DISPATCH

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History

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86	11/02/2019	C Wu	M Sanders	B Nelson	T Van Der Walt	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.
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81	11/12/2015	C Wu	N White		J Spurio	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 6.2.2.
80	23/10/2014	T van der Walt F Boros	P Ryan	C Brownlee	M Stedwell	Removed section 6 and Appendix D
79	16/05/2014	P Ryan T van der Walt	T van der Walt	C Brownlee	M. Stedwell	Update section 5 Remote AGC selection Added Section 6 and appendix D Clarified phone communication

Version	Date	Author	Checker	Endorser	Approver	Comments
						requirements for non – conformance Appendix A.3 Changes made to incorporate addition of solar generation forecasts (ASEFS) to market systems processes.
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75	19/09/2012	J. Zhai	P. Biddle	H .Gorniak	M. Lyons	Section 15.1 clarified participants must advise AEMO of any work that may impact SCADA values
74	01/07/2012	P. Uribe	S. Mathur		H. Gorniak	Reference to CPT updated in section 19.4.
73	01/05/2012	P. Biddle	G. Gillin		H. Gorniak	Section 6.3 revised.

Contents

Figures

Tables

Glossary

a) In this document, a word or phrase *in this style* has the same meaning as given to that term in the NER.

b) In this document, capitalised words or phrases or acronyms have the meaning set out opposite those words, phrases, or acronyms in the table below.

c) Unless the context otherwise requires, this document will be interpreted in accordance with Schedule 2 of the *National Electricity Law*.

Table 1 Glossary

Term	Meaning
AEMC	Australian Energy Market Commission
AGC	Automatic Generation Control
EMMS	Electricity Market Management System
FCAS	Frequency Control Ancillary Service
MPC	*Market Price Cap*
NEMDE	National Electricity Market Dispatch Engine
NER	National Electricity Rules
NSP	*Network Service Provider*
RTU	Remote Terminal Equipment
SCADA	Supervisory Control and Data Acquisition

1 Introduction

a) This Dispatch procedure is a *power system operating procedure* made in accordance with clause 4.10 of the National Electricity Rules (NER).

b) If there is any inconsistency between this Procedure and the National Electricity Law (NEL) or the NER, the NEL and NER will prevail to the extent of that inconsistency.

2 Purpose

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

3 Application

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

4 Related Policies and Procedures

Table 2 Related policies and procedures

Policies and Procedure	Title
SO_OP_3708	Non Market Ancillary Services
SO_OP_3710	Load Forecasting
	AEMO website: Over-Constrained Dispatch Rerun Process
	AEMO website: Constraint Implementation Guidelines
	AEMO website: Constraint Formulation Guidelines

5 Dispatch Instructions

Dispatch targets for all *scheduled generating units*, *semi-scheduled generating units*, *scheduled network services* and *scheduled loads* are derived by NEMDE after co-optimising the energy market with the FCAS market.

Where possible, *dispatch instructions* will be issued electronically via the *automatic generation control system* (AGC) or the *AEMO* Electricity Market Management System (EMMS) interfaces.

It is the responsibility of *Generators* to notify *AEMO* when *dispatch instructions* are required to be issued electronically via the AGC. *Generators* will not be *dispatched* for *regulation services* or paid for *regulation services* until the unit is selected to remote AGC at *AEMO*.

As part of a *dispatch instruction*, NER 4.9.5(a)(3) requires *AEMO* to specify a *ramp rate* or a specific target time to reach the outcome specified in the *dispatch instruction*.

Absent a specified *ramp rate*, *scheduled generating units* and *scheduled loads* that are not on AGC are expected to ramp linearly from their initial energy output or consumption to their dispatch target applying at the end of the 5-minute *dispatch interval*.

Generating units with bid *dispatch inflexibility profiles* will receive *commitment* and *dispatch instructions* via the *AEMO* EMMS interfaces. *Dispatch instructions* may also be issued via AGC if available.

Semi-scheduled generating units will receive *semi-dispatch interval* flag status and *dispatch instructions* via the *AEMO* EMMS interfaces.

AEMO may issue *dispatch instructions* in some other form if in its reasonable opinion the normal processes are not available.

5.1 Automatic Generation Control

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

- 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.
- 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.

5.2 Semi-Scheduled Generating Units

Semi-scheduled generating units are those *generating units* registered in accordance with NER clause 2.2.7. Generally these *generating units* will be:

- Greater than 30 MW and
- *Intermittent* generation (typically, wind and solar farms)

The *dispatch instruction* for a *semi-scheduled generating unit* requires that unit's *active power* output to be capped at the *dispatch level* set by *AEMO* only when its *semi-dispatch interval* flag is set to 'TRUE'. This is called its "semi-dispatch cap".

NER 4.9.5(a)(3) also requires *AEMO* to specify a *ramp rate* or a specific target time to reach the outcome specified in the *dispatch instruction*.

Absent a specified *ramp rate*, the *semi-scheduled generating unit* is expected to ramp linearly from its initial *active power* output to its semi-dispatch cap applying at the end of the 5-minute *dispatch interval*, subject to energy availability.

This requirement applies to s*emi-scheduled generating units* that have an *active power control system* capable of linear ramping as agreed in the relevant *performance standard*.

When the *semi-dispatch interval* flag is set to 'FALSE' the *semi-scheduled generating unit* is free to generate at any level.

Refer to Appendix C for information on the management of *Semi-Scheduled Generators* (wind and solar farms).

5.3 Dispatch of Non-Market Ancillary Services

Refer to SO_OP_3708 Non-Market Ancillary Services.

6 Non-Conformance with Dispatch Targets

6.1 Principles of Compliance Monitoring (Energy Market)

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

Two trigger mechanisms are utilised to identify the severity of Non-Compliance. 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-Compliance 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.

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

6.1.1 FCAS Conformance

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

6.1.2 Conditions for Semi-Dispatch Compliance

The *central dispatch* process determines for each *semi-scheduled generating unit* both a dispatch cap and an associated "semi-dispatch compliance" requirement flag, and electronically issues these quantities confidentially to the relevant *Semi-Scheduled Generator*.

A *semi-scheduled generating unit* only needs to comply with its dispatch cap (as a maximum generation limit) for *dispatch intervals* where the "semi-dispatch compliance" requirement flag for that *dispatch interval* is also set.

The "semi-dispatch compliance" requirement flag is set when either one of the following conditions is satisfied:

- Dispatch Cap limited by Binding or Violated Network or FCAS Constraint
    - The generating unit's forecast output (its dispatch cap) is explicitly limited by any binding or violated network or FCAS constraint equation, and if the actual output were to exceed the dispatch cap value this would result in violating (or further violating) that network or FCAS constraint equation;

OR

- Dispatch Cap otherwise below the Unit's *unconstrained intermittent generation forecast*
    - The generating unit's forecast output (its dispatch cap) is not explicitly limited by a binding or violated network constraint equation

      BUT
    - The generating unit's dispatch cap is less than its *unconstrained intermittent generation forecast* as a result of either a purely inter-regional limitation, or an offer or market-related limitation, the latter including:
        - Unit Ramp Rate
        - Unit Fixed Loading Level
        - Non-dispatch of uneconomic price bands
        - Marginal dispatch of economic price bands

When one of the above “semi-dispatch compliance” conditions is met for a particular *semi-scheduled generating unit*, its “semi-dispatch compliance” requirement flag is set for that *dispatch interval* (called a *semi-dispatch interval*) and the generating unit is “semi-dispatched”.

For all other *dispatch intervals* where neither of the above conditions is met for a particular *semi-scheduled generating unit*, its “semi-dispatch compliance” requirement flag is reset for that *dispatch interval* (called a *non semi-dispatch interval*) and the *generating unit* is “non-semi-dispatched”.

The *AEMO* Compliance 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 Compliance action then follows in a Manual or Automated manner with the automated option only applying to *generating units*.

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

6.2 Generating Units and Network Services

Plant in this category may be processed by *AEMO* in a Manual or Automated manner. The Compliance Data Report indicates the mode of operation at any time. Manual and Automated processing are as follows:

6.2.1 Manual Processing

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

- Identify non-responsive *scheduled generating unit*, *semi-scheduled generating unit* or *scheduled network service* using *AEMO* Compliance Module.
- Contact participant and request a reason for the non-compliance to the *dispatch instruction*. Log the reason given. Note that the Compliance Data Report is available to the participant each *dispatch interval*, so any non-response issue should have already been observed. The Compliance Status at this point will be Not-Responding. Note that in Manual operating mode, the Compliance Status as reported by the Compliance Module will not advance beyond Not-Responding. All subsequent actions are manually applied and involve phone communication between *AEMO* and the participant.
- If modification to the bid is necessary to achieve a realistic real-time dispatch, request the participant to submit a *rebid* to reflect the current performance of the plant.
- If the participant fails to follow the dispatch targets or to submit a *rebid* within two *dispatch intervals*, the *Scheduled Generator* or *Semi-Scheduled Generator* 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.
- The 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 Compliance Status returning to Normal. This is to be expected as the error has been corrected and the Non-Conforming declaration is being processed manually.
- 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 Participant that it is now capable of following *dispatch instructions*.

6.2.2 Automated Processing

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

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

6.3 Scheduled Loads

Plant in this category will be processed by *AEMO* in a Manual manner only. The Compliance 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:

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

- *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*.
- 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.
- The 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 Compliance Status returning to Normal. This is to be expected as the error has been corrected and the Non-Conforming declaration is being processed manually.
- The *scheduled load* is to remain at the loading determined by the non-conformance constraint until *AEMO* is advised by the Participant that it is now capable of following *dispatch instructions*.

6.4 Conditions to apply to Fast Start registered generating units

Registered Fast Start units will immediately be declared non-conforming if:

- A unit has synchronised and increased its generation level greater than 0 MW without having received a *dispatch instruction* from *AEMO*, OR
- A unit has received a *dispatch instruction* to reduce to 0 MW and fails to meet that *dispatch instruction*.

The declaration of non-conformance will remain in place until such time that *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 Compliance Module. In either case *AEMO* will initiate communication with the participant for any accelerated Non-Conformance Declaration.

Appropriate participant staff should contact *AEMO* when the unit is able to follow dispatch targets.

These provisions enable units to *decommit* if they receive a start signal but decide not to generate.

6.5 Non-Conformance constraints

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.

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.

6.6 Market Reporting of Non-Conformance

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

- identity of the *scheduled generating unit*, *semi scheduled generating unit, scheduled load* or *scheduled network service*
- *trading intervals* affected
- magnitude of non-conformance (the difference between the actual generation and the dispatch target)
- the reason for the non-conformance

6.7 Accelerated non-conformance process

It is to be noted that at any stage of pursuing the non-conformance, if the participant who owns 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.

7 Commitment and De-commitment of Scheduled Generating Units

7.1 Self-Commitment

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*.

National Electricity Rules clauses 4.9.6(a)(1) and 4.9.7(a) 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*.

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*.

7.2 Fast-Start Generators that choose not to Self-Commit

Fast-start generators that choose not to *self-commit*, are subject to the same obligations as all the 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 generators 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.

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.

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.

8 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*.

8.1 Over Constrained Dispatch (OCD) Re-Runs

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.

The OCD re-run process is initiated when:

- An *interconnector*, intra-regional network or FCAS constraint is violated

AND

- An energy *dispatch price* is greater than or equal to MPC or;
- An energy *dispatch price* is less than or equal to the *Market Floor Price* or
- Any *market ancillary service* price is greater than or equal to MPC.

Refer to the flowchart below for further clarification of the OCD process. Section 5 also includes a reference to the *AEMO* website.

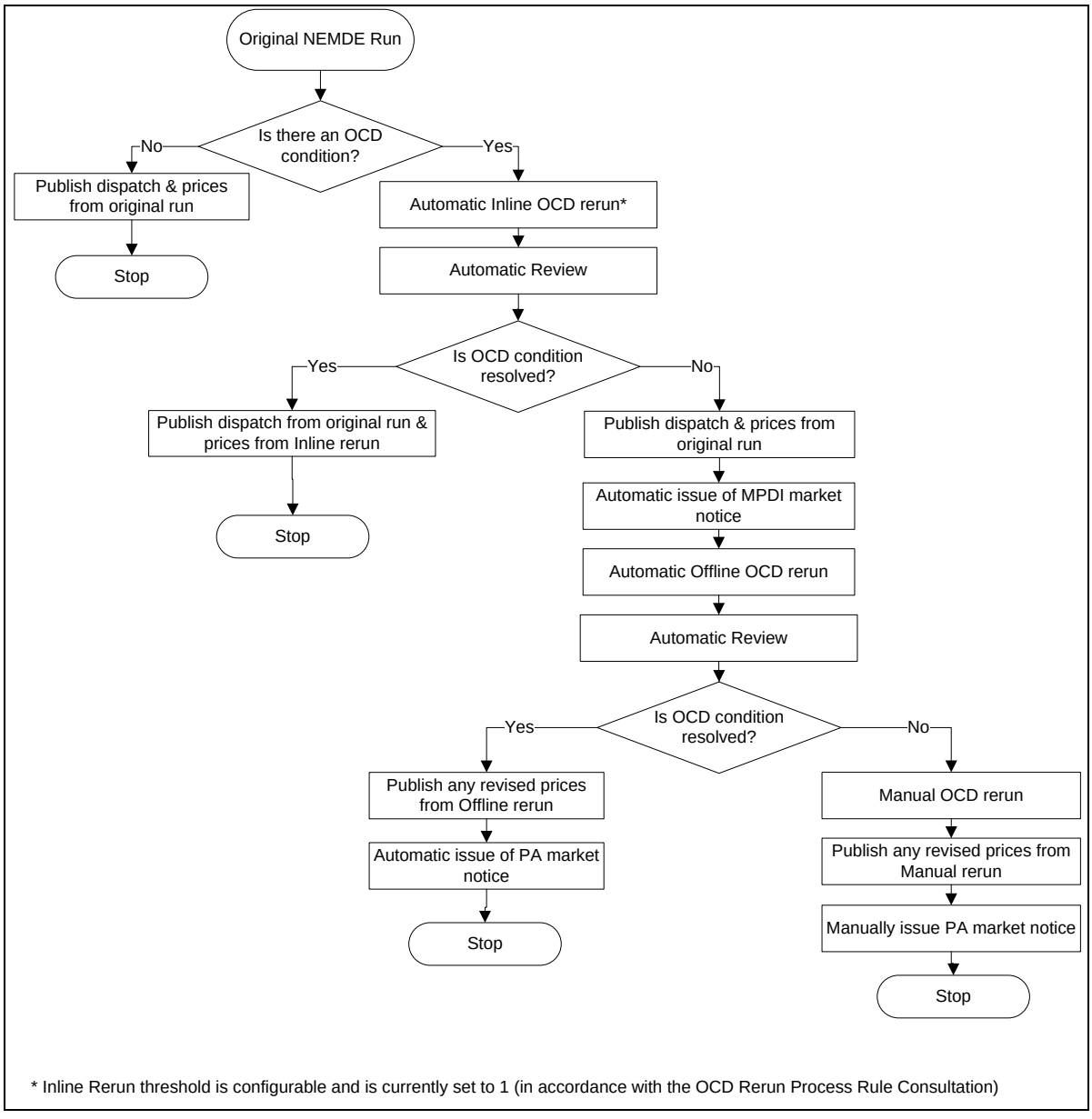

Figure 1 Over Constrained Dispatch Re-run Flow Diagram

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.

Commitment of fast start plant is determined on the basis of the unit *commitment* undertaken prior to the initial unrelaxed pricing run.

If the OCD is resolved after the Automatic Inline review then no market notice will be issued.

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.

8.2 NEMDE second run for Basslink dispatch

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*:

- 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.
- 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.

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.

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:

- 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.
- A reduction in unnecessary counter price flows across the Basslink HVDC interconnector.

9 Aggregate Dispatch Error

9.1 Background

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.

- ADE = Target value – Actual Value

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.

The resulting ADE value for each region is then added to the respective region demand forecast in the next *dispatch interval*.

9.2 ADE calculation

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*.

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.

- Time Weighted Average ADE = ((Sample 1 * Weight1) + (Sample2 * Weight2) +… + (Sample6 * Weight6)) / (Weight1 + Weight2 + . … + Weight6)

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

9.3 Frequency element in ADE

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

To ensure short duration frequency excursions are not passed to the ADE calculation the frequency input is a 60 second time weighted average.

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.

- Time Weighted Average Hz = ((Sample 1 * Weight1) + (Sample2 * Weight2) +…(Sample6 * Weight6)) / (Weight1 + Weight2 +. …Weight6)

A separate calculation is performed for each NEM region.

The frequency dead bands are:

- Tasmania ±0.05Hz
- Other regions ±0.025Hz

9.4 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:

- Queensland, New South Wales and Victoria = ±50 MW
- South Australia ±25 MW
- Tasmania ±25 MW.

10 Directions and Intervention Pricing

NER clause 3.9.3 (a) states, “In respect of a *dispatch interval* where a *AEMO intervention event* occurs *AEMO* must declare that *dispatch interval* to be an *intervention price dispatch interval*”.

Under these conditions *AEMO* may initiate ‘intervention’ or ‘What If’ pricing if the RRN test is passed unless reserve trader is invoked then intervention pricing will be initiated automatically. If the RRN test is passed and *AEMO* applies intervention pricing NEMDE will do an intervention price run after completion of the dispatch or outturn run. The first dispatch run (outturn run) which includes the reserve contract or direction in the form of a constraint is used to determine dispatch targets. The second dispatch run (intervention price or what if run) is used to determine *dispatch prices* and does not contain the *reserve contract* or direction constraint.

For more information regarding Directions and Intervention Pricing refer to SO_OP_3707 Intervention, Direction and Clause 4.8.9 Instructions.

11 Review of Constraints

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.

Until the constraints are revised, the power system will be managed by Contingency Analysis, Constraint Automation and/or discretionary constraints.

12 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.

12.1 Up and Down Ramp Rate Requirements

Aggregated[1] *scheduled generating units*, *semi-scheduled generating units*, *scheduled loads* and *scheduled network services* have higher *minimum ramp rate requirements* than non-aggregated generators, loads and network services.

- For *scheduled network services* or *scheduled loads*:
  - If aggregated, Minimum *Ramp Rate* = 3 x No. of units within the aggregation
  - If non-aggregated, Minimum *Ramp Rate* = 3 MW/min
- For *scheduled generating units*:
  - If aggregated, Minimum *Ramp Rate*

    = Sum[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.
  - If non-aggregated, Minimum *Ramp Rate*

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

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

    = Minimum (3 MW/minute, 3% of the maximum capacity).

[1] 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.

At the time of publication of this procedure, there are no aggregated *semi-scheduled generating units* in the NEM. Though some *semi-scheduled generating units* have more than one cluster within them, Rule Clause 2.2.7(i) allows for such generators to be registered as one *semi-scheduled generating unit* and treated as non-aggregated as per Rule Clause 3.8.3 (i).

- 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*.

12.2 Ramp Rate Less than Requirements

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

- The r*amp rate* provided must be the maximum the plant can safely attain at that time.
- 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.

12.3 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:

- The *maximum ramp rate* provided must be the maximum the relevant plant can safely attain at that time.
- The participant must provide a brief, verifiable and specific reason why the *maximum ramp rate* is below the requirements.
- 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.

12.4 Minimum Safe Operating Level

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.

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.

In instances where a *Scheduled Generator* or *Semi-Scheduled Generator* 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*.

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.

The complete "Rebidding and Technical Parameters Guideline" can be found on the AER website.

13 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 >=X MW (where X is the megawatt amount subject to the network support agreement) and will have a constraint violation penalty (CVP) of 30.

14 Outages and Work on Market Related SCADA

14.1 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. 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. 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.

15 Mandatory Restrictions

Mandatory restrictions are defined as the restrictions imposed by a *participating jurisdiction* by a relevant law, other than the rules, on the use of electricity in a *region*. The jurisdictions can decide to use *mandatory restrictions* whenever supply scarcities are predicted, to achieve desired levels of load reductions in *regions* while minimising overall impact to the customers by avoiding *involuntary load shedding*.

Clause 3.12A of the NER gives the obligations of *AEMO* and the *Registered Participants* with regards to the management of *mandatory restrictions*. Refer to the Operating Procedure SO_OP_3713 Mandatory Restriction Offers for the details of the processes to be followed by *AEMO* and the *Registered Participants* in the event of jurisdictions imposing *mandatory restrictions*.

16 Scheduling Error and Process Review

A *scheduling error* is one of the following circumstances (clause 3.8.24 of the NER):

- The *dispute resolution panel* determined under clause 8.2 of the NER that *AEMO* has failed to follow the *central dispatch* process set out in clause 3.8 of the NER.
- *AEMO* declares that it failed to follow the *central dispatch* process as set out in clause 3.8 of the NER
- *AEMO* determines under clause 3.9.2B(d) of the NER that a *dispatch interval* contained a manifestly incorrect input

If *AEMO* identifies a potential failure by *AEMO* to follow the *central dispatch* process, *AEMO* will issue a market notice stating that *AEMO* is undertaking a process review and that *AEMO* is reviewing whether *AEMO's* action during that particular period were in accordance with the Rules and *AEMO*'s operation procedures.

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* would declare that a *scheduling error* has occurred and issue an AEMO Communication to advise *Market Participants* of the event.

17 Setting MPC Override

17.1 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
- *AEMO* issues an instruction to load shed in that *region*, then from the time that the *AEMO* instruction is to apply
- 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.

17.2 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*.

18 Administered Price Periods

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

18.1 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:

- The sum of the uncapped spot prices for that *region* over the previous 336 *trading intervals* (7 days) exceeds the *cumulative price threshold*; or
- 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
- Refer 18.2.

18.2 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.

18.3 Dispatch during Administered Price Period

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

18.4 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.

18.5 Pricing during Administered Price Periods

18.5.1 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*:

- If the *dispatch price* exceeds the APC, then *AEMO* must set the *dispatch price* to the APC.
- If the *dispatch price* is less than the *administered floor price*, *AEMO* must set the *dispatch price* to the *administered floor price*.
- 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.

18.5.2 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:*

- 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.

19 Manifestly Incorrect Input/s (MII) and Price Review

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

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.

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.)

19.2 Manifestly Incorrect Inputs and revision of prices

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:

- SCADA measurements of power system
- Five minute demand forecast values

- Constraint equations entered by *AEMO*
- Software setup

If *AEMO* staff determine that the *dispatch interval* in question was affected by a MII, all the published prices for the "affected" *dispatch interval*s 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*).

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*.

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 interval*s will automatically be accepted and their Price_Status flags will change to "Firm".

19.3 Dispatch intervals following a dispatch interval identified as subject to review

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).

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 interval*s. 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 interval*s with Price_Status flag "Not Firm" following the first *dispatch interval* until *AEMO* completes the price review process.

19.4 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*.

19.5 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 8.1). *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 8.1.

20 Negative Settlements Residues

20.1 General Approach

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.

These constraints would remain in place until, in *AEMO*'s reasonable opinion, the constraints could be revoked without creating counter-price flows.

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).

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.

20.2 Constraints in Dispatch

To halt further accumulation of negative *settlements residues AEMO* will constrain the d*irectional 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:

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

20.3 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.

- The *directional interconnector*
- The actual or forecast times of the event
- Any constraints invoked to manage the event

21 Requests for clarification of market reports or for additional information

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:

1) All requests for further information about specific market notices should be to the AEMO Information and Support Hub.

2) At times when the Information and Support Hub is not staffed then all enquiries from energy traders will be handled by the control centres.

The response will depend on the nature of the enquiry as follows:

- If the enquiry involves a confidential matter for that energy trader then the question will be directly answered
- 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.
- If the enquiry involves *confidential information* to which that energy trader is not entitled, then a response will not be provided

22 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:

- Predefined constraint sets prepared for system normal conditions
- Predefined constraint sets prepared for routine *transmission network* outages
- Blocking constraint equations
- Predefined discretionary constraint sets
- Quick constraints
- Constraint sets and/or equations built by control room staff as a need arises
- 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.

22.1 System Normal and Network Outage Constraints

A system security issue may arise at any time under system normal conditions, network outage conditions or following the occurrence of a contingent event. Generally, if predefined generic constraints are available for a system normal or network outage condition then they will be invoked in the MMS.

In the case of a contingent 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*.

22.2 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 11 for more details about when *AEMO* may block a constraint equation.

22.3 Discretionary and Quick Constraints

There is a predefined series of constraints referred to as discretionary constraints. These are generally simple format constraints with either a generator, a collection of generators, 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.

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:

- A Single generator or interconnector.
- Multiple generators or interconnectors.
- FCAS for any combination of selected regions or for a single generator.

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.

22.4 Generic Constraints Built as Required by Control Room Staff

The case may arise where 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.

22.5 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

22.6 Network Constraint Ramping.

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:

- 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.
- 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:
    - 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 interval*s prior to the completion of hard constraint ramping.
    - 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.

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 interval*s 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.

The timing in which the ramping process should be invoked and revoked is determined by the number of *dispatch interval*s 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.

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.

The ramping process would not apply to FCAS constraint sets or any network outage constraint sets that have FCAS terms in their LHS.

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.

The ramping constraint sets and constraints will be named as follows

- Constraint Set: #R<RAMP_SEQ>_RAMP
- Soft Constraint: #R<RAMP_SEQ>_nnn_RAMP_V
- Hard Constraint: #R<RAMP_SEQ>_nnn_RAMP_F

Where the <RAMP_SEQ> is a six digit unique number.

Constraint ramping will not be used for situations where *AEMO* reclassifies a non-credible contingency as a credible contingency.

23 *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.

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

23.1 *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:

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

23.2 *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.

23.3 *AEMO* Action for Binding Constraints

Clause 3.8.1(a) in the Rules states that *AEMO* must operate a *central dispatch* process to *dispatch scheduled generating units*, *semi-scheduled generating units*, *scheduled loads*, *scheduled network services* and *market ancillary services* in order to balance power system supply and demand, using 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*.

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.

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-Compliance Calculations and Process Overview

A.1 Overview

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

The Compliance calculation includes all applicable items of plant in the NEM, these are:

- *Scheduled generating unit*
- *Semi-scheduled generating*
- *Scheduled network services*
- *Scheduled loads*

The following abbreviations are used in this Appendix:

- MW = Actual Generation.
- MWB = Dispatch Target; *Dispatch Level* for a Semi Scheduled Unit.
- MWO = Bid Unit Availability; UIGF for a Semi Scheduled Unit.
- ROC = Rate of Change or Ramp Rate of a Unit.
- FCR = FCAS Raise Regulation Band (enabled).
- FCL = FCAS Lower Regulation Band (enabled)

A.2 Compliance Calculations

Detection of Non-Compliance 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: MAX (6, MIN [3% MWO, 2*ROC])

Large Error Trigger threshold:
Trigger level (MW) is: MAX (6, MIN [5% MWO, 4*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 progress Non-Compliance action.

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

- For error detection above MWB
  - If MW - (MWB + FCR) > Small Trigger Threshold
    - Then Increment Small Error Counter

- If MW - (MWB + FCR) > Large Trigger Threshold
  - Then increment Large Error Counter
- For error detection below MWB
  - If (MWB - FCL) - MW > Small Trigger Threshold
    - Then increment Small Error Counter
  - If (MWB - FCL) - MW > 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-Compliance 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 for semi-scheduled units are:

- If SemiDispatchCap status = 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 unit is operating at or above Dispatch Level and SemiDispatchCap status = True. For this case there is no reset of the error counters and the process is the same as a Scheduled unit.

A.3 Compliance Status

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

Possible Compliance 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 Compliance Process.

Compliance 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 Compliance 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 Compliance Status until the *AEMO* user confirms the Non-Conformance Declaration. This option may be applied or not at the *AEMO* users discretion.

- Manual, where Compliance 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, Compmon 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 Compliance Status change based on error counters with no *AEMO* user input. **The dotted lines (arrows) represent possible *AEMO* user initiated Compliance Status change.**

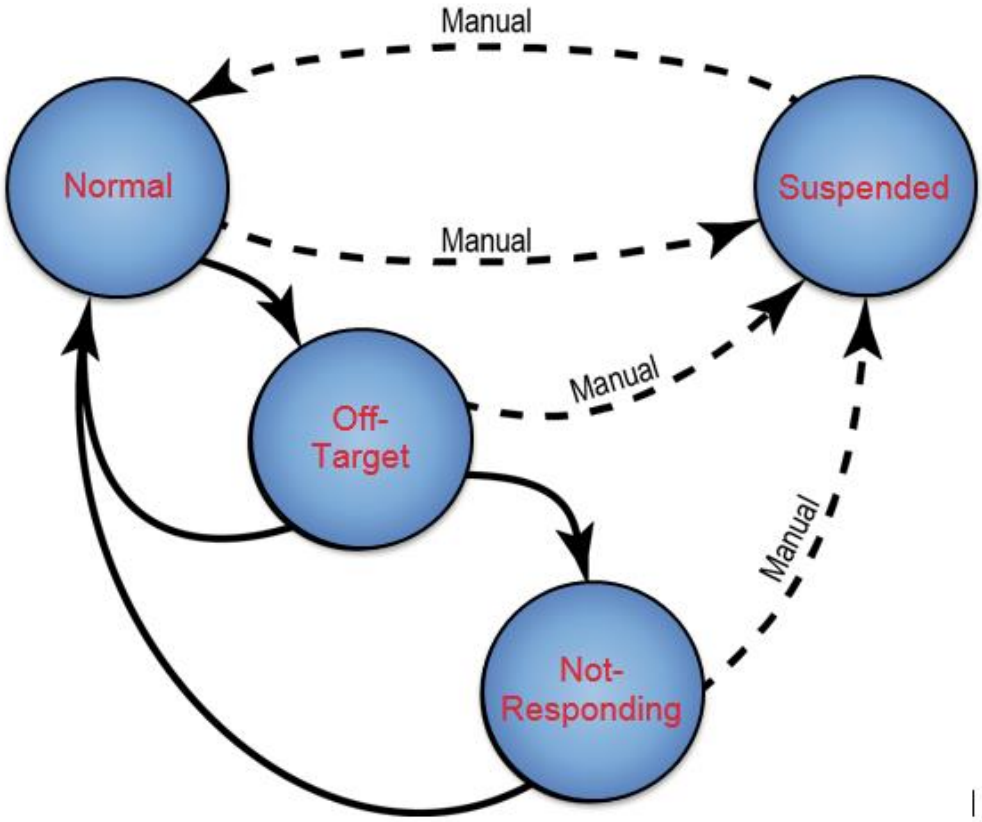

Figure 2 Status Transition in Manual Mode

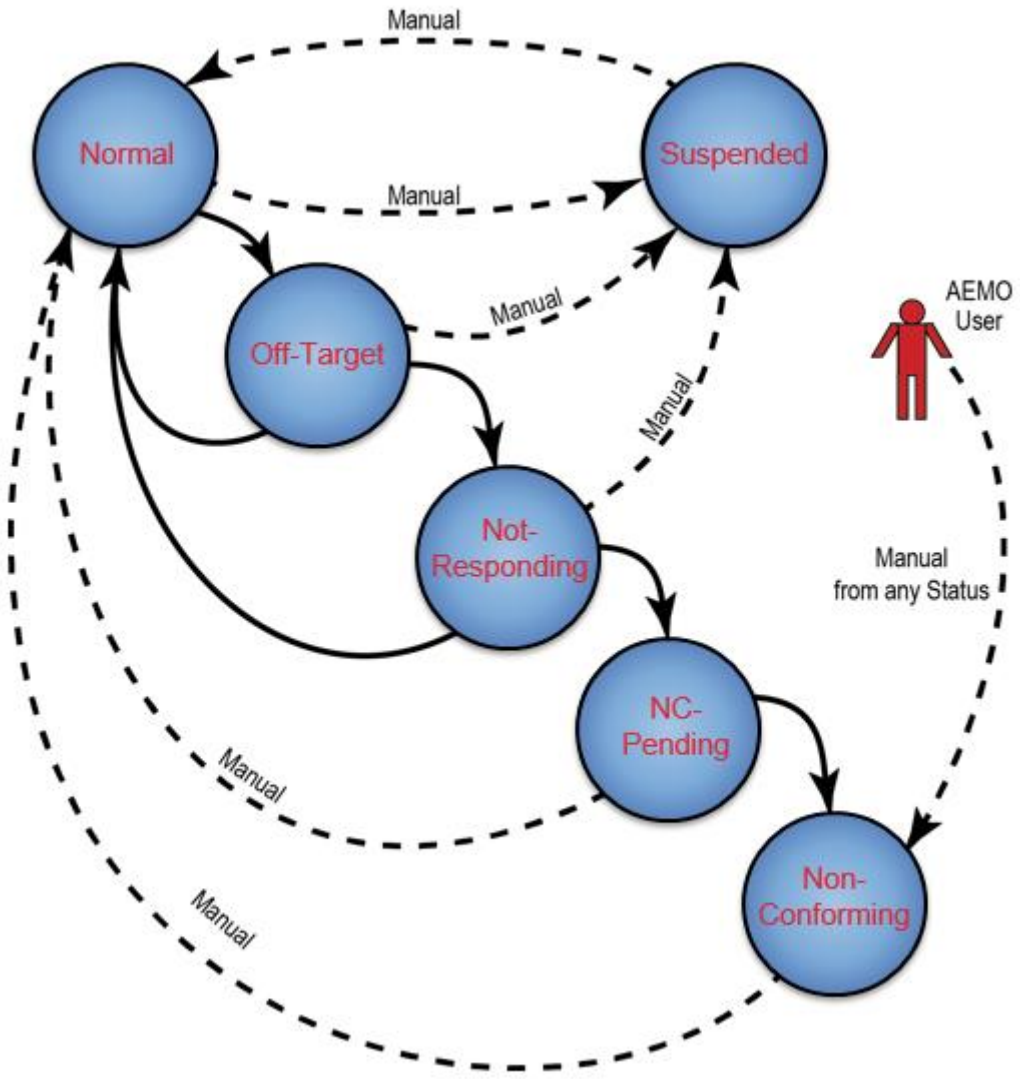

Figure 3 Status Transition in Auto Mode

As can be seen from the illustrations above and the previous descriptions of Compliance Status, plant following target within the error thresholds will have a Compliance 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 Compliance status indicated by the *AEMO* Compliance 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 Compliance Status will revert to Normal as a result of the constraint action.

In Auto mode, the Compliance 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 Compliance process.

The criteria for Compliance 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 Compliance Status Change in Manual or Auto Modes

Previous Status	Criteria for Compliance 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 Compliance Status Change in Auto Mode

Previous Status	Criteria for Compliance 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 Compliance Data Report will be published to applicable plant following each Compliance 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 compliance 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 Compliance 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 compliance 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 Compliance Data Report is expected to be used by plant operating staff during normal operation.

Note 7	If *AEMO* is operating in Manual mode, the Compliance 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 x 200 = 10 MW.
- The term representing 4* [*ramp rate*] is 4 x 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 Compliance Status will be Off-Target. If this occurs for 3 consecutive *dispatch intervals* the Compliance Status will be Not-Responding. If this occurs for five consecutive *dispatch intervals* the Compliance 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 x 200 = 6 MW.
- The term representing 2* [*ramp rate*] is 2 x 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 Compliance Status will be Off-Target. If this occurs for 6 consecutive *dispatch intervals* the Compliance Status will be Not-Responding. If this occurs for 8 consecutive *dispatch intervals* the Compliance 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 Management of semi-scheduled generators

C.1 Process inputs

The *dispatch* of semi-scheduled wind and solar farms depend on the output from the Australian Wind Energy Forecasting System (AWEFS) and Australian Solar Energy Forecasting System (ASEFS) respectively.

SCADA is the primary input for the production of the *Unconstrained Intermittent Generation Forecast* (UIGF) used in the dispatch time frame to produce the *dispatch* targets. The table below lists the SCADA items used for generating the forecasts in AWEFS and ASEFS.

AWEFS	ASEFS
Active Power generation (MW)	Active Power generation (MW)
Wind farm control system set point (MW set point)	Active Power Control set point (MW set point)
No. of Turbines ON (actively generating)	Barometric pressure
No. of Turbines Available	No. of inverters available
Wind Speed	Wind Speed
Wind Direction	Wind Direction
Ambient Temperature	Ambient Temperature
	Module Surface Temperature
	Global Horizontal Irradiance
	Global Inclined Irradiance
	Relative Humidity

All SCADA must be operational at least 10 business days prior to first generation from the intermittent generator to allow sufficient time for integration into the AWEFS/ASEFS production system. Failure to do this will result in inaccurate forecast outputs and potential non-compliance issues.

If any of the above SCADA inputs fail, the forecasting systems will not use this data, and will revert to using forecast weather and turbine availability information to produce the five minute ahead dispatch forecast, resulting in a potentially inaccurate forecast. Failed SCADA must be rectified as soon as possible.

C.2 The semi-dispatch process

For all *Semi-Scheduled Generators*, the AWEFS (for wind farms) or ASEFS (for solar farms) UIGF forecasts are used in place of the generating unit availability normally provided by a generator as part of the bidding process.

The National Electricity Market Dispatch Engine (NEMDE) will then *dispatch* the *semi-scheduled generating unit* in a similar manner to a normal *scheduled generating unit* based on the bid information provided and the UIGF provided from AWEFS/ASEFS, with the only difference being that a semi-scheduled cap flag will also be provided. This flag may be set on the basis of constraint limitations or bidding reasons.

If this cap is set to false then the intermittent generator is not required to follow *dispatch* targets and will not be considered by the non-compliance monitor. If the flag is set to true then the intermittent generator is required to follow the *dispatch* target only in that its output must not exceed the *dispatch* target value and will be monitored by the non-compliance monitor.