

DISPATCH

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CURRENT VERSION RELEASE DETAILS

Version	Effective Date	Summary of Changes
87.0	31 March 2021	<p>Updates to reflect semi-scheduled generator dispatch obligations rule change. Conversion to new template and general drafting review.</p> <p>Minor updates:</p> <ul style="list-style-type: none">• Replace “compliance” with “conformance” when referring to AEMO’s process• Use consistent terminology for dispatch target, semi-dispatch cap and semi-dispatch cap flag• Updates for rule changes on intervention pricing and mandatory restrictions• Remove Appendix C, merge into section 2.4• Updates to section 2.2 to clarify the issue of dispatch instructions via AGC

Note: There is a version history at the end of this document.

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1. INTRODUCTION

1.1. Purpose and scope

These are the *power system operating procedures* made in accordance with clause 4.10 of the National Electricity Rules (NER).

These Procedures have effect only for the purposes set out in the NER. The NER and the National Electricity Law prevail over these Procedures to the extent of any inconsistency.

1.2. Purpose

The purpose of Procedure is to provide instructions and guidelines covering *market* operations in relation to the operation of the *power system*.

1.3. Application

This Procedure applies to *AEMO* and all *Registered Participants*

1.4. Definitions and interpretation

1.4.1. Glossary

Terms defined in the National Electricity Law and the NER have the same meanings in these Procedures unless otherwise specified in this clause.

Terms defined in the NER are intended to be identified in these Procedures by italicising them, but failure to italicise a defined term does not affect its meaning.

The words, phrases and abbreviations in the table below have the meanings set out opposite them when used in these Procedures.

Table 1 Glossary

Term	Definition
AEMC	Australian Energy Market Commission
AGC	Automatic Generation Control
ASEFS	Australian Solar Energy Forecasting System
AWEFS	Australian Wind Energy Forecasting System
Dispatch Target	The <i>active power</i> outcome specified in a <i>dispatch instruction</i> , which represents the level to be achieved at the end of the relevant <i>dispatch interval</i> . For <i>semi-scheduled generating units</i> , this is the same as the <i>dispatch level</i> .
EMMS	Electricity Market Management System
FCAS	Frequency Control Ancillary Service
LHS	Left Hand Side (of a <i>constraint</i> equation)
Local Limit	For an <i>intermittent generating unit</i> , the lower of its <i>plant availability</i> and all technical limits on the capacity of its connection assets to export energy, in accordance with its <i>energy conversion model</i> .
MPC	<i>Market Price Cap</i>
NEMDE	National Electricity Market Dispatch Engine, used in the <i>central dispatch</i> process
NER	National Electricity Rules
NSP	<i>Network Service Provider</i>

Term	Definition
RHS	Right Hand Side (of a <i>constraint</i> equation)
RTU	Remote Terminal Equipment
SCADA	Supervisory Control and Data Acquisition
Semi-dispatch cap	The Dispatch Target for a <i>semi-scheduled generating unit</i> when its semi-dispatch cap flag is set to 'TRUE'
Semi-dispatch cap flag	A flag in a <i>dispatch instruction</i> indicating whether the relevant interval is a <i>semi-dispatch interval</i> .
UIGF	<i>Unconstrained intermittent generation forecast</i>

1.4.2. Interpretation

These Procedures are subject to the principles of interpretation set out in Schedule 2 of the National Electricity Law.

1.5. Related documents

Table 2 Related policies and procedures

Reference	Title	Location
SO_OP_3707	Intervention, Direction and Clause 4.8.9 Instructions	AEMO website
SO_OP_3708	Non Market Ancillary Services	AEMO website
SO_OP_3710	Load Forecasting	AEMO website
	Over-Constrained Dispatch Rerun Process	AEMO website
	Constraint Implementation Guidelines	AEMO website
	Constraint Formulation Guidelines	AEMO website
	Intervention Pricing Methodology	AEMO website

2. DISPATCH INSTRUCTIONS

2.1. Content of dispatch instructions

- (a) A *dispatch instruction* to produce, consume or transfer *active power* includes:
 - (i) for a *scheduled generating unit*, a *semi-scheduled generating unit*, a *scheduled network service* or a *scheduled load*, a Dispatch Target; and
 - (ii) for a *semi-scheduled generating unit*, a semi-dispatch cap flag.
- (b) Dispatch Targets for all *scheduled generating units*, *semi-scheduled generating units*, *scheduled network services* and *scheduled loads* are determined by NEMDE after co-optimising the *energy market* with the FCAS markets.
- (c) *Generating units* with bid *dispatch inflexibility profiles* will also receive a commitment *dispatch instruction* to start, synchronise and follow their *dispatch inflexibility profile*.

2.2. Issue of dispatch instructions

- (a) *Dispatch instructions* will be issued electronically via the AEMO Electricity Market Management System (EMMS) interfaces.
- (b) Where possible, *dispatch instructions* for *generating units* will also be issued electronically via the *automatic generation control system (AGC)*. A *generating unit* providing *regulation services* must be set up to receive and respond to *dispatch instructions* issued via the AGC. For a *generating unit* not providing *regulation services*, it is the responsibility of the *Generator* to notify *AEMO* whether they wish to be set up to receive *dispatch instructions* via the AGC.
- (c) A *generating unit* will not be issued *dispatch instructions* via AGC unless the unit indicates via SCADA that its AGC is available for remote control and *AEMO* selects the unit to remote AGC.
- (d) *AEMO* may issue *dispatch instructions* in some other form if in its reasonable opinion the normal processes are not available.

2.3. Automatic Generation Control

The AGC serves two purposes in the NEM. They are:

- (a) *Energy market dispatch of generating units* which are on remote control:
Dispatch results from the NEMDE run are ramped into the AGC (to prevent any large step change in megawatt output). In general any *generating unit* not *dispatched* for regulation FCAS will be ramped to its *energy Dispatch Target*.
- (b) *Regulating FCAS dispatch*:
 Actual *frequency* and time error values are compared to the desired frequency and time error to calculate the Area Control Error (ACE). This value is then used by the AGC to determine the desired megawatt outputs of *generating units dispatched* for regulation FCAS.

2.4. Semi-Scheduled Generating Units

- (a) *Semi-scheduled generating units* will generally be *intermittent* generation (typically, wind and solar farms) greater than 30 MW.
- (b) The *central dispatch* process determines the *dispatch* of *semi-scheduled generating units* in a similar manner to *scheduled generating units*, on the basis of bid *price bands* and availability. However, for *semi-scheduled generating units* the availability information is in the form of *unconstrained intermittent generation forecasts* provided either by *AEMO's* AWEFS/ASEFS or by the participant. SCADA is a primary input to the production of AWEFS/ASEFS dispatch forecasts and the *Generator* must rectify failed SCADA as soon as possible¹.
- (c) The *central dispatch* process determines for each *semi-scheduled generating unit* both a Dispatch Target and an associated semi-dispatch cap flag, and electronically issues these confidentially in a *dispatch instruction* to the relevant *Semi-Scheduled Generator*.
- (d) The *dispatch instruction* for a *semi-scheduled generating unit* requires that unit's *active power* output to be capped at the Dispatch Target value set by *AEMO* only when its semi-dispatch cap flag is set to 'TRUE'. This value is called its "semi-dispatch cap". Otherwise, if its

¹ Further information and resources for *Semi-Scheduled Generators* on forecasting and dispatch requirements, SCADA signals, etc. can be found at: <https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/operational-forecasting/solar-and-wind-energy-forecasting>

semi-dispatch cap flag is set to 'FALSE' the unit's *active power* output may only deviate from its Dispatch Target due to energy source availability, physical capability or when providing frequency response.

- (e) The semi-dispatch cap flag is set to 'TRUE' for a *semi-scheduled generating unit* when either one of the following conditions is satisfied for a *dispatch interval* (called a *semi-dispatch interval*):
- (i) The Dispatch Target is limited by Binding or Violated Network or FCAS Constraint:
The generating unit's forecast output (its UIGF) is explicitly limited by any binding or violated *network constraint* or *ancillary service constraint* equation, and if the actual output were to exceed the value of the semi-dispatch cap, this would result in violating (or further violating) that constraint equation; or
 - (ii) The Dispatch Target is otherwise below the UIGF:
The *generating unit's* forecast output (its UIGF) is not explicitly limited by a binding or violated *network constraint* or *ancillary service constraint* equation, but is limited as a result of either a purely inter-regional limitation, or an offer or market-related limitation, the latter including:
 - (A) Unit Ramp Rate
 - (B) Unit Fixed Loading Level
 - (C) Non-dispatch of uneconomic price bands
 - (D) Marginal dispatch of economic price bands.
- (f) For all other *dispatch intervals* where neither of the above conditions is met for a particular *semi-scheduled generating unit*, its semi-dispatch cap flag is set to 'FALSE' for that *dispatch interval* (called a *non semi-dispatch interval*).

2.5. Dispatch of Non-Market Ancillary Services

Refer to SO_OP_3708 Non-Market Ancillary Services.

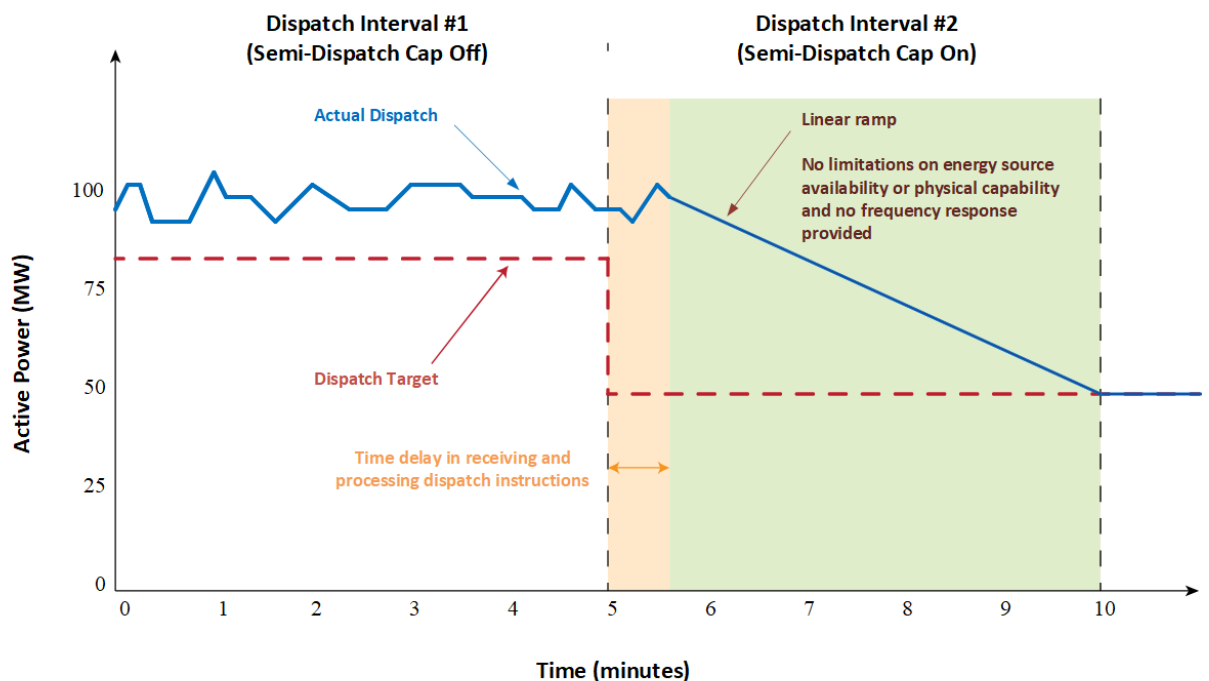
2.6. Ramp rates in energy dispatch instructions

- (a) As part of a *dispatch instruction* for energy, NER 4.9.5(a)(3) requires AEMO to specify a *ramp rate* or a specific target time for a *generating unit* to reach an applicable outcome (being the target *active power*) specified in the *dispatch instruction*. This section makes provision for this requirement, which extends to *scheduled loads* subject to capability. Note that NEMDE already accounts for the maximum and minimum *ramp rate* requirements (described in section 9) when it produces a Dispatch Target.
- (b) Absent a *ramp rate* provided directly in a *dispatch instruction*:
- (i) *scheduled generating units*;
 - (ii) *scheduled loads*; and
 - (iii) during *semi-dispatch intervals* or when constrained by a Local Limit, *semi-scheduled generating units*,
- must linearly ramp their *active power* across the *dispatch interval* in a uniform way, from their initial *active power* at the time of receiving the *dispatch instruction* to the Dispatch Target at the end of the 5-minute *dispatch interval*, subject to:
- (iv) energy source availability (for *semi-scheduled generating units*);

- (v) physical limitations of the *facility*;
 - (vi) technical capabilities of the *facility*, which must, as a minimum, be consistent with its applicable *performance standards*; and
 - (vii) provision of frequency response in accordance with the NER or the *market ancillary service specification* (as applicable),
- (c) Outside of *semi-dispatch intervals* or intervals where they are constrained by a Local Limit, *semi-scheduled generating units* must either linearly ramp to their Dispatch Target or generate in accordance with their energy source availability (subject to paragraphs (b)(v), (b)(vi) and (b)(vii) above).

Figure 1 below shows the expected *dispatch* for a *semi-scheduled generating unit* assuming no limiting factors.

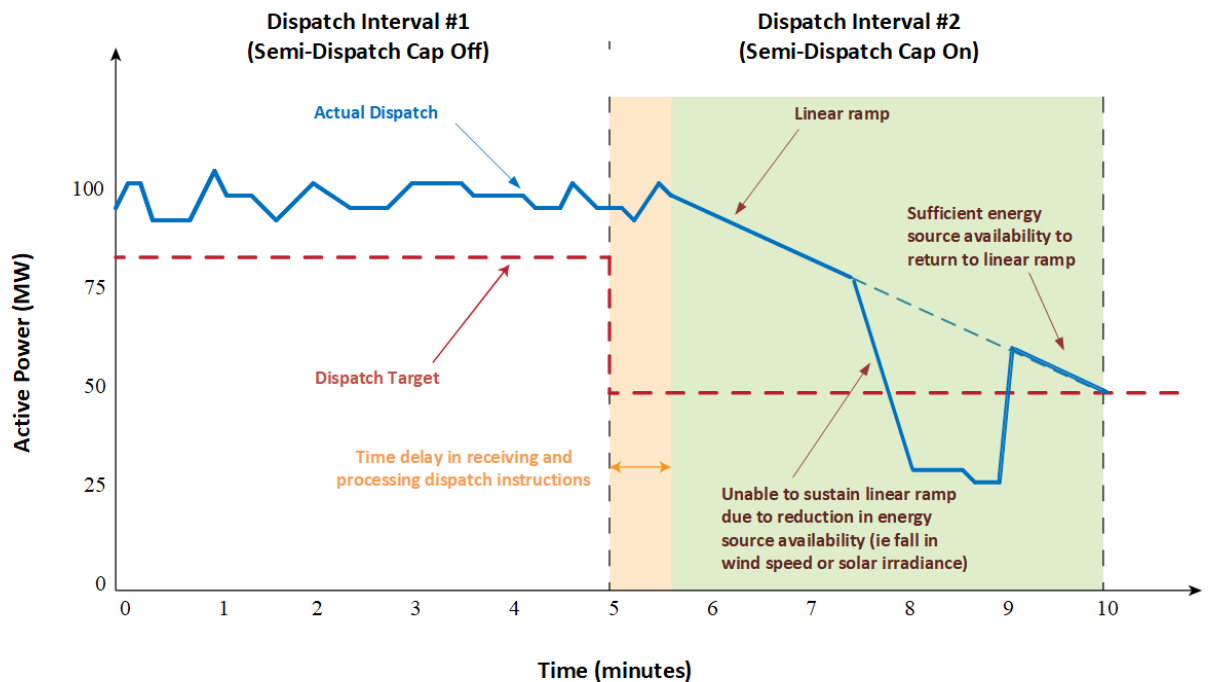
Figure 1 Semi-scheduled generating unit linear ramping with no limiting factors



Note that for Dispatch Interval #1, the *semi-scheduled generating unit* is deviating from the red dashed "Dispatch Target" line (being a straight line between two successive Dispatch Targets) due to variations in its available energy source (shown as "Actual Dispatch").

Figure 2 shows the expected *dispatch* for a *semi-scheduled generating unit* that cannot sustain its linear ramp due to a reduction in energy available.

Figure 2 Semi-scheduled generating unit cannot sustain linear ramp due to reduction in energy available



Note that for Dispatch Interval #2, where a drop in energy source availability causes the the *semi-scheduled generating unit* to fall below the linear ramp line, it must generate at its maximum output level (subject to paragraphs (b) (v), (b)(vi) and (b)(vii) above) in order to meet its dispatch requirements.

3. NON-CONFORMANCE WITH DISPATCH TARGETS

3.1. Principles of Conformance Monitoring

Conformance Monitoring is a process that AEMO applies to *scheduled generating units*, *semi-scheduled generating units*, *scheduled loads* and *scheduled network services* services using the AEMO Conformance Module. The aim of the process is to identify and implement corrective measures if a *Market Participant* fails to follow a *dispatch instruction*.

The AEMO Conformance Module automatically flags non-responsive *scheduled generating units*, *semi-scheduled generating units*, *scheduled loads* and *scheduled network services* based on the SCADA quantities used by the *central dispatch* process. Non-conformance action then follows in a Manual or Automated manner with the automated option only applying to *generating units*.

Two trigger mechanisms are utilised to identify the severity of non-conformance. These are the Small Error Trigger and the Large Error Trigger. Corrective measures are then taken depending on the severity and duration of the non-conformance event. The corrective measures are a logical defined sequence of actions aimed at resolving the mismatch between actual and total dispatched generation in the NEM.

In addition to the communication steps set out in this section, participants should contact the AEMO control room when clarification of conformance status is necessary.

The Non-conformance Calculations and Process Overview, including worked examples, are detailed in Appendix A of this document.

3.1.1. FCAS Conformance

If an *Ancillary Service Provider* is enabled to provide a service and fails to respond in the manner expected by the *market ancillary service specification* (as determined in AEMO's reasonable opinion), then the NER provide for AEMO to take certain actions, including:

- (a) The FCAS *generating unit* or *load* is to be declared and identified as non-conforming
- (b) AEMO must advise the *Market Participant* that the FCAS *generating unit* or *load* is identified as non-conforming, and request a reason for the non-conformance. The *Market Participant* must promptly provide a reason.
- (c) AEMO may set a fixed constraint for the relevant FCAS and the *Market Participant* must ensure that the FCAS *generating unit* or *load* complies with the fixed constraint.

3.2. Generating Units and Network Services

Plant in this category may be processed by AEMO in a Manual or Automated manner. The Conformance Data Report indicates the mode of operation at any time. Manual and Automated processing are described in this section.

3.2.1. Manual Processing

If a non-conformance exists for a *scheduled generating unit*, *semi-scheduled generating unit* or *scheduled network service* but does not cause *power system security* violations, the following actions are to be taken:

- (a) Identify non-responsive *scheduled generating unit*, *semi-scheduled generating unit* or *scheduled network service* using the AEMO Conformance Module.
- (b) Contact *Market Participant* and request a reason for the non-conformance. Log the reason given. Note that the Conformance Data Report is available to the participant each *dispatch interval*, so any non-response issue should have already been observed. The Conformance Status at this point will be Not-Responding. Note that in Manual operating mode, the Conformance Status as reported by the AEMO Conformance Module will not advance beyond Not-Responding. All subsequent actions are manually applied and involve telephone communication between AEMO and the *Market Participant*.
- (c) If modification to the bid is necessary to achieve a realistic real-time dispatch, request the *Market Participant* to submit a *rebid* to reflect the current performance of the plant.
- (d) If the *Market Participant* fails to follow the Dispatch Targets or to submit a *rebid* within two dispatch intervals, the relevant unit is to be declared non-conforming. If required, AEMO will set the unit at an output determined by AEMO so that a physically realisable dispatch is achieved. This will be achieved by AEMO applying a non-conformance constraint. The constraint violation penalty factor for this constraint will be set at 1160 x MPC.
- (e) The *Market Participant* will be advised that the *scheduled generating unit*, *semi-scheduled generating unit* or *scheduled network service* has been declared non-conforming and that a non-conformance constraint has been applied. Note that the non-conformance constraint action will result in the error being reduced, this may result in the reported Conformance Status returning to Normal. This is to be expected as the error has been corrected and the Non-Conforming declaration is being processed manually.
- (f) The *scheduled generating unit*, *semi-scheduled generating unit* or *scheduled network service* is to remain at the loading determined by the non-conformance constraint until AEMO is advised by the *Market Participant* that it is now capable of following *dispatch instructions*.

3.2.2. Automated Processing

If a non-conformance exists but does not cause *power system security* violations, the following actions are to be taken:

- (a) Observe non-responsive *scheduled generating unit, semi scheduled generating unit or scheduled network service* using the *AEMO Conformance Module*. The participant will be in an informed position as the *Conformance Data Report* is published each *dispatch interval*.
- (b) The *Conformance Status* change observed in the *AEMO Conformance Module* is identical to the *ConformanceData Report* content. The *Market Participant* also receives a message corresponding to the *Conformance Status* in each *Report*. The sequence of *Conformance Status* change and message content is as follows:
 - (i) Off-Target
Participant Message: Please move to Dispatch Target or rebid.
 - (ii) Not-Responding
Participant Message: Please move to Dispatch Target or rebid.
 - (iii) NC-Pending
Participant Message: Unit not responding to Dispatch Target. Non-Conformance action pending
 - (iv) Non-Conforming
Participant Message: Unit declared Non-Conforming. Non-Conformance Constraint is invoked. AEMO is requesting a reason for the Non-Conformance.
- (c) Note that the non-conformance constraint application mentioned in this automated process is the same as that applied for the manual process.
- (d) If the *Market Participant* has not contacted *AEMO* in a reasonable time following the Non-Conformance Declaration then *AEMO* will contact the *Market Participant* and request a reason for the non-conformance to the *dispatch instruction*. *AEMO* will log the reason given.
- (e) The *scheduled generating unit, semi scheduled generating unit or scheduled network service* is to remain at the loading determined by the non-conformance constraint until *AEMO* is advised by the *Market Participant* that it is now capable of following *dispatch instructions*.

3.3. Scheduled Loads

Non-conformance of *scheduled loads* will be processed by *AEMO* in a Manual manner only. The *Conformance Data Report* will indicate Manual mode of operation at all times. Manual processing is as follows:

If a non-conformance exists but does not cause system security violations, the following actions are to be taken:

- (a) Identify non-responsive scheduled load using the *AEMO Conformance Module*.
- (b) Contact *Market Participant* and request a reason for the non-conformance to the *dispatch instruction*. Log the reason given. Note that the *Conformance Data Report* is available to the participant each *Dispatch Interval*, so any non-response issue should have already been observed. The *Conformance Status* at this point will be Not-Responding.
- (c) If modification to the bid is necessary to achieve a realistic real-time *dispatch*, request the *Market Participant* to submit a *rebid* to reflect the current performance of the plant.

- (d) If the *Market Participant* fails to follow the Dispatch Targets or to submit a *rebid* within two *dispatch intervals*, the *scheduled load* is to be declared non-conforming.
- (e) AEMO will then consider the viability of the previous daily bid accepted by AEMO prior to the non-conforming bid currently in use. AEMO will determine whether the bid is viable or not and, if it is viable, the bid should be submitted by AEMO.
- (f) If the previous bid is not viable, AEMO will set the load at a fixed output determined by AEMO so that a physically realisable dispatch is achieved. This will be realised by AEMO applying a non-conformance constraint. The constraint violation penalty factor for this constraint will be set at 1160 x MPC.
- (g) The *Market Participant* will be advised that a non-conformance constraint has been applied. Note that the non-conformance constraint action will result in the error being reduced, this may result in the reported Conformance Status returning to Normal. This is to be expected as the error has been corrected and the Non-Conforming declaration is being processed manually.
- (h) The *scheduled load* is to remain at the loading determined by the non-conformance constraint until AEMO is advised by the *Market Participant* that it is now capable of following *dispatch instructions*.

3.4. Conditions to apply to Fast Start registered generating units

- (a) Registered Fast Start units will immediately be declared non-conforming if:
 - (i) a unit has synchronised and increased its generation level greater than 0 MW without having received a *dispatch instruction* from AEMO; or
 - (ii) a unit has received a *dispatch instruction* to reduce to 0 MW and fails to meet that *dispatch instruction*.
- (b) The declaration of non-conformance will remain in place until AEMO is satisfied that the relevant generating unit will accurately respond to future *dispatch instructions*. The Non-Conformance Declaration may be implemented in an Automated or Manual manner by AEMO depending on the current operating mode of the AEMO Conformance Module. In either case AEMO will initiate communication with the *Market Participant* for any accelerated Non-Conformance Declaration.
- (c) Appropriate participant staff should contact AEMO to confirm when the unit is able to follow Dispatch Targets.

3.5. Non-Conformance constraints

- (a) When *scheduled plant* is declared as non-conforming, AEMO may apply a constraint. In most cases this will be a dynamic constraint where the Right Hand Side equals the telemetered generation, consumption or transfer.
- (b) However, in some cases this dynamic constraint is not appropriate (e.g. it may cause or not remove a security violation), AEMO may apply a different constraint formulation or may determine not to apply a specific non-conformance constraint.

3.6. Market Reporting of Non-Conformance

If a declaration of non-conformance is made then this will be advised to all *Market Participants* before the end of next day. The notice should include the following details:

- (a) identity of the *scheduled generating unit, semi scheduled generating unit, scheduled load or scheduled network service*;
- (b) *trading intervals* affected;
- (c) magnitude of non-conformance (the difference between the actual generation and the Dispatch Target); and
- (d) the reason for the non-conformance.

3.7. Accelerated non-conformance process

It is to be noted that at any stage of pursuing the non-conformance, if the *Market Participant* in respect of the *scheduled generating unit, semi scheduled generating unit, scheduled load or scheduled network service* clearly indicates that the plant will not be conforming to *dispatch instructions*, the details of the discussion / communication will be logged and the *scheduled generating unit, semi scheduled generating unit, scheduled load or scheduled network service* may be declared immediately as non-conforming. Then the listed actions above for non-conformance will be taken as appropriate.

4. COMMITMENT AND DE-COMMITMENT OF SCHEDULED GENERATING UNITS

4.1. Self-Commitment

- (a) A *scheduled generating unit* is self-committing if it has a *self-dispatch level* of greater than 0 MW, where the *self-dispatch level* equals the sum of all energy bid in offloading (that is, negatively priced) price bands in its *dispatch offer*.
- (b) Clauses 4.9.6(a)(1) and 4.9.7(a) of the NER require a *Scheduled Generator* to confirm with AEMO the expected *synchronising* time and *de-synchronising* time at least 1 hour before, and update this advice 5 minutes before *synchronising* or *de-synchronising*.
- (c) *Scheduled generating units* that are self-committing are not required to further inform AEMO of their expected *synchronising* or *de-synchronising* times providing the relevant bid has been received by AEMO at least 1 hour prior to the expected *synchronising* or *de-synchronising* time, unless specifically requested by AEMO.

4.2. Fast-Start Generators that choose not to Self-Commit

- (a) Fast-start *generating units* that choose not to *self-commit*, are subject to the same obligations as all other *Generators* in relation to PASA (NER clause 3.7.2 and 3.7.3). They are not, however, subject to the requirement in NER clause 4.9.6(a) to confirm expected *synchronisation* times with AEMO. Those *generating units* are subject to *dispatch instructions* from AEMO under NER clause 4.9.6(b). Those instructions must include a *synchronisation* time nominated by AEMO. This will be via the normal *dispatch* process.
- (b) Clause 4.9.6(b)(3) of the NER requires a generator that receives such a *dispatch instruction* to advise AEMO promptly if it cannot meet the nominated *synchronisation* time set out in that instruction.
- (c) However, if a fast-start generator chooses to *self-commit* then that generating unit is subject to the same requirements in relation to advice to AEMO regarding *synchronising* or *de-synchronising* times as other self-committing units.

5. DISPATCH RE-RUNS

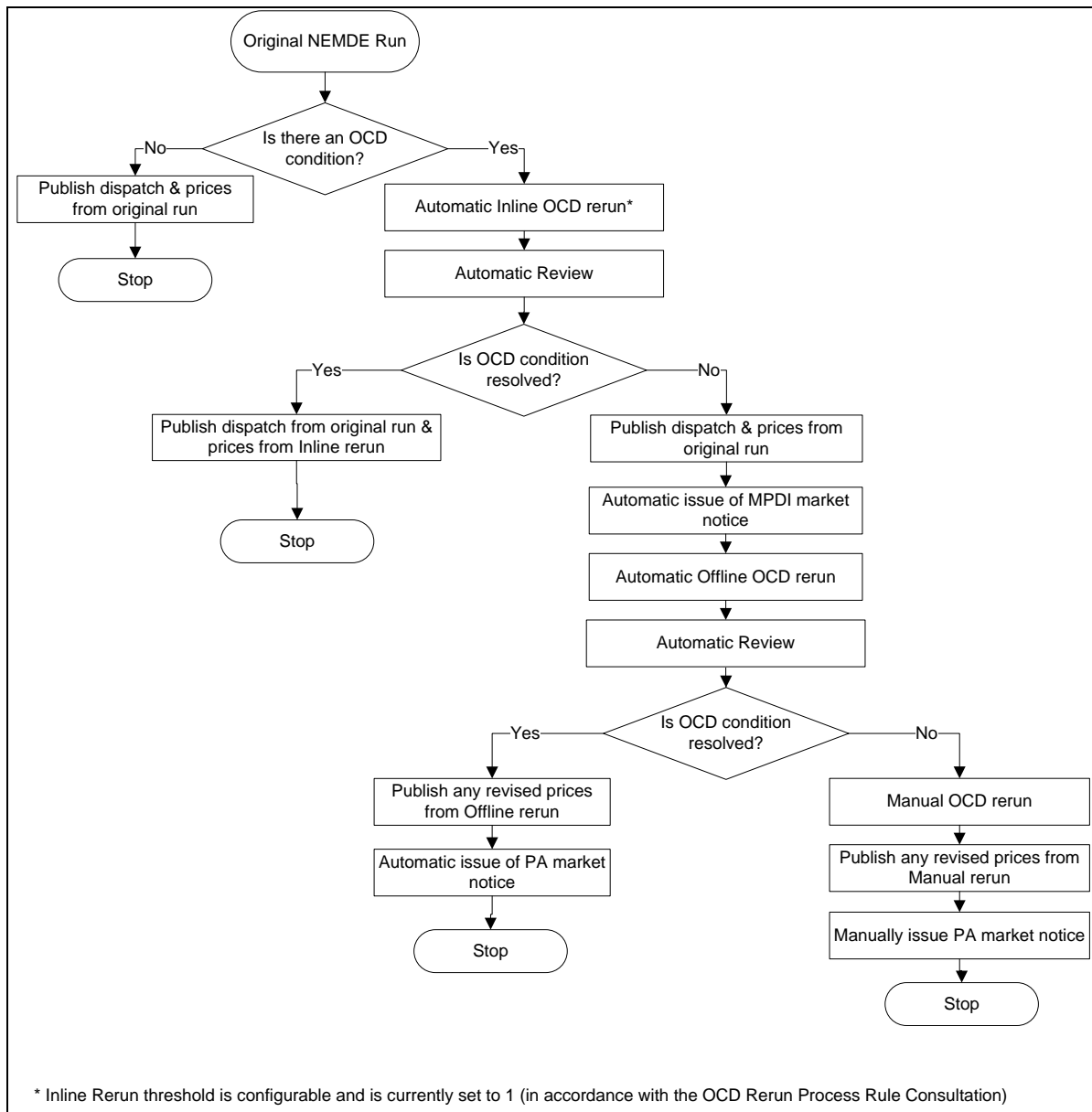
There are a number of conditions that could trigger an automatic re-run of the dispatch solution. The automatic re-run solution is completed and published within the original *dispatch interval*.

5.1. Over Constrained Dispatch (OCD) Re-Runs

- (a) The automation of this process detects, adjusts, re-runs and reports an adjusted energy price for a high percentage of over-constrained *dispatch intervals* thereby allowing the automatic publishing of correct *dispatch prices* in real time.
- (b) The OCD re-run process is initiated when an *interconnector, intra-regional network constraint or ancillary service constraint* is violated, and one or more of the following applies:
 - (i) An *energy dispatch price* is greater than or equal to MPC or;
 - (ii) An *energy dispatch price* is less than or equal to the *Market Floor Price* or
 - (iii) Any *ancillary service price* is greater than or equal to MPC.

Refer to the flowchart below for further clarification of the OCD process. Section 1 also includes a reference to the *AEMO* website.

Figure 3 Over Constrained Dispatch Re-run Flow Diagram



- (c) The OCD re-run process is run with relaxed violated constraint inputs to determine adjusted *dispatch prices*. In such cases all regional energy and *market ancillary service* prices are revised from the OCD re-run.
- (d) *Commitment* of fast start plant is determined on the basis of the unit *commitment* undertaken prior to the initial unrelaxed pricing run.
- (e) If the OCD is resolved after the Automatic Inline review then no market notice will be issued.
- (f) If an automatic OCD re-run occurs then the original run prices (greater than MPC or less than the *Market Floor Price*) are not published.

5.2. NEMDE second run for Basslink dispatch

- (a) There are two important characteristics of Basslink that can cause NEMDE to be unable to find the optimal solution in a significant number of *dispatch intervals*:
 - (i) No-go Zone - NEMDE is a linear program, and will attempt to produce Dispatch Targets anywhere in the no-go zone if demanded by the market conditions.
 - (ii) FCAS Transfer Capability - When operating at levels greater than 50 MW in either direction, Basslink has the capability to transfer FCAS from one region to another. This allows, for example, the FCAS requirement for the Tasmanian region to be met in part by scheduling additional FCAS on the mainland, if it is economical to do so.
- (b) NEMDE performs two runs for every *dispatch interval*. The first run uses the SCADA indication for the status of the Basslink frequency controller, and for the additional NEMDE run the input status of the Basslink frequency controller is assumed to be switched off. i.e. if the Basslink frequency controller is turned off, the two runs are identical.
- (c) The final solution and the associated NEMDE input status of the Basslink frequency controller is decided by selecting the run with the least cost objective function. This allows:
 - (i) NEMDE to increase the set of allowable dispatch outcomes that satisfy the complex model of Basslink available to NEMDE so that it can maximise the value of spot market trade, as required under clause 3.8.1(a) of the NER.
 - (ii) A reduction in unnecessary counter price flows across the Basslink HVDC interconnector.

6. AGGREGATE DISPATCH ERROR

6.1. Background

- (a) Aggregate Dispatch Error is an adjustment to the Dispatch regional demand forecast. This adjustment is based on the following calculation for each unit not performing regulation duty:

$$\text{ADE} = \text{Target value} - \text{Actual Value}$$
- (b) ADE will be positive when units are operating below targets and negative when units are operating above targets. The ADE for each unit in a region is summed to produce an ADE for that region.
- (c) The resulting ADE value for each region is then added to the respective region demand forecast in the next *dispatch interval*.

6.2. ADE calculation

- (a) Using a 30-minute time weighted average for the *region* ADE provides a more accurate predictor of the level of sustained dispatch error that should apply as a forecast demand adjustment in the next *dispatch interval*.
- (b) The following calculation of each *region* ADE is performed. The calculation is based on 6 data samples at 5 minute intervals with the most recent sample being given a weight of 6 and the oldest a weight of 1.

$$\text{Time Weighted Average ADE} = ((\text{Sample 1} * \text{Weight1}) + (\text{Sample2} * \text{Weight2}) + \dots + (\text{Sample6} * \text{Weight6})) / (\text{Weight1} + \text{Weight2} + \dots + \text{Weight6})$$

- (c) This calculation will be performed on a *regional* basis rather than on an individual *generating unit* basis.

6.3. Frequency element in ADE

- (a) To ensure that any frequency deviation is not caused by or exacerbated by the ADE a frequency element is introduced into the ADE calculation. This ensures that if a frequency deviation occurs only ADE in a direction that would help to restore frequency is passed to the market systems.

IF Frequency > high dead band value AND ADE > 0 THEN

ADE = 0

ELSE ADE = ADE

Conversely

If Frequency < low dead band value AND ADE < 0 THEN

ADE = 0

ELSE ADE = ADE

- (b) To ensure short duration frequency excursions are not passed to the ADE calculation the frequency input is a 60 second time weighted average.
- (c) The calculation is based on 6 data samples at 10 second intervals with the most recent sample being given a weight of 6 and the oldest a weight of 1.

$$\text{Time Weighted Average Hz} = ((\text{Sample 1} * \text{Weight1}) + (\text{Sample2} * \text{Weight2}) + \dots (\text{Sample6} * \text{Weight6})) / (\text{Weight1} + \text{Weight2} + \dots \text{Weight6})$$

- (d) A separate calculation is performed for each NEM region. The frequency dead bands are:
- (i) Tasmania $\pm 0.05\text{Hz}$
 - (ii) Other regions $\pm 0.025\text{Hz}$

6.4. ADE cap values

To ensure excessive ADE values do not compromise *power system security* the ADE for each region is capped to the following values:

- (a) Queensland, New South Wales and Victoria = ± 50 MW
- (b) South Australia ± 25 MW
- (c) Tasmania ± 25 MW.

7. DIRECTIONS AND INTERVENTION PRICING

- (a) Where, during an *intervention dispatch interval*, AEMO is required to set a price at a value which AEMO considers would have applied had an *AEMO intervention event* not occurred, NEMDE will be run twice:
- (i) First, the dispatch or outturn run, which includes *reserve contracts* or direction constraints to determine Dispatch Targets.
 - (ii) Second, the intervention price run to determine *dispatch prices* and does not contain *reserve contracts* or direction constraints.

- (b) For more information regarding *directions* and intervention pricing refer to AEMO's SO_OP_3707 (Intervention, Direction and Clause 4.8.9 Instructions) and Intervention Pricing Methodology.

8. REVIEW OF CONSTRAINTS

- (a) Constraint equations that are overly conservative or not functioning correctly can unnecessarily constrain the market. If such constraint equations are identified they can be removed from *dispatch* and *pre-dispatch* by either blocking the constraint equation or removing it from the constraint set. Only constraints associated with thermal limits and not transient or voltage stability constraints will be removed.
- (b) Until the constraints are revised, the *power system* will be managed by Contingency Analysis, Constraint Automation and/or discretionary constraints.

9. RAMP RATE REQUIREMENTS

A *Scheduled Generator*, *Semi-Scheduled Generator* or *Market Participant* with *generating units*, *scheduled network services* and/or *scheduled loads* must provide up and down *ramp rates*, and *maximum ramp rates* as outlined below.

9.1. Up and Down Ramp Rate Requirements

- (a) Aggregated² scheduled generating units, semi-scheduled generating units, scheduled loads and scheduled network services have higher minimum ramp rate requirements than non-aggregated units.
- (b) For scheduled network services or scheduled loads:
- (i) If aggregated, Minimum *Ramp Rate* = 3 x No. of units within the aggregation
 - (ii) If non-aggregated, Minimum *Ramp Rate* = 3 MW/min.
- (c) For scheduled generating units:
- If aggregated, Minimum *Ramp Rate*:

$$= \text{Sum}[\text{Minimum (3 MW/minute, 3\% of the maximum capacity)}]_{\text{per generating unit}} \text{All units}$$

The minimum *ramp rate* calculation of 3 MW/min or 3% of the maximum capacity is applied to each *generating unit* within the aggregation. The *minimum ramp rate requirement* applied to the DUID is the summation of the minimum *ramp rates* of all *generating units* within the aggregation.
 - (i) If non-aggregated, Minimum *Ramp Rate*

$$= \text{Minimum (3 MW/minute, 3\% of the maximum capacity)}.$$
- (d) For a semi-scheduled generating unit:
- (i) If aggregated, Minimum *Ramp Rate*

$$= \text{Sum}[\text{Minimum (3 MW/minute, 3\% of the maximum capacity)}]_{\text{per cluster}} \text{All clusters}$$
 - (ii) If non-aggregated, Minimum *Ramp Rate*

$$= \text{Minimum (3 MW/minute, 3\% of the maximum capacity)}.$$

² Aggregation for scheduled generators, loads and network services refers to any more than one unit within a DUID. Aggregation for semi-scheduled generators is based on Rule Clause 3.8.3 (i), i.e. semi-scheduled generators registered as a single unit as per Rule Clause 2.2.7(i) are treated as non-aggregated for ramp rate purposes.

- (e) All values provided must be rounded down to the nearest whole number greater than or equal to 1 MW/minute. *Ramp rates* cannot be greater than the relevant maximum *ramp rate*.

9.2. Ramp Rate Less than Requirements

A *ramp rate* less than the minimum requirements specified in section 9.1 may be provided if an event physically prevents or makes it unsafe for the relevant plant to operate. In this case:

- (a) The *ramp rate* provided must be the maximum the plant can safely attain at that time.
- (b) The participant must simultaneously provide a brief, verifiable and specific reason why the *ramp rate* is below the requirements. This is to be included in the 'reason' field in the participant bid.

9.3. Maximum Ramp Rate Less than Requirements

A *maximum ramp rate* less than the minimum requirements specified above may be provided if an event physically prevents or makes it unsafe for the relevant *generating unit, scheduled load or scheduled network service* to operate. In this case:

- (a) The *maximum ramp rate* provided must be the maximum the relevant plant can safely attain at that time.
- (b) The participant must provide a brief, verifiable and specific reason why the *maximum ramp rate* is below the requirements.
- (c) In this instance the participant has reported on the limitation of the *maximum ramp rate* value, hence there is no requirement for the participant to report on the limitation in the *ramp rate* value.

9.4. Minimum Safe Operating Level

- (a) As *generating units* approach the lowest output they can sustain without becoming unstable, a *rebid* may need to be submitted to ensure that the unit does not receive an even lower Dispatch Target. This is required to ensure safe operation of the plant.
- (b) For clarity, the minimum safe operating level is assumed to be the level below which the unit would become unstable, after other technical responses have been exhausted (for example, auxiliary firing). The minimum safe operating level does not reflect commercial issues, only technical and plant safety issues. Plant availability reflecting commercial considerations should still be managed through the normal price-band bidding dispatch process.
- (c) In instances where a *scheduled generating unit* or *semi-scheduled generating unit* has reached its minimum safe operating level and cannot safely follow a *dispatch instruction* to vary its output downwards, it is appropriate for a zero down *ramp rate* to be provided to AEMO, as long as the zero *ramp rate* can be justified on the basis of a technical limitation. This approach should be used in preference to submitting an inflexible bid, as it provides greater flexibility to ensure the market remains in a *secure operating state*.
- (d) As soon as the output of the unit moves materially above the minimum safe operating level, a *rebid* must be submitted to provide a *ramp rate* compliant with clause 3.8.3A of the NER.
- (e) The complete "Rebidding and Technical Parameters Guideline" can be found on the AER website.

10. DISPATCH OF GENERATION UNDER NETWORK SUPPORT AGREEMENTS

NER clause 5.3A.12(b) provides that where a NSP decides to use generation to provide a network support function, the NSP must advise *AEMO* of any *network support agreements* entered into. To ensure that a *generating unit* that is the subject of a *network support agreement* is *dispatched* at the agreed level *AEMO* will constrain the *generating unit* on and as such the *generating unit* will not be eligible to set *spot prices* when *constrained on* in accordance with clause 3.9.7 of the NER. The *constraint* will normally take the form:

- GenID \geq X MW (where X is the megawatt amount subject to the network support agreement) and will have a constraint violation penalty (CVP) of 30.

11. OUTAGES AND WORK ON MARKET RELATED SCADA

11.1. Impact on Market Processes

Failed, suspect or incorrect SCADA has the potential to adversely affect Dispatch Targets, constraint outcomes and *AEMO's power system security* monitoring applications. *Market Participants* and NSPs must advise *AEMO* in advance of any work that has the potential to affect market processes via SCADA values supplied to *AEMO*. This may include, but is not limited to SCADA equipment, RTU outages or injection testing. *Market Participants* and NSPs must report any SCADA failures to *AEMO* as a matter of urgency. When *AEMO* becomes aware of suspect or failed SCADA, *AEMO* will take appropriate action to ensure the integrity of the market processes and its security monitoring applications. This may involve using alternate data sources or replacing failed or suspect values with estimated or hand dressed values.

12. MANDATORY RESTRICTIONS

Mandatory restrictions may be imposed by a *participating jurisdiction* under a relevant law, other than the rules, on the use of electricity in a *region*. A *participating jurisdiction* may apply mandatory restrictions when supply scarcities are predicted, to achieve desired levels of load reduction while minimising overall impact to customers by avoiding or reducing *involuntary load shedding*.

The *central dispatch* process is not directly altered by a jurisdictional exercise of mandatory restrictions. *AEMO* may consider adjustment of demand forecasts.

13. SCHEDULING ERROR AND PROCESS REVIEW

- (a) A *scheduling error* is one of the circumstances described in clause 3.8.24 of the NER, which include a declaration by *AEMO* that it failed to follow the *central dispatch* process as set out in clause 3.8 of the NER.
- (b) Where *AEMO* or a *Registered Participant* identified a potential scheduling error, *AEMO* will investigate and determine whether it has failed to follow the central dispatch instruction.
- (c) If as a result of the process review *AEMO* identifies that it has failed to follow the *central dispatch* process set out in NER clause 3.8, *AEMO* will declare that a *scheduling error* has occurred and publish a summary of the error on *AEMO's* website.
- (d) A *dispute resolution panel* may also determine a *scheduling error* as set out in clause 3.8.24 of the NER.

14. SETTING MPC OVERRIDE

14.1. Load shed under instruction from AEMO

If AEMO reasonably believes that the *central dispatch* process would determine that there would be insufficient supply options to meet all the demand in a *region*, and issues an instruction to load shed in that *region*, then from the time that the AEMO instruction is to apply AEMO will set the *dispatch price* to MPC for that *region*.

Note 1 If the *dispatch algorithm* has already set the *dispatch price* then that price must remain.

14.2. Resetting of MPC Override

The MPC override *dispatch price* for a *region* must be removed when clearance is given to restore the final block of shed load in that *region*.

15. ADMINISTERED PRICE PERIODS

An *administered price period* is determined to apply separately for each *region*.

15.1. Triggers for an Administered Price Period

Under clause 3.14.2(c) of the NER, an *administered price period* for a *region* is triggered if:

- (a) The sum of the uncapped spot prices for that *region* over the previous 336 *trading intervals* (7 days) exceeds the *cumulative price threshold*; or
- (b) The sum of the uncapped ancillary service prices for a *market ancillary service* in that *region* in the previous 2016 *dispatch intervals* (7 days) exceeds 6 times the *cumulative price threshold*; or
- (c) Refer 15.2.

15.2. Current Trading Day

Once an *administered price period* is declared for a *region*, the remaining *trading intervals* and *dispatch intervals* for that *trading day* will also be *administered price periods*.

15.3. Dispatch during Administered Price Period

During *administered price periods* AEMO will continue dispatching generation and loads in accordance with the *central dispatch* process.

15.4. Administered Price Cap & Cumulative Price Threshold

The *administered price cap* (APC) sets the maximum price and the *administered floor price* (AFP) sets the minimum price that can apply while an *administered price period* is in place.

- The APC is \$300/MWh.
- The AFP is set to the negative of the APC.

Note 2 The AFP does not apply to ancillary service prices, those prices are limited by the \$0 offer restriction.

The latest *cumulative price threshold* can be found on the AEMC website.

15.5. Pricing during Administered Price Periods

15.5.1. Triggered by Spot Prices exceeding CPT

If the sum of the uncapped spot prices in a *region* has triggered an *administered price period*, then from the next *trading interval*:

- (a) If the *dispatch price* exceeds the APC, then AEMO must set the *dispatch price* to the APC.
- (b) If the *dispatch price* is less than the *administered floor price*, AEMO must set the *dispatch price* to the *administered floor price*.
- (c) If an *ancillary service price* for any *market ancillary services* in that *region* exceeds the APC, AEMO will set that *ancillary service price* to the APC.

15.5.2. Triggered by Ancillary Service Prices exceeding 6 times CPT

If the sum of the uncapped ancillary service prices for a *market ancillary service* in a *region* has triggered an *administered price period*, then from the next *dispatch interval*:

- (a) If an ancillary service price for any market ancillary services in that region exceeds the APC, AEMO will set that ancillary service price to the APC.

16. MANIFESTLY INCORRECT INPUT/S (MII) AND PRICE REVIEW

16.1. Dispatch intervals that are subject to review (clause 3.9.2B (b), (c))

- (a) AEMO has developed an automated method of monitoring and identifying *dispatch intervals* that are subject to review. Refer to Appendix B for the details of this method and the trigger thresholds used. The dispatch outputs associated with all the *regions* are independently monitored for this purpose.
- (b) A Price Status flag of “*Not Firm*” is published to indicate *dispatch intervals* for which all the prices associated with those *dispatch intervals* are subject to review, pending the identification of manifestly incorrect inputs. A Price_Status flag of “*Firm*” is published for all other *dispatch intervals*. (Note that the Price_Status flag may not be set to “*Not Firm*” for *dispatch intervals* affected by MII/s where there are violated prices (MPC) that were not resolved by the automatic over-constrained dispatch (OCD) process. In these cases an MPDI Market Notice will be issued, as is currently done.)

16.2. Manifestly Incorrect Inputs and revision of prices

- (a) Whenever a *dispatch interval* is identified as subject to review, AEMO control room staff will check whether the inputs used in that *dispatch interval* contained a MII. The inputs to dispatch mean any value used by NEMDE including:
 - (i) SCADA measurements of power system
 - (ii) Five minute demand forecast values
 - (iii) Constraint equations entered by AEMO
 - (iv) Software setup
- (b) If AEMO determines that the *dispatch interval* in question was affected by a MII, all the published prices for the “*affected*” *dispatch intervals* will be rejected (energy and all FCAS prices, for all *regions*) and will be replaced using the corresponding prices of the last correct

dispatch interval. The last correct *dispatch interval* is the previous *dispatch interval* that was not affected by a MII (that is, preceding the "affected" *dispatch interval*).

- (c) After the original publication of prices for a *dispatch interval* identified as subject to review, there is a time limit of 30 minutes within which AEMO can subsequently reject those prices and automatically replace them with the corresponding set of prices from the last correct *dispatch interval*.
- (d) Once AEMO has followed the price revision process for the *dispatch interval* identified as subject to review the Price_Status flag for that *dispatch interval* will change to "Firm". If 30 minutes has expired since the publication of prices for the *dispatch interval* identified as subject to review and AEMO have not taken any action to either reject or accept prices for that *dispatch interval*, then the prices for that and all subsequent *dispatch intervals* will automatically be accepted and their Price_Status flags will change to "Firm".

16.3. Dispatch intervals following a dispatch interval identified as subject to review

- (a) Whenever a *dispatch interval* is identified as subject to review, the *dispatch interval* immediately following that interval may also be identified as being subject to review if AEMO considers that it is likely to be subject to that same MII (clause 3.9.2B(c) of the NER).
- (b) AEMO's automatic "subject to review" monitoring system is such that whenever a *dispatch interval* is identified as subject to review, the Price_Status of the following *dispatch interval(s)* will continue to be automatically flagged internally to AEMO as either subject to review or indeterminate (externally, these are flagged as "Not Firm") until AEMO rejects and/or accepts all the preceding subject to review or indeterminate ("Not Firm") *dispatch intervals*. Since there is a time limit of 30 minutes for the price revision of the first interval identified as subject to review, potentially there could be up to five *dispatch intervals* with Price_Status flag "Not Firm" following the first *dispatch interval* until AEMO completes the price review process.

16.4. Dispatch intervals identified as subject to review that had successful Over-constrained Dispatch (OCD) re-runs

Where an automatic OCD re-run has occurred for a *dispatch interval* identified as "subject to review", AEMO will review that *dispatch interval* for the presence of a MII and, if found, the prices will be rejected and then automatically replaced using the corresponding prices from the last correct *dispatch interval*.

16.5. Dispatch intervals identified as subject to review following a dispatch interval declared as Manually Priced Dispatch Interval (MPDI)

The last correct *dispatch interval* available for price revision could be an interval declared as a MPDI following an unsuccessful OCD re-run (refer section 5.1). AEMO will reject and automatically replace prices of the *dispatch interval* identified as subject to review (if a MII is found) with the prices from the last correct interval (i.e. the MPDI). The prices of the original MPDI as well as the following, rejected *dispatch interval* (which inherits the MPDI prices) would now both be considered MPDIs. Market Notices would be issued covering both *dispatch intervals* and the price revision process for MPDIs will be followed as shown in section 5.1.

17. NEGATIVE SETTLEMENTS RESIDUES

17.1. General Approach

- (a) If the accumulation of negative *settlements residues* over the period of counter-price flows is forecast to reach the threshold value of \$100 000 then AEMO would use reasonable endeavours to apply constraints to the affected *directional interconnector* to prevent the accumulation exceeding the threshold, provided system security can be maintained.
- (b) These constraints would remain in place until, in AEMO's reasonable opinion, the constraints could be revoked without creating counter-price flows.
- (c) AEMO will treat each occurrence individually and the *billing period* accumulation will not be used to offset the trigger. (I.e. will not use the amount of positive residue accumulated during the *billing period* to offset the trigger).
- (d) If negative *settlements residues* began to occur due to a binding fully co-optimised constraint in dispatch at a material rate but had not been forecast in *pre-dispatch* then AEMO would take action to halt the further accumulation of negative *settlements residues* when the total negative *settlements residues* was estimated to have accumulated to \$100,000. In order to ensure a response within a *trading interval* such estimates of negative *settlements residues* accumulation will be made on the basis of *dispatch interval* quantities.

17.2. Constraints in Dispatch

To halt further accumulation of negative *settlements residues* AEMO will constrain the *directional interconnector* flow ("interconnector capping") at a rate no greater than that which applies for a planned outage. This would cease at the point at which counter price flows were halted. From that point on periodic adjustment of the level of the constraint might be necessary due to changing market conditions by:

- (a) Increasing the level of constraint if counter-price flows re-emerged OR
- (b) Relaxing the level of constraint if significant positive inter-regional settlements accumulations indicated that current level of constraint was excessive.

17.3. Market reporting of negative settlements residue management

AEMO will issue Market Notices, providing details of the actions taken to manage negative *settlements residues* containing the following information:

- (a) The directional interconnector
- (b) The actual or forecast times of the event
- (c) Any constraints invoked to manage the event

18. REQUESTS FOR CLARIFICATION OF MARKET REPORTS OR FOR ADDITIONAL INFORMATION

- (a) AEMO will ensure that *confidential information* is not inadvertently provided to *Market Participants* and that any information designated as public information is equitably provided to all *Market Participants* at the same time. To achieve this, the following policy is adopted:
 - (i) All requests for further information about specific market notices should be to the AEMO Information and Support Hub.

- (ii) At times when the Information and Support Hub is not staffed then all enquiries from energy traders will be handled by the control centres.
- (b) The response will depend on the nature of the enquiry as follows:
 - (i) If the enquiry involves a confidential matter for that energy trader then the question will be directly answered.
 - (ii) If the enquiry involves a request for additional public information then the enquiry will not be directly answered instead a response may be sent out in the form of an AEMO Communication or market notice so that the information is available to all *Market Participants* at the same time.
 - (iii) If the enquiry involves *confidential information* to which that energy trader is not entitled, then a response will not be provided.

19. GENERIC CONSTRAINT APPLICATION OPTIONS IN MMS

There are a number of options available to AEMO control room staff when generic constraints are to be invoked in the MMS. The options include the use of:

- (a) Predefined constraint sets prepared for system normal conditions
- (b) Predefined constraint sets prepared for routine *transmission network* outages
- (c) Blocking constraint equations
- (d) Predefined discretionary constraint sets
- (e) Quick constraints
- (f) Constraint sets and/or equations built by control room staff as a need arises
- (g) Constraint Automation created constraint sets and equations prepared for any network condition

Depending on the circumstances at the time, one or a number of these types of generic constraint will be invoked in the MMS. These are briefly described in this section.

19.1. System Normal and Network Outage Constraints

- (a) A system security issue may arise at any time under system normal conditions, *network outage* conditions or following the occurrence of a *contingency event*. Generally, if predefined generic constraints are available for a system normal or network outage condition then they will be invoked in the MMS.
- (b) In the case of a *contingency event*, one of the many tasks undertaken would be to determine if *network* equipment was going to be returned to service in a very short time. If not then depending on requirements, a *network outage constraint* set may be invoked provided an appropriate associated generic constraint is available. Generic constraints of this nature are prepared on the basis of accommodating a *network outage* while maintaining the network in a *secure operating state*.

19.2. Blocking Constraint Equations

If a constraint equation, which is part of an invoked constraint set, is malfunctioning, AEMO can 'block' that constraint equation without removing it from the constraint set. 'Blocking' a constraint equation removes it from dispatch, *pre-dispatch* and 5 min pre-dispatch calculations. Blocking is linked to the constraint equation name, not the constraint set. So, if any other constraint set

containing the blocked equation is invoked, the equation will remain blocked. Blocking will also remain in place if a constraint equation is reviewed and the constraint equation name does not change. AEMO may replace the blocked constraint equation with a discretionary or quick constraint. AEMO can 'Unblock' the constraint equation when it considers appropriate. Refer to section 8 for more details about when AEMO may block a constraint equation.

19.3. Discretionary and Quick Constraints

- (a) There is a predefined series of constraints referred to as discretionary constraints. These are generally simple format constraints with either a *generating unit*, a collection of *generating units*, or an *interconnector* term on the LHS. There are no dynamic RHS components, only a static RHS. These are for use at the discretion of AEMO control room staff to meet any requirement that results in the need to limit power flow on major network components. Discretionary constraints may be used with routine planned network outages where a constant limit on power flow is required. They may also be used as a post-contingent response to reduce or limit network power flow or at any time that a system security issue arises and control of power flow on a single network element is required.
- (b) The AEMO MMS has constraint type labelled as a quick constraint. The quick constraint is simply a constraint which acts on a selected LHS with a user defined RHS value. The selected LHS may be:
 - (i) A single *generating unit* or *interconnector*.
 - (ii) Multiple *generating units* or *interconnectors*.
 - (iii) FCAS for any combination of selected *regions* or for a single *ancillary service* unit.
- (c) The label "quick constraint" is a reflection of the method of application. A quick constraint may be invoked in a short time compared to other constraints that may take a number of minutes to search for, verify and apply.

Note 3 All quick constraints are prefixed with a # symbol for ease of identification.

19.4. Generic Constraints Built as Required by Control Room Staff

The case may arise where *power system security* is an issue and there is not a suitable network outage constraint, discretionary constraint or quick constraint available. In such circumstances control room staff may develop constraint equations or constraint sets as required to maintain system security.

Note 4 The ID of all constraint equations and constraint sets built by control room staff are prefixed with an @ symbol for ease of identification.

19.5. Constraint Automation

Constraint Automation is an EMS based application that allows AEMO staff to generate thermal constraints based on an EMS study case. This system is used to create constraints for system conditions where constraints don't already exist or existing constraints are not operating correctly. Constraint Automation generates constraints based on violations in the EMS Contingency Analysis; these are then packaged together into a single constraint set and loaded into the MMS where they can be invoked like any other constraint set. Constraints generated by this system are uniquely identified. Constraint Sets have IDs which start with CA_xxx_ and are followed by a unique

identifier. Constraint Equations use the same ID suffixed by a number for each constraint in the series (01, 02 etc.)

e.g. Constraint Set: CA_MQS_36661FF1

Constraint Equation: CA_MQS_36661FF1_01

19.6. Network Constraint Ramping

- (a) The Network Constraint Ramping Tool (part of the SOMMS application) allows the creation of ramping constraints for any planned outage constraint irrespective of whether the LHS of the constraint includes *interconnectors* and/or generators. This ramping system includes the following features:
 - (i) The process will source the data for an outage from 30 minute Pre-dispatch forecasts, and ramp the RHS of all constraint equations associated with the outage gradually to values forecast to apply when the outage commences.
 - (ii) The process will utilise two forms of ramping for each constraint in the outage set thus creating double the number of constraints then in the outage set:
 - (A) Soft ramping towards the final outage level, to minimise transient dispatch pricing disturbances that would otherwise occur without ramping. The soft constraint will complete ramping two *dispatch intervals* prior to the completion of hard constraint ramping.
 - (B) Hard ramping at slower rate than soft ramping, to ensure that the outage is ready to proceed within a certain maximum time regardless of dispatch pricing outcomes.
- (b) The soft constraint and hard constraint will have the same constraint equation formulation, but the soft constraint will ramp faster than the hard constraint because the soft constraint has fewer *dispatch intervals* to ramp than the hard constraints. Consequently, the soft constraint has a small value of generic constraint weight which is typically less than MPC. The constraint violation penalty (CVP) of the soft constraint will be determined by the marginal value of its outage constraint equation in pre-dispatch, while the CVP for hard constraints will be set as the same as a normal network constraint.
- (c) The timing in which the ramping process should be invoked and revoked is determined by the number of *dispatch intervals* required for the ramp, plus an allowance for a safety margin. During the ramping constraint set creation and invocation process, the final outage level will be obtained from the *pre-dispatch* forecast for the outage constraint equations' RHS.

Note 5 If an outage constraint equation was not binding in pre-dispatch, the ramping constraint equation will still use the RHS value for its formulation. Consequently, all the constraint equations in the outage constraint set will be ramped in dispatch even though not all of them were binding during pre-dispatch.

- (d) The ramping process can be applied to any constraint sets related to the planned network outage, especially fully co-optimised constraints which contain a mixture of *interconnector* and generator terms on the LHS. The ramping process should be used for all planned outage constraints where ramping is required, irrespective of whether an *interconnector* is involved or not.

- (e) The ramping process would not apply to FCAS constraint sets or any network outage constraint sets that have FCAS terms in their LHS.
- (f) The process is required to ramp all the constraints that are included in the invoked outage constraint set regardless of whether all the constraints were binding in *Pre-dispatch*.

Note 6 If there is not at least one Pre-dispatch interval in which the network outage constraint has been invoked, the process will be prevented from being enabled.

- (g) The ramping constraint sets and constraints will be named as follows
 - (i) Constraint Set: #R<RAMP_SEQ>_RAMP
 - (ii) Soft Constraint: #R<RAMP_SEQ>_nnn_RAMP_V
 - (iii) Hard Constraint: #R<RAMP_SEQ>_nnn_RAMP_F
 - (iv) Where the <RAMP_SEQ> is a six digit unique number.
- (h) Constraint ramping will not be used for situations where AEMO reclassifies a non-credible contingency event as a *credible contingency event*.

20. AEMO CONSTRAINT EQUATION PERFORMANCE

Binding constraint equations are simply a result of the network being operated at or near a design limit. These are generally a normal market outcome. However there is always the possibility of a constraint equation not performing as expected. This may result in either limits falling short of system security requirements or in limits being more restrictive or conservative. The latter can result in the market being constrained with available generation capacity being restricted unnecessarily.

The process for reviewing non-performing constraint equations is progressed as soon as possible and in any case within 30 mins of the problem occurring. In general, participants should contact AEMO immediately if they suspect that a constraint equation is not performing as expected. This action should assist the participant by providing an understanding of the situation at that time.

This section outlines the steps that may be taken in response to a non-performing constraint equation.

20.1. AEMO Action for Under Conservative Constraint Equations

This is the situation where a constraint equation should be binding but is failing to set appropriate power system limits. Actions taken by AEMO under such conditions may include:

- (a) Confirm *power system security* violations evident from network analysis tools.
- (b) Assess alternative network configuration to remove the security violation.
- (c) Use the Constraint Automation tool to create a new constraint for the system condition.
Note: Thermal constraints only.
- (d) Invoke appropriate network generic constraints to restore the power system to a secure operating state.
- (e) Request constraint builders to tune or replace the inadequate constraint equation.

20.2. AEMO Action for Over Conservative Constraint Equations

- Establish that a constraint equation is binding by observing a non-zero marginal value for the equation.

- Determine the purpose of the constraint equation and ensure it is required at that time.
- Based on network study results, estimate the constraint equation result that should be reasonably expected at that time.
- Compare the expected result to the binding constraint equation result.
- Depending on the significance of any discrepancy, appropriate actions may be :
 - Minor discrepancies: Continue to monitor.
 - Block the constraint equation or remove it from the set or revoke the constraint set from MMS.
 - Apply discretionary network constraints to manage power system security. If a thermal constraint, replace using the constraint automation tool.
 - During business hours: Arrange for tuning or replacement of the binding constraint equation.

Until the constraints have been revised, the *power system* will be managed by Constraint Automation and/or discretionary constraints as appropriate.

In situations where an over conservative constraint problem exists control room staff will not revoke constraints associated with Transient stability, Steady State Stability or Voltage Stability. The control room does not have sufficient analysis facilities to establish acceptable levels to extend these types of limits.

20.3. AEMO Action for Binding Constraints

- (a) Under clause 3.8.1(a) of the NER, in operating the *central dispatch* process AEMO is to use its reasonable endeavours to maintain *power system security* in accordance with Chapter 4 and to maximise the value of *spot market* trading on the basis of *dispatch offers* and *dispatch bids*.
- (b) When a *constraint* binds in dispatch, AEMO will, to the extent that is reasonably possible, review the *constraint* to assess the validity and accuracy of the constraint outcome and use reasonable endeavours to determine if there are actions AEMO can initiate to relieve the network congestion.
- (c) These actions may include utilising the full extent of the thermal ratings of transmission elements as specified by the Network Service Provider (NSP) in accordance with the Rules, clause 4.6.4.

APPENDIX A. NON-CONFORMANCE CALCULATIONS AND PROCESS OVERVIEW

A.1 Overview

AEMO operates Conformance Monitoring software (Compmon) to assist with the management of the non-conformance process. Compmon operates continuously in AEMO control rooms. Conformance calculations are initiated immediately following each dispatch calculation. Each conformance calculation is relevant to the previous *dispatch interval* but calculated at a time when both the Dispatch Targets for that DI and the final actual megawatt values for that DI are known.

The conformance calculation includes all applicable items of *scheduled plant* in the NEM, these are:

- *Scheduled generating units*
- *Semi-scheduled generating units*
- *Scheduled network services*
- *Scheduled loads*³

The following abbreviations are used in this Appendix:

- MW = Actual Generation.
- MWB = Dispatch Target (also referred to as *dispatch level* for *semi-scheduled generating units*).
- MWO = Bid Unit Availability; UIGF for *semi-scheduled generating units*.
- ROC = Rate of Change or Ramp Rate of a Unit.
- FCR = FCAS Raise Regulation Band (enabled).
- FCL = FCAS Lower Regulation Band (enabled)

A.2 Conformance Calculations

Detection of non-conformance is based on two error thresholds. The Small Error Trigger and the Large Error Trigger are defined in Compmon.

Small Error Trigger threshold

Trigger level (MW) is: $\text{MAX} (6, \text{MIN} [3\% \text{MWO}, 2 \cdot \text{ROC}])$

Large Error Trigger threshold:

Trigger level (MW) is: $\text{MAX} (6, \text{MIN} [5\% \text{MWO}, 4 \cdot \text{ROC}])$

Note that 6 MW is the minimum Small Error Trigger threshold and 6 MW is the minimum Large Error Trigger threshold.

After every DI run, the Compmon application compares the difference between the MWB of the previous DI and the megawatt of the current DI with the error trigger thresholds. In addition to MWB, a compensation for FCAS is included to allow for regulating plant movement.

The Small and Large Error Triggers each have an associated counter. The counters each increment on detection of error and are used to trigger applicable non-conformance action.

The counters are incremented if any of the following conditions are true:

- For error detection above MWB

³ Under some circumstances, some units or classes of units may be suspended from non-conformance monitoring. Currently batteries are suspended to avoid triggering due to response to frequency events.

- If $MW - (MWB + FCR) > \text{Small Trigger Threshold}$
 - Then Increment Small Error Counter
- If $MW - (MWB + FCR) > \text{Large Trigger Threshold}$
 - Then increment Large Error Counter
- For error detection below MWB
 - If $(MWB - FCL) - MW > \text{Small Trigger Threshold}$
 - Then increment Small Error Counter
 - If $(MWB - FCL) - MW > \text{Large Trigger Threshold}$
 - Then increment Large Error Counter

The Small Error Trigger is measured over 6 consecutive *dispatch intervals* and the Large Error Trigger is measured over 3 consecutive *dispatch intervals*. These error counter values will progress the non-conformance action. The error counters reset to 'zero' if no error is apparent or reset to 'one' if the direction of error reverses.

In the case of *semi-scheduled generating units*, the error counters reset to 'zero' under defined conditions. The defined conditions are:

- If semi-dispatch cap flag = 'FALSE'
 - Then reset small and large error counters to zero.
- If $MW < MWB$ (Unit operating below Dispatch Level)
 - Then reset small and large error counters to zero.

This leaves the one remaining condition where a *semi-scheduled generating unit* unit is operating at or above MWB and semi-dispatch cap flag = 'TRUE'. For this case there is no reset of the error counters and the process is the same as a scheduled unit.

A.3 Conformance Status

Following the conformance calculation, each item of plant is allocated a conformance Status. An item of plant can only have one conformance Status allocated to it in a DI.

Possible conformance Status states and explanations of each are:

- Normal: Plant is following Target within Error thresholds.
- Off-Target: Plant is not following Target. MW Error exceeds detection thresholds.
- Not-Responding: A number of *dispatch intervals* have passed and plant is still not following target. (The number of *dispatch intervals* depends on the severity of error.)
- NC-Pending: The non-response has reached a stage where the plant will be declared Non-Conforming.
- Non-Conforming: The plant is Declared Non-Conforming and a Non-Conformance constraint is applied.
- Suspended: The plant is not included in the Conformance Process.

Conformance Status change for an item of plant may be achieved by:

- An automated process based on the error counters.
- An AEMO user initiated action.

Additionally two operating modes exist for Compmon, these are:

- Auto, where all Conformance Status changes through to Non-Conforming are based on error counters. Once plant has been declared Non-Conforming a phone communication is required from the participant advising *AEMO* of the reason for the non-conformance. The participant must advise *AEMO* when they are capable of following Dispatch Targets, then the non-conformance declaration can be lifted. There is an optional "Verify Non-Conformance Declaration" function available to the *AEMO* user when operating in this mode. This will hold the process at the NC-Pending Conformance Status until the *AEMO* user confirms the Non-Conformance Declaration. This option may be applied or not at the *AEMO* users discretion.
- Manual, where Conformance Status changes up to the Not-Responding stage only are determined on an automated basis. Any further action to declare plant Non-Conforming is based on *AEMO* user actions. These actions include initiating phone calls to plant operations staff, Non-Conformance and Conformance Declarations, Constraint application, manual logging and Market Notice publication. In Manual mode, Compton is used only as an alarm mechanism for *AEMO* operations staff to take manual action.

Possible status changes in Manual and Auto operating modes are illustrated below. Note that the solid lines (arrows) represent a Conformance Status change based on error counters with no *AEMO* user input. The dotted lines (arrows) represent possible *AEMO* user initiated Conformance Status change.

Figure 4 Status Transition in Manual Mode

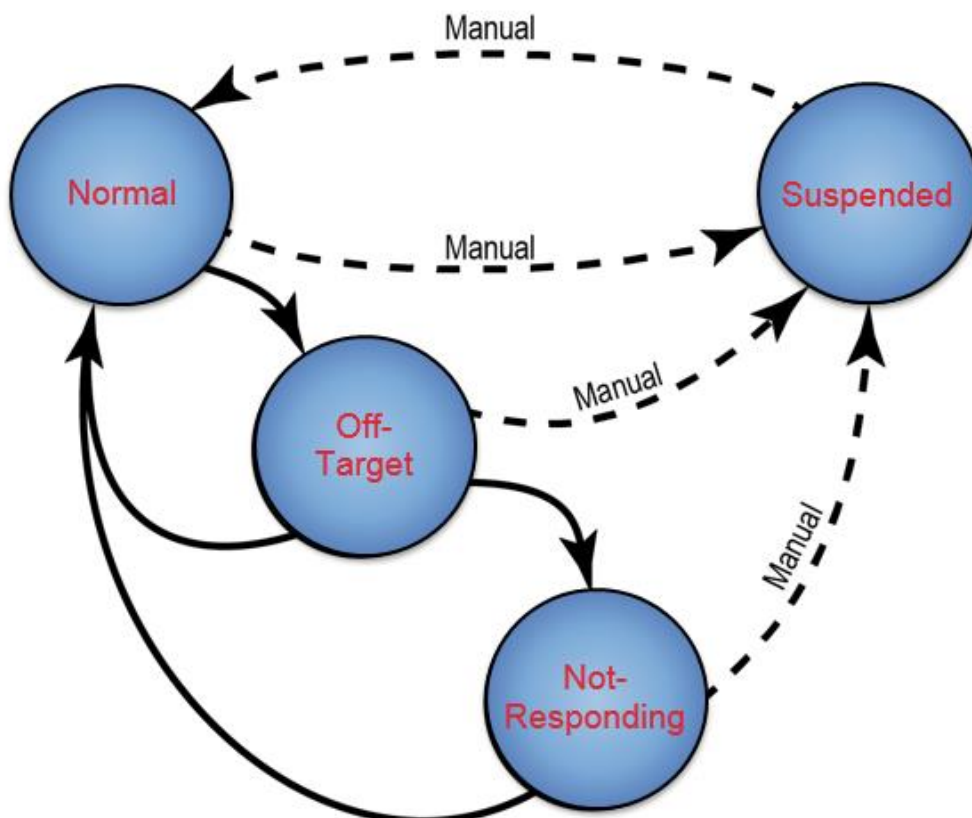
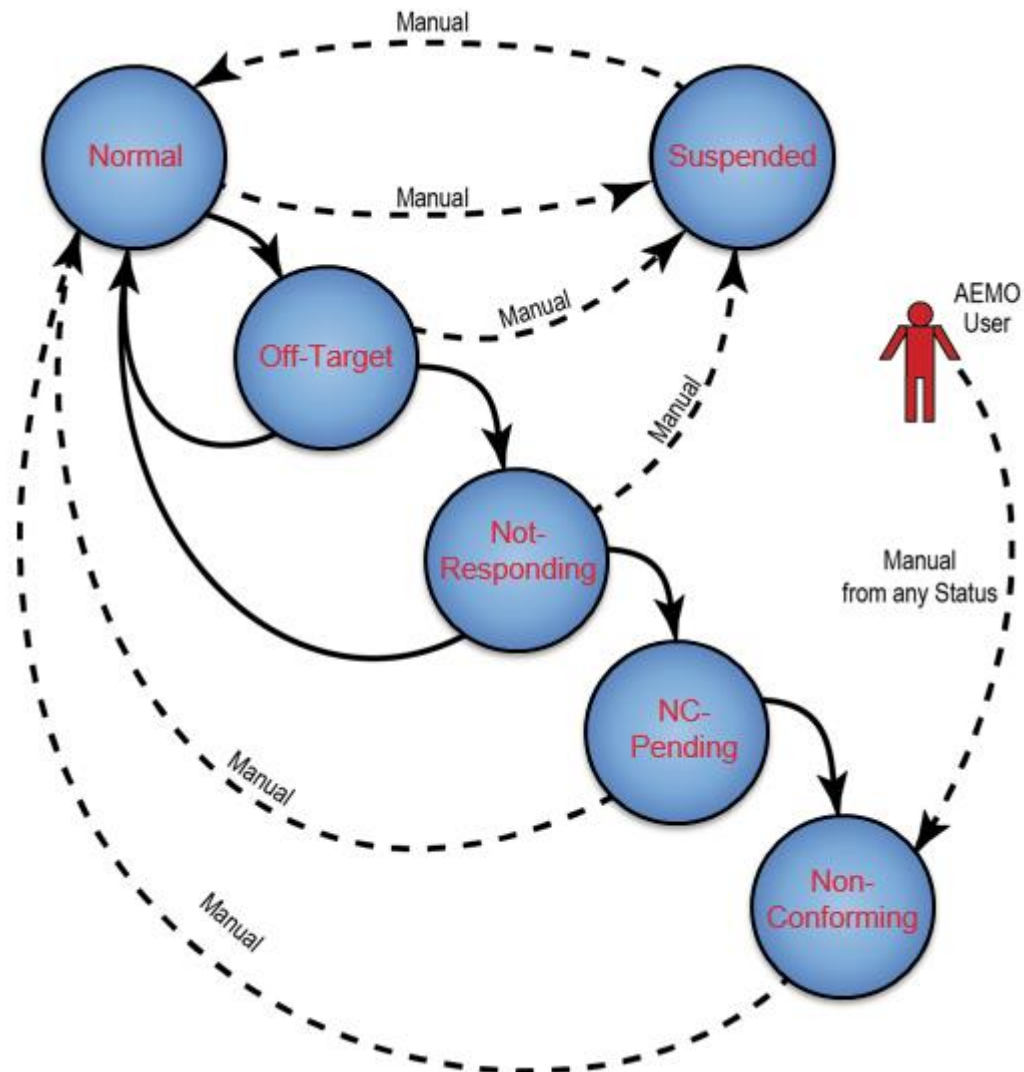


Figure 5 Status Transition in Auto Mode



As can be seen from the illustrations above and the previous descriptions of Conformance Status, plant following target within the error thresholds will have a Conformance status of Normal.

In Manual mode, this will change to Off-Target then to Not-Responding based on error counters. Non-Conformance Declaration by AEMO will then be a manual AEMO user action in this mode. This includes constraint application, logging, market notice issue, and phone conversations with plant control staff regarding the declaration of Non-Conformance. The severity of the Conformance status indicated by the AEMO Conformance Module will be limited to Not-Responding while the manual action takes place. Note that if plant is manually declared Non-Conforming and a non-conformance constraint is applied then it is likely that the reported Conformance Status will revert to Normal as a result of the constraint action.

In Auto mode, the Conformance Status will change to Off-Target, Not-Responding, NC-Pending and Non-Conforming based on error counters.

In either mode, the AEMO user may accelerate the process and declare Non-Conformance at any time or Suspend a unit from taking part in the Conformance process.

The criteria for Conformance Status change in Manual and Auto operating modes is presented in the following two tables. In addition to this information, the AEMO user initiated changes illustrated in the diagrams above are available at the user's discretion in line with current policy.

Table 3 Conformance Status Change in Manual or Auto Modes

Previous Status	Criteria for Conformance Status Change In Manual or Auto Mode	Resulting Status Change
Normal	Large Error Count ≥ 1	Off-Target
Normal	Small Error Count ≥ 1	Off-Target
Off-Target	Large Error Count ≥ 3	Not-Responding
Off-Target	Small Error Count ≥ 6	Not-Responding
Off-Target or Not-Responding	Large Error Count = 0 and Small Error Count = 0	Normal

Table 4 Conformance Status Change in Auto Mode

Previous Status	Criteria for Conformance Status Change In Auto Mode	Resulting Status Change
Not-Responding	Large Error Count ≥ 5	NC-Pending
Not-Responding	Small Error Count ≥ 8	NC-Pending
NC-Pending	The Status in the next dispatch interval will be Non-Conforming.	Non-Conforming

A.4 Information to Participants

A Conformance Data Report will be published to applicable plant following each Conformance Module calculation, once per DI. As well as the relevant unit and time information, the report will contain the following information.

Status

The status of the particular unit following the last conformance module calculation. That is, Normal, Suspended, Off-Target, Not-Responding, NC-Pending, Non-Conforming.

Action Message

An action message is included on the report corresponding to each status as follows:

- Normal: No action required. Unit is following Dispatch Target.
- Suspended: No action required. Unit is excluded from the Conformance process at this time.
- Off-Target: Please move to Dispatch Target or rebid.
- Not-Responding: Please move to Dispatch Target or rebid.
- NC-Pending (Possible in Auto mode only): Unit not responding to Dispatch Target. Non-Conformance action pending.
- Non-Conforming (Possible in Auto mode only): Unit declared Non-Conforming. Non-Conformance Constraint is *invoked*. AEMO is requesting a reason for the Non-Conformance.

Energy values relevant to the specific conformance calculation

- MWB: NEMDE Dispatch Target or Dispatch Level for the DI.
- MW: Actual plant MW at the end of the DI.
- MW Error: Difference between MWB and MW values with allowance for FCR and FCL.

- Max MW Error: Max absolute MW Error since error counters were last zero.

Mode

- "Manual" (AEMO is currently operating in Manual mode)
- "Auto" (AEMO is currently operating in Auto mode)

This Conformance Data Report is expected to be used by plant operating staff during normal operation.

Note 7 If AEMO is operating in Manual mode, the Conformance Status of NC-Pending and Non-Conforming does not exist. As previously discussed, the Declaration of Non-Conformance and Conformance is carried out via phone communication initiated by AEMO.

A.5 Worked Examples

Large Error Example

A hypothetical generating unit A has a bid unit availability of 200 MW and a *ramp rate* of 2 MW/min.

The large error trigger is determined as follows:

- The term representing 5% of the bid unit availability is $5/100 \times 200 = 10$ MW.
- The term representing $4^* [ramp\ rate]$ is $4 \times 2 = 8$ MW.
- The minimum of these two terms (10 MW and 8 MW) is 8 MW.
- The minimum allowable error is 6 MW.
- The maximum of these two terms (6 MW and 8 MW) is 8 MW.
- Therefore the large error trigger is 8 MW.

This means that if the generation or load of the plant differs from its Dispatch Target by more than 8 MW the Conformance Status will be Off-Target. If this occurs for 3 consecutive *dispatch intervals* the Conformance Status will be Not-Responding. If this occurs for five consecutive *dispatch intervals* the Conformance Status will be NC-Pending (only if in Auto mode). The result for the following DI will be Non-Conforming (only if in Auto mode).

Small Error Example

The small error trigger is determined as follows:

- The term representing 3% of the bid unit availability is $3/100 \times 200 = 6$ MW.
- The term representing $2^* [ramp\ rate]$ is $2 \times 2 = 4$ MW.
- The minimum of these two terms (6 MW and 4 MW) is 4 MW.
- The minimum allowable error is 6 MW.
- The maximum of these two terms (6 MW and 4 MW) is 6 MW.
- Therefore the small error trigger is 6 MW.

This means that if the generation or load of the plant differs from its Dispatch Target by more than 6 MW the Conformance Status will be Off-Target. If this occurs for 6 consecutive *dispatch intervals* the Conformance Status will be Not-Responding. If this occurs for 8 consecutive *dispatch intervals* the Conformance Status will be NC-Pending (only if in Auto mode). The result for the following DI will be Non-Conforming (only if in Auto mode).

APPENDIX B. LOGIC USED IN IDENTIFYING DISPATCH INTERVALS AS SUBJECT TO REVIEW AND THE TRIGGER THRESHOLDS

Trigger logic used to identify *dispatch intervals* as subject to review (S):

For each Region

IF {Unusual change in Region Energy Price} AND {Unusual change in any connected Interconnector Cleared Flow}

THEN

Set DI Price Status flag = 'SUBJECT TO REVIEW' (S)

ELSE

IF Previous DI Price Status is either 'SUBJECT TO REVIEW' (S)

OR

'INDETERMINATE' (I)

THEN

Set Current DI Price Status to 'INDETERMINATE' (I)

Note 8 The following table explains the AEMO internal and external flagging of *dispatch intervals* identified as subject to review with the progress of price revision process.

Table 5 Flags used with Dispatch Intervals Subject to Review

AEMO internal flagging	External flagging
'SUBJECT TO REVIEW' and AEMO action pending (up to 30 minutes from the publication of the price for the dispatch interval)	NOT FIRM
'INDETERMINATE' and AEMO action pending	NOT FIRM
'SUBJECT TO REVIEW' was flagged and AEMO has 'Rejected' the published price due to the presence of MII	FIRM
'SUBJECT TO REVIEW' was flagged and AEMO has 'Accepted' the published price since AEMO determined that the dispatch interval was not affected by a MII	FIRM

Trigger for unusual change in the Energy Price of a *region*:

IF EITHER

- The lesser of the absolute values of both the current DI energy price and the previous DI energy price of *Region 'R'* is greater than threshold $\$X_R$

AND

The absolute difference between the current & previous DI energy prices of *Region 'R'* expressed as an absolute percentage change over the lesser of the current & previous DI energy prices, is greater than percentage threshold Y_R

OR

- The lesser of the absolute values of both the current DI energy price and the previous DI energy price of *Region 'R'* is less than or equal to threshold $\$X_R$

AND

The absolute difference between the current & previous DI energy prices of *Region 'R'* is greater than threshold $\$X_R$ multiplied by percentage threshold $Y_R/100$

THEN

An unusual change in *Region 'R'* Energy Price has occurred.

Trigger for Unusual change in the Cleared Flow of any *Interconnector* associated with the *region*:

IF EITHER

For any *interconnector 'I'* connected to *region 'R'*

- The absolute difference between the current & previous DI Cleared Flow is greater than threshold $Q_{(R,I)}$

OR

For all *interconnectors 'I'* connected to the *Region 'R'*

- Cleared Flow = zero MW for both the current & previous DIs.

THEN

An unusual change in connected *Interconnector* Cleared Flow has occurred.

Trigger Thresholds

Table 6 Region Energy Price Trigger Thresholds

Region Energy Price Change Triggers	Default Values	
	$\$X_R$ (\$/MWh)	Y_R (%)
QLD1	20	300
NSW1	20	300
VIC1	20	300
SA1	20	300
TAS1	20	400

Table 7 Region-Interconnector Flow Change Trigger Thresholds

Region-Interconnector Flow Change Trigger $Q_{R,I}$ (MW)	QNI	Terranora	Vic-NSW	Heywood	Murraylink	Basslink
QLD1	240	80				
NSW1	450	80	500			
VIC1			500	150	100	190
SA1				150	100	
TAS1						190

APPENDIX C. HISTORY OF VERSION RELEASE DETAILS

Version	Effective Date	Summary of Changes
86.0	11 February 2019	Section 8.3 removed. Non-Physical Loss (NPL) obsolete with NEMDE V3.3.8 upgrade using Special Order Set 2 (SOS2). There is an option to use or not use SOS2.
85.0	26 July 2018	Added requirement for linear ramping for semi-scheduled generating units in section 2.2. Obsolete references removed. NER-defined terms italicized
84.0	14 August 2017	Updated the procedure to match automated processing messages sent to participants. Added clause on linear ramping in section 2.
83.0	14 November 2016	Periodic review
82.0	24 June 2016	Updated Section 9 to reflect rule change for minimum ramp rate requirements
81.0	11 December 2015	Reduce change history to only 1 page (most recent). Remove 'Next Review' box for online documents. Update the automated processing message sent to participants in section 3.2.2.
80.0	23 October 2014	Removed section 3 and Appendix D
79.0	16 May 2014	Update section 2 Remote AGC selection Added Section 3 and appendix D Clarified phone communication requirements for non –conformance Appendix A.3 Changes made to incorporate addition of solar generation forecasts (ASEFS) to market systems processes.
78.0	20 August 2013	Applied changes to reflect new CVP factors in constraints. Update interconnector flow change trigger thresholds of Heywood and Murraylink
77.0	07 May 2013	Transferred content to new template. Added SO_OP_3709 Section 12-13 into Section 22-23.
76.0	03 January 2013	Section 18.2 clarified due to negative settlement residues automation project.
75.0	19 September 2012	Section 12.1 clarified participants must advise AEMO of any work that may impact SCADA values
74.0	01 July 2012	Reference to CPT updated in section 16.4.
73.0	01 May 2012	Section 3.3 revised.