Contingency Reserve Requirements in the WEM

Fact Sheet

This fact sheet provides an overview of how Contingency Reserve Raise (CRR) and Contingency Reserve Lower (CRL) requirements are calculated in the Wholesale Electricity Market (WEM) to maintain system frequency within the Credible Contingency Event Frequency Band following a Credible Contingency Event. It highlights the impact of Distributed Photovoltaic (DPV) and load disconnections caused by voltage and frequency disturbances and explains the role of the Dynamic Frequency Control Model (DFCM) in determining the requirements for both markets.

Contingency Reserve Requirements

CRR and CRL requirements are determined by the WEM Dispatch Engine (WEMDE) according to WEM Procedure: Essential System Services (ESS) Quantities[1] to maintain the South West Interconnected System (SWIS) frequency within the Credible Contingency Event Frequency Band set out in Appendix 13 of the Electricity System and Market Rules (ESM Rules).

CRR Requirement

The DFCM[1] is an offline simulation of the SWIS frequency that calculates the CRR Requirement and Facility Performance Factors for a set of ESS System Configurations.

The WEM Procedure: ESS Quantities[1] provides a detailed explanation of the DFCM. The latest version is available for download on the AEMO website[2].

In the DFCM, DPV loss following a Credible Contingency Event[3] is modelled as two distinct components:

1. **Voltage-dependent loss**

   Network faults can lead to DPV and load disconnections due to their inability to ride through voltage disturbances.

   The net impact is referred to as voltage-dependant net DPV loss ($P_{net\_dpv\_loss\_v}$), which is estimated using statistical models developed by Western Power that are driven by Voltage Vector Shift (VVS) values obtained from fault simulations.

   This value is included within the Largest Credible Supply Contingency (LCSC), which is an input to the DFCM. Further details are explained in a fact sheet[4] published by AEMO.

2. **Frequency-dependant loss**

   This is modelled within the DFCM as three discrete blocks of DPV loss following a Credible Contingency Event. This is applied to the contingency size as system frequency declines to specific thresholds. Refer to Table 1 for the values currently used in this estimate; these were provided to AEMO by Western Power under the Low Load Project[5].

   A plot illustrating how this loss is incorporated into the contingency size in the DFCM can be found in the WEM Procedure: ESS Quantities[1].

Table 1 – Estimated DPV loss due to frequency

Frequency Threshold (Hz)	% of DPV	Delay (s)
49.25	2.57	0.04
49	1.9	0.04
49	3.88	2

[1] Refer to WEM Procedure: ESS Quantities
[2] Refer to Contingency Reserve Quantities webpage
[3] Refer to WEM Procedure: Credible Contingency Events
[4] Refer to Fact Sheet: Estimating Voltage-dependent DPV and Load Loss During Network Faults
[5] Refer to Energy Policy WA Low Load Project - Stage 1 Report

Voltage-dependent and frequency-dependent DPV loss is scaled by a DPV time factor (τ_{dpv_tf}), which accounts for the increasing compliance of DPV systems with disturbance ride-through standards. This time factor reduces the expected proportion of DPV loss over time as the older systems make up a declining share of total installations. The DPV time factor equation is as follows:

$$\tau_{dpv\_tf} = \frac{P_{Estimated\ DPV\ Installed\ Capacity}}{1900\ MW}$$

CRL Requirement

The CRL Requirement (P_{crlr}) is calculated as:

$$P_{crlr} = \alpha \cdot P_{lclc} - \beta - P_{load\_relief} - P_{dpv\_f}$$

Where:

- P_{lclc} is the Largest Credible Load Contingency (LCLC),
- α and β are adjustable parameters set by AEMO (refer to Parameter Explanation section below for more details),
- P_{load_relief}, represents the change in Operational Demand resulting from frequency increases due to load relief,
- P_{dpv_f}, reflects the contribution of DPV in response to over-frequency events expected as per AS/NZS 4777:2:2020[6]. To ensure a conservative estimation, this value is capped at and includes a deadband to account for inverters that may not comply with the standard and therefore not respond to over-frequency events.

Similar to supply contingencies, voltage-dependent DPV and load loss can increase the size of a credible load contingency. For load contingencies, the net impact is represented by the voltage-dependent net load loss ($P_{net\_load\_loss\_v}$), which is estimated using statistical models driven by VVS values derived from fault simulations. This is included within the LCLC.

Further details are explained in a fact sheet[4] published by AEMO.

Parameter Explanation

Modelling studies found the CRLR calculation required revision to account for the increasing LCLC sizes in the SWIS, driven by the growing presence of large-scale Battery Energy Storage System (BESS) facilities.

A linear approximation of the DFCM was required to ensure compatibility with WEMDE. This led to the introduction of parameters α and β on 20 May 2025.

To quantify these parameters, the DFCM was used as an offline simulation tool to model multiple over-frequency events and identify the optimal CRLR value for each scenario by navigating a non-linear search space.

The simulations incorporate a range of system configurations, including different Unscheduled Operational Demand (UOD), DPV generation, system inertia, and LCLC values.

AEMO determined the parameters α and β by selecting a representative set of Facility Speed Factors that reflect typical facility responses to a Credible Contingency Event under standard SWIS dispatch patterns. These factors are combined with outputs from the DFCM to derive the optimal parameter values.

To ensure accuracy over time, AEMO periodically reviews and updates these parameters to account for significant changes in SWIS dispatch patterns or system conditions.

As of 22 December 2025, the parameters are:

$$\alpha = 1.3\ \ and\ \ \beta = 30$$

[6] Refer to AEMO | AS/NZS 4777.2 – Inverter Requirements standard