MARKET ANCILLARY SERVICE SPECIFICATION

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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
2.0	1 Jul 2009	Updated to reflect NEMMCO's transition to AEMO
3.0	1 Jul 2010	Revised after consultation
3.01	1 Jul 2010	Typographical ~~Error~~error in Table 4 ~~Corrected~~corrected. The entry in level 3, column 3 was previously an incorrect value of 51.875 and is corrected to 50.875. This is the only change to this version.
3.02	23 Sep 2011	This draft version is prepared for the first stage consultation. The proposed changes are intended to address the matters raised in the Issues Paper issued as part of the first stage consultation.
3.03	25 Jan 2012	Revisions made as a part of the draft determination report and the notice of second stage. The proposed changes are intended to address the matters raised in the submissions and meetings with consulted parties in response to the first stage notice
4.0	30 Mar 2012	Revised after consultation
5.0	30 Jun 2017	Revised after consultation

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1. INTRODUCTION

1.1. Purpose and scope

This is the *market ancillary service specification* (MASS) made under Rule 3.11.2(b) of the National Electricity Rules (NER).

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.

The MASS must contain:

(1) a detailed description of each kind of *market ancillary service*; and

(2) the performance parameters and requirements which must be satisfied in order for a service to qualify as the relevant *market ancillary service* and also when a *Market Participant* provides the relevant kind of *market ancillary service*.

For more information about market ancillary services, please contact ~~AEMO's~~the Australian Energy Market Operator (AEMO) Information & Support Hub (Support.Hub@aemo.com.au) or call AEMO on 1300 236 600.

1.2. Definitions and interpretation

1.2.1. Glossary

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

Terms defined in the National Electricity Law or the NER have the same meanings in the MASS unless otherwise specified in this clause. Those terms/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.

Table 1 Definition of ~~Terms~~terms

Term	Definition
Aggregated Ancillary Service Facility	The relevant plant which *ancillary service generating units* and/or *ancillary service loads* have aggregated to provide the relevant *market ancillary service*
Aggregated Generation Amount	means the amount of power flow through one or more *connection points* of an aggregated *ancillary service generating unit*, measured in megawatts (MW~~,~~), with flow from the *ancillary service generating unit* being positive
Aggregated Load Amount	means the amount of power flow through one or more *connection points* of an aggregated *ancillary service load*, measured in MW, with flow towards the *ancillary service load* being negative
Ancillary Service Facility	The *ancillary service generating unit* and/or *ancillary service load* used to provide the relevant *market ancillary service*
Contingency Services	means the (1) the fast raise service; (2) the fast lower service; (3) the slow raise service; (4) the slow lower service; (5) the delayed raise service; and (6) the delayed lower service

Term	Definition
Controlled Quantity	means a measured quantity of *generation* or *load* that is: (a) controlled by the action of Raise Signals and Lower Signals; (b) measured and transmitted to *AEMO's* control centre; and (c) unless otherwise agreed between *AEMO* and the relevant *Market Participant*, the same quantity specified in a *dispatch bid* or *dispatch offer* of the Ancillary Service Facility
Frequency Control Ancillary Services (FCAS)	means those *ancillary services* concerned with balancing, over short intervals (shorter than the dispatch interval), the power supplied by *generating units* and the power consumed by *loads*. Procured as *market ancillary services*
Frequency Control Ancillary Service Ancillary Service Verification Tool (FCASVT)	means the Frequency Control Ancillary Service Ancillary Service Verification Tool; an excel spreadsheet designed to verify the performance of Contingency Services
Frequency Dead-Band	means the range of Local Frequency through which a Variable Controller will not operate
Frequency Deviation Setting(s)	means the setting or settings allocated to *the* Ancillary Service Facility by AEMO within the range shown in Table 3~~Table 2~~ for *regions* other than Tasmania and Table 4~~Table 3~~ for the Tasmania *region*
Frequency Disturbance	means an occasion when the *frequency* of the *power system* moves outside the *normal operating frequency band*
Frequency Disturbance Time	means the time at which Local Frequency falls or rises outside the *normal operating frequency band* during a Frequency Disturbance, referenced to Australian Eastern Standard Time[1]
Frequency Operating Standards	has the meaning given in the *NER*, as applicable to the *region* in which the relevant Ancillary Service Facility is located
Frequency Ramp Rate	Means 0.125 hertz (Hz) per second for *regions* other than Tasmania or 0.4 Hz per second for the Tasmanian *region*
Frequency Rate of Change Multiplier	means a value in Table 3~~Table 2~~ for *regions* other than Tasmania, or Table 4~~Table 3~~ for the Tasmanian *region*, which corresponds to the allocated Frequency Setting
Frequency Recovery	means the first change in Local Frequency from above 50.15 Hz to below 50.1 Hz, or below 49.85 Hz to above 49.9 Hz, to occur after a Frequency Disturbance
Frequency Setting(s)	means ~~a~~the level(s) of *frequency* or a combined level(s) of *frequency* and *frequency* rate of change determined by *AEMO* in accordance with the procedure set out in clause 7.2 of the *MASS* and notified in writing to the *Market Participant* for use by a Switching Controller or a *combined* Switching Controller for a particular Ancillary Service Facility when providing a particular *market ancillary service*
Generation Amount	means the amount of power flow through a *connection point* of an *ancillary service generating unit*, measured in MW, with flow from the *ancillary service generating unit* being positive

[1] The Frequency Disturbance Time is referred to in the equations in the MASS as occurring at t = 0.

Term	Definition
Generation Event	has the meaning given or implied in the relevant Frequency Operating Standards
Inertial Response	means the change in Generation Amount or Load Amount due to the effect of the inertia of the Ancillary Service Facility
Initial Value	means the Generation Amount or Load Amount just prior to the Frequency Disturbance Time of a Frequency Disturbance
Load Amount	means the amount of power flow through a *connection point* of an *ancillary service load*, measured in MW, with flow towards the *ancillary service load* being negative
Load Event	has the meaning given or implied in the relevant Frequency Operating Standards
Local Frequency	means the *frequency* of the electricity ~~delivered~~measured by an *ancillary service generating unit* or consumed by an *ancillary service load*, measured in Hz
Lower Control Limit	means the lowest level to which a Controlled Quantity may be controlled in response to Lower Signals, as transmitted to *AEMO's* control centre
Lower Rate Limit	means the highest rate at which a Controlled Quantity may be controlled in response to Lower Signals, as transmitted to *AEMO's* control centre
Lower Reference Frequency	means the containment frequency above 50 Hz for Load Events, as given in the relevant Frequency Operating Standards
Lower Response	means the decrease in Generation Amount or increase in Load Amount with respect to the corresponding Initial Value
Lower Signal	means a control signal sent by or on behalf of *AEMO* in a form agreed between *AEMO* and the relevant *Market Participant* in order to request delivery of Regulating Lower Response
Operational Frequency Tolerance Band	has the meaning given in the *NER* and the value given in the relevant *frequency operating standard*
Raise Control Limit	means the highest level to which a Controlled Quantity may be controlled in response to Raise Signals, as transmitted to *AEMO's* control centre
Raise Rate Limit	means the highest rate at which a Controlled Quantity may be controlled in response to Raise Signals, as transmitted to *AEMO's* control centre
Raise Reference Frequency	means the containment frequency below 50 Hz for Generation Events, as given in the relevant Frequency Operating Standards
Raise Response	means the increase in Generation Amount or decrease in Load Amount with respect to the corresponding Initial Value
Raise Signal	means a control signal sent by or on behalf of *AEMO* in a form agreed between *AEMO* and the relevant *Market Participant* in order to request delivery of Regulating Raise Response
Regulating Lower Response	means the decrease in Generation Amount or increase in Load Amount delivered in response to one or more Lower Signals

Term	Definition
Regulating Raise Response	means the increase in Generation Amount or decrease in Load Amount delivered in response to one or more Raise Signals
Standard Frequency Ramp	means a linear change of Local Frequency from one level to another at the applicable Frequency Ramp Rate and then sustained, as shown in Appendix A
Switching Controller	means a *control system* that delivers a specific amount of service when one or more specified conditions are met
System Frequency	means a *frequency* measured by or for *AEMO* that represents the *frequency* of the *power system* to which the Ancillary Service Facility is connected
Time Average	means, in respect of 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 time interval duration
Trigger Range	means the contiguous range comprising the upper 40% of the range between 50 Hz and the Raise Reference Frequency and the lower 40% of the range between 50 Hz and the Lower Reference Frequency
Trigger Rate	means 0.05 Hz per second for *regions* other than Tasmania and 0.15 Hz per second for the Tasmanian *region*
Variable Controller	means a *control system* that delivers a variable amount of *market ancillary service* commensurate with the size of the Frequency Disturbance

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) References to time are references to Australian Eastern Standard Time.

1.3. Related documents

Table 2 Title and location of related documents

Title	Location
Guide to Ancillary Services in the National Electricity Market	http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Ancillary-services
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
(External) MASS 4.0 FCAS Verification Tool_v2.08	http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Ancillary-services/Market-ancillary-services-specifications-and-FCAS-verification

2. MARKET ANCILLARY SERVICES PRINCIPLES

2.1. Principles

As defined in clause 3.11.1 of the *NER*, *ancillary services* are services that are essential to the management of *power system security*, facilitate orderly trading in electricity, and ensure that electricity supplies are of acceptable quality. Frequency Control Ancillary Services (FCAS) are acquired by *AEMO* as *market ancillary services* as part of the *spot market* in accordance with Chapter 3 of the NER to maintain the System Frequency within the operating limits specified in the *frequency operation standards*.

The MASS sets out the more detailed specification of the *market ancillary services* and how *Market Participants'* performance when providing these *market ancillary services* is measured and verified.

The MASS is designed to:

- Avoid any special treatment in respect of different technologies used by *Market Participants*.
- Treat ~~*ancillary service facilities*~~Ancillary Service Facilities with the same performance equally.
- Provide for equal access to the market for existing and prospective *Market Participants*.

The definitions and requirements of the *market ancillary services* detailed in the MASS are designed to allow *AEMO* to manage System Frequency in accordance with the Frequency Operating Standards.

AEMO employs two types of *market ancillary services* to manage System Frequency during normal operational conditions and following *contingency events*:

- Contingency Services, which are *enabled* to correct material *frequency deviations* that might arise from larger supply-demand imbalances.
- *Regulation services*, which are *enabled* to manage minor *frequency deviations* within the five minute *dispatch interval*.

2.1.1. Contingency Services

The purpose of the Contingency Services is to manage Frequency Recovery after an under- or-over-frequency event to arrest the *frequency* fall or raise, and recover the *frequency* as required by the Frequency Operating Standards. As such, Contingency Services, while always enabled to cover *contingency events*, are only occasionally used.

Contingency Services are locally controlled and triggered by the *frequency* deviation that follows a *contingency event*.

Contingency Services are provided by technologies that can locally detect the *frequency* deviation and respond in a manner that corrects the *frequency*. Some examples of these technologies include:

- *Generating unit* governor response~~:~~ – where the *generating unit* governor on a steam turbine reacts to the *frequency* deviation by opening or closing the turbine steam valve and altering the megawatt (MW) output of the *generating unit* accordingly.
- *Load* reduction~~:~~ – where a *load* can be quickly disconnected from the electrical system (can act to correct a low *frequency* only).
- Rapid *generating unit* loading~~:~~ – where a *frequency* relay will detect a low *frequency* and correspondingly start a fast *generating unit* (can act to correct a low *frequency* only).
- Rapid *generating unit* unloading~~:~~ – where a *frequency* relay will detect a high *frequency* and correspondingly reduce a *generating unit* output (can act to correct a high *frequency* only).
- Potential rapid change in consumption/generation from batteries.

By contrast, the actions from the inertia of plant connected to the power system are not considered a supply of Contingency Services.

There are six Contingency Services:

- *fast raise service*;
- *fast lower service*;
- *slow raise service*;
- *slow lower service*;
- *delayed raise service*; and
- *delayed lower service*.

It is possible for a registered Ancillary Service Facility to be enabled to provide any or all of these Contingency Services.

~~*Ancillary service facilities* should not provide Contingency Services once the Local Frequency has recovered, for example:~~

- ~~If *frequency* recovers above 49.9 Hz within six seconds, there should be no slow Raise Response or delayed Raise Response.~~
- ~~If *frequency* recovers below 50.1 Hz within six seconds, there should be no slow Lower Response or delayed Lower Response.~~
- ~~If the *frequency* recovers above 49.9 Hz between six seconds and 60 seconds, there would be no delayed Raise Response.~~
- ~~If the *frequency* recovers below 50.1 Hz between six seconds and 60 seconds, there would be no delayed Lower Response.~~

2.1.2. Regulation services

Regulation services are enabled to manage minor changes to System Frequency within the *normal operating frequency band* following small deviations in the demand~~ / ~~/generation balance within the five minute *dispatch interval*. There are two *regulation services*:

- *Regulating raise*~~;~~ – to increase System Frequency
- *Regulating lower*~~;~~ – to reduce System Frequency.

Regulation services are centrally controlled by *AEMO*. *AEMO's Automatic Generation Control (AGC)* system allows *AEMO* to continually monitor the *frequency* and time error. It also sends control signals through the *supervisory control and data acquisition (SCADA)* systems to ~~*ancillary service facilities*~~Ancillary Service Facilities enabled to provide *regulation services* so *frequency* is maintained within the *normal operating frequency band* of 49.85 ~~Hz to 50.15 Hz. These control signals alter the megawatt (MW) output of *generating units* or the consumption of *loads* to correct the demand / generation imbalance.~~hertz (Hz) to 50.15 Hz.

These control signals alter the MW output of *generating units* or the consumption of *loads* to correct the demand/generation imbalance. In contrast to the occasional use of Contingency Services, enabled *regulation services* are normally utilised by *AEMO* in each dispatch interval.

It is possible for a registered Ancillary Service Facility to be enabled to provide either or both *regulation services*.

2.2. Contracting

Nothing in this *MASS* is intended to prevent a *Market Participant* procuring a third party to provide equipment or recording service, or perform any other action required or contemplated by this *MASS*.

2.3. Accuracy of Market Ancillary Service bids

Market Participants must ensure that *market ancillary service offers* reflect the physical availability and capability of the *market ancillary service* as per Rule 3.8.7A of the NER. Where there is a condition that results in changed availability and capability of the *market ancillary service*, the *Market Participant* must rebid to reflect changes to the *market ancillary service* availability and capability in the *central dispatch* process. This includes services that are aggregated across multiple *connection points*.

2.4. Aggregation of Ancillary Service Facilitates

Market Participants who wish to aggregate their *generating units*, or *Market Ancillary Service Providers* or *Market Customers* who wish to aggregate their *loads* as *ancillary service loads* for the purpose of *central dispatch*, may apply to do so in accordance with Rule 3.8.3 of the NER.

Unless otherwise agreed with AEMO, a *market ancillary service offer* for *ancillary services* in respect of a *generating unit* or *load* that is aggregated for *central dispatch* of *energy* must apply to the whole aggregated *generating unit* or *load*.

In relation to *regulating services*, *AEMO's AGC* system may support the aggregated dispatch of *regulating raise service* or *regulating lower service*. In this situation, *AEMO's AGC* system will send a single signal to the aggregated unit, and the operator of that aggregated unit is responsible for ensuring that the ~~constituent~~relevant plant ~~of~~that form the ~~aggregated *ancillary service facilities*~~Aggregated Ancillary Service Facilities responds such that, in total, the aggregated unit provides the required response in an accurate and timely manner.

For the purposes of Rule 3.11.2(f) of the NER, the equipment required to monitor and record aggregated responses of ~~*ancillary service facilities*~~Ancillary Service Facilities must have the following characteristics:

i. The power flow representing the amount of *generation* or *load* of each ~~constituent~~relevant plant of the ~~aggregated~~Aggregated Ancillary Service Facility must be measured at or close to each of the relevant *connection points* and summed to calculate the Aggregated Generation Amount or Aggregated Load Amount. Where a ~~constituent unit~~relevant plant that forms part of an ~~aggregated~~Aggregated Ancillary Service Facility shares a *connection point* with a variable *load* or *generating unit*, it is the gross power flow to or from the relevant plant that ~~constituent unit~~forms the aggregated response, and must be directly measured.

ii. For Contingency Services, the Local Frequency must be measured at or close to each relevant *connection point* or, if otherwise agreed with AEMO, an alternative measurement may be provided that closely represents the *frequency* of each ~~aggregated~~Aggregated Ancillary Service Facility.

iii. Subject to clause 2.4(iv), the measurements of power flow and Local Frequency of aggregated ~~*ancillary service facilities*~~Ancillary Service Facilities must be made at an interval specified under clauses 3.6, ~~(e)~~(e)4.6 and 5.6. Sufficient information should be provided to compare the Local Frequency and power flow data in a common time scale.

iv. If agreed with *AEMO*, where a Switching Controller is used, the measurement of power flow representing the Aggregated Generation Amount or Aggregated Load Amount may be made at intervals of up to four seconds, provided that another measurement of power flow at an interval of 50 milliseconds or less is provided sufficient to determine the timing of the *market ancillary service* provision relative to Local Frequency.

v. ~~As the~~The clocks associated with the meters of ~~constituent units of~~relevant plant that form an ~~aggregated~~Aggregated Ancillary Service Facility may record slightly differing times. To correct for this, *Market Participants* must time-align the data logged by each meter to the actual time the Frequency Disturbance was detected,
being the time the System Frequency measurement first falls outside the *normal operating frequency band*.

A request issued by *AEMO* to a *Market Participant* under Rule 3.11.2 (h) of the NER~~,~~ may include a request for the *Market Participant* with an ~~aggregated~~Aggregated Ancillary Service Facility to provide a report detailing the response of each unit that constitutes the ~~aggregated~~Aggregated Ancillary Service Facility to a particular change or changes in the *frequency* of the power system. For Contingency Services, this may include the response as determined by the Frequency Control Ancillary Services Tool (FCASVT*)*, or the *Market Participant* may propose an alternate method of demonstrating the response of the ~~constituent units~~relevant plant that form the Aggregated Ancillary Services Facility which *AEMO*, at its discretion, may accept. A *Market Participant* must provide a report promptly but, in any event, no more than 20 business days after notice is given.

2.5. The Frequency Control Ancillary Services Verification Tool (FCASVT)

The FCASVT[2] has been made available to *Market Participants* to help calculate the Contingency Services delivered by their plant.

The FCASVT will calculate the quantities of *fast raise, slow raise, delayed raise, fast lower, slow lower, and delayed lower service*~~,~~ delivered by the Ancillary Service Facility in accordance with the principles contained in the MASS.

The FCASVT contains detailed algorithms that implement the principles listed in the MASS. These algorithms are used by *AEMO* to verify Contingency Services delivered by market ancillary service facilities.

The FCASVT is currently implemented as an excel spreadsheet. *AEMO* may update the algorithms and its form from time to time.

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 does not constitute a part of the MASS.

3. FAST RAISE AND FAST LOWER SERVICES

3.1. Principles

The purpose of *fast raise and fast lower services* is to arrest the fall or rise in System *Frequency* following a *contingency event* that results in System *Frequency* being outside the *normal operating frequency band*.

3.2. Definitions

AEMO will issue *dispatch instructions* through its market systems to *registered* providers of *fast raise and fast lower services* to enable the required quantities of *fast raise and fast lower services* based on the *bids* and *offers* received. Once enabled, the provider of *fast raise or fast lower services* must respond to Local Frequency without further instruction from *AEMO* during the period of enablement.

Fast raise service is the service to either increase *generation* or decrease *load* rapidly in response to decreases in Local Frequency. It has traditionally been provided by governor systems on *generating units* and by under-frequency *load* reduction.

Fast lower service is the service to either decrease *generation* or increase *load* rapidly in response to increases in Local Frequency. It has traditionally been provided by governor systems on *generating units*.

These fast services are valued by their ability to arrest a rapid change in System Frequency within the first six seconds of a Frequency Disturbance, then provide an orderly transition to the *slow raise service* or *slow lower service*.

3.3. Amount of Fast Raise Service for Dispatch Purposes

For the purposes of a *market ancillary service* offer for *dispatch*, 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 between zero and six seconds from the Frequency Disturbance Time, excluding any Inertial Response; and

(b) twice the Time Average of the Raise Response between six and 60 seconds from the Frequency Disturbance Time, excluding any Inertial Response,

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

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

3.4. Amount of Fast Lower Service for Dispatch Purposes

For the purposes of a *market ancillary service* offer for *dispatch*, 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 between zero and six seconds from the Frequency Disturbance Time, excluding any Inertial Response; and

(b) twice the Time Average of the Lower Response between six and sixty seconds from the Frequency Disturbance Time, excluding any Inertial Response,

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

3.5. Control Facilities for Fast Raise Service and Fast Lower Service

For the purposes of Rule 3.11.2(b) of the NER:

(a) The Ancillary Service Facility must have *a control system* to automatically initiate:

  (i) a fast Raise Response when Local Frequency changes are below the lower limit of the *normal operating frequency band*; or

  (ii) a fast Lower Response when Local Frequency changes are above the upper limit of the *normal operating frequency band*,

  in accordance with the *control system* requirements of paragraphs (b) and (c) below, whenever the respective *market ancillary service* is *enabled*.

(b) The *control system* for a fast Raise Response may be either a Variable Controller or a Switching Controller or a discrete combination of both, and must operate so that the amount of Raise Response is either:

  (i) for a Variable Controller, a variable amount of *market ancillary service* commensurate with the difference between Local Frequency and controller's Frequency Dead-Band for a range of Local Frequency between the *normal operating frequency band* and the lower limit of the Operational Frequency Tolerance Band; or

  (ii) for a Switching Controller, one or more step changes if the Local Frequency falls through its Frequency Setting; or

  (iii) for a discrete combination of both, responses in accordance with clauses 3.5(b)(i) and (ii) with each metered separately in accordance with metering requirements specified in clause 3.6(b).

(c) The *control system* for a fast Lower Response may be either a Variable Controller or a Switching Controller or a discrete combination of both, and must operate so that the amount of Lower Response is either:

  (i) for a Variable Controller, a variable amount of *market ancillary service* commensurate with the difference between Local Frequency and controller's Frequency Dead-Band for a range of Local Frequency between the *normal operating frequency band* and the upper limit of the Operational Frequency Tolerance Band; or

  (ii) for a Switching Controller, one or more step changes if the Local Frequency rises through its Frequency Setting; or

  (iii) for a discrete combination of both, responses in accordance with clauses 3.5(c)(i) and (ii), with each metered separately in accordance with metering requirements specified in clause 3.6(b).

(d) The *Market Participant* must inform AEMO of the details of the *control system* described by paragraphs (a), (b) and (c) above, as reasonably required by AEMO for *central dispatch* or for determining Frequency Settings*.*

(e) A Switching Controller for a *fast raise service* or *fast lower service* must be capable of adjusting its Frequency Setting to the setting provided by AEMO within the ranges shown in Table 3~~Table 2~~ for *regions* other than Tasmania or Table 4~~Table 3~~ for the Tasmanian *region*. The error needs to be no greater than 0.05 Hz for absolute Frequency Settings and 0.05 seconds for Frequency Rate of Change Multiplier.

(f) A Switching Controller must not operate if the Local Frequency is within the *normal operating frequency band*.

3.6. Measurement ~~Facilities~~facilities for Fast Raise Service and Fast Lower Service

(a) For the purposes of *Rule* 3.11.2(f) of the NER, the equipment required to monitor and record the Raise Response in respect of a *fast raise service* or the Lower Response in respect of a *fast lower service*, including both the source transducer(s) and the data recorder, must have the following characteristics:

   (i) The power flow representing the Generation Amount or Load Amount must be measured at or close to the relevant *connection point* or, if otherwise agreed with *AEMO*, sufficient measurements may be provided to calculate the Generation Amount or Load Amount.

   (ii) The Local Frequency must be measured at or close to the relevant *connection point* or, if otherwise agreed with *AEMO*, an alternate measurement may be provided that closely represents the *frequency* at the *connection point*.

   (iii) Subject to clause 3.6(a)(iv), the measurements of power flow and Local Frequency must be made at intervals of 50 millisecond or less. Sufficient information should be provided to compare the Local Frequency and power flow data in a common time scale.

   (iv) If agreed with *AEMO*, where a Switching Controller is used, the measurement of power flow representing the Generation Amount or Load Amount may be made at intervals of up to four seconds. This is provided that another measurement of power flow at an interval of 50 milliseconds or less is provided sufficient to determine the timing of the *market ancillary service* provision relative to Local Frequency.

   (v) Measurements of power flow must have a measurement range appropriate to the Ancillary Service Facility, error of less than or equal to 2% of the measurement range, and resolution of less than or equal to 0.2% of the measurement range.

   (vi) Measurements of Local Frequency must have a measurement range of at least the range defined by the Operational Frequency Tolerance Band, error of less than or equal to 0.01 Hz, and resolution of less than or equal to 0.0025 Hz.

   (vii) The measurements must have a settling time (to 99% of final value after a step change from zero) of less than 50 milliseconds.

   (viii) The equipment must record the Frequency Disturbance Time to within ten seconds.

   (ix) The equipment must trigger recording at least whenever Local Frequency changes at a rate of at least the Trigger Rate and exceeds the Trigger Range.

   (x) The equipment must record its power and *frequency* measurements for a period of at least five seconds before the Frequency Disturbance Time and at least 60 seconds after the Frequency Disturbance Time, making a total duration of at least 65 seconds.

   (xi) The recordings must be made digitally and stored in a computer file format that is reasonably acceptable to *AEMO* for analysis using commercial spreadsheet software.

   (xii) The recordings must be provided to *AEMO* on request (or as otherwise agreed) and retained by the *Market Participant* for at least 12 calendar months from the Frequency Disturbance Time.

(xiii) If a *Market Participant* is of the view that the information provided by the four second measurements can be provided more simply and with adequate accuracy by other means, they should present their case to *AEMO* for determination. A proposal that does not align with the requirements of clauses 3.6(i)(a)(i) to (xii) must ensure that the provision of the *market ancillary service* can be verified.

(xiv) Refer also to clause 2.4 in relation to aggregation of *ancillary service generating units* and *ancillary service loads*.

(b) If the *control system* is a discrete combination of a Variable Controller and a *switched controller,* there must be a process in place, agreed to by AEMO, to determine the separate amounts of Raise Response or Lower Response supplied by the Variable Controller and the Switching Controller. This can be through separate metering or from *control system* data logged at the time of the Frequency Disturbance or application of appropriate *control system* models.

3.7. Verification of ~~Performance~~performance for Fast Raise Service and Fast Lower Service

3.7.1. Principles

(a) To verify the amount of *fast raise service* or *fast lower service* delivered in response to a change in Local Frequency, the amount of service delivered must be determined using the recordings made under clause 3.6 above and is compared with the amount of the relevant *market ancillary service offer enabled* as follows:

(i) FCAS assessment commences at the Frequency Disturbance Time and ends at Frequency Recovery or, in the event that Frequency Recovery does not occur within 60 seconds of the Frequency Disturbance Time, 60 seconds from the Frequency Disturbance Time.

(ii) If the Ancillary Service Facility or ~~aggregated~~Aggregated Ancillary Service Facility is *scheduled* or *semi-scheduled*, determine the reference generation or consumption energy trajectory for the facility that the *generating unit(s)* or *load(s)* would be expected to have followed had the frequency event not occurred.

(iii) Commencing from the Frequency Disturbance Time, use this reference trajectory to adjust the measure power flows to reverse any impact of an Ancillary Service Facility being scheduled in a direction that would hinder the Frequency Recovery. For an Ancillary Service Facility that is neither *scheduled* nor *semi-scheduled*, no such adjustment is required.

(iv) Remove the impact of the Inertial Response from (ii) above, to the extent that an Inertial Response exists.

(v) The basic response is the difference between the value calculated in (iv) and a measure of the operating point of the facility just prior to the Frequency Disturbance.

(vi) For a Variable Controller, the basic response is compensated to take into account the difference between the Local Frequency and the Standard Frequency Ramp. For a Switching Controller, the basic response is compensated to take into account the timing difference for the Local Frequency to reach the Frequency Setting, compared to the Standard Frequency Ramp.

If a discrete combination of Switching Controller and Variable Controller is used, then the compensated basic response is the sum of the compensated basic responses in (v).

(vii) The definition in clauses 3.3 and 3.4 is applied to calculate the *fast raise service* or *fast lower service* delivered.

(viii) If *slow raise service* or *slow lower service* is also *enabled* for the Ancillary Service Facility, then ~~its~~the Facility's response should exceed the required response, such that the *slow raise service* or *slow lower service* can be provided.

(b) The amount of *fast raise service* or *fast lower service* delivered in response to a change in Local Frequency must be at least equal to the dispatched quantity of the relevant fast service.

4. SLOW SERVICES

4.1. Principles

The purpose of *slow raise* and *slow lower services* is to stabilise System Frequency following a *contingency event* that results in System Frequency being outside the *normal operating frequency band*.

4.2. Definitions

AEMO will issue *dispatch instructions* through its market systems to *registered* providers of *slow raise and slow lower services* to enable the required quantities of *slow raise and slow lower services* based on the *bids* and *offers* received. Once enabled, the provider of *slow raise or slow lower services* must respond to Local Frequency without further instruction from *AEMO* during the period of enablement.

Slow raise service is the service to either increase *generation* or decrease *load* rapidly in response to decreases in Local Frequency. It has traditionally been provided by governor systems on *generating units*.

Slow lower service is the service to either decrease *generation* or increase *load* rapidly in response to increases in Local Frequency. It has traditionally been provided by governing systems on *generating units*.

These slow services are valued by their ability to stabilise System Frequency within the first 60 seconds of a Frequency Disturbance, then provide an orderly transition to *delayed raise service* or *delayed lower service*.

Ancillary Service Facilities should not provide Contingency Services once the Local Frequency has recovered, for example:

- If *frequency* recovers above 49.9 Hz within six seconds from the Frequency Disturbance Time, there should be no slow Raise Response or delayed Raise Response.
- If *frequency* recovers below 50.1 Hz within six seconds from the Frequency Disturbance Time, there should be no slow Lower Response or delayed Lower Response.

4.3. Amount of Slow Raise Service for Dispatch Purposes

For the purposes of a *market ancillary service* offer for *dispatch*, 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 six and 60 seconds from the Frequency Disturbance Time, excluding any Inertial Response and fast raise service provided; and

(b) twice the Time Average of the Raise Response between 60 seconds and five minutes from the Frequency Disturbance Time,

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

4.4. Amount of Slow Lower Service for Dispatch Purposes

For the purposes of a *market ancillary service* offer for dispatch, 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 six and 60 seconds from the Frequency Disturbance Time, excluding any Inertial Response and *fast lower service* provided; and

(b) twice the Time Average of the Lower Response between 60 seconds and five minutes from the Frequency Disturbance Time, that the person making the *market ancillary service* offer expects would be delivered at the relevant *connection point* or *points* in response to a Standard Frequency Ramp from 50 Hz to the Lower Reference Frequency while this *price band* is *enabled*.

4.5. Control Facilities for Slow Raise Service and Slow Lower Service

For the purposes of Rule 3.11.2(b) of the NER:

(a) The Ancillary Service Facility must have a *control system* to automatically initiate:

  (i) a slow Raise Response when Local Frequency changes are below the lower limit of the *normal operating frequency band*; or

  (ii) a slow Lower Response when Local Frequency changes are above the upper limit of the *normal operating frequency band*,

  in accordance with the *control system* requirements of paragraphs (b) and (c) below, whenever the respective *market ancillary service* is *enabled*.

(b) The *control system* for a slow Raise Response may be either a Variable Controller or a Switching Controller or a discrete combination of both, and must operate so that the amount of Raise Response is either:

  (i) for a Variable Controller, a variable amount of *market ancillary service* commensurate with the difference between Local Frequency and controller's Frequency Dead-Band for a range of Local Frequency between the *normal operating frequency band* and the lower limit of the Operational Frequency Tolerance Band; or

  (ii) for a Switching Controller, one or more step changes, if the Local Frequency falls through its Frequency Setting; or

  (iii) for a discrete combination of both, responses in accordance with clauses 4.5(b)(i) and (ii), with each metered separately in accordance with metering requirements specified in clause (e)(b).

(c) The *control system* for a slow Lower Response may be either a Variable Controller or a Switching Controller or a discrete combination of both, and must operate so that the amount of Lower Response is either:

  (i) for a Variable Controller, a variable amount of *market ancillary service* commensurate with the difference between Local Frequency and a controller's Frequency Dead-Band for a range of Local Frequency between the *normal operating frequency band* and the upper limit of the Operational Frequency Tolerance Band; or

  (ii) for a Switching Controller, one or more step changes if the Local Frequency rises through its Frequency Setting; or

  (iii) for a discrete combination of both, responses in accordance with clauses 4.5(c)(i) and (ii), with each metered separately in accordance with metering requirements specified in clause (e)(b).

(d) The *Market Participant* must inform *AEMO* of the details of the *control system* described by paragraphs (a), (b) and (c) above, as reasonably required by *AEMO* for *central dispatch* or for determining Frequency Settings.

(e) A Switching Controller for a *slow raise service* or *slow lower service* must be capable of adjusting its Frequency Setting to the setting provided by *AEMO* within the ranges shown in Table 3~~Table 2~~ for *regions* other than Tasmania or Table 4~~Table 3~~ for the Tasmanian *region*. The error needs to be no greater than 0.05 Hz for the absolute Frequency Settings and 0.05 seconds for Frequency Rate of Change Multiplier.

4.6. Measurement Facilities for Slow Raise Service and Slow Lower Service

(a) For the purposes of Rule 3.11.2(f) of the NER, the equipment required to monitor and record the Raise Response in respect of a *slow raise service* or Lower Response in respect of a *slow lower* *service*, including both the source transducer(s) and the data recorder, must have the following characteristics:

(i) The power flow representing the Generation Amount or Load Amount must be measured at or close to the relevant *connection point* or, if otherwise agreed with *AEMO*, sufficient measurements may be provided to calculate the Generation Amount or Load Amount.

(ii) The Local Frequency must be measured at or close to the relevant *connection point* or, if otherwise agreed with *AEMO*, an alternative measurement may be provided that closely represents the *frequency* at the *connection point*.

(iii) The measurements of power flow and Local Frequency must be made at intervals of four seconds or less.

(iv) The measurements of power flow must have a measurement range appropriate to the *ancillary service non-conforming*, error of less than or equal to 2% of the measurement range, resolution of less than or equal to 0.2% of the measurement range.

(v) The measurements of Local Frequency must have a measurement range of at least the range defined by the Operational Frequency Tolerance Band, error of less than or equal to 0.02 Hz, and resolution of less than or equal to 0.01 Hz.

(vi) Any analogue measurements prior to sampling must have a settling time (to 99% of final value) of less than four seconds.

(vii) The equipment must record the Frequency Disturbance Time to within 10 seconds.

(viii) The equipment must trigger recording at least whenever Local Frequency changes at a rate of at least the Trigger Rate and exceeds the Trigger Range.

(ix) The equipment must record its power and *frequency* measurements for a period of at least 20 seconds before the Frequency Disturbance Time and five minutes after the Frequency Disturbance Time.

(x) The recordings must be made digitally and stored in a computer file format that is reasonably acceptable to *AEMO* for analysis using commercial spreadsheet software.

(xi) The recordings must be provided to *AEMO* on request (or as otherwise agreed) and retained by the *Market Participant* for at least 12 calendar months from the Frequency Disturbance Time.

(xii) If a *Market Participant* is of the view that the information provided by the four second measurements can be provided more simply and with adequate accuracy by other means, they should present their case to *AEMO* for determination. A proposal that does not align with the requirements of clauses (e)(a)(i) to (xi) must ensure that the provision of the *market ancillary service* can be verified.

(xiii) Refer also to clause 2.4 in relation to aggregation of ~~*ancillary service facilities*~~Ancillary Service Facilities.

(b) If the *control system* is a discrete combination of a Variable Controller and a Switching Controller, there must be a process in place to determine the amount of Raise Response or Lower Response supplied by the Variable Controller and Switching Controller. This can be through separate metering or from *control system* data logged at the time of the Frequency Disturbance or application of appropriate *control system* models.

4.7. Verification of Performance for Slow Raise Service and Slow Lower Service

4.7.1. Principles

(a) To verify the amount of *slow raise service* or *slow lower service* delivered in response to a change in Local Frequency, the amount of service delivered must be determined using the recordings made under clause 4.6 above and is compared with the amount of the relevant *market ancillary service offer enabled* as follows:

(i) FCAS assessment commences at the Frequency Disturbance Time and ends at Frequency Recovery or, in the event that Frequency Recovery does not occur within 300 seconds of the Frequency Disturbance Time, 300 seconds from the Frequency Disturbance Time.

(ii) If the Ancillary Service Facility or ~~aggregated~~Aggregated Ancillary Service Facility is *scheduled* or *semi-scheduled*, determine the reference generation or consumption energy trajectory for the facility that the *generating unit* or *load* would be expected to have followed had the frequency event not occurred.

(iii) Commencing from the Frequency Disturbance Time, use this reference trajectory to adjust the measure power flows to reverse any impact of an Ancillary Service Facility being *scheduled* in a direction that would hinder the Frequency Recovery. For an Ancillary Service Facility that is neither *scheduled* nor *semi-scheduled*, no such adjustment is required.

(iv) The basic response is the difference between the value calculated in (iii) and a measure of the operating point of the facility just prior to the Frequency Disturbance.

(v) For a Variable Controller, the basic response is compensated to take into account the difference between the Local Frequency and the Standard Frequency Ramp.

If a discrete combination of Switching Controller and Variable Controller is used, the compensated basic response is the sum of the compensated basic responses in (iv).

(vi) The definition in clauses 4.3 and 4.4 is applied to calculate the slow raise service or slow lower service delivered.

(vii) If *delayed raise service* or *delayed lower service* is also enabled for the Ancillary Service Facility, its response should exceed the required response such that the *delayed raise service* or *delayed lower service* can be provided.

(b) The amount of *slow raise service* or *slow lower service* delivered in response to a change in Local Frequency must be at least equal to the dispatched quantity of the relevant delayed service.

5. DELAYED SERVICES

5.1. Principles

The purpose of *delayed raise and delayed lower services* is to return System Frequency to 50 Hz within the first five minutes of a Frequency Disturbance that resulted in System Frequency being outside the *normal operating frequency band*.

5.2. Definitions

Delayed raise service is the service to either increase *generation* or decrease *load* in response to decreases in Local Frequency. It has traditionally been provided by manual load reduction and starting up hydroelectric or gas *generating units*.

Delayed lower service is the service to either decrease *generation* or increase *load* in response to increases in Local Frequency. It has traditionally been provided by reducing the output of *generating units*.

These delayed services are valued by their ability to restore System Frequency to 50 Hz within the first five minutes of a Frequency Disturbance, and to sustain their response until *central dispatch* can take the *generation* requirement into account.

Ancillary Service Facilities should not provide Contingency Services once the Local Frequency has recovered, for example:

- If the *frequency* recovers above 49.9 Hz between six seconds and 60 seconds from the Frequency Disturbance time, there would be no delayed Raise Response.

- If the *frequency* recovers below 50.1 Hz between six seconds and 60 seconds from the Frequency Disturbance Time, there would be no delayed Lower Response.

5.3. Amount of Delayed Raise Service for ~~Dispatch Purposes~~dispatch purposes

For the purposes of a *market ancillary service* offer for dispatch, 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 one and five minutes from the Frequency Disturbance Time and *slow raise service* provided; and

(b) the Time Average of the Raise Response between five and ten minutes from the Frequency Disturbance Time,

that the person 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*.

5.4. Amount of Delayed Lower Service for ~~Dispatch Purposes~~dispatch purposes

For the purposes of a *market ancillary service* offer for dispatch, the amount of *delayed lower service* in a *price band* is the lesser of:

(a) twice the Time Average of the Lower Response between one and five minutes from the Frequency Disturbance Time and *slow lower service* provided; and

(b) the Time Average of the Lower Response between five and ten minutes from the Frequency Disturbance Time,

that the person making the *market ancillary service* offer expects would be delivered at the relevant *connection point.* This is 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 this *price band* is *enabled*.

5.5. Control ~~Facilities Required~~facilities required for Delayed Raise Service and Delayed Lower Service

For the purposes of Rule 3.11.2(b) of the NER:

(a) The Ancillary Service Facility must have a *control system* to automatically initiate:

 (i) a delayed Raise Response when Local Frequency changes are below the lower limit of the *normal operating frequency band*; or

 (ii) a delayed Lower Response when Local Frequency changes are above the upper limit of the *normal operating frequency band*,

 in accordance with the *control system* requirements of paragraphs (b) and (c) below, whenever the respective *market ancillary service* is *enabled*.

(b) The *control system* for a delayed Raise Response may be either a Variable Controller or a Switching Controller or a discrete combination of both, and must operate so that the amount of Raise Response is either:

 (i) for a Variable Controller, a variable amount of *market ancillary service* commensurate with the difference between Local Frequency and controller's Frequency Dead-Band for a range of Local Frequency between the *normal operating frequency band* and the lower limit of the Operational Frequency Tolerance Band; or

 (ii) for a Switching Controller, one or more step changes if the Local Frequency falls through its Frequency Setting; or

(iii) for a discrete combination of both, responses in accordance with clauses 5.5(b)(i) and (ii), with each metered separately in accordance with metering requirements specified in clause 5.6(b).

(c) The *control system* for a delayed Lower Response may be either a Variable Controller or a Switching Controller or a discrete combination of both, and must operate so that the amount of Lower Response is either:

(i) for a Variable Controller, a variable amount of *market ancillary service* commensurate with the difference between Local Frequency and a controller's Frequency Dead-Band for a range of Local Frequency between the *normal operating frequency band* and the upper limit of the Operational Frequency Tolerance Band; or

(ii) for a Switching Controller, one or more step changes if the Local Frequency rises through its Frequency Setting; or

(iii) for a discrete combination of both, responses in accordance with clauses 5.5(c)(i) and (ii), with each metered separately in accordance with metering requirements specified in clause 5.6.

(d) The *Market Participant* must inform *AEMO* of the details of the *control system* described by paragraphs (a), (b) and (c) above, as reasonably required by AEMO for *central dispatch* or for determining Frequency Settings.

(e) A Switching Controller for a *delayed raise service* or *delayed lower service* must be capable of adjusting its Frequency Setting to the setting provided by *AEMO* within the ranges shown in Table 3~~Table 2~~ for *regions* other than Tasmania or Table 4~~Table 3~~ for the Tasmanian *region*. The error needs to be no greater than 0.05 Hz for absolute Frequency Settings and 0.05 seconds for Frequency Rate of Change Multiplier.

5.6. Measurement ~~Facilities Required~~facilities required for Delayed Raise Service and Delayed Lower Service

(a) For the purposes of *Rule* 3.11.2(f) of the NER, the equipment required to monitor and record the Raise Response in respect of a *delayed raise service* or Lower Response in respect of a *delayed lower service*, including both the source transducer(s) and the data recorder, must have the following characteristics:

(i) The power flow representing the Generation Amount or Load Amount must be measured at or close to the relevant *connection point* or, if otherwise agreed with *AEMO*, sufficient measurements may be provided to calculate the Generation Amount or Load Amount.

(ii) The Local Frequency must be measured at or close to the relevant *connection point* or, if otherwise agreed with *AEMO*, an alternative measurement may be provided that closely represent the *frequency* at the *connection point*.

(iii) The measurements of *power* flow and Local Frequency must be made at intervals of four seconds or less.

(iv) The measurements of power flow must have a measurement range appropriate to the Ancillary Service Facility, error of less than or equal to 2% of the measurement range, and resolution of less than or equal to 0.2% of the measurement range.

(v) The measurements of Local Frequency must have a measurement range of at least the range defined by the Operational Frequency Tolerance Band, error of less than or equal to 0.02 Hz, and resolution of less than or equal to 0.01 Hz.

(vi) The equipment must record the Frequency Disturbance Time to within ten seconds.

(vii) The equipment must trigger recording at least Local Frequency to change at a rate of at least the Trigger Rate and exceeding the Trigger Range.

(viii) The equipment must record its power and *frequency* measurements for a period of at least 20 seconds before the Frequency Disturbance Time and 10 minutes after the Frequency Disturbance Time.

(ix) The recordings must be made digitally and stored in a computer file format that is reasonably acceptable to *AEMO* for analysis using commercial spreadsheet software.

(x) The recordings must be provided to *AEMO* on request (or as otherwise agreed) and retained by the *Market Participant* for at least 12 calendar months from the Frequency Disturbance Time.

(xi) If a *Market Participant* is of the view that the information provided by the four second measurements can be provided more simply and with adequate accuracy by other means, they should present their case to *AEMO* for determination. A proposal that does not align with the requirements of clauses 5.6(a)(i) to (x) must ensure that provision of the *market ancillary service* can be verified.

(xii) Refer also to clause 2.4 in relation to aggregation of ~~*ancillary service facilities*~~Ancillary Service Facilities.

(b) If the *control system* is a discrete combination of a Variable Controller and a Switching Controller*,* there must be a process in place to determine the amount of Raise Response or Lower Response supplied by the Variable Controller and Switching Controller. This can be through separate metering or from *control system* data logged at the time of *the* Frequency Disturbance or application of appropriate *control system* models.

5.7. Verification of Delayed Raise Service and Delayed Lower Service

5.7.1. Principles

(a) To verify the amount of ~~*fast*~~*delayed raise service* or ~~*fast*~~*delayed lower service* delivered in response to a change in Local Frequency, the amount of service delivered must be determined using the recordings made under clause 5.6 above and is compared with the amount of the relevant market ancillary service offer enabled as follows:

(i) FCAS assessment commences at the Frequency Disturbance Time and ends at Frequency Recovery or, in the event that Frequency Recovery does not occur within 600 seconds of the Frequency Disturbance Time, 600 seconds from the Frequency Disturbance Time.

(ii) If the Ancillary Service Facility or ~~aggregated~~Aggregated Ancillary Service Facility is *scheduled* or *semi-scheduled*, determine the reference generation or consumption energy trajectory for the facility that the *generating unit* or *load* would be expected to have followed had the *frequency event* not occurred.

(iii) Commencing from the Frequency Disturbance Time, use this reference trajectory to adjust the measure power flows to reverse any impact of an Ancillary Service Facility being scheduled in a direction that would hinder the Frequency Recovery. For an Ancillary Service Facility that is neither *scheduled* nor *semi-scheduled*, no such adjustment is required.

(iv) The basic response is the difference between the value calculated in (iii) and a measure of the operating point of the facility just prior to the Frequency Disturbance.

(v) The definition in clauses 5.3 and 5.4 is applied to calculate the *delayed raise service* or *delayed lower service* delivered.

(b) The amount of *delayed raise service* or *delayed lower service* delivered in response to a change in Local Frequency, must be at least equal to the dispatched quantity of the relevant delayed service.

6. REGULATION SERVICES

6.1. Overview

Regulation services are enabled to manage changes in *frequency* within the *normal operating frequency band* following small deviations in the demand~~ / ~~/generation balance within the five minute *dispatch interval*. These are controlled centrally by *AEMO*. *AEMO* monitors power System Frequency and time error, and instructs *generating units* or *loads enabled* to provide *regulation services* through the *AGC* system.

The *AGC* system allows *AEMO* to continually monitor System Frequency and send control signals to ~~*ancillary service facilities*~~Ancillary Service Facilities providing *regulation services* so *frequency* is maintained within the *normal operating frequency band* of 49.~~85Hz~~85 Hz to 50.~~15Hz~~15 Hz. These control signals alter the megawatt (MW) output of the *generating units* or the consumption (MW) of the *loads* to correct the *demand* ~~/~~ */generation* imbalance.

6.2. Definitions

Regulating raise service is the service of either increasing *generation* or decreasing *load* in response to electronic Raise Signals from *AEMO*. It has traditionally been provided by generation setpoint controllers on *generating* units.

Regulating lower service is the service of either decreasing *generation* or increasing *load* in response to electronic Lower Signals from AEMO. It has traditionally been provided by generation setpoint controllers on *generating units*.

These *regulation services* are valued by their ability to control System Frequency and time error in response to variations of system *demand* within a *dispatch interval*.

A *market ancillary service offer* to provide *regulating raise service* or *regulating lower service* in respect of an Ancillary Service Facility that is aggregated for *central dispatch* of *energy*, must apply to the whole aggregated *generating unit* or *load*.

The *AGC* system sends signals through the SCADA system to all *enabled* plant that are required to respond to the signals in an accurate and timely manner.

6.3. Amount of Regulating Raise Service for ~~Dispatch Purposes~~dispatch purposes

For the purposes of a *market ancillary service offer* for dispatch, the amount of *regulating raise service* in a *price band* is the amount of Regulating Raise Response that the person making the *market ancillary service offer* expects would be delivered:

(a) at the relevant *connection point*;

(b) progressively over a five minute period;

(c) in addition to the amounts in all cheaper *price bands*; and

(d) in response to Raise Signals sent to request the maximum possible Regulating Raise Response while this *price band* is enabled.

6.4. Amount of Regulating Lower Service for ~~Dispatch Purposes~~dispatch purposes

For the purposes of a *market ancillary service offer* for *dispatch*, the amount of *regulating lower service* in a *price band* is the amount of Regulating Lower Response that the person making the *market ancillary service* offer expects would be delivered:

(a) at the relevant *connection point*;

(b) progressively over a five minute period;

(c) in addition to the amounts in all cheaper *price bands*; and

(d) in response to Lower Signals sent to request the maximum possible Regulating Lower Response while this *price band* is enabled.

6.5. Performance parameters and requirements for Regulating Raise Service and Regulating Lower Service

AEMO needs to be assured that that *generating units* and *loads enabled* to provide *regulation services* respond in accurate and timely manner.

AEMO will monitor the performance of registered *generating units* and *loads* to determine if acceptable performance is being maintained.

As described in 3.8.23(g) of the NER, if, in *AEMO's* reasonable opinion, an Ancillary Service Facility is *enabled* to provide *regulating raise service* or *regulating lower service* and fails to respond in an accurate and timely manner, the Ancillary Service Facility will be declared as non-conforming.

AEMO may impose a fixed constraint with respect to the Ancillary Service Facility until *AEMO* is reasonably satisfied (as a result of a test or otherwise) that the Ancillary Service Facility is capable of responding in the manner contemplated by the MASS.

6.6. Control ~~Facilities Required~~facilities required for Regulating Raise Service and Regulating Lower Service

For the purposes of Rule 3.11.2(b) of the NER, the Ancillary Service Facility must have a *control system* to:

(a) transmit values of the Controlled Quantity, Raise Control Limit, Lower Control Limit, *Raise Rate Limit* and, if different from the Raise Rate Limit, the Lower Rate Limit every four seconds;

(b) receive Raise Signals and Lower Signals;

(c) when *enabled* for the respective service, automatically deliver a Regulating Raise Response or a Regulating Lower Response corresponding to those Raise Signals or Lower Signals; and

(d) not suspend the service for more than 60 seconds during a Frequency Disturbance, and only if Local Frequency has exceeded the Raise Reference Frequency or Lower Reference Frequency.

A *control system* for *regulating raise service* or *regulating lower service* with respect to a *generating unit* or *load* aggregated for *central dispatch* of *energy*, must only apply to the whole aggregated *generating unit* or *load*.

6.7. Measurement ~~Facilities Required~~facilities required for Regulating Raise Service and Regulating Lower Service

For the purposes of Rule 3.11.2(f) of the NER, the equipment required to monitor and record the Regulating Raise Response in respect of a *regulating raise service*, or Regulating Lower Response in respect of a *regulating lower service*, including both the source transducer(s) and the data recorder, must have the following characteristics:

(a) The power flow representing the Generation Amount or Load Amount must be measured at or close to the relevant *connection point* or, if otherwise agreed with AEMO, sufficient measurements may be provided to calculate the Generation Amount or Load Amount.

(b) The measurements of power flow must be made at intervals of four seconds or less.

(c) The measurements of power flow must have a measurement range appropriate to the Ancillary Service Facility, error of less than or equal to 2% of the measurement range, and resolution of less than or equal to 0.2% of the measurement range.

(d) The recordings must be made digitally and stored in a computer file format reasonably acceptable to *AEMO* for analysis using commercial spreadsheet software.

(e) The recordings must be provided to *AEMO* on request (or as otherwise agreed) and retained by the *Market Participant* for at least six calendar months from the Frequency Disturbance Time.

6.8. Verification of Regulating Raise Service and Regulating Lower Service

For the purpose of verifying the 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 clause 6.7 above as follows:

(a) If *AEMO* or the *Market Participant* wishes to verify performance, *AEMO* must:

(i) transmit no Raise Signals or Lower Signals to the relevant Ancillary Service Facility for a period of at least 60 seconds; and then immediately

(ii) transmit Raise Signals or Lower Signals to the relevant 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* of the relevant *market ancillary services offer* and the corresponding Raise Rate Limit or Lower Rate Limit. This would last for at least 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 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

(iii) determine the Regulating Raise Response or Regulating Lower Response as the slope of the function to which paragraph (b)(ii) refers (in MW per minute) multiplied by five minutes.

6.9. Response to AGC instructions during and after a contingency event

Should a *contingency event* occur at a time when a *generating unit* or *load* is *enabled* to provide both *regulation services* and Contingency Services, the *generating unit* or *load* should give priority to providing the Contingency Services and not respond to *AGC* instructions while responding to Contingency Service actions until such time as the Local Frequency has returned to the *normal operating frequency band*.

~~If *frequency* recovers above 49.9 Hz within six seconds, no *slow raise* or delayed Raise Response would be required and the *generation unit* or *load* would resume responding to *AGC* instructions.~~

~~If *frequency* recovers below 50.1 Hz within six seconds, no *slow lower* or delayed Lower Response would be required and the *generation unit* or *load* would resume responding to *AGC* instructions.~~

~~If the *frequency* recovers above 49.9 Hz between six seconds and sixty seconds, no delayed Raise Response would be required and the *generation unit* or *load* would resume responding to *AGC* instructions.~~

~~If the *frequency* recovers below 50.1 Hz between six seconds and 60 seconds, no delayed Lower Response would be required and the *generation unit* or *load* would resume responding to *AGC* instructions.~~

~~*Generating units enabled* for *regulation services* should respond to *AGC* instructions as soon as *frequency* returns to the range of 49.9 Hz to 50.1 Hz.~~

7. COMMON PROCEDURES

7.1. Enablement

The provider of a *market ancillary service* must promptly operate its equipment to deliver the relevant service as soon as reasonably practicable following enablement of it by *AEMO*.

7.2. Allocation of the Frequency Settings of Switching Controllers

(a) *AEMO* will allocate Frequency Settings to particular ~~*ancillary service facilities*~~Ancillary Service Facilities for each *market ancillary service* other than *regulating raise service and regulating lower service*, separately for Tasmania *region* and for all other *regions* combined.

(b) In allocating the *frequencies*, *AEMO* may consider one or more of the following principles as appropriate:

(i) Ancillary ~~*service facilities*~~Service Facilities registering for multiple services will be allocated the same settings for each raise service and lower service.

(ii) Ancillary ~~*service facilities*~~Service Facilities with larger switched blocks of *generation* or *load* will be allocated to *frequencies* closer to *normal operating frequency bands*.

(iii) Ancillary ~~*service* facilities~~Service Facilities with higher availability will be allocated to *frequencies* closer to *normal operating frequency bands*.

(iv) Where possible, for aggregated ~~*ancillary service facilities*~~Ancillary Service Facilities AEMO will ~~be allocated~~negotiate with the Market Participant to allocate multiple ~~*frequencies* settings~~Frequencies Settings across the relevant plant of the Facility to simulate the behaviour of Variable Controllers and so minimise the potential ~~to avoid~~for over-delivery of the services.

(v) *AEMO* will consider any physically-appropriate characteristics of the ~~*ancillary service facilities*~~Ancillary Service Facilities.

(c) If there is a technical reason why a particular Ancillary Service Facility will be unable to provide *market ancillary services* due to its allocated Frequency Setting, the relevant *Market Participant* may request *AEMO* to change the allocated Frequency Setting. *AEMO* will have sole discretion in accepting the request for change. If one or more Frequency Settings have been changed, *AEMO* may elect to re-allocate the remaining Frequency Settings as per clause 7.2(b).

(d) *AEMO* must not request a change to an existing Frequency Setting unless:

(i) the procedure for determining Frequency Settings, as shown in paragraph (~~a~~b) above has been amended; or

(ii) an Ancillary Service Facility that uses a Switching Controller to provide the service has been registered or deregistered, or its registration has materially changed since the last change to existing settings; or

(iii) at least six months has elapsed since Frequency Settings were changed and one or more Ancillary Service Facility has changed its maximum response capability; or

(iv) a Frequency Disturbance has occurred that involved loss of *load* or *generation* and *AEMO* has determined that the relevant Frequency Setting was not adequate under that circumstance.

(e) Until an Ancillary Service Facility that uses a Switching Controller to provide the service is allocated a Frequency Setting under clause 7.2(b), the *Market Participant* may apply the relevant default Frequency Deviation Setting shown in Table 3~~Table 2~~ for *regions* other than Tasmania and Table 4~~Table 3~~ for the Tasmania *region*.

(f) For the purposes of clauses 3.5(b)(ii) and 3.5(c)(ii) a Frequency Setting may be a Frequency Deviation Setting or a combination of both Frequency Deviation Setting allocated and Frequency Rate of Change Multiplier shown in Table 3~~Table 2~~ for *regions* other than Tasmania and Table 4~~Table 3~~ for the Tasmania *region*.

For the purposes of clauses 4.5(b)(ii), 4.5(c)(ii), 5.5(b)(ii) and 5.5(c)(ii) a Frequency Setting is based on allocated Frequency Deviation Setting alone.

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 the both of the following conditions are satisfied:

if Local Frequency < 49.85 and

Local Frequency < Frequency Deviation Setting + Frequency Rate of Change Multiplier * Local Frequency *rate of change*

where:

Frequency Deviation Setting is setting allocated within the range shown in Table 3~~Table 2~~ for *regions* other than Tasmania and Table 4~~Table 3~~ for the Tasmania *region*;

Frequency Rate of Change Multiplier is equal to the value in Table 3~~Table 2~~ for *regions* other than Tasmania and Table 4~~Table 3~~ for the Tasmania *region*;

Local Frequency *rate of change* is the measured *rate of change of* Local Frequency;

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 the both of the following conditions are satisfied:

if Local Frequency > 50.15 and

Local Frequency > Frequency Deviation Setting - *Frequency Rate of Change Multiplie*r * Local Frequency *rate of change*

where:

Frequency Deviation Setting is setting allocated within the range shown in Table 3~~Table 2~~ for *regions* other than Tasmania and Table 4~~Table 3~~ for the Tasmania *region*;

Frequency Rate of Change Multiplier is equal to the value in Table 3~~Table 2~~ for *regions* other than Tasmania and Table 4~~Table 3~~ for the Tasmania *region*;

Local Frequency *rate of change* is the measured rate of *change of* Local Frequency;

~~Table 2~~Table 3 Frequency Settings for ~~Regions~~regions other than Tasmania

Level	Raise service Frequency Deviation Setting (Hz)	Lower service Frequency Deviation Setting (Hz)	Frequency Rate of Change Multiplier (seconds)
Frequency Deviation Setting range	49.80 Hz to 49.60 Hz	50.20 Hz to 50.4 Hz	0.4
Default Frequency Deviation Setting	49.65 Hz	50.35 Hz	0.4

~~Table 3~~Table 4 Frequency Settings for the ~~Tasmanian Region~~Tasmania region

Level	Raise service Frequency Deviation Setting (Hz)	Lower service Frequency Deviation Setting (Hz)	Frequency Rate of Change Multiplier (seconds)
Frequency Deviation Setting range	49.50 Hz to 48.75 Hz	50.50 Hz to 51.25 Hz	0.875
Default Frequency Deviation Setting	49.125 Hz	50.825 Hz	0.875

7.3. Trials of new technologies

AEMO, at its absolute discretion, may allow an Ancillary Service Facility to participate in a trial to test the performance of new technologies.

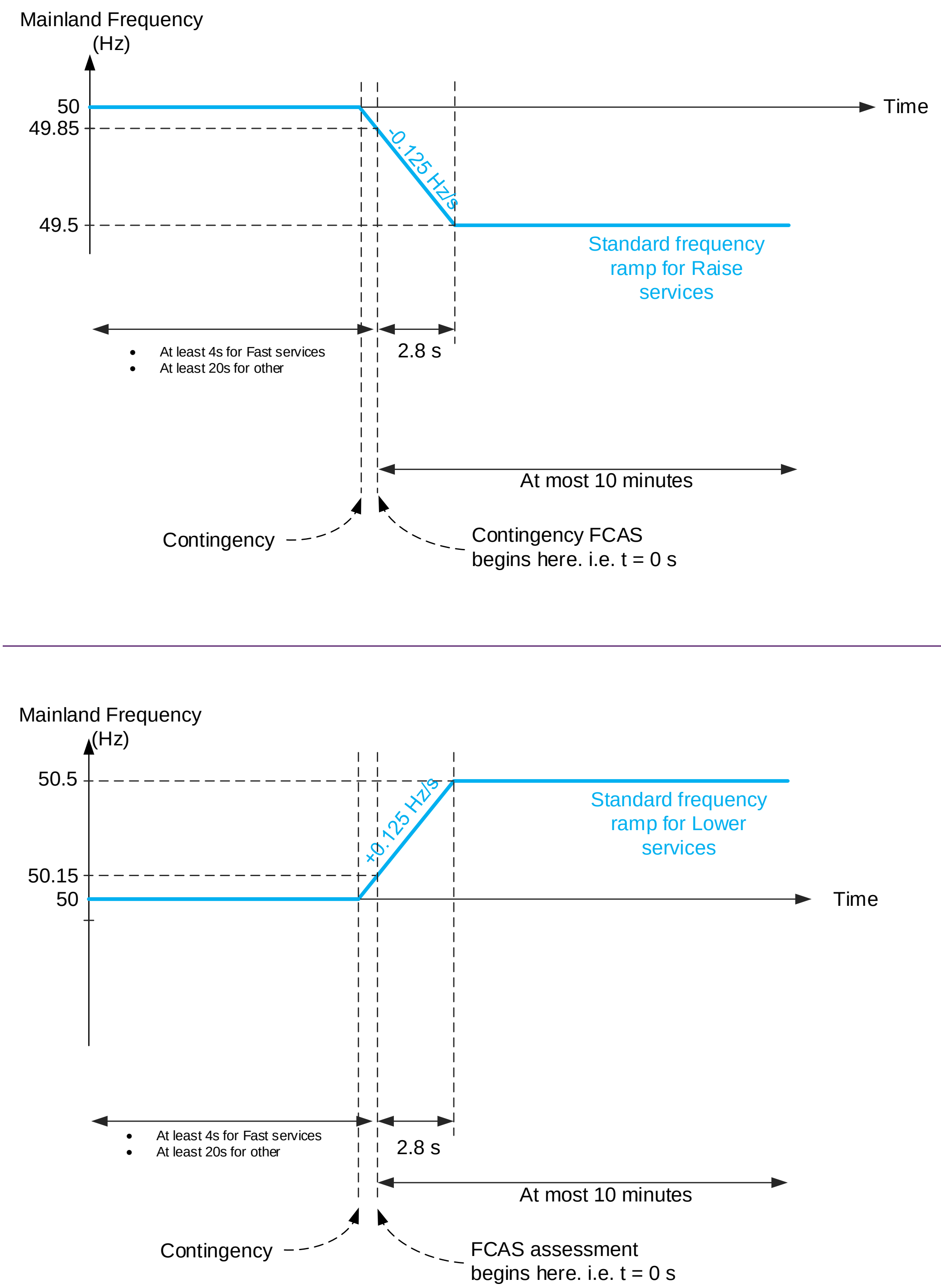
It is envisaged that any trial will~~-~~:

- ~~be of~~Be for a limited period~~.~~,
- ~~beBe~~Be for a limited measurable ~~-~~quantity of the service~~.~~
- , and

- ~~-~~Be subject to the conditions that the party conducting the trial:
  - ~~withdraw~~Withdraw from the market if directed by *AEMO.*
  - ~~use~~Use best endeavours to meet the full requirements of the MASS.
  - ~~meet~~Meet any other requirements *AEMO*, at its discretion, requests.

APPENDIX A. STANDARD FREQUENCY RAMP

Figure 1 ~~**Figure 1**~~ **Standard Frequency Ramp for *regions* other than Tasmania**



~~Figure 2~~

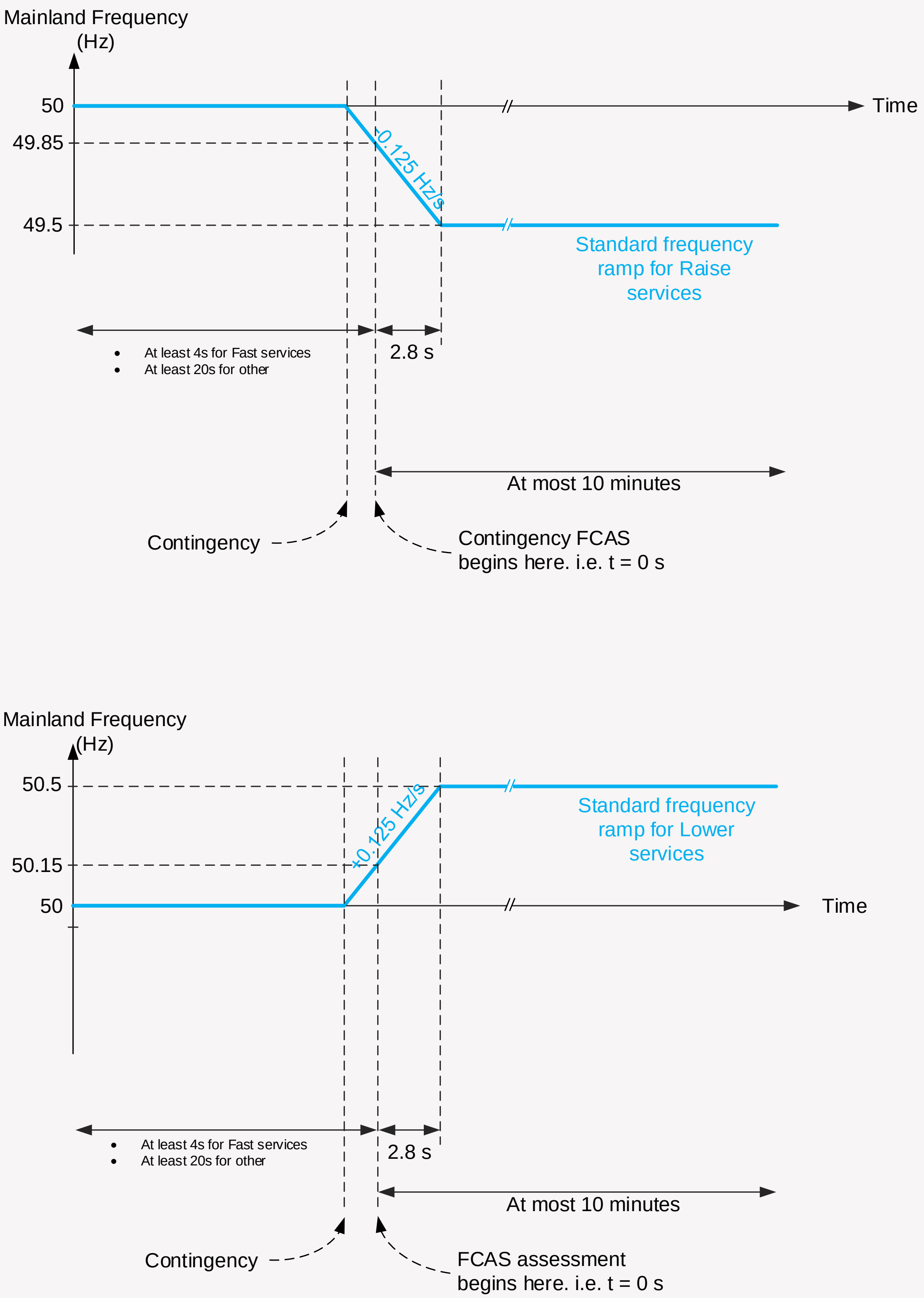
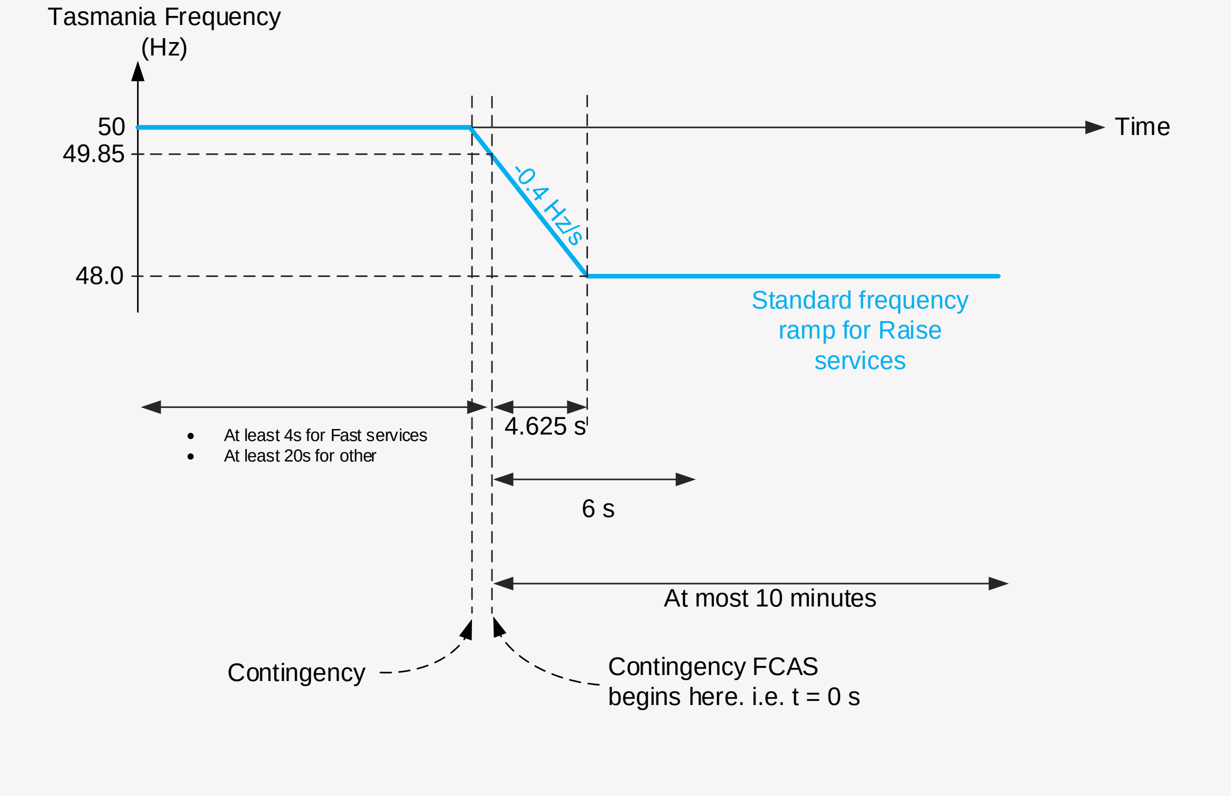
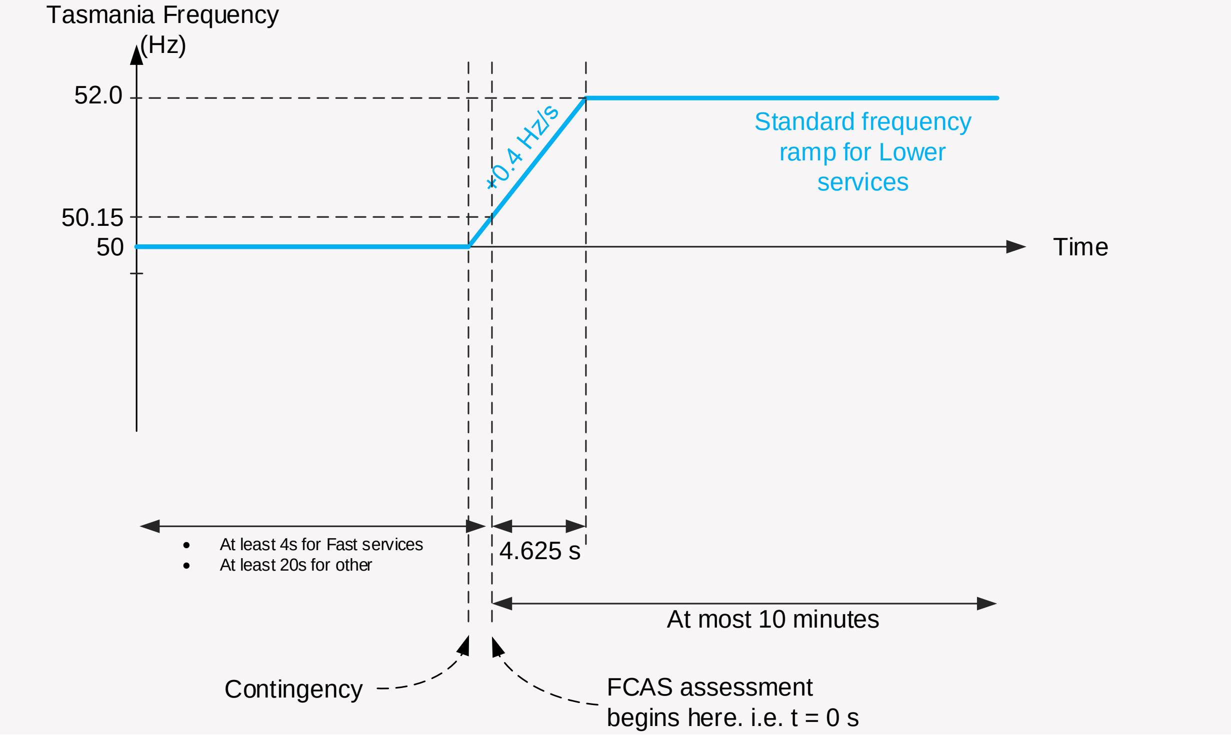
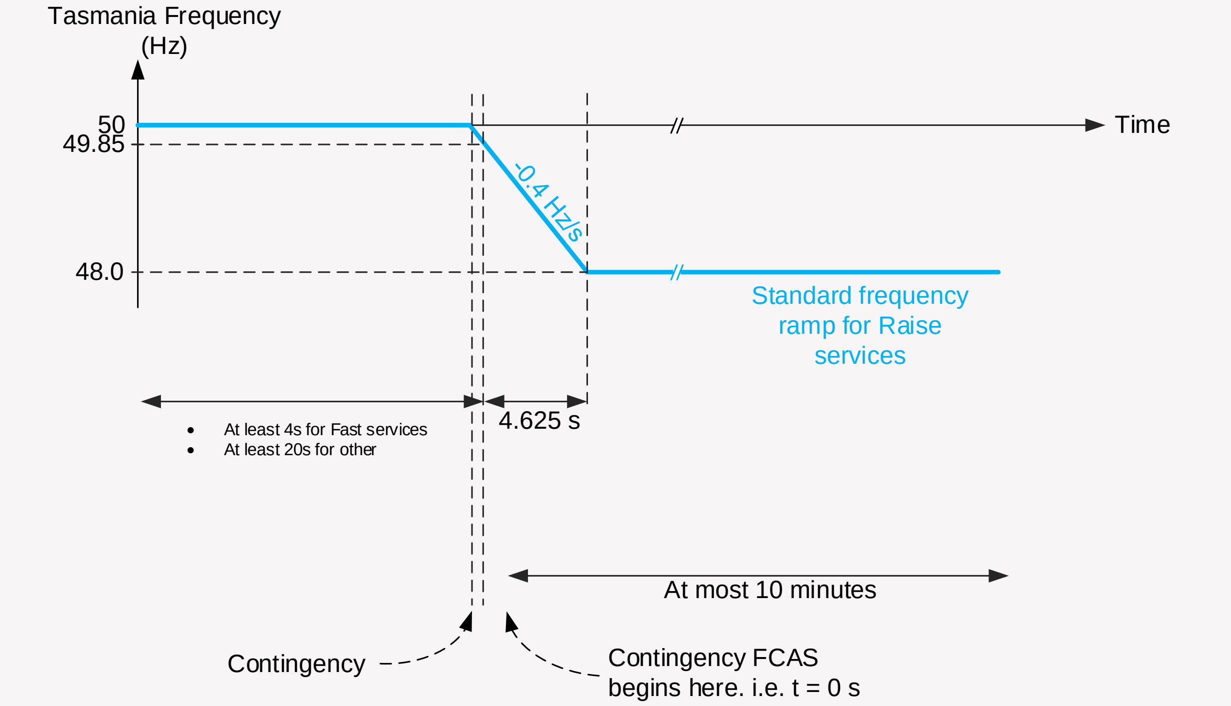
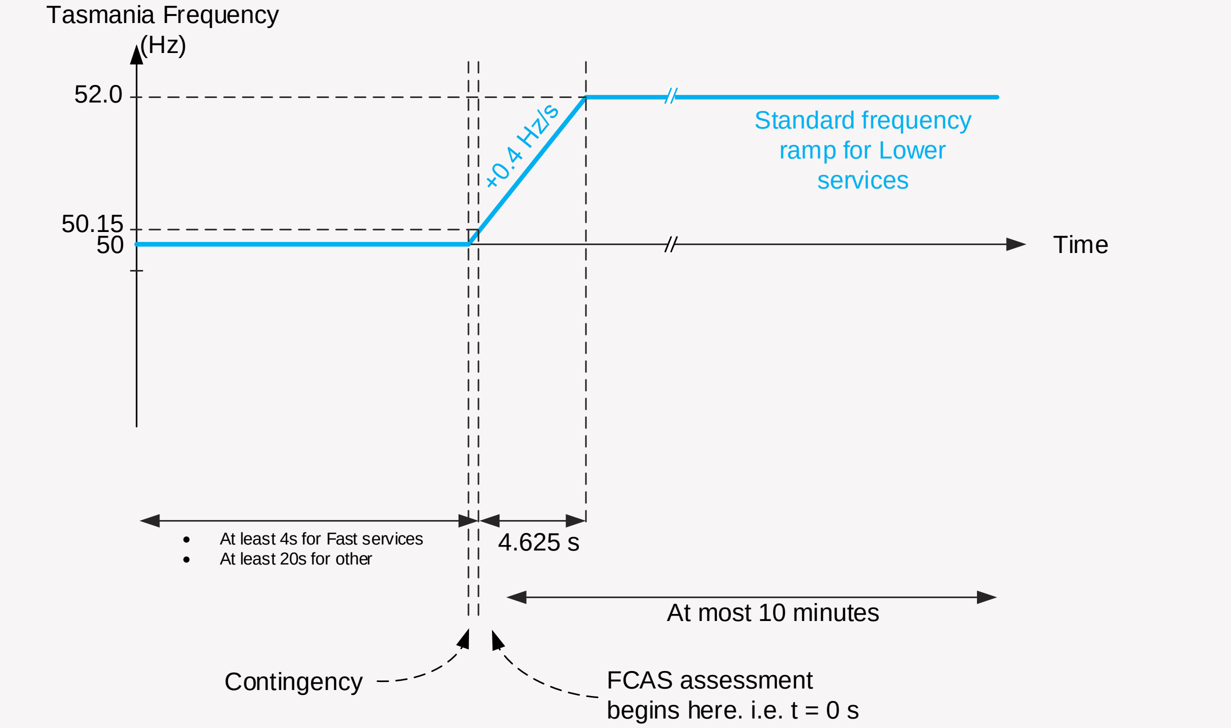

Mainland Frequency
(Hz)
50
49.85
49.5
Time
-0.125 Hz/s
Standard frequency
ramp for Raise
services
At least 4s for Fast services
At least 20s for other
2.8 s
At most 10 minutes
Contingency
Contingency FCAS
begins here. i.e. t = 0 s
Mainland Frequency
(Hz)
50.5
50.15
50
+0.125 Hz/s
Standard frequency
ramp for Lower
services
Time
At least 4s for Fast services
At least 20s for other
2.8 s
At most 10 minutes
Contingency
FCAS assessment
begins here. i.e. t = 0 s

Figure 2 Standard Frequency Ramp for Tasmania


Tasmania Frequency
(Hz)
50
49.85
48.0
Time
-0.4 Hz/s
Standard frequency
ramp for Raise
services
At least 4s for Fast services
At least 20s for other
4.625 s
6 s
At most 10 minutes
Contingency
Contingency FCAS
begins here. i.e. t = 0 s


Tasmania Frequency
(Hz)
52.0
50.15
50
Time
+0.4 Hz/s
Standard frequency
ramp for Lower
services
At least 4s for Fast services
At least 20s for other
4.625 s
At most 10 minutes
Contingency
FCAS assessment
begins here. i.e. t = 0 s


Tasmania Frequency
(Hz)
50
49.85
48.0
Time
-0.4 Hz/s
Standard frequency
ramp for Raise
services
At least 4s for Fast services
At least 20s for other
4.625 s
At most 10 minutes
Contingency
Contingency FCAS
begins here. i.e. t = 0 s


Tasmania Frequency
(Hz)
52.0
50.15
50
+0.4 Hz/s
Standard frequency
ramp for Lower
services
Time
At least 4s for Fast services
At least 20s for other
4.625 s
At most 10 minutes
Contingency
FCAS assessment
begins here. i.e. t = 0 s