled for Regulation FCAS and Contingency FCAS, it should be able to deliver both types of FCAS together in a co-ordinated manner. Section 10.3 10.4 provides guidance on how controls may be co-ordinated, including examples. If a contingency event

~~occurs while an Ancillary Service Facility is enabled to deliver both Regulation FCAS and Contingency FCAS, until Local Frequency has returned to be within the NOFB, the Ancillary Service Facility must deliver Contingency FCAS only.~~

~~If a contingency event occurs while an Ancillary Service Facility is enabled to deliver both Regulation FCAS and Contingency FCAS, the Ancillary Service Facility should give priority to providing the Contingency Services Unless directed by AEMO to do otherwise<sup>4</sup>, subject to clause 4.9.4 of the NER, an Ancillary Service Facility providing Regulation FCAS should follow and not respond to AGC instructions while responding to Contingency Service actions until such time as the Local Frequency has returned to the NOFBAGC instructions at all times, noting that AGC instructions are subject to local frequency as outlined in 10.3.~~

### 2.3. Contracting

Nothing prevents an FCAS Provider from procuring a third party to provide equipment or a monitoring or recording service to the FCAS Provider under contract, or perform any other action required or contemplated by the MASS on behalf of that FCAS Provider.

The FCAS Provider remains responsible for compliance with its NER obligations regardless of whether it provides *market ancillary services* itself or outsources part or all of their delivery.

### 2.4. Inertia

FCAS does not include the impact of *inertia*.<sup>5</sup>

### 2.5. Delivery of FCAS by Ancillary Service Facilities

An Ancillary Service Facility can be *enabled* to deliver any combination of FCAS it is capable of delivering and must deliver all types of FCAS for which it is enabled.

## 3. DESCRIPTION OF EACH TYPE OF FCAS

FCAS are essential to the management of *power system security*, facilitation of orderly trading in electricity, and ensuring that electricity supplies are of acceptable quality. -They are effectively reserves procured through the FCAS *spot markets* operated by AEMO and the *central dispatch* process in accordance with clause 3.8.1 of the NER.

AEMO procures FCAS to manage System Frequency during normal operating conditions and following *contingency events*. FCAS usually takes the form of an increase or decrease in *active power* output or consumption by an Ancillary Service Facility to address the impact of supply/demand imbalances on System Frequency at any given point within a dispatch interval. Each type of FCAS is delivered to different specifications to address different needs.

Clause 3.11.2(a) of the NER specifies that there are eight different types of FCAS. -Table 3 details these, provides their common names, differentiates between Contingency FCAS and Regulation FCAS, and provides a brief description of how they are usually provided.

<sup>4</sup> Aside from reasons of safety or in a situation where a risk to unit stability exists.

<sup>5</sup> See also the definition of Frequency Disturbance Time.

**Table 3 Description of each FCAS**

Type	NER Term	Commonly Referred to as...	Group	Description	Key Purpose	Usually Facilitated by...	
Contingency FCAS	Fast raise service	6-Second Raise FCAS	Fast FCAS	A rapid increase in <i>generation</i> or a decrease in <i>load</i> in response to decreases in Local Frequency.	To arrest a change in System Frequency following a <i>contingency event</i> that takes it outside the NOFB within the first 6 s of a Frequency Disturbance and then provide an orderly transition to a Slow FCAS.	<ul style="list-style-type: none"> <li>Governor or governor-like <i>control systems</i></li> <li>Frequency relay detecting <i>System Frequency below NOFB</i> and a <i>frequency deviation</i> and starting a fast <i>generating unit</i> or <i>disconnecting load</i>.</li> <li>Rapid change in charging or discharging from batteries.</li> </ul>	
	Fast lower service	6-Second Lower FCAS		A rapid decrease in <i>generation</i> or an increase in <i>load</i> in response to increases in Local Frequency.			<ul style="list-style-type: none"> <li>Governor or governor-like <i>control systems</i>.</li> <li>Frequency relay detecting <i>System Frequency above NOFB</i> and a <i>frequency deviation</i> and reducing a <i>generating unit's</i> output or <i>reducing-increasing load</i>.</li> </ul>
	Slow raise service	60-Second Raise FCAS	Slow FCAS	An increase in <i>generation</i> or a decrease in <i>load</i> in response to decreases in Local Frequency.		To stabilise System Frequency following a <i>contingency event</i> within the first 60 s of a Frequency Disturbance, and then provide an orderly transition to a Delayed FCAS.	<ul style="list-style-type: none"> <li>Governor or governor-like <i>control systems</i></li> <li>Frequency relay detecting a <i>frequency deviation</i> and reducing <i>load</i>.</li> </ul>
	Slow lower service	60-Second Lower FCAS		A decrease in <i>generation</i> or an increase <i>load</i> in response to increases in Local Frequency.			
	Delayed raise service	5-Minute Raise FCAS	Delayed FCAS	An increase in <i>generation</i> or a decrease in <i>load</i> in response to decreases in Local Frequency.		To return System Frequency to 50 Hz within the first 5 min of a Frequency Disturbance, and to sustain that response until <i>central dispatch</i> can re-schedule <i>generation</i> and <i>load</i> to balance the <i>power system</i> .	Frequency relay detecting a <i>frequency deviation</i> starting up <i>generating units</i> or reducing <i>load</i> .
	Delayed lower service	5-Minute Lower FCAS		A decrease in <i>generation</i> or an increase in <i>load</i> in response to increases in Local Frequency.			Frequency relay detecting a <i>frequency deviation</i> and reducing <i>generating unit</i> output or increasing <i>loads</i> .
Regulation FCAS	Regulating raise service	Raise Regulation FCAS	Regulation FCAS	Increasing <i>generation</i> or decreasing <i>load</i> <u>relative to the facility's reference trajectory</u> in response to Raise Signals to increase System Frequency.	To support the control of System Frequency <u>within the NOFB</u> and time error <u>in tandem with PFR</u> in response to variations of demand and <i>generation</i> within a <i>dispatch interval</i> .	Setpoint controllers on <i>generating units</i> .	
	Regulating lower service	Lower Regulation FCAS		Decreasing <i>generation</i> or increasing <i>load</i> <u>relative to the facility's reference trajectory</u> in response to Lower Signals to reduce System Frequency.			

### 3.1. Contingency FCAS

Contingency FCAS manages Frequency Recovery after an under-frequency or over-frequency event to arrest a fall or rise in System Frequency (as applicable), ~~then stabilise and assist to restore so that~~ System Frequency ~~can recover so that AEMO can meet the conditions specified in as required by~~ the FOS. This means that, while always *enabled* for delivery following a *contingency event*, Contingency FCAS ~~are only delivered~~ ~~are only required to be delivered~~ if a *contingency event* occurs.

Contingency FCAS are provided by technologies that can detect a System Frequency deviation and respond in a manner that corrects System Frequency following a *contingency event*.

Ancillary Service Facilities ~~need not provide~~ ~~may cease to provide~~ Contingency FCAS once Local Frequency ~~has recovered~~ ~~once Frequency Recovery has occurred~~. For example:

- If Local Frequency recovers above 49.9 Hz within 6 s from the Frequency Disturbance Time, the Ancillary Service Facility is not required to deliver any ~~60-Second-Slow~~ Raise FCAS or ~~5-minute-Delayed~~ Raise FCAS.
- If Local Frequency recovers below 50.1 Hz within 6 s from the Frequency Disturbance Time, the Ancillary Service Facility is not required to deliver any ~~60-Second-Slow~~ Lower FCAS or ~~5-minute-Delayed~~ Lower FCAS.
- If Local Frequency recovers above 49.9 Hz between 6 s and 60 s from the Frequency Disturbance time, the Ancillary Service Facility is not required to deliver any ~~5-minute-Delayed~~ Raise FCAS.
- If Local Frequency recovers below 50.1 Hz between 6 s and 60 s from the Frequency Disturbance Time, the Ancillary Service Facility is not required to deliver any ~~5-minute~~ ~~Delayed~~ Lower FCAS.

### 3.2. Regulation FCAS

Regulation FCAS are centrally controlled by AGC, which allows AEMO to monitor System Frequency, ~~and~~ time error ~~and facility output~~ at all times. AGC ~~also~~ sends control signals through SCADA (~~on a regular cycle such as every four seconds~~) to Ancillary Service Facilities *enabled* to deliver Regulation FCAS to alter the controlled MW output of *generating units* or electricity consumption of *loads* to assist with correcting the demand/supply imbalance ~~and return System Frequency within the NOFB~~. ~~Adjustments to MW output are from an Ancillary Service Facility's basepoint<sup>6</sup>; the enabled Regulation Raise and Regulation Lower quantities form a band around the Ancillary Service Facility's basepoint within which AGC may control it. An Ancillary Service Facility must be scheduled or semi-scheduled to provide Regulation FCAS as it is required to have a centrally controlled MW output or consumption level visible to AGC.~~

Regulation FCAS are normally delivered during each *dispatch interval*.

#### 3.2.1. Relationship with PFR

Regulation FCAS works in tandem with primary frequency response (PFR) to help control frequency and power system imbalance within and outside the NOFB<sup>7</sup>, however, it is distinguished from PFR in two key ways:

1. Headroom, footroom and stored energy – Regulation FCAS is provided by the reserved headroom, footroom and stored energy, as specified in a market ancillary service offer. -PFR is

<sup>6</sup> Basepoint refers to the *current dispatch process*.

<sup>7</sup> Refer to guidance on co-ordination of PFR and Contingency FCAS controls with AGC controls in Section 10.3.

- a response based on a *scheduled generating unit* or *semi-scheduled generating unit's* available capacity and energy at the time; there is no requirement to reserve capacity or energy.
2. AGC – Regulation FCAS need only be provided in response to an AGC control signal request from AEMO to do so, whereas PFR is an ongoing *power system security* requirement every time a *Scheduled Generator* or *Semi-Scheduled Generator* receives a *dispatch instruction* to generate a volume greater than zero MW, as required by clause 4.4.2(c1) of the NER.

## 4. AGGREGATION OF ANCILLARY SERVICE FACILITIES

### 4.1. Requests for aggregation

#### 4.1.1. Generally

FCAS Providers may apply to AEMO under clause 3.8.3 of the NER to aggregate their *ancillary service generating units* or *ancillary service loads* for the purposes of *central dispatch*. Where aggregation has been approved, *market ancillary service offers* must only be made in respect of the Aggregated Ancillary Service Facility.

#### 4.1.2. Regulation FCAS

With Regulation FCAS, AEMO will approve aggregation if an FCAS Provider's AGC can support the aggregated *dispatch* of Regulation FCAS, namely it will respond to a single AGC signal from AEMO to deliver the requested Regulation FCAS.

The FCAS Provider must ensure that its Aggregated Ancillary Service Facility provides the requested Regulation FCAS in an accurate and timely manner.

### 4.2. Requests for reports on Aggregate Ancillary Service Facilities

#### 4.2.1. Generally

A request from AEMO to an FCAS Provider for a report ~~dealing~~ detailing how an Ancillary Service Facility responded to changes in System Frequency under clause 3.11.2(h) of the NER may also be made in respect of an Aggregated Ancillary Service Facility, in which case the FCAS Provider must detail in its report the response of each *plant* within the Aggregated Ancillary Service Facility.

An FCAS Provider must provide a report promptly but, in any event, no more than 20 *business days* after AEMO's request.

#### 4.2.2. Contingency FCAS

Where the report requested concerns the delivery of Contingency FCAS, this may include the response as determined by the FCASVT, or the FCAS Provider may propose an alternative method of demonstrating the response of the relevant *plant*. AEMO, in its absolute discretion, may accept an FCAS Provider's alternative method.

## 5. COMMON REQUIREMENTS

### 5.1. Market ancillary service offers

FCAS Providers must ensure their *market ancillary service offers* reflect the physical availability and capability of their Ancillary Service Facility or Aggregated Ancillary Service Facility (as applicable) to deliver the relevant FCAS, as required by clause 3.8.7A of the NER.

FCAS Providers must rebid in accordance with clause 3.8.22 to reflect changes to FCAS availability and capability.

## 5.2. Enablement

FCAS Providers must operate their equipment in accordance with clause 4.9.3A(c) of the NER to deliver FCAS in response to a *dispatch instruction* immediately following *enablement* by AEMO.

## 5.3. Measurement

### 5.3.1. Connection point

All measurements of Local Frequency, Generation Amount and Load Amount must be taken at or close to a relevant *connection point*.

If an FCAS Provider considers that an alternative measurement methodology can provide AEMO the required data more simply and accurately, the FCAS Provider must request AEMO’s approval prior to using it. AEMO may approve any alternative measurement methodology on such conditions as AEMO considers appropriate.

### 5.3.2. Measurement requirements

#### Ancillary Service Facilities

The equipment required to measure and record the delivery of FCAS, including both the source transducer and data recorder, must have the characteristics detailed in Table 4:

**Table 4 Measurement requirements for FCAS**

Requirement	Fast FCAS	Slow FCAS	Delayed FCAS	Regulation FCAS
Frequency of Local Frequency measurements	<del>≤50 ms</del> ≤200 ms for aggregated ancillary facilities with no inertial response and ≤ 50ms <sup>8</sup> otherwise	≤4 s	≤4 s	NR
Frequency of Generation Amount and Load Amount measurements	<del>≤50 ms</del> ≤200 ms for aggregated ancillary facilities with no inertial response and ≤ 50ms otherwise	≤4 s	≤4 s	≤4 s
Measurement Range of Power Flow Measurements	As appropriate to the Ancillary Service Facility, with a margin of error of ≤2%, and resolution of ≤0.2%			
Settling Time	<del>≤50 ms</del> The time required for the measurement to remain within (to 99% of final value after a step change from zero)			
	≤200 ms for aggregated ancillary facilities with no inertial response and ≤ 50ms otherwise	≤4 s	≤4 s	NR

<sup>8</sup> If another measurement at ≤50 ms is sufficient to determine the timing of the delivery of the Fast FCAS where a Switching Controller is used, the measurement may be at 4-s intervals. Sufficient information should be provided to AEMO to compare the Local Frequency and power flow data in a common time scale.

Requirement	Fast FCAS	Slow FCAS	Delayed FCAS	Regulation FCAS
<b>Local Frequency Measurement Range</b>	At least the range specified in the OFTB, with:			NR
	Margin of error:			
	≤0.01 Hz	≤to 0.02 Hz		
	Resolution:			
	≤0.0025 Hz	≤0.01 Hz		
<b>Frequency Disturbance Time</b>	< 10 s			NR
<b>Recording Period for Power &amp; <u>System</u> Frequency Measurements</b>	≥5 s before the Frequency Disturbance Time and ≥60 s after it	≥20 s before the Frequency Disturbance Time and 5 min after it	≥20 s before the Frequency Disturbance Time and 10 min after it	NR
<b>Trigger for Recording Measurements</b>	At least whenever Local Frequency changes ≥ Trigger Range.			NR

### Aggregate Ancillary Service Facilities

If an Aggregate Ancillary Service Facility is used for the delivery of FCAS, measurements must meet these **additional** requirements:

- (a) The Generation Amount or Load Amount must be measured at, or close to, each relevant *connection point* and summed to calculate the Aggregated Generation Amount or Aggregated Load Amount. Where any part of an Aggregated Ancillary Service Facility shares a *connection point* with a variable *load* or *generating unit*, it is the gross *active power* flow to or from the relevant *plant* that forms the aggregated response and must be measured directly.
- (b) To correct for any discrepancy in the time measurement by Aggregated Ancillary Service Facility *meter* clocks, FCAS Providers must time-align the data logged by each *meter* to the actual time a Frequency Disturbance was detected.
- (c) If the number of ancillary service generating units or ancillary service loads aggregated by an FCAS Provider is below 200 and the measurements of power flow and local frequency are captured with a sampling rate of more than 50 ms, AEMO will apply a discount of 5% to the quantity of Fast FCAS measured at all connection points.

### 5.4. Data retention

Measurement and other data recordings must be digital and stored in a format that is reasonably acceptable to AEMO for analysis using commercial spreadsheet software.

Each FCAS Provider must retain recordings of data measurements for at least 12 months from the Frequency Disturbance Time and provide them to AEMO on request.

## 6. CONTINGENCY FCAS REQUIREMENTS

### 6.1. Frequency Deviation Settings provided by Switching Controllers

#### 6.1.1. Default Frequency Deviation Setting

Until an Ancillary Service Facility that uses a Switching Controller to deliver Contingency FCAS is allocated one or more Frequency Deviation Settings under section 6.1.2, the FCAS Provider must apply the default Frequency Deviation Setting shown in Table 5 if the Ancillary Service Facility is on the Mainland or Table 6 if the Ancillary Service Facility is in Tasmania.

**Table 5 Frequency Settings for the Mainland**

Level	Raise FCAS Frequency Deviation Setting (Hz)	Lower FCAS Frequency Deviation Setting (Hz)	Frequency Rate of Change Multiplier
Frequency Deviation Setting range	49.80 Hz to 49.60 Hz	50.20 Hz to 50.4 Hz	0.4
Default Frequency Deviation Setting	49. <del>65</del> <u>8</u> Hz	50. <del>25</del> Hz	0.4

**Table 6 Frequency Settings for Tasmania**

Level	Raise FCAS Frequency Deviation Setting (Hz)	Lower FCAS Frequency Deviation Setting (Hz)	Frequency Rate of Change Multiplier
Frequency Deviation Setting range	49.50 Hz to 48.75 Hz	50.50 Hz to 51.25 Hz	0.875
Default Frequency Deviation Setting	49. <del>5</del> <u>125</u> Hz	50. <del>5</del> <u>825</u> Hz	0.875

#### 6.1.2. Allocation of Frequency Settings

When allocating Frequency Settings to Ancillary Service Facilities for each Contingency FCAS, AEMO will take into account the following principles, as appropriate:

- (a) Where an Ancillary Service Facility is used to deliver more than one type of Contingency FCAS, it will be allocated the same Frequency Settings for each.
- (b) Ancillary Service Facilities with larger switched blocks of *generation* or *load* will be allocated Frequency Settings closer to the NOFB.
- (c) Ancillary Service Facilities with higher availability will be allocated Frequency Settings closer to the NOFB.
- (d) For Aggregate Ancillary Service Facilities, where possible, AEMO will negotiate with the FCAS Provider to allocate multiple Frequency Settings to simulate the behaviour of Variable Controllers to minimise the potential for over-delivery of Contingency FCAS.
- (e) AEMO will consider the physical characteristics of the Ancillary Service Facilities.
- (f) A Frequency Setting:
  - (i) for Fast FCAS may be a Frequency Deviation Setting or a combination of both the Frequency Deviation Setting and Frequency Rate of Change Multiplier shown in Table 5 for the Mainland and Table 6 for Tasmania; and
  - (ii) for Slow FCAS or Delayed FCAS will be based on the allocated Frequency Deviation Setting alone.



- (g) The criteria for a combined Switching Controller to initiate delivery of a *fast raise service* based on a combination of both Frequency Deviation Setting and Frequency Rate of Change Multiplier is to occur if both of the following conditions are satisfied:

- (i) Local Frequency < 49.85; and
- (ii) Local Frequency < FDS + (FRCM \* LFRC).

Where:

**FDS** is the allocated Frequency Deviation Setting

**FRCM** is taken from Table 5 for the Mainland and Table 6 for Tasmania

**LFRC** is the measured rate of change of Local Frequency.

- (h) The criteria for a combined Switching Controller to initiate delivery of a *fast lower service* based on a combination of both Frequency Deviation Setting and Frequency Rate of Change Multiplier is to occur if both of the following conditions are satisfied:

- (i) if Local Frequency > 50.15; and
- (ii) Local Frequency > FDS – (FRCM \* LFRC)

Where acronyms in the formula bear the same meanings as in paragraph (g).

- (i) At AEMO's absolute discretion, a Frequency Deviation Setting outside the range specified in Table 5 for the Mainland and Table 6 for Tasmania may be allocated.

AEMO encourages FCAS Providers with Ancillary Service Facilities using Switched Controllers to configure them so that different Frequency Settings can be assigned to different parts of their Ancillary Service Facilities.

### **6.1.3. FCAS Provider request to change allocation**

An FCAS Provider may request AEMO to change a Frequency Deviation Setting if there is a technical reason preventing an Ancillary Service Facility from delivering Contingency FCAS due to its Frequency Deviation Setting. -AEMO may change the Frequency Deviation Setting in its absolute discretion subject to the principles in section 6.1.2.

### **6.1.4. AEMO request to change allocation**

The only circumstances in which AEMO may request a change to a Frequency Deviation Setting are the following:

- (a) the principles in section 6.1.2 have been amended;
- (b) the classification of an Ancillary Service Facility that uses a Switching Controller to deliver a Contingency FCAS has changed;
- (c) at least ~~six~~6 months have elapsed since the last change of Frequency Deviation Settings and one or more Ancillary Service Facility has changed its maximum *response capability*; or
- (d) a Frequency Disturbance that involved loss of *load* or *generation* has occurred and AEMO has determined that the relevant Frequency Deviation Setting was inadequate under those circumstances.

## 6.2. Control of Contingency FCAS

### ~~6.2.1. No Operation within the Normal Operating Frequency Band~~

~~A Switching Controller must not operate if Local Frequency is within the NOFB.~~

### ~~6.2.4.6.2.1. Notification of Control System Settings~~

Each FCAS Provider must inform AEMO of the details of each relevant *control system* as reasonably required by AEMO for the purposes of *central dispatch* or allocating the Frequency Settings.

### ~~6.2.5.6.2.2. Control System Requirements~~

- (a) Whenever Contingency FCAS is *enabled*, the Ancillary Service Facility used to deliver the requested Contingency FCAS must have a *control system* to automatically initiate:
- (i) a Raise Response when Local Frequency ~~changes are below the lower limit of the NOFB exceeds the Ancillary Service Facility's response Frequency Deadband, which for a Variable Controller must be no wider than the lower limit of the NOFB and for a Switched Controller, must be equal to the Frequency Deviation Setting;~~ and
  - (ii) a Lower Response when Local Frequency ~~changes are above the upper limit of the NOFB exceeds the Ancillary Service Facility's response Frequency Deadband, which for a Variable Controller must be no wider than the upper limit of the NOFB and for a Switched Controller, must be equal to the Frequency Deviation Setting.~~
- (b) The *control system* may be either a Variable Controller or a Switching Controller, or a discrete combination of both, and must operate so that the Raise Response or Lower Response is:
- ~~(i)~~ for a Variable Controller, ~~an variable~~ amount commensurate with the difference between Local Frequency and Frequency Deadband where the Local Frequency is between the ~~Frequency Deadband NOFB~~ and the lower limit of the OFTB (for a Raise Response) or upper limit of the OFTB (for a Lower Response) ~~in accordance with the Ancillary Service Facility's proportional response function<sup>9</sup>;~~
- ~~**Example:** If the frequency deviation reaches the OFTB (usually 0.5 Hz), the facility should deliver at least the amount of FCAS enabled by central dispatch, but if the frequency deviation only reaches half-way between the Frequency Deadband and the OFTB, the FCAS response should deliver at least half of the enabled amount;~~
- ~~(ii)~~ for a Switching Controller, one or more step changes if Local Frequency falls below its Frequency Deviation Setting (for a Raise Response) or exceeds its Frequency Deviation Setting (for a Lower Response); or
  - ~~(iii)~~ for a discrete combination of both, responses in accordance with subparagraphs (a) and (b).
- (c) Where a Switching Controller is used, it must be capable of adjusting its Frequency Deviation Setting to the Frequency Setting provided by AEMO with an error margin of <0.05 Hz for absolute Frequency Deviation Settings and <0.05 s for Frequency Rate of Change Multiplier.

<sup>9</sup> Commonly known as a 'droop function' or 'droop curve'.

### 6.3. Measurement when using a combination of Variable Controller and Switching Controller

In addition to the requirements specified in section 5.3, when proposing to use a combination of a Variable Controller and a Switching Controller, FCAS Providers must agree with AEMO on the process used to determine separate amounts of each Contingency FCAS that will be delivered through each type of controller.

### 6.4. Verification

The verification requirements that must be followed by FCAS Providers are provided in Table 7:

**Table 7 Verification Requirements of Contingency FCAS**

	Fast FCAS	Slow FCAS	Delayed FCAS
<b>Assessment Period - From the Contingency Event Time to Frequency Recovery up to a maximum of:</b>	60 s	300 s	600 s
<b>Calculation Method</b>	<p>The amount of Contingency FCAS delivered must be compared with the amount of <i>enabled</i> Contingency FCAS as follows:</p> <ul style="list-style-type: none"> <li>(a) If the Ancillary Service Facility is a <i>scheduled generating unit, scheduled load or semi-scheduled generating unit</i>, determine the <i>generation</i> or electricity consumption <i>reference trajectory</i> it would be expected to have followed if the Frequency Disturbance had not occurred<sup>10</sup>.</li> <li>(b) Use this <i>reference trajectory</i> to adjust the measured Generation Amount and Load Amount to <i>reverse any response in a direction that would hinder Frequency Recovery obtain the response relative to this reference trajectory</i>.</li> <li>(c) Remove the impact of any Inertial Response.</li> <li>(d) The difference between the value calculated following paragraph (c) and a measure of the output of the Ancillary Service Facility just prior to the Frequency Disturbance constitutes the Ancillary Service Facility's 'basic response'. <i>Note that the 'basic response' includes all frequency response, regardless of whether it is inside or outside of the NOFB.</i></li> <li>(e) Where a Variable Controller was used, the 'basic response' is compensated to take into account the difference between Local Frequency and the Standard Frequency Ramp.</li> <li>(f) Where a Switching Controller<sub>r</sub> was used the 'basic response' is compensated to take into account the timing difference for Local Frequency to reach the Frequency Setting, compared to the Standard Frequency Ramp.</li> <li>(g) Where a discrete combination of Switching Controller and Variable Controller was used, the compensated 'basic response' is the sum of the compensated 'basic responses' of each.</li> </ul>		
<b>Where more than one Contingency FCAS Enabled</b>	If a Slow FCAS was also <i>enabled</i> , the Ancillary Service Facility's response should exceed the required response, such that the Slow FCAS can be delivered.	If a Delayed FCAS was also <i>enabled</i> , the Ancillary Service Facility's response should exceed the required response such that the Delayed FCAS can be delivered.	

<sup>10</sup> [Reference trajectories take into account AGC control signals if required.](#)

	Fast FCAS	Slow FCAS	Delayed FCAS
<b>Specification of Market Ancillary Service Offers</b>	The specifications in sections 7.1 and 7.2 are applied to calculate the Fast FCAS offered.	The specifications in sections 8.1 and 8.2 are applied to calculate the Slow FCAS offered.	The specifications in sections 9.1 and 9.2 are applied to calculate the Delayed FCAS offered.
<b>Delivery Requirements</b>	The amount of Fast FCAS delivered in response to a change in Local Frequency must be at least equal to the <i>dispatched</i> quantity.	The amount of a Slow FCAS delivered in response to a change in Local Frequency must be at least equal to the <i>dispatched</i> quantity.	The amount of Delayed FCAS delivered in response to a change in Local Frequency must be at least equal to the <i>dispatched</i> quantity.

### 6.5. The FCAS Verification Tool

The FCASVT<sup>11</sup> is available to help calculate the quantity of any Contingency FCAS delivered by an Ancillary Service Facility. It contains detailed algorithms used by AEMO to verify whether Contingency FCAS has been delivered in accordance with the MASS.

If there is any inconsistency between the FCASVT and the MASS, the MASS will prevail to the extent of that inconsistency.

To avoid doubt, the FCASVT is not part of the MASS.

## 7. FAST FCAS REQUIREMENTS

### 7.1. Specification of Fast Raise Service in Market Ancillary Service Offer

The amount of *fast raise service* in a *price band* and all cheaper *price bands* is the **lesser** of:

- (a) twice the Time Average of the Raise Response starting at the Contingency Event Time and ending 6 s from the Frequency Disturbance Time, excluding any Inertial Response; and
- (b) twice the Time Average of the Raise Response between 6 s and 60 s from the Frequency Disturbance Time, excluding any Inertial Response,

that the FCAS Provider making the *market ancillary service offer* expects would be delivered at the relevant *connection point* in response to a Standard Frequency Ramp from 50 Hz to the Raise Reference Frequency while this *price band* is *enabled*.

#### 7.1.7.2. Specification of Fast Lower Service in Market Ancillary Service Offer

The amount of *fast lower service* in a *price band* and all cheaper *price bands* is the **lesser** of:

- (a) twice the Time Average of the Lower Response starting at the Contingency Event Time and ending 6 s past the Frequency Disturbance Time, excluding any Inertial Response; and
- (b) twice the Time Average of the Lower Response between 6 s and 60 s from the Frequency Disturbance Time, excluding any Inertial Response,

that the FCAS Provider making the *market ancillary service offer* expects would be delivered at the relevant *connection point* in response to a Standard Frequency Ramp from 50 Hz to the Lower Reference Frequency while this *price band* is *enabled*.

<sup>11</sup> Available at <http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Ancillary-services/Market-ancillary-services-specifications-and-FCAS-verification>.

### **7.2.7.3. Dispatch**

AEMO will issue *dispatch instructions* for the delivery of Fast FCAS to *enable* the required quantities based on the *market ancillary service offers* received.

During *enablement*, an Ancillary Service Facility must respond to Local Frequency without further instruction from AEMO.

## **8. SLOW FCAS REQUIREMENTS**

### **8.1. Specification of Slow Raise Service in Market Ancillary Service Offer**

The amount of *slow raise service* in a *price band* and all cheaper *price bands* is the **lesser** of:

- (a) twice the Time Average of the Raise Response between 6 s and 60 s from the Frequency Disturbance Time, excluding any *fast raise service* provided; and
- (b) twice the Time Average of the Raise Response between 60 s and 5 min from the Frequency Disturbance Time,

that the FCAS Provider making the *market ancillary service offer* expects would be delivered at the relevant *connection point* in response to a Standard Frequency Ramp from 50 Hz to the Raise Reference Frequency while this *price band* is *enabled*.

### **8.2. Specification of Slow Lower Service in Market Ancillary Service Offer**

The amount of *slow lower service* in a *price band* and all cheaper *price bands* is the **lesser** of:

- (a) twice the Time Average of the Lower Response between 6 s and 60 s from the Frequency Disturbance Time, excluding any *fast lower service* provided; and
- (b) twice the Time Average of the Lower Response between 60 s and 5 min from the Frequency Disturbance Time,

that the FCAS Provider making the *market ancillary service offer* expects would be delivered at the relevant *connection point* in response to a Standard Frequency Ramp from 50 Hz to the Lower Reference Frequency while the *slow lower service* in this *price band* is *enabled*.

### **8.3. Dispatch**

AEMO will issue *dispatch instructions* for the delivery of Slow FCAS to *enable* the required quantities based on the *market ancillary service offers* received.

During *enablement*, an Ancillary Service Facility must respond to Local Frequency without further instruction from AEMO.

## **9. DELAYED FCAS REQUIREMENTS**

### **9.1. Amount of Delayed Raise Service in Market Ancillary Service Offer**

The amount of *delayed raise service* in a *price band* and all cheaper *price bands* is the **lesser** of:

- (a) twice the Time Average of the Raise Response between 1 min and 5 min from the Frequency Disturbance Time and *slow raise service* provided; and
- (b) the Time Average of the Raise Response between 5 min and 10 min from the Frequency Disturbance Time,

that the FCAS Provider making the *market ancillary service offer* expects would be delivered at the relevant *connection point* in response to a Standard Frequency Ramp from 50 Hz to the Raise Reference Frequency while the *delayed raise service* in this *price band* is *enabled*.

## 9.2. Amount of Delayed Lower Service in Market Ancillary Service Offer

The amount of *delayed lower service* in a *price band* is the **lesser** of:

- (a) twice the Time Average of the Lower Response between 1 min and 5 min from the Frequency Disturbance Time and *slow lower service* provided; and
- (b) the Time Average of the Lower Response between 5 min and 10 min from the Frequency Disturbance Time,

that the FCAS Provider making the *market ancillary service offer* expects would be delivered at the relevant *connection point* in addition to the amounts in all cheaper *price bands* in response to a Standard Frequency Ramp from 50 Hz to the Lower Reference Frequency while the *delayed lower service* in this *price band* is *enabled*.

## 10. REGULATION FCAS

### 10.1. Specification of Regulating Raise Service in Market Ancillary Service Offer

Provided the amount bid is at least the greater of 1 MW or 1% (rounded to nearest whole MW) of the 'Max Cap' recorded for 'Raisereg' in the Ancillary Services worksheet in AEMO's NEM Registration and Exemption List,<sup>12</sup> the amount of *regulating raise service* specified in a *price band* must be the amount of Regulating Raise Response that the FCAS Provider making the *market ancillary service offer* expects would be delivered at the relevant *connection point* progressively over a *dispatch interval* in addition to the amounts in all cheaper *price bands* in response to Raise Signals sent to request the maximum possible Regulating Raise Response while this *price band* is *enabled*.

### 10.2. Specification of Regulating Lower Service in Market Ancillary Service Offer

Provided the amount bid is at least the greater of 1 MW or 1% (rounded to nearest whole MW) of the 'Max Cap' recorded for 'Lowerreg' in the Ancillary Services worksheet in AEMO's NEM Registration and Exemption List,<sup>13</sup> the amount of *regulating lower service* specified in a *price band* must be the amount of Regulating Lower Response that the FCAS Provider making the *market ancillary service offer* expects would be delivered at the relevant *connection point* progressively over a *dispatch interval* in addition to the amounts in all cheaper *price bands* in response to Lower Signals sent to request the maximum possible Regulating Lower Response while this *price band* is *enabled*.

<sup>12</sup> Available at <https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/participate-in-the-market/registration>. FCAS Providers must comply with this requirement by **TBD**

<sup>13</sup> Available at <https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/participate-in-the-market/registration>. FCAS Providers must comply with this requirement by **TBD**

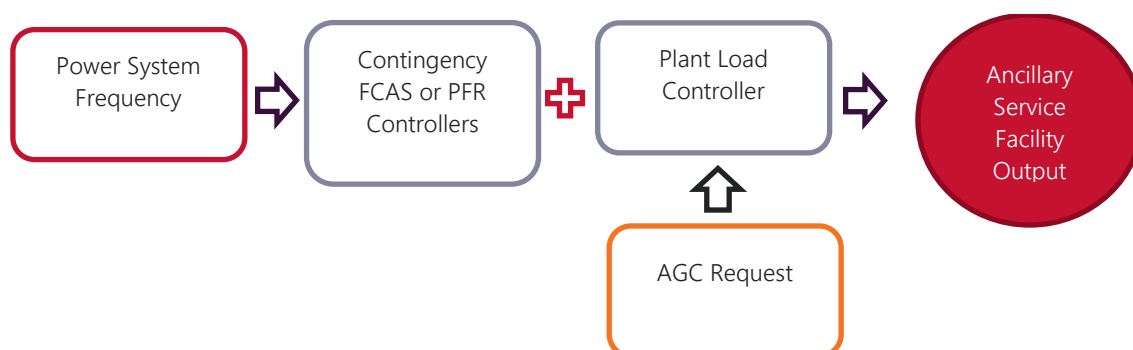
### 10.3. Compliance monitoring and action

AEMO needs assurance that ~~that~~ an Ancillary Service Facility or Aggregated Ancillary Service Facility (as applicable) *enabled* to deliver Regulation FCAS will respond in an accurate ~~and~~ timely and co-ordinated manner.

To do so, Ancillary Service Facilities that are controlled by AEMO’s AGC (including all facilities registered for Regulation FCAS) need to be able to respond in an additive manner (i.e. a net sum) using their Contingency FCAS or PFR controllers and AGC controls. The total expected change in output is subject to enabled quantities of each FCAS and a facility’s PFR obligations where applicable. A high-level example is shown in Figure 1, which outlines the expected plant behaviour. Actual control design will vary by plant and technology and may be subject to other control actions, various limits and intermediate controllers.

The Contingency FCAS or PFR controls must detect Local Frequency and calculate a response, which represents an offset to the output the Ancillary Service Facility would otherwise target<sup>14</sup>. -The plant load controller must take the sum of the response calculated by the Contingency FCAS or PFR controllers and response requested by the AGC control signal to determine the required output from the Ancillary Service Facility. Occasionally, the direction of the Contingency FCAS or PFR response may oppose an AGC control signal; this is not unexpected as AGC is operating to a set of objectives. Example responses are provided in Appendix B.

**Figure 1 High level frequency-coordinated control design**



AEMO will monitor the output of Ancillary Service Facilities and Aggregated Ancillary Service Facilities *enabled* to deliver Regulation FCAS in accordance with Appendix A of the Dispatch Procedure.

AEMO may invoke a fixed *constraint* equation until it is reasonably satisfied that the Ancillary Service Facility or Aggregated Ancillary Service Facility (as applicable) responds as contemplated by the MASS.

### 10.4. Control system

The Ancillary Service Facility must have a *control system* ~~that can~~:

- (a) transmit ~~the~~ an agreed set of control parameters including Controlled Quantity, Control Request Feedback, Online/Offline Status, Remote/Local Status, Raise Control Limit, Lower Control Limit, Raise Rate Limit and, if different from the Raise Rate Limit, the Lower Rate Limit

<sup>14</sup> One simple way to interpret this is to consider an AGC set-point request to be a 50 Hz, and Contingency and/or PFR action should determine an offset to this set-point (e.g. in accordance with their droop function).

every 4 ~~seconds~~ to AEMO via SCADA and with no greater than 8 s latency, excluding external processing and communications delays<sup>15</sup>;

(b) receive Raise Signals and Lower Signals;

(c) when *enabled* for Regulation FCAS, automatically deliver a Regulating Raise Response or a Regulating Lower Response corresponding to those Raise Signals or Lower Signals<sup>16</sup>;

~~(e)~~(d) ensure the Regulating Raise Response or Regulating Lower Response, where it exceeds the facility's Setpoint Change Deadband, is clearly discernible from any noise and oscillation in the telemetered output; and

~~— not suspend the Regulating Raise Response or Regulating Lower Response (as applicable) for more than 60 s during a Frequency Disturbance, and even then, only if Local Frequency has exceeded the Raise Reference Frequency or Lower Reference Frequency;~~

(e) maintain at all times a Control Response Delay (CRD) no greater than 150 seconds<sup>17</sup>; and

~~(d)~~(f) maintain at all times a Setpoint Change Deadband greater than or equal to half of the facility's minimum Regulation FCAS offer quantity as defined in Sections 10.1 and 10.2<sup>18</sup>

An Aggregated Ancillary Service Facility's *control system* for *regulating raise service* or *regulating lower service* must only apply to the whole aggregated *generating unit* or *load*.

## 10.5. Verification

For the purpose of verifying the maximum amount of *regulating raise service* or *regulating lower service* that can be delivered in response to a Raise Signal or a Lower Signal, the amount of service to be compared with the *enabled price bands* of the relevant *market ancillary service* offer must be determined using the recordings made under section 5.3.2 as follows:

- (a) If AEMO or the FCAS Provider wishes to verify delivery of Regulation FCAS, AEMO must transmit no Raise Signals or Lower Signals to the relevant Ancillary Service Facility for at least 60 seconds and then immediately transmit Raise Signals or Lower Signals to the Ancillary Service Facility that would produce either a Regulating Raise Response or Regulating Lower Response equal to the lesser of the sum of the *enabled price bands*<sup>19</sup> of the relevant *market ancillary services offer* and the corresponding Raise Rate Limit or Lower Rate Limit for at least 5-five minutes such that the Controlled Quantity remains at all times between the Raise Control Limit and the Lower Control Limit.
- (b) The following procedure must be used:
- (i) fit a linear function of time (of the form  $P = P1 + R1 * t$ ) to the power measurements made during the ~~sixty~~ 60 seconds to which paragraph (a)(i) refers;
  - (ii) fit a linear function of time (of the form  $P = P2 + R2 * t$ ) to the earliest power measurements made over the following five minutes that are all greater than (for Regulating Raise Response) or less than (for Regulating Lower Response) the function to which paragraph (b)(i) refers; and

<sup>15</sup> FCAS Providers must comply with this requirement by TBD.

<sup>16</sup> AEMO's AGC will control facility output within the ramping rates telemetered to AEMO by the facility.

<sup>17</sup> FCAS Providers must comply with this requirement by TBD.

<sup>18</sup> FCAS Providers must comply with this requirement by TBD.

<sup>19</sup> For assessing Raise capability, only the enabled Raise price bands apply. For assessing Lower capability, only the enabled Lower price bands apply.



- (iii) determine the Regulating Raise Response or Regulating Lower Response as the slope of the function to which paragraph (b)(ii) refers (in MW/min) multiplied by **five** minutes.
- (c) The test must be discarded if the Ancillary Service Facility produces a Contingency FCAS response or significant PFR action during the test period as this may invalidate the results.

## **10.6. Tests**

FCAS Providers must initiate engagement with AEMO to undertake tests to reasonably demonstrate that their Ancillary Service Facilities meet the MASS requirements applicable to Regulation FCAS:

- (a) no less than every four years;
- (b) within eight weeks following a major overhaul of the facility or any change to active power controls; and
- (c) within eight weeks of a request from AEMO.

Test results must be provided to AEMO in a timely manner. Any failure to provide test results to AEMO or to demonstrate that an Ancillary Service Facility complies with the MASS may result in AEMO constraining the Ancillary Service Facility's participation in the Regulation FCAS market as contemplated in the NER.

## **11. TRIALS OF NEW TECHNOLOGIES**

### **11.1. AEMO's requirements**

From time to time, a trial to demonstrate the capability of new technologies in the delivery of FCAS may be authorised. Where this occurs, AEMO may specify the capabilities, measurements, verification, duration and other requirements and conditions of the trial in its absolute discretion.

### **11.2. Report to AEMO**

AEMO may specify the contents of a report and supporting data that trial participants must submit to AEMO upon the conclusion of a trial to enable AEMO to assess the efficacy of reviewing the MASS to address any issues that the trial has raised as to the performance of the new technologies in the delivery of FCAS or the operation of the *spot markets* for FCAS.

### **11.3. Transitional arrangements for VPP Demonstrations facilities**

#### **11.3.1. VPP Demonstrations and definitions**

AEMO commenced a trial of the ability of virtual power plant (VPP) to deliver Contingency FCAS in June 2019 (VPP Demonstrations).

Participants enrolled in the VPP Demonstrations (Trial Participants) were permitted to deliver Fast FCAS in accordance with the VPP Demonstrations FCAS Specification<sup>20</sup> (Trial Specification), which included a power flow and frequency measurement time resolution of 1 second taken at the connection point of each ancillary service load.

<sup>20</sup> AEMO. VPP Demonstrations FCAS Specification. Available: <https://aemo.com.au/initiatives/major-programs/nem-distributed-energy-resources-der-program/der-demonstrations/virtual-power-plant-vpp-demonstrations>

For the period ending on 30 June 2023, (VPP transition period), the transitional requirements in section 11.3.2 will apply to Aggregated Ancillary Service Facilities that were classified by a Trial Participant and included in the VPP Demonstrations as at the date this section 11.3 comes into effect (Trial Facilities).

### **11.3.2. VPP transitional requirements**

During the VPP transition period:

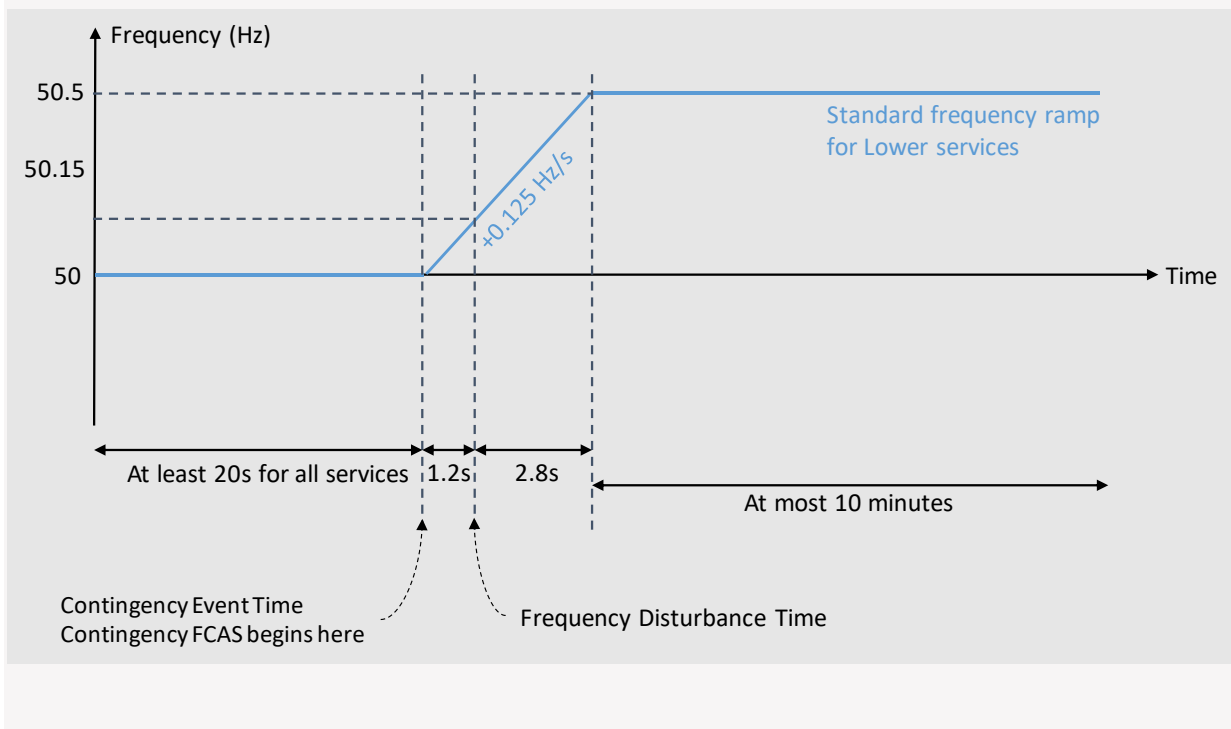
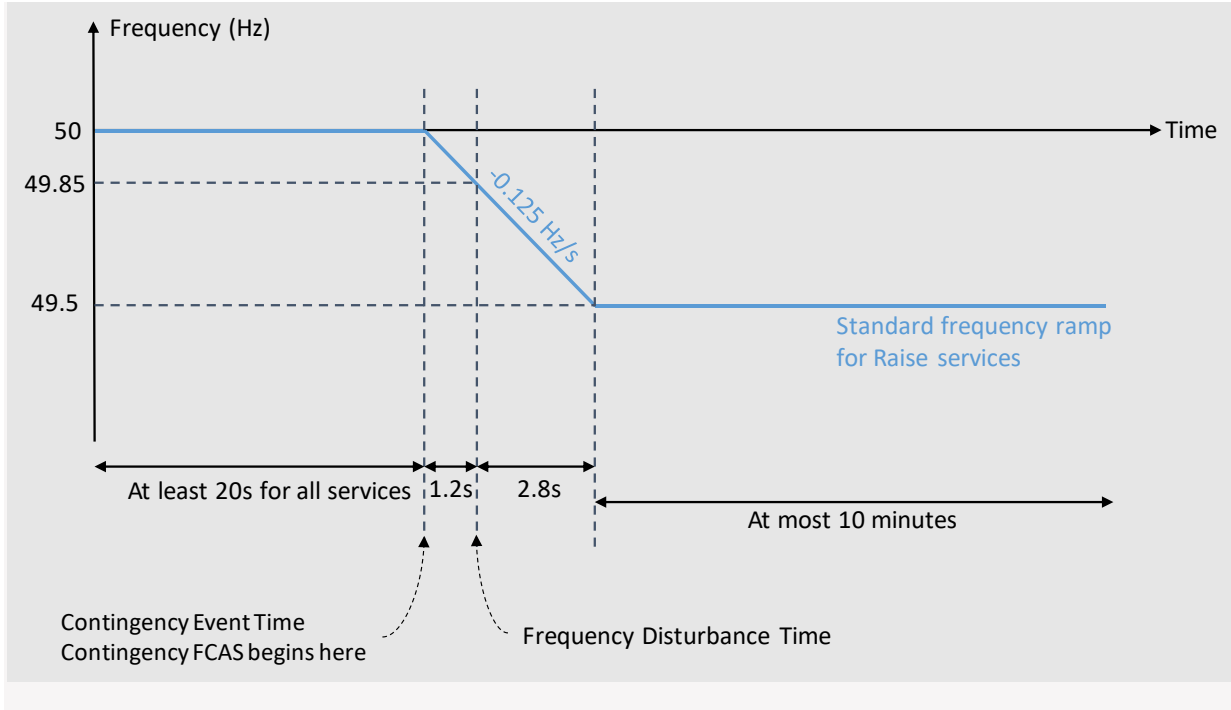
- (a) Fast FCAS from a Trial Facility must be provided in accordance with the MASS as varied by the Trial Specification;
- (b) Trial Participants are not permitted to make changes to the device types or controller types in their Trial Facilities;
- (c) where, in accordance with the Trial Specification, measurements of *power flow and local frequency at connection points* in a Trial Facility are captured with a sampling rate of more than 200 ms, AEMO will apply a discount of 5% to the quantity of Fast FCAS measured at all *connection points* in the Trial Facility;
- (d) Ancillary Service Facilities that were not part of a Trial Facility immediately prior to the VPP transition period can only be added to a Trial Facility operating under paragraph (a)(ii):
  - (i) to replace or add *ancillary service loads* so as to maintain (but not exceed) the total aggregate MW capacity of the Trial Facility to deliver Contingency FCAS immediately before the VPP transition period, allowing for customer churning and for the discount applied under paragraph (c); and
  - (ii) in accordance with all applicable registration and classification requirements, including relevant fees.

### **11.3.3. After the VPP transition period**

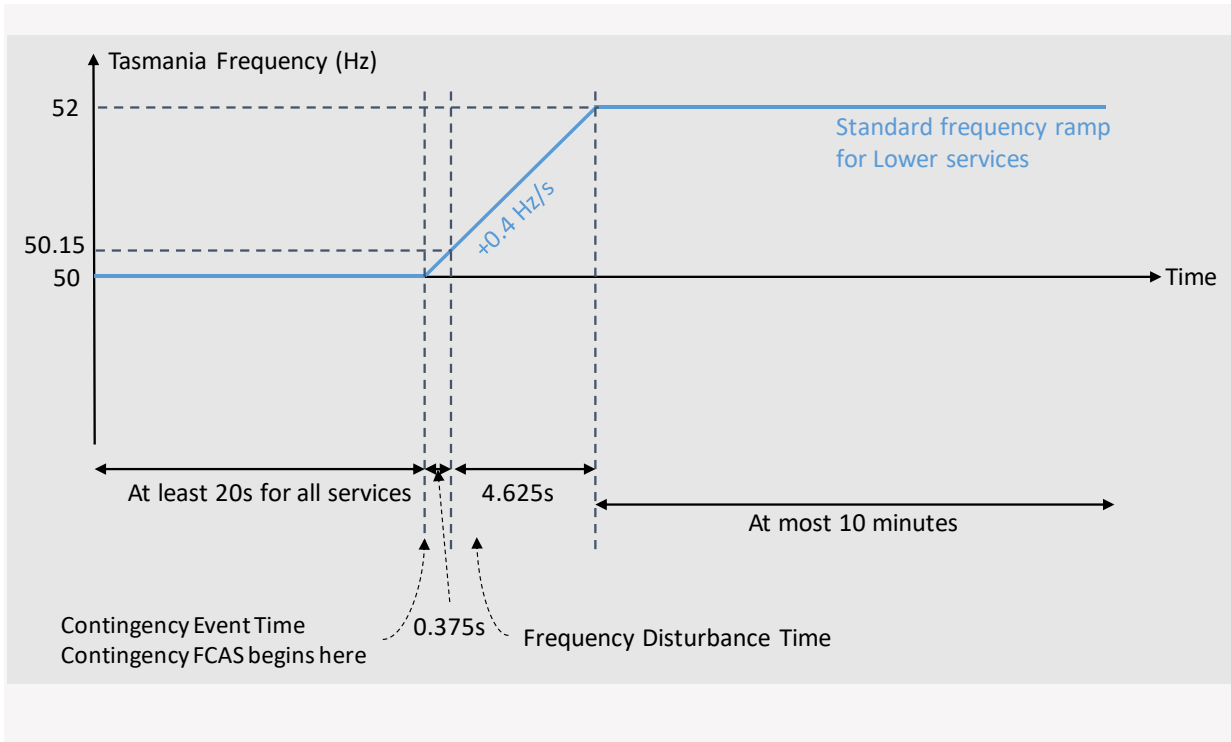
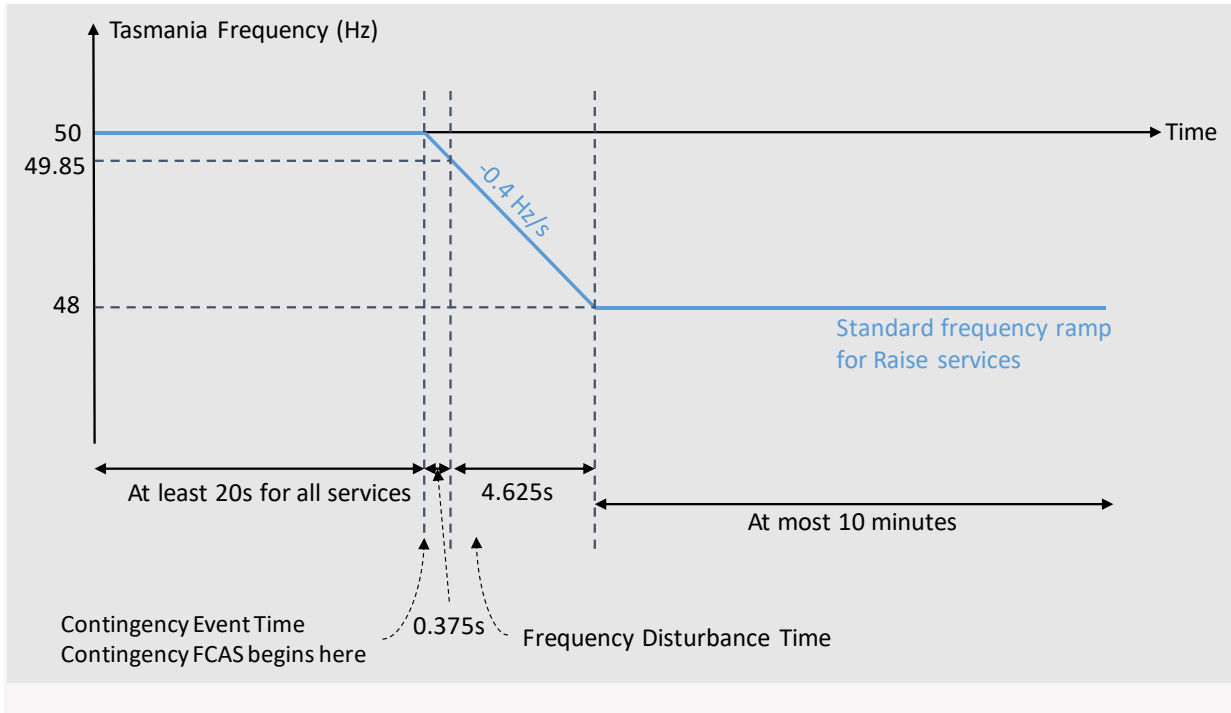
All Trial Facilities that are not providing Contingency FCAS in accordance with the MASS (without application of the Trial Specification) by the end of the VPP transition period will be declassified by AEMO, effective on and from the day after the VPP transition period ends.

## APPENDIX A. STANDARD FREQUENCY RAMP

Figure 2 Standard Frequency Ramp for regions other than Tasmania



**Figure 3 Standard Frequency Ramp for Tasmania**



## APPENDIX B. EXAMPLES OF FCAS MEASUREMENT AND DELIVERY

### Measurement and delivery of Contingency FCAS

Figure 4 shows a visual representation of the measurements applied to verify that at least the minimum required Contingency FCAS has been delivered in each timeframe. It is not recommended that FCAS Providers use these measurements as the sole basis of FCAS control design.

**Figure 4 Measurement timeframes for Raise Contingency FCAS**

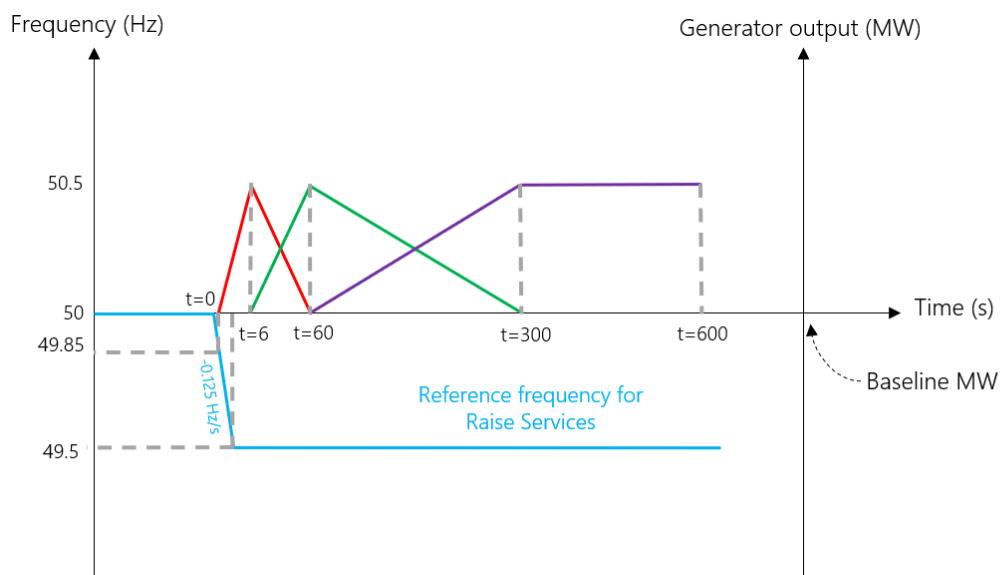
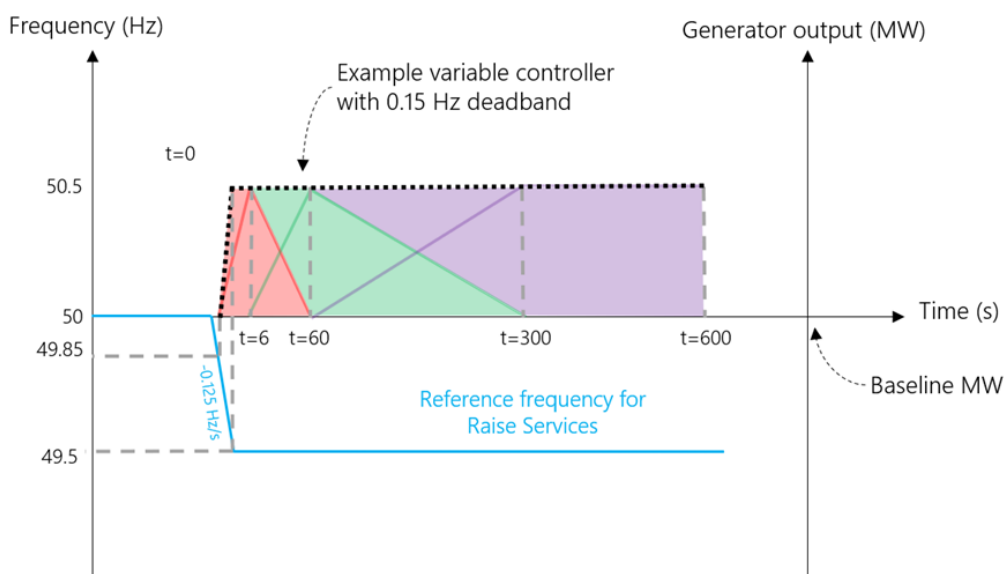


Figure 5 shows an example of how a simple Variable Controller that supplies a droop-based response to a frequency deviation can deliver across the Contingency FCAS timeframes.

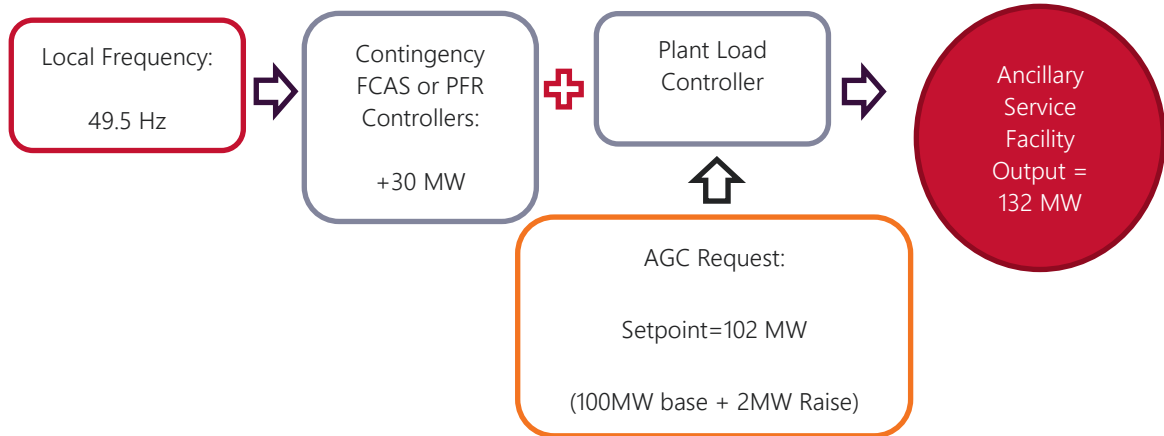
**Figure 5 Combined measurement timeframes for Raise Contingency FCAS**



**Examples of frequency co-ordinated response**

Note that these examples are high level only and are shown for setpoint controlled plants. Pulse controlled plants (also known as Raise/Lower control plants) are given Raise or Lower controls that are relative to their current output, rather than a setpoint, but otherwise the desired behaviour is consistent. In all cases, the minimum expected response is subject to enabled quantities and ramp rates and agreed PFR settings where relevant.

**Figure 6 Co-ordinated output for Ancillary Service Facility at 100 MW given Raise Regulation FCAS request of 2 MW while responding with 30 MW to a Frequency Disturbance**



**Figure 7 Co-ordinated output for Ancillary Service Facility at 100 MW given Lower Regulation FCAS request of 3 MW while responding with 30 MW to a Frequency Disturbance**

