# Market ancillary service specification

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| **Prepared by:** | AEMO Systems Performance |
| **Document ref:** | ESOPP_12 |
| **Version:** | 8.2 |
| **Effective date:** | 3 June 2024 |
| **Status:** | FINAL |

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| **Date:** | 2 May 2024 |

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# Current version release details

| Version | Effective date | Summary of changes |
|---|---|---|
| 8.2 | 3 June 2024 | Updates to reflect National Electricity Amendment (Integrating energy storage systems into the NEM) Rule 2021 No.13 and National Electricity Amendment (Implementing integrated energy storage systems) Rule 2023 No.2. |

**Note: There is a full version history at the end of this document.**

# 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 NER 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 |
|---|---|
| AGC | AEMO's automatic generation control system. |
| Aggregated FCAS Facility | The *ancillary service units* aggregated by an FCAS Provider under NER 3.8.3 for the purpose of providing FCAS. |
| Aggregated Generation Amount | The aggregate Generation Amounts through one or more *connection points* of an Aggregated FCAS Facility. |
| Aggregated Load Amount | The aggregate Load Amounts through one or more *connection points* of an Aggregated FCAS Facility. |
| Contingency FCAS | A term used to refer to *very fast raise service*, *very fast lower services*, *fast raise service*, *fast lower service*, *slow raise service*, *slow lower service*, *delayed raise service* and *delayed lower service* collectively. |
| Control Response Delay or CRD | Applies to Regulation FCAS Providers: defines the maximum end-to-end time in seconds an FCAS Facility takes to achieve at least 63.2%[1] of a step change in output following instructions via AGC. |
| Control Request Feedback | Applies to Regulation FCAS Providers: the latest AGC-issued control signal request (in MW) as known by an FCAS Facility. This value excludes any change in output from frequency controller action, including PFR.<br>• For FCAS Facilities with Setpoint Control, this is simply an echo of the AGC control signal request.<br>• For FCAS Facilities with Raise/Lower Controls, this is the MW value of the stream of Raise Control Limits or Lower Control Limits as accumulated internal to the Plant Controller or equivalent. |
| Controlled Quantity | A quantity of *generation* or *load* that is:<br>a) controlled by Raise Signals and Lower Signals; and |

[1] This value is specific to AGC.

| Term | Definition |
|---|---|
| | b) measured at the relevant *connection point*. |
| Delayed FCAS | *delayed raise services* and *delayed lower services*. |
| Fast FCAS | *fast raise services* and *fast lower services*. |
| Fast Frequency Ramp | 1 Hz/s for the mainland or 2 Hz/s for Tasmania. |
| FCAS | *market ancillary services*, commonly referred to as "frequency control ancillary services". |
| FCAS Facility | An *ancillary service unit* used to deliver FCAS, and includes an Aggregated FCAS Facility unless the context otherwise requires. |
| FCAS Provider | An *Ancillary Service Provider*. The term can be combined with 'Regulation', 'Delayed', 'Raise', 'Lower', 'Very Fast', 'Fast', 'Slow' or 'Contingency' or a combination of these to indicate an FCAS Provider providing a particular type of FCAS. |
| FCASVT | Frequency Control Ancillary Service Verification Tool: An Excel spreadsheet used to verify the delivery of Contingency FCAS. |
| FDT[2] | Frequency disturbance time: The time[3] when Local Frequency is outside the NOFB following a Frequency Disturbance, as determined by AEMO. |
| FOS | *frequency operating standard*. |
| Frequency Deadband | The range of Local Frequency through which a Variable Controller will not operate. |
| Frequency Deviation Setting | The setting allocated to an FCAS Facility by AEMO within the range shown in Table 6 for the Mainland and Table 7 for the Tasmania *region*. |
| Frequency Disturbance | An occasion when System Frequency is outside the NOFB. |
| Frequency Ramp Rate | 0.125 Hz/s for the Mainland or 0.4 Hz/s 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 *frequency* determined by AEMO in accordance with section 6 for use by an FCAS Facility's Switching Controller. |
| Generation Amount | The amount of *active power* flow through the *connection point* of an FCAS Facility into the *transmission network* or *distribution network* to which it is *connected*, expressed as a positive value in MW.<br>In respect of an Aggregated FCAS Facility, a reference to the Generation Amount means the Aggregated Generation Amount. |
| Generation Event | As defined in the FOS. |
| IANZ | International Accreditation New Zealand |
| ILAC MRA | International Laboratory Accreditation Cooperation Mutual Recognition Arrangements |
| Inertial Response | The change in Generation Amount or Load Amount due to the impact of an FCAS Facility's *inertia*. |
| Initial Value | The Generation Amount or Load Amount immediately prior to an FDT. |
| Initiation Delay | The time difference between Local Frequency exceeding an FCAS Facility controller's deadband or deviation setting and the start of the Raise Response or Lower Response. |
| Intrinsic Uncertainty | The uncertainty of a measuring instrument for the nominated measurement range. |
| Load Amount | The amount of *active power* flow through the *connection point* of an FCAS Facility from the *transmission network* or *distribution network* to which it is *connected*, expressed as a negative value in MW. |

[2] Referred to as occurring at t=0 in the equations used in the MASS.

[3] *Australian Eastern Standard Time.*

| Term | Definition |
|---|---|
| | In respect of an Aggregated FCAS Facility, a reference to the Load Amount means the Aggregated Load Amount. |
| Load Event | As defined in the FOS. |
| Load Reference | An AGC term that refers to the target power output of an FCAS Facility when System Frequency is at its nominal value (50 Hz). Other commonly used terminology to refer to this is 'speed-load reference' or 'basepoint'. |
| Local Frequency | The *frequency* measured by an FCAS Provider at the *connection point* of the FCAS Provider's FCAS Facility or at each *connection point* in an Aggregated FCAS Facility, in Hz. |
| Lower Control Limit | The lowest level to which a Controlled Quantity can be controlled in response to Lower Signals, subject to the *enablement* amount. |
| Lower Rate Limit | The highest rate at which a Controlled Quantity can be controlled in response to Lower Signals, subject to the *enablement* amount. |
| Lower Reference Frequency | The upper value in the 'containment band' for Generation Events and Load Events, as specified in Table A.3 of the FOS for the Mainland and Table A.6 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 *regions* other than Tasmania. |
| MASS | This document, namely, the *market ancillary service specification*. |
| NATA | National Association of Testing Authorities |
| NER | National Electricity Rules. NER followed by a number indicates the corresponding rule or clause of the NER. |
| NOFB | The relevant *normal operating frequency band* corresponding to 'normal' conditions, specified in Column 2 of Table A.1 in the FOS. |
| OFTB | The relevant *operational frequency tolerance band* corresponding to 'normal' conditions, specified in Column 2 of Table A.1 in the FOS. |
| Online/Offline Status | Applies to Regulation FCAS Providers: a binary status flag indicating whether their FCAS Facility is *connected* and ready to implement AGC-issued control requests. |
| Peak active power change | The maximum delta in active power between the reference trajectory and the recorded active power output of the FCAS facility during the relevant FCAS timeframe. |
| PFR | *primary frequency response*. |
| Plant Controller | The system within an FCAS Facility that controls the overall behaviour of the FCAS Facility and is responsible for a variety of duties, including actioning AGC control requests and co-ordinating the behaviour of all *plant* within the FCAS Facility. |
| Raise Control Limit | The highest level to which a Controlled Quantity can be controlled in response to Raise Signals, subject to the *enablement* amount. |
| Raise/Lower Control | An AGC term that refers to a method of AGC control where Load Reference controls are issued as relative MW values (e.g. an AGC request to set an FCAS Facility's Load Reference to 100 MW would be sent as a value of +2 MW if the machine was currently at 98 MW). Raise/Lower Control is also sometimes referred to as 'pulse control'. See also Setpoint Control. |
| Raise Rate Limit | The highest rate at which a Controlled Quantity can be controlled in response to Raise Signals, subject to the *enablement* amount. |
| Raise Reference Frequency | The lower value in the 'containment band' for Generation Events and Load Events, as specified in Table A.3 of the FOS for the Mainland and Table A.6 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. |

| Term | Definition |
|---|---|
| Reference Trajectory | A linear trajectory between two consecutive *energy market dispatch* targets, or if requested by an FCAS Provider with an FCAS Facility that is required to provide PFR, a trajectory as agreed with AEMO. |
| 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. |
| Remote/Local Status | Applies to Regulation FCAS Providers: a binary status flag. 'Remote' indicates an FCAS Facility's Plant Controller, or equivalent for Aggregated FCAS Facilities, is ready to receive AGC control signal requests. |
| SCADA | Supervisory control and data acquisition system. |
| Setpoint Change Deadband | A value set parameter assigned to each FCAS Facility in AGC that indicates the minimum change in MW output AGC may request from that FCAS Facility. |
| Setpoint Control | An AGC term that refers to a method of AGC control where Load Reference controls are issued as absolute MW values (e.g. an AGC request to set an FCAS Facility's Load Reference to 100 MW would be sent as a value of 100 MW). See also Raise/Lower Control. |
| Slow FCAS | *Slow raise services* and *slow lower services*. |
| Standard Frequency Ramp | A linear change in Local Frequency from one level to another at the applicable Frequency Ramp Rate and then sustained, as described in Appendix A. |
| Switching Controller | A *control system* that automatically delivers a specific amount of FCAS by either switching *generation* or *load* on or off (as applicable) or rapidly altering an FCAS Facility's output when its Frequency Settings are detected. |
| System Frequency | The *frequency* 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 *frequency* 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. |
| Variable Controller | A *control system* that is used by an FCAS Facility to deliver FCAS upon the commencement of a Frequency Disturbance in proportion to the size of the *frequency* excursion. |
| Very Fast FCAS | *very fast raise services* and *very fast lower services*. |

### 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 | https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/participate-in-the-market/registration/register-as-a-customer-in-the-nem |
| Application for Registration as a Generator in the NEM | https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/participate-in-the-market/registration/register-as-a-generator-in-the-nem |
| Application for Registration as a as a Demand Response Service Provider | https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/participate-in-the-market/registration/register-as-a-drsp |
| Dispatch Procedure SO_OP_3705 | https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/power-system-operation/power-system-operating-procedures |
| Frequency Control Ancillary Service Ancillary Service Verification Tool | https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/ancillary-services/market-ancillary-services-specification-and-fcas-verification-tool |
| FCAS Verification Tool User Guide | http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Ancillary-services/Market-ancillary-services-specifications-and-FCAS-verification |
| Generator Exemption and Classification Guide | http://aemo.com.au/-/media/Files/Electricity/NEM/Participant_Information/New-Participants/Generator-Exemption-and-Classification-Guide.pdf |
| Generator Registration Guide | https://aemo.com.au/-/media/files/electricity/nem/participant_information/registration/generator/nem-generator-registration-guide.pdf?la=en |
| Guide to Ancillary Services in the National Electricity Market | http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Ancillary-services |
| Guide for Demand Response Service Providers – NEM – change or classify new Ancillary Service Load | https://aemo.com.au/-/media/files/electricity/nem/participant_information/registration/demand-response-service-provider/application-guide-nem-demand-response-service-provider-asl.pdf?la=en |
| Pre-Dispatch Procedure SO_OP_3704 | http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Power-system-operation/Power-system-operating-procedures |
| Interim Primary Frequency Response Requirements | https://aemo.com.au/-/media/files/initiatives/primary-frequency-response/2020/interim-pfrr.pdf |

# 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

If an FCAS 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 7.3 provides guidance on how controls may be co-ordinated, including examples. Unless directed by AEMO to do

otherwise[4], subject to NER 4.9.4, an FCAS Facility providing Regulation FCAS should follow AGC instructions at all times, noting that AGC instructions are subject to Local Frequency as outlined in section 7.3.

## 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*.[5]

## 2.5. Delivery of FCAS

An FCAS Facility can be *enabled* to deliver any combination of FCAS it is capable of delivering (consistent with its classification and *market ancillary service offers*) 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 NER 3.8.1.

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 FCAS Facility to address the impact of supply/demand imbalances on System Frequency at any given point within a *trading interval*. Each type of FCAS is delivered to different specifications to address different needs.

NER 3.11.2(a) specifies that there are ten 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.

[4] Aside from reasons of safety or in a situation where a risk to unit stability exists.

[5] See also the definition of FDT.

**Table 3 Description of each FCAS**

| Type | NER Term | Commonly Referred to as… | Group | Description | Key Purpose | Usually Facilitated by… |
|---|---|---|---|---|---|---|
| Contingency FCAS | Very fast raise service | 1-Second Raise FCAS or R1 | Very Fast FCAS | A very rapid increase in *generation* or a decrease in *load* in response to decreases in Local Frequency. | To arrest a change in System Frequency following a *contingency event* that takes it outside the NOFB within the first 1 s of a Frequency Disturbance and then provide an orderly transition to a Fast FCAS. | • Frequency relay detecting a *frequency* deviation and increasing a *generating unit's* output or disconnecting a *load or* reducing consumption by a *load*.<br>• Rapid change in charging or discharging from batteries. |
| | Very fast lower service | 1-Second Lower FCAS or L1 | | A very rapid decrease in *generation* or an increase in *load* in response to increases in Local Frequency. | | • Frequency relay detecting a *frequency* deviation and reducing a *generating unit's* output or increasing consumption by a *load*.<br>• Rapid change in charging or discharging from batteries. |
| | Fast raise service | 6-Second Raise FCAS or R6 | Fast FCAS | A rapid increase in *generation* or a decrease in *load* in response to decreases in Local Frequency. | To arrest a change in System Frequency following a *contingency event* 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. | • Governor or governor-like *control systems.*<br>• Frequency relay detecting a *frequency* deviation and starting a fast *generating unit* or disconnecting a *load* or reducing *load* consumption.<br>• Rapid change in charging or discharging from batteries. |
| | Fast lower service | 6-Second Lower FCAS or L6 | | A rapid decrease in *generation* or an increase in *load* in response to increases in Local Frequency. | | • Governor or governor-like *control systems.*<br>• Frequency relay detecting a *frequency* deviation and reducing a *generating unit's* output or increasing consumption by a *load*.<br>• Rapid change in charging or discharging from batteries. |
| | Slow raise service | 60-Second Raise FCAS or R60 | Slow FCAS | An increase in *generation* or a decrease in *load* in response to decreases in Local Frequency. | To stabilise System Frequency following a *contingency event* within the first 60 s of a Frequency Disturbance, and | • Governor or governor-like *control systems*.<br>• Frequency relay detecting a *frequency* deviation and reducing consumption by a *load* or *disconnecting* a *load*. |

| Type | NER Term | Commonly Referred to as… | Group | Description | Key Purpose | Usually Facilitated by… |
|---|---|---|---|---|---|---|
| | | | | | then provide an orderly transition to a Delayed FCAS. | • Rapid change in charging or discharging from batteries. |
| | Slow lower service | 60-Second Lower FCAS or L60 | | A decrease in *generation* or an increase *load* in response to increases in Local Frequency. | | • Governor systems on *generating units*.<br>• Rapid change in charging or discharging from batteries. |
| | Delayed raise service | 5-Minute Raise FCAS or R5 | Delayed FCAS | An increase in *generation* or a decrease in *load* 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 *central dispatch* can re-schedule *generation* and *load* to balance the *power system*. | • *Frequency* relay detecting a *frequency* deviation starting up *generating units* or reducing consumption by a *load* or *disconnecting* a *load*.<br>• Rapid change in charging or discharging from batteries. |
| | Delayed lower service | 5-Minute Lower FCAS or L5 | | A decrease in *generation* or an increase in *load* in response to increases in Local Frequency. | | • *Frequency* relay detecting a *frequency* deviation and reducing *generating unit* output or increasing consumption by a *load*.<br>• Rapid change in charging or discharging from batteries. |
| Regulation FCAS | Regulating raise service | Raise Regulation FCAS or RREG | Regulation FCAS | Increasing *generation* or decreasing *load* relative to the FCAS Facility's Reference Trajectory in response to Raise Signals to increase System Frequency. | To support control of System Frequency and time error in tandem with *primary frequency response* (PFR) in response to variations of demand and *generation* within a *trading interval*. | • Setpoint controllers on *generating units*. |
| | Regulating lower service | Lower Regulation FCAS or LREG | | Decreasing *generation* or increasing consumption by a *load* relative to the FCAS Facility's Reference Trajectory 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 System Frequency so that AEMO can meet the conditions specified in the FOS. This means that, while always *enabled* for delivery following a *contingency event*, Contingency FCAS are only required to be delivered if a *contingency event* occurs.

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

FCAS Facilities may cease to provide Contingency FCAS once Frequency Recovery has occurred. In other words, if Local Frequency recovers following a *contingency event* within the parameters specified in the first two columns of Table 4, the FCAS Facility is not required to deliver the types of FCAS listed in column 3.

**Table 4 Delivery requirements for different Contingency FCAS**

| Frequency Recovery | Time from FDT | FCAS not required |
|---|---|---|
| **Above 49.9 Hz within…** | 1 s | Fast Raise FCAS, Slow Raise FCAS, Delayed Raise FCAS. |
| | 6 s | Slow Raise FCAS, Delayed Raise FCAS. |
| | 60 s | Delayed Raise FCAS. |
| **Below 50.1 Hz within…** | 1 s | Fast Lower FCAS, Slow Lower FCAS, Delayed Lower FCAS. |
| | 6 s | Slow Lower FCAS, Delayed Lower FCAS. |
| | 60 s | Delayed Lower FCAS. |

### 3.1.1. Relationship with PFR

Contingency FCAS works in tandem with *primary frequency response* (**PFR**) to help control *frequency* and *power system* imbalance within and outside the NOFB[6]. It is distinguished from PFR in that it is provided by the reserved headroom, footroom and stored energy, as specified in a *market ancillary service offer.* PFR is 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.

Any frequency response provided within the NOFB by an FCAS Facility providing PFR, is considered as contributing towards its delivery requirements for Contingency FCAS.

## 3.2. Regulation FCAS

Regulation FCAS are centrally controlled by AGC*,* which allows AEMO to monitor System Frequency, time error and FCAS Facility output at all times. AGC sends control signals through SCADA (on a regular cycle, such as every 4 s) to FCAS 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. Adjustments to MW output are from an

[6] Refer to guidance on co-ordination of PFR and Contingency FCAS controls with AGC controls in section 7.3.

FCAS Facility's Load Reference; the *enabled* Regulation Raise and Regulation Lower quantities form a band around the FCAS Facility's Load Reference within which AGC may control it. An FCAS Facility must be a *scheduled generating unit*, *scheduled load* or *semi-scheduled generating unit* 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 *trading interval*.

### 3.2.1. Relationship with PFR

Regulation FCAS works in tandem with PFR to help control *frequency* and *power system* imbalance within and outside the NOFB[7], however, it is distinguished from PFR in two key ways:

(a) Headroom, footroom and stored energy – As for Contingency FCAS, Regulation FCAS is provided by the reserved headroom, footroom and stored energy, as specified in a *market ancillary service offer.* PFR is 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.

(b) 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 NER 4.4.2(c1).

# 4. Aggregation of FCAS Facilities

## 4.1. Requests for aggregation

### 4.1.1. Generally

FCAS Providers may apply to AEMO under NER 3.8.3 to aggregate their *ancillary service units* for the purposes of *central dispatch*. Where aggregation has been approved, *market ancillary service offers* must only be made in respect of the Aggregated FCAS 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 FCAS Facility provides the requested Regulation FCAS in an accurate and timely manner.

[7] Refer to guidance on co-ordination of PFR and Contingency FCAS controls with AGC controls in section 7.3.

## 4.2. Requests for reports on Aggregated FCAS Facilities

### 4.2.1. Generally

A request from AEMO to an FCAS Provider for a report detailing how an FCAS Facility responded to changes in System Frequency under NER 3.11.2(h) may also be made in respect of an Aggregated FCAS Facility, in which case the FCAS Provider must detail in its report the response of each FCAS Facility within the Aggregated FCAS 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 FCAS Facility within the Aggregated FCAS Facility. 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 FCAS Facility to deliver the relevant FCAS, as required by NER 3.8.7A.

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

## 5.2. Enablement

FCAS Providers must ensure they have sufficient headroom or footroom and operate their equipment in accordance with NER 4.9.3A(c) so that their FCAS Facilities can deliver FCAS in response to a *dispatch instruction* immediately following *enablement* by AEMO.

Where an Aggregated FCAS Facility is used, the reservation of headroom or footroom applies to the Aggregated FCAS Facility only.

## 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.* Sufficient information should be provided to compare the Local Frequency and power flow data on a common time scale.

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

The equipment used to measure and record the FCAS delivered must have the characteristics detailed in Table 5.

**Table 5 Measurement requirements for FCAS**

| Requirement | Applicable to… | Very Fast FCAS | Fast FCAS | Slow FCAS | Delayed FCAS | Regulation FCAS |
|---|---|---|---|---|---|---|
| **Sampling rate of Local Frequency measurements** | Aggregated FCAS Facilities comprised of ≥25 FCAS Facilities with **no** Inertial Response and with an Initiation Delay of ≤500 ms | ≤100 ms | ≤200 ms | ≤4 s | ≤4 s | NR |
| | Aggregated FCAS Facilities comprised of ≥25 FCAS Facilities with **no** Inertial Response and with an Initiation Delay of >500 ms | ≤50 ms | ≤200 ms | ≤4 s | ≤4 s | NR |
| | Aggregated FCAS Facilities with Inertial Response and those comprised of <25 FCAS Facilities with **no** Inertial Response | ≤50 ms | ≤50 ms[8] | ≤4 s | ≤4 s | NR |
| | All other FCAS Facilities | ≤50 ms | ≤50 ms | ≤4 s | ≤4 s | NR |
| **Sampling rate of Generation Amount and Load Amount measurements** | Aggregated FCAS Facilities comprised of ≥25 FCAS Facilities with **no** Inertial Response and with an Initiation Delay of ≤500ms | ≤100 ms | ≤200 ms | ≤4 s | ≤4 s | ≤4 s |
| | Aggregated FCAS Facilities comprised of ≥25 FCAS Facilities with **no** Inertial Response and with an Initiation Delay of >500ms | ≤50 ms | ≤200 ms | ≤4 s | ≤4 s | ≤4 s |
| | Aggregated FCAS Facilities with Inertial Response and those comprised of <25 FCAS Facilities with **no** Inertial Response. | ≤50 ms | ≤50 ms[9] | ≤4 s | ≤4 s | ≤4 s |
| | All other FCAS Facilities | ≤50 ms | ≤50 ms | ≤4 s | ≤4 s | ≤4 s |
| **Measurement Range of Power Flow Measurements** | Intrinsic Uncertainty of ≤2%, and resolution of ≤0.2% | | | | | |

[8] 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. Information should be provided to AEMO's reasonable satisfaction to compare the Local Frequency and power flow data on a common time scale.

[9] 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. Information should be provided to AEMO's reasonable satisfaction to compare the Local Frequency and power flow data on a common time scale.

| Requirement | Applicable to… | Very Fast FCAS | Fast FCAS | Slow FCAS | Delayed FCAS | Regulation FCAS |
|---|---|---|---|---|---|---|
| **Local Frequency Measurement Range** | At least the range specified in the OFTB, with: | | | | | NR |
| | Intrinsic Uncertainty | ≤0.01 Hz | | ≤0.02 Hz | | |
| | Resolution | ≤0.0025 Hz | | ≤0.01 Hz | | |
| **FDT** | < 10 s | | | | | NR |
| **Recording Period for Power & System Frequency Measurements** | ≥5 s before FDT and ≥60 s after it | | | ≥20 s before FDT and 5 min after it | ≥20 s before FDT and 10 min after it | NR |
| **Trigger for Recording Measurements** | At least whenever Local Frequency changes ≥ Trigger Range. | | | | | NR |

### 5.3.3. Additional requirements for Aggregated FCAS Facilities

If an Aggregated FCAS 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 FCAS 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 by the Aggregated FCAS Facility and must be measured directly.

(b) To correct for any discrepancy in the time measurement by Aggregated FCAS Facility meter clocks, FCAS Providers must time-align the data logged by each meter to the actual time a Frequency Disturbance was detected.

## 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 and other measurements for at least 12 months from the FDT and provide them to AEMO on request.

## 5.5. Reporting requirements

### 5.5.1. Request for Report

If AEMO reasonably considers there might be a non-compliance with the MASS, AEMO may require an FCAS Provider to submit one or more reports to AEMO demonstrating compliance with any aspect of the MASS. At the time when AEMO requests the report, AEMO will specify:

(a) the content of the required report;

(b) whether the report is required once only, or on a regular basis;

(c) if AEMO requires regular reports, the frequency of the reports; and

(d) the due date(s) for the report(s).

For example, AEMO may require an FCAS Provider to demonstrate that adequate headroom and footroom (where appropriate) have been reserved for the delivery of FCAS whenever the FCAS Facility was *enabled*.

### 5.5.2. How Report to be Submitted

Reports requested under section 5.5.1 must be forwarded to Freq_Event.Data@aemo.com.au by the relevant due date, and where applicable must cover the performance of the FCAS Provider's FCAS Facilities for the specified reporting period.

### 5.5.3. Requests for Extension

FCAS Providers who cannot provide the requested report by the due date specified by AEMO must apply to AEMO before that due date for an extension, explaining why the FCAS Provider cannot reasonably meet the due date and proposing an extension period. AEMO may grant an extension in its sole discretion.

# 6. Contingency FCAS Requirements

## 6.1. Frequency Deviation Settings provided by Switching Controllers

### 6.1.1. Default Frequency Deviation Setting

Until an FCAS 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 6 if the FCAS Facility is on the Mainland or Table 7 if the FCAS Facility is in Tasmania.

**Table 6 Frequency Settings for the Mainland**

| Level | Raise FCAS Frequency Deviation Setting (Hz) | Lower FCAS Frequency Deviation Setting (Hz) |
|---|---|---|
| Frequency Deviation Setting range | 49.80 Hz to 49.60 Hz | 50.20 Hz to 50.4 Hz |
| Default Frequency Deviation Setting | 49.8 Hz | 50.2 Hz |

**Table 7 Frequency Settings for Tasmania**

| Level | Raise FCAS Frequency Deviation Setting (Hz) | Lower FCAS Frequency Deviation Setting (Hz) |
|---|---|---|
| Frequency Deviation Setting range | 49.50 Hz to 48.50 Hz | 50.50 Hz to 51.50 Hz |
| Default Frequency Deviation Setting | 49.00 Hz | 51.00 Hz |

### 6.1.2. Allocation of Frequency Settings

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

(a) Where an FCAS Facility is used to deliver more than one type of Contingency FCAS, it will be allocated the same Frequency Settings for each.

(b) FCAS Facilities with larger switched blocks of *generation* or *load* will be allocated Frequency Settings closer to the NOFB.

(c) FCAS Facilities with higher availability will be allocated Frequency Settings closer to the NOFB.

(d) For Aggregated FCAS Facilities, where possible, AEMO will negotiate with the FCAS Provider to allocate a series of Frequency Settings to minimise the potential for over-delivery of Contingency FCAS.

(e) AEMO will consider the physical characteristics of the FCAS Facilities.

(f) A Frequency Setting for Very Fast FCAS, Fast FCAS, Slow FCAS or Delayed FCAS will be based on the allocated Frequency Deviation Setting shown in Table 6 for the Mainland and Table 7 for Tasmania.

(g) At AEMO's absolute discretion, a Frequency Deviation Setting outside the range specified in Table 6 for the Mainland and Table 7 for Tasmania may be allocated.

AEMO encourages FCAS Providers with FCAS Facilities using Switching Controllers to configure them so that different Frequency Settings can be assigned to different parts of their FCAS 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 FCAS 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 FCAS Facility that uses a Switching Controller to deliver a Contingency FCAS has changed;

(c) at least six months have elapsed since the last change of Frequency Deviation Settings and one or more FCAS 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. 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.

### 6.2.2. Control System Requirements

(a) Whenever Contingency FCAS is enabled, the FCAS Facility used to deliver the requested Contingency FCAS must have a *control system* to automatically initiate:

(i) a Raise Response when Local Frequency exceeds the FCAS Facility's Frequency Deadband, which for a Variable Controller must not be less than the lower limit of

the NOFB and for a Switching Controller, must be equal to the Frequency Deviation Setting; and

(ii) a Lower Response when Local Frequency exceeds the FCAS Facility's Frequency Deadband, which for a Variable Controller must not be greater than the upper limit of the NOFB and for a Switching 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 amount commensurate with the difference between Local Frequency and Frequency Deadband where the Local Frequency is between the Frequency Deadband 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 FCAS Facility's proportional response function[10];

(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 sub-paragraphs (i) and (ii).

(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 Intrinsic Uncertainty of <0.05 Hz for absolute Frequency Deviation Settings.

## 6.3. Ancillary service offer requirements

(a) Contingency FCAS Providers must make market *ancillary service offers* based on their expectation of what their FCAS Facility can deliver at its *connection point* in response to the Frequency Ramp from 50 Hz to the Raise Reference Frequency or Lower Reference Frequency (as applicable) while a *price band* is *enabled*.

(b) Subject to paragraph (a), the amount of Very Fast FCAS, Fast FCAS and Slow FCAS in a *price band* and all cheaper *price bands* must exclude any Inertial Response and is calculated as the lesser of twice the Time Average of the Raise Response or Lower Response between the times shown in Column 3 and Column 4 of Table 8 and is capped at the peak active power change.

(c) Subject to paragraph (a), the amount of Delayed FCAS in a *price band* and all cheaper *price bands* is calculated as the lesser of twice the Time Average of the Raise Response or Lower Response between the times shown in Column 3 and the Time Average of the Raise Response or Lower Response between the times shown in Column 4 of Table 8 and is capped at the peak active power change.

[10] Commonly known as a 'droop function' or 'droop curve'.

**Table 8 Market ancillary service offer requirements**

| Type of Contingency FCAS | Frequency Ramp | Column 3 | Column 4 |
|---|---|---|---|
| ***very fast raise service*** ***very fast lower service*** | Fast Frequency Ramp | FDT and 1 s from FDT | 1 s and 6 s from FDT |
| ***fast raise service*** | Standard Frequency Ramp or Fast Frequency Ramp if the FCAS Provider is also a Very Fast FCAS Provider | 1 s and 6 s from FDT, excluding any *very fast raise service* provided | 6 s and 60 s from FDT |
| ***fast lower service*** | | 1 s and 6 s from FDT, excluding any *very fast lower service* provided | |
| ***slow raise service*** | | 6 s and 60 s from FDT, excluding any *fast raise service* provided | 60 s and 5 min from FDT |
| ***slow lower service*** | | 6 s and 60 s from FDT, excluding any *fast lower service* provided | |
| ***delayed raise service*** | | 1 min and 5 min from FDT, excluding any *slow raise service* provided | 5 min and 10 min from FDT |
| ***delayed lower service*** | | 1 min and 5 min from FDT, excluding any *slow lower service* provided | |

## 6.4. Dispatch

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

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

## 6.5. Measurement

### 6.5.1. Traceability of Contingency FCAS metering equipment

If the datasheet for a type of metering equipment does not clearly specify the Intrinsic Uncertainty and resolution for capturing measurements of power and *frequency*, a Contingency FCAS Provider must demonstrate to AEMO's reasonable satisfaction that the type of metering equipment meets the requirements in Table 5 by one of the following means:

(a) ensuring that the type of metering equipment is certified to the sections of the IEC 61557-12[11] standard specified in Table 9 and that the type of equipment is:

(i) tested by a facility accredited by:

A. The Australian National Association of Testing Authorities (NATA);

B. The International Accreditation New Zealand (IANZ); or

[11] IEC 61557-12 edition 2.1-2021-05 is adopted for MASS performance and test requirements. These are not affected by subsequent revisions of the IEC standard, unless the MASS is subsequently amended to incorporate them.

C. accreditation bodies that are signatories to the International Laboratory Accreditation Cooperation Mutual Recognition Arrangements (ILAC MRA); and

(ii) compliant with the respective clause in Annex H of the IEC61557-12 standard, which applies where a meter is embedded in another device (e.g. an inverter or a protection relay);

**Table 9 Application of IEC 61557-12 type-tests**

| Measurement Parameters | Requirements Section | Description | Type Test Section | Comment |
|---|---|---|---|---|
| Power and Frequency | | | 6.2.1<br>6.2.2<br>6.2.3<br>6.2.4 | General test and acceptance requirements, temperature influence. |
| Power only | 4.8.2 | Specifies the limits of uncertainty, over the rated measuring range, under reference conditions and influence quantities, environmental and electromagnetic.<br>Sample rate, measurement range and uncertainty as specified in Table 5 | 6.2.5<br>6.2.16 | Specific tests for active power measurement and EMC test. |
| Frequency only | 4.8.5 | Specifies the limits of uncertainty, over the rated measuring range, under reference conditions and influence quantities, environmental and electromagnetic.<br>Sample rate, measurement range and uncertainty as specified in Table 5 | 6.2.9 | Specific test for frequency measurement. |

(b) ensuring that the type of metering equipment meets the requirements of other relevant standards through certification by one of the bodies listed in paragraph (a)(i); or

(c) providing test results or other evidence of compliance.

### 6.5.2. 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, Contingency 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.

### 6.5.3. Discounting Very Fast FCAS from Aggregated FCAS Facilities in certain circumstances

If a Contingency FCAS Provider provides Very Fast FCAS using an Aggregated FCAS Facility for which the measurements of *power flow* and Local Frequency are captured with a sampling

rate >50 ms but ≤100ms, AEMO will apply a discount of 5% to the combined quantity of Very Fast FCAS measured at or close to the *connection points* of the Aggregated FCAS Facility if the *control system* is a Variable Controller, or 10% if the *control system* is a Switching Controller or a discrete combination of both.

The discount is applied during registration. The Aggregated FCAS Facility must be able to deliver up to the maximum registered capacity for Very Fast FCAS after factoring in the discount, as the quantity of Very Fast FCAS delivered in response to a *contingency event* must be greater than the *enabled* quantity by at least 5% for a Variable Controller, and 10% for a Switching Controller or a discrete combination of both.

### 6.5.4. Discounting Fast FCAS from Aggregated FCAS Facilities in certain circumstances

If a Contingency FCAS Provider provides Fast FCAS using an Aggregated FCAS Facility for which:

(a) the number of FCAS Facilities aggregated by the FCAS Provider is ≥25 but <500; and

(b) the measurements of *power flow* and Local Frequency are captured with a sampling rate >50 ms but ≤200ms,

AEMO will apply a discount of 5% to the combined quantity of Fast FCAS measured at or close to the *connection points* of the Aggregated FCAS Facility.

The discount is applied during the registration. The Aggregated FCAS Facility must be able to deliver up to the maximum registered capacity for Fast FCAS after factoring in the discount, as the quantity of Fast FCAS delivered in response to a *contingency event* must be at least 5% greater than the *enabled* quantity.

## 6.6. Verification

The verification requirements that must be followed by FCAS Providers are provided in Table 10:

**Table 10 Verification Requirements of Contingency FCAS**

| Requirement | Very Fast FCAS | Fast FCAS | Slow FCAS | Delayed FCAS |
|---|---|---|---|---|
| **Assessment Period - From FDT to Frequency Recovery up to a maximum of:** | 6 s | 60 s | 300 s | 600 s |
| **Calculation Method** | The amount of Contingency FCAS delivered must be compared with the amount of *enabled* Contingency FCAS as follows:<br>(a) If the FCAS Facility is a *scheduled generating unit*, *scheduled load* or *semi-scheduled generating unit*, determine the *generation* or electricity consumption Reference Trajectory it would be expected to have followed if the Frequency Disturbance had not occurred[12]. | | | |

[12] Reference Trajectories take into account AGC control signals if required.

| Requirement | Very Fast FCAS | Fast FCAS | Slow FCAS | Delayed FCAS |
|---|---|---|---|---|
| | (b) Use this Reference Trajectory to adjust the measured Generation Amount and Load Amount to obtain the response relative to this Reference Trajectory.<br>(c) Remove the impact of any Inertial Response.<br>(d) The difference between the value calculated following paragraph (c) and a measure of the output of the FCAS Facility just prior to the Frequency Disturbance constitutes the FCAS Facility's 'basic response'. Note that the 'basic response' includes all *frequency* response, regardless of whether it is inside or outside the NOFB.<br>(e) Where a Variable Controller was used, the 'basic response' is compensated to take into account the difference between Local Frequency and the Fast Frequency Ramp (for Very Fast FCAS) or the Standard Frequency Ramp (for all other Contingency FCAS) if the FCAS Facility is not registered in the Very Fast FCAS markets.<br>(f) Where a Switching Controller 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 Fast Frequency Ramp (for Very Fast FCAS) or the Standard Frequency Ramp (for all other Contingency FCAS) if the FCAS Facility is not registered in the Very Fast FCAS markets.<br>(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. | | | |
| **Where more than one Contingency FCAS Enabled** | If more than one type Contingency FCAS is *enabled* at the same time, the FCAS Facility must deliver at least the amount enabled in each FCAS category. For the avoidance of doubt, delivering an amount of Raise (or Lower) FCAS based on the greatest *enablement* across the Raise (or Lower) Contingency services is an appropriate (but not mandatory) strategy. | | | NR |
| **Specification of Market Ancillary Service Offers to calculate the Contingency FCAS offered** | See section 6.3. | | | |
| **Delivery Requirements** | The amount of each Contingency FCAS delivered in response to a change in Local Frequency must be at least equal to the corresponding *enabled* quantity. | | | |

## 6.7. The FCAS Verification Tool

The FCASVT[13] is available to help calculate the quantity of any Contingency FCAS delivered by an FCAS 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.

[13] Available at http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Ancillary-services/Market-ancillary-services-specifications-and-FCAS-verification.

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

# 7. Regulation FCAS

## 7.1. 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,[14] 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 *trading 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*.

## 7.2. 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,[15] 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 *trading 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*.

## 7.3. Compliance monitoring and action

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

AGC control requests apply to an FCAS Facility's Load Reference point. If Local Frequency is not 50 Hz, any active Contingency FCAS or PFR controllers should adjust the FCAS Facility output to take into account Local Frequency in accordance with the FCAS Facility's droop function.

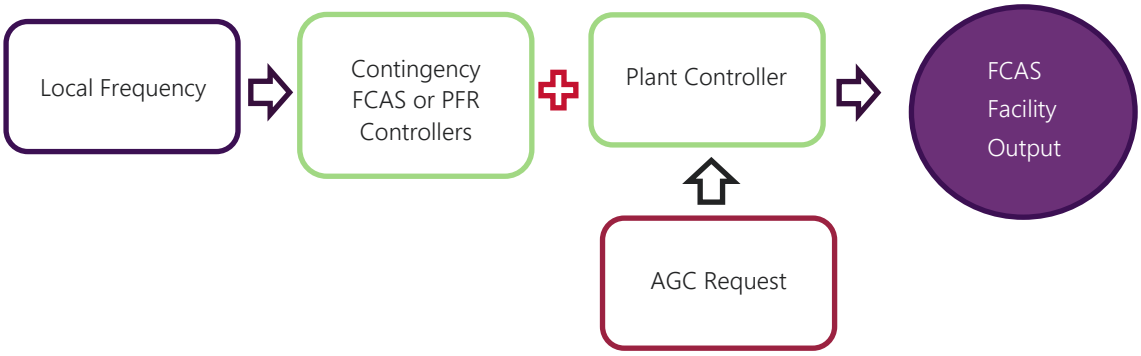
To achieve this control co-ordination, FCAS Facilities that are controlled by AGC must ensure that their Plant Controller is able to respond in an additive manner (i.e. a net sum) using their Contingency FCAS or PFR controllers and AGC controls. The total expected change in output is

[14] 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 22 December 2023.

[15] 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 22 December 2023.

subject to *enabled* quantities of each FCAS and applicable PFR obligations[16]. A high-level example is shown in Figure 1, which outlines the expected FCAS Facility behaviour. Actual control design will vary by *plant* and technology and may be subject to other control actions, various limits and intermediate controllers.

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




Hence, where relevant, Contingency FCAS or PFR controllers must detect Local Frequency and calculate an appropriate response. The FCAS Facility's Plant Controller should 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 FCAS Facility.

Because AGC must balance various objectives simultaneously (including frequency control, load following, time error correction and dispatch ramping), occasionally, the direction of the Contingency FCAS or PFR response calculated by the FCAS Provider could be the opposite to the AGC control signal. Example responses are provided in Appendix B.

AEMO will monitor the output of FCAS Facilities and Aggregated FCAS Facilities *enabled* to deliver Regulation FCAS in accordance with Appendix A of the Dispatch Procedure[17].

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

## 7.4. Control System

The FCAS Facility must have a *control system* that can:

(a) transmit 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 every 4 s to AEMO via SCADA and with no greater than 8 s latency, excluding external processing and communications delays[18];

(b) receive Raise Signals and Lower Signals;

[16] Only *Scheduled Generators* and *Semi-Scheduled Generators* have PFR obligations.

[17] Available at http://aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Power_System_Ops/Procedures/SO_OP_3705---Dispatch.pdf.

[18] FCAS Providers must comply with this requirement by 22 December 2023.

(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[19];

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

(e) maintain at all times a Control Response Delay (CRD) no greater than 150 s[20]; and

(f) maintain at all times a Setpoint Change Deadband greater than or equal to half of the FCAS Facility's minimum Regulation FCAS offer quantity as required by Sections 7.1 and 7.2[21].

An Aggregated FCAS Facility's *control system* for *regulating raise service* or *regulating lower service* must only apply to the whole Aggregated FCAS Facility.

## 7.5. 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 FCAS Facility for at least 60 s and then immediately transmit Raise Signals or Lower Signals to the FCAS 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[22] of the relevant market ancillary services offer and the corresponding Raise Rate Limit or Lower Rate Limit for at least 5 min 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 60 s to which paragraph (a) refers;

  (ii) fit a linear function of time (of the form P = P2 + R2 * t) to the earliest power measurements made over the following 5 min 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

  (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 5 min.

[19] AGC will control FCAS Facility output within the ramp rates telemetered to AEMO by the FCAS Facility.

[20] FCAS Providers must comply with this requirement by 22 December 2023.

[21] FCAS Providers must comply with this requirement by 22 December 2023.

[22] For assessing Raise capability, only the enabled Raise price bands apply. For assessing Lower capability, only the enabled Lower price bands apply.

(c) The test must be discarded if the FCAS Facility produces a Contingency FCAS response or significant PFR action during the test as this may invalidate the results.

## 7.6. Tests

FCAS Providers must notify AEMO of the date on which they intend to undertake tests to reasonably demonstrate that their FCAS Facilities meet the MASS requirements applicable to Regulation FCAS:

(a) no less than every 4 years;

(b) within 8 weeks following a major overhaul of the FCAS Facility or any change to *active power* controls; and

(c) within 8 weeks of a request from AEMO.

Tests should be undertaken within 8 weeks after the date of the FCAS Provider's notice to AEMO.

Test results must be provided to AEMO within 20 *business days* of completion of the relevant test. Any failure to provide test results to AEMO or to demonstrate that an FCAS Facility complies with the MASS may result in AEMO constraining the FCAS Facility's participation in the Regulation FCAS *market* as contemplated in the NER.

# 8. Trials of new technologies

## 8.1. 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.

## 8.2. 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.

## 8.3. Transitional arrangements for VPP Demonstrations facilities

### 8.3.1. 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[23] (**Trial Specification**), which included a power flow and *frequency* measurement time resolution of 1 s taken at the *connection point* of each *ancillary service load*.

For the period ending on 30 June 2023, (**VPP transition period**), the transitional requirements in section 8.3.2 will apply to Aggregated FCAS Facilities that were classified by a Trial Participant and included in the VPP Demonstrations as at the date this section 8.3 comes into effect (**Trial Facilities**).

### 8.3.2. 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 section 2.1 and clauses 2.2(a) and 2.2(b) of 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 a Trial Facility's *connection points* are captured with a sampling rate >200 ms, AEMO will apply a discount of 5% to the quantity of Fast FCAS measured at all those *connection points*;

(d) FCAS Facilities that were not part of a Trial Facility immediately prior to the VPP transition period can only be added to a Trial Facility:

  (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 churn and for the discount applied under paragraph (c); and

  (ii) in accordance with all applicable registration and classification requirements, including relevant fees.

### 8.3.3. After the VPP transition period

All Trial Facilities that are not providing Contingency FCAS in accordance with the requirements of the MASS as if this section 8.3 did not apply (i.e, not as varied by 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.

[23] AEMO. VPP Demonstrations FCAS Specification. Available at https://aemo.com.au/initiatives/major-programs/nem-distributed-energy-resources-der-program/der-demonstrations/virtual-power-plant-vpp-demonstrations.

# Appendix A. Standard Frequency Ramp

**Figure 2 Standard Frequency Ramp for the Mainland**

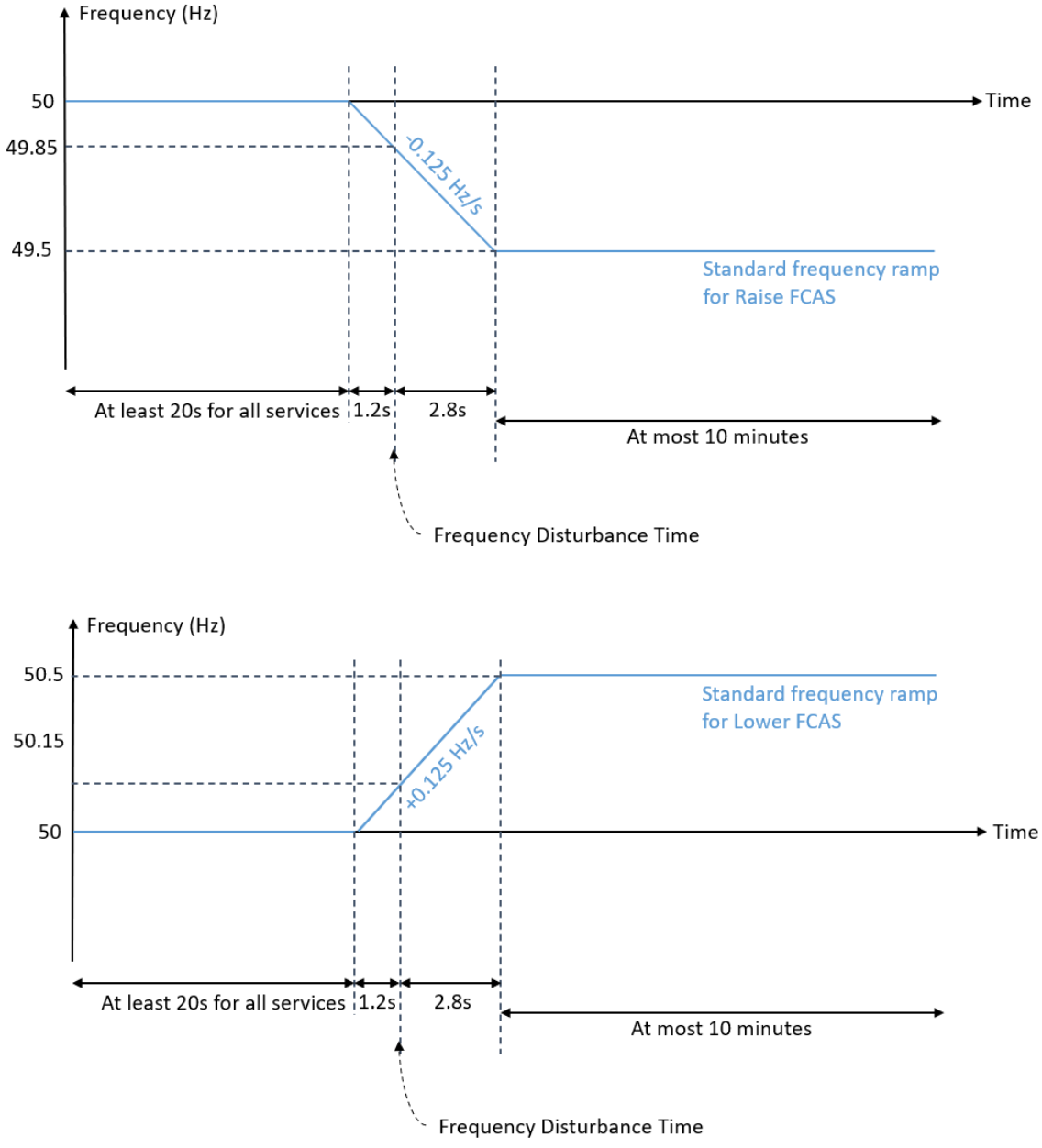
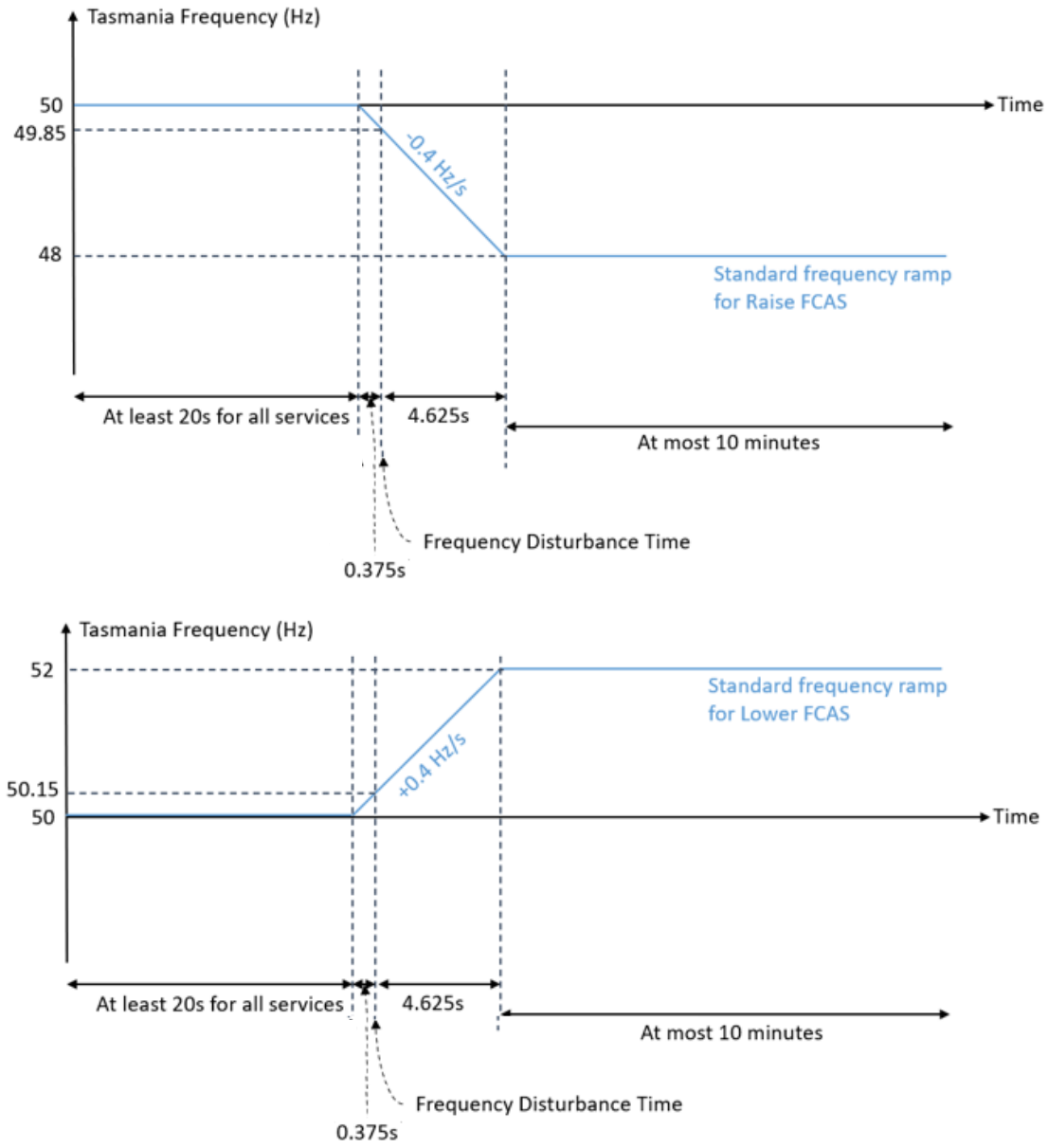


**Figure 3 Standard Frequency Ramp for Tasmania**



# Appendix B. Fast Frequency Ramp

**Figure 4 Fast Frequency Ramp for the Mainland**

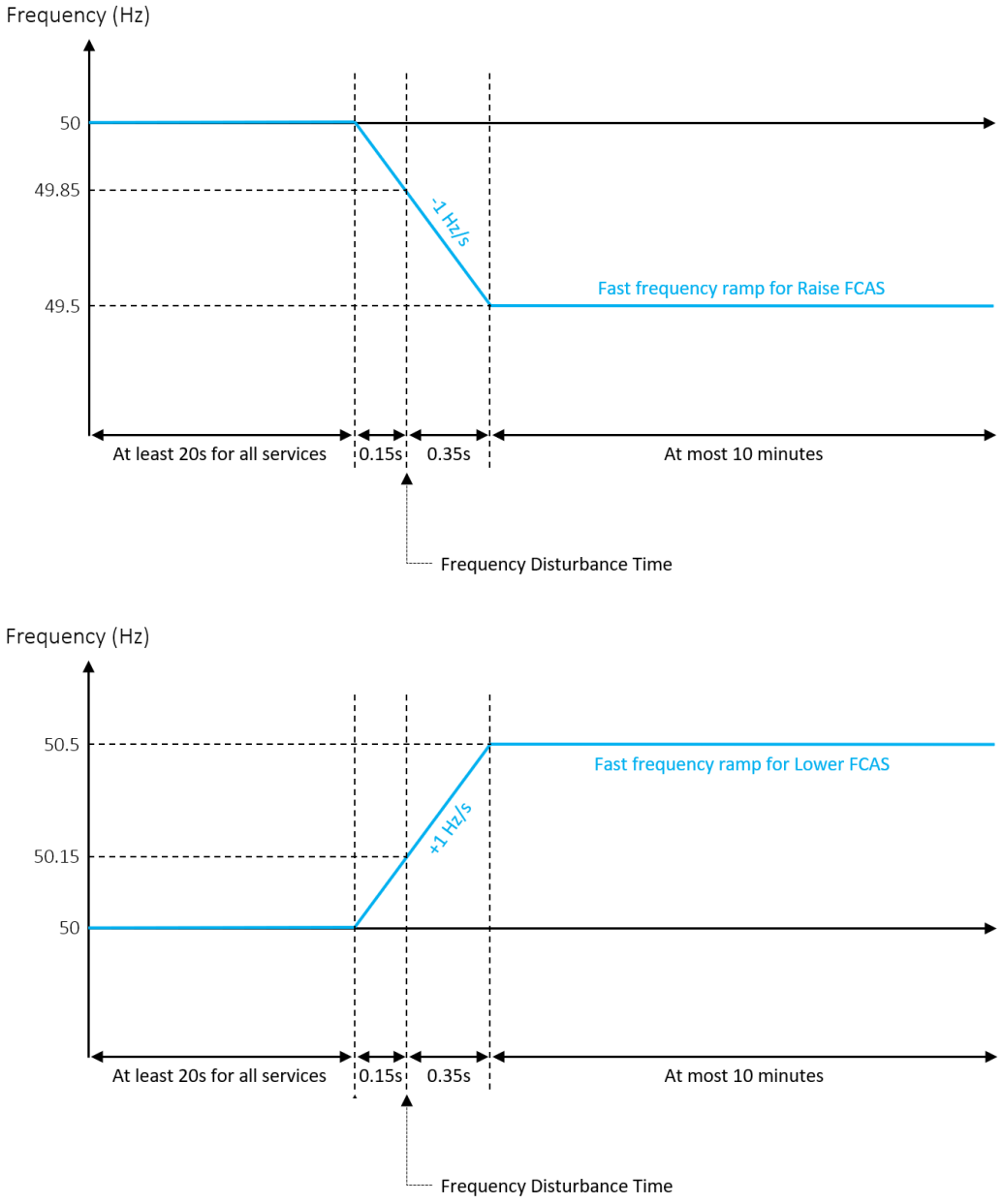
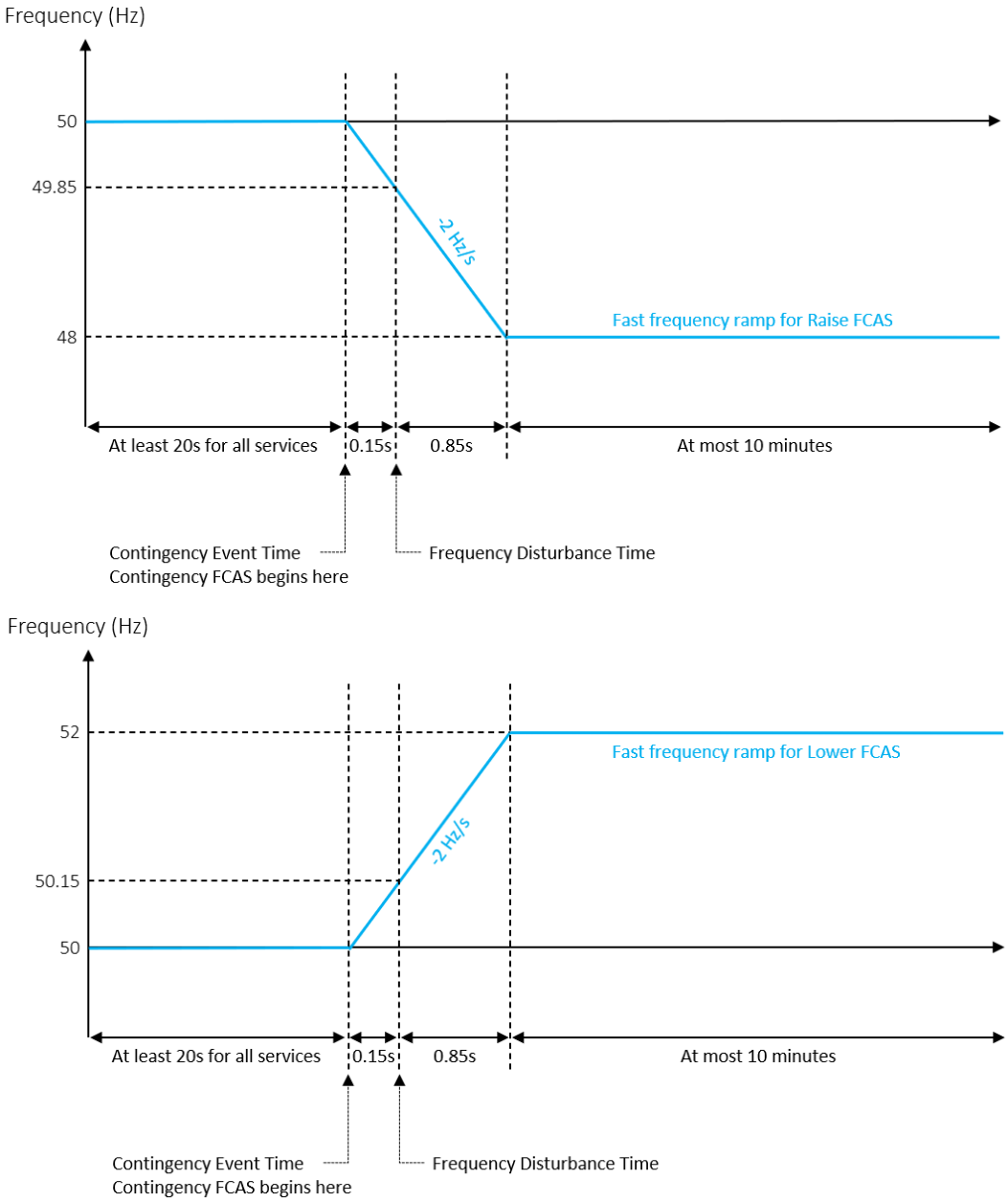


**Figure 5 Fast Frequency Ramp for Tasmania**



# Appendix C. Examples of FCAS measurement and delivery

### Measurement and delivery of Contingency FCAS

Figure 6 shows a visual representation of the measurements applied to verify that at least the minimum required Contingency FCAS has been delivered in each timeframe by an FCAS Provider not registered in the Very Fast FCAS markets.

It is not recommended that FCAS Providers use these measurements as the sole basis of FCAS control design.

**Figure 6 Measurement timeframes for Raise Contingency FCAS for the Mainland and Tasmania**

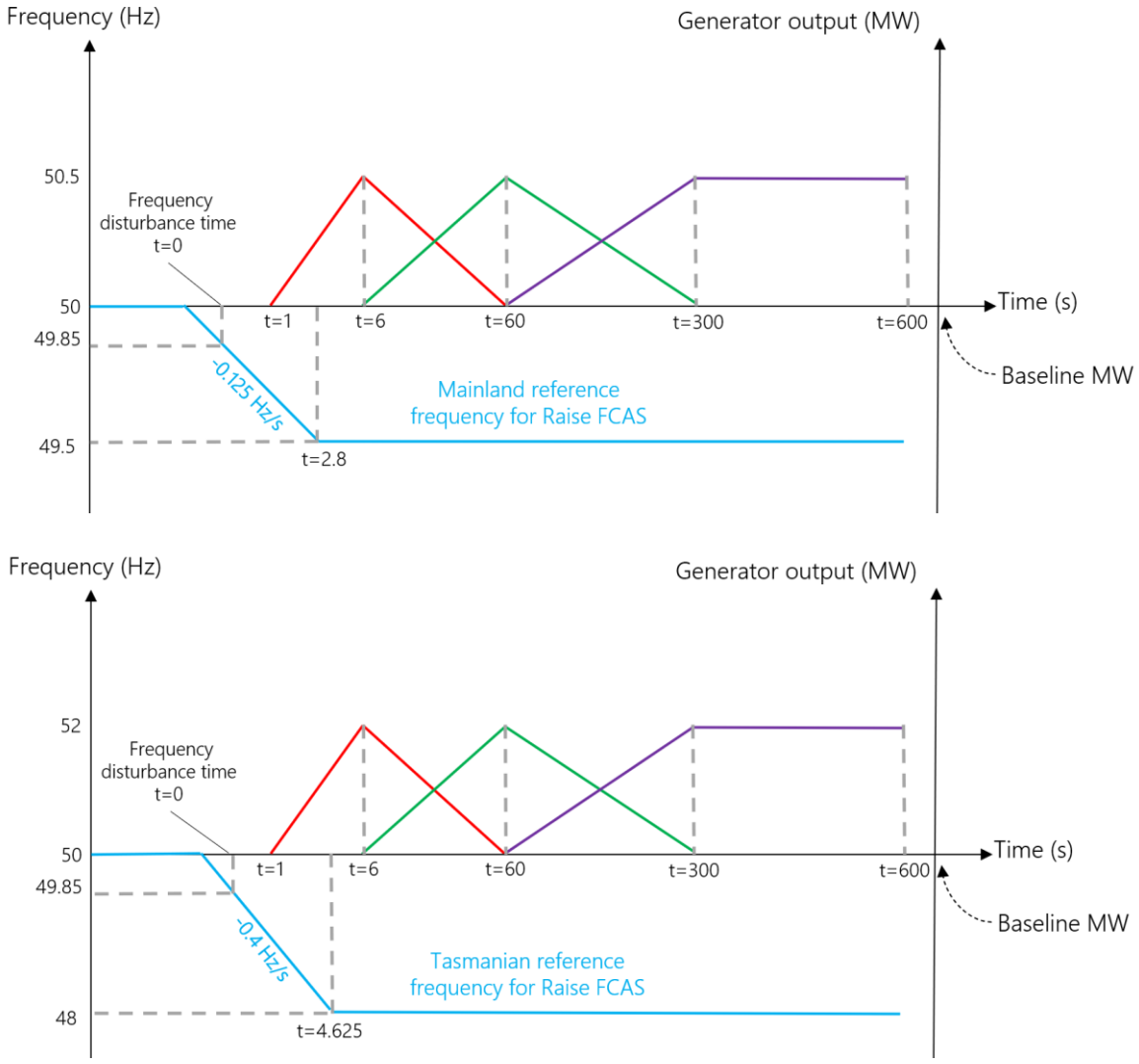



Figure 7 shows an example of how a simple Variable Controller that supplies a droop-based response to a Frequency Disturbance can deliver across the Contingency FCAS timeframes by an FCAS Provider not registered in the Very Fast FCAS markets.

**Figure 7 Combined measurement timeframes for Raise Contingency FCAS for Mainland and Tasmania**

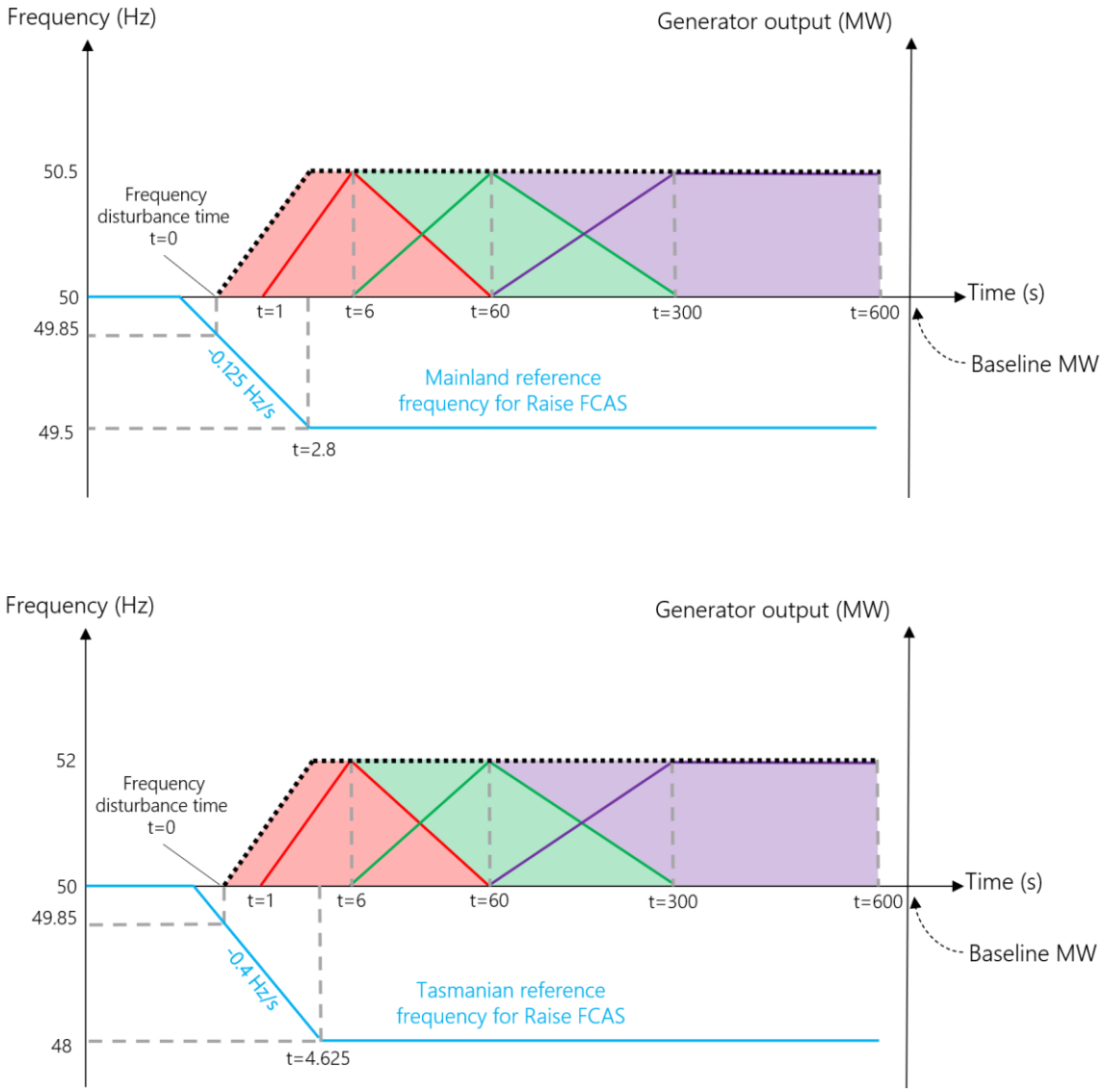



Figure 8 shows a visual representation of the measurements applied to verify that at least the minimum required Contingency FCAS has been delivered in each timeframe by an FCAS Provider also registered in the Very Fast FCAS markets.

**Figure 8 Measurement timeframes for Raise Contingency FCAS for the Mainland and Tasmania**

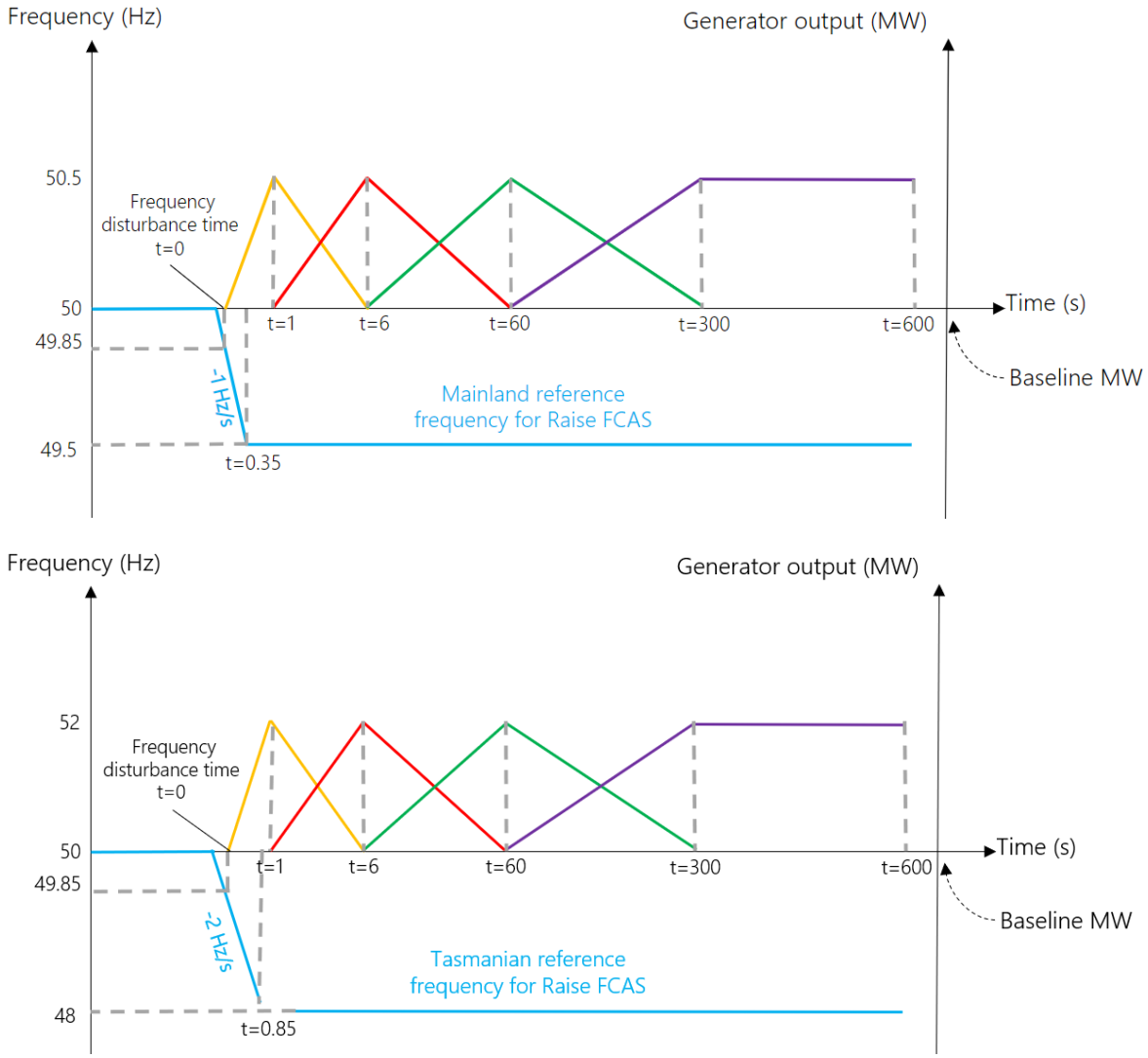
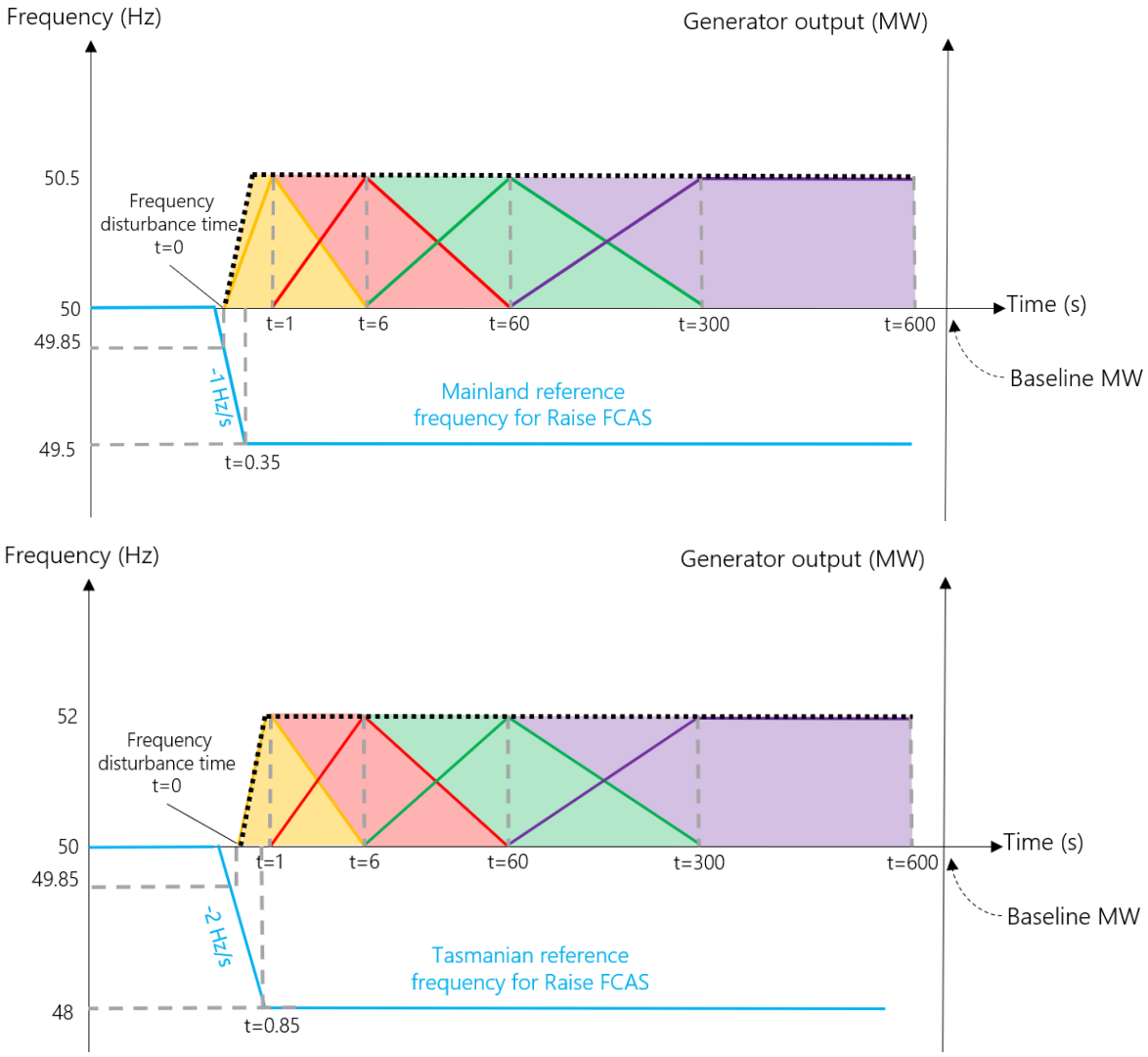



Figure 9 shows an example of how a simple Variable Controller that supplies a droop-based response to a Frequency Disturbance can deliver across the Contingency FCAS timeframes by an FCAS Provider also registered in the Very Fast FCAS markets.

**Figure 9 Combined measurement timeframes for Raise Contingency FCAS for Mainland and Tasmania**




### Examples of frequency co-ordinated response

Note that these examples are high level only and use a FCAS Facility with Setpoint Control. FCAS Facilities with Raise/Lower Controls are given Raise Controls 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 Regulation FCAS response is subject to *enabled* quantities, ramp rates and PFR settings, where relevant.

**Figure 10 Co-ordinated output for FCAS Facility at 100 MW given Raise Regulation FCAS request of 2 MW while responding with 30 MW to a Frequency Disturbance**

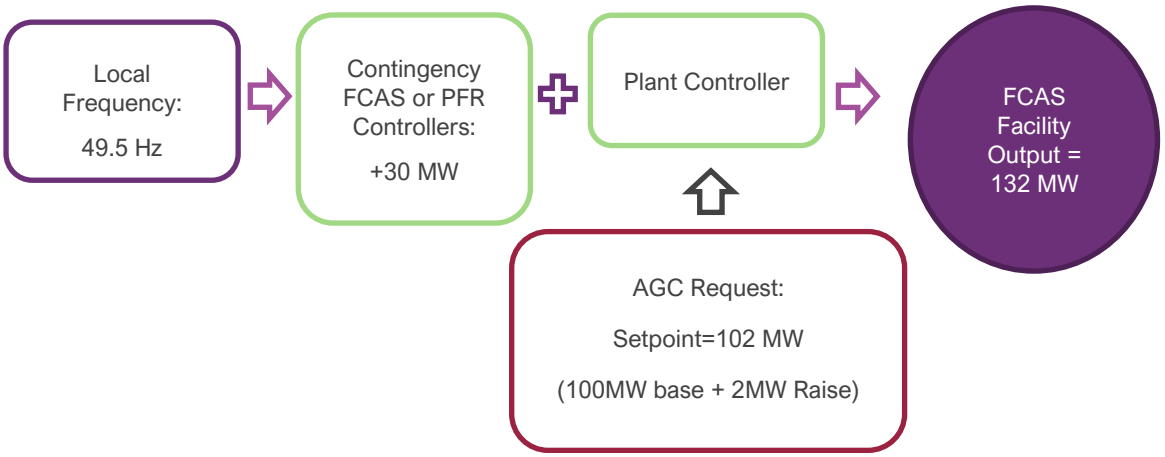
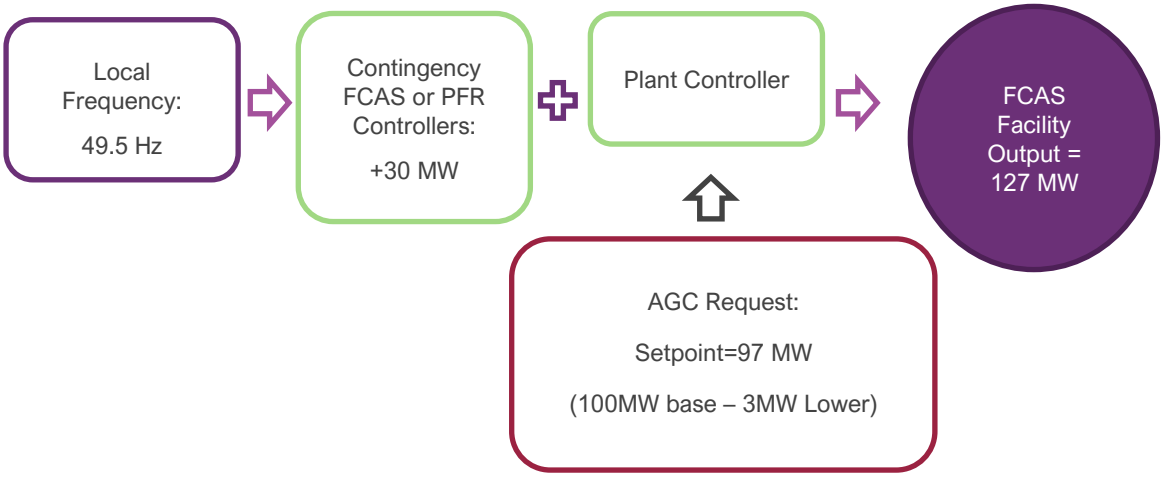



**Figure 11 Co-ordinated output for FCAS Facility at 100 MW given Lower Regulation FCAS request of 3 MW while responding with 30 MW to a Frequency Disturbance**



# Version release history

| Version | Effective date | Summary of changes |
|---|---|---|
| 8.2 | 3 June 2024 | Updates to reflect National Electricity Amendment (Integrating energy storage systems into the NEM) Rule 2021 No.13 and National Electricity Amendment (Implementing integrated energy storage systems) Rule 2023 No.2. |
| 8.1 | 9 Oct 2023 | Revised following consultation on the Fast Frequency Ramp for Tasmania. |
| 8.0 | 9 Oct 2023 | Revised following consultation on the creation of Very Fast FCAS markets. |
| 7.0 | 1 Feb 2022 | • Revised following consultation on measurement arrangements for aggregated ancillary service facilities.<br>• Restructure to remove unnecessary duplication and improve readability. |
| 6.0 | 1 Jun 2020 | • Revised following consultation on relationship with the draft Primary Frequency Response rule change (ERC0274).<br>• Minor drafting updates, corrections and clarifications. |
| 5.0 | 30 Jun 2017 | Revised after consultation |
| 4.0 | 30 Mar 2012 | Revised after consultation |
| 3.0 | 1 Jul 2010 | Revised after consultation |
| 2.0 | 5 May 2009 | Revised to align with the revised Tasmania frequency operating standards |
| 1.5 | 27 Feb 2004 | Revised to include the Tasmania region |
| 1.0 | Sep 2001 | Initial document issued at the commencement of the market ancillary services |