MANAGEMENT OF RISKS ON NEM CONGESTION

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1	9 August 2011	Ben Blake, Mark Miller & Michael Lyons	Mark Miller & Michael Lyons	Mark Miller	First version

This document has been created by the System Operations Division and will be reviewed from time to time.

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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*.

TERM	MEANING
Constraint Equation	The mathematical representation that AEMO uses to manage power system limitations and FCAS requirements in NEMDE.
DPRG	Dispatch and Pricing Reference Group
LHS	Left Hand Side of a constraint equation. This consists of the variables that can be optimised by NEMDE. These terms include scheduled or semi-scheduled generators, scheduled loads, regulated Interconnectors, MNSPs or regional FCAS requirements.
Limit Equation	A mathematical expression describing a limitation on a part of the transmission or distribution network. These are provided to AEMO by both TNSPs and DNSPs.
NEMDE	National Electricity Market Dispatch Engine
PASA	Projected Assessment of System Adequacy
RHS	Right Hand Side of a constraint equation. The RHS is pre-calculated and presented to the solver as a constant; these terms cannot be optimised by NEMDE.
SCADA	Supervisory Control And Data Acquisition. Information such as line flows and generator outputs are delivered via SCADA.
System Normal	The configuration of the power system where: • All transmission elements are in service; or • The network is operating in its normal network configuration.

1 Introduction

a) This document identifies the sources of risk in the management of congestion in the NEM and details the measures *AEMO* is taking to manage these risks

b) This document may be amended from time to time

c) If there is any inconsistency between this document and the NER, the NER will prevail to the extent of that inconsistency

2 Purpose

The purpose of this Guide is to provide *AEMO* and market participants with information on the risks associated with the management of congestion and the steps *AEMO* is taking to manage these risks. The guide also provides an indication of the level of impact that issues in the constraints area are having on the NEM.

3 Related Policies and Procedures

- Constraint Formulation Guidelines: http://www.aemo.com.au/Electricity/Market-and-Power-Systems/Dispatch/Constraint-Formulation-Guidelines
- Congestion Information Resource: http://www.aemo.com.au/Electricity/Congestion-Information-Resource
- Congestion Information Resource consultations:
  http://www.aemo.com.au/Electricity/Market-and-Power-Systems/Dispatch/2010-Congestion-Information-Resource-Guidelines-Consultation
  http://www.aemo.com.au/Electricity/Market-and-Power-Systems/Dispatch/Congestion-Information-Resource-Guidelines-Consultation
  http://www.aemo.com.au/Electricity/Congestion-Information-Resource/2012-Congestion-Information-Resource-Guidelines-Consultation

4 Introduction

In the NEM, network congestion is almost exclusively managed by constraint equations applied to the dispatch algorithm. This involves the creation of constraint equations to model the transmission network limitations. These constraint equations ensure that dispatch instructions for scheduled and semi-scheduled entities in the NEM (normally generating units) take into account the need to maintain the power system in a secure operating state.

This approach is in contrast to many other electricity markets where manual dispatch of network support services plays a much bigger role in congestion management. This means that the network congestion management processes in the NEM are more complex than other markets but manage congestion in a more precise manner.

Furthermore, the approach adopted allows more accurate constraints to be implemented and, consequently, the power system to be operated closer to its full capability and, therefore, more efficiently. In particular constraint equations allow a much quicker response to be implemented following a major power system incident, compared to reliance on a manual dispatch process as used in other electricity markets.

In the NEM constraint equations are also used to set the frequency control ancillary service requirements. These equations facilitate a more accurate and efficient process for enabling services to manage frequency during normal operation and following the loss of large loads or generating units.

The two major risks associated with the congestion management process are:

1. Inaccurate network constraints in the dispatch time frame could result in either insecure power system operation or unnecessary restriction on market operation.
2. Inaccurate modelling of network limitations in pre-dispatch or PASA time frames could result in:
    - Price forecasts not being as accurate as they otherwise would be
    - Inaccurate forecasts of reserves leading to either unnecessary intervention or failure to intervene in a timely manner.

5 Risk in Dispatch Timeframe

5.1 Sources of Risk

The main sources of risk in the dispatch timeframe are:

- Failure to base network constraint equations on the latest limit advice
- Failure to correctly design constraint equations
- Failure to formulate appropriate constraint equations for unusual conditions
- Failure to activate correct constraint equations for a given system condition
- Failure to correctly activate or deactivate constraint equations in a timely manner when system configuration changes occur
- Incorrect input data

Measures to reduce these risks are detailed in the section 5.3.

5.2 Level of Impact on NEM Pricing and Dispatch

A summary of incidents over the last four years affecting NEM pricing and dispatch, which have led to issues in the congestion management process, is included in Appendix 1. The number of incidents per year is provided in Table 1 below (in those cases where an issue persisted across more than one year the issue has been placed in the year in which the issue was first reported):

Table 1 - Summary of incidents

PARAMETER	2008	2009	2010	2011
Constraint equation incorrectly formulated	3	4	2	2
Appropriate constraint equation not available	0	8	0	2
Incorrect constraint set invoked	1	2	1	0
Constraint set activation/deactivation not timely	3	0	0	1
Incorrect input to constraint	0	3	2	3
Total	**7**	**17**	**5**	**8**

Table 2 - Cost of congestion management incidents

PARAMETER	2008	2009	2010	2011
Constraint equation incorrectly formulated	Nil	Minor	Immaterial	Immaterial

PARAMETER	2008	2009	2010	2011
Appropriate constraint equation not available	Nil	Moderate	Nil	Minor
Incorrect constraint set invoked	Major	Minor	Nil	Nil
Constraint set activation/deactivation not timely	Nil	Nil	Nil	Immaterial
Incorrect input to constraint	Nil	Nil	Moderate	Moderate
Total	**Major**	**Moderate**	**Moderate**	**Moderate**

Note 1: The amounts are represented by the following: Immaterial: < $25,000, Minor: <$1 million, Moderate: <$10 million, Major: < $25 million, Extreme > $25 million.

Note 2: There was one constraint issue that persisted from 13 April 2008 to 4 June 2009 which had an estimated Immaterial to Minor cost. As this issue occurred over a year it has not been included in the table.

The total market impact of constraint issues was dominated by 4 issues (the 1 major and 3 moderate ones in Table 2). These 4 issues contributed to 97% of this cost. Furthermore, 60% of issues had minimal impact. This indicates that only a small percentage of constraint issues are significantly impacting the market, but when this happens the impact can be substantial.

5.2.1 Analysis of the Issues

The number of constraint issues increased significantly from 2008 to 2009 before reducing again in 2010 and 2011. From the table it is apparent that the increase in 2009 is caused mainly by issues arising due to an appropriate constraint equation not being available to manage a congestion issue. In all bar one of the eight cases in 2009 multiple transmission elements were out of service at the time. In these cases an appropriate constraint set was not available because either the plant outages were not planned or the requirement for a constraint set for a multiple outage was not identified during the assessment phase. In the remaining case a power station had shut down and this, combined with the commissioning of new wind farms in SA, resulted in unexpected thermal limits for which constraint equations were not available.

In six of the eight cases on-line staff invoked the constraint set that most closely approximated the multiple outage conditions. However, the constraint equations in the set proved to be ineffective or overly conservative resulting in constraint issues.

In four cases the constraint automation tool was then used to provide the appropriate constraint equations. In one of these cases the tool could not create the required equations due to a software problem, while the tool was not designed to manage power system conditions in a second case. In the remaining two cases the constraint automation tool created the required constraint equations, which correctly managed the constraint situation.

There were no occasions in 2010 or in 2011 where a congestion incident occurred due to an appropriate constraint equation not being available, which has resulted in a significant reduction in constraint issues. It is believed this reduction is due to:

- Increased confidence of on-line staff to use the constraint automation tool when appropriate constraint equations are not available.
- Improved performance of the constraint automation tool following the resolution of a number of software and setup issues detected in 2009.
- Improved procedures to manage constraint issues and adherence to peer review requirements for on-line staff.
- Improved procedures to formulate and test constraint equations and adherence to peer review requirements for constraint builders.

5.3 Measures Implemented to Reduce Dispatch Risks

5.3.1 Failure to Base a Network Constraint Equation on the Latest Limit Advice

The likelihood of incidents from this source is minimised through implementation of a structured process to the way TNSPs communicate limit advices to *AEMO*. This allows *AEMO* to be:

- Aware of when these advices have been received
- Identify which advices have not yet been actioned, and
- Track action being taken on each advice including the performance of due diligence and constraint equation design or revision.

In addition a new process to track the work required to accommodate network augmentations has been introduced in cooperation with the TNSPs. This has been largely successful in ensuring revised limit advices are provided to *AEMO* in a timely manner.

5.3.2 Failure to Correctly Design Constraint Equations

This section briefly describes the issues involved and measures that have been taken to ensure constraint equations are thoroughly checked before being placed in the production environment where they can then be used by on-line staff.

AEMO's constraint builders employ a number of techniques to reduce the risk of errors in constraint equations. No one technique is able to manage all risks of errors so each technique has been designed to cover a different area of risk.

Constraint Editor – Evaluate RHS & LHS

When constructing a new or modifying an existing constraint equation constraint builders use a custom spreadsheet called the Constraint Editor.

The evaluate function in the Constraint Editor allows the constraint builder to self-test the right hand side (RHS) of the constraint equation using manually entered, real-time measured data (SCADA) or data from the current dispatch run. The evaluate function also calculates the left hand side (LHS) value of the constraint equation so the constraint builder can assess whether the constraint equation would bind or violate if it were to be invoked.

Constraint Editor - Compare with database

The "compare with database" function in the Constraint Editor compares a revision to the constraint equation with the current active version. Where changes are detected (including deleted terms and factor changes) the affected RHS or LHS term is highlighted along with details of the change. In this way the constraint builder can quickly determine if incorrect terms have been deleted / added to the constraint equation or if the change in factor is incorrect.

Save Constraints

The "Save Constraints" application is used by the constraint builders to input new and modified constraint sets, equations and functions into *AEMO*'s electricity market systems.

"Save Constraints" performs a number of validation checks and all must pass before the constraint sets, equations and functions can be uploaded to the database. This is similar to syntax checking in computer programming.

Peer Review

The peer review process requires a second constraint builder to assess the formulation of constraint equations prior to them being placed in the production environment. Peer review is:

- a holistic view of the constraint equation / function /set, allowing a set of fresh eyes to review a change before it is implemented
- required for all work performed by constraint builders who are in training or where the work is outside their normal area of expertise
- not required when the method of constraint construction is automated[1] (such as importing from a load flow program (such as PSSE), using Constraint Automation or the Find/Insert feature in the constraint editor). Even so spot checking is recommended:
    - for changes involving a large number of constraint equations
    - where manual transcribing of factors is involved
- not required when a simple offset is applied to an already constructed constraint equation (usually for complex transient stability limits under outage conditions)

Plain English

The Plain English constraint converter transforms a constraint equation into an easy-to-read readable form. The converter provides a different way of looking at the constraint equation and is also used to check complex logic. It is also used as one of the checks performed by the peer reviewer.

Pre-Production

All constraint equations are loaded and invoked in the Pre-Production environment prior to being loaded into Production. This allows the constraint builder to confirm the constraint equation will load correctly (using Save Constraints), looks correct in Plain English as well as reviewing the performance of the constraint equation without impacting the dispatch process.

Pre-Production is only useful for gross error checking as the SCADA inputs and forecast data do not exactly match those used in Production.

NEM Simulator

The NEM Simulator is a very flexible testing platform that includes both a power system and market system model. The constraint builder is able to control power flows and can test constraint equations under a range of power system conditions. Due to the complexity of the system it is currently used primarily to test complex constraint equations.

5.3.3 Failure to Formulate Appropriate Constraint Equations for Unusual Conditions

Normally when power system conditions change new constraint equations, which reflect these new conditions, are selected from a library of constraint equations[2]. When unusual conditions arise, generally due to multiple outages of transmission elements, there may not be suitable constraint equations in the library.

In such cases the operators need to invoke discretionary constraints that are designed to limit power flow on critical interconnectors or power stations based upon general instructions regarding power system capability. Such constraint equations tend to be overly conservative. Alternatively,

[1] These automatic systems are fully tested at the implementation stage using standard approaches for IT testing including unit testing and user acceptance testing

[2] Currently this library contains about 9000 constraint equations

an existing constraint set that approximates the outage conditions may be invoked. This can cause problems if the constraint set includes constraint equations that are incompatible with the outage conditions, resulting in overly conservative or ineffective outcomes.

The likelihood of incidents from this source has been minimised through the:

- Development of a constraint automation tool to allow the operator to construct thermal constraint equations in real-time based on the actual configuration of the network
- Development of advanced tools to monitor voltage, transient and oscillatory stability limits in real-time to provide more accurate indications of the required stability limit

5.3.4 Failure to Activate Correct Constraint Equations for a Given System Condition

The likelihood of incidents from this source is minimised through a peer review process for control room staff when activating and deactivating constraint equations. This process was introduced soon after the start of the NEM but its effectiveness was initially disappointing. Following advice from KEMA Consulting of the need to improve the process, a revised process was developed with the assistance of an expert on the psychology of situational awareness and involved detailed consultation and feedback from control room staff. The revised process has proved much more effective in reducing the likelihood of incidents from this source.

5.3.5 Failure to Activate or Deactivate Constraint Sets in a Timely Manner When System Configuration Changes Occur

The likelihood of incidents from this source is minimised through a series of “constraint pending” alarms which alert the control room when times for the start or end of planned outages is approaching to ensure that activation or deactivation of the appropriate constraint equations is undertaken in a timely manner.

5.3.6 Incorrect Input Data

In order to correctly model transmission limitations for the current power system conditions, the dispatch algorithm relies upon real–time data, which is provided by the NSPs and Generators via the SCADA networks. If incorrect data is received by *AEMO* and used in the constraint equations, incorrect pricing and dispatch outcomes could occur. To reduce the likelihood of risk from this source a number of measures have been introduced or refined over the last decade. These are:

- data quality checking by NSPs
- reasonability checks by *AEMO*
- consistency checks by *AEMO*

These measures have been successful in substantially reducing the likelihood of incidents due to this cause. Other forms of input data include static ratings and status information provided by NSPs. This information is transferred through a structured manual process. Short notice changes are communicated verbally to control staff and then hand dressed in the computer systems. The risk in this case is managed through the peer review process.

5.4 Measures to Minimise the Consequences of an Incident

As well as measures to reduce the likelihood of incidents occurring as discussed above, a number of measures have been introduced which aim to reduce the consequence of an incident. These are as follows.

5.4.1 Introduction of a Price Revision Process

This process operates as follows:

- When a dispatch run results in pre-defined unusual outcomes, these results are initially marked as under review
- The operators then review the results and if within 30 minutes a manifest error is identified, the published prices are replaced by the prices from the previous correct dispatch interval
- If no error is identified within 30 minutes, the published prices are confirmed and are then firm

This process has been successful in reducing the impact of a number of events. However the pre-defined conditions are set as a balance between detecting errors and minimising the number of "false alarms". Because of this need, some incidents related to failures in the congestion management process do not result in the triggering of this process.

5.4.2 Introduction of a Process to Deactivate Overly Conservative Constraint Equations

This manual process operates as follows:

- A constraint equation is noted as having a significant impact on dispatch.
- The contingency that the constraint equation is seeking to manage is compared against the results of the on-line power system monitoring tools for the same contingency
- If the power system monitoring tools indicate that actual operating conditions are below the actual secure limit for this contingency[3], then the constraint equation is considered to be "overly conservative"
- This particular constraint equation is then revoked provided the operator is satisfied this can be done without prejudicing system security

This process has been successful on a number of occasions in reducing the amount of time an overly conservative constraint has impacted on dispatch outcomes. However, it has limitations:

- because it is an intensive manual process, it can only be applied to constraint equations that are already having a significant impact on dispatch
- it can only be applied to certain classes of constraint equations (chiefly those where the secure limit is set by equipment ratings)

6 Risk in Pre-Dispatch and PASA Timeframes

Pre-dispatch forecast inaccuracies arise because network constraint equations in dispatch use a wide range of real time data for inputs to accurately model secure operating limits, whereas network constraints in pre-dispatch have to rely on forecast values of these same inputs. In many cases these values are not forecast by tools and the constraint builder must instead assume fixed values to cover all operating conditions. These include

- Subregional demands
- Dynamic line ratings
- Equipment status

6.1 Impact on Pre-dispatch Accuracy

Forecasting inaccuracy can result in significant differences between constraint outcomes in the dispatch and pre-dispatch time frames. These differences are monitored through a number of initiatives as listed in Section 8 below.

[3] Taking into account the operating margin agreed for that constraint equation

6.2 Sources of Forecasting Inaccuracy

The sources of inaccuracies in pre-dispatch forecasting due to constraint equations are generally as follows:

6.2.1 Subregional Demands

At present under the manual demand forecasting process only a limited number of sub-regional demands can be actively forecasted. In other cases subregional demands are forecast as a fixed proportion of the forecast regional demand. As temperature conditions can vary widely across a region, this technique can produce significant inaccuracies.

With the introduction of the new NEM demand foresting system in late 2011, it is now possible to actively forecast many more sub-regional demands. The new system has currently implemented a further four sub-regional demands which are actively forecast. Over time a number of others, which can impact upon constraint equation forecasting, will be added.

6.2.2 Dynamic Line Ratings

Ratings provided by the TNSPs for use in the dispatch time frame may vary from one five minute dispatch interval to the next depending on a number of factors including ambient temperature and wind speed and direction measured at the transmission line. The pre-dispatch tools have a limited amount of forecast information regarding ambient temperature, none of which is measured at the transmission line, and no forecast information regarding wind speed or direction. As such, pre-dispatch rating values are static; generally either the dynamic rating at the time pre-dispatch is run or a longer term default static value provided by the TNSPs.

Analysis performed on these static values has indicated they can be up to several hundred MVA below the dynamic ratings used in dispatch. This magnitude of discrepancy can have a significant impact on the performance of pre-dispatch forecasting and methods to improve pre-dispatch rating accuracy are being considered.

AEMO is currently evaluating methods of forecasting thermal ratings in the pre-dispatch timeframe.

6.2.3 Equipment Status

In many cases the secure transfer limit is heavily influenced by the status of network equipment such as reactive plant. In the dispatch timeframe this can be easily modelled by using real-time plant status information. In pre-dispatch this is much more difficult as it is necessary to forecast the future status of such equipment. Currently this is done by using simple rules, which vary depending upon the nature of the plant. Such an approach carries with it risks of inaccuracies.

A long term aim is to develop approaches to allow power system analysis tools to be run in a forecast mode over the entire pre-dispatch timeframe, which would need to include modelling of expected voltage control strategies. Once this process is implemented, more reliable forecasts of plant status should be available.

6.2.4 5 min dispatch interval versus 30 min trading interval

In the case of the dispatch algorithm, prices and targets are determined on the basis of 5 minute dispatch intervals; whereas in pre-dispatch forecasts of prices and targets are determined on a 30 minute trading interval basis. Thus, even if the modelling of the secure transfer limit for a constraint equation was perfect, it is possible that the forecast impact of the constraint equation would differ from what actually occurs in dispatch.

7 Future Projects

There are a number of initiatives currently under consideration to further improve congestion management processes. These include:

7.1 Next Stage of Constraint Automation

The next stage of constraint automation is to create a closed loop automatic system, which will involve:

- Detection of thermal contingencies where current power system conditions are close to the secure limit for that contingency
- Automatic creation of constraint equations for these identified contingencies
- Automatic activation of these constraint equations in the dispatch algorithm

The implementation of this scheme will reduce the likelihood of incidents arising due to failure to apply appropriate thermal constraint equations or failure to activate or deactivate thermal constraint equations in a timely manner. A similar system has been recently introduced into the New Zealand electricity market.

AEMO consulted with Participants as to the merits of proceeding with this project in late 2011 and is currently developing the system with the goal to test in Pre-Production over summer 2012/13. It should be noted that very careful implementation will be required to ensure that the application has a very low error rate (of the order of 1 in 10^6). Otherwise it could create more problems than it avoids.

7.2 Improved Operator Interface for the NEM Market Systems

A new type of operator interface to the NEM Market Systems is expected to be introduced in mid-2012. This software will provide improved tools to assist with the current manual process of detecting overly conservative constraints.

7.3 Use of B2B System to Transfer Rating Information

It is proposed to replace the present manual system for transferring thermal rating information from TNSPs to *AEMO* by an automated process using *AEMO*'s B2B system. At present *AEMO* is seeking the support of the TNSPs to implement this new approach.

7.4 Use of Root Cause Analysis Techniques

A failure in the congestion management process can be due to one of a range of immediate causes. A review of recent past incidents shows a wide range of immediate causes with no single dominant immediate cause.

Reviews of selected events are now being undertaken using a root cause analysis approach to see if it can identify any common underlying causes. An analysis of one set of incidents related to constraint equation design was recently completed. This exercise showed that a common underlying cause was the lack of more detailed design instructions. This meant that the design of constraint equations for more unusual situations was left to the discretion of the constraint builder. This has resulted in a number of different approaches being used in such cases. Whilst each was correct, the use of differing approaches to similar situations carries the risk of confusion.

It has thus been decided to enhance the scope of the design instructions to ensure a more uniform approach.

7.5 Initiatives in the longer term

7.5.1 Automatic Detection of Overly Conservative Constraint Equations

As indicated earlier there is a disadvantage with the present manual process in that, because of practical limitations, it can only be applied to suitable constraint equations that are already having a significant impact on dispatch. If this process were to be automated it could potentially also be applied to other suitable constraint equations before they have a significant impact on dispatch.

However this can only be achieved by creating a reliable mapping between the network model used by the power system monitoring tools and the quite different regional model used by the dispatch algorithm. This is not straight forward and could require significant implementation costs. At this stage the cost benefit balance is not seen as compelling.

7.5.2 More Detailed Forecasting of the Impact of Network Constraints

Another possible initiative being investigated is whether improved forecasting tools would allow operators to identify potential problems before they have any impact on dispatch outcomes. To be effective such tools would need to be capable of detecting potential issues whilst at the same time generating only a limited number of “false alarms”.

7.6 Improvements to the CIR

The completed and upcoming improvements to the CIR are listed in Appendix 1 of the Guide to the CIR: http://www.aemo.com.au/Electricity/Congestion-Information-Resource/~/media/Files/Other/Dispatch/0178-0028%20pdf.ashx

8 Monitoring Constraint Equation Performance

Monitoring of constraint equation performance is carried out at a number of levels by System Operations.

8.1 Real Time Communication Between Control Room and Constraint Builders

Any issues occurring in real time within normal office hours are communicated promptly by the control room staff to the relevant constraint builders. Outside normal office hours issues are communicated at the start of the next working day.

8.2 Daily NEM Operations Report

Any significant issues are included in this daily report and are reviewed at a daily meeting involving on-line staff. The implication of these incidents and any action initiated in response is then reviewed at the weekly System Operations electrical operations meeting attended by the EGM System Operations, Senior Manager PSO and Senior Manager ESOPP. Should these issues constitute non-compliances, they are reported through the compliance incident reporting system.

8.3 Weekly NEM Constraint Report

A weekly internal constraint report is prepared, which highlights constraints equations in dispatch that violated or had a significant impact on the market over the past week. The report also identifies constraint equations in pre-dispatch which produced significantly different outcomes to the dispatch equation. This is achieved through a table showing the top 10 binding constraint equations (in dispatch or pre-dispatch) having the largest percentage difference between the dispatch right hand side (RHS) value and the RHS value predicted by pre-dispatch, 4 hours in the future. An example of this report is provided as a separate attachment. This report allows trends to be observed and high impact constraint equations to be identified for more detailed analysis.

8.4 “Six weekly” Review of the Accuracy of Network Constraint Equations in Pre-Dispatch

At each meeting of the Dispatch and Pricing Reference Group (DPRG)[4] a list of the network constraint equations that demonstrated significant differences between dispatch and pre-dispatch

[4] DPRG consists of representatives from all relevant participant sectors

outcomes are reported including details of action being taken to improve future performance. Over the past year action has been taken to improve the performance of about 50 constraint equations through this process.

8.5 Improvement in Reporting of Variances Between Dispatch and Pre-dispatch

AEMO will investigate the appropriateness of publishing the report discussed in section 8.4 which is currently provided only to the DPRG, to participants more generally. *AEMO* has also raised through the 2011 CIR consultation the quality and amount of pre-dispatch constraint equation information that is provided to participants. No submissions were received on this particular topic.

9 Other Related Risk Management Activities

Other measures that have been adopted by System Operations to manage risk in this area are:

9.1 Near Hit Register

A near hit register has been established. Staff are encouraged to record near hits (i.e. where no actual incident occurred but where events came close to resulting in an incident). This near hit register is reviewed at regular intervals by the *AEMO* Electrical Operations Risk Management Working Group to see whether these represent systematic issues requiring changes to procedures, systems or training programmes. In 2011 14 near hits were recorded in the register and reviewed by the working group.

9.2 Participant Information

AEMO is also working to assist participants through ongoing enhancements to the Congestion Information Resource (CIR). The 2012 consultation is in progress, which is seeking participant feedback about the type of enhancements that are seen as a priority by participants. It is intended to conduct these consultations on an annual basis.

10 Appendix 1 - Summary of Network Constraint Issues 2008-2011

Table 3 - Network constraint issues

DATE	SUMMARY OF EVENT	TYPE OF EVENT	ESTIMATE OF MARKET IMPACT
7 Feb 2008	An incorrect constraint set was invoked to manage the potential loss of multiple transmission lines.	Incorrect constraint invoked	Major
10 March 2008	Two NSW constraint equations were incorrectly formulated to include the Hume (NSW) instead of Hume (Vic) term.	Constraint incorrectly formulated	Nil
13 April 2008 – 4 June 2009	Incorrect constraint formulation of 12 constraint equations resulted in overly conservative constraint outcomes for 657 dispatch intervals.	Constraint incorrectly formulated	Difficult to estimate but considered to be between Immaterial and Minor
13 June 2008	A constraint set was not revoked following the return to service of a transmission element.	Constraint activation/deactivation not timely	Nil
17 July 2008	An FCAS equation was not invoked to manage the loss of two transmission lines being declared credible.	Constraint activation/deactivation not timely	Nil
23 July 2008	A non-conformance constraint equation was invoked for 30 minutes longer than required.	Constraint activation/deactivation not timely	Immaterial
23 July 2008 to 23 January 2010	A constraint equation in SA was incorrectly formulated resulting in a generating unit in SA being constrained off ahead of other units that would have been more effective.	Constraint incorrectly formulated	Minor
19 January 2009	Manifestly incorrect input	Incorrect input to constraint	Nil
8 February 2009	An incorrect constraint equation was invoked to manage an issue with Directlink	Incorrect constraint invoked	Minor
8 February 2009	Manifestly incorrect input	Incorrect input to constraint	Nil
17 February 2009	A system normal constraint violated for two dispatch intervals as it was setting a limit lower than the outage constraint.	Constraint incorrectly formulated	Immaterial
19 – 20 February 2009	Overly-conservative constraint not removed in a reasonable time		Minor
5 April 2009	A constraint set was incorrectly invoked to manage a transformer outage in Victoria.	Incorrect constraint invoked	Immaterial
7 to 9 April 2009	FCAS constraint equations in Tasmania bound for 32 dispatch intervals because they were incorrectly formulated.	Constraint incorrectly formulated	Minor
5 May 2009	Regulation FCAS was incorrectly dispatched due to an incorrect time error SCADA value.	Incorrect input to constraint	Immaterial
19 May 2009 – 14 Jan 2010	Constraint not reformulated as per *AEMO* policy in a reasonable time	Constraint incorrectly formulated	Minor
1 June 2009	A constraint equation was not available to manage thermal limits during the outage of two transmission lines.	Appropriate constraint equation not available	Immaterial

DATE	SUMMARY OF EVENT	TYPE OF EVENT	ESTIMATE OF MARKET IMPACT
17 June 2009	A constraint equation was not available to manage thermal limits during the shutdown of Playford Power Station.	Appropriate constraint equation not available	Immaterial
26 August 2009	A constraint equation was not available to manage thermal limits during a planned outage and subsequent opening of four circuit breakers.	Appropriate constraint equation not available	Nil
30 August 2009	A constraint equation to manage FCAS requirements for trip of the AETV generating unit in Tasmania was incorrectly formulated.	Constraint incorrectly formulated	Minor
2 September 2009	Failed SCADA data resulted in the required constraint equations being unable to manage the loading on a South Morang transformer in Victoria.	Incorrect input to constraint	Nil
11 September 2009	A constraint equation was not available to manage the short notice outage of two transmission lines during the planned outage of a third transmission line. In addition a constraint equation that was invoked in an attempt to manage the situation was overly conservative.	Appropriate constraint equation not available	Moderate
6 October 2009	A constraint equation was not available to manage the planned outage of two transmission lines in Victoria.	Appropriate constraint equation not available	Immaterial
20 November 2009	A rating increase was not applied to both transmission lines modelled in a Queensland constraint equation, which subsequently constrained down a generator.	Incorrect input to constraint	Immaterial
22 November 2009	A constraint equation was not available to manage the unplanned outage of a Playford PS bus.	Appropriate constraint equation not available	Nil
23 November 2009	A constraint equation was not available to manage the unplanned outage of a Playford PS bus.	Appropriate constraint equation not available	Nil
27 November 2009	A constraint equation was not available to manage the declaration of the loss of two transmission lines being credible during the planned outage of an additional two transmission lines.	Appropriate constraint equation not available	Immaterial
11 December 2009	A constraint equation in Northern NSW was incorrectly formulated.	Constraint incorrectly formulated	Immaterial
29 June 2010	The incorrect constraint set was invoked for three dispatch interval following the loss of two lines in SA as credible.	Incorrect constraint invoked	Immaterial
30 June 2010	An incorrectly formulated constraint equation unnecessarily constrained Basslink.	Constraint incorrectly formulated	Immaterial
1 July 2010	Manifestly incorrect input	Incorrect input to constraint	Nil
15 September 2010	An incorrectly formulated constraint equation resulted in the trip of Basslink setting FCAS requirements while it was out of service.	Constraint incorrectly formulated	Immaterial
2 November 2010	An increased thermal rating was not applied to a constraint equation, which consequently bound and violated during a transmission line outage in Queensland.	Incorrect input to constraint	Moderate

DATE	SUMMARY OF EVENT	TYPE OF EVENT	ESTIMATE OF MARKET IMPACT
31 December 2010	An incorrectly hand-dressed SCADA value caused a constraint equation to bind for 20 dispatch intervals.	Incorrect input to constraint	Immaterial
3 January 2011	An outage constraint set was not invoked at the start of the outage and an out of service generator was given FCAS targets	Constraint activation/deactivation not timely	Immaterial
17 January 2011	A higher rating was not used in a constraint equation which consequently violated for one dispatch interval.	Incorrect input to constraint	Moderate
11 Feb 2011	Constraint equation not available following the tripping of the Robertstown – Para and Robertstown – Tungkillo lines.	Appropriate constraint equation not available	Immaterial
17 Feb 2011	Manifestly incorrect input	Incorrect input to constraint	Nil
11 April 2011	An incorrect rating was used by the constraint equation after the TNSP advised a higher rating was available	Constraint incorrectly formulated	Immaterial
20 August 2011	Arthurs Lake not dispatched for R6 FCAS during outage of two Palmerston to Poatina 110 kV lines	Constraint incorrectly formulated	Immaterial
30 September 2011	FCAS constraint equations not in place to cover generator over tripping in the Tasmanian Network Control System Protection Scheme (NCSPS)	Appropriate constraint equation not available	Minor
24 October 2011	Basslink status value in constraint equations indicated Basslink was out of service when Basslink was in service	Incorrect input to constraint	Immaterial

The estimate of market impact uses the same scale as in section 5.2: Immaterial: < $25,000, Minor: <$1 million, Moderate: <$10 million, Major: < $25 million, Extreme > $25 million.