Market Ancillary Service Specification and Causer Pays Procedure

February 2020

Draft Determination

NOTICE OF SECOND STAGE CONSULTATION – MARKET ANCILLARY SERVICE SPECIFICATION REVIEW

National Electricity Rules – Rule 8.9

Date of Notice: 25 February 2020

This notice informs all Registered Participants and interested parties (Consulted Persons) that AEMO is commencing the second stage of its consultation on the market ancillary service specification (MASS) review.

This consultation is being conducted under clauses 3.11.2(c) and (d) of the National Electricity Rules (NER), in accordance with the Rules consultation requirements detailed in rule 8.9 of the NER.

Invitation to make Submissions

AEMO invites written submissions on the matter under consultation.

Please identify any parts of your submission that you wish to remain confidential and provide the reasons why you wish that information to be treated as confidential. AEMO may still publish that information if it does not consider it to be confidential but will consult with you before doing so.

Consulted Persons should note that material identified as confidential may be given less weight in the decision-making process than material that is published.

Closing Date and Time

Submissions in response to this Notice of Second Stage of Rules Consultation should be sent by email to matthew.holmes@aemo.com.au, to reach AEMO by 5.00pm (Melbourne time) on 16 March 2020.

All submissions must be forwarded in electronic format. Please send any queries about this consultation to the same email address.

Submissions received after the closing date and time will not be valid, and AEMO is not obliged to consider them. Any late submissions should explain the reason for lateness and the detriment to you if AEMO does not consider your submission.

Publication

All submissions will be published on AEMO's website, other than confidential content.

EXECUTIVE SUMMARY

The publication of this Draft Report and Determination (Draft Report) commences the second stage of the Rules consultation process conducted by AEMO to consider proposed amendments to the *market ancillary services specification* (MASS) under the National Electricity Rules (NER).

AEMO is required by clause 3.11.2(b) to make and *publish* a *market ancillary services specification* (**MASS**), which AEMO may subsequently amend at any time subject to the rules consultation process in rule 8.9. AEMO commenced this consultation on 1 November 2019 and received ten submissions in response to an issues paper on the proposed changes to the MASS (Issues Paper).

The submissions largely supported AEMO's proposed changes, which were largely around the reformulation of a methodology to recognise the provision of Contingency FCAS before frequency exits the normal operating frequency band (NOFB). There was some variation in views as to whether all Contingency FCAS should be recognised and rewarded.

In response to submissions on the proposed methodology, AEMO has determined to apply a modified method 3. This methodology does not explicitly concern any particular Contingency service, but rather will be applied consistently across all services and focus on measurement of response rather than the mechanism by which it is delivered, or the service it applies to. AEMO's draft determination is to amend the MASS in the form published with this Draft Report.

AEMO wishes to acknowledge the time, effort parties spent in making submissions to Stage One of this consultation on amendments to the MASS. These submissions were very helpful in reaching a draft determination on a complex issue.

Contents

1. Consultation Process

As required by clause 3.11.2(c) and (d) of the NER, AEMO is consulting on proposed amendments to the *market ancillary services specification* (MASS) in accordance with the consultation process in rule 8.9 of the National Electricity Rules (NER).

AEMO's indicative timeline for this consultation is outlined below. Future dates may be adjusted depending on the number and complexity of issues raised in submissions.

Deliverable	Indicative date
Notice of first stage consultation and Issues Paper published	1 November 2019
First stage submissions closed	6 December 2019
Draft Report and Determination (Draft Report) & Notice of Second Stage Consultation published	25 February 2020
Submissions due on Draft Report	16 March 2020
Final Report and Determination published	29 April 2020

The publication of this Draft Report marks the commencement of the second stage of consultation.

A glossary of terms used in this Draft Report can be found at Appendix A.

2. Background

2.1 NER requirements

AEMO is required by clause 3.11.2(b) to make and *publish* a *market ancillary services specification* (**MASS**), which AEMO may subsequently amend at any time subject to the rules consultation process in rule 8.9.

2.2 Context for this consultation

In August 2019, AEMO submitted two proposals to the Australian Energy Market Commission (**AEMC**) requesting to amend the NER to facilitate the provision of primary frequency response (**PFR**) by *Generators* under normal operating conditions (AEMO's Rule Change Proposals). In response to these, the AEMC has separated the two and is progressing the one referred to as the Mandatory Primary Response rule change proposal (ERC0274) and has published a Draft Determination on the National Electricity Amendment (Mandatory Primary Frequency Response) Rule 2020[1].

AEMO commenced a consultation on updates to the MASS concurrently with the AEMC's consultation on ERC0274.

While this consultation was prompted by potential new rules for the provision of PFR, the matter contemplated by this consultation does not depend on the making of those rules.

This consultation does not replace the need for a broader review of the MASS, which AEMO will conduct separately.

2.3 First stage consultation

AEMO issued a Notice of First Stage Consultation on 1 November 2019 along with an issues paper (Issues Paper) and a mark-up of the proposed changes to the MASS.

AEMO received ten written submissions in the first stage of consultation.

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[1] Available at: https://www.aemc.gov.au/news-centre/media-releases/consultation-commences-proposed-rules-better-control-power-system.

AEMO also held a meeting with CS Energy on 9 December 2019 to gain a better understanding of the alternative method of measurement it proposed in its submission, .

Copies of all written submissions (excluding any confidential information) have been published on AEMO's website at: https://aemo.com.au/consultations/current-and-closed-consultations/primary-frequency-response-under-normal-operating-conditions.

3. Discussion of Material Issues

A detailed summary of issues raised by Consulted Persons in submissions and at the meeting on 9 December 2019 with CS Energy together with AEMO's responses, is contained in Appendix B. This section discusses the material issues.

3.1 Recognition of the provision of frequency response within the NOFB as Contingency FCAS

3.1.1 Issue summary and submissions

The current structure of Contingency FCAS focuses on how *facilities* respond to provide frequency response during a *contingency event*.

Since the Frequency Operating Standard (**FOS**) allows the *frequency* to move outside the *normal operating frequency band* (**NOFB**) when a *contingency event* occurs, the MASS was developed around the assumption that Contingency FCAS is how *facilities* respond when the *frequency* departs the NOFB. Thus, the amount of Contingency FCAS a *facility* is seen to deliver is essentially the amount by which the *facility* changes its net power injection when the *frequency* departs the NOFB (ignoring timing considerations and other subtleties like *inertia*).

AEMO's Rule Change Proposals aim to increase the amount of PFR within the NOFB within the national electricity market (NEM). This means that *facilities* providing PFR would be initiating a Local Frequency response at a deadband significantly within the NOFB. If a requirement to provide PFR in the NEM were to be mandated without a suitable amendment to the MASS, the PFR provided by an *enabled* Contingency FCAS *generating unit* prior to the *power system's* departing the NOFB would not be recognised as Contingency FCAS. This could result in *facilities* not being able to provide the same level of Contingency FCAS as they do currently under comparable situations. For instance, when Contingency FCAS delivery is limited by available headroom, an early PFR response would use some of that headroom that would then be unavailable for Contingency FCAS delivery.

In the Issues Paper, AEMO proposed to recognise PFR provided by an *enabled* Contingency FCAS *generating unit* as Contingency FCAS before the *frequency* exits the NOFB because:

- Any PFR provided by an *enabled* Contingency FCAS *generating unit* acts to contain a *frequency* deviation, regardless of whether it is provided while frequency is within or outside of the NOFB.
- Responding sooner can provide superior control, better system performance and increased resilience, since frequency deviations are arrested sooner and thus power system frequency is unlikely to deviate as far as it would otherwise.

All except one submission supported the concept of valuing PFR within the NOFB as Contingency FCAS. The dissenting submission was from Stanwell, who suggested that the proposed changes should only be considered once there was greater clarity on the outcome of AEMO's Rule Change Proposals.

3.1.2 AEMO's assessment

The proposed change to the MASS is not contingent on any rule being made. Since submissions closed, however, the AEMC has published its Draft Determination on the ERC0274 rule change proposal (Mandatory primary frequency response) indicating that it will make a rule that mandates the provision of PFR from all capable scheduled and semi-scheduled generation. AEMO considers that the benefits of the proposed change to the MASS will be significantly greater in a mandatory PFR environment, by appropriately recognising the power system benefits delivered by Contingency FCAS providers.

3.1.3 AEMO's conclusion

AEMO will amend the MASS to ensure that all frequency response apart from inertia is recognised as Contingency FCAS as appropriate. The treatment of inertia in FCAS will be considered in a subsequent consultation.

3.2 Scope of recognising frequency response within NOFB as Contingency FCAS

3.2.1 Issue summary and submissions

In the Issues Paper, AEMO raised questions about any limitations Consulted Persons saw on recognising frequency response within the NOFB as Contingency FCAS. For example, AEMO asked whether this should be applied to Fast Contingency FCAS only, or to all Contingency FCAS.

Consulted Persons provided a range of responses. At a high level, AEMO considers these may be reasonably characterised by the statement that frequency response within the NOFB should be recognised as Contingency FCAS in all cases where it is reasonable to do so. Some submissions identified particular services:

- CS Energy stated that it should be applied to all services except Delayed Contingency FCAS, since that service is chiefly delivered by 'switched' controllers.
- EnergyAustralia and Hydro Tasmania submitted that it should apply only to Fast Contingency FCAS, where a PFR-type mechanism (e.g. 'governor action') would be active.

3.2.2 AEMO's assessment

While the Consultation sought comment on PFR, concentrating on the response of a facility to frequency, rather than the mechanism by which it does so (be it PFR, or a switched response, or something else) leads AEMO to conclude that any physical action where the *facility* has changed its *active power* output to contain frequency should contribute to that *facility's* Contingency FCAS measurement. By valuing the output of the facility compared with frequency, the measurement approach is transparent and technology-neutral.

3.2.3 AEMO's conclusion

Considering the examples and issues raised by Consulted Persons, AEMO has determined to recognise frequency response (as opposed to strictly PFR) as Contingency FCAS should apply to all Contingency FCAS where it can be measured.

3.3 Methods for verifying frequency response within the NOFB

3.3.1 Issue summary and submissions

In the MASS, Contingency FCAS is calculated by measuring how an *ancillary service facility* shifts its active power output throughout a specified time window following a Frequency Disturbance (defined as where the frequency first departs the NOFB). For example, delivery of the *fast raise service* is set out in Section 3.3 as follows (this is the definition for 'dispatch purposes' but the principle is consistent with verification):

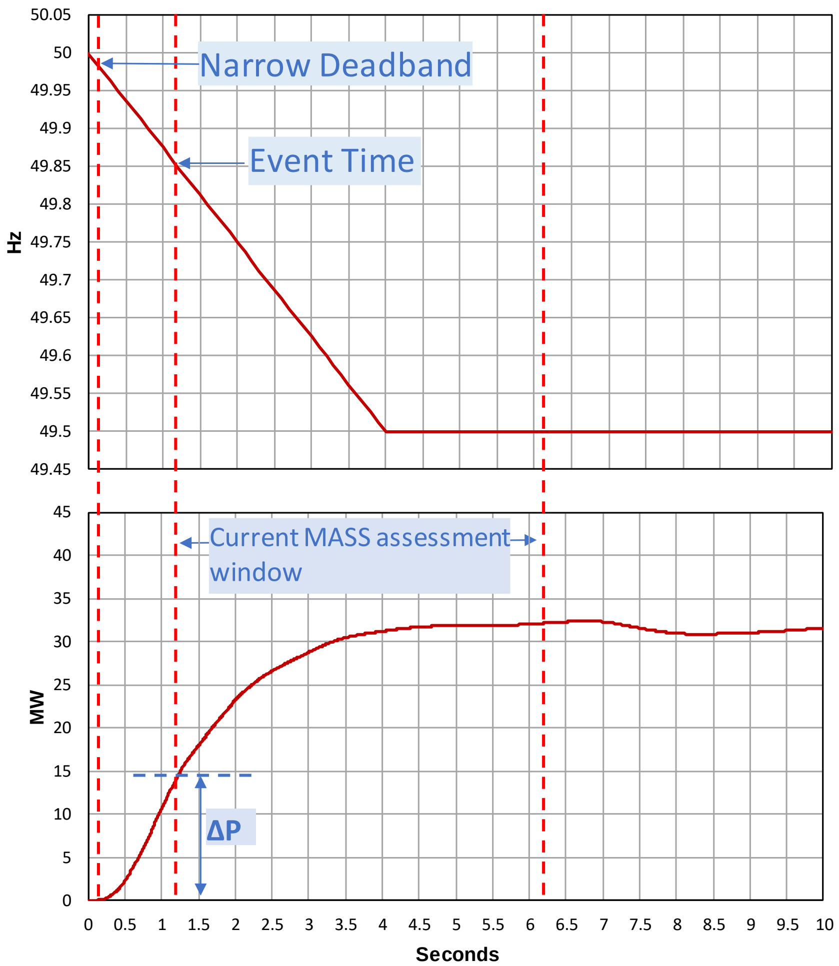
> [...] the amount of *fast raise service* [..] is the lesser of:

(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

The Issues Paper considered various methods by which the MASS (and associated supporting documents[2]) could be amended to measure the response of a facility within the NOFB as Contingency FCAS. AEMO used the term 'ΔP' to refer to the control action provided by a *facility* prior to the Frequency Disturbance Time, that is, before the *frequency* exits the NOFB. Figure 1 demonstrates these concepts under the current MASS with a hypothetical low frequency event, and a facility providing *fast raise services* during this event from some narrow deadband within the NOFB. The area labelled 'ΔP' indicates the response that might not be recognised as Contingency FCAS under the MASS, since the assessment window commences once frequency departs the NOFB.

Figure 1 Fast Contingency FCAS ΔP with narrow deadband response (in a low frequency event)



In the Issues Paper, AEMO identified three potential ways by which ΔP could be derived. Consulted Persons were invited to comment on the appropriateness of each of these methods, and whether they could propose any other superior method of measurement. AEMO indicated a preference for Method 3, on the basis that it would be the most accurate of the proposed methods.

The three methods AEMO identified were:

[2] This refers to the MASS "Verification Tool and User Guide" available at: https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/system-operations/ancillary-services/market-ancillary-services-specification-and-fcas-verification-tool

Method 1: Static ΔP value based on droop and deadband

This method ignores the dynamic behaviour of the *facility* and assumes it has provided the full MW as per its droop function. In this case, there will be a static ΔP calculated once for each Contingency FCAS *generating unit*. The static value would then be applied for each assessment of each event.

$$\Delta\mathbf{P} \ = \boldsymbol{P_{MAX}} \times \frac{(\mathbf{0.15} - \mathbf{deadband})/\mathbf{50}}{\boldsymbol{Droop}\ (\%)}$$

FCAS Provided = FCAS (as measured from the Frequency Disturbance Time) + ΔP

Method 2: Derive a static ΔP on standard site test or historic data

In this method, ΔP is calculated as the change in the MW output once *frequency* crosses its deadband until *frequency* reaches the edge of the NOFB for the injection of a standard frequency ramp into the facility's relevant control systems. Once calculated, the ΔP would be applied to the assessment of each subsequent event.

Method 3: Calculate ΔP based on the event response

In this method, ΔP is calculated as the change in the MW output from the last time *frequency* crossed its deadband until *frequency* reaches the edge of the NOFB. The assessment is made for each event.

Most submissions supported Method 3, to calculate ΔP based on the response of a facility during an event. There was limited support for Method 2 (Origin), while Method 1 was not supported, except possibly as a fallback where Method 3 or Method 2 could not be used.

3.3.2 AEMO's assessment

AEMO agrees with the submissions that Method 1 is the least preferred method. While attractive in its simplicity, it has two major drawbacks:

1. It does not take into account the speed or accuracy by which a facility can achieve its response within the NOFB. This is especially important for Fast Contingency FCAS, where the speed of response is critical to *power system security* (this service must quickly arrest deviating frequency before it reaches dangerous levels).
2. It assumes that facility performance will always be predictable, which has not been AEMO's experience in managing the FCAS markets over many years. Many factors can impact FCAS delivery, and careful assessment based on actual data is often a key part of identifying issues for subsequent correction.

Hence, AEMO does not believe that this method provides a reliable and equitable measure of FCAS delivery.

Support for Method 2 was due to concerns over the possible cost and complexity of implementing a mechanism based on actual recorded data, which is the basis of Method 3, and in particular, that the current data retention requirements could be significantly increased. Unfortunately, Method 2 suffers from Method 1's second drawback, that a model of facility performance (even based on test data) is not a highly reliable predictor of future performance. This position is based on various historical incidents of non-delivery or deficient delivery where factors such as changes to control settings, operational mode changes or inconsistencies between trading and facility operation lead to non-performance.

While support for Method 3 was widespread, some Consulted Persons noted that changing data recording and retention requirements could be problematic, costly, and a barrier to some Contingency FCAS providers. In particular, it was noted that the proposed approach means that data recording and retention requirements cannot be quantified. This is because it is possible that frequency could stay between a facility's deadband and the NOFB for an indeterminate period. Another issue with Method 3 noted by CS Energy, was that using a facility's deadband as the boundary for event assessment would be problematic for generating units that have a zero deadband.

CS Energy also suggested an alternative approach, that it may be possible to calculate 'delta P' as the "difference between the rate limited target load and the actual measured load at the time frequency crosses the NOFB." An advantage of this approach is that all timings related to FCAS assessment could remain consistent across all FCAS providers and, indeed, unchanged from existing timings.

AEMO believes that this method would operate in a manner very similar to that outlined in this determination. The methodology already determines a reference trajectory (for example, see 2.1(a)(i) of the FCAS Verification Tool User Guide), which would be analogous to a 'rate limited target load', excepting behaviour associated with unit-specific AGC tuning. In particular, using AGC targets to establish a trajectory is problematic as this is complicated by conditions in the MASS surrounding the interplay of AGC and contingency response[3]. In particular, the MASS states in Section 6.9 that:

> "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*."

Furthermore, there are several issues that may affect this approach:

1. Various facilities that provide Contingency FCAS are not included in AGC.
2. There are variable delays in AGC/SCADA systems that can vary considerably between generating systems, meaning that AGC targets could differ significantly from the facility's output at any time. Unit-specific tuning is also an important factor.
3. Using a single data point (loading at time of NOFB departure) to establish delta P would be risky in case of any data misalignment or measurement quality.

Until these issues are resolved satisfactorily, AEMO believes it is prudent to use actual recorded data for all aspects of the FCAS measurement and to establish a facility's 'baseline' over a suitable period of time rather than from a point measurement.

3.3.3 AEMO's conclusion

Careful consideration of the identified options leads AEMO to the conclusion that no method delivers a precise result under all possible frequency behaviours and for all kinds of FCAS technologies. Therefore, AEMO has focussed on a method that is robust enough to deliver an accurate and reliable measurement under the vast majority of conditions. In reaching this conclusion, AEMO notes:

1. Methods that rely on a static calculation (such as Method 1) do not provide AEMO with sufficient confidence that the calculated amount of Contingency FCAS has been delivered. Since it is the service responsible for arresting frequency deviations before frequency reaches dangerous levels, Fast Contingency FCAS is quite critical. Therefore, it is important that the measurement method uses actual performance to the extent possible. With the benefit of years of FCAS verification, AEMO notes how often generating systems can fail to perform as expected, especially during unusual power system events.
2. FCAS Providers need certainty regarding the data recording requirements, so methods that do not specify the amount of data that must be recorded and retained are problematic.

Based on these considerations, AEMO considers that a methodology for recognising frequency response within the NOFB should be based on a modified Method 3, which can be summarised as:

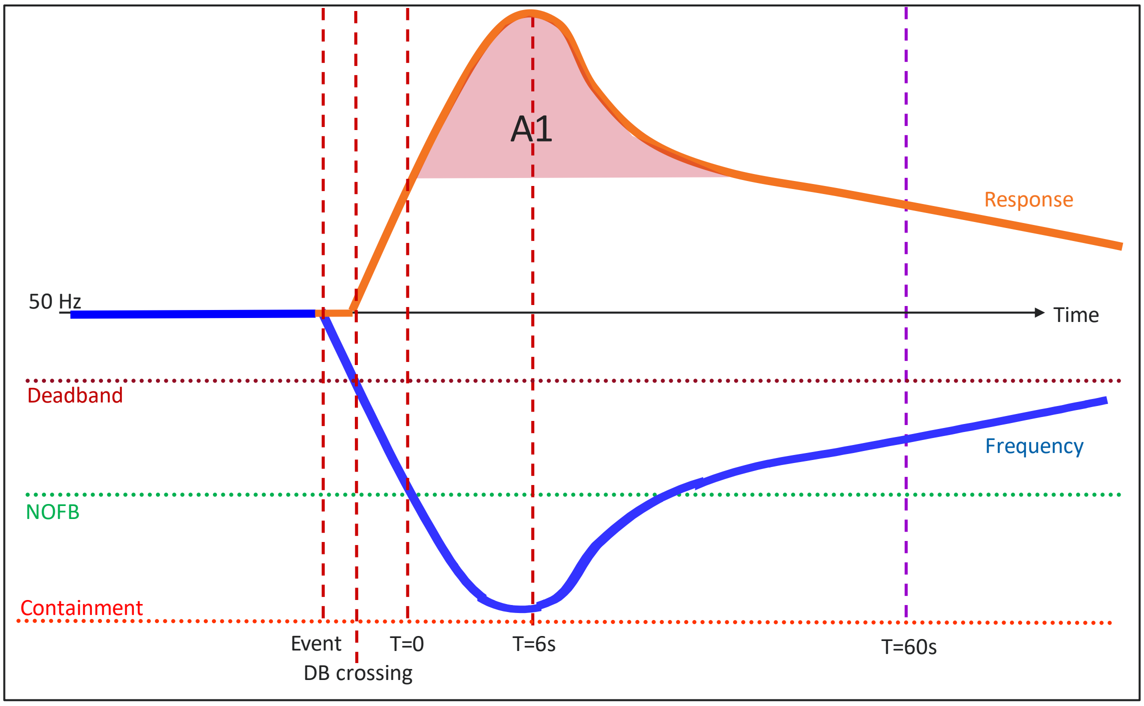
1. Assign the facility reference point for the Fast Contingency FCAS to be the average output of a facility between 8 and 20 seconds prior to a frequency disturbance (rather than the average between 2 and 4 seconds).
2. Extend the Contingency FCAS assessment window to the event time, which should be well within the current data measurement/recording requirements.

[3] AEMO believes this should be explored in a more fundamental review of the MASS as there are may be better approaches to co-ordinating AGC and contingency responses.

The response measured as Contingency FCAS is summarised graphically in the following figures, which show a hypothetical low frequency deviation (from a stable 50Hz reference) and the response of a facility to this deviation. In this example, the facility starts responding when a deadband well within the NOFB is crossed. AEMO's aim is to measure as much of the facility's 'response' (being the area under the orange curve) as possible. These diagrams aim to visually draw out the differences between the different measurement methods, and are not to scale. Furthermore, actual FCAS measurements are derived as time-averages over the relevant time periods, not as integrals.

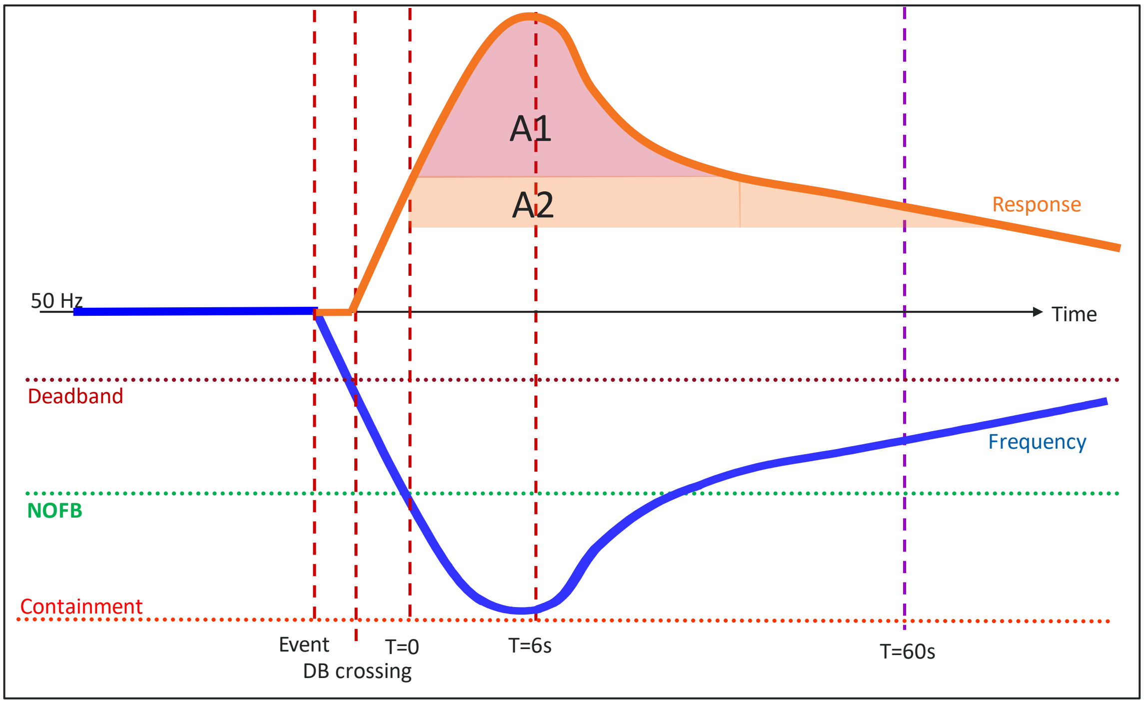
Area 'A1' in Figure 2 shows the response that would be measured if Contingency FCAS were to be measured from the disturbance time (t=0) and the reference point were to be the facility's output at t=0. Area 'A1' excludes a significant proportion of the facility's response because at the reference point (where frequency exits the NOFB), the generating unit has already moved off its 'base point'.

Figure 2 Fast Raise Contingency FCAS measurement (from disturbance time)



If, instead of taking the facility's reference point at t=0, it was taken to be the facility's average output just slightly prior to the frequency disturbance (that is, some point after the facility started to respond), Figure 3 shows that in addition to area 'A1', area 'A2' would also be measured as Contingency FCAS. This may be characterised as the current method employed by the MASS, which uses the average output between 2 and 4 seconds before the frequency disturbance as the facility's reference point.

Figure 3 Fast raise services measurement (from disturbance time with 2-4s reference)



If the reference point were to be moved earlier, such that it looks at a point prior to the facility having any measurable response, Figure 4 shows how, in addition to areas 'A1' and 'A2', area 'A3' would also be measured as Contingency FCAS. In this example, the reference point used for the facility precedes any frequency response and measures the full deviation away from this as Contingency FCAS. A small portion of the response is still excluded as measurement only commences once frequency exits the NOFB.

Figure 4 Fast raise services measurement (from disturbance with 8-20s reference)

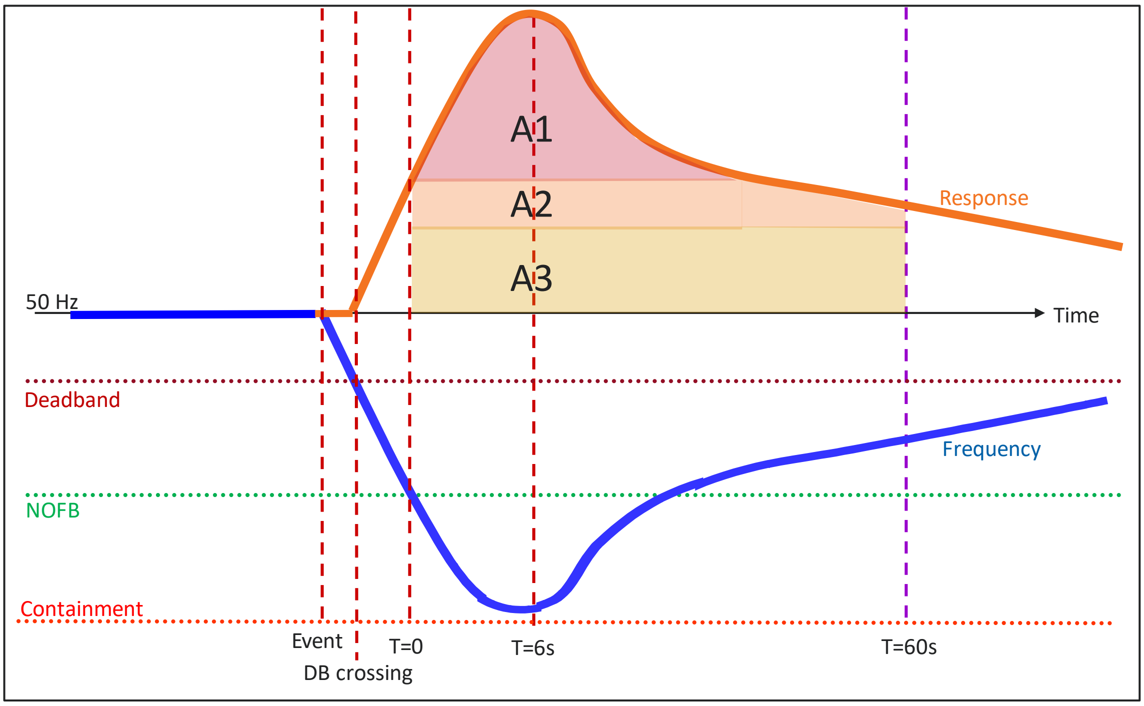
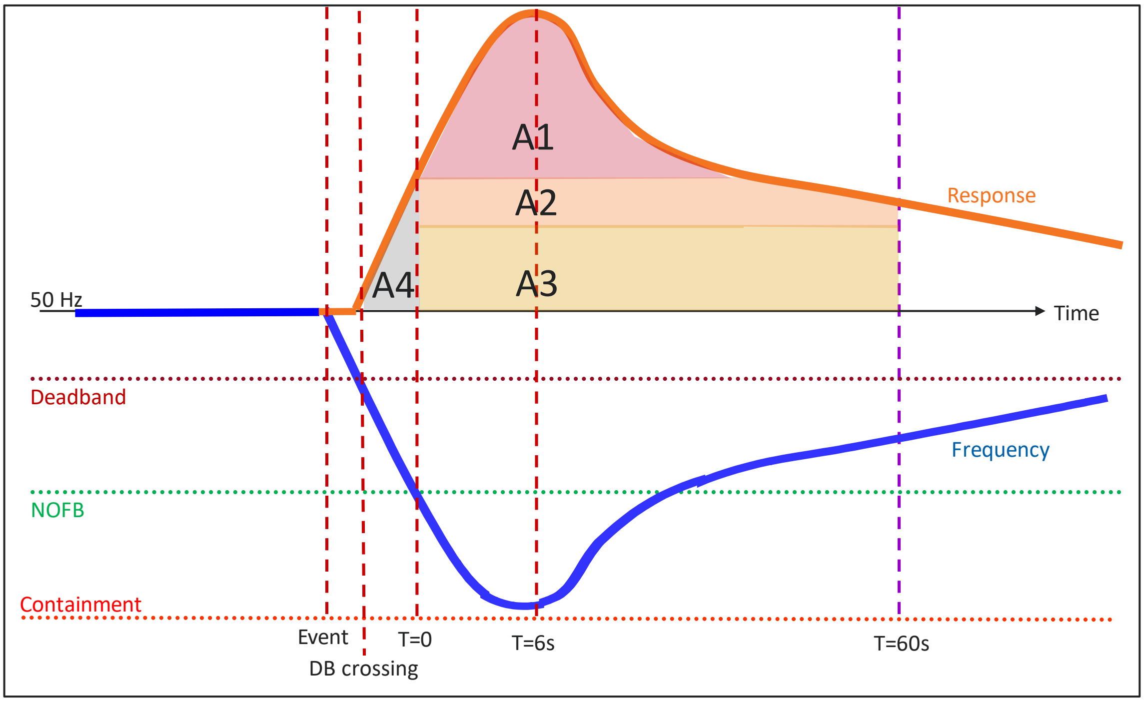


Figure 5 shows how area 'A4' is also measured as Contingency FCAS if the assessment window is extended to the event time, rather than commencing at the frequency disturbance time (t=0). In this example, all the facility's response is measured as Contingency FCAS.

Figure 5 Fast raise services measurement (from event with 8-20s reference)

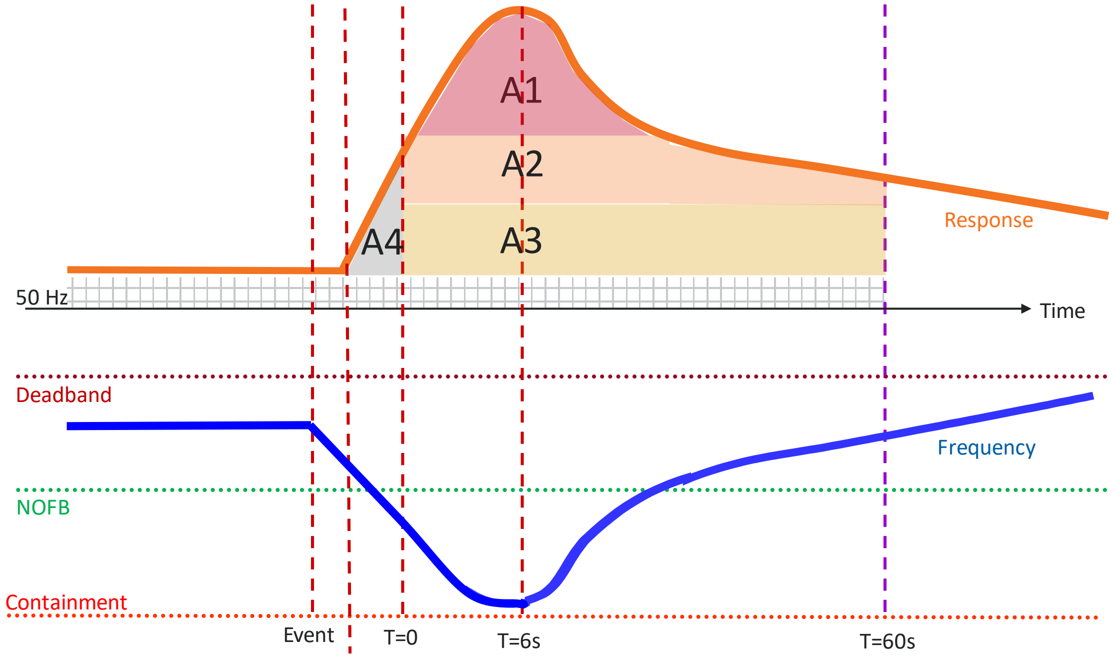


The advantages of this approach are:

1. In a single clean deviation from 50Hz, it measures all frequency response.
2. The approach does not increase data recording/retention requirements, since it uses data already captured under the current MASS requirements.
3. Reference points are still relatively close to the frequency event, meaning that the effect of energy market ramping, AGC behaviour, and other factors do not interfere too much.

It is nonetheless the case that in a more complex frequency event, the proposed approach might not recognise all frequency response. Consulted Persons pointed out what is, potentially, the most problematic kind of frequency deviation for measuring response within the NOFB, which is where frequency remains between facility deadbands and the NOFB for an extended period. An example is shown in Figure 6. The area shown in cross-hatch might not be recognised by the measurement since the facility has been away from its reference point for some time due to the extended frequency deviation exceeding its deadband.

Figure 6 Extended frequency deviation prior to contingency event



AEMO suggests that this situation would be quite rare. While this may be observed occasionally at present, the changes here need to be considered in the context of a mandated PFR. Because of the widespread narrow band response within the NOFB, in the absence of a contingency event, frequency would be expected to be much closer to 50 Hz, and to be returned to, or very close to, 50 Hz quickly (perhaps well within the ~20s timeframe used for reference).

Secondly, in the absence of a contingency event, it is unlikely that facilities would be very far off their base points. To illustrate this, consider a hypothetical 100 MW generating system providing proportional response from a narrow deadband (±0.015 Hz) at a typical 4% droop. For a frequency deviation of 30 mHz (i.e. twice the proposed deadband for mandatory PFR), this generating system would move by less than 1 MW. Even for a 100 mHz deviation – a large deviation that AEMO considers is unlikely to be sustained in an environment of near-universal PFR – this 100 MW generating system would move by, at most, ~4 MW.

In assessing Contingency FCAS delivery, AEMO always considers the circumstances of the event and how it might impact the measurement (and delivery) of Contingency FCAS. If the reference points happened to be when frequency was not quite close to 50 Hz, AEMO would, and does, take this into consideration when evaluating how FCAS delivery compares with enabled Contingency FCAS.

3.4 Other associated amendments

AEMO proposes to modify parts of Section 4.2 and 5.2 of the MASS as these give the impression that frequency response should be actively prevented if frequency moves within ±0.1 Hz, which is clearly incompatible with a frequency deadband well within this range. Rather, this is clarified to make the point that Contingency FCAS is not required to be provided if frequency has recovered. As always, there is no issue with a frequency response being provided; it is just not required for Contingency FCAS purposes. PFR obligations would still apply for affected Generators.

Section 4.2:

Ancillary Service Facilities ~~should~~ need 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~~ facilities are not required to deliver 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~~ facilities are not required to deliver slow Lower Response or delayed Lower Response.

Section 5.2:

Ancillary Service Facilities ~~should~~ need 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 should be no~~ facilities are not required to deliver 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~~ facilities are not required to deliver delayed Lower Response.

4. Draft Determination

Having considered the matters raised in submissions, AEMO's draft determination is to amend the MASS in the form of Attachment 1, in accordance with clause 3.11.2(c) of the NER.

Appendix A Glossary

In this paper, words in italics have the same meaning as under the NER. Capitalised terms are as defined below.

Term or acronym	Meaning
AEMO's Rule Change Proposals	The following two rule change proposals submitted by AEMO to the AEMC: • ERC0274 — Mandatory primary frequency response • ERC0263 — Removal of disincentives to primary frequency response during normal operation
Contingency FCAS	Any of the following: • *fast raise service*; • *fast lower service*; • *slow raise service*; • *slow lower service*; • *delayed raise service*; and • *delayed lower service*.
Delayed Contingency FCAS	*Delayed raise service* and *delayed lower service*.
ERC0274	National Electricity Amendment (Mandatory Primary Frequency Response) Rule 2020
Fast Contingency FCAS	*Fast raise service* and *fast lower service*.
FCAS	*frequency* control *ancillary services*
Frequency Disturbance	An occasion when the *power system frequency* moves outside the NOFB.
Frequency Disturbance Time	The time at which the Local Frequency fall or rises outside the NOFB during a Frequency Disturbance referenced to Australian Eastern Standard Time.
FOS	*frequency operating standards*
Local Frequency	The *frequency* of the electricity delivered by an *ancillary service generating unit* or consumed by an *ancillary service load*, measured in Hz.
MASS	The *market ancillary service specification* contemplated by clause 3.11.2(b) of the NER.
Raise Contingency FCAS	*Fast raise service*, *slow raise service* and *delayed raise service*
Slow Contingency FCAS	*Slow raise service* and *slow lower service*.

Appendix B Summary of submissions and AEMO responses

No.	Consulted person	Issue	AEMO response
1.	AGL	There is no reason not to recognise PFR falling within the NOFB as Contingency FCAS. In our submission to the AEMC consultation paper, we expressed concerns that Generators who previously were paid to provide Contingency FCAS, would no longer be paid to the extent that the Contingency FCAS band intersected with the mandatory PFR requirements. AEMO's proposal goes some way to addressing this concern, offsetting the anticipated reduction of FCAS revenues for Generators should mandatory PFR be implemented.	Noted.
2.	CS Energy	AEMO proposes to amend the MASS to ensure that an enabled Contingency FCAS generating unit's PFR is recognised as Contingency FCAS where this is appropriate. This is sensible for the reasons provided by AEMO.	Noted.
3.	CS Energy	[Recognition of PFR as Contingency FCAS] should apply to all Contingency FCAS 6/60 that is provided in proportion to system frequency. It should not apply to Delayed Contingency FCAS, given the requirement of Delayed Contingency FCAS to not be in proportion to frequency.	See Section 3.2.
4.	CS Energy	It is difficult to measure values preceding [frequency exiting the NOFB] because the period is ill-defined. The problem for Method 3 is recording the initial load with potentially long delays between frequency moving outside the governor dead band and the NOFB, with the extreme case being a hydraulic governor with no dead band not catered for.	See Section 3.3
5.	CS Energy	It may be possible to calculate 'delta P' as the difference between the rate limited target load and the actual measured load at the time frequency crosses the NOFB. This will ensure all timings remain bounded by the same starting time as currently.	See Section 3.3
6.	CS Energy	[On recognising PFR as Contingency FCAS for registration and dispatch rather than just delivery of FCAS] There are other Rule changes and Reviews which are investigating measurement, dispatch and payment for frequency services. Best dealt with in these processes.	This consultation is not about recognising PFR as Contingency FCAS but recognising that where Contingency FCAS providers commence the delivery of Contingency FCAS before frequency exits the NOFB, it should be rewarded appropriately.
7.	Delta Electricity	The changes being considered for the MASS that intend to include for supportive energy that occurs prior to frequency leaving the NOFB ought to be made regardless of the Rule changes because many FCAS providers already have governors and maintained stored energy which currently provides rapid supporting PFR energy prior to the frequency disturbance time in the 6s FCAS service delivery and the employment of this energy is agreed by Delta Electricity to warrant recognition in the MASS.	See Section 3.1

No.	Consulted person	Issue	AEMO response
8.	Delta Electricity	Regarding methodology, Delta Electricity believes an approach based on Method 3 and utilising FCAS recorded information is appropriate but should have two separate objectives: 1. Adjustments to all values of Initial Power i.e. values described in clause 3.7.1.(a)(v), 4.7.1.(a)(iv) and 5.7.1.(a)(iv) of the MASS being the value of power prior to PFR support relevant to the event that is considered to have commenced at the frequency disturbance time, AND 2. Inclusion in the response determination for the Fast Contingency FCAS (as described in AEMOs FCAS Verification Tool User Guide version 2 30 July 2017) affecting the wordings of 3.7.1.(a)(i),(iii) and (v). Instead of commencing from the frequency disturbance time, this assessment should be extended to include the period time between the relevant PFR commencement and the frequency disturbance time.	See Section 3.3
9.	Delta Electricity	[PFR within NOFB] warrants incorporation of the service into the FCAS regulation market. … With tighter deadbands of PFRR conditions, PFR utilisation of prepared stored energy will be continuous suggesting it should be market dispatched and settled separate to Contingency FCAS and generate appropriate compensation to suppliers for the necessary storage or throttling back of energy to provide rapid PFR. Without stored energy headroom, Contingency 6s FCAS provisions, scheduled by AEMO to cover contingency events, will be utilised by PFR on a continuous basis corrupting both the scheduling process and the delivery process for Fast Contingency FCAS. Delta Electricity favours a process of incorporating PFR into regulation FCAS which, like PFR, is regularly dispatched and utilised in each DI unlike Contingency FCAS which, although prepared for in each DI, is much more infrequently required to be delivered.	Noted. AEMO considers this would be best addressed in a more fundamental review of the MASS.
10.	Delta Electricity	The assignment of initial MWs to periods prior to the PFR support before the frequency disturbance time, will apply recognition to all services by adjusting the MW reference point for fast, slow and delayed delivery. The resultant service is compared to an initial MWs pre-event and if this is pre-PFR, the support will be more compliant and better reflect actual delivery than the current MASS which sometimes is assigning initial MWs after PFR has been delivered.	See Section 3.3
11.	Delta Electricity	[Regarding increased data recording windows] Delta Electricity considers that it is easily achieved.	Noted.
12.	Delta Electricity	…in investigating and assessing contingency event response, recorded data is considered superior to modelled expectations.	Noted. AEMO agrees that where feasible, recorded data is preferable to modelled data.

No.	Consulted person	Issue	AEMO response
13.	Delta Electricity	AEMO has now realised that PFR is essential for system security. Delta Electricity believes that rapid PFR is an expensive product to deliver which either requires storage of energy at a cost of around $1M p.a. in fuel alone on each 660MW coal-fired Unit for Raise Contingency FCAS or throttling of energy resulting in significant energy losses across throttling mechanisms for lower services. To adequately compensate suppliers for this energy service and to efficiently dispatch only the energy and throttling required to suit market conditions and maintain a designed system standard, a market process would be superior.	See response to issue 6. Separate markets or other mechanisms for PFR are beyond the scope of this Consultation and best considered through the AEMC's rule change consultations on PFR.
14.	EnergyAustralia	We support [recognition of PFR within the NOFB as Contingency FCAS] in principle; it is reasonable to recognise the response of generation plants to manage frequency.	Noted.
15.	EnergyAustralia	Recognition should only apply to Fast Contingency FCAS as this reflects the services that will be acting to arrest frequency before it departs the NOFB, and responding immediately after an event that causes frequency to depart the NOFB.	See Section 3.3
16.	EnergyAustralia	[On proposed methods to recognise PFR as Contingency FCAS] Method 3 proposed by AEMO appears reasonable.	See Section 3.3.
17.	ERM Power	We support the proposed change to recognise the level of frequency response provided by a generating unit, or load, enabled for the provision of Contingency FCAS following a system frequency event during the period that power system frequency remains in the NOFB. We believe this change to the MASS should occur regardless of the outcomes of AEMO's currently proposed rule changes	See Section 3.1.
18.	ERM Power	Recognition of service provision should apply to all three contingency services: Fast, slow and delayed for both Raise Contingency FCAS and lower Contingency FCAS.	See Section 3.2
19.	ERM Power	The event time should be defined as the time at which the contingency event occurred, not the time at which frequency first crossed the boundary of the NOFB or the provider's nominated control system deadband setting. We recommend that the contingency provider's response be calculated based on its deviation away from its initial output, or consumption, at the time of the event.	See Section 3.3
20.	ERM Power	This calculation methodology should apply to all generating units or loads enabled for Contingency FCAS response irrespective of any PFR registration status.	There is no PFR registration status. We assume the substance of the issue is addresses in Section 3.2.
21.	ERM Power	AEMO should provide the length of data it believes is reasonably required and the justification for these requirements. In considering this, AEMO should consider the frequency rate for the provision of data for the Fast Contingency FCAS, as this will have a direct cost implication for current providers.	See Section 3.3

No.	Consulted person	Issue	AEMO response
22.	ERM Power	We do not support AEMO's view that allowing the inclusion of response within the NOFB should be restricted to verification of the provision of services only; the inclusion of this hitherto excluded response should be able to be used by providers in determining the amount of response that can be provided.	See response to issue 6.
23.	ERM Power	The MASS should be revised as soon as practically possible, preferably as part of this consultation, to allow the provision of regulation FCAS via PFR or AEMO's AGC signals or a combination of these two.	This will be considered as part of the next more general consultation of the MASS.
24.	Hydro Tasmania	Hydro Tasmania supports the recognition of PFR within the NOFB as part of Contingency FCAS delivery based upon the definition and nature of a contingency event. The definition of a contingency event in the NER references the event by which the power system becomes affected. All response which acts to arrest the fall or rise in System Frequency following a contingency event should be recognised as Contingency FCAS, whether this response is in or outside the NOFB.	See Section 3.1.
25.	Hydro Tasmania	Recognition of Contingency FCAS provided inside the NOFB should only be for Fast Contingency FCAS.	See Section Error! Reference source not found.
26.	Hydro Tasmania	If frequency response within the NOFB is to be recognised, Hydro Tasmania's preference is for method 3 in determining the 'ΔP' value to be adopted. However, it is not clearly stated how the 'ΔP' value is calculated and Hydro Tasmania is concerned that the inertial response of its hydro units will not be considered and it should be.	Inertia is explicitly excluded from the calculation of Contingency FCAS. AEMO considers that valuing inertia as FCAS is issue best considered in the next more general Consultation on the MASS. See also Section 3.3.
27.	Hydro Tasmania	Based upon advice received from meter providers, increasing the pre-event recording may be achievable on most meters. This will involve changing the pre-event settings in compatible existing FCAS meters and installing new meters to replace those that will not be able to achieve the required settings.	Noted. See Section 3.3.
28.	Hydro Tasmania	All responses within the NOFB which act to arrest the fall or rise in System Frequency should be recognised for dispatch purposes.	See section 3.2..
29.	Infigen Energy	Infigen broadly supports the general concept of recognising frequency response within the NOFB as Contingency FCAS. Contingency FCAS should not disincentivise the operation of PFR within the NOFB and conversely should not penalise enabled Contingency FCAS providers for providing a response before frequency deviation outside of NOFB.	See Section 3.1.
30.	Infigen Energy	Infigen agrees that Method 3 seems to be the preferred option for assessing the total volume of contingency FCAS delivered, subject to sufficient data being available. In the case where data cannot verify the unit's response from when it crossed its frequency deadband to NOFB, that Method 1 could be fallen back on.	See Section 3.3

No.	Consulted person	Issue	AEMO response
31.	Infigen Energy	In the future, when a PFR mechanism is formalised Infigen supports a detailed consideration for the trade-off between PFR procurement and Fast Contingency FCAS market procurement. As above, Infigen recommends that any modifications to the MASS be considered once the AEMC rule change process has been finalised.	Noted.
32.	Infigen Energy	Counting response within the NOFB may lead to insufficient reserves being available if a contingency event occurs towards the edges of the NOFB (e.g., due to natural (slow) variations in supply and demand, the frequency is sitting at 49.86 Hz and a contingency event occurs; any Contingency FCAS providers also enabled for PFR will have already used some response, and will not be eligible to deliver their full enabled response).	Consideration of this kind of scenario is covered in Section 3.3
33.	MEA Group or Powershop	MEA Group supports the general concept of recognising PFR within the NOFB as Contingency FCAS on the basis that: • the change can be facilitated through the amendment of the MASS rather than the creation of a new market; • the provision of PFR within the NOFB is expected to significantly improve the frequency keeping of the power system; and • it will minimise the quantity of Contingency FCAS required due to the earlier response within the NOFB from enabled generators, hence reducing the overall total cost of FCAS.	See Section 3.1.
34.	MEA Group or Powershop	To the extent that the provision of PFR across all time horizons contributes to better frequency keeping services, MEA Group believes it is reasonable and fair to reward the provision of PFR within the NOFB for all services.	See Section 3.2
35.	MEA Group or Powershop	We agree with AEMO’s assessment that Option 3 is the most appropriate method for assessing a generators provision of PFR within the NOFB.	See Section 3.3
36.	MEA Group or Powershop	MEA Group does not hold a view on the pre-event recording window and how easily an increased window could be achieved. We would need to engage our power quality meter specialists and suppliers to determine what timeframes would be achievable and at what granularity.	See Section 3.3
37.	MEA Group or Powershop	MEA Group would expect the recognition of PFR within the NOFB to be for verification purposes only, on the basis that this approach requires the least amount of change to AEMOs NEM dispatch engine and participants market models.	Noted.
38.	Origin Energy	A generator providing contingency FCAS that is also configured to provide PFR will respond to frequency deviations both inside and outside the NOFB. Given this, we agree that if the rules are changed to provide for mandatory PFR, then responses within the NOFB should be included in the verification of FCAS providers.	See Section 3.1.

No.	Consulted person	Issue	AEMO response
39.	Origin Energy	The main issue with [method 3] is the need to increase the pre-recording window which will require Generators to store more data. This is likely to result in higher metering costs for Generators providing Contingency FCAS […] Additionally, the AEMC's Frequency Control Frameworks Review identified high metering costs as a barrier for small generators entering FCAS markets. Origin considers that method 2 is more appropriate given the expected general repetitive nature of the outcomes.	See Section 3.3
40.	Stanwell	The proposal appears to pre-suppose the outcome of the parallel AEMC rule change process relating to the provision of PFC. Given it is likely that the outcome of the AEMC process will require additional changes to similar aspects of the MASS, Stanwell questions the appropriateness of undertaking this targeted MASS review now, particularly given the volume and scope of other market changes currently underway.	See Section 3.1.
41.	Stanwell	Separate valuation of this service now will more accurately capture the costs of provision and better incentivise market participants to provide this service in the long-term, as envisioned in the AEMC Frequency Control Frameworks Review.	Separate markets or other mechanisms for PFR are beyond the scope of this Consultation and will be considered by the AEMC as part of its consultations on rule changes on PFR.
42.	Stanwell	The Issues Paper acknowledges that AEMO's preferred measurement approach (Method 3: Calculate delta-P based on event response) would require an extended recording period However, it does not address how long this recording period should be, or how the interaction with the dispatch ramping trajectory would be treated. The Issues Paper also does not mention if or how the upfront costs of Market Participants upgrading data acquisition equipment to capture data for the necessary duration would be compensated.	See Section 3.3
43.	Stanwell	The scenario presented in the Issues Paper (Figure 1: Fast Contingency FCAS delta-P with narrow deadband response) utilises a duration of around one second between crossing the deadband and the NOFB. During an actual contingency event, it is likely that this would occur within less than a second, making measurement of any PFC provision difficult. Conversely, if frequency were to remain between the narrow deadband and NOFB for an extended period before an unrelated contingency event, significant energy may have been expended by the Contingency FCAS provider (in providing PFC) well before the event occurs. If the measurement window does not include the full pre-event period, compliance evaluations may be skewed towards false negative outcomes.	See Section 3.3

Attachment 1 Draft Market Ancillary Services Specification

MARKET ANCILLARY SERVICE SPECIFICATION

PREPARED BY:	AEMO Systems Performance and Commercial
DOCUMENT REF:	ESOPP_12
VERSION:	[6.0]~~5.0~~
EFFECTIVE DATE:	TBA
STATUS:	~~FINAL~~DRAFT

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DATE:	~~30 / 06 / 2017~~ TBA

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NEW SOUTH WALESQUEENSLANDSOUTH AUSTRALIAVICTORIAAUSTRALIAN CAPITAL TERRITORY TASMANIAWESTERN AUSTRALIA

VERSION RELEASE HISTORY

Version	Effective Date	Summary of Changes
1.0	Sep 2001	Initial document issued at the commencement of the market ancillary services
1.5	27 Feb 2004	Revised to include the Tasmania region
2.0	5 May 2009	Revised to align with the revised Tasmania frequency operating standards
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 in Table 4 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
[6.0]	TBA	• Revised following consultation on relationship with the draft Primary Frequency Response rule change (ERC0274). • Minor drafting updates, corrections and clarifications.

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TABLES

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1. INTRODUCTION

1.1. Purpose and scope

This is the *market ancillary service specification* (MASS) made under clause ~~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 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 section~~clause~~. NER ~~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.

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

Table 1 Definition of 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-~~-~~b~~B~~and	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 for *regions* other than Tasmania and Table 4 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 for *regions* other than Tasmania, or Table 4 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 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 section~~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
Generation Event	has the meaning given or implied in the relevant Frequency Operating Standards

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

Term	Definition
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 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
Regulating Raise Response	means the increase in Generation Amount or decrease in Load Amount delivered in response to one or more Raise Signals

Term	Definition
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 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~~ ensure the *power system* can arrest and recover from 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~~ may only occasionally be 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.

2.1.2. Regulation services

Regulation services are enabled to manage minor ~~changes~~ supply-demand imbalances ~~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 low*er – 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 enabled to provide *regulation services* so *frequency* is maintained within the *normal operating frequency band* of 49.85 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~~irregular use of Contingency Services, enabled *regulation services* are normally utilised continually 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~~ clause 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 clause~~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 relevant plant that form the 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 clause~~Rule~~ 3.11.2(f) of the NER, the equipment required to monitor and record aggregated responses of Ancillary Service Facilities must have the following characteristics:

i. The power flow representing the amount of *generation* or *load* of each relevant plant of the 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 relevant plant that forms part of an 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 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 Ancillary Service Facility.

iii. Subject to section~~clause~~ 2.4(iv), the measurements of power flow and Local Frequency of aggregated Ancillary Service Facilities must be made at an interval specified under sections ~~clauses~~ 3.6~~,~~ (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. The clocks associated with the meters of relevant plant that form an 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 clause~~Rule~~ 3.11.2 (h) of the NER may include a request for the *Market Participant* with an Aggregated Ancillary Service Facility to provide a report detailing the response of each unit that constitutes the 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 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.

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

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~~ the time of the contingency event 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,

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~~ the time of the contingency event 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 clause~~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 no later than when Local Frequency ~~changes are below~~ reaches the lower limit of the *normal operating frequency band*, unless a Switching Controller is used; or

(ii) a fast Lower Response no later than when Local Frequency ~~changes are above~~ reaches the upper limit of the *normal operating frequency band*, *unless a Switching Controller is used*,

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 the Variable C~~c~~ontroller's Frequency Deadb~~-B~~and 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 sections ~~clauses~~ 3.5(b)(i) and (ii) with each metered separately in accordance with metering requirements specified in section ~~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 the Variable C~~c~~ontroller's Frequency Deadb~~-B~~and 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 sections ~~clauses~~ 3.5(c)(i) and (ii), with each metered separately in accordance with metering requirements specified in section ~~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 for *regions* other than Tasmania or Table 4 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 for Fast Raise Service and Fast Lower Service

(a) For the purposes of ~~*Rule*~~ clause 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 section~~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 section~~clause~~s 3.6(i)(a)(i) to (xii) must ensure that the provision of the *market ancillary service* can be verified.

(xiv) Refer also to section ~~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 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 section~~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 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 measured 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 sub-paragraph (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 section~~clause~~s 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 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~~ need 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~~ *facilities* are not required to deliver 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*~~*facilities* are not required to deliver 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 clause~~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 no later than when Local Frequency ~~changes are~~ reaches ~~below~~ the lower limit of the *normal operating frequency band*, unless a Switching Controller is used; or

(ii) a slow Lower Response no later than when Local Frequency ~~changes are above the~~reaches the upper limit of the *normal operating frequency band*, unless a Switching Controller is used,

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 the Variable Controller's Frequency Deadband 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 section~~clause~~s 4.5(b)(i) and (ii), with each metered separately in accordance with metering requirements specified in section ~~clause (e)~~4.6(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 the Variable Controller's Frequency Deadband 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 sections ~~clauses~~ 4.5(c)(i) and (ii), with each metered separately in accordance with metering requirements specified in section 4.6 ~~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 for *regions* other than Tasmania or Table 4 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 clause ~~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 section ~~clause~~s 4.6~~(e)~~(a)(i) to (xi) must ensure that the provision of the *market ancillary service* can be verified.

(xiii) Refer also to section ~~clause~~ 2.4 in relation to aggregation of 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 section ~~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 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 measured 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 section~~clause~~s 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~~ need 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*~~*facilities* are not required to deliver 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~~ *facilities* are not required to deliver delayed Lower Response.

5.3. Amount of Delayed Raise Service for 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

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 for Delayed Raise Service and Delayed Lower Service

For the purposes of clause~~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 no later than when Local Frequency ~~changes are below~~ reaches the lower limit of the *normal operating frequency band*; or

   (ii) a delayed Lower Response no later than when Local Frequency ~~changes are above~~ reaches 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 the Variable Controller's Frequency Deadband 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~~ sections 5.5(b)(i) and (ii), with each metered separately in accordance with metering requirements specified in ~~clause~~ section 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 the Variable Controller's Frequency Deadband 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 sections ~~clauses~~ 5.5(c)(i) and (ii), with each metered separately in accordance with metering requirements specified in section ~~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 for *regions* other than Tasmania or Table 4 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 for Delayed Raise Service and Delayed Lower Service

(a) For the purposes of clause ~~*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 section~~clause~~s 5.6(a)(i) to (x) must ensure that provision of the *market ancillary service* can be verified.

(xii) Refer also to ~~clause~~ section 2.4 in relation to aggregation of 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 *delayed raise service* or *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~~ section 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 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~~ sections 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 help 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 providing *regulation services* ~~so~~ to assist in ~~*frequency* is maintained within the~~ managing *frequency* within the *normal operating frequency band* of 49.85 Hz to 50.15 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 u*nits.

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

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

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 for Regulating Raise Service and Regulating Lower Service

For the purposes of clause~~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 for Regulating Raise Service and Regulating Lower Service

For the purposes of clause~~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 section~~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*.

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 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 registering for multiple services will be allocated the same settings for each raise service and lower service.

(ii) Ancillary 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 with higher availability will be allocated to *frequencies* closer to *normal operating frequency bands*.

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

(v) *AEMO* will consider any physically-appropriate characteristics of the 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 section~~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 (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 section ~~clause~~ 7.2(b), the *Market Participant* may apply the relevant default Frequency Deviation Setting shown in Table 3 for *regions* other than Tasmania and Table 4 for the Tasmania *region*.

(f) For the purposes of sections ~~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 for *regions* other than Tasmania and Table 4 for the Tasmania *region*.

For the purposes of sections ~~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 for *regions* other than Tasmania and Table 4 for the Tasmania *region*;

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

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

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

Table 3 Frequency Settings for 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 4 Frequency Settings for the 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 for a limited period,
- Be for a limited measurable quantity of the service, and
- Be subject to the conditions that the party conducting the trial:
  - Withdraw from the market if directed by *AEMO.*
  - Use best endeavours to meet the full requirements of the MASS.
  - Meet any other requirements *AEMO*, at its discretion, requests.

APPENDIX A. STANDARD FREQUENCY RAMP

Note: these figures to be updated in final MASS to show measurement commencing from Contingency Event, rather than from NOFB crossing.

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

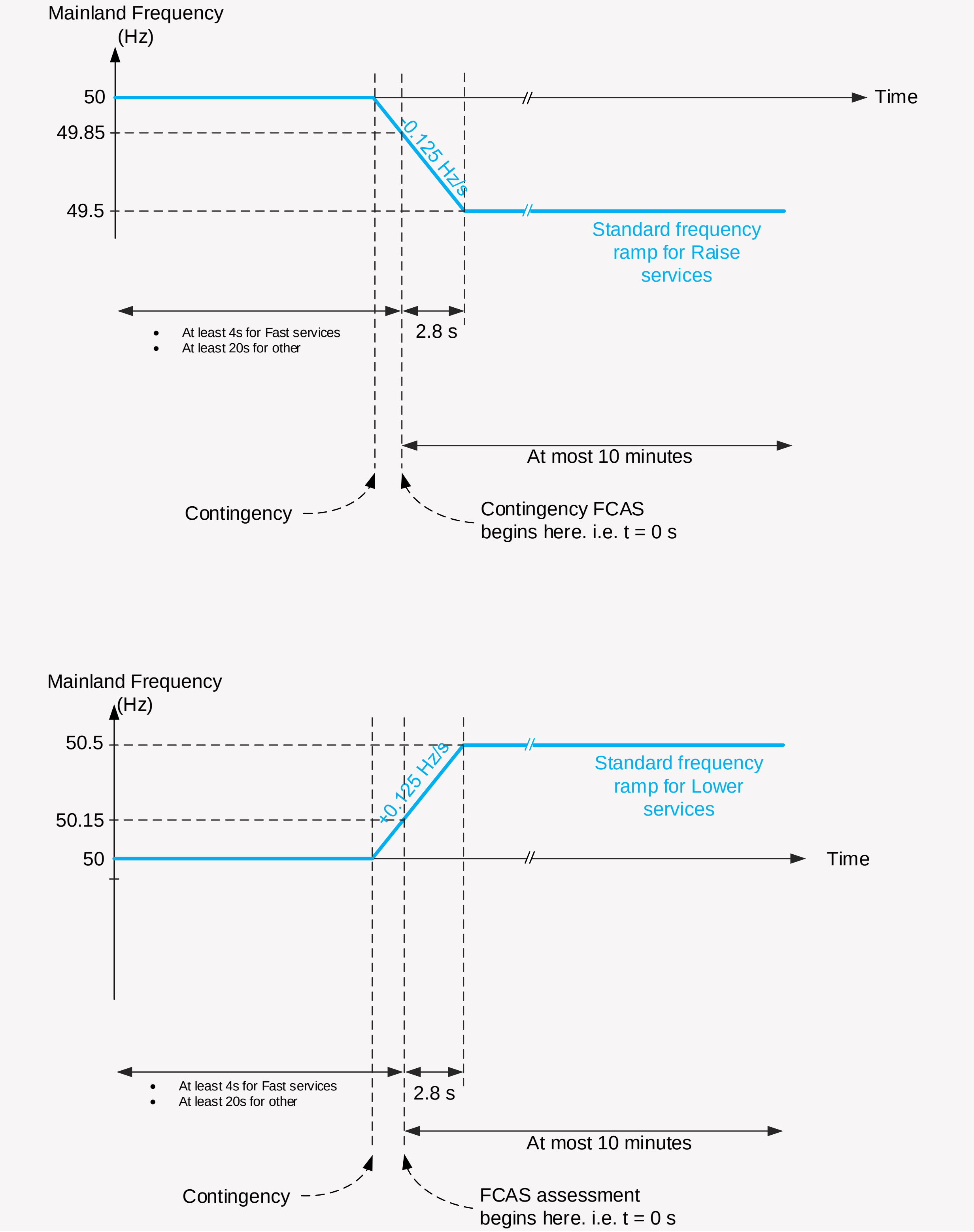

Figure 2 Standard Frequency Ramp for Tasmania