



National Electricity Market  
Management Company Limited  
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# Market Ancillary Service Specification

*Draft*

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Performance*

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**DRAFT**

**1 INTERPRETATION**

**1.1 Definition of terms**

In this *Specification*, italicised words and phrases have the meaning given to them in Table 1.

**Table 1**

<b>Word of Phrase</b>	<b>Meaning</b>
<i>ancillary service generating unit</i>	has the meaning given to it in the <i>Rules</i>
<i>ancillary service load</i>	has the meaning given to it in the <i>Rules</i>
<i>central dispatch</i>	has the meaning given to it in the <i>Rules</i>
<i>connection point</i>	has the meaning given to it in the <i>Rules</i>
<i>control system</i>	has the meaning given to it in the <i>Rules</i>
<i>controlled quantity</i>	means a measured quantity of <i>generation</i> or <i>load</i> that is: <ul style="list-style-type: none"> <li>(a) controlled by the action of <i>raise signals</i> and <i>lower signals</i>;</li> <li>(b) measured and transmitted to <i>NEMMCO's</i> control centre; and</li> <li>(c) unless otherwise agreed between <i>NEMMCO</i> and the relevant <i>Market Participant</i>, the same quantity specified in a <i>dispatch bid</i> or <i>dispatch offer</i> of the <i>ancillary service generating unit</i> or <i>ancillary service load</i></li> </ul>
<i>delayed lower service</i>	has the meaning given to it in the <i>Rules</i>
<i>delayed raise service</i>	has the meaning given to it in the <i>Rules</i>
<i>dispatch bid</i>	has the meaning given to it in the <i>Rules</i>
<i>dispatch interval</i>	has the meaning given to it in the <i>Rules</i>
<i>dispatch offer</i>	has the meaning given to it in the <i>Rules</i>
<i>enabled</i>	has the meaning given to it in the <i>Rules</i>
<i>fast lower service</i>	has the meaning given to it in the <i>Rules</i>
<i>fast raise service</i>	has the meaning given to it in the <i>Rules</i>
<i>frequency</i>	has the meaning given to it in the <i>Rules</i>
<i>frequency disturbance</i>	means an occasion when the <i>frequency</i> of the <i>power system</i> moves outside the <i>normal operating frequency band</i>
<i>frequency disturbance time</i>	means the time at which <i>local frequency</i> falls or rises outside the <i>normal operating frequency band</i> during a <i>frequency disturbance</i> , referenced to Australian Eastern Standard Time

<b>Word of Phrase</b>	<b>Meaning</b>
<i>frequency operating standards</i>	has the meaning given in the <i>Rules</i> , as applicable to the <i>region</i> in which the relevant <i>ancillary service generating unit</i> or <i>ancillary service load</i> is located
<i>frequency ramp rate</i>	means 0.4 Hz per second in Tasmania and 0.125 Hz per second elsewhere.
<i>frequency setting</i>	means a level of <i>frequency</i> determined by NEMMCO in accordance with the procedure set out in section 6.2 of the <i>Specification</i> and notified in writing to the Market Participant for use by a <i>switching controller</i> for a particular <i>ancillary service generating unit</i> or <i>ancillary service load</i> when providing a particular <i>market ancillary service</i>
<i>frequency recovery</i>	means the first change in <i>local frequency</i> from above 50 Hz to below 50 Hz, or vice versa, to occur after a <i>frequency disturbance</i>
<i>generation</i>	has the meaning given to it in the <i>Rules</i>
<i>generation amount</i>	means the amount of power flow through a <i>connection point</i> of an <i>ancillary service generating unit</i> , measured in MW, flow from the <i>ancillary service generating unit</i> being positive
<i>generation event</i>	has the meaning given or implied in the relevant <i>frequency operating standards</i>
<i>generating unit</i>	has the meaning given to it in the <i>Rules</i>
<i>inertial response</i>	means the change in <i>generation amount</i> or <i>load amount</i> due to the effect of the inertia of the <i>ancillary service generating unit</i> or <i>ancillary service load</i>
<i>initial value</i>	means the <i>generation amount</i> or <i>load amount</i> just prior to the <i>frequency disturbance time</i> of a <i>frequency disturbance</i>
<i>load</i>	has the meaning given to it in the <i>Rules</i>
<i>load amount</i>	means the amount of power flow through a <i>connection point</i> of an <i>ancillary service load</i> , measured in MW, flow towards the <i>ancillary service load</i> being negative
<i>load event</i>	has the meaning given or implied in the relevant <i>frequency operating standards</i>
<i>local frequency</i>	means the <i>frequency</i> of the electricity delivered by an <i>ancillary service generating unit</i> or consumed by an <i>ancillary service load</i> , measured in Hz
<i>lower control limit</i>	means the lowest level to which a <i>controlled quantity</i> may be controlled in response to <i>lower signals</i> , as transmitted to NEMMCO's control centre
<i>lower rate limit</i>	means the highest rate at which a <i>controlled quantity</i> may be controlled in response to <i>lower signals</i> , as transmitted to NEMMCO's control centre
<i>lower reference frequency</i>	means the containment frequency above 50 Hz for <i>load events</i> , as given in the relevant <i>frequency operating standards</i>

<b>Word of Phrase</b>	<b>Meaning</b>
<i>lower response</i>	means the decrease in <i>generation amount</i> or increase in <i>load amount</i> with respect to the corresponding <i>initial value</i>
<i>lower signal</i>	means a control signal sent by or on behalf of <i>NEMMCO</i> in a form agreed between <i>NEMMCO</i> and the relevant <i>Market Participant</i> in order to request delivery of <i>regulating lower response</i>
<i>market ancillary service</i>	has the meaning given to it in the <i>Rules</i>
<i>market ancillary service offer</i>	has the meaning given to it in the <i>Rules</i>
<i>Market Participant</i>	has the meaning given to it in the <i>Rules</i>
<i>Rules</i>	means the National Electricity <i>Rules</i>
<i>NEMMCO</i>	has the meaning given to it in the <i>Rules</i>
<i>normal operating frequency band</i>	has the meaning given to it in the <i>Rules</i>
<i>normal operating frequency excursion band</i>	has the meaning given to it in the <i>Rules</i>
<i>operational frequency tolerance band</i>	has the meaning given in the <i>Rules</i> and the value given in the relevant <i>frequency operating standard</i>
<i>power system</i>	has the meaning given to it in the <i>Rules</i>
<i>price band</i>	has the meaning given to it in the <i>Rules</i>
<i>proportional controller</i>	means a <i>control system</i> that controls the amount of service delivery essentially in proportion to the difference between <i>local frequency</i> and 50 Hz.
<i>raise control limit</i>	means the highest level to which a <i>controlled quantity</i> may be controlled in response to <i>raise signals</i> , as transmitted to <i>NEMMCO's</i> control centre
<i>raise rate limit</i>	means the highest rate at which a <i>controlled quantity</i> may be controlled in response to <i>raise signals</i> , as transmitted to <i>NEMMCO's</i> control centre
<i>raise reference frequency</i>	means the containment frequency below 50 Hz for <i>generation events</i> , as given in the relevant <i>frequency operating standards</i>
<i>raise response</i>	means the increase in <i>generation amount</i> or decrease in <i>load amount</i> with respect to the corresponding <i>initial value</i>
<i>raise signal</i>	means a control signal sent by or on behalf of <i>NEMMCO</i> in a form agreed between <i>NEMMCO</i> and the relevant <i>Market Participant</i> in order to request delivery of <i>regulating raise response</i>
<i>region</i>	has the meaning given in the <i>Rules</i>
<i>regulating lower service</i>	has the meaning given to it in the <i>Rules</i>

<b>Word of Phrase</b>	<b>Meaning</b>
<i>regulating lower response</i>	means the decrease in <i>generation amount</i> or increase in <i>load amount</i> delivered in response to one or more <i>lower signals</i>
<i>regulating raise service</i>	has the meaning given to it in the <i>Rules</i>
<i>regulating raise response</i>	means the increase in <i>generation amount</i> or decrease in <i>load amount</i> delivered in response to one or more <i>raise signals</i>
<i>response capability</i>	has the meaning given to it in the <i>Rules</i>
<i>service cancellation</i>	means the time when <i>NEMMCO</i> has notified the <i>Market Participant</i> that the relevant service is not <i>enabled</i> or not required
<i>slow lower service</i>	has the meaning given to it in the <i>Rules</i>
<i>slow raise service</i>	has the meaning given to it in the <i>Rules</i>
<i>Specification</i>	means this document, the Market Ancillary Service Specification as contemplated by clause 3.11.2(b) of the <i>Rules</i>
<i>standard frequency ramp</i>	means a linear change of <i>local frequency</i> from one level to another at the applicable <i>frequency ramp rate</i> and then sustained
<i>switching controller</i>	means a <i>control system</i> that delivers a specific amount of service when one or more specified conditions are met
<i>system frequency</i>	means a <i>frequency</i> measured by or for <i>NEMMCO</i> that represents the <i>frequency</i> of the <i>power system</i> to which the <i>ancillary service generating unit</i> or <i>ancillary service load</i> is connected
<i>time average</i>	means, in respect of a <i>raise response</i> or <i>lower response</i> and a time interval, the average value of that <i>raise response</i> or <i>lower response</i> over that time interval, determined as the integral of the <i>raise response</i> or <i>lower response</i> over the time interval divided by the time interval duration
<i>trigger range</i>	means the contiguous range comprising the upper 40% of the range between 50 Hz and the <i>raise reference frequency</i> and the lower 40% of the range between 50 Hz and the <i>lower reference frequency</i>
<i>trigger rate</i>	means 0.15 Hz per second in Tasmania and 0.05 Hz per second elsewhere.

## 1.2 Region-Dependent Frequencies

In Table 2, the *region*-dependent frequencies are provided as numerical values, as at the date of issue of this revision of the Specification. To the extent of any inconsistency between this *Specification* (including Table 2) and the *Frequency Operating Standards for the relevant region* the *Frequency Operating Standards* prevail.

**Table 2**

<b>Frequency</b>	<b>Tasmania <i>Region</i></b>	<b><i>Regions other than Tasmania</i></b>
<i>trigger range</i>	49.2 to 50.8 Hz	49.8 to 50.2 Hz
<i>raise reference frequency</i>	48.0 Hz	49.5 Hz
<i>lower reference frequency</i>	52.0 Hz	50.5 Hz
<i>operational frequency tolerance band</i>	48.0 to 52.0 Hz	49.0 to 51.0 Hz
<i>trigger rate</i>	0.15 Hz per second	0.05 Hz per second
<i>frequency ramp rate</i>	0.4Hz per second	0.125 Hz per second

### **1.3 Contracting**

Nothing in this *Specification* is intended to prevent a *Market Participant* from procuring the services of a third party to provide equipment or recordings, or to perform any other action required or contemplated by this *Specification*.

## 2 FAST RAISE SERVICE AND FAST LOWER SERVICE

### 2.1 Description of Fast Raise Service and Fast Lower Service

*Fast raise service* is the service of providing the capability to either increase *generation* or decrease *load* rapidly in response to decreases in *local frequency*. It has traditionally been provided by governing systems on *generating units* and by under-frequency load shedding.

*Fast lower service* is the service of providing the capability to either decrease *generation* or increase *load* rapidly in response to increases in *local frequency*. It has traditionally been provided by governing systems on *generating units*.

These fast services are valued by their ability to arrest a rapid change in system *frequency* within the first six seconds of a disturbance, and then provide an orderly transition to *slow raise service* or *slow lower service*.

Unless otherwise agreed with NEMMCO, a *market ancillary service offer* to provide *fast raise service* or *fast lower service* in respect of a *generating unit* or *load* that is aggregated for the purpose of *central dispatch* of energy must apply to the whole aggregated *generating unit* or *load*.

### 2.2 Amount of Fast Raise Service for Dispatch Purposes

For the purposes of a *market ancillary service offer* for dispatch, the amount of *fast raise service* in a *price band* is the lesser of:

- (a) twice the *time average* of the *raise response* between zero and six seconds from the *frequency disturbance time*, excluding any *inertial response*; and
- (b) twice the *time average* of the *raise response* between six and sixty seconds from the *frequency disturbance time*, excluding any *inertial response*,

that the person making the *market ancillary service offer* expects would be delivered at the relevant *connection point* in addition to the amounts in all cheaper *price bands* in response to a *standard frequency ramp* from 50 Hz to the *raise reference frequency* while this *price band* is enabled.

### 2.3 Amount of Fast Lower Service for Dispatch Purposes

For the purposes of a *market ancillary service offer* for dispatch, the amount of *fast lower service* in a *price band* is the lesser of:

- (a) twice the *time average* of the *lower response* between zero and six seconds from the *frequency disturbance time*, excluding any *inertial response*; and
- (b) twice the *time average* of the *lower response* between six and sixty seconds from the *frequency disturbance time*, excluding any *inertial response*,

that the person making the *market ancillary service offer* expects would be delivered at the relevant *connection point* in addition to the amounts in all cheaper *price bands* in response to a *standard frequency ramp* from 50 Hz to the *lower reference frequency* while this *price band* is enabled.

## 2.4 Control Facilities for Fast Raise Service and Fast Lower Service

For the purposes of clause 3.11.2(b) of the *Rules*:

- (a) The *ancillary services generating* unit or *ancillary service load* must have a *control system* to automatically initiate:
  - (i) a *fast raise response* when *local frequency* changes below the lower limit of the *normal operating frequency band*; or
  - (ii) a *fast lower response* when *local frequency* changes above the upper limit of the *normal operating frequency band*,in accordance with the *control system* requirements of paragraphs (b) and (c) below, whenever the respective service is *enabled*.
- (b) The *control system* for a *fast raise response* may be either a *proportional controller* or a *switching controller* and must operate so that the amount of *raise response* is either:
  - (i) for a *proportional controller*, a monotonically increasing function of the difference between 50 Hz and *local frequency* for a range of *local frequency* between the lower limit of the *operational frequency tolerance band* and the *normal operating frequency band*; or
  - (ii) for a *switching controller*, one or more step changes. if the *local frequency* falls through its *frequency setting*.
- (c) The *control system* for a *fast lower response* may be either a *proportional controller* or a *switching controller* and must operate so that the amount of *lower response* is either:
  - (i) for a *proportional controller*, a monotonically increasing function of the difference between *local frequency* and 50 Hz for a range of *local frequency* between the *normal operating frequency band* and the upper limit of the *operational frequency tolerance band* ; or
  - (ii) for a *switching controller*, one or more step changes. if the *local frequency* rises through its *frequency setting*.
- (d) The *Market Participant* must inform *NEMMCO* of the details of the *control system* described by paragraphs (a), (b) and (c) above, as reasonably required by *NEMMCO* for *central dispatch*.h or for determining *frequency settings*.
- (e) A *switching controller* for a *fast raise service* or *fast lower service* must be capable of adjustment of its *frequency setting* to any of the relevant values in Table 3 with error no greater than  $\pm 0.05$  Hz.
- (f) *NEMMCO* must allow the *Market Participant* a reasonable amount of time to change a *frequency setting*, during which time the relevant service is not disqualified if the relevant *control system* continues to use the previous corresponding *frequency setting*.

## 2.5 Measurement Facilities for Fast Raise Service and Fast Lower Service

- (a) For the purposes of clause 3.11.7(a) of the *Rules*, the equipment required to monitor and record the *raise response* in respect of a *fast raise service* or the *lower response* in respect of a *fast lower service* must have the following characteristics:

- (i) The power flow representing the *generation amount* or *load amount* must be measured at or close to the relevant *connection point* or, if otherwise agreed with NEMMCO, sufficient measurements may be provided to calculate the *generation amount* or *load amount*.
- (ii) The *local frequency* must be measured at or close to the relevant *connection point* or, if otherwise agreed with NEMMCO, an alternative measurement may be provided that closely represents the *frequency* at the *connection point*.
- (iii) Subject to clause 2.5(a)(iv), the measurements of power flow and *local frequency* must be made at intervals of 50 millisecond or less, and may be synchronised to *local frequency*.
- (iv) If agreed with NEMMCO, where a *switching controller* is used, the measurement of power flow representing the *generation amount* or *load amount* may be made at intervals of up to 4 seconds provided that another measurement of power flow at an interval of 50 milliseconds or less is provided sufficient to determine the timing of the *market ancillary service* provision relative to *local frequency*.
- (v) Measurements of power flow must have a measurement range appropriate to the *ancillary service generating unit* and *ancillary service load*, error of less than or equal to 2% of the measurement range, and resolution of less than or equal to 0.2% of the measurement range.
- (vi) Measurements of *local frequency* must have a measurement range of at least the range defined by the *operational frequency tolerance band*, error of less than or equal to 0.01 Hz, and resolution of less than or equal to 0.0025 Hz.
- (vii) The measurements must have a settling time (to 99% of final value after a step change from zero) of less than 50 milliseconds.
- (viii) The equipment must record the *frequency disturbance time* to within ten seconds.
- (ix) The equipment must initiate recording at least whenever there is a loss or gain of *load* or *generation* that has caused local frequency to change at a rate of at least the *trigger rate* and exceed the *trigger range*.
- (x) The equipment must record its power and frequency measurements for a period of at least 5 seconds before the *frequency disturbance time* and at least 60 seconds after the *frequency disturbance time*, making a total duration of at least 65 seconds.
- (xi) The recordings must be made digitally and stored in a computer file format reasonably acceptable to NEMMCO for analysis using commercial spreadsheet software.
- (xii) The recordings must be provided to NEMMCO on request (or as otherwise agreed) and retained by the Market Participant for at least twelve calendar months from the *frequency disturbance time*.

## 2.6 Verification of Fast Raise Service and Fast Lower Service

For the purpose of verifying that the amount of *fast raise service* or *fast lower service* delivered in response to a change in *local frequency*, the amount of service to be

compared with the *enabled price bands* of the relevant *market ancillary service offer* must be determined using the recordings made under clause 2.5 above as follows:

(a) Perform the following steps:

- (i) adjust each power measurement ( $P_i$  at time interval  $i$ ) for *inertial response* by adding to it an amount of:

$$IR_i = 4 \pi^2 I f_i df/dt_i$$

where  $IR_i$  is the *inertial response* at time  $t_i$ ,

$I$  is the effective moment of inertia of the *ancillary service generating unit* or *ancillary service load* as agreed between NEMMCO and the relevant *Market Participant*,

$f_i$  is the measurement of *local frequency* at time  $t_i$  corresponding to the power measurement at time  $t_i$ , and

$df/dt_i$  is the rate of change of *local frequency* at time  $t_i$  determined as:

$$df/dt_i = (2 * f_{i+2} + f_{i+1} - f_{i-1} - 2 * f_{i-2}) / (5 * t_{i+1} - 5 * t_{i-1})$$

where  $f_i$  is the measurement of *local frequency* at time  $t_i$ ,  $f_{i-1}$  and  $f_{i+1}$  are the measurements in the preceding and following samples, and  $f_{i-2}$  and  $f_{i+2}$  are the measurements in the samples preceding  $f_{i-1}$  and following  $f_{i+1}$  respectively.

- (ii) determine value FA as the average of the adjusted power measurements made during the period between four and two seconds before the *frequency disturbance time*;
- (iii) determine the basic response measurements by subtracting value FA from each adjusted power measurement after the *frequency disturbance time*;
- (iv) if the *control system* is a *proportional controller*, compensate each basic response measurement after the *frequency disturbance time* for frequency change by multiplying it by the following factor, disregarding any measurement at or after a *frequency recovery*:

$$\text{MAX}(1, \text{ABS}(50 - f_{\text{ref}}) / \text{ABS}(50 - f_{\text{local}}))$$

where  $f_{\text{local}}$  is the *local frequency* measurement coincident with the basic response measurement being compensated,

$f_{\text{ref}}$  is the relevant *raise reference frequency* or *lower reference frequency*;

MAX(x,y) means the function of the greater of x and y, and

ABS(x) means the function of the absolute value of x;

- (v) determine value FB as twice the average of the basic response measurements (after any necessary compensation) made between zero and six seconds after the *frequency disturbance time* disregarding measurements made at or after a *frequency recovery*;
- (vi) determine value FC as twice the average of the basic response measurements (after any necessary compensation) made between six and sixty seconds after the *frequency disturbance time* but disregarding measurements made at or after a *frequency recovery*.

- (b) Determine the amounts of *fast raise response* and *fast lower response* from the values of FB and FC as follows:
- (i) Round the values of FB and FC to the nearest 0.1 MW;
  - (ii) If *local frequency* was below 50 Hz at the *frequency disturbance time*, the amount of *fast raise response* is the lesser of value FB and value FC;
  - (iii) If *local frequency* was above 50 Hz at the *frequency disturbance time*, the amount of *fast lower response* is the negative of the greater of value FB and value FC; and
  - (iv) For the purposes of clause 3.6(b), value FD is value FC less value FB.
- (c) If two or more *ancillary service generating units* or *ancillary service loads* that share a common *connection point* were *enabled* for the same service at the time of the *frequency disturbance*, allocate the responses determined in paragraphs (b)(i) and (b)(ii) above to each of them in proportion to the corresponding amounts of response that they should have delivered taking into account:
- (i) the amounts for which they were *enabled*; and
  - (ii) the actual *frequency* trajectory compared with the *frequency setting* of each relevant *switching controller*.

### 3 SLOW RAISE SERVICE AND SLOW LOWER SERVICE

#### 3.1 Description of Slow Raise Service and Slow Lower Service

*Slow raise service* is the service of providing the capability to either increase *generation* or decrease *load* rapidly in response to decreases in *local frequency*. It has traditionally been provided by governing systems on *generating units*.

*Slow lower service* is the service of providing the capability to either decrease *generation* or increase *load* rapidly in response to increases in *local frequency*. It has traditionally been provided by governing systems on *generating units*.

These slow services are valued by their ability to stabilise system *frequency* within the first sixty seconds of a disturbance, and then provide an orderly transition to *delayed raise service* or *delayed lower service*.

Unless otherwise agreed with NEMMCO, a *market ancillary service offer* to provide *slow raise service* or *slow lower service* in respect of a *generating unit* or *load* that is aggregated for the purpose of *central dispatch* of energy must apply to the whole aggregated *generating unit* or *load*.

#### 3.2 Amount of Slow Raise Service for Dispatch Purposes

For the purposes of a *market ancillary service offer* for dispatch, the amount of *slow raise service* in a *price band* is the lesser of:

- (a) twice the *time average* of the *raise response* between six and sixty seconds from the *frequency disturbance time*, excluding any *inertial response*; and
- (b) twice the *time average* of the *raise response* between sixty seconds and five minutes from the *frequency disturbance time*,

that the person making the *market ancillary service offer* expects would be delivered at the relevant *connection point* in addition to the amounts in all cheaper *price bands* in response to a *standard frequency ramp* from 50 Hz to the *raise reference frequency* while this *price band* is *enabled*.

#### 3.3 Amount of Slow Lower Service for Dispatch Purposes

For the purposes of a *market ancillary service offer* for dispatch, the amount of *slow lower service* in a *price band* is the lesser of:

- (a) twice the *time average* of the *lower response* between six and sixty seconds from the *frequency disturbance time*, excluding any *inertial response*; and
- (b) twice the *time average* of the *lower response* between sixty seconds and five minutes from the *frequency disturbance time*,

that the person making the *market ancillary service offer* expects would be delivered at the relevant *connection point* in addition to the amounts in all cheaper *price bands* in response to a *standard frequency ramp* from 50 Hz to the *lower reference frequency* while this *price band* is *enabled*.

#### 3.4 Control Facilities for Slow Raise Service and Slow Lower Service

For the purposes of clause 3.11.2(b) of the *Rules*:

- (a) The *ancillary services generating* unit or *ancillary service load* must have a *control system* to automatically initiate:
- (i) a *slow raise response* when *local frequency* changes below the lower limit of the *normal operating frequency band*; or
  - (ii) a *slow lower response* when *local frequency* changes above the upper limit of the *normal operating frequency band*,
- in accordance with the *control system* requirements of paragraphs (b) and (c) below, whenever the respective service is *enabled*.
- (b) The *control system* for a *slow raise response* may be either a *proportional controller* or a *switching controller* and must operate so that the amount of *raise response* is either:
- (i) for a *proportional controller*, a monotonically increasing function of the difference between 50 Hz and *local frequency* for a range of *local frequency* between the lower limit of the *operational frequency tolerance band* and the *normal operating frequency band*; or
  - (ii) for a *switching controller*, one or more step changes. if the *local frequency* falls through its *frequency setting*.
- (c) The *control system* for a *slow lower response* may be either a *proportional controller* or a *switching controller* and must operate so that the amount of *lower response* is either:
- (i) for a *proportional controller*, a monotonically increasing function of the difference between *local frequency* and 50 Hz for a range of *local frequency* between the *normal operating frequency band* and the upper limit of the *operational frequency tolerance band* ; or
  - (ii) for a *switching controller*, one or more step.
- (d) The *Market Participant* must inform *NEMMCO* of the details of the *control system* described by paragraphs (a), (b) and (c) above, as reasonably required by *NEMMCO* for *central dispatch*. or for determining *frequency settings*.
- (e) A *switching controller* for a *slow raise service* or a *slow lower service* must be capable of adjustment of its *frequency setting* to any of the relevant values in Table 3 with error no greater than  $\pm 0.05$  Hz.
- (f) *NEMMCO* must allow the *Market Participant* a reasonable amount of time to change a *frequency setting*, during which time the relevant service is not disqualified if the relevant *control system* continues to use the corresponding previous *frequency setting*.

### 3.5 Measurement Facilities for Slow Raise Service and Slow Lower Service

- (a) For the purposes of clause 3.11.7(a) of the *Rules*, the equipment required to monitor and record the *raise response* in respect of a *slow raise service* or *lower response* in respect of a *slow lower service* must have the following characteristics:
- (i) The power flow representing the *generation amount* or *load amount* must be measured at or close to the relevant *connection point* or, if otherwise agreed with *NEMMCO*, sufficient measurements may be provided to calculate the *generation amount* or *load amount*.

- (ii) The *local frequency* must be measured at or close to the relevant *connection point* or, if otherwise agreed with NEMMCO, an alternative measurement may be provided that closely represent the *frequency* at the *connection point*.
- (iii) The measurements of power flow and *local frequency* must be made at intervals of four seconds or less.
- (iv) The measurements of power flow must have a measurement range appropriate to the *ancillary service generating unit* and *ancillary service load*, error of less than or equal to 2% of the measurement range, resolution of less than or equal to 0.2% of the measurement range.
- (v) The measurements of *local frequency* must have a measurement range of at least the range defined by the *operational frequency tolerance band*, error of less than or equal to 0.02 Hz, and resolution of less than or equal to 0.01 Hz.
- (vi) Any analogue measurements prior to sampling must have a settling time (to 99% of final value) of less than 4 second.
- (vii) The equipment must record the *frequency disturbance time* to within ten seconds.
- (viii) The equipment must initiate recording at least whenever there is a loss or gain of *load* or *generation* that has caused local frequency to change at a rate of at least the *trigger rate* and exceed the *trigger range*.
- (ix) The equipment must record its power and frequency measurements for a period of at least 20 seconds before the *frequency disturbance time* and 5 minutes after the *frequency disturbance time*.
- (x) The recordings must be made digitally and stored in a computer file format reasonably acceptable to NEMMCO for analysis using commercial spreadsheet software.
- (xi) The recordings must be provided to NEMMCO on request (or as otherwise agreed) and retained by the Market Participant for at least twelve calendar months from the *frequency disturbance time*.

### 3.6 Verification of Slow Raise Service and Slow Lower Service

For the purpose of verifying that the amount of *slow raise service* or *slow lower service* delivered in response to a change in *local frequency*, the amount of service to be compared with the *enabled price bands* of the relevant *market ancillary service offer* must be determined using the recordings made under clause 3.5 above as follows:

- (a) Perform the following steps:
  - (i) if the measurements conform to the requirements of clause 2.5(a)(iii), adjust each power measurement made until 60 seconds after the *frequency disturbance time* in accordance with the procedure given in clause 2.6(a)(i);
  - (ii) determine value SA as the average of the adjusted power measurements made during the period between twenty seconds and eight seconds before the *frequency disturbance time*;

- (iii) determine the basic response measurements by subtracting value SA from each power measurement (as adjusted) after the *frequency disturbance time*;
  - (iv) if the *control system* is a *proportional controller*, compensate each basic response measurement for frequency change by multiplying it by the following factor, disregarding measurements made at or after a *frequency recovery*:
    - $MAX(1, ABS(50 - f_{ref})/ABS(50 - f_{local}))$
    - where  $f_{local}$  is the *local frequency* measurement coincident with the basic response measurement being compensated,
    - $f_{ref}$  is the relevant *raise reference frequency* or *lower reference frequency*;
    - MAX(x,y) means the function of the greater of x and y, and
    - ABS(x) means the function of the absolute value of x;
  - (v) determine value SB as twice the average of the basic response measurements (after any necessary compensation) made between six and sixty seconds after the *frequency disturbance time* disregarding measurements made at or after a *frequency recovery*;
  - (vi) determine value SC as twice the average of the basic response measurements (after any necessary compensation) made between sixty seconds and five minutes after the *frequency disturbance time* disregarding measurements made at or after a *frequency recovery* or after a *service cancellation*.
- (b) Determine the amounts of *slow raise response* and *slow lower response* from the values of SB and SC as follows:
- (i) Round the values of SB and SC to the nearest 0.1 MW;
  - (ii) If *local frequency* was below 50 Hz at the *frequency disturbance time*, determine the amount of *slow raise response* as the lesser of value SC and:
    - A if the *ancillary service generating unit* or *ancillary service load* was not enabled for a *fast raise service*, value SB; and
    - B otherwise, the greater of zero and value FD determined under clause 2.6(b)(iv);
  - (iii) If *local frequency* was above 50 Hz at the *frequency disturbance time*, determine the amount of *slow lower response* as the negative of the greater of value SC and:
    - A if the *ancillary service generating unit* or *ancillary service load* was not enabled for a *fast lower service*, value SB; and
    - B otherwise, the lesser of zero and value FD determined under clause 2.6(b)(iv); and
  - (iv) For the purposes of clause 4.6(b), value SE is value SC less:
    - A if the *ancillary service generating unit* or *ancillary service load* was not enabled for the corresponding *fast raise service* or *fast lower service*, value SB; and
    - B otherwise, value FD determined under clause 2.6(b)(iv).

- (c) If two or more *ancillary service generating units* or *ancillary service loads* that share a common *connection point* were *enabled* for the same service at the time of the *frequency disturbance*, allocate the responses determined in paragraphs (b)(i) and (b)(ii) above to each of them in proportion to the corresponding amounts of response that they should have delivered taking into account:
- (i) the amounts for which they were *enabled*; and
  - (ii) the actual *frequency* trajectory compared with the *frequency setting* of each relevant *switching controller*.

## 4 DELAYED RAISE SERVICE AND DELAYED LOWER SERVICE

### 4.1 Description of Delayed Raise Service and Delayed Lower Service

*Delayed raise service* is the service of providing the capability to either increase *generation* or decrease *load* rapidly in response to decreases in *local frequency*. It has traditionally been provided by manual load shedding and starting up hydroelectric *generating units*.

*Delayed lower service* is the service of providing the capability to either decrease *generation* or increase *load* rapidly in response to increases in *local frequency*. It has traditionally been provided by reducing the output of *generating units*.

These delayed services are valued by their ability to restore system *frequency* to 50 Hz within the first five minutes of a disturbance, and to sustain their response until *central dispatch* can take the generation requirement into account.

Unless otherwise agreed with NEMMCO, a *market ancillary service offer* to provide *delayed raise service* or *delayed lower service* in respect of a *generating unit* or *load* that is aggregated for the purpose of *central dispatch* of energy must apply to the whole aggregated *generating unit* or *load*.

### 4.2 Amount of Delayed Raise Service for Dispatch Purposes

For the purposes of a *market ancillary service offer* for dispatch, the amount of *delayed raise service* in a *price band* is the lesser of:

- (a) twice the *time average* of the *raise response* between one and five minutes from the *frequency disturbance time*; and
- (b) the *time average* of the *raise response* between five and fifteen minutes from the *frequency disturbance time*,

that the person making the *market ancillary service offer* expects would be delivered at the relevant *connection point* in addition to the amounts in all cheaper *price bands* in response to a *standard frequency ramp* from 50 Hz to the *raise reference frequency* while this *price band* is *enabled*.

### 4.3 Amount of Delayed Lower Service for Dispatch Purposes

For the purposes of a *market ancillary service offer* for dispatch, the amount of *delayed lower service* in a *price band* is the lesser of:

- (a) twice the *time average* of the *lower response* between one and five minutes from the *frequency disturbance time*; and
- (b) the *time average* of the *lower response* between five and fifteen minutes from the *frequency disturbance time*,

that the person making the *market ancillary service offer* expects would be delivered at the relevant *connection point* in addition to the amounts in all cheaper *price bands* in response to a *standard frequency ramp* from 50 Hz to the *lower reference frequency* while this *price band* is *enabled*.

#### 4.4 Control Facilities Required for Delayed Raise Service and Delayed Lower Service

For the purposes of clause 3.11.2(b) of the *Rules*:

- (a) The *ancillary services generating unit* or *ancillary service load* must have a *switching controller* to automatically or manually initiate a *raise response* or a *lower response* in accordance with the requirements of paragraphs (b) and (c) below, whenever the respective service is *enabled*.
- (b) The *switching controller* for a *delayed raise response* must operate so that the *enabled* amount of *raise response* is delivered if the *local frequency* falls through an initiating *frequency setting* between the *raise reference frequency* and the lower range of the *normal operating frequency excursion band*.
- (c) The *switching controller* for a *delayed lower response* must operate so that the *enabled* amount of *lower response* is delivered if the *local frequency* rises through an initiating *frequency setting* between the upper range of the *normal operating frequency excursion band* and the *lower reference frequency*.
- (d) The *Market Participant* must inform *NEMMCO* of the details of the *control system* described by paragraphs (a), (b) and (c) above, as reasonably required by *NEMMCO* for *central dispatch* or for determining *frequency settings*.
- (e) A *switching controller* for a *delayed raise service* or *delayed lower service* must be capable of adjustment of its *frequency setting* to any of the relevant values in Table 3 with error no greater than  $\pm 0.05$  Hz.
- (f) *NEMMCO* must allow the *Market Participant* a reasonable amount of time to change a *frequency setting*, during which time the relevant service is not disqualified if the relevant *control system* continues to use the previous corresponding *frequency setting*.

#### 4.5 Measurement Facilities Required for Delayed Raise Service and Delayed Lower Service

- (a) For the purposes of clause 3.11.7(a) of the *Rules*, the equipment required to monitor and record the *raise response* in respect of a *delayed raise service* or *lower response* in respect of a *delayed lower service* must have the following characteristics:
  - (i) The power flow representing the *generation amount* or *load amount* must be measured at or close to the relevant *connection point* or, if otherwise agreed with *NEMMCO*, sufficient measurements may be provided to calculate the *generation amount* or *load amount*.
  - (ii) The *local frequency* must be measured at or close to the relevant *connection point* or, if otherwise agreed with *NEMMCO*, an alternative measurement may be provided that closely represent the *frequency* at the *connection point*.
  - (iii) The measurements of power flow and *local frequency* must be made at intervals of four seconds or less.
  - (iv) The measurements of power flow must have a measurement range appropriate to the *ancillary service generating unit* and *ancillary service load*, error of less than or equal to 2% of the measurement

range, and resolution of less than or equal to 0.2% of the measurement range.

- (v) The measurements of *local frequency* must have a measurement range of at least the range defined by the *operational frequency tolerance band*, error of less than or equal to 0.02 Hz, and resolution of less than or equal to 0.01 Hz.
- (vi) The equipment must record the *frequency disturbance time* to within ten seconds.
- (vii) The equipment must initiate recording at least whenever there is a loss or gain of *load* or *generation* that has caused local frequency to change at a rate of at least the *trigger rate* and exceed the *trigger range*.
- (viii) The equipment must record its power and frequency measurements for a period of at least 20 seconds before the *frequency disturbance time* and 15 minutes after the *frequency disturbance time*.
- (ix) The recordings must be made digitally and stored in a computer file format reasonably acceptable to NEMMCO for analysis using commercial spreadsheet software.
- (x) The recordings must be provided to NEMMCO on request (or as otherwise agreed) and retained by the Market Participant for at least twelve calendar months from the *frequency disturbance time*.

#### 4.6 Verification of Delayed Raise Service and Delayed Lower Service

For the purpose of verifying that the amount of *delayed raise service* or *delayed lower service* delivered in response to a change in *local frequency*, the amount of service to be compared with the *enabled price bands* of the relevant *market ancillary service offer* must be determined using the recordings made under clause 4.5 above as follows:

- (a) Perform the following steps:
  - (i) determine value DA as the average of the power measurements made during the period between twenty and eight seconds before the *frequency disturbance time*;
  - (ii) determine the basic response measurements by subtracting value DA from each power measurement after the *frequency disturbance time*;
  - (iii) determine value DB as twice the average of the basic response measurements (after any necessary compensation) made between one and five minutes after the *frequency disturbance time* disregarding measurements made at or after a *frequency recovery* or after *service cancellation*;
  - (iv) determine value DC as the average of the basic response measurements made between five and fifteen minutes after the *frequency disturbance time* disregarding measurements made at or after a *frequency recovery* or after *service cancellation*.
- (b) Determine the amounts of *delayed raise response* and *delayed lower response* from the values of DB and DC as follows:
  - (i) Round the values of DB and DC to the nearest 0.1 MW;

- (ii) If *local frequency* was below 50 Hz at the *frequency disturbance time*, determine the amount of *delayed raise response* as the lesser of value DC and:
  - A if the *ancillary service generating unit* or *ancillary service load* was not enabled for a *slow raise service*, value DB; and
  - B otherwise, the greater of zero and value SE determined under clause 3.6(b)(iv);
- (iii) If *local frequency* was above 50 Hz at the *frequency disturbance time*, determine the amount of *delayed lower response* as the negative of the greater of value DC and:
  - A if the *ancillary service generating unit* or *ancillary service load* was not enabled for a *slow lower service*, value DB; and
  - B otherwise, the lesser of zero and value SE determined under clause 3.6(b)(iv).
- (c) If two or more *ancillary service generating units* or *ancillary service loads* that share a common *connection point* were *enabled* for the same service at the time of the *frequency disturbance*, allocate the responses determined in paragraphs (b)(i) and (b)(ii) above to each of them in proportion to the corresponding amounts of response that they should have delivered taking into account:
  - (i) the amounts for which they were *enabled*; and
  - (ii) the actual *frequency* trajectory compared with the *frequency setting* of each relevant *switching controller*.

## 5 REGULATING RAISE SERVICE AND REGULATING LOWER SERVICE

### 5.1 Description of Regulating Raise Service and Regulating Lower Service

*Regulating raise service* is the service of either increasing *generation* or decreasing *load* in response to electronic *raise signals* from NEMMCO. It has traditionally been provided by load controllers on *generating units*.

*Regulating lower service* is the service of either decreasing *generation* or increasing *load* in response to electronic *lower signals* from NEMMCO. It has traditionally been provided by load controllers on *generating units*.

These regulating services are valued by their ability to control system *frequency* in response to variations of system demand within a *dispatch interval*.

A *market ancillary service offer* to provide *regulating raise service* or *regulating lower service* in respect of a *generating unit* or *load* that is aggregated for the purpose of *central dispatch* of energy must apply to the whole aggregated *generating unit* or *load*.

### 5.2 Amount of Regulating Raise Service for Dispatch Purposes

For the purposes of a *market ancillary service offer* for dispatch, the amount of *regulating raise service* in a *price band* is the amount of *regulating raise response* that that the person making the *market ancillary service offer* expects would be delivered:

- (a) at the relevant *connection point*;
- (b) progressively over a five minute period;
- (c) in addition to the amounts in all cheaper *price bands*; and
- (d) in response to *raise signals* sent to request the maximum possible *regulating raise response* while this *price band* is *enabled*.

### 5.3 Amount of Regulating Lower Service for Dispatch Purposes

For the purposes of a *market ancillary service offer* for dispatch, the amount of *regulating lower service* in a *price band* is the amount of *regulating lower response* that the person making the *market ancillary service offer* expects would be delivered:

- (a) at the relevant *connection point*;
- (b) progressively over a five minute period;
- (c) in addition to the amounts in all cheaper *price bands*; and
- (d) in response to *lower signals* sent to request the maximum possible *regulating lower response* while this *price band* is *enabled*.

### 5.4 Control Facilities Required for Regulating Raise Service and Regulating Lower Service

For the purposes of clause 3.11.2(b) of the *Rules*, the *ancillary services generating unit* or *ancillary service load* must have a *control system* to:

- (a) transmit values of the *controlled quantity*, *raise control limit*, *lower control limit*, *raise rate limit* and, if different from the *raise rate limit*, the *lower rate limit* every four seconds;
- (b) receive *raise signals* and *lower signals*;
- (c) when *enabled* for the respective service, automatically deliver a *regulating raise response* or a *regulating lower response* corresponding to those *raise signals* or *lower signals*; and
- (d) not suspend the service for more than 60 seconds during a *frequency disturbance*, and only if *local frequency* has exceeded the *raise reference frequency* or *lower reference frequency*.

A control system for *regulating raise service* or *regulating lower service* in respect of a *generating unit* or *load* that is aggregated for the purpose of *central dispatch* of energy must only apply to the whole aggregated *generating unit* or *load*.

## 5.5 Measurement Facilities Required for Regulating Raise Service and Regulating Lower Service

- (a) For the purposes of clause 3.11.7(a) of the *Rules*, the equipment required to monitor and record the *regulating raise response* in respect of a *regulating raise service*, or *regulating lower response* in respect of a *regulating lower service* must have the following characteristics:
  - (i) The power flow representing the *generation amount* or *load amount* must be measured at or close to the relevant *connection point* or, if otherwise agreed with NEMMCO, sufficient measurements may be provided to calculate the *generation amount* or *load amount*.
  - (ii) The measurements of power flow must be made at intervals of four seconds or less.
  - (iii) The measurements of power flow must have a measurement range appropriate to the *ancillary service generating unit* and *ancillary service load*, error of less than or equal to 2% of the measurement range, and resolution of less than or equal to 0.2% of the measurement range.
  - (iv) The recordings must be made digitally and stored in a computer file format reasonably acceptable to NEMMCO for analysis using commercial spreadsheet software.
  - (v) The recordings must be provided to NEMMCO on request (or as otherwise agreed) and retained by the Market Participant for at least six calendar months.

## 5.6 Verification of Regulating Raise Service and Regulating Lower Service

For the purpose of verifying that the amount of *regulating raise service* or *regulating lower service* delivered in response to a *raise signal* or a *lower signal*, the amount of service to be compared with the *enabled price bands* of the relevant *market ancillary service offer* must be determined using the recordings made under clause 5.5 above as follows:

- (a) If NEMMCO or the Market Participant wishes to verify performance, NEMMCO must:

- (i) transmit no *raise signals* or *lower signals* to the relevant *ancillary service generating unit* or *ancillary service load* for a period of at least sixty seconds; and then immediately
  - (ii) transmit *raise signals* or *lower signals* to the relevant *ancillary service generating unit* or *ancillary service load* that would produce either a *regulating raise response* or *regulating lower response* equal to the lesser of the sum of the *enabled price bands* of the relevant *market ancillary services offer* and the corresponding *raise rate limit* or *lower rate limit*, lasting for at least five minutes and such that the *controlled quantity* remains at all times between the *raise control limit* and the *lower control limit*.
- (b) The following procedure must be used:
- (i) fit a linear function of time (of the form  $P = P1 + R1 * t$ ) to the power measurements made during the sixty seconds to which paragraph (a)(i) refers;
  - (ii) fit a linear function of time (of the form  $P = P2 + R2 * t$ ) to the earliest power measurements made over the following five minutes that are all greater than (for *regulating raise response*) or less than (for *regulating lower response*) the function to which paragraph (b)(i) refers; and
  - (iii) determine the *regulating raise response* or *regulating lower response* as the slope of the function to which paragraph (b)(ii) refers (in MW per minute) multiplied by five minutes.

## 6 COMMON PROCEDURES

### 6.1 Enablement

The provider of a *market ancillary service* must promptly operate its equipment to deliver the relevant service as soon as reasonably practicable following enablement of it by NEMMCO, without regard to *dispatch interval* boundaries.

### 6.2 Procedure for allocation of frequency settings

- (a) NEMMCO must apply the following procedure to allocate *frequency settings* to particular *ancillary service generating units* and *ancillary service loads* for each *market ancillary service* other than *regulating raise service* and *regulating lower service*, separately for *Tasmania region* and for all other *regions* combined:
- (i) Establish a list of *ancillary service generating units* and *ancillary service loads* that require *frequency settings*, taking account of any information provided under clause 2.4(d), 3.4(d) or 4.4(d).
  - (ii) If a particular *ancillary service generating unit* or *ancillary service load* is represented in the list for *fast raise service* or *fast lower service*, then remove it from each list for the corresponding slow service or delayed service in which it appears.
  - (iii) If a particular *ancillary service generating unit* or *ancillary service load* is represented in the list for *slow raise service* or *slow lower service*, then remove it from each list for the corresponding delayed service in which it appears.
  - (iv) Determine the *response capability* for each *ancillary service generating unit* and *ancillary service load* in the list.
  - (v) Sort the list in descending order of *response capability* with entries having the same *response capability* sorted in ascending order of identifier given to the *ancillary service generating unit* or *ancillary service load* by NEMMCO for *central dispatch* purposes.
  - (vi) If any information provided under clause 2.4(d), 3.4(d) or 4.4(d) indicates that two or more *ancillary service generating units* or *ancillary service loads* in a list share *frequency comparison equipment* such that they cannot use separate *frequency settings*, combine their entries in the list.
  - (vii) If there are more *ancillary service generating units* and *ancillary service loads* in the list than available setting values (see Table 3), apply the following procedure repeatedly until the numbers of each are equal:
    - A combine the two lowest ranked entries on the list, being those having the smallest *response capability*; and
    - B re-sort the list in the manner described in paragraph (v) above).
  - (viii) For the purpose of paragraphs (vi), (vii) and (ix):
    - A the *response capability* of a combination of entries is the sum of the *response capabilities* of the entries being combined;

- B the identifier of a combination of entries is the identifier of the higher ranked of the entries being combined; and
  - C an entry applies to each of the *ancillary service generating units* and *ancillary service loads* to which the entries being combined applied.
- (ix) Allocate each setting in the relevant column of Table 3 to the correspondingly ranked entry of the list and then to each *ancillary service generating unit* or *ancillary service load* to which the entry applies, such that the first setting in the table (shown as level 1) is allocated to the entry with the largest *response capability*.
  - (x) A *frequency setting* allocated to an *ancillary service generating unit* or *ancillary service load* for any raise service applies to all of its raise services that use a *switching controller*, and a *frequency setting* allocated to an *ancillary service generating unit* or *ancillary service load* for any lower service applies to all of its lower services that use a *switching controller*.
  - (xi) The relevant column of Table 3 is the one that applies to the relevant service and to the *region* in which the *ancillary service generating unit* or *ancillary service load* is located.
- (b) NEMMCO must not request a change to an existing *frequency setting* unless:
    - (i) the procedure for determining *frequency settings*, as shown in paragraph (a) above has been amended; or
    - (ii) an *ancillary service generating unit* or *ancillary service load* that uses a *switching controller* to provide the service has been registered or deregistered or its registration has materially changed since the last change to existing settings; or
    - (iii) at least six months has elapsed since settings were changed and one or more *ancillary service generating units* or *ancillary service loads* has changed its *response capability*; or
    - (iv) a *frequency disturbance* has occurred that involved loss of *load* or *generation* and NEMMCO has determined that the relevant setting was not adequate under that circumstance.
  - (c) Until an *ancillary service generating unit* or *ancillary service load* that uses a *switching controller* to provide the service is allocated a *frequency setting* under clause 6.2(a), the *Market Participant* may apply the relevant *frequency setting* shown in Table 3 corresponding to level 3 if the *ancillary service generating unit* or *ancillary service load* is in the Tasmania *region* and level 4 otherwise.

**Table 3**

<b>Column 1</b>	<b>Column 2</b>	<b>Column 3</b>	<b>Column 4</b>	<b>Column 5</b>
	<i>Regions other than Tasmania</i>	<i>Regions other than Tasmania</i>	<b>Tasmania region</b>	<b>Tasmania region</b>
<b>Level</b>	<b>Raise service frequency setting (Hz)</b>	<b>Lower service frequency setting (Hz)</b>	<b>Raise service frequency setting (Hz)</b>	<b>Lower service frequency setting (Hz)</b>
1	49.75	50.25	49.5	50.5
2	49.7	50.3	49.25	50.75
3	49.65	50.35	49.0	51.0
4	49.6	50.4	48.75	51.25
5	49.55	50.45	48.5	51.5

Note: the shaded areas apply as the defaults under clause 6.2 (c).