GUIDELINE: FREQUENCY CO-OPTIMISED ESSENTIAL SYSTEM SERVICES TESTING

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APPROVED BY:	Teresa Smit
TITLE:	Manager - Power System & Market Planning

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1.0	15 October 2021	Initial release

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1. INTRODUCTION

1.1. Purpose and Scope

1.1.1. Pursuant to paragraph 9.1.1 of the AEMO WEM Procedure: Frequency Co-Optimised Essential System Services Accreditation, this document is intended to provide guidance for participants in the Wholesale Electricity Market (WEM) wishing to accredit their Facilities for the following Frequency Co-Optimised Essential System Services:

(a) Regulation Raise;

(b) Regulation Lower;

(c) Contingency Reserve Raise; and

(d) Contingency Reserve Lower.

1.1.2. Guidelines for certifying the following Essential System Services are excluded from this document as these services are assessed on a case-by-case basis:

(a) System Restart Service (SRS); and

(b) Non-Co-optimised Essential System Services (NCESS).

1.1.3. Please contact AEMO in accordance with the details on the WEM Website for general enquiries or technical enquiries regarding the accreditation of these Essential System Services.

1.2. Definitions and interpretation

1.2.1. In this document:

(a) terms that are capitalised, but not defined, have the meaning given in the WEM Rules, or for terms not defined in the WEM Rules, the Frequency Co-optimised Essential System Services Accreditation WEM Procedure;

(b) to the extent that this document is inconsistent with the WEM Rules or WEM Procedures, the WEM Rules or Market Procedures prevail to the extent of the inconsistency;

(c) a reference to the WEM Rules, or Market Procedures, includes any associated forms required or contemplated by the WEM Rules or Market Procedures; and

(d) words expressed in the singular include the plural and vice versa.

Term	Definition
AGC	Automatic Generation Control
DCS	Distributed Control System
DI	Dispatch Instruction
NOFB	Normal Operating Frequency Band (49.8 to 50.2 Hz)
PoE	Probability of Exceedance
PFR	Primary Frequency Response

Term	Definition
RoCoF	Rate of Change of Frequency
IL	Interruptible Load
SRS	System Restart Service
UFLS	Under-Frequency Load Shedding

1.3. Related documents

Reference	Title	Location
WEM Rules	Wholesale Electricity Market Rules	Energy Policy WA Website
FCESS Accreditation	WEM Procedure: Frequency Co-Optimised Essential System Services Accreditation	WEM Website
Communications and Control Systems	WEM Procedure: Communications and Control Systems	WEM Website
Operational Data Points for Registered Facilities	Operational Data Points for Registered Facilities	WEM Website
ABC and AGC Interface Requirements	ABC and AGC Interface Requirements – Technical Specification	WEM Website

2. REGULATION

2.1. General Requirements

2.1.1. Regulation Raise and Regulation Lower (Regulation) are services provided by Accredited Facilities to frequently adjust Injection or Withdrawal in accordance with AEMO's centralised AGC control scheme [Clause 3.9.1]. To provide Regulation, the following general requirements apply:

(a) Facilities must comply with the interface requirements the Communications and Control Systems WEM Procedure, including the ABC/AGC as per Sections 2, 3, 4 and 5 (as applicable) of the ABC and AGC Interface Requirements technical specification and have the necessary points identified in the Operational Data Points for Registered Facilities technical specification, in accordance with Paragraph 4.1.1 of the Frequency Co-optimised Essential System Services WEM Procedure. The relevant SCADA signals must be fully commissioned, functioning and scanning correctly; and

(b) Regulation Accreditation tests must be carried out in real time under an approved Commissioning Test Plan, as required under Paragraph 9.2.2 of the Frequency Co-optimised Essential System Services WEM Procedure.

E[A] ABC and AGC Interface Requirements

The ABC and AGC Interface Requirements Technical Specification will be updated following publication of this Guideline, it is expected that some amendments will be required to this section to reflect these updates.

2.2. [Optional] Pre-Accreditation Response Time Test Requirements

2.2.1. Before submitting a Commissioning Test Plan for a Regulation accreditation test, a Market Participant may choose to demonstrate that the Facility is capable of responding to a step change in Desired MW (i.e. from a Dispatch Instruction) by commencing ramping within any maximum communications lag time published in accordance with Paragraph 2.4.3 of the Communications and Control Systems WEM Procedure. This pre-accreditation test may reduce overall costs for the Participant to undertake accreditation.

2.2.2. The communication lag times which may be demonstrated, where specified by AEMO, include:

(a) the time when the Facility DCS receives the AGC signal to the time the Facility responds; and

(b) the maximum allowable time from when a control command is issued by AEMO to the time that the Facility responds.

2.2.3. The following apply for pre-accreditation response tests:

(a) the response time tests for at least one (1) upward ramp and at least one (1) downward ramp of a step size sufficient for the relevant Facility to demonstrate response capability, as agreed with AEMO;

(b) the unit response time can be affected by Droop Response depending on the variability of system frequency at the time of receiving an AGC signal. A Market Participant may agree with AEMO the means by which this impact is addressed in confirming the capability of the Facility, including:

(i) disabling Droop Response during the time of the test; or

(ii) overlaying the system frequency on the Facility response to allow the theoretical Droop Response from the data; or

(iii) any alternative means of reflecting theoretical Droop Response; and

(c) response measurements should be recorded with a resolution of 500 ms or higher (ideally $\leq$ 100 ms);

(d) raw test measurements for the response, without additional processing or manipulation, should be submitted to AEMO.

2.2.4. Figures 1 to 4 below provide guidance on the assessment of response time test results.

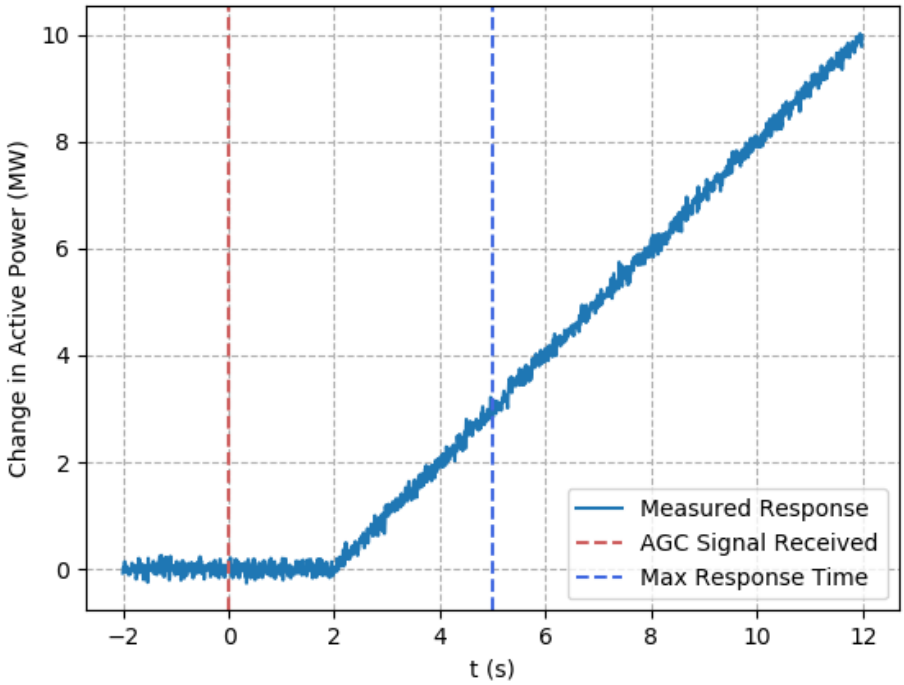

Figure 1 Acceptable AGC response time (model response)

2.2.5. Figure 1 is the model response time test result showing an unambiguous unit ramp response (where the Max Response Time is a representative requirement).

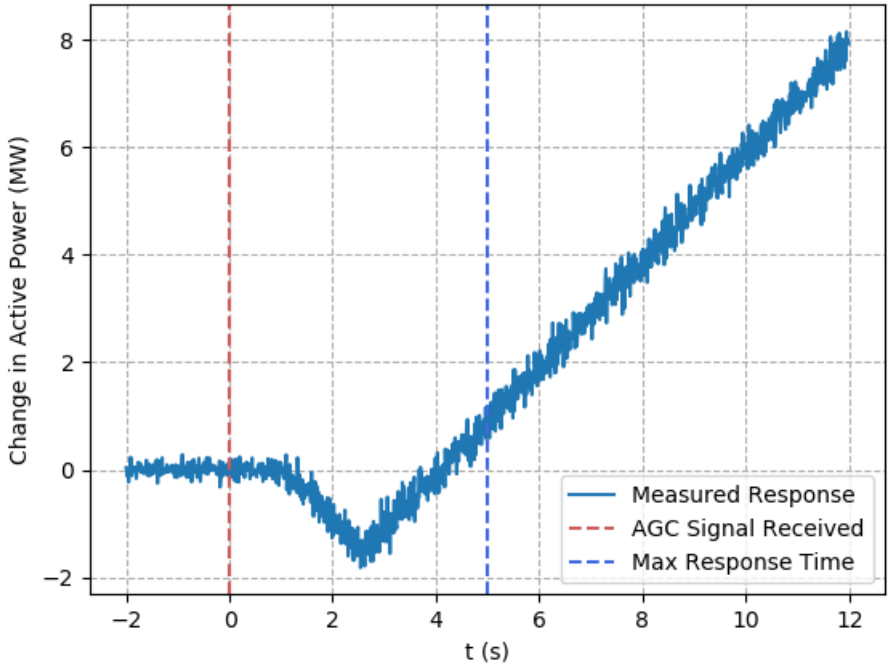

Figure 2 Acceptable AGC response time (positive ΔP at t=5s)

2.2.6. A deviation from the original basepoint is acceptable provided that the unit begins ramping within the communication lag time and that the change in active power from receipt of the signal (ΔP) is positive. Figure 2 shows an acceptable response despite the negative drift before starting the ramp.

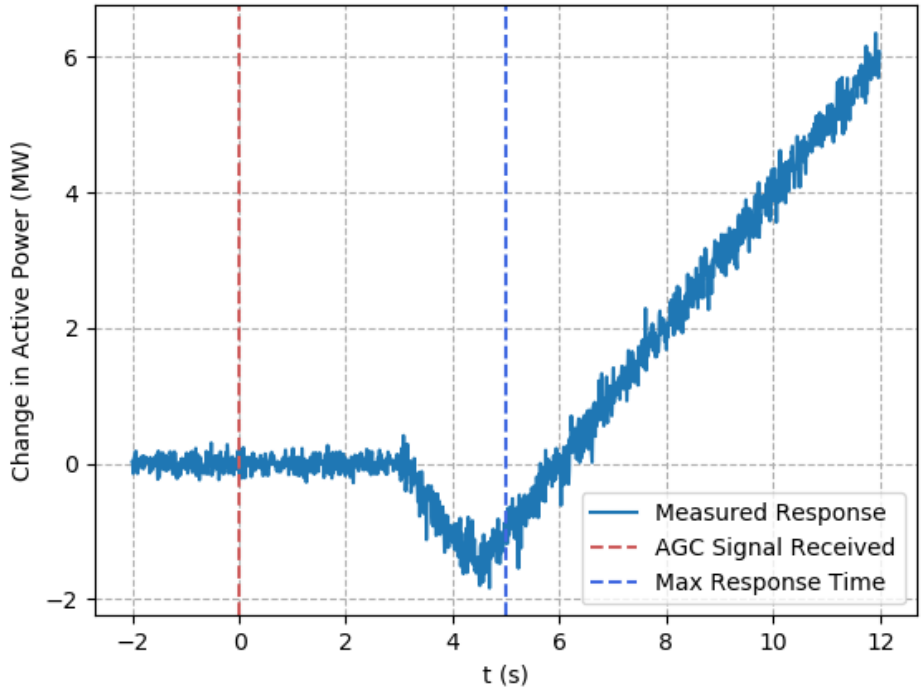

Figure 3 Unacceptable AGC response time (negative ΔP at t=5s)

2.2.7. Figure 3 is an unacceptable response because there is a negative drift in power output, and while the ramp does commence before the Max Response Time, the output is still below the original basepoint output.

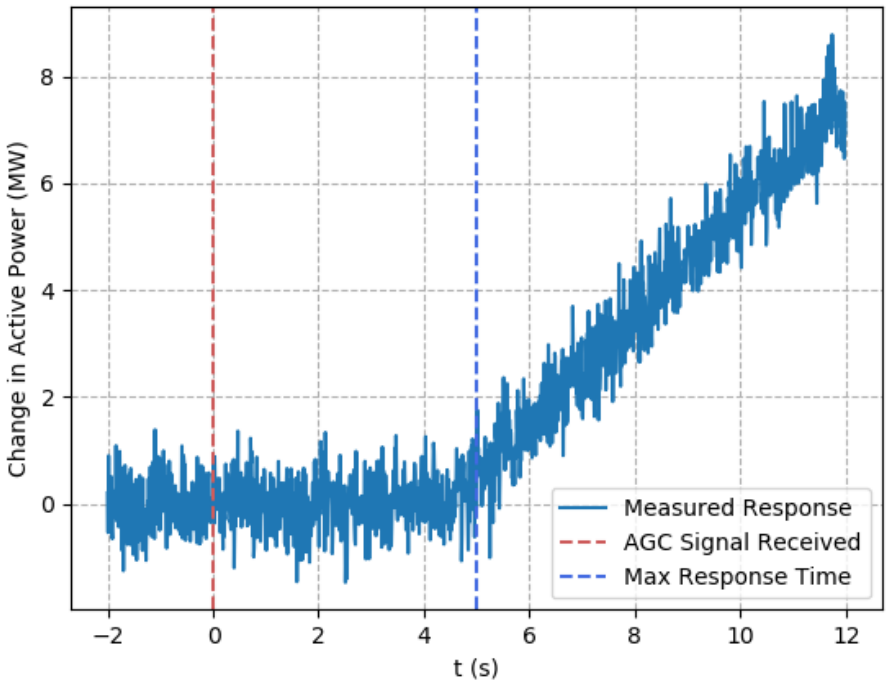

Figure 4 Unacceptable AGC response time (ambiguous ramp start time due to high noise)

2.2.8. Figure 4 is an unacceptable response because the high level of noise obscures the commencement of the ramp.

2.3. Regulation Accreditation Test Requirements

2.3.1. The following tests are applicable for all relevant Operating Configurations in order for a Facility to demonstrate capability to meet Performance Requirements set out in Paragraph 4.1 of the Frequency Co-optimised Essential System Services WEM Procedure, covering tests required under Paragraph 9.1.2(a) of the Frequency Co-optimised Essential System Services WEM Procedure may include:

(a) Response Time Test to verify that the Facility is capable of responding to a step change in desired MW by commencing ramping within any defined maximum communications lag time as published on the WEM Website. This is a repeat of the pre-accreditation response time test described earlier in Section 2.2;

(b) Maximum Ramp Rate Test to verify, at least twice for each relevant Operating Configuration, that the Facility is capable of ramping within ± 5% of its proposed maximum quantity for Regulation Raise and/or Regulation Lower and delivering at least that quantity over 5-minutes. For example, a facility that is tested for 30 MW Regulation up and down, the average ramp rate should be:

(i) not less than 6 MW/min on average over that 5-minutes;

(ii) not more than 6.3 MW/min at any point within that 5-minutes; and

(iii) not less than 5.7 MW/min at any point within that 5-minutes; and

(c) AGC Failure Test to verify that the Facility AGC control mode turns to manual following an AGC failure and stops responding to AGC signals. Ensure that the Facility automatically reconnects to AGC when AGC control is re-established;

(d) Communications Failure Test to verify that the facility AGC control mode turns to manual following a communication failure and stops responding to AGC signals. Ensure that the Facility goes to "local control" after 40 seconds and holds its current output. This prevents the Facility going to "local control" due to short communication outages; and

(e) Reliability Tests to verify that the unit can reliably respond to AGC signals for 2 continuous hours including operating for at least 5-minutes within:

(i) an enablement quantity up to the proposed Standing Enablement Minimum; and

(ii) an enablement quantity down to the proposed Standing Enablement Maximum,

during these enablement tests AEMO will seek to operate that Facility at both its maximum or minimum enablement limits.

2.3.2. Tests for Response Time, Maximum Ramp Rate and Reliability Tests must be conducted for all relevant Operating Configurations in accordance with Paragraph 4.1.3 of the Frequency Co-optimised Essential System Services WEM Procedure, including:

(a) fuel type (where capable of operating using different fuels);

(b) different fixed ramp rates (where applicable);

(c) control mode; and

(d) quantity of components of that Facility which are Available Capacity, In-Service Capacity or Un-available Capacity.

2.3.3. Tests for Response Time, Maximum Ramp Rate and Reliability Test may be impacted by Droop Response depending on the variability of system frequency at the time of receiving an AGC signal. A Market Participant may agree with AEMO the means by which this impact may be addressed in confirming the capability of the Facility for the Regulation tests, including:

(a) disabling Droop Response during the time of the test; or

(b) overlaying the system frequency on the Facility response to allow the theoretical Droop Response from the data; or

(c) any alternative means of reflecting theoretical Droop Response.

2.3.4. Note that the Facility is not required to offer or be cleared in the Regulation Raise or Regulation Lower market to conduct these tests.

3. CONTINGENCY RESERVE RAISE

3.1.1. Contingency Reserve Raise is a service of holding response capability associated with a Facility in reserve so that the relevant Facility can rapidly adjust Injection or Withdrawal in order to assist in maintaining the SWIS Frequency for downward frequency excursions [Clause 3.9.5]. Specific requirements for testing and accreditation of Contingency Reserve Raise from each type of Facility are described in the following sections, in accordance with Paragraph 9.1.2(b) of the Frequency Co-optimised Essential System Services WEM Procedure.

3.1.2. For the testing and Accreditation of Contingency Reserve Raise, the following general requirements may apply, for each relevant Operating Configuration:

(a) results from at least two (2) separate tests be submitted to AEMO for assessment;

(b) tests to be performed by injecting a frequency bias to the Facility's frequency measurement signal:

(i) an alternative process may be used by the Market Participant to inject a frequency bias to be agreed with AEMO where it meets the requirements of the Facility Speed Factor determination (Paragraph 7.2 of the ESS Accreditation WEM Procedure); and

(c) response measurements recorded with a High-Resolution Time Synchronised Data Recorder (in accordance with the Communications and Control Systems WEM Procedure);

(d) all other test measurements, format and measurement specifications agreed with AEMO and meet the requirements of the Facility Speed Factor determination (paragraph 7.2 of the ESS Accreditation WEM Procedure);

(e) raw data without additional processing or manipulation submitted to AEMO; and

(f) where required by AEMO, a valid generation system model where not provided under an approved Registered Generator Performance Standard supplied to AEMO in advance of any testing.

3.1.3. Tests should be conducted for all relevant Operating Configurations in accordance with Paragraph 4.1.3 of the Frequency Co-optimised Essential System Services WEM Procedure, including:

(a) fuel type (where capable of operating using different fuels);

(b) control mode; and

(c) quantity of components of that Facility which are Available Capacity, In-Service Capacity or Un-available Capacity.

3.1.4. Tests should be conducted for an initial Facility operating level of:

(a) the proposed Standing Enablement Minimum for Contingency Reserve Raise; and

(b) a level below the proposed Standing Enablement Maximum corresponding with the enablement quantity.

3.2. Accreditation of Contingency Reserve Raise delivered by Droop Response

3.2.1. For a Droop Response, the Contingency Reserve Raise quantity may be accredited by injecting either:

(a) the standard under-frequency trace shown in Figure 5; or

(b) where agreed with AEMO an alternative frequency profile as close to Figure 5 as possible,

where that under-frequency trace represents a 1.025 Hz excursion from 50 Hz for at least 15 minutes.

3.2.2. Where a Facility delivers Contingency Reserve Raise via Droop Response and delivers the service with AGC Assist (Paragraph 4.2.9(a) of the Frequency Co-optimised Essential System Services Accreditation WEM Procedure) AEMO may test the capability of that Facility to operate in AGC Assist through setpoint control using the AGC system during tests.

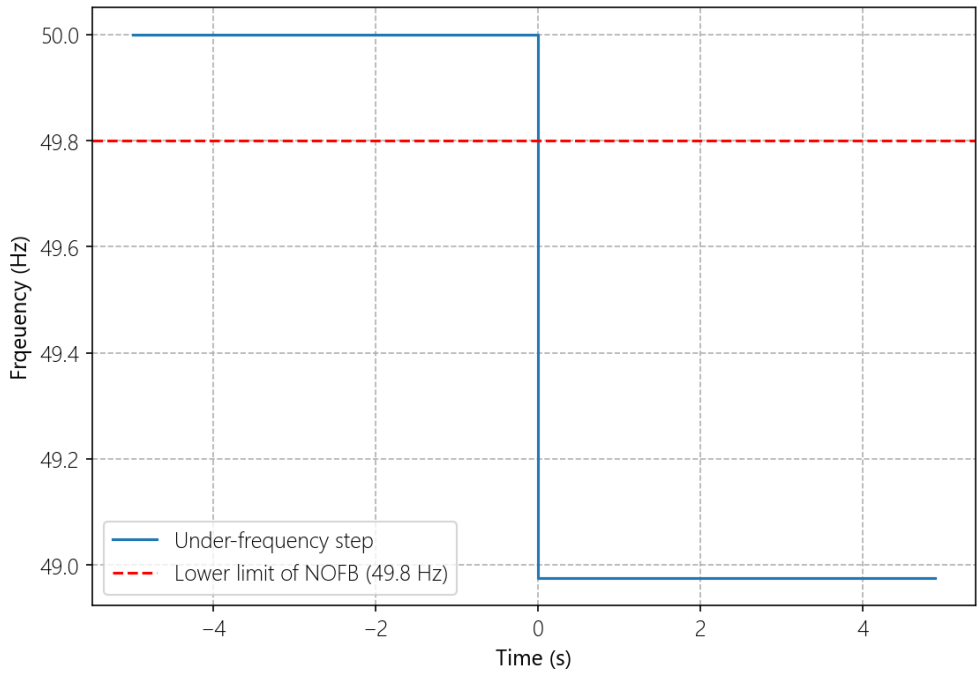

Figure 5 Standard under-frequency step for certifying Contingency Reserve Raise quantities based on a droop response

3.3. Accreditation of Contingency Reserve Raise delivered by Block Responses

3.3.1. Facilities seeking accreditation to provide Contingency Reserve Raise using a Block Response will be tested through an injection test in accordance with frequency setpoints agreed to by AEMO, in order to demonstrate a capability to meet relevant Performance Requirements outlined under Paragraph 4.2 of the Frequency Co-optimised Essential System Services WEM Procedure.

3.4. Assessment of Contingency Reserve Raise Accreditation Test Responses

3.4.1. Contingency Reserve Raise requires a Facility to respond to an event and sustain or exceed the required response for at least 15 minutes [Clause 7.10.18].

3.4.2. AEMO will determine, in accordance with paragraph 7.1 of the Frequency Co-Optimised Essential System Services WEM Procedure, the Maximum Quantity for Contingency Reserve Raise for each test conducted.

3.4.3. AEMO will determine, in accordance with paragraph 7.2 of the Frequency Co-Optimised Essential System Services WEM Procedure, a Speed Factor for each test conducted.

3.5. Specific Requirements for Interruptible Loads

3.5.1. Interruptible Loads provide Contingency Reserve Raise by shedding loads triggered by local under-frequency relays or equivalent control schemes.

3.5.2. Because the Facility load fluctuates over time, the Contingency Reserve Raise testing process can only evaluate the response of the Facility to frequency deviations that exceed the under-frequency threshold settings, i.e. ensure that the specified loads trip at the correct frequency settings and within the timeframes required by AEMO under Paragraph 4.2.7 of the Frequency Co-Optimised Essential System Services WEM Procedure.

3.5.3. The testing may be performed by injecting a frequency bias into the frequency measurement signal and verifying the operation of the local under frequency relay or control scheme. The test frequency should be set to the under-frequency setpoint less 0.05 Hz. For example, if the under-frequency setpoint is 49.5 Hz, then the test frequency must be 49.45 Hz.

3.5.4. The maximum response time must be the sum of the components as described in Error! Reference source not found., as required under Paragraph 4.2.7 of the Frequency Co-Optimised Essential System Services WEM Procedure.

Table 1: Interruptible Load maximum Contingency Reserve Raise response time components.

Component	Maximum Time
Load shedding time delay	250 ms
Relay and breaker operating time (*)	150 ms

(*) Includes relay pickup time, communications delays, circuit breaker operating times, etc.

3.5.5. If a single load shedding stage is spread across multiple sites, then the recorded measurements should be time-synchronised, e.g. via GPS clock synchronisation.

3.5.6. The High-Resolution Time Synchronised Data used to assess the response should show the actual point the relay triggered against its input frequency, and when the individual block load(s) tripped in order for AEMO to assess whether the service was provided adequately.

3.6. Assessment of Contingency Reserve Raise Quantities

3.6.1. The accredited Contingency Reserve Raise quantity for an Interruptible Load is assessed based on the 90% PoE value for the specific loads / feeders in the load shedding scheme using at least 12 months of historical load data, or relevant periods for which that Facility would offer the service. The minimum resolution for the historical load data should be 30 minutes, i.e. at least 17,520 data points for an ordinary year.

3.7. Assessment of Contingency Reserve Raise Quantities from Facilities containing Intermittent Generating Systems

3.7.1. The accredited Contingency Reserve Raise quantity for an Intermittent Generating System is assessed by AEMO based on the accuracy of that Facility's Unadjusted Semi-Scheduled Injection Forecast, to establish any reduction factor which may be applied to that Facility's maximum enablement quantity to reflect the accuracy of that Facility's Unadjusted Semi-Scheduled Injection Forecast.

4. CONTINGENCY RESERVE LOWER

4.1. General Requirements

4.1.1. Contingency Reserve Lower (Contingency Reserve Lower) is a service of holding response capability associated with a Facility in reserve so that the relevant Facility can rapidly adjust Injection or Withdrawal in order to assist in maintaining the SWIS Frequency for upward frequency excursions [Clause 3.9.6]. Specific requirements for testing and accreditation of Contingency Reserve Raise from each type of Facility are described in the following sections, in accordance with Paragraph 9.1.2(b) of the Frequency Co-optimised Essential System Services WEM Procedure.

4.1.2. For the testing and accreditation of Contingency Reserve Lower, the following general requirements may apply, for each Standard Operating Configuration:

(a) results from at least two (2) separate tests be submitted to AEMO for assessment;

(b) tests to be performed by injecting a frequency bias to the Facility's frequency measurement signal:

(i) an alternative process may be used by the Market Participant to inject a frequency bias to be agreed with AEMO; and

(c) response measurements recorded with a High-Resolution Time Synchronised Data Recorder (in accordance with the Communications and Control Systems WEM Procedure);

(d) all other test measurements, format and measurement specifications agreed with AEMO;

(e) raw data without additional processing or manipulation submitted to AEMO; and

(f) where required by AEMO, a valid generation system model where not provided under an approved Registered Generator Performance Standard supplied to AEMO in advance of any testing.

4.1.3. Tests should be conducted for all relevant Operating Configurations including:

(a) fuel type (where capable of operating using different fuels);

(b) control mode; and

(c) quantity of components of that Facility which are Available Capacity, In-Service Capacity or Un-available Capacity.

4.1.4. Tests should be conducted for an initial Facility operating level of:

(a) the proposed Standing Enablement Maximum for Contingency Reserve Lower;

(b) a level above the proposed Standing Enablement Minimum corresponding with the enablement quantity.

4.2. Accreditation of Contingency Reserve Lower delivered by Droop Response

For a Droop Response, the Contingency Reserve Lower quantity may be accredited by injecting either:

(a) the standard under-frequency trace shown in Figure 6; or

(b) where agreed with AEMO an alternative frequency profile as close to Figure 6 as possible,

where that under-frequency trace represents a 1.025 Hz excursion from 50 Hz for at least 15 minutes.

4.2.1. Where a Facility delivers Contingency Reserve Lower via Droop Response and delivers the service with AGC Base Assist (paragraph 4.2.9 (a)) AEMO may test the capability of that Facility to operate in AGC Base Assist through setpoint control using the AGC system during tests.

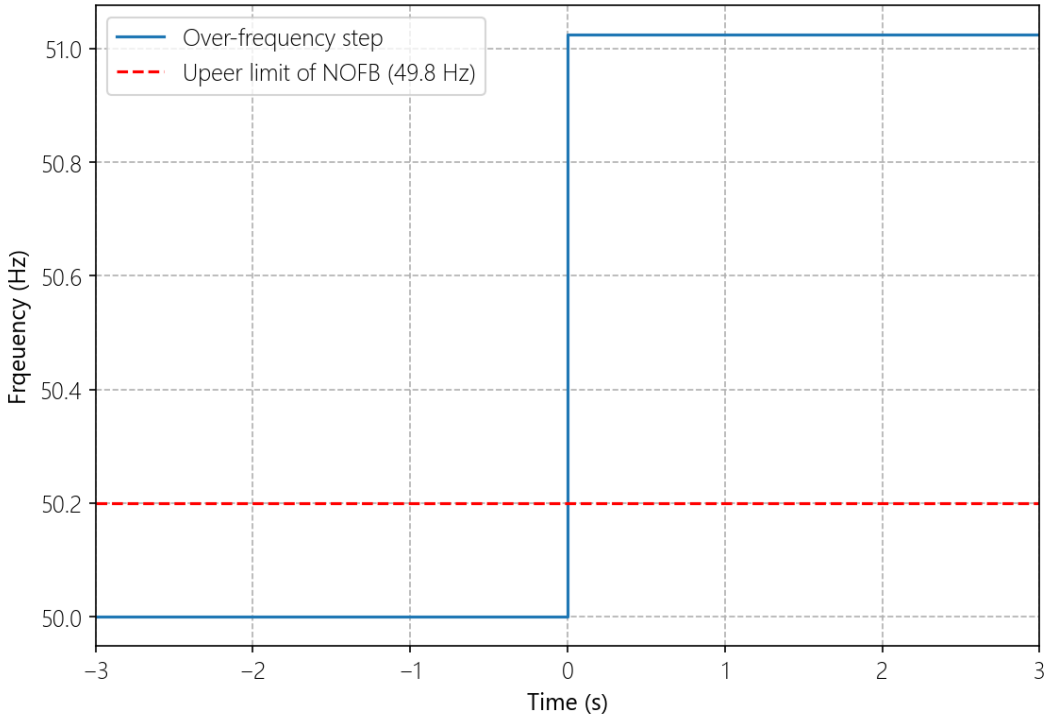

Figure 6 Standard under-frequency step for certifying Contingency Reserve Lower quantities based on a droop response

4.3. Assessment of Contingency Reserve Lower

4.3.1. Contingency Reserve Lower requires a Facility to respond to an event and sustain or exceed the required response for at least 15 minutes [Clause 7.10.18].

4.3.2. AEMO will determine, in accordance with paragraph 7.1 of the Frequency Co-Optimised Essential System Services WEM Procedure, the Maximum Quantity for Contingency Reserve Lower for each test conducted.

4.4. Assessment of Contingency Reserve Lower Quantities from Facilities containing Intermittent Generating Systems

4.4.1. The accredited Contingency Reserve Lower quantity for an Intermittent Generating System will be assessed by AEMO based on the accuracy of that Facility's Unadjusted Semi-Scheduled Injection Forecast, to establish any reduction factor which must be applied to that Facility's maximum enablement quantity to reflect the accuracy of that Facility's Unadjusted Semi-Scheduled Injection Forecast.