WEM Procedure: Essential System Service Quantities

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0.1		Draft for consultation. First version developed in accordance with clauses 3.11.7 and 7.2.5 of the WEM Rules

IMPORTANT NOTICE – EXPLANATORY NOTES

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1. Introduction

1.1. Purpose and scope

1.1.1. This WEM Procedure: ESS Quantities (Procedure) is made in accordance with AEMO's functions under clause 2.1A.2(h) of the Wholesale Electricity Market Rules (WEM Rules).

1.1.2. The *Electricity Industry Act 2004* (WA), the WEM Regulations and the WEM Rules prevail over this Procedure to the extent of any inconsistency.

1.1.3. In this Procedure, where obligations are conferred on a Rule Participant, that Rule Participant must comply with the relevant obligations in accordance with clause 2.9.7A, 2.9.7D or 2.9.8 of the WEM Rules, as applicable.

1.1.4. The purpose of this Procedure is to document:

(a) the methodologies and processes to be followed by AEMO in determining, for each Pre-Dispatch Interval and Dispatch Interval:

(i) the quantity of Regulation to schedule and dispatch, including:

(A) the identification and measurement of sources of variability; and

(B) the method by which the quantity of Regulation required is calculated;

(ii) the combination of Contingency Reserve and RoCoF Control Service required to maintain the frequency of the SWIS within the Credible Contingency Event Frequency Band, including the use of Facility Speed Factors for a Facility; and

(iii) the expected quantities of any other Frequency Co-optimised Essential System Services required in each Dispatch Interval or Pre-Dispatch Interval to meet the Essential System Service Standards' **[clause 3.11.7]**,

(b) the Dispatch Algorithm used by AEMO for the purpose of the Central Dispatch Process and setting Market Clearing Prices and the mathematical formulation of the Dispatch Algorithm, including:

(i) the conversion of Facility Speed Factors into Facility Performance Factors **[clause 7.2.5(a)(i)]**; and

(ii) the calculation of Minimum RoCoF Control Requirement and Additional RoCoF Control Requirement **[clause 7.2.5(a)(ii)]**,

(c) the methodology AEMO uses determine:

(i) Contingency Raise Offsets **[clause 7.2.5(b)(i)]**;

(ii) Contingency Lower Offsets **[clause 7.2.5(b)(ii)]**;

(iii) Facility Performance Factors **[clause 7.2.5(b)(iii)]**;

(iv) the Minimum RoCoF Control Requirement **[clause 7.2.5(b)(iv)]**;

(v) the Additional RoCoF Control Requirement **[clause 7.2.5(b)(v)]**;and

(vi) the RoCoF Upper Limit **[clause 7.2.5(b)(vii)]**.

E[A] Items from 7.2.5

Clause 7.2.5 of the WEM Rules requires AEMO to document a range of detailed aspects in the design and implementation of the Dispatch Algorithm.

The bulk of these requirements are included in a separate document (AEMO WEM Procedure: Dispatch Algorithm Formulation), which covers the core optimisation problem to be solved by the dispatch engine.

The select sub-clauses of 7.2.5 listed above [(a)i, (a)ii, (b)i, (b)ii, and (b)vii] are instead included in this Procedure. These items are not determined as part of the regular dispatch engine solutions, but rather well in advance of Market Schedules and using similar analysis techniques as the Frequency Co-optimised Essential System Services required under clause 3.11.7.

1.1.5. Appendix A of this Procedure outlines the head of power clauses that this Procedure is made under, as well as other obligations in the WEM Rules covered by this Procedure.

1.2. Definitions

1.2.1. Terms defined in the *Electricity Industry Act 2004* (WA), the WEM Regulations and the WEM Rules have the same meanings in this Procedure unless the context requires otherwise.

1.2.2. The following definitions apply in this Procedure unless the context requires otherwise.

Table 1 Definitions

Term	Definition
Dynamic Frequency Control Model (DFCM)	Has the meaning in paragraph 3.1.2
ESS Maximum Provision Percentage	Means the percentage figure stated in paragraph 4.1.1.
ESS System Configuration	Has the meaning in paragraph 3.1.1
High-Resolution Time Synchronised Data Recorder	Has the meaning outlined in the WEM Procedure: Communications and Control Systems, as amended from time to time
Load Relief Factor	A parameter to be applied to the Underlying System Load within the DFCM, to account for the phenomenon in which electrical load varies proportionally with system frequency
Non-Securable ESS System Configuration	An ESS System Configuration in which the DFCM determines no quantity of FCESS would allow a Secure Operating State.
Margin for Operation	A margin applied by AEMO when determining frequency co-optimised essential system services (FCESS) quantities to account for uncertainty.
Reference ESS System Configuration	Has the meaning in paragraph 3.2.1
Regulation Baseline Model	Has the meaning in paragraph 6.1.1
Residual Inertia	AEMO's estimate of Inertia provided by any Facilities, Load, Network equipment and other equipment connected to the SWIS that are not accredited for RoCoF Control Service.
RoCoF Control Service Requirement	The portion of the RoCoF Control Service quantity that is determined endogenously in the Dispatch Algorithm and must be procured for the Dispatch Interval or Pre-Dispatch Interval.
Underlying System Load	AEMO’s estimate of behind-the-meter demand that is responsive to changes in frequency. Underlying System Load may differ from Forecast Operational Demand due to “behind the meter” and other non-registered generation sources.

Term	Definition
WEMDE	The software that AEMO uses to solve the Dispatch Algorithm.

1.3. Interpretation

1.3.1. The following principles of interpretation apply in this Procedure unless the context requires otherwise.

(a) Clauses 1.3 to 1.5 of the WEM Rules apply in this Procedure.

(b) References to time are references to Australian Western Standard Time.

(c) Terms that are capitalised, but not defined in this Procedure, have the meaning given in the WEM Rules.

(d) A reference to the WEM Rules or WEM Procedures includes any associated forms required or contemplated by the WEM Rules or WEM Procedures.

(e) Words expressed in the singular include the plural and vice versa.

(f) A reference to a paragraph refers to a paragraph of this Procedure.

(g) A reference to an appendix refers to an appendix of this Procedure.

(h) A reference to a clause refers to a clause or section of the WEM Rules.

(i) References to WEM Rules in this Procedure in bold and square brackets **[Clause XXX]** are included for convenience only, and do not form part of this Procedure.

(j) Text located in boxes and headed as **E[X]** in this Procedure is included by way of explanation only and does not form part of this Procedure. The Procedure prevails to the extent of any inconsistency with the explanatory notes contained within it.

(k) The body of this Procedure prevails to the extent of any inconsistency with the figures, diagrams, appendices, schedules, annexures or attachments contained within this document.

(l) Measurements are specified using the International System of Units with the following symbols:

(i) Hz: hertz

(ii) mHz: millihertz

(iii) MW: megawatts

1.4. Related documents

1.4.1. The documents in Table 2 are associated with this Procedure.

Table 2 Related documents

Reference	Title	Location
	Wholesale Electricity Market Rules	Energy Policy WA Website
WEM Procedure	WEM Procedure: Communications and Control Systems	AEMO Website

Reference	Title	Location
WEM Procedure	WEM Procedure: Dispatch Algorithm Formulation	AEMO Website
WEM Procedure	WEM Procedure: Frequency Co-optimised Essential System Service Accreditation	AEMO Website

2. FCESS Principles

2.1.1. AEMO will take the following principles into account in determining frequency co-optimised essential system services (FCESS) quantities for each Dispatch Interval and each Pre-Dispatch Interval:

(a) in managing risk and uncertainty in real time operations:

(i) the application of empirical validation and Margin for Operations is essential in applying good system operations engineering practice;

(ii) a simpler approach that covers a wider range of plausible operational circumstances is preferred to a complex approach that performs better under a narrower range of circumstances; and

(iii) any model or practice needs continual monitoring, refinement, and tuning to remain effective in a changing environment,

(b) advanced models and fundamental analysis may inform the selection of input variables, but physical measurements, statistics, and feedback control systems should be used to define, support, or validate determinations where possible; and

(c) controlled experimentation is necessary to validate model predictions and confirm the secure operating envelope.

E[B] Feedback control systems

The term feedback control system is used here to mean an algorithm or decision-making component that repeatedly measures output performance against a target reference and adjusts input variables to minimise the difference between output performance and the target reference.

2.1.2. Where AEMO is required to make an operational decision or determination that is not explicitly described in this Procedure that may be to ensure power system security or reliability, AEMO must make reasonable endeavours (to the extent that time constraints and other circumstances allow) to follow the principles in paragraph 2.1.1.

3. Contingency services

E[C] Contingency services

For the purposes of this explanatory note, contingency services are Contingency Reserve Service and RoCoF Control Service.

Contingency services keep generation capacity in reserve to maintain frequency stability following the sudden and large disconnection of generation or Load from the system. To procure these services, AEMO completes the following:

1. Analyse the system configuration and historical occurrences to determine the set of Credible Contingency Events to prepare for;
2. Model system performance and determine the necessary quantities of contingency services to manage the set of Credible Contingency Events to meet the Frequency Operating Standards; and;
3. Operate the Real Time Market to purchase the necessary quantities and dispatch reserves among the fleet of Facilities accordingly.

This section describes the second step of the process – refer to:

- WEM Procedure: Credible Contingency Events (step 1)
- WEM Procedure: Dispatch Algorithm Formulation (step 3)

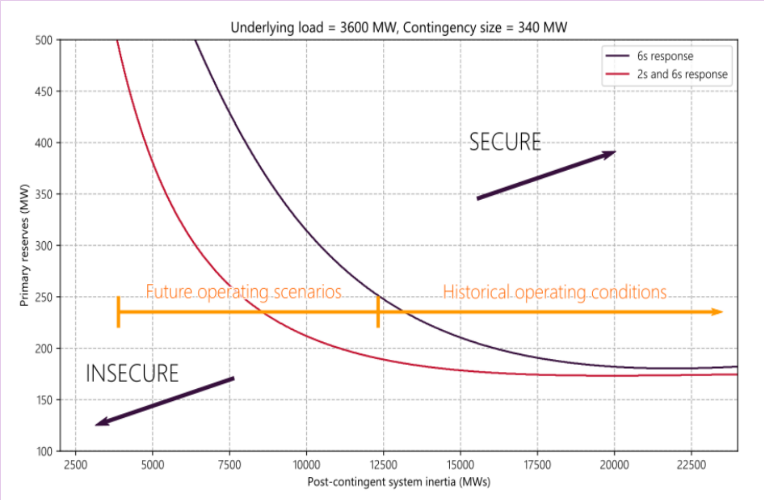
For more information on the other steps.

3.1. The Dynamic Frequency Control Model

E[D] Dynamic Contingency Modelling

Figure E[1] shows a conceptual overview of the Contingency Event management framework, as applied in the SWIS.

Figure E[1] Inertia-Primary Reserve Secure Zone



For the purposes of this explanatory note, contingency services are Contingency Reserve Service and RoCoF Control Service.

The diagram illustrates how, for a given Contingency Event size (in MW) and Underlying System Load, the interplay between system Inertia and Contingency Reserves (both speed and quantity) defines a secure operating region. In the SWIS, system Inertia and Contingency Reserves are procured through the RoCoF Control Service and Contingency Reserve services respectively.

It is not practical to run the detailed calculations needed to determine the secure operating region in real time. The relationship between parameters (such as speed of response and inertia) and contingency services is also non-linear, while the WEMDE can only optimise linear Constraint Equations to procure these contingency services.

This section describes the methodology AEMO will use to manage the requirements for Contingency Event management to support secure and optimal market dispatch. At a high level, AEMO will use an “offline” power systems model to pre-calculate the required contingency services for all plausible operating configurations and store secure results as a look-up table.

AEMO will use the look-up table as an input to the Dispatch Algorithm, which will interpolate between the Secure Operating States to select the optimal configuration of Continency Reserves.

3.1.1. An ESS System Configuration is a scenario defined by a combination of parameters representing:

(a) Underlying System Load;

(b) Load Relief Factor;

(c) Facility Speed Factor;

(d) Largest Credible Supply Contingency or Largest Credible Load Contingency; and

(e) any other factor that AEMO determines necessary to accurately predict frequency performance for system operations.

3.1.2. The Dynamic Frequency Control Model (DFCM) is a computer simulation of the SWIS power system frequency that uses an ESS System Configuration as an input and, for a given quantity of RoCoF Control Service, calculates the quantity of:

(a) Contingency Reserve Raise in response to the Largest Credible Supply Contingency; or

(b) Contingency Reserve Lower in response to the Largest Credible Load Contingency,

required to maintain the frequency of the SWIS within the Credible Contingency Frequency Band.

3.1.3. AEMO:

(a) will determine the set of ESS System Configurations needed to cover the range of credible operating conditions for the SWIS; and

(b) may, from time to time, change the set of ESS System Configurations determined in paragraph 3.1.3(a) to better reflect the current operating conditions of the SWIS.

3.1.4. For any set of ESS System Configurations determined by AEMO in accordance with paragraph 3.1.3, AEMO will:

(a) develop and maintain the DFCM, and use it to determine, for each of the relevant ESS System Configurations, the combinations of RoCoF Control Service and Contingency Reserve required to maintain the frequency of the SWIS within the Credible Contingency Frequency Band; and

(b) publish on the WEM Website, the set of ESS System Configurations and the associated combinations of RoCoF Control Service and Contingency Reserve determined in paragraph 3.1.4(a).

3.1.5. In developing and maintaining the DFCM in paragraph 3.1.4(a), AEMO:

(a) may determine and use a single estimation of SWIS Frequency to apply at all Network locations;

(b) will use an initial condition of SWIS Frequency at 50 Hz;

(c) may include a Margin for Operation from the Credible Contingency Frequency Band to account for the uncontrolled risk of:

(i) an initial condition of SWIS Frequency other than 50 Hz; and

(ii) Facility non-delivery or under-delivery of Contingency Service,

(d) may independently determine the appropriate form and level of detail of the DFCM components, inputs, approximations, and simulation parameters; and

(e) may, from time to time, change any of the aspects listed in paragraph 3.1.5(d) to improve the model accuracy, robustness, or performance.

3.1.6. If AEMO includes a Margin for Operation in the DFCM in accordance with paragraph 3.1.5(c), AEMO must publish the Margin for Operation on the WEM Website.

3.1.7. Where the DFCM is applied in accordance with paragraph 3.1.4 to determine combinations of RoCoF Control Service and Contingency Reserve, and the simulation identifies that system frequency:

(a) exceeds the RoCoF Safe Limit for the quantity of RoCoF Control Service; or

(b) cannot be maintained within Credible Contingency Event Frequency Band for a quantity of Contingency Reserve less than or equal to the relevant Largest Credible Supply Contingency or Largest Credible Load Contingency,

AEMO will determine that ESS System Configuration is a Non-Securable ESS System Configuration.

3.1.8. For each Dispatch Interval or Pre-Dispatch Interval, AEMO will:

(a) estimate or forecast the ESS System Configuration for the relevant Dispatch Interval or Pre-Dispatch Interval;

(b) use the estimated ESS System Configuration in paragraph 3.1.8(a) to select from the combinations of RoCoF Control Service and Contingency Reserve determined under paragraph 3.1.4(a); and

(c) identify the RoCoF Control Service and Contingency Reserve quantities for the relevant Dispatch Interval or Pre-Dispatch interval as the combinations selected in paragraph 3.1.8(b).

3.1.9. AEMO will, as soon as practicable, use the DFCM to recalculate and publish the model outputs in accordance with paragraph 3.1.4 where:

(a) AEMO changes the DFCM in accordance with paragraph 3.1.5(e); or

(b) the Frequency Operating Standards change,

3.1.10. AEMO may, following an occurrence of either a Largest Credible Supply Contingency or Largest Credible Load Contingency:

(a) validate the approximations and predicted outcomes of the DFCM against power system frequency data measured using a High-Resolution Time Synchronised Data Recorder from at least two Network locations;

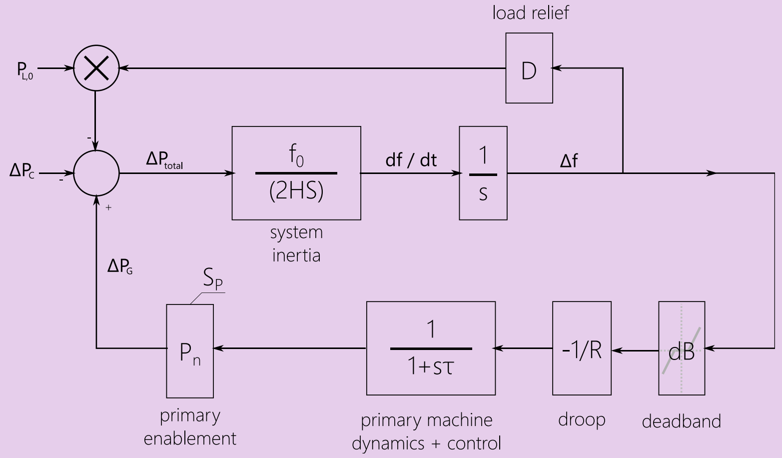
(b) determine and make any necessary changes to the DFCM in accordance with paragraph 3.1.5(e); and

(c) publish the reasons for the changes to the WEM Website.

E[E] The Dynamic Frequency Control Model

Figure E[2] shows the conceptual form of DFCM (setup for a Contingency Event relating to generation) as a control system block diagram:

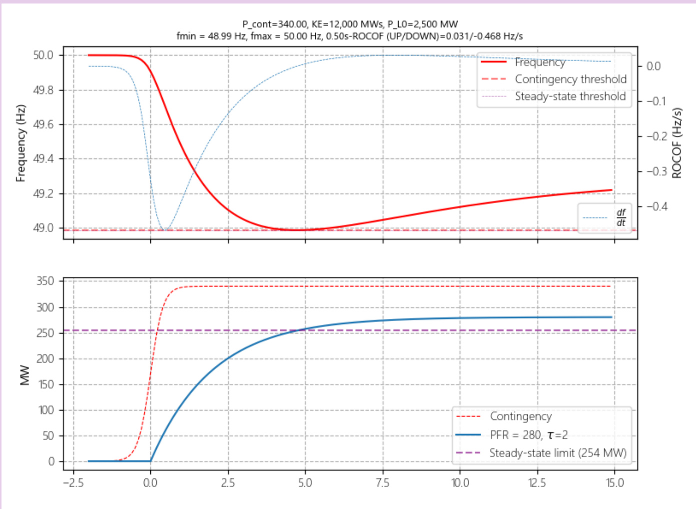
Figure E[2] Illustrative format of the DFCM



For a given set of inputs, system total kinetic energy (HS), and facility speed factor (τ), the required combinations of Contingency Reserve service and ROCOF Control Service are determined by numerically integrating the DFCM. From a starting frequency of 50 Hz and a contingency ΔP_C, the DFCM is run over different levels of primary enablement (S_p) to ensure that the Frequency Operating Standards (± any Margin for Operation) are exactly met.

In the model, a standard droop response of 4% ($R = 25$) and deadband of 25 mHz are used. Refer to the AEMO WEM Procedure: Frequency Co-optimised Essential System Service (FCESS) Accreditation for how these parameters are calibrated against physical Facility performance.

Figure E[3] Example output form the DFCM



The diagram in Figure E[3] shows example simulation results, determining that 280 MW of $\tau = 2s$ Contingency Reserve Raise are required in combination with 12,000 MWs of RoCoF Control Service for the given inputs. This example satisfies a minimum frequency of 48.90 Hz, allowing a 250 mHz Margin for Operation above the Credible Contingency Event Frequency Band.

Historical event analyses have demonstrated comparable frequency across the SWIS which makes a low-order single mass machine model suitable for frequency stability studies. AEMO will monitor this performance across incidents and may identify conditions where this assumption is no longer suitable in accordance with paragraph 3.1.5(d).

Note that the DFCM does not otherwise choose or give preference to any specific FCESS combinations for dispatch; this is optimised using Facilities' Real-Time Market Offers by the Dispatch Algorithm.

3.2. Conversion of DFCM solutions for the Dispatch Algorithm

3.2.1. For a given ESS Configuration, the Reference ESS System Configuration is another ESS System Configuration with identical parameters except for Facility Speed Factor = 0.2.

3.2.2. Using the outputs of the DFCM calculated in accordance with paragraph 3.1.4(a), for each ESS System Configuration and associated combinations of RoCoF Control Service and Contingency Reserve, AEMO will determine the corresponding:

(a) Contingency Raise Offset as the difference between the Largest Credible Supply Contingency and required Contingency Reserve Raise for the Reference ESS System Configuration;

(b) Contingency Lower Offset as the difference between the Largest Credible Load Contingency and required Contingency Reserve Lower for the Reference ESS System Configuration; and

(c) Facility Performance Factor for the ESS System Configuration:

(i) as zero if the relevant ESS System Configuration was determined as a Non-Securable ESS System Configuration in accordance with paragraph 3.1.7;

(ii) otherwise:

$$\mathrm{FPF}_{\tau} = \frac{\mathrm{CR}_{0.2}}{\mathrm{CR}_{\tau}}$$

where:

- τ is the Facility Speed Factor in the relevant ESS Configuration
- FPF_{τ} is the Facility Performance Factor corresponding to τ
- CR_{τ} is the Contingency Reserve quantity for τ
- $\mathrm{CR}_{0.2}$ is the Contingency Reserve quantity for the Reference ESS System Configuration.

E[F] Conversion of DFCM parameters for the Dispatch Algorithm

Outputs of the DFCM need to be converted into the format required by the Dispatch Algorithm.

Consider the example shown in Figure E[3], which has following set of input parameters:

- Underlying System Load: 2500 MW
- Load Relief Factor: 2%
- Facility Speed Factor of 3s
- Largest Credible Supply Contingency of 340 MW

For a RoCoF Control Service of 12,000 MWs, the example DFCM determines 280 MW of Contingency Raise Reserves are required. The relevant parameters for the Dispatch Algorithm are:

- Contingency Raise Offset = 340 MW – 280 MW = 60 MW
- Contingency Lower Offset is not applicable as the input set does not include a Largest Credible Load Contingency
- Re-running the same input set with a Facility Speed Factor of 0.2 s determines $\mathrm{CR}_{0.2}$ = 250 MW, hence

  FPF_{3}= 250 MW / 280 MW = 0.893

Refer to the WEM Procedure: Dispatch Algorithm Formulation for a description of how these parameters are used in the Dispatch Algorithm.

4. Maximum Service proportions

4.1.1. AEMO may limit the provision of Contingency Reserve Raise or Contingency Reserve Lower from a single provider to the ESS Maximum Provision Percentage, being 80% of the total required quantity of the relevant Contingency Reserve service.

E[G] Maximum Provisions

In circumstances where market outcomes result in a single provider supplying most of a Contingency Reserve service, the (non-credible) combination of a largest Contingency Event and non-delivery of the single provider can result in frequency instability that risks total loss of electricity to the SWIS. The 80% threshold allows AEMO to ensure that under-frequency load shedding schemes have sufficient time to operate in these extreme circumstances.

5. Settlement ESS Quantities

E[H] Settlement ESS Quantities

The quantities described in this section:

- Minimum RoCoF Control Requirement
- Additional RoCoF Control Requirement
- RoCoF Upper Limit

are part of the settlement and cost allocation processes. Except Minimum RoCoF Control Requirement, these settlement quantities do not define any aspects of the FCESS Contingency Reserves needed for secure operation and are not used in the dispatch processes. They are described in this document, as similar analysis techniques are used to determine them.

5.1. Minimum and Additional RoCoF Control Requirement

5.1.1. AEMO will prepare calculations for the Minimum RoCoF Control Requirement, at least once every 12 months, as follows:

(a) create a dataset of estimated Underlying System Load and Largest Credible Supply Contingency that is:

(i) for a period of at least 12 months;

(ii) recorded at intervals of 1 hour or less; and

(iii) includes the last 6 months of data from the time of calculation; and

(b) apportion the dataset into bins for increments of Underlying System Load, where the increments may be up to a maximum of 100 MW;

(c) create a set of Underlying System Load and Largest Credible Supply Contingency pairs by:

(i) selecting the 10th percentile of the Largest Credible Supply Contingency associated with the bin value for Underlying System Load; or

(ii) where there are either insufficient historical samples available or samples are comparatively scattered within the associated bin in accordance with 5.1.1(c)(i), using engineering judgment to create and determine the relevant pair,

(d) calculate the minimum System Inertia required for the set of pairs created in paragraph 5.1.1(c) so that RoCoF would be within the RoCoF Safe Limit, as:

$$\text{Inertia} = \frac{\Delta P_C \times f_0}{2P_L \times RoCoF_{safeLimit}}$$

where:

- f_0 is the nominal frequency (50 Hz);
- ΔP_C is the Largest Credible Supply Contingency;
- P_L is the Underlying System Load;
- $RoCoF_{safeLimit}$ is the RoCoF Safe Limit; and

(e) publish the set of Underlying System Load and System Inertia pairs, calculated under 5.1.1(d), on the WEM Website.

5.1.2. For each Dispatch Interval and Pre-Dispatch Interval, AEMO will:

(a) for the same Underlying System Load determined for the relevant Dispatch Interval or Pre-Dispatch Interval in paragraph 3.1.8(a), use the corresponding System Inertia value calculated in paragraph 5.1.1(d) as the Minimum RoCoF Control Requirement; and

(b) determine the Additional RoCoF Control Requirement to be the greater of:

(i) the sum of the Residual Inertia and the RoCoF Control Service Requirement determined by the Dispatch Algorithm for the relevant Dispatch Interval or Pre-Dispatch Interval, minus the Minimum RoCoF Control Requirement determined in paragraph 5.1.2(a); and

(ii) zero.

5.1.3. AEMO may review the methodology used in paragraph 5.1.1 based upon the correlation between Largest Credible Supply Contingency and Underlying System Load sizes.

E[I] Minimum RoCoF Control Requirement

In the SWIS, the most critical factor in determining the amount of RoCoF Control Service is the size of Largest Credible Supply Contingency, which is in turn however dependent on the co-optimisation of energy and FCESS offer.

Thus, there is no completely “physically objective” minimum that is independent of a RoCoF Control Service enablement. The approach in paragraph 5.1.1 sets an empirical rolling benchmark that resolves the circular interactions by taking the lower end of real outcomes.

5.2. RoCoF Upper Limit

5.2.1. In determining and publishing the RoCoF Upper Limit in accordance with clause 7.5.14, AEMO will:

(a) determine an ESS System Configuration that includes AEMO's forecast estimate for the next 12 months of the credible scenario of:

(i) lowest Underlying System Load;

(ii) lowest applicable Load Relief Factor; and

(iii) highest Largest Credible Supply Contingency;

(b) determine the RoCoF Upper Limit as the maximum rate of change of frequency in the DFCM when run with inputs consisting of the ESS System Configuration in paragraph 5.2.1(a) and a RoCoF Control Service determined as the lesser of:

(i) 3000 MWs; or

(ii) an estimate of the forecast equivalent minimum Inertia available over the next 12 months that AEMO identifies from a Registered Facility and is not already accredited as RoCoF Control Service.

6. Regulation Services

E[J] Regulation Services

Frequency Regulation is the practice of gradually adjusting generation output to match relatively small fluctuations in demand that occur during real time operations.

Unlike contingency management, the longer timescales, uncertainty, and range of phenomena that contribute to demand fluctuations means that analytic power system models are ineffective at predicting Regulation service quantity requirements.

Instead, the core approach described in this paragraph is a feedback process consisting of:

- the selection of forecastable inputs to feed into a statistical prediction (machine learning) model; and
- the ability for AEMO to gradually increase or decrease quantities as required to manage real time volatility conditions.

The statistical model is continually fed actual (measured) Regulation usage statistics and uses these to improve forecasting performance.

Similarly, both the input selection and detailed parameters of the model may be refined over time to improve both accuracy and operation effectiveness.

6.1. The Regulation Baseline Model

6.1.1. The Regulation Baseline Model is a statistical model that relates forecastable signals to the observed usage of Regulation in real time system operations.

6.1.2. AEMO will:

(a) develop and maintain the Regulation Baseline Model; and

(b) periodically use the Regulation Baseline Model to set the required quantity of Regulation Lower and Regulation Raise for each Dispatch Interval and Pre-Dispatch Interval, except where this quantity is varied under paragraph 7 of this Procedure.

6.1.3. In developing and maintaining the Regulation Baseline Model in accordance with paragraph 6.1.2(a), AEMO:

(a) will use a combination of the following as inputs (as relevant) to the model:

(i) solar irradiation and cloud cover;

(ii) wind speed;

(iii) Forecast Operational Demand;

(iv) other indirect factors that affect approximate quantities in paragraph 6.1.2(b), including but not limited to:

(A) time of day;

(B) day of the week, public holidays, or other scheduled events; and

(C) time of year or season; and

(v) approximations of uncertainty and dispatch error, including but not limited to:

(A) output variation and non-conformance of Registered Facilities;

(B) communications delay and other latency in market dispatch or physical Facility response; and

(vi) any other forecastable source of variation that AEMO deems necessary to consider; and

(b) will determine a metric that quantifies the usage of Regulation service through any period of at least 5 minutes;

(c) will determine a statistical relationship between each of the factors in paragraph 6.1.3(a) and the usage metric determined in accordance with paragraph 6.1.3(b); and

(d) may modify the raw statistics determined in paragraph 6.1.3(c) to reduce error and improve operational performance through any combination of the following:

(i) removal of select time periods from the statistics due to corrupt data or inapplicable system conditions;

E[K] Inapplicable system conditions

Emergency and other non-standard operating conditions may generate statistics that do not reflect effective use of Regulation services for frequency management.

For example, in the period following a major Contingency Event, Regulation resources are generally exhausted, and these statistics will bias a requirement for additional Regulation services. However, by definition, these circumstances should be managed using Contingency Reserve services, and therefore may be removed from the regulation statistics.

Similarly, system conditions following a system black event or market suspension may also result in non-standard Regulation metrics and should be removed forecasts of future requirements.

(ii) application of a smoothing filter;

(iii) determination of a confidence interval and selection of an appropriate confidence level;

(iv) addition of a Margin for Operation; and

(e) will determine the appropriate Regulation quantities for a Dispatch Interval or Pre-Dispatch Interval as the result of applying the statistical relationship in paragraph 6.1.3(c), including any modifications in accordance with paragraph 6.1.3(d), to the input quantities forecast under 6.1.3(a) for the relevant Dispatch Interval or Pre-Dispatch Interval; and

(f) may, from time to time, change any of the following aspects of the Regulation Baseline Model:

(i) add a new input in accordance with paragraph 6.1.3(a);

(ii) redetermine a metric to apply under paragraph 6.1.3(b);

(iii) adjust, add, or remove any modifications in accordance with paragraph 6.1.3(d)

to improve accuracy, performance, or robustness of the model overall.

6.1.4. For any input used in the Regulation Baseline Model in accordance with paragraph 6.1.3(a), AEMO:

(a) will determine the appropriate data source and forecasting method; and

(b) may, from time to time, update the data source or forecasting method determined in accordance with paragraph 6.1.4(a).

6.2. Real time adjustment of Regulation Quantities

6.2.1. For any Dispatch Interval in the Dispatch Schedule or Pre-Dispatch Interval in the Pre-Dispatch Schedule, as new information becomes available to AEMO, if AEMO determines that the scheduled Regulation service quantities are:

(a) insufficient to manage expected system conditions; or

(b) in excess of what is required to manage expected system conditions,

AEMO may increase or decrease Regulation service quantities for the relevant Dispatch Interval as AEMO determines are necessary to ensure the Frequency Operating Standards.

7. Other Requirements/Unforeseen Circumstances

7.1.1. During circumstances where any of the following apply:

(a) the SWIS is in an Emergency Operating State, or AEMO determines that immediate action is required to avoid an Emergency Operating State;

(b) AEMO has activated the System Restart Plan;

(c) the SWIS is operating under Controlled Circumstances;

(d) AEMO has suspended the Real-Time Market;

(e) an AEMO Intervention Event is in progress;

(f) AEMO has:

(i) directed the Network Operator to maintain frequency in accordance with clause 3.1A.2 of the WEM Rules; or

(ii) Delegated functions in accordance with clause 2.1A.3 of the WEM Rules; or

(g) a Forced Outage has resulted in under-delivery of FCESS;

(h) a Non-Credible Contingency Event has occurred;

(i) a Commissioning Test is in progress; or

(j) any other event has occurred that AEMO determines is a material threat to AEMO's ability to manage Power System Security;

AEMO may override any FCESS quantity for a Dispatch Interval or Pre-Dispatch Interval determined in accordance with paragraph 3.1.8(c), 5.1.2 or 6.1.2(b), and replace the quantity with a value AEMO determines necessary to manage Power System Security for the duration that the circumstances apply.

7.1.2. There are no methodologies or processes required for other FCESS, as no other FCESS are required to meet the Essential System Service Standards.

Appendix A. Relevant clauses of the WEM Rules

Table 3 details:

(a) the head of power clauses in the WEM Rules under which the Procedure has been developed; and

(b) each clause in the WEM Rules requiring an obligation, process or requirement be documented in a WEM Procedure, where the obligation, process or requirement has been documented in this Procedure.

Table 3 Relevant clauses of the WEM Rules

Clause
3.11.7(a)
3.11.7(b)
3.11.7(c)
7.2.5(a)i 7.2.5(b)iii
7.2.5(a)ii 7.2.5(b)iv 7.2.5(b)v
7.2.5(b)i
7.2.5(b)ii
7.2.5(b)vii