AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

WEM Ancillary Services Certification Guidelines

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1.0

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1. Introduction

1.1 Purpose

In accordance with step 3.1.1 of the Power System Operation Procedure: Ancillary Services (Procedure), this guideline is intended to provide guidance for Participants in the Wholesale Electricity Market (WEM) wishing to certify their Facilities for the following Ancillary Services:

- Load Following Ancillary Service (LFAS);
- Spinning Reserve Ancillary Service (SRAS); and
- Load Rejection Reserve (LRR).

Guidelines for certifying the following Ancillary Services are excluded from this document, because these services are assessed on a case-by-case basis:

- System Restart Service (SRS); and
- Dispatch Support Service (DSS).

In accordance with step 3.1.1 of the Procedure, AEMO may, at its discretion, vary the requirements specified in this guideline.

Please contact AEMO System Management Operations (wa.sm.operations@aemo.com.au) for general enquiries or AEMO Power System & Market Planning (wa.sm.planning@aemo.com.au) for technical enquiries regarding the certification of these Ancillary Services.

1.2 Reference documents

This procedure should be read in conjunction with the following documents:

Table 1 Reference documents

Document	Published by	Revision
Wholesale Electricity Market Rules	ERA WA	Latest version
Western Power Technical Rules	Western Power	3 (1 December 2016)
Power System Operation Procedure – Ancillary Services	AEMO (WA)	1 July 2019
ABC and AGC Interface Requirements – Technical Specification	AEMO (WA)	September 2018

1.3 Glossary

Table 2 Glossary of terms

Term	Definition
ABC	Automatic Balancing Control
AGC	Automatic Generation Control
DCS	Distributed Control System
DI	Dispatch Instruction

Term	Definition
DSS	Dispatch Support Service
LFAS	Load Following Ancillary Service
LRR	Load Rejection Reserve
NOFB	Normal Operating Frequency Band (49.8 to 50.2 Hz)
PoE	Probability of Exceedance
PFR	Primary Frequency Response
RoCoF	Rate of Change of Frequency
SIL	System Interruptible Load
SRAS	Spinning Reserve Ancillary Service
SRS	System Restart Service
SWIS	Southwest Interconnected System
UFLS	Under-Frequency Load Shedding
UFR	Under-Frequency Relay
WEM	Wholesale Electricity Market

1.4 Relationship with the Market Rules

Reference to particular Market Rules within the guideline are in bold and square brackets **[MR XX.XX.XX]**. These references are included for convenience only and are not part of this guideline.

2. Load Following

2.1 General requirements

Load Following Ancillary Service (LFAS) can be provided by Scheduled Generators or Non-Scheduled Generators **[MR 3.9.1]**. For the certification of LFAS, the following general requirements apply:

(1) The Facility must be registered to provide LFAS and have an operating agreement with AEMO[1].

(2) Facilities installed prior to 2016 must comply with the interface requirements of Automatic Balancing Control/Automatic Generation Control (ABC/AGC) as per sections 2, 3, 4 and 5 (as applicable) of the document *ABC and AGC Interface Requirements*. The relevant Supervisory Control and Data Acquisition (SCADA) signals in Table 2 of the technical specification must be fully commissioned, functioning and scanning correctly. All new Facilities are assumed to meet these requirements once connecting to AGC.

(3) LFAS certification tests must be carried out in real time under an approved Commissioning Test Plan as indicated in Section 2.3 of this guideline.

2.2 Pre-certification response time test requirements (optional)

Before submitting a Commissioning Test Plan for an LFAS certification test, the Participant may choose to demonstrate that the Facility is capable of responding to a step change in desired MW (that is, from a Dispatch Instruction) by commencing ramping within 5 seconds. This pre-certification test may reduce overall costs for the Participant.

Otherwise, the response time test can be performed as part of the certification tests in section 2.3 of this guideline. The response time being measured is the duration between the time the Facility's Distributed Control System (DCS) receives the AGC signal and the time the Facility commences ramping.

The following requirements and/or considerations apply for pre-certification response tests:

(1) The response time tests must include at least:

  (a) one downward ramp; and

  (b) one upward ramp.

(2) Response time test measurements should be recorded with a resolution of 500 ms or higher (ideally, less than 100 ms).

(3) The unit response time can be affected by governor droop response depending on the variability of system frequency at the time of receiving an AGC signal. It may be necessary to turn off governor droop during the test to isolate this problem. Overlaying the system frequency on the unit response could also aid in understanding the results.

(4) Plots of the raw test measurements (and/or the raw data itself), without additional processing or manipulation, must be submitted to AEMO.

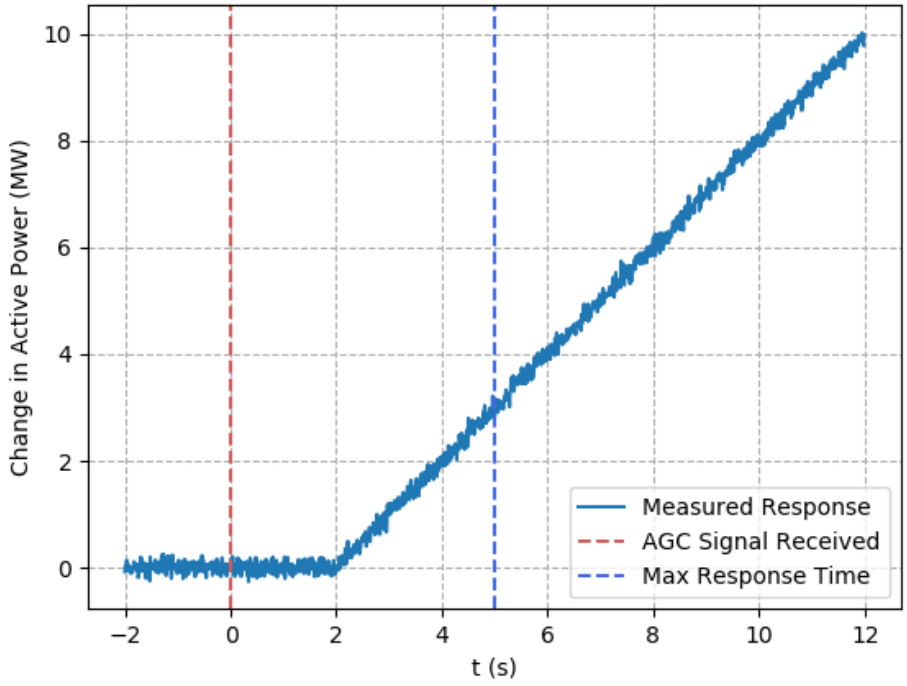
(5) It may also be necessary to provide additional information to demonstrate that the unit has commenced responding to the latest Dispatch Instruction or AGC signal, e.g. 'gate' positions, governor action etc.

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

[1] Contact AEMO System Management Operations for more information.

Figure 1 is the model response time test result showing an unambiguous unit ramp response well within the 5 second time limit.

Figure 1 Acceptable AGC response time (model response)



A deviation from the original basepoint is acceptable provided that the unit begins ramping within 5 seconds and the change in active power (ΔP) at t=5s is positive. Figure 2 shows an acceptable response despite the negative drift before starting the ramp.

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

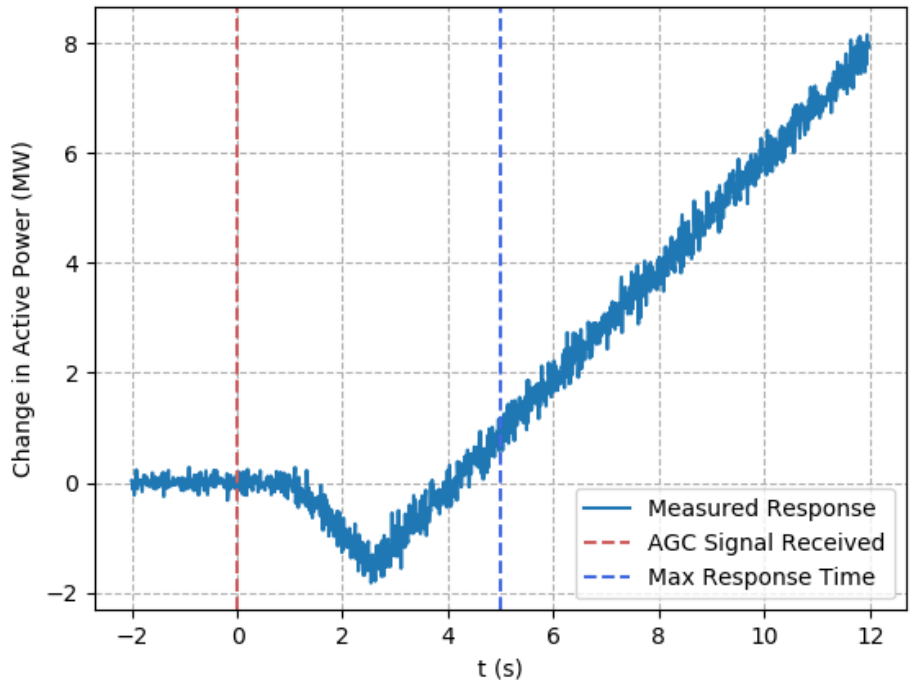


Figure 3 is an unacceptable response because there is a negative drift in power output, and while the ramp does commence before 5 seconds, the output at t=5s is still below the original basepoint output.

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

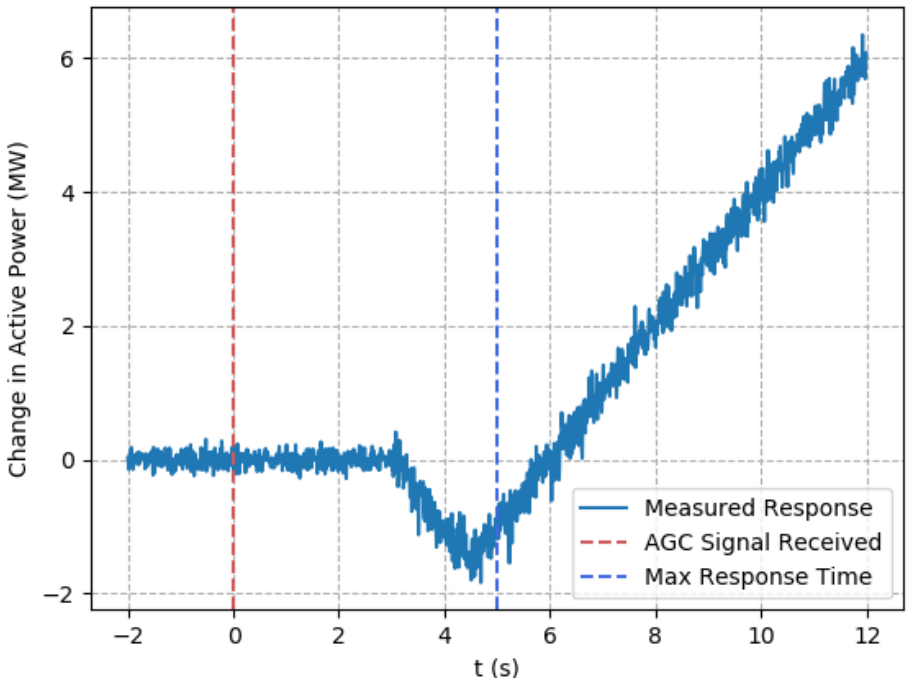
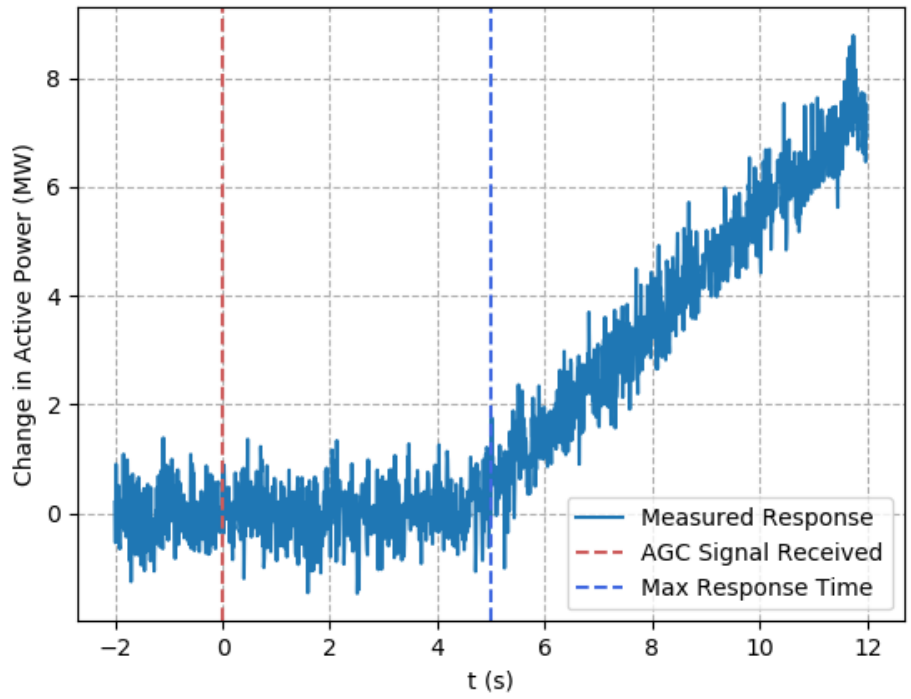


Figure 4 is an unacceptable response because the high level of noise obscures the commencement of the ramp and it is ambiguously close to the 5 second response time limit.

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



2.3 Certification test requirements

LFAS certification tests must be carried out in real time. The certification tests consist of two separate stages of certification. Stage 2 must only be attempted once stage 1 is approved by AEMO.

2.3.1 Stage 1 certification

The following tests are applicable for Stage 1 certification and must be carried out under an approved Commissioning Test Plan:

(1) **Response Time Test:** verify that the Facility is capable of responding to a step change in Desired MW by commencing ramping within 5 seconds. This is a repeat of the pre-certification response time test described in section 2.2 of this guideline.

(2) **Ramp Rate Test:** verify that the unit's ramp rate is not less than 0.2 MW/min for each MW cleared in LFAS. For example, a Facility that is tested for 30 MW LFAS up and down, the ramp rate should not be less than 6 MW/min. For the ramp rate test, the unit should be tested over its LFAS range.

(3) **AGC Failure Test:** 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.

(4) **Communications Failure Test:** 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 to go to "Local control" due to short communication glitches.

(5) **Reliability Test:** verify that the unit can reliably respond to AGC signals for 6 continuous hours.

Note that the Facility is not to bid or be cleared in the LFAS market to conduct the Stage 1 certification tests.

2.3.2 Stage 2 certification

The following test is applicable for Stage 2 certification:

Market Systems Test: verify that market systems have been correctly configured, i.e. the Facility is cleared for LFAS and the AGC automatically sets the participation mode of the Facility to "Base/Full" and the high/low operating limits to reflect the cleared values. Note that this will require the Participant to bid accordingly such that the Facility is successfully cleared in the LFAS market for at least two (2) consecutive intervals.

The Facility must be cleared in the LFAS market for at least two (2) consecutive intervals to perform the Stage 2 certification tests. As LFAS bids cannot be changed within 10 hours of the trading interval, it is required that the Market System Tests be scheduled in a separate window to the Stage 1 certification tests to mitigate the risk of calling on Backup LFAS should the outcome of the Stage 1 certification tests be unsuccessful.

3. Spinning Reserve

3.1 General requirements

Spinning Reserve Ancillary Service (SRAS) can be provided by Scheduled Generators or Interruptible Loads **[MR 3.9.2]**. Specific requirements for testing and certification of SRAS from each type of Facility are described in the following sections.

For the testing and certification of SRAS, the following general requirements apply:

(1) Results from at least two (2) separate tests must be submitted to AEMO for assessment.

(2) Tests can be performed:

  (a) by injecting a frequency bias to the Facility's frequency measurement signal; or

  (b) by demonstrating actual Facility responses to real system events.

(3) Test measurements must be recorded with a resolution of 500 ms or higher (ideally ≤100 ms). The requirements are relaxed for Interruptible Loads, where a resolution of up to 1s is acceptable.

(4) Plots of the raw test measurements and/or the raw data itself, without additional processing or manipulation, must be submitted to AEMO.

3.2 Specific requirements for Scheduled Generators

Scheduled Generators may provide SRAS either in the form of:

(1) a droop response; or

(2) a fixed response (frequency-invariant).

For the purposes of testing and certifying SRAS, the two different types of responses are treated separately.

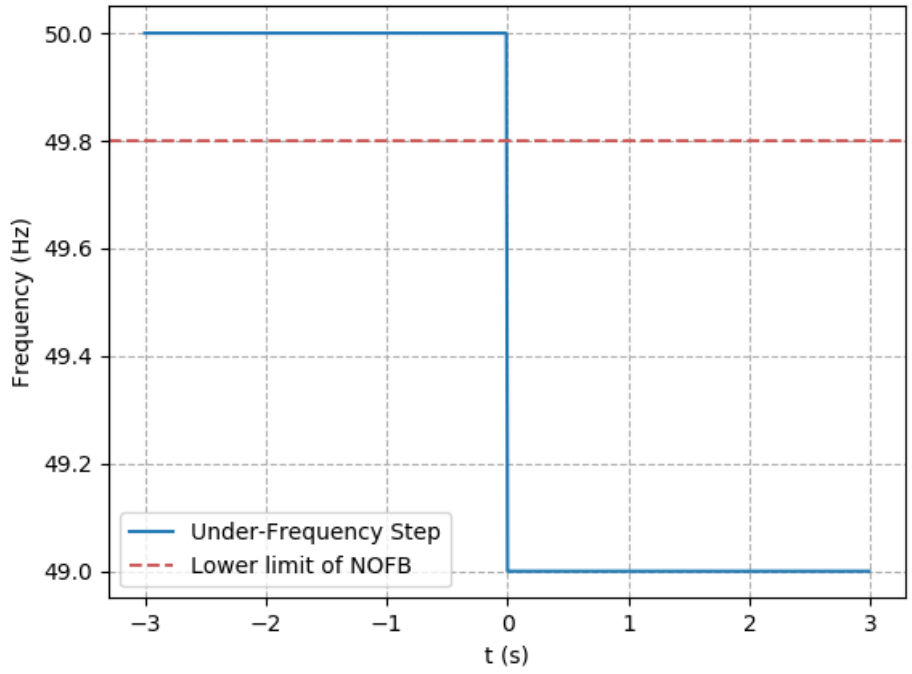
3.2.1 Certifying droop-based responses

For droop-based spinning reserve responses, the SRAS quantity must be certified by injecting the standard under-frequency step shown in Figure 5, reflecting a frequency deviation and Rate of Change of Frequency (RoCoF) deemed to be the worst-case under normal operating conditions. This forms the basis for provisioning spinning reserve quantities by AEMO.

3.2.2 Certifying fixed responses

Scheduled Generators can elect to provide a fixed spinning reserve response to any frequency deviation below 49.8 Hz (subject to AEMO's approval which will be provided, as appropriate, on a case-by-case basis). Fixed responses must be certified by injecting a fixed frequency signal of 49.75 Hz.

Figure 5 Standard under-frequency step for certifying SRAS quantities based on a droop response



3.2.3 Assessment of SRAS certification test responses

An SRAS Facility must respond appropriately within the appropriate timeframe (either 6 seconds, 60 seconds, or 6 minutes) and sustain or exceed the required response for an appropriate response time **[MR 3.9.3]**.

For Scheduled Generators, the certified SRAS quantity is the output that it can sustain (or exceed) 6s/60s/6min *after the frequency falls below 49.8 Hz*.

To clarify any ambiguities pertaining to generator ramping behaviour and its prime-mover/governor control response, interpretations for the certified SRAS quantities under the possible scenarios are indicated in the figures below (with 6 second SRAS used as a prototypical example).

Figure 6 Model SRAS response

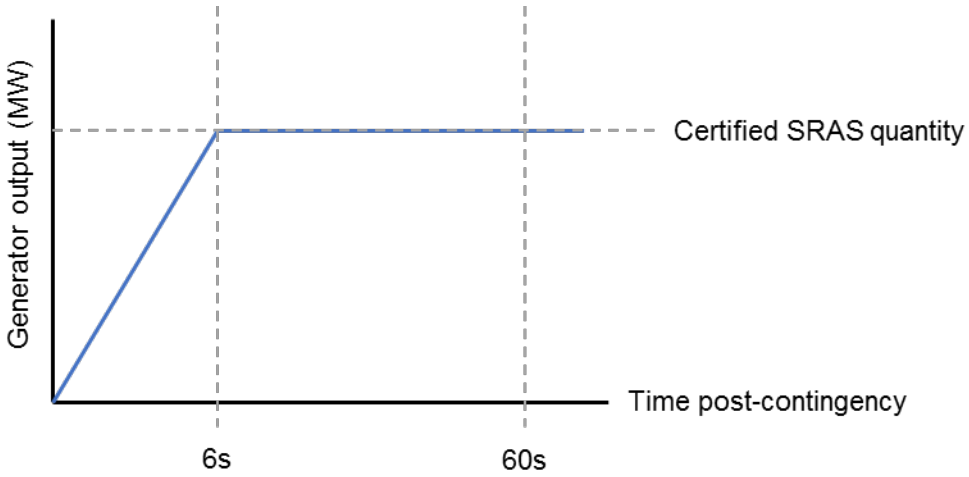


Figure 7 Slow ramp-rate SRAS response

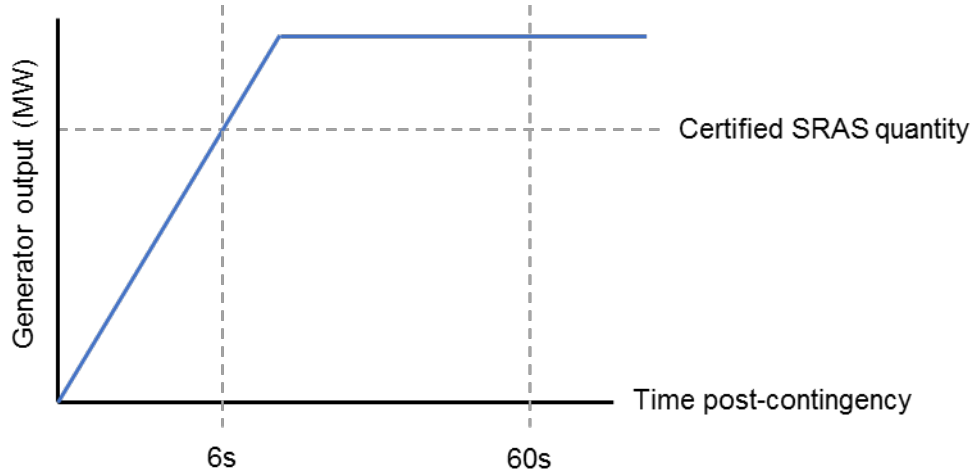
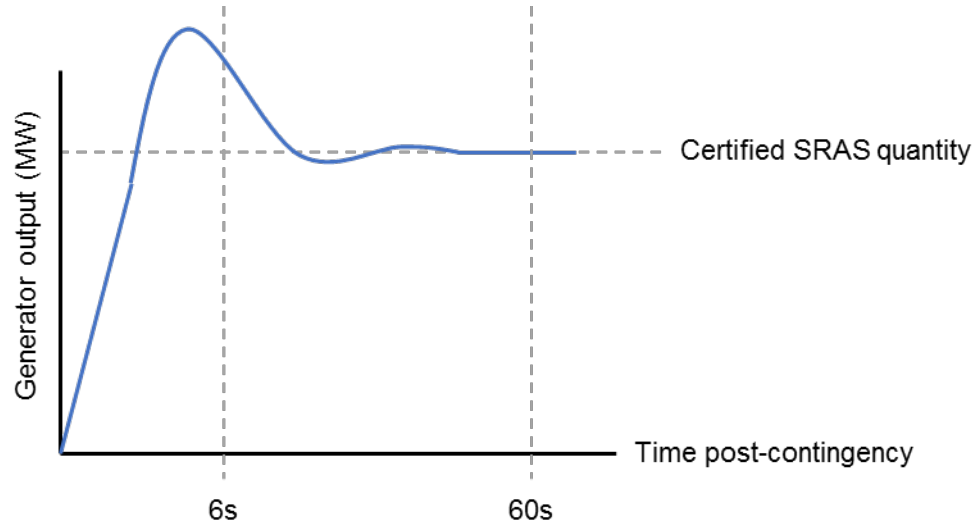


Figure 8 Fast ramp-rate and overshoot SRAS response



3.2.4 Impact of generator initial loading

If the quantity of SRAS that can be provided by the generator varies depending on its initial loading, then the Participant must perform tests at different levels of initial loading such that a table of initial loading and certified SRAS quantities[2] can be developed (see Table 3 as an example).

Table 3 Example of certified SRAS quantities at different levels of initial loading

Initial Loading (%)	Certified SRAS (MW)
25%	50
50%	50
75%	40
>85%	0

[2] Certified and contracted quantities may differ.

3.3 Specific requirements for Interruptible Loads

Interruptible Loads provide SRAS by shedding loads triggered by local under-frequency relays (UFR) or a signal from a remote control system. The process for certification of SRAS from Interruptible Loads is:

(1) testing that the equipment in the field provides the desired SRAS response; and

(2) using historical load data to certify the SRAS quantity and availability.

3.3.1 Testing SRAS response

Because the Facility loads fluctuate over time, the SRAS testing process can only evaluate the response of the Facility to frequency deviations that exceed the under-frequency threshold settings, that is, ensure that the specified loads trip at the correct frequency settings and within the timeframes as agreed by the Participant and AEMO.

The testing must be performed by injecting a frequency bias into the frequency measurement signal and verifying the operation of the local UFR or remote control system. The test frequency must 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. The maximum response time must be the sum of the components as described in Table 4.

Table 4 Interruptible Load maximum SRAS response time components

Component	Maximum Time
Load shedding time delay	As agreed with AEMO (typically 400 ms)
Relay and breaker operating time (*)	250 ms

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

If a single load shedding stage is spread across multiple sites, then the recorded measurements must be time-synchronised, for example via GPS clock synchronisation.

3.3.2 Assessment of certified SRAS quantities

The certified SRAS quantity for an Interruptible Load must be assessed based on the 90% Probability of Exceedance (PoE) value for the specific loads/feeders in the load shedding scheme using at least 12 months of historical load data. The minimum resolution for the historical load data must be 30 minutes, which equates to at least 17,520 data points for a non-leap year.

4. Load Rejection Reserve

4.1 General requirements

Load Rejection Reserve (LRR) can be provided by Scheduled Generators **[MR 3.9.6]**. Specific requirements for testing and certification of LRR from each type of Facility are described in the following sections.

For the testing and certification of LRR, the following general requirements apply:

(1) Results from at least two (2) separate tests must be submitted to AEMO for assessment.

(2) Tests can be performed:

  (a) by injecting a frequency bias to the Facility's frequency measurement signal; or

  (b) by demonstrating actual Facility responses to real system events.

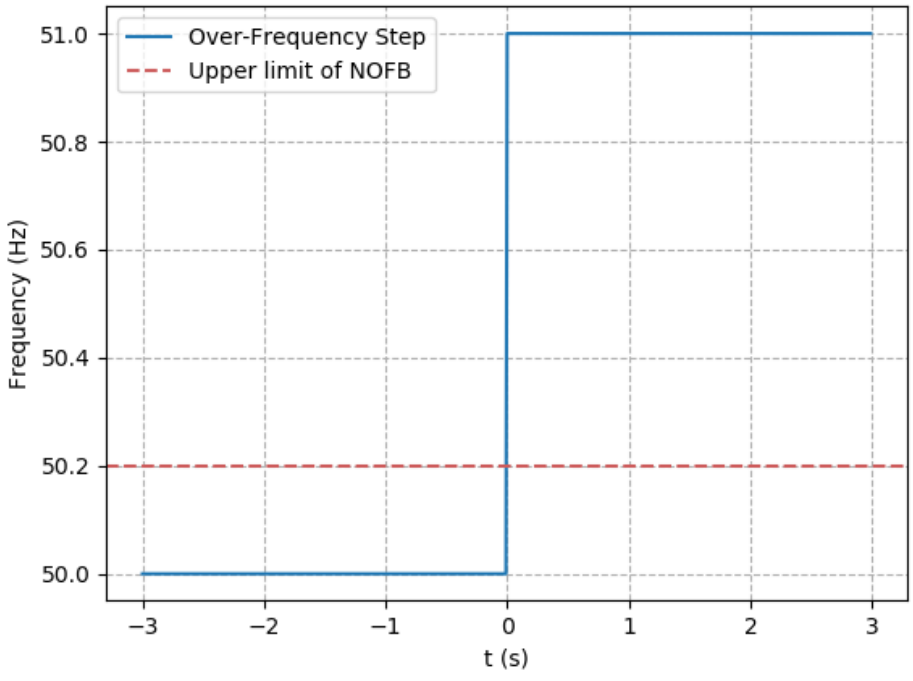
(3) Test measurements must be recorded with a resolution of 500 ms or higher (ideally ≤100 ms).

(4) Plots of the raw test measurements (and/or the raw data itself), without additional processing or manipulation, must be submitted to AEMO.

4.2 Specific requirements for Scheduled Generators

Scheduled Generators must only provide LRR in the form of a droop response. The LRR quantity must be certified by injecting the standard over-frequency step shown in Figure 9, reflecting a frequency deviation and RoCoF deemed to be the worst-case under normal operating conditions. This forms the basis for provisioning spinning reserve quantities by AEMO.

Figure 9 Standard over-frequency step for certifying LRR quantities



4.2.1 Assessment of LRR Certification Test Responses

An LRR Facility must respond appropriately respond appropriately within the appropriate timeframe (either 6 seconds or 60 seconds) and sustain or exceed the required response for an appropriate response time **[MR 3.9.7]**.

For Scheduled Generators, the certified LRR quantity is the output that it can sustain (or be below) 6s/60s *after the frequency rises above 50.2 Hz*.

To clarify any ambiguities pertaining to generator ramping behaviour and its prime-mover/governor control response, interpretations for the certified LRR quantities under the possible scenarios are indicated in the figures below (with 6 second LRR used as a prototypical example).

Figure 10 Model LRR response

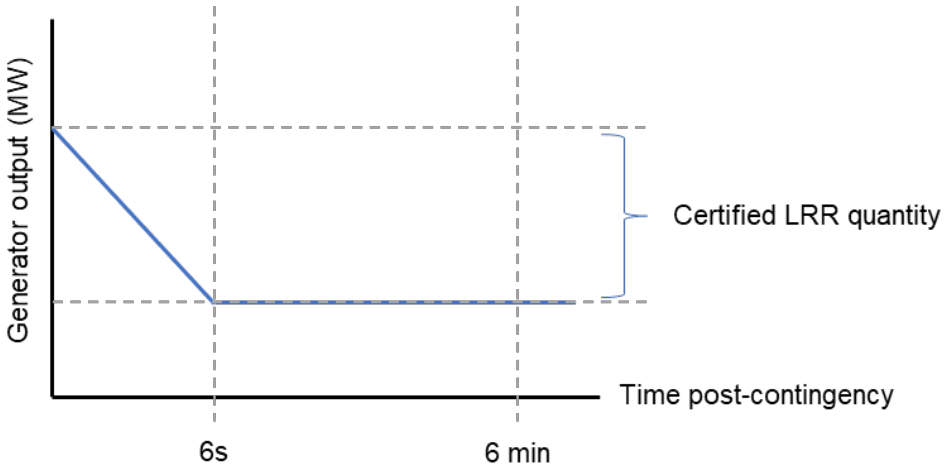


Figure 11 Slow ramp-rate LRR response

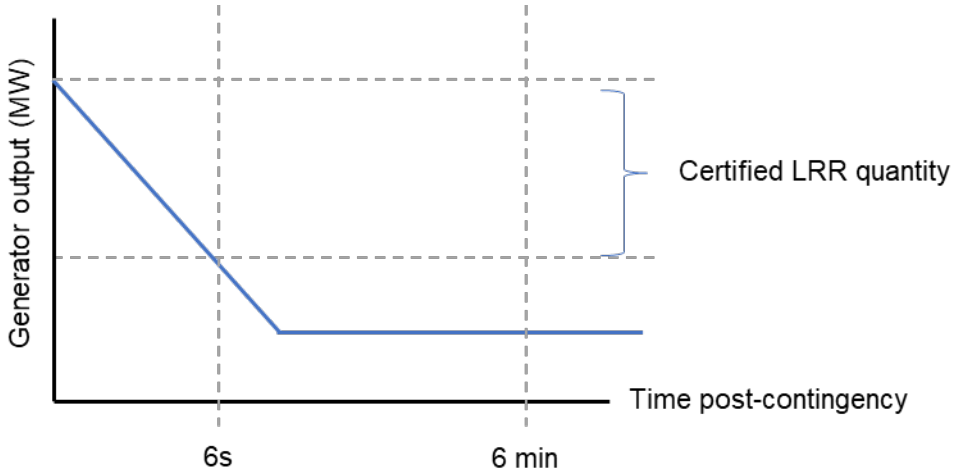
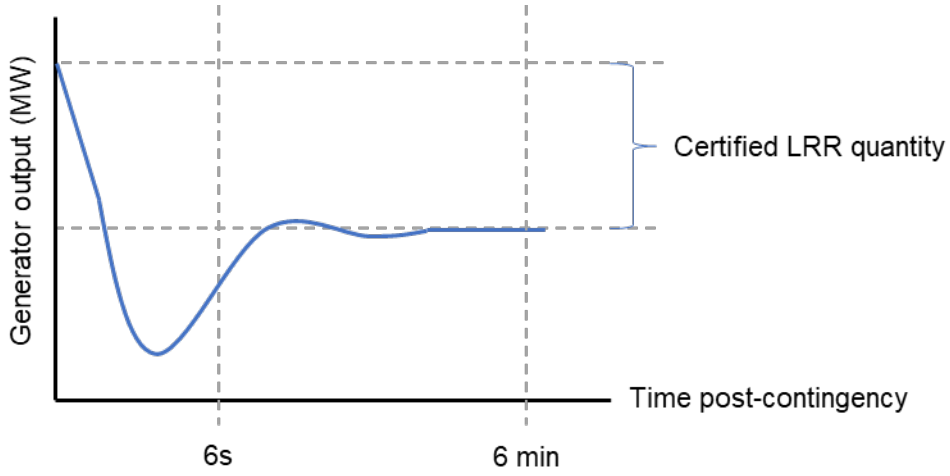


Figure 12 Fast ramp-rate and overshoot LRR response



4.2.2 Impact of generator initial loading

If the quantity of LRR that can be provided by the generator varies depending on its initial loading, then the Participant must perform tests at different levels of initial loading such that a table of initial loading and certified LRR quantities[3] can be developed (see the table below as an example).

Table 5 Example of certified LRR quantities at different levels of initial loading

Initial Loading (%)	Certified LRR (MW)
≤25%	0
50%	40
75%	50
100%	50

[3] Certified and contracted quantities may differ.