BATTERY ENERGY STORAGE SYSTEM REQUIREMENTS FOR CONTINGENCY FCAS REGISTRATION

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VERSION: 1.0
EFFECTIVE DATE: 14 January 2019
STATUS: FINAL

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PUBLISHED: 14 /01 / 2019

VERSION RELEASE HISTORY

Version	Effective Date	Summary of Changes
1.0	14 January 2019	First Issue of the battery energy storage system requirements for Contingency FCAS registration

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GLOSSARY

In this document, terms defined in the National Electricity Rules (NER) have the same meanings unless otherwise specified. Other words or phrases or acronyms are defined in the table below:

TERM	MEANING
BESS	Battery Energy Storage Systems. The information in this document applies for utility scale batteries.
FCAS	Frequency control ancillary services
FOS	Frequency operating standard published by the AEMC Reliability Panel.
MASS	Market ancillary service specification
NOFB	Normal operating frequency band as specified in the FOS (refers to system frequency between 49.85 Hz to 50.15 Hz, when not operating in an island or during supply scarcity).
OFTB	Operational frequency tolerance band as specified in the FOS (refers to the frequency between 49.0 Hz to 51.0 Hz in mainland when not operating during supply scarcity and 48.0 Hz to 52.0 Hz in Tasmania).
Raise Reference Frequency	means the containment frequency below 50 Hz for Generation Events, as specified in the relevant FOS. The raise reference frequency used for the FCAS assessment is 49.5 Hz for mainland and 48.0 Hz for Tasmania
Lower Reference Frequency	means the containment frequency above 50 Hz for Load Events, as specified in the applicable FOS. The lower reference frequency used for the FCAS assessment is 50.5 Hz for mainland and 52.0 Hz for Tasmania

1. INTRODUCTION AND PURPOSE

A battery energy storage system (BESS) can initiate a contingency FCAS response by varying its active power when the local frequency exceeds the lower or upper limit of the normal operating frequency band (NOFB). The purpose of this document is to assist market participants in the National Electricity Market (NEM) looking to register a battery energy storage system to provide contingency FCAS. Information on the type of frequency controllers to be used and the allowable droop settings when delivering FCAS is also provided to help participants determine the maximum ancillary service capacity that can be registered, subject to a successful FCAS assessment by AEMO. A guidance document[1] on utility scale battery technology has been published by AEMO for industry, describing interim arrangements to apply in a number of key areas including: registration, metering, SCADA, negotiation of generator performance standards (GPS) and engagement with NSPs.

2. CONTINGENCY FCAS REGISTRATION REQUIREMENTS FOR BESS

An operator seeking to provide contingency FCAS will need to account for the following:

1. A single droop setting is to be chosen if the control system to provide FCAS is a proportional/variable controller. A piecewise linear type droop response is expected from contingency FCAS providers delivering an increase or decrease in active power in response to changes in frequency.

2. Unless agreed by AEMO, the delivery of active power must be configured to be in proportion to the local frequency.

3. Unless an alternative droop limit is specified by AEMO, the minimum allowable droop setting of any BESS is 1.7%, regardless of its capacity.

4. Using a sufficiently accurate model on PSCAD, PSSE or Simulink, simulate a frequency disturbance and provide data to demonstrate the active power response. The simulation test data is required before registration and the details of the simulation are below:
   i. Unless the BESS is only registered as either an ancillary service load or an ancillary generating unit, the simulation would need to show that the BESS can cycle (charge to discharge and vice versa) to deliver FCAS.
   ii. The frequency deviation modelled needs to be at least to the raise and lower reference frequency as shown in Figure 1 and Figure 2 of the Market Ancillary Service Specification[2] (MASS)
   iii. The standard frequency ramp rate to be used in the simulation is specified in Table 1 of the MASS. If step changes are used for the simulation, the difference in 2 consecutive step changes would need to be equal to the standard frequency ramp rate.

5. Demonstrate the active power response to a frequency disturbance during the commissioning stage. The data from the test on-site will be used to confirm the maximum ancillary service capacity of the BESS. An example of the expected FCAS delivery of a BESS and the required tests to be carried out is provided in Section 3.

6. The metering facilities must comply with the MASS requirements. The data provided following the tests during the commissioning process will be used to confirm whether the facility complies with clauses 3.6, 4.6 and 5.6 of the MASS.

[1] https://www.aemo.com.au/-/media/Files/Electricity/NEM/Participant_Information/New-Participants/Interim-arrangements-for-utility-scale-battery-technology.docx

[2] https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Ancillary_Services/Market-Ancillary-Service-Specification-V50--effective-30-July-2017.pdf

3. BESS CONTINGENCY FCAS REGISTRATION EXAMPLE

The section below provides more information on the expected response of a BESS when delivering FCAS. In this example, the capacity of the BESS is assumed to be 50 MW and is registered by AEMO as a scheduled generator and a scheduled load.

3.1 Calculation of the droop percentage

As per clauses 3.5(b)(i), 3.5(c)(i), 4.5(b)(i), 4.5(c)(i), 5.5(b)(i), 5.5(c)(i) of the MASS for a variable controller, the raise response is assessed for a range of local frequency between the edge of the NOFB and the lower limit of the Operational Frequency Tolerance Band (OFTB). The lower response is provided for a range of local frequency between the NOFB and the upper limit of the OFTB.

The droop of the battery is calculated using the formula below:

$$\% \text{ Droop} = 100 \; * \frac{(FB-D)}{50} * \frac{C}{SP}$$

$$= 100 \; * \frac{(1-0.15)}{50} * \frac{50}{50}$$

$$= 1.7 \;\%$$

Where

FB is the frequency deviation at which the maximum charge or discharge of the BESS is provided.

D is the frequency dead band which has a default value of +/-0.15 Hz.

C is the registered capacity of the BESS which is 50 MW (not the full cycle capacity of 100 MW).

SP is the capacity of the BESS used to provide an FCAS response.

Figure 1 shows the droop curve of the 50 MW BESS for FCAS delivery.

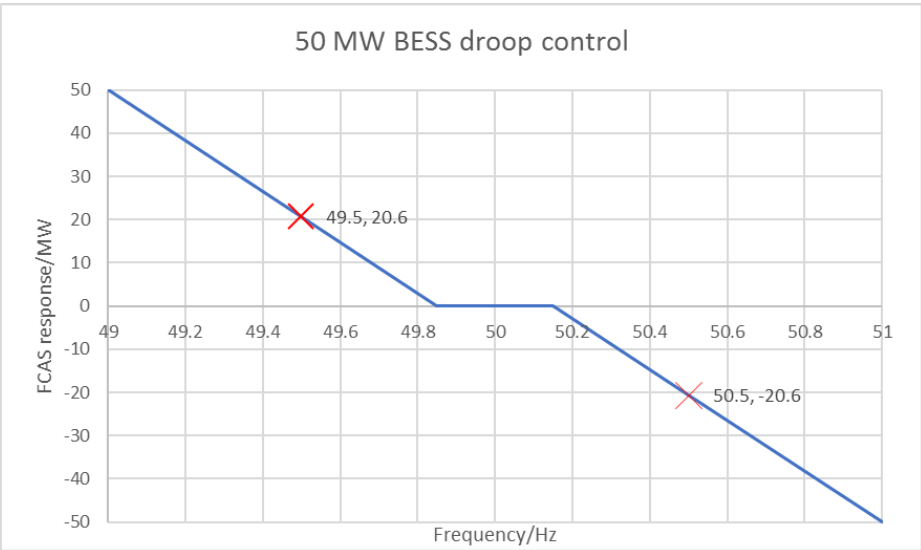

Fig 1: Droop curve of a 50 MW BESS providing FCAS

3.2 Calculation of the FCAS capacity

As per clauses 3.3, 3.4, 4.3, 4.4, 5.3 and 5.4 of the MASS, the amount of raise service delivered for dispatch purposes is in response to a standard frequency ramp from 50 Hz to the raise reference frequency and the amount of lower service delivered for dispatch purposes is in response to a standard frequency ramp from 50 Hz to the lower reference frequency.

The maximum ancillary service capacity is calculated using the formula below:

$$\text{Contingency FCAS capacity} = 100 * \frac{1}{\%Droop} * \frac{(\min(FB,FR) - D)}{50} * C$$

$$= 100 * \frac{1}{1.7} * \frac{(\min(1,0.5) - 0.15)}{50} * 50$$

$$= 20.6 \ MW$$

Where

FR is the absolute value of the difference between 50 Hz and the raise or lower reference frequency.

The calculated maximum FCAS capacity is rounded down to the closest integer and is therefore equal to 20 MW.

3.3 Expected simulation and commissioning FCAS test results

For a 50 MW BESS providing FCAS when charging and discharging in the mainland, the following test results shown in the figures below are expected in order to confirm the FCAS capability of the BESS.

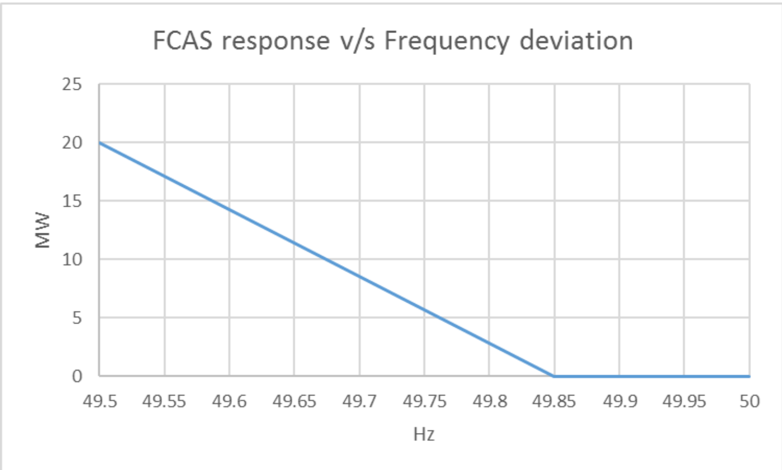

Fig 2: Increase in active power from 0 MW to +20 MW following a 0.5 Hz frequency deviation to the raise reference frequency

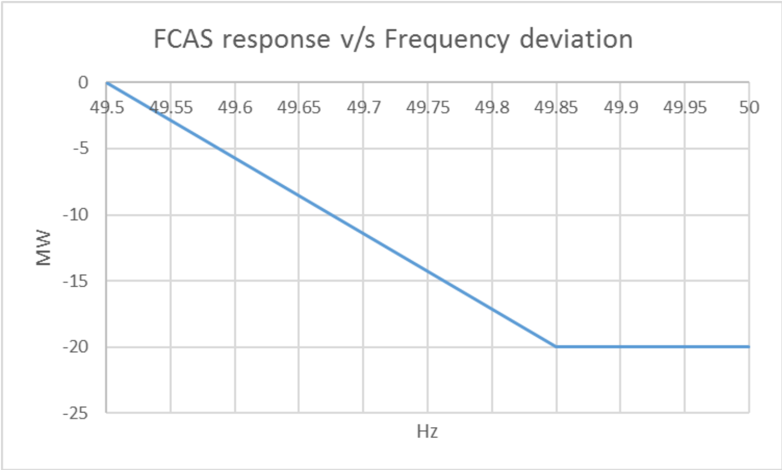

Fig 3: Increase in active power from -20 MW to 0 MW following a 0.5 Hz frequency deviation to the raise reference frequency

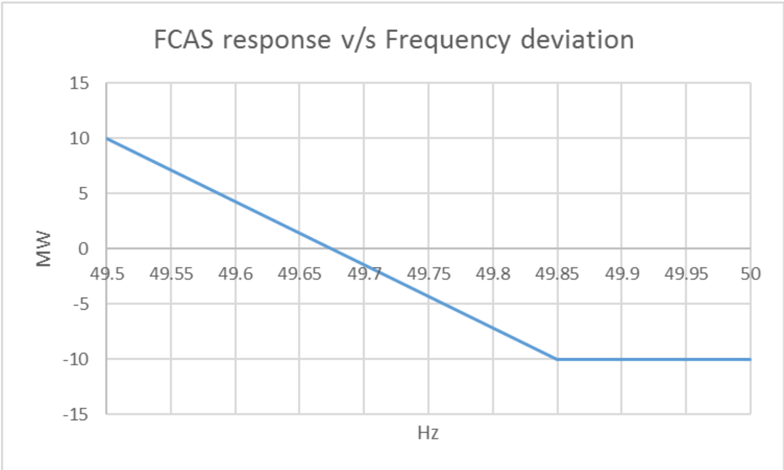

Fig 4: Increase in active power from -10 MW (charging) to +10 MW following a 0.5 Hz frequency deviation to the raise reference frequency

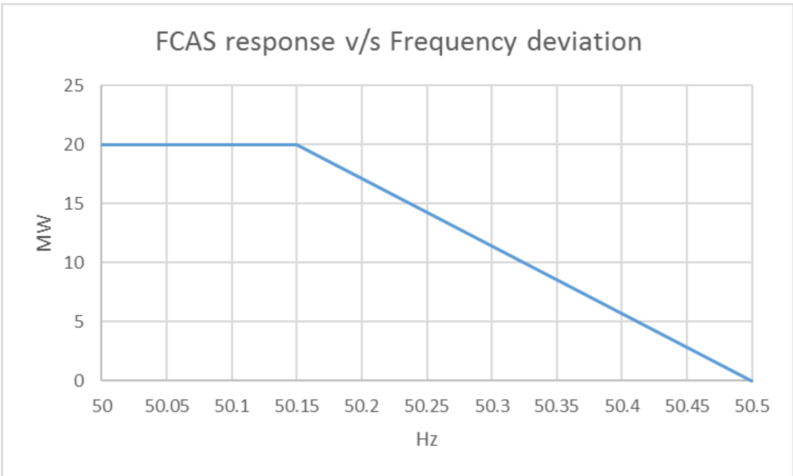

Fig 5: Decrease in active power from +20 MW to 0 MW following a 0.5Hz frequency deviation to the lower reference frequency

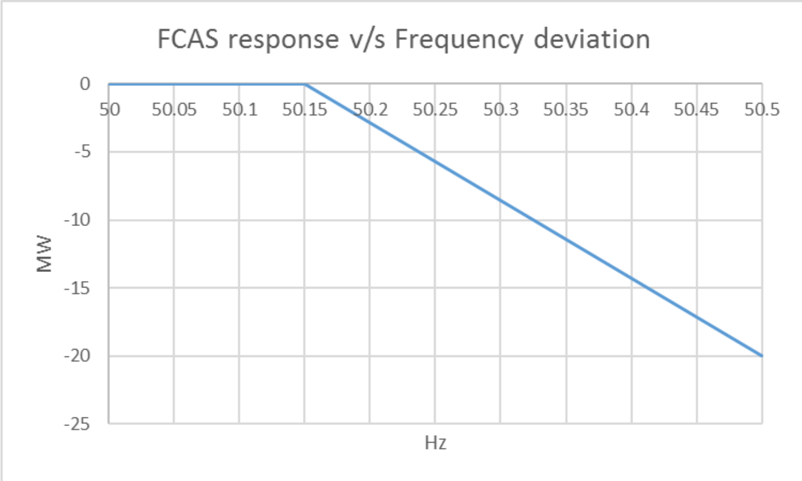

Fig 6: Decrease in active power from 0 MW to -20 MW following a 0.5Hz frequency deviation to the lower reference frequency

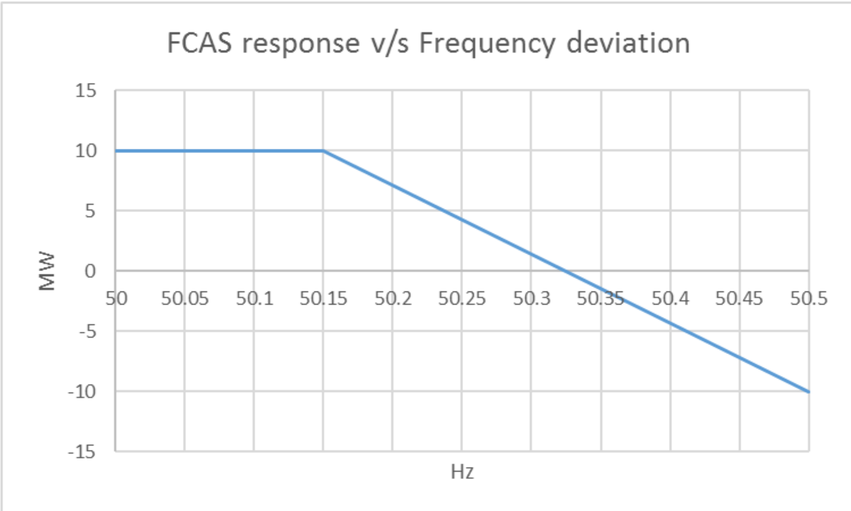

Fig 7: Decrease in active power from +10 MW to -10 MW following a 0.5Hz frequency deviation to the lower reference frequency

3.4 FCAS delivery verification and frequency recovery

The MASS FCAS verification tool[3] is used to confirm the maximum ancillary service capacity of the BESS, based on the data provided following the commissioning FCAS tests. As per section 2.5 of the MASS, if there is any inconsistency between the FCASVT and the MASS, the MASS will prevail to the extent of that inconsistency.

As defined in the MASS, Frequency Recovery means the first change in Local Frequency from above 50.15 Hz to below 50.1 Hz, or below 49.85 Hz to above 49.9 Hz, to occur after a Frequency Disturbance.

As per clause 3.7(a)(i) of the MASS for the fast raise and fast lower service, FCAS assessment commences at the Frequency Disturbance Time and ends at Frequency Recovery. In the event that

[3] https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Ancillary_Services/EXTERNAL-MASS-50-FCAS-Verification-Toolv209.xlsx

Frequency Recovery does not occur within 60 seconds of the Frequency Disturbance Time, the assessment will occur 60 seconds from the Frequency Disturbance Time.

As per clause 4.7(a)(i) of the MASS for the slow raise and slow lower service, FCAS assessment commences at the Frequency Disturbance Time and ends at Frequency Recovery. In the event that Frequency Recovery does not occur within 300 seconds of the Frequency Disturbance Time, the assessment will occur 300 seconds from the Frequency Disturbance Time.

As per clause 5.7(a)(i) of the MASS for the delayed raise and delayed lower service, FCAS assessment commences at the Frequency Disturbance Time and ends at Frequency Recovery. In the event that Frequency Recovery does not occur within 600 seconds of the Frequency Disturbance Time, the assessment will occur 600 seconds from the Frequency Disturbance Time.