

Frequency Contribution Factors Procedure

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[1.0]	[8 June 2025]	First issue
[1.1]	[8 June 2025]	Amended to reflect National Electricity Amendment (Integrating energy storage systems into the NEM) Rule 2021 No.13 and National Electricity Amendment (Implementing integrated energy storage systems) Rule 2023 No.2

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

1. Introduction

1.1. Purpose and scope

This is the Frequency Contribution Factors Procedure (**Procedure**) made under clause 3.15.6AA(f) of the National Electricity Rules (**NER**). The contribution factors (**CFs**) and other factors determined in accordance with this Procedure are used for the purpose of determining the allocation and amount of:

- (a) payments relating to frequency performance under NER 3.15.6AA(b) (**Frequency Performance Payments or FPPs**); and
- (b) cost recovery for *regulating raise service* and *regulating lower service* (**Regulation FCAS**) under NER 3.15.6AA(c) and (d).

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

1.2. Definitions and interpretation

1.2.1. Definitions

Terms defined in the National Electricity Law and the NER (in chapter 10 or clause 3.15.6AA) have the same meanings in this Procedure unless otherwise specified in this section 1.2.1.

Terms defined in the NER are intended to be identified in this Procedure by italicising them, but failure to italicise a defined term does not affect its meaning.

In addition, the words, phrases and abbreviations in the table below have the meanings set out opposite them when used in this Procedure.

Table 1 Glossary

Term	Definition
AGC (automatic generation control system)	The system into which the <i>loading levels</i> from economic <i>dispatch</i> will be entered for <i>generating units</i> and <i>bidirectional units</i> operating on automatic generation control in accordance with clause 3.8.21(d)
Bad Quality	Any telemetered data that is not 'Good Quality', as defined in the Power System Data Communication Standard.
CF (contribution factor)	A factor calculated in accordance with section 6 and applied to an <i>eligible unit</i> with <i>appropriate metering</i> .
DCF (default contribution factor)	A CF determined in accordance with section 6.3 and applied to an <i>eligible unit</i> with <i>appropriate metering</i> in the circumstances described in NER 3.15.6AA(g)(4).
FM (frequency measure)	The indication of a need to raise or lower <i>frequency</i> calculated by AEMO in accordance with section 4.
FPP (frequency performance payment)	A <i>trading amount</i> payable by, or to, a <i>Cost Recovery Market Participant</i> determined in accordance with NER 3.15.6AA(b).
HPP (historical performance period)	A seven-day period, starting at 12:00 AM on a Sunday and ending at 12:00 AM on the following Sunday, which concludes 14 days prior to the commencement of the <i>billing period</i> , inclusive of the 5 business days' notice period, as referred to in NER 3.15.6AA(i).

Term	Definition
Lower Performance	The performance in MWhz of the Residual or an <i>eligible unit</i> with <i>appropriate metering</i> where the FM is negative, in respect of <i>trading intervals</i> .
Mainland	The part of the NEM comprising the regions of Queensland, New South Wales, Victoria and South Australia.
MMS Data Model	The interface to participants of data published by AEMO from the NEM system.
NEM	<i>National Electricity Market</i> .
NEMDE	National Electricity Market Dispatch Engine.
NER	National Electricity Rules. NER followed by a number refers to that numbered rule or clause of the NER.
NCF (negative contribution factor)	A CF that is less than zero.
Performance	Collectively refers to Raise Performance and Lower Performance.
Power System Data Communication Standard	The standards and protocols determined by AEMO under NER 4.11.1 and 4.11.2(c).
Raise Performance	The performance in MWhz of the Residual or an <i>eligible unit</i> with <i>appropriate metering</i> where the FM is positive, in respect of <i>trading intervals</i> .
RCR (requirement for corrective response)	The requirement for corrective response as described in NER 3.15.6AA(g)(6)(i).
Relevant Eligible Units	<i>Eligible units</i> located within a <i>region</i> that is included in a Regulation FCAS Requirement.
Reference Trajectory	The expected <i>active power</i> output or consumption of an <i>eligible unit</i> or the Residual, calculated in accordance with section 5.
Regulation FCAS	<i>Regulating lower service</i> and <i>regulating raise service</i> .
Regulation FCAS Requirement	A <i>market ancillary service requirement</i> for Regulation FCAS.
Residual	All Relevant Eligible Units without <i>appropriate metering</i> .
Residual Deviation	The aggregate deviation of the Residual.
Residual Performance	The aggregate Performance of the Residual.
SCADA	Supervisory control and data acquisition.
Usage or U	The proportion of Regulation FCAS that is deemed to be Used Regulation FCAS, calculated in accordance with section 8.
Unused Regulation FCAS	Regulation FCAS that is deemed to be unused and for which costs are determined in accordance with NER 3.15.6AA(d).
Used Regulation FCAS	Regulation FCAS that is deemed to be Used and for which costs are determined in accordance with NER 3.15.6AA(c).

1.2.2. Interpretation

This Procedure is subject to the principles of interpretation set out in Schedule 2 of the National Electricity Law.

1.3. Related documents

Reference	Title	Location
160-0392	Efficient Dispatch and Localised Recovery of Regulation	https://www.aemo.com.au/-/media/files/electricity/nem/security_and_reliability/ancillary_services/0160-0049-pdf.pdf

Reference	Title	Location
	Services Business Specification	
N.A.	Power System Data Communication Standard	https://aemo.com.au/-/media/files/electricity/nem/network_connections/transmission-and-distribution/aemo-standard-for-power-system-data-communications.pdf
N.A.	Frequency Contribution Factor Tuning Parameters and Input Sources	https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/ancillary-services/frequency-contribution-factors
N.A.	Guide to Ancillary Services in the National Electricity Market	https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/ancillary_services/guide-to-ancillary-services-in-the-national-electricity-market.pdf
N.A.	MMS Data Model Reports	https://visualisations.aemo.com.au/aemo/di-help/Content/Data_Model/MMS_Data_Model.htm

2. Process overview

2.1. Frequency Performance Payments and Regulation FCAS

Frequency Performance Payments (**FPPs**) provide *Cost Recovery Market Participants* (among whom the costs of Regulation FCAS are allocated) with an incentive to operate their *facilities* in a way that provides the *power system* with good primary *frequency* control, and a disincentive against operating in a way that negatively impacts *frequency*. It is a zero-sum system in which *Cost Recovery Market Participants* whose *eligible units* are determined to contribute to poor *frequency* outcomes fund payments made to *Cost Recovery Market Participants* whose *eligible units* contributed to positive *frequency* performance.

For each *eligible unit*, each Regulation FCAS Requirement, and each *trading interval*, AEMO calculates a *trading amount* under the following provisions:

- (a) NER 3.15.6AA(b) (FPPs payable to, or by, *Cost Recovery Market Participants*);
- (b) NER 3.15.6AA(c) (Recovery of the Used Regulation FCAS cost); and
- (c) NER 3.15.6AA(d) (Recover of the Unused Regulation FCAS cost).

2.2. Calculation overview

Broadly, the process undertaken for each *trading interval* is as follows:

1. For each *eligible unit* with *appropriate metering*, compare SCADA measurements with a Reference Trajectory to determine deviations from that trajectory. Calculate Residual Deviations based on the sum of deviations of *eligible units* with *appropriate metering*.
2. Determine the FM, which indicates whether there is a need to raise or lower *power system frequency*.
3. For each *eligible unit* with *appropriate metering* and the Residual, calculate Performance based on the FM and the deviations.
4. Calculate CFs for *eligible units* with *appropriate metering* and for the Residual based on Performance.

5. Determine a price for FPPs based on the marginal cost of each Regulation FCAS Requirement ($P_{\text{regulation}}$) as determined by the *market management systems*.
6. Determine the RCR, which is multiplied by price to calculate the total amount of FPPs based on the amount of *frequency response* provided by *eligible units*.
7. Use the CFs for each *Cost Recovery Market Participant* to apportion FPPs.
8. Apportion the Residual CF to *eligible units* without *appropriate metering* pro rata, based on total *adjusted gross energy* amounts.
9. Calculate Usage.
10. Apportion the cost of Used Regulation FCAS to each *Cost Recovery Market Participant* on the basis of NCFs.
11. Apportion the cost of Unused Regulation FCAS to each *Cost Recovery Market Participant* using DCFs.

Figure 1 shows the general workflow of this process, excluding the application of any exceptions.

Figure 1 Flowchart of the general process

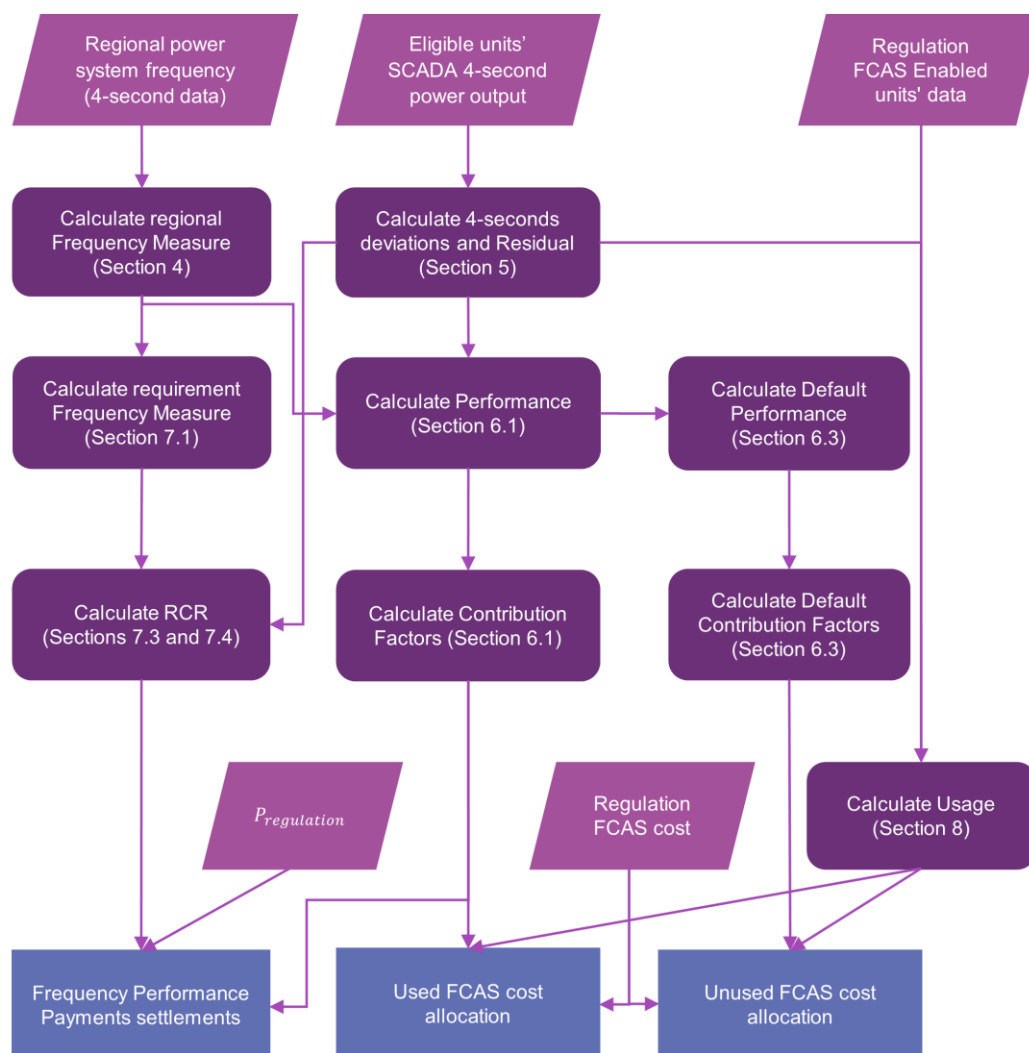


Table 2 details the equations that are used to determine the FPPs and the recovery of Regulation FCAS costs.

Table 2 Settlement equations

Trading Amounts	Eligible unit	Residual Deviation
FPPs	NER 3.15.6AA(b)(1)	NER 3.15.6AA(b)(2)
	$TA = CF \times \frac{P_{regulation}}{12} \times RCR$	$TA = RCF \times \frac{P_{regulation}}{12} \times RCR \times \frac{TE}{ATE}$
Recovery of Used Regulation FCAS	NER 3.15.6AA(c)(1)	NER 3.15.6AA(c)(2)
	$TA = TSFCAS \times U \times NCF$	$TA = TSFCAS \times U \times NRCF \times \frac{TE}{ATE}$
Recovery of Unused Regulation FCAS	NER 3.15.6AA(d)(1)	NER 3.15.6AA(d)(2)
	$TA = TSFCAS \times (1 - U) \times DCF$	$TA = TSFCAS \times (1 - U) \times DRCF \times \frac{TE}{ATE}$

2.3. Unit aggregation

Eligible units with appropriate metering that are aggregated must be in the same region and owned by the same financially responsible Market Participant of the same participant ID.

2.3.1. NER 3.8.3 bid aggregation

Eligible units with appropriate metering that have been aggregated under NER 3.8.3, will also be treated as aggregated units when determining their CFs.

2.3.2. Aggregation of eligible units for aggregated dispatch conformance

If, during a trading interval, two or more eligible units with appropriate metering are registered to participate in “aggregated dispatch conformance”¹ under NER 4.9, they will be assessed as a single eligible unit, regardless of the status of their compliance mode in NEMDE “dispatch” for that trading interval.

2.3.3. Aggregation of other eligible units

AEMO may, where appropriate, assess the deviation of eligible units with appropriate metering with more than one NER classification as a single eligible unit. An example of where this would apply is with a battery system not registered as a bidirectional unit, which operates with more than one dispatchable unit identifier (DUID) and are classified as a scheduled generating unit and a scheduled load, but, physically, operate as one integrated unit.

¹ As that term is defined in that provision.

3. Criteria for determining whether an eligible unit has appropriate metering

For a *trading interval*, an *eligible unit* will have *appropriate metering* if it has *remote monitoring equipment* that transmits the *active power* output or consumption of the *eligible unit* at its *connection point* to AEMO in accordance with the Power System Data Communication Standard at intervals of not more than 4 seconds if the *eligible unit* is located in the Mainland, and not more than 8 seconds if in Tasmania.

4. Determination of the need to raise or lower power system frequency

4.1. Formulation of Frequency Measure

For each 4-second interval, AEMO determines an FM based on the *frequency* of the *power system* that signals the direction (raise or lower) in which *eligible unit* deviations from the Reference Trajectory are helpful (helping to correct *power system frequency* towards 50 Hz), or unhelpful.

Power system frequency, which is fed into the calculation of FM, is measured uniquely for each *region*. For *regions* with more than one suitable *frequency* measurement, multiple measurements will provide redundancy, but only one is used as the input for FM in the *region*.

The FM in a *region* is derived by applying an exponential weighted moving average filter (a low-pass filter) to the negative of the *frequency* deviations in the *region*.

$$FM_t = (1 - \alpha)FM_{t-1} + \alpha(-FD_t)$$

where:

t is the index of 4-second intervals;

FM_t is the FM at 4-second interval t ;

FD_t is the real-time *frequency* deviation (difference between instantaneous frequency and 50Hz); and

α (alpha) is the smoothing factor, which is between 0 and 1, as specified in AEMO's document "Frequency Contribution Factor Tuning Parameters and Input Sources".

4.2. Misalignment between FM and real-time frequency deviations

AEMO will exclude from the Performance calculation (sections 6.2.1 and 6.2.3) the 4-second intervals where FM and *frequency* deviations indicate opposite needs to raise or lower *power system frequency*. This happens when the FM and *frequency* deviation in a 4-second interval have the same sign, and *power system frequency* is outside the *primary frequency control band*.

4.3. Frequency Measure conditions

4.3.1. When the Frequency Measure is considered unreliable

An FM for *regulating raise services* will be considered unreliable for a *trading interval* if:

- (a) there are fewer than seven 4-second intervals within a *trading interval* in which the FM is positive; or
- (b) there are no 4-second intervals within a *trading interval* where the FM is above 0.01 Hz.

An FM for *regulating lower services* will be considered unreliable for a *trading interval* if:

- (a) there are less than seven 4-second intervals within a *trading interval* in which the FM is negative; or
- (b) there are no 4-second intervals within a *trading interval* where the FM is below -0.01 Hz.

An FM for both *regulating raise services* and *regulating lower services* will be considered unreliable for a *trading interval* if:

- (c) a system separation occurs and the AGC area does not align with the *dispatched* Regulation FCAS Requirement in NEMDE and a manual reconfiguration of AEMO's systems is required; or
- (d) a significant number of raw frequency data points² are Bad Quality or missing within the *trading interval*.

4.3.2. Consequences of unreliable Frequency Measure

In a *region*, for a *trading interval* where one or more of the conditions in section 4.3.1 is met for *regulating raise services*:

- (a) Raise Performance of all *eligible units* in the *region* is NULL;
- (b) Raise RCR for any Regulation FCAS Requirement which includes the *region* is zero; and
- (c) Raise Usage for any Regulation FCAS Requirement which includes the *region* is zero.

In a *region*, for a *trading interval* where one or more of the conditions in section 4.3.1 is met for *regulating lower services*:

- (d) Lower Performance of all *eligible units* in the *region* is NULL;
- (e) Lower RCR for any Regulation FCAS Requirement which includes the *region* is zero; and
- (f) Lower Usage for any Regulation FCAS Requirement which includes the *region* is zero.

Note:

A NULL Performance at a *trading interval* for an *eligible unit* with *appropriate metering* means no value is stored at the *trading interval*. As a result, the *trading interval* would not be included in the Historical Performance Period (HPP) used to determine the data for the DCFs of the *eligible unit*.

² As defined in AEMO's Frequency Contribution Factor Tuning Parameters and Input Sources document.

This applies to all RCR and U values for a given Regulation FCAS Requirement even where the FM for other *regions* included in the same Regulation FCAS Requirement is not subject to any of the conditions described in section 4.3.1.

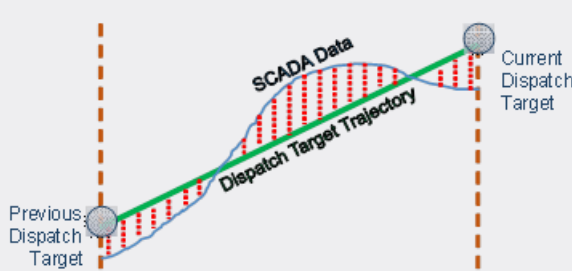
5. Reference Trajectory and deviation calculation

AEMO calculates 4-second deviations (in MW) by comparing SCADA measurements against a Reference Trajectory that differs depending on the deviation source. The sign of deviations is always with respect to the relevant *region* – a positive deviation is one that increases the net amount of energy within that *region* (more *generation* or less *load*) and vice versa for negative deviations. These calculations are described in the remainder of section 5.

5.1. Deviation of scheduled and semi-scheduled plants, and interconnectors

The Reference Trajectory for *scheduled generating units*, *semi-scheduled generating units*, *scheduled loads*, *scheduled bidirectional units* and *interconnectors* is illustrated in Table 3.

Table 3 Scheduled generating units, semi-scheduled generating units, bidirectional units and scheduled loads

Reference trajectory	Actual measurement	Example
Straight line between previous NEMDE <i>dispatch target/dispatch level</i> and current NEMDE <i>dispatch target/dispatch level</i> .	SCADA data for the eligible unit, load, or interconnector.	

Thus, for each *scheduled generating unit*, *semi-scheduled generating unit*, *scheduled load*, *scheduled bidirectional unit* or *interconnector*, the Reference Trajectory at 4-second interval t (Ref_t) and the deviation (Dev_t) are calculated as follows:

$$Ref_t = DT_{ti-1} + (DT_{ti} - DT_{ti-1}) \times \frac{t}{75}$$

$$Dev_t = Gen_t - Ref_t$$

where:

ti is the index of *trading intervals*;

t is the index of 4-second intervals during *trading interval* ti , which can be from 1 to 75;

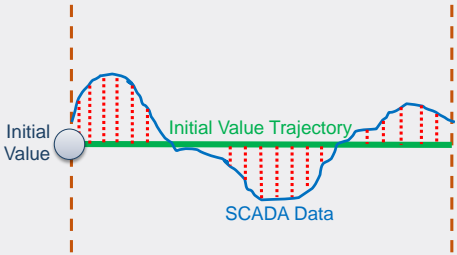
DT_{ti} is the NEMDE *dispatch target/dispatch level* at *trading interval* ti ; and

Gen_t is the SCADA metered value at 4-second interval t .

5.2. Deviation of non-scheduled plants with appropriate metering

The Reference Trajectory for *non-scheduled market generating units, non-scheduled bidirectional units* and *non-scheduled market loads with appropriate metering* is illustrated in Table 4.

Table 4 Non-scheduled generating units and non-scheduled loads with appropriate metering

Reference trajectory	Actual measurement	Example
Continuation of SCADA metered value at the start of the current <i>trading interval</i> .	SCADA data for the <i>eligible unit</i> or <i>load</i> .	

Thus, for each *non-scheduled market generating unit, non-scheduled bidirectional unit* and *non-scheduled market load with appropriate metering*, the Reference Trajectory at 4-second interval t (Ref_t) and the deviation (Dev_t), are calculated as follows:

$$Ref_t = Gen_{ti-1}$$

$$Dev_t = Gen_t - Ref_t$$

where:

ti is the index of *trading intervals*;

t is the index of 4-second intervals during *trading interval* ti , which can be from 1 to 75;

Gen_t is the SCADA metered value at 4-second interval t ; and

Gen_{ti-1} is the SCADA metered value in the last 4-second of *trading interval* $ti - 1$.

5.3. Residual Deviation

AEMO calculates the Residual Deviation and Performance on a *regional* basis, however, the Residual Performance of all *regions* included in each Regulation FCAS Requirement is aggregated before determining the CF and apportioning the FPPs and the costs of Regulation FCAS to the Relevant Eligible Units without *appropriate metering*. The Residual Deviation in *region* R at 4-second interval t ($Dev_{Res,t}^R$) is calculated as:

$$Dev_{Res,t}^R = -1 \times \left(\sum_m Dev_{m,t} + \sum_{ic} Dev_{ic,t} \right)$$

where:

m is the index of *eligible units with appropriate metering* in *region* R ;

ic is the index of *interconnectors* relevant to *region* R ;

$Dev_{m,t}$ is the deviation of *eligible unit* m with *appropriate metering* in *region* R ; and

$Dev_{ic,t}$ is the deviation of *interconnector ic* relevant to *region R*.

6. Contribution factors and default contribution factors

6.1. NER references

CFs and DCFs will be determined for each Relevant Eligible Unit with *appropriate metering* and for the Residual, for use in the calculation of *trading amounts* under NER 3.15.6AA.

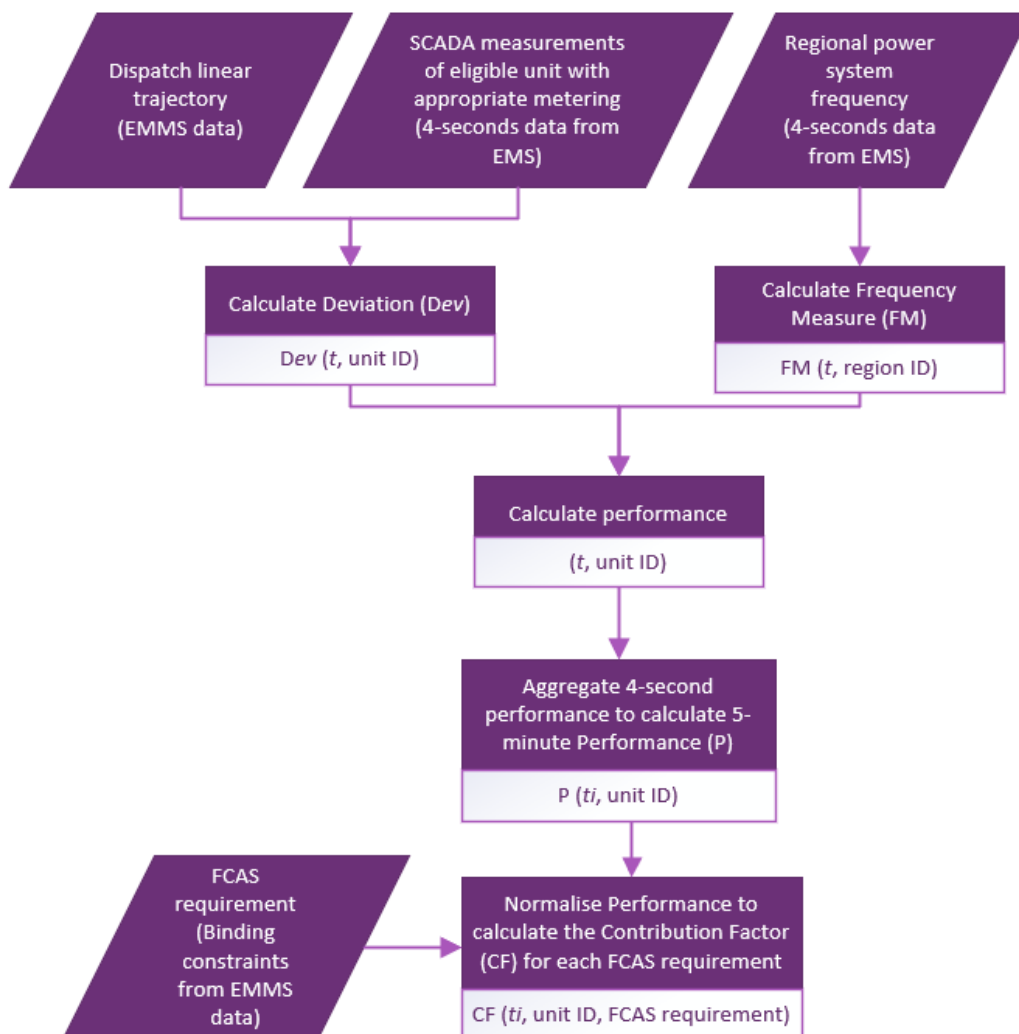
Table 5 Cross references from NER

Relevant Rule	Variable in settlement equation	Cross-reference
3.15.6AA(b)	CF, RCF	Calculated under sections 6.2.2 (for raise requirements) and 6.2.4 (for lower requirements). There is no distinction between RCF and CF as they are calculated together in the same manner. The Residual is treated as just another Relevant Eligible Unit with <i>appropriate metering</i> .
3.15.6AA(c)	NCF, NRCF	Calculated under sections 6.2.2 (for raise requirements) and 6.2.4 (for lower requirements). There is no separate calculation for NCFs; AEMO ignores positive CFs when applying this equation.
3.15.6AA(d)	DCF, DRCF	Calculated under section 6.4.1. There is no distinction between DCF and DRCF as they are calculated together in the same manner. The Residual is treated as if it were another Relevant Eligible Unit with <i>appropriate metering</i> .

6.2. Calculation of Contribution Factors

Unless a DCF applies under section 6.4(b), the CFs for FPPs and the NCFs for Used Regulation FCAS will be calculated in accordance with this section 6.2.

Figure 2 Contribution Factor calculation process



6.2.1. Raise Performance

For a trading interval, the Raise Performance for each eligible unit with appropriate metering or Residual in region R (P^{raise}) is:

$$P^{raise} = \sum_{t=1}^{75} \max(0, FM_t^R) \times Dev_t$$

where:

t is the index of 4-second intervals within the trading interval;

Dev_t is the deviation of eligible units with appropriate metering or Residual in MW at 4-second interval t , as defined in section 5.3. The sign of the deviation is determined from the perspective of the relevant region(s). A positive deviation represents a net addition of MW into the relevant region(s), and vice versa for negative deviations; and

FM_t^R is the FM at 4-second interval t in region R .

Note that P^{raise} is NULL when:

- (i) a condition under section 4.3 applies;
- (ii) where AEMO has incomplete data for the *eligible units with appropriate metering* (under sections 9.1 or 9.2); or
- (iii) AEMO is otherwise unable to calculate P^{raise} .

When P^{raise} is NULL, it will be substituted with a default Performance calculated under either section 6.4.3 or 6.4.2, depending on whether the calculation is under NER 3.15.6AA(b) or 3.15.6AA(c).

6.2.2. Raise Contribution Factor

For a *trading interval*, the Raise Contribution Factor for each Relevant Eligible Unit with *appropriate metering* or Residual, m , for the *regulating raise service* of a Regulation FCAS Requirement ($CF_{m,req}^{raise}$), is determined as follows:

$$AP_{req}^{raise} = \sum_m P_m^{raise}$$

$$CF_{m,req}^{raise} = \frac{P_m^{raise}}{AP_{req}^{raise}}$$

where:

m is the index of *eligible units with appropriate metering* and Residual that relate to Regulation FCAS Requirement req ;

req is the index of Regulation FCAS Requirements;

P_m^{raise} is the Raise Performance of the Relevant Eligible Unit with *appropriate metering* or Residual, m ; and

AP_{req}^{raise} is the absolute value of the sum of the Raise Performances (including Raise Performance that is substituted under section 6.3(b)) for all Relevant Eligible Units with *appropriate metering* and the Residual in Regulation FCAS Requirement req , which have the same sign (positive or negative) as P_m^{raise} .

6.2.3. Lower Performance

For a *trading interval*, the Lower Performance for each *eligible unit with appropriate metering* or Residual in *region R* (P^{lower}) is:

$$P^{lower} = \sum_{t=1}^{75} \min(0, FM_t^R) \times Dev_t$$

where:

t is the index of 4-second intervals within the *trading interval*;

Dev_t is the deviation of *eligible units with appropriate metering* or Residual in MW at 4-second interval t , as defined in section 5.3. The sign of the deviation is determined from the perspective of the relevant *region(s)*. A positive deviation represents a net addition of MW into the relevant *region(s)*, and vice versa for negative deviations; and

FM_t^R is the FM at 4-second interval t in region R .

Note that P^{lower} is NULL when:

- (i) a condition under section 4.3 applies;
- (ii) where AEMO has incomplete data for the *eligible units with appropriate metering* (under sections 9.1 or 9.2); or
- (iii) AEMO is otherwise unable to calculate P^{lower} .

When P^{lower} is NULL, it will be substituted with a default Performance calculated under either section 6.4.3 or 6.4.2, depending on whether the calculation is under NER 3.15.6AA(b) or 3.15.6AA(c).

6.2.4. Lower Contribution Factor

For a *trading interval*, the Lower Contribution Factor for each Relevant Eligible Unit with *appropriate metering* or Residual, m , of a Regulation FCAS Requirement req ($CF_{m,req}^{lower}$), is determined as follows:

$$AP_{req}^{lower} = \sum_m P_m^{lower}$$

$$CF_{m,req}^{lower} = \frac{P_m^{lower}}{AP_{req}^{lower}}$$

where:

m is the index of *eligible units with appropriate metering* and Residual that relate to Regulation FCAS Requirement req ;

P_m^{lower} is the Lower Performance of the Relevant Eligible Unit with *appropriate metering* or Residual, m , in the *trading interval*; and

AP_{req}^{lower} is the absolute value of the sum of the Lower Performances (including Lower Performance substituted under section 6.3(b)) for all Relevant Eligible Units with *appropriate metering* and the Residual in Regulation FCAS Requirement req , which have the same sign (positive or negative) as P_m^{lower} .

6.3. Application of Default Contribution Factors

DCFs will be applied:

- (a) to determine the *trading amount* payable by a *Cost Recovery Market Participant* for each *eligible unit* under NER 3.15.6AA(d); and
- (b) to determine a *trading amount* payable by a *Cost Recovery Market Participant* under NER 3.15.6AA(b) or (c), where Performance, calculated under section 6.2, is NULL.

DCFs will be calculated differently depending on whether they are applied under NER 3.15.6AA(b), 3.15.6AA(c), or 3.15.6AA(d).

6.4. Calculation of Default Contribution Factors

DCFs are based on Performance during the HPP and can only be used to determine *trading amounts* payable by (not to) a *Cost Recovery Market Participant*. Therefore, the Performance value for all DCFs is capped at zero.

6.4.1. Calculation of a Default Contribution Factor for the purposes of NER 3.15.6AA(d)

Raise Performance for Default Contribution Factors

Raise Performance for DCFs applied under NER 3.15.6AA(d) for each *eligible unit* with *appropriate metering* or the Residual in a *region* ($P_{raise}^{default}$) is:

$$P_{raise}^{default} = \frac{\sum_{ti} \min(0, P_{ti}^{raise})}{H_{raise}}$$

where:

H_{raise} is the number of *trading intervals* that have a Raise Performance value for the *eligible unit* with *appropriate metering* or the Residual within the HPP;

ti is the index of *trading intervals* amongst the *trading intervals* that have a Raise Performance value for the *eligible unit* with *appropriate metering* or Residual within the HPP; and

P_{ti}^{raise} is the Raise Performance of the *eligible unit* with *appropriate metering* or Residual in *trading interval* ti .

Raise Default Contribution Factor

For each *trading interval*, the Raise DCF for each Relevant Eligible Unit with *appropriate metering* or Residual for the *regulating raise service* of a Regulation FCAS Requirement (DCF_{raise}) is:

$$DCF_{raise} = \frac{P_{raise}^{default}}{AP_{raise}^{default}}$$

where:

$P_{raise}^{default}$ is the Raise Performance for DCFs for the Relevant Eligible Unit with *appropriate metering* or Residual; and

$AP_{raise}^{default}$ is the absolute value of the sum of the Raise Performance for DCFs for all Relevant Eligible Units with *appropriate metering* and the Residual that relate to a Regulation FCAS Requirement.

Lower Performance for Default Contribution Factors

Lower Performance for DCFs applied under NER 3.15.6AA(d) for each *eligible unit* with *appropriate metering* or the Residual in a *region* ($P_{lower}^{default}$) is:

$$P_{lower}^{default} = \frac{\sum_{ti} \min(0, P_{ti}^{lower})}{H_{lower}}$$

where:

H_{lower} is the number of *trading intervals* that have a Lower Performance value for the *eligible unit* with *appropriate metering* or the Residual within the HPP;

ti is the index of a *trading interval* amongst the *trading intervals* that have a Lower Performance value for the *eligible unit* with *appropriate metering* or Residual within the HPP; and

P_{ti}^{lower} is the Lower Performance of the *eligible unit* with *appropriate metering* or Residual for *trading interval* ti .

Lower Default Contribution Factor

For each *trading interval*, the Lower DCF for each Relevant Eligible Unit with *appropriate metering* or Residual for the *regulating lower service* of a Regulation FCAS Requirement (DCF_{lower}) is:

$$DCF_{lower} = \frac{P_{lower}^{default}}{AP_{lower}^{default}}$$

where:

$P_{lower}^{default}$ is the Lower Performance for DCF for the Relevant Eligible Unit with *appropriate metering* or Residual; and

$AP_{lower}^{default}$ is the absolute value of the sum of the Lower Performance for DCFs for all Relevant Eligible Units with *appropriate metering* and the Residual that relate to a Regulation FCAS Requirement.

6.4.2. Calculation of a Default Contribution Factor for NER 3.15.6AA(c)

A DCF applied under NER 3.15.6AA(c) is calculated in the same manner as a CF under section 6.2, except that Performance (P_{raise} or P_{lower}) of the *eligible unit* with *appropriate metering* or Residual is substituted with the Performance calculated under this section 6.4.2 ($P_{raise}^{substitute}$ and $P_{lower}^{substitute}$).

Raise Performance

$$P_{raise}^{substitute} = \frac{\sum_{ti} \min(0, P_{ti}^{raise})}{H_{raise}}$$

where:

$P_{raise}^{substitute}$ is the value that will be substituted for Raise Performance of the *eligible unit* with *appropriate metering* or Residual under this section;

H_{raise} is the number of *trading intervals* that have a Raise Performance value for the *eligible unit* with *appropriate metering* or the Residual within the HPP;

ti is the index of a *trading interval* amongst the *trading intervals* that have a Raise Performance value for the *eligible unit* with *appropriate metering* or Residual within the HPP; and

P_{ti}^{raise} is the Raise Performance of the *eligible unit* with *appropriate metering* or Residual in *trading interval* ti .

Lower Performance

$$P_{lower}^{substitute} = \frac{\sum_{ti} \min(0, P_{ti}^{lower})}{H_{lower}}$$

where:

$P_{lower}^{substitute}$ is the value that will be substituted for Lower Performance of the *eligible unit* with *appropriate metering* or Residual under this section;

H_{lower} is the number of *trading intervals* that have a Lower Performance value for the *eligible unit* with *appropriate metering* or the Residual within the HPP;

ti is the index of a *trading interval* amongst the *trading intervals* that have a Lower Performance value for the *eligible unit* with *appropriate metering* or Residual within the HPP; and

P_{ti}^{lower} is the Lower Performance of the *eligible unit* with *appropriate metering* or Residual in *trading interval ti*.

6.4.3. Calculation of a Default Contribution Factor for NER 3.15.6AA(b)

A DCF under NER 3.15.6AA(b) is calculated in the same manner as a CF under section 6.2, except that Performance (P_{raise} or P_{lower}) of the *eligible unit* with *appropriate metering* or Residual is substituted with the Performance calculated under this section 6.4.3 ($P_{raise}^{substitute}$ and $P_{lower}^{substitute}$).

Raise Performance

$$P_{raise}^{substitute} = \min\left(0, \frac{\sum_{ti} P_{ti}^{raise}}{H_{raise}}\right)$$

where:

$P_{raise}^{substitute}$ is the value that will be substituted for Raise Performance under this section of the *eligible unit* with *appropriate metering* or Residual under this section;

H_{raise} is the number of *trading intervals* that have a Raise Performance value for the *eligible unit* with *appropriate metering* or the Residual within the HPP;

ti is the index of a *trading interval* amongst the *trading intervals* that have a Raise Performance value for the *eligible unit* with *appropriate metering* or Residual within the HPP; and

P_{ti}^{raise} is the Raise Performance of the *eligible unit* with *appropriate metering* or Residual in *trading interval ti*.

Lower Performance

$$P_{lower}^{substitute} = \min\left(0, \frac{\sum_{ti} P_{ti}^{lower}}{H_{lower}}\right)$$

where:

$P_{lower}^{substitute}$ is the value that will be substituted for Lower Performance of the *eligible unit* with *appropriate metering* or Residual under this section;

H_{lower} is the number of *trading intervals* that have a Lower Performance value for the *eligible unit* with *appropriate metering* or the Residual within the HPP;

ti is the index of a *trading interval* amongst the *trading intervals* that have a Lower Performance value for the *eligible unit with appropriate metering* or Residual within the HPP; and

P_{tt}^{lower} is the Lower Performance of the *eligible unit with appropriate metering* or Residual for *trading interval* ti .

6.4.4. Where there is not enough historical data to calculate a Default Contribution Factor

Within an HPP, if an *eligible unit with appropriate metering* does not have Raise or Lower Performance values in a significant number of *trading intervals*³, AEMO will use the data from the last HPP in which the unit has Performance values in a significant number of *trading intervals* to determine its Raise or Lower DCFs applied under NER 3.15.6AA(b), 3.15.6AA(c), and 3.15.6AA(d).

If there is no HPP in which an *eligible unit with appropriate metering* has Performance values in a significant number of *trading intervals*⁴, the DCFs applied under NER 3.15.6AA(b), 3.15.6AA(c), and 3.15.6AA(d) for the *eligible unit* in all Regulation FCAS Requirements will be zero.

7. Requirement for Corrective Response

The RCR is used to scale FPPs in accordance with NER 3.15.6AA(b) and is determined separately for *trading amounts for regulating raise services* and *trading amounts for regulating lower services*.

7.1. Frequency Measure for RCR

AEMO calculates the FM relevant to a Regulation FCAS Requirement for the purpose of calculating the RCR based on a weighted average of FMs in the relevant *regions*, where the weight of each *region* is the total amount of generation in the *region* for the *trading interval*.

7.2. Residual Deviation for RCR

Within a *trading interval*, the Residual Deviation ($Dev_{Res,t}^{req}$) relevant to Regulation FCAS Requirement req at 4-second interval t is determined as follows:

$$Dev_{Res,t}^{req} = -1 \times \left(\sum_m Dev_{m,t} \right)$$

where:

t is the index of 4-second intervals within the *trading interval*;

req is the index of Regulation FCAS Requirements;

³ As defined in AEMO's Frequency Contribution Factor Tuning Parameters and Input Sources document.

⁴ As defined in AEMO's Frequency Contribution Factor Tuning Parameters and Input Sources document.

m is the index of *eligible units with appropriate metering* that relate to Regulation FCAS Requirement req ; and

$Dev_{m,t}$ is the deviation of *eligible units with appropriate metering* m at 4-second interval t .

7.3. Raise RCR

Subject to sections 4.3 and 7.5, for each *trading interval*, in respect of *regulating raise services*, the Raise RCR in MW for Regulation FCAS Requirement req (RCR_{req}^{raise}) is determined as follows:

$$SumPosDev_t^{req} = \sum_m \max(0, Dev_{m,t}) + \max(0, Dev_{Res,t}^{req})$$

$$RCR_{req}^{raise} = \max \left(\begin{array}{l} SumPosDev_t^{req} \\ \text{where } FM_t^{req} > 0 \end{array} \right)$$

where:

t is the index of 4-second intervals within the *trading interval*;

req is the index of Regulation FCAS Requirements;

m is the index of *eligible units with appropriate metering* that relate to Regulation FCAS Requirement req ;

$Dev_{m,t}$ is the deviation of an *eligible unit with appropriate metering* m at 4-second interval t ;

$Dev_{Res,t}^{req}$ is Residual Deviation relevant to Regulation FCAS Requirement req at 4-second interval t ;

$SumPosDev_t^{req}$ is the sum of all positive deviations and Residual, if positive, in MW, that relate to Regulation FCAS Requirement req at 4-second interval t ; and

FM_t^{req} is the FM relevant to Regulation FCAS Requirement req at 4-second interval t .

7.4. Lower RCR

Subject to sections 4.3 and 7.5, for each *trading interval*, in respect of *regulating lower services*, the Lower RCR in MW for Regulation FCAS Requirement req (RCR_{req}^{lower}) is determined as follows:

$$SumNegDev_t^{req} = \sum_m \min(0, Dev_{m,t}) + \min(0, Dev_{Res,t}^{req})$$

$$RCR_{req}^{lower} = - \min \left(\begin{array}{l} SumNegDev_t^{req} \\ \text{where } FM_t^{req} < 0 \end{array} \right)$$

where:

t is the index of 4-second intervals within the *trading interval*;

req is the index of Regulation FCAS Requirements;

m is the index of *eligible units with appropriate metering* that relate to Regulation FCAS Requirement req ;

$Dev_{m,t}$ is the deviation of *eligible unit* with *appropriate metering m* at 4-second interval t ;

$Dev_{Res,t}^{req}$ is Residual Deviation relevant to Regulation FCAS Requirement req at 4-second interval t ;

$SumNegDev_t^{req}$ is the sum of all negative deviations and Residual, if negative, in MW, that relate to Regulation FCAS Requirement req at 4-second interval t ; and

FM_t^{req} is the FM relevant to Regulation FCAS Requirement req at 4-second interval t .

7.5. Exceptions related to RCR

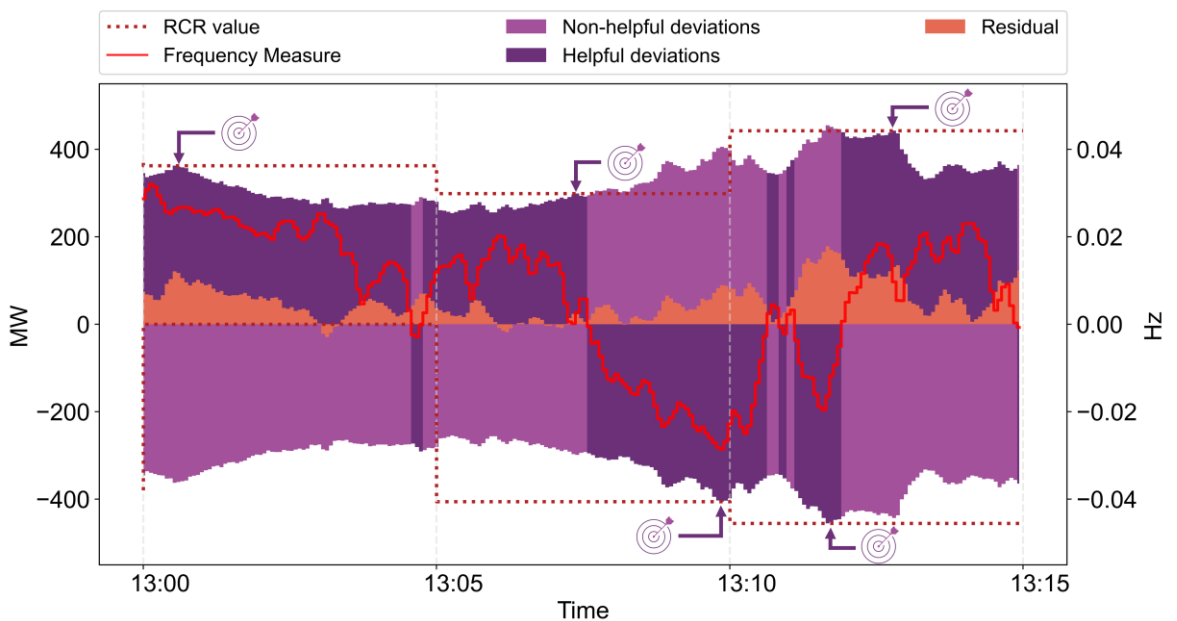
7.5.1. Global requirements

For a *global market ancillary service requirement*, the sum of the gross values (MW) of all deviations at each 4-second interval will be considered in the RCR calculation only when the FMs relevant to the Mainland and Tasmania are aligned during the *trading interval* (i.e., have the same sign).

7.5.2. General exceptions

- (a) Where AEMO is:
 - (i) unable to calculate the Performance of the relevant Residual; or
 - (ii) unable to calculate the RCR for any reason,
 the RCR will be zero.
- (b) AEMO may recalculate RCR in accordance with section 9.1.

Figure 3 RCR visual



8. Usage of Regulation FCAS

Usage is described in NER 3.15.6AA(g)(ii) as the proportion of *enabled* Regulation FCAS that contributes to reducing the deviation in *power system frequency*.

In section 8, Usage is a factor that, for the purposes of NER 3.15.6AA(c) and (d), determines the percentage of Regulation FCAS costs to be recovered on the basis of NCFs (based on measured performance within a *trading interval*) and the percentage to be recovered on the basis of DCFs.

8.1. Raise Usage

Subject to sections 4.3 and 8.3, for each *trading interval*, in respect of *regulating raise services*, the Raise Usage for Regulation FCAS Requirement *req* (U_{req}^{raise}) is determined as follows:

$$RegPosDev_t^{req} = \sum_m \min(RegEn_m^{raise}, \max(0, Dev_{m,t}))$$

$$U_{req}^{raise} = \frac{RegPosDev_t^{req}}{TotReg_{req}^{raise}}$$

where:

t is the index of 4-second intervals within the *trading interval*;

req is the index of Regulation FCAS Requirements in the *trading interval*;

m is the index of *eligible units* that relate to Regulation FCAS Requirement *req* and are *enabled* to provide the *regulating raise service*;

$Dev_{m,t}$ is the deviation of *eligible unit m* at 4-second interval *t*;

$RegEn_m^{raise}$ is the amount of *enabled regulating raise service* for *eligible unit m* in the *trading interval*;

$RegPosDev_t^{req}$ is the sum of all positive deviations of Relevant Eligible Units for Regulation FCAS Requirement *req* that were *enabled* to provide the *regulating raise service* at 4-second interval *t*, where the deviation of each *eligible unit* is capped to its *enabled* amount; and

$TotReg_{req}^{raise}$ is the total amount of *enabled regulating raise service* that relates to Regulation FCAS Requirement *req* in the *trading interval*.

8.2. Lower Usage

Subject to sections 4.3 and 8.3, for each *trading interval*, in respect of *regulating lower services*, the Lower Usage for Regulation FCAS Requirement *req* (U_{req}^{lower}) is determined as follows:

$$RegNegDev_t^{req} = \sum_m \min(RegEn_m^{lower}, -\min(0, Dev_{m,t}))$$

$$U_{req}^{lower} = \frac{RegNegDev_t^{req}}{TotReg_{req}^{lower}}$$

where:

t is the index of 4-second intervals within the *trading interval*;

req is the index of Regulation FCAS Requirements in the *trading interval*;

m is the index of *eligible units* that relate to Regulation FCAS Requirement req and are *enabled* to provide the *regulating lower service* in the *trading interval*;

$Dev_{m,t}$ is the deviation of *eligible unit* m at 4-second interval t ;

$RegEn_m^{lower}$ is the amount of *enabled regulating lower service* for *eligible unit* m in the *trading interval*;

$RegNegDev_t^{req}$ is the sum of all negative deviations of Relevant Eligible Units for Regulation FCAS Requirement req that are *enabled* to provide the *regulating lower service* at 4-second interval t , where the deviation of each *eligible unit* is capped to its *enabled* amount; and

$TotReg_{req}^{lower}$ is the total amount of *enabled regulating lower service* that relates to Regulation FCAS Requirement req in the *trading interval*.

8.3. Exceptions related to Usage

- (a) Where AEMO is unable to calculate Usage, Usage will be zero.
- (b) AEMO may recalculate Usage in accordance with section 9.1.

9. Bad Quality data

9.1. Impact of eligible unit with Bad Quality data

If the proportion of Bad Quality data points that AEMO receives for a Relevant Eligible Unit with *appropriate metering* during a *trading interval* is significant⁵, AEMO will exclude the Relevant Eligible Unit from all calculations for that *trading interval* and then:

- (a) Set its Performance to NULL and calculate its DCFs under section 6.4;
- (b) recalculate the Residual Performance for all Regulation FCAS Requirements involving the Relevant Eligible Unit; and
- (c) recalculate RCR, U, and CFs for all Regulation FCAS Requirements involving the Relevant Eligible Unit.

9.2. Impact of significant number of units with Bad Quality data

If a significant proportion⁶ of Relevant Eligible Units with *appropriate metering* in a *region* contain more than significant Bad Quality data points, AEMO will not calculate the CFs for the Regulation FCAS Requirements that include the region and will recover the Regulation FCAS costs using DCFs.

⁵ As defined in AEMO's Frequency Contribution Factor Tuning Parameters and Input Sources document.

⁶ As defined in AEMO's Frequency Contribution Factor Tuning Parameters and Input Sources document.

10. Data provision

10.1. Data description and frequency

To the extent reasonably practicable, AEMO will make data relating to the determination and application of CFs available as outlined in Table 6. These are in addition to the data that will be provided by settlement reports.

Table 6 Data provision

Timing	Data	Public ⁷ or Private ⁸	Comments	Requirement
End of billing period minus 5 business days	Data to determine DCF			
	Default Raise Performance ($p_{raise}^{default}$)	Public	For DCFs applied under NER 3.15.6AA(d). Same as substitute Raise Performance for DCFs applied under NER 3.15.6AA(c).	NER 3.15.6AA(i)
	Default Lower Performance ($p_{lower}^{default}$)	Public	For DCFs applied under NER 3.15.6AA(d). Same as substitute Lower Performance for DCFs applied under 3.15.6AA(c).	
	Default Raise CF (DCF_{raise})	Public	NER 3.15.6AA(d)	
	Default Lower CF (DCF_{lower})	Public	NER 3.15.6AA(d)	
	Substitute Raise Performance ($p_{raise}^{substitute}$)	Public	For DCFs applied NER 3.15.6AA(b)	
	Substitute Lower Performance ($p_{lower}^{substitute}$)	Public	For DCFs applied NER 3.15.6AA(b)	
5 business days prior to application	Parameters used to determine FM, RCR and U			
	α (alpha) smoothing factor of exponential weighted moving average	Public	For FM calculation	NER 3.15.6AA(j)
ASAP after start of trading interval	Unit target (MW)	Private	Published in Dispatchload table	NER 3.8.21
	FCAS Requirement	Public	Binding constraint equations and regions	
	TSFCAS	Public	Published as adjusted cost in FCAS_requirement table	
	$P_{regulation}$	Public	Published as marginal value in FCAS_requirement table	
ASAP after the FPP run	Raise RCFs (CF^{raise})	Public	5-minute per requirement	NER 3.15.6AA(k)(1)
	Lower RCFs (CF^{lower})	Public	5-minute per requirement	NER 3.15.6AA(k)(1)
	Raise CFs (CF^{raise})	Private	5-minute per requirement	NER 3.15.6AA(k)(1)
	Lower CFs (CF^{lower})	Private	5-minute per requirement	NER 3.15.6AA(k)(1)
	Raise or Lower RCR	Public	5-minute per requirement	NER 3.15.6AA(k)(3)
	Raise or Lower Usage	Public	5-minute per requirement	NER 3.15.6AA(k)(4)

⁷ Public means that the data will be published on AEMO’s website.

⁸ Private means that notices will be issued confidentially to each affected *Registered Participant*.

Timing	Data	Public ⁷ or Private ⁸	Comments	Requirement
	Data calculated from determining FM			
	Frequency deviation (FD)	Public	4-seconds per <i>region</i>	NER 3.15.6AA(k)(2)
	FM	Public	4-seconds per <i>region</i>	
	FM for RCR	Public	4-seconds per requirement	
	Data to determine CF			
	<i>Eligible unit</i> SCADA data	Private	4-seconds per <i>eligible unit</i>	NER 3.15.6AA(l)
	Deviation (Dev_t)	Private	4-seconds per <i>eligible unit</i>	
	Raise Performance (P^{raise})	Private	5-minute per <i>eligible unit</i>	
	Lower Performance (P^{lower})	Private	5-minute per <i>eligible unit</i>	
	Absolute sum of Raise Performances (AP^{raise}) with positive (AP^+) or negative sign (AP^-)	Public	5-minute per requirement	
	Absolute sum of Lower Performances (AP^{lower}) with positive (AP^+) or negative sign (AP^-)	Public	5-minute per requirement	
	Residual Performance	Public	5-minute per requirement	
	Settlements and relevant information (per requirement per 5-minute)			
	FPP payment rate per Performance (\$/MWh) of each <i>eligible unit</i> with appropriate metering	Public	$((P_{regulation} * RCR)/12) / AP^+$	N/A
	FPP payment rate per total energy (\$/MWh) of each <i>eligible unit</i> without appropriate metering	Public	$(RCF * (P_{regulation} * RCR)/12) / ATE$	N/A
	FPP recovery rate per Performance (\$/MWh) of each <i>eligible unit</i> with appropriate metering	Public	$((P_{regulation} * RCR)/12) / AP^-$	N/A
	FPP recovery rate per total energy (\$/MWh) of each <i>eligible unit</i> without appropriate metering	Public	$(RCF * (P_{regulation} * RCR)/12) / ATE$	N/A
	Used Regulation FCAS cost recovery rate per Performance (\$/MWh) of each <i>eligible unit</i> with appropriate metering	Public	$(TSFCAS * U) / AP^-$	N/A
	Use recovery rate per total energy (\$/MWh) of each <i>eligible unit</i> without appropriate metering	Public	$TSFCAS * U * NRCF / ATE$	N/A
	Unused recovery rate per default Performance (\$/MWh) of each <i>eligible unit</i> with appropriate metering	Public	$(TSFCAS * (1 - U)) / AP^- (default)$	N/A
	Unused recovery rate per total energy (\$/MWh) of	Public	$TSFCAS * (1 - U) * DRCF / ATE$	N/A

Timing	Data	Public ⁷ or Private ⁸	Comments	Requirement
	each <i>eligible unit</i> without <i>appropriate metering</i>			
	FPP (\$)	Private	NER 3.15.6AA(b)(1) known as TA	N/A
	Recovery of Used Regulation FCAS (\$)	Private	NER 3.15.6AA(c)(1) known as TA	N/A
	Recovery of Unused Regulation FCAS (\$)	Private	NER 3.15.6AA(d)(1) known as TA	N/A
Pre-dispatch timeframes	Estimates of recovery amounts of Regulation FCAS costs based on DCFs	Public		N/A

10.2. Failure to calculate and publish CFs within the required timeframe

NER 3.15.6AA(k) requires CFs to be *published* as soon as practicable after the relevant *trading interval*.

AEMO’s systems are configured to retrieve relevant input data (as listed in sections 6.2.1 to 6.2.4) for the CF calculation for 30 minutes after the end of each *trading interval*. If AEMO’s systems are unable to receive relevant data after that 30-minute period expires, the Performances of Relevant Eligible Units with *appropriate metering* and Residual will be NULL, all Regulation FCAS costs will be allocated to *eligible units* using DCFs, and no FPP will be due or paid.

When this occurs, AEMO will:

- issue a market notice; and
- inform affected *Registered Participants* via MMS Data Model that DCFs are being used for the relevant period.

If AEMO’s inability to retrieve data applies only to specific *eligible units*, AEMO will only inform the affected *Registered Participants* via MMS Data Model.

Version release history

Version	Effective date	Summary of changes
1.0	8 June 2025	First issue
1.1	8 June 2025	Updated to include bidirectional units