



National Electricity Market
Management Company Limited
ABN 94 072 010 327

Market Ancillary Service Specification

*Prepared by: System Operations Planning and
Performance*

Version No: 2.0

5 May 2009

Effective Date:

This amended *market ancillary service specification*
(version 2.0) will take effect on the later date of:

- (a) 5 June 2009, being the date 30 days after the amended *market ancillary service specification* is published, and
- (b) the date that the revised Tasmanian *frequency operating standards* take effect in accordance with the AEMC Reliability Panel's final report dated 18 December 2008.

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

Word of Phrase	Meaning
<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: (a) controlled by the action of <i>raise signals</i> and <i>lower signals</i> ; (b) measured and transmitted to <i>NEMMCO's</i> control centre; and (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>
<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

Word of Phrase	Meaning
<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>

Word of Phrase	Meaning
<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 Rules
<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>

Word of Phrase	Meaning
<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 this revision of the Specification becomes effective. 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

Frequency	Tasmania <i>Region</i>	<i>Regions other than Tasmania</i>
<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>	0.4 Hz 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* 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 ± 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_{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 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 ± 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*:

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

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 ± 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

Column 1	Column 2	Column 3	Column 4	Column 5
	<i>Regions other than Tasmania</i>	<i>Regions other than Tasmania</i>	Tasmania region	Tasmania region
Level	Raise service frequency setting (Hz)	Lower service frequency setting (Hz)	Raise service frequency setting (Hz)	Lower service frequency setting (Hz)
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).