CONSTRAINT AUTOMATION – CLOSING THE LOOP – DISCUSSION PAPER

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Approved for distribution and use

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Version Release History

VERSION	DATE	AUTHOR	PEER REVIEW	APPROVED	COMMENTS
3.1	3 April 2013	Ben Blake		Michael Lyons	Added plain English examples
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1.1	13 July 2011	Ben Blake		Michael Lyons	Updated definition of RTCA and added reference to rating info on AEMO website
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0.1 – 0.6	29 December 2010 – 13 January 2011	Ben Blake			Internal AEMO drafts

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

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Contents

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.
EMS	Energy management system
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.
MMS	Market management system
Monitored element	The transmission element (either a line or transformer) whose flow is to be controlled so to avoid it exceeding the rating of the transmission element
NBT	Near binding threshold
NBET	Near binding exit threshold
NEM	National Electricity Market
NEMDE	National Electricity Market Dispatch Engine
NOS	Network Outage Schedule
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.
RTCA	Real time contingency analysis. This is an application in *AEMO*'s EMS that continually monitors the pre and post contingent element flows and alerts if element ratings are exceeded. The RTCA has a list of elements (approximately 2000 are normally active) of which each is tripped in turn and a power flow run. RTCA reports any elements that exceed their NORM, EMER or LDSH element rating pre-contingent, and any elements that exceed their EMER or LDSH rating post-contingent. The list can also include multiple element trips for cases where these are classified as credible contingencies.
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
Tripped element	The transmission element (either a line or transformer) that trips

1   Introduction

a) This document provides an explanation/background to *AEMO*'s plan for the next stages of the constraint automation.

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 document is to provide both *AEMO* and *market participants* with details on how *AEMO* remove the manual steps and allow the constraint automation to operate in "closed loop" mode, in the dispatch timeframe, such that the creation, updating and invocation of constraint equations is fully automated.

3   Background

The constraint automation is a software application in *AEMO*'s energy management system (EMS) that automatically generates thermal overload constraint equations based on the current or planned state of the power system. These constraint equations follow the constraint formulation guidelines as applied to manually constructed thermal overload constraint equations. Currently the constraint automation requires several manual steps to create and invoke constraint equations.

AEMO's plan for the next stages of the constraint automation is to allow further automation of the process starting with the Dispatch timeframe and moving through 5 minute Pre-dispatch, 30 minute Pre-dispatch and potentially the PASA timeframes.

In summary the new constraint automation will have:

- Consistent constraint equation IDs based on the tripped and managed elements

- A list of tripped / managed elements that always have constraint equations created and updated. This is known as the white list.

- A list of cases where constraint equations are not to be created. This is known as the black list.

- Thresholds to ensure that constraint equations are activated before they are required and they are deactivated once they are not required

- Alarms for *AEMO*'s control room so that once new tripped / managed elements exceed thresholds they can be approved / not approved for invocation.

The benefits of this change are:

- Removal of the manual steps in the constraint automation process

- New constraint equations will be applied in NEMDE before they would bind unlike the current manually activated process

- The most optimal/accurate constraint equation will be applied for the current power system topology

- Consistent and predictable constraint equation IDs

This is not intended to replace any of the existing *AEMO* constraint building resources as only thermal constraint equations will be automated.

Before work is commenced on the next stage of the constraint automation, *AEMO* is seeking comment from both internal and external parties.

4 Related Policies and Procedures

- Constraint formulation guidelines (CFG): http://www.aemo.com.au/Electricity/Market-Operations/Congestion-Information-Resource/Constraint-Formulation-Guidelines

- Constraint naming guidelines: http://www.aemo.com.au/Electricity/Market-Operations/Congestion-Information-Resource/Policies-and-Processes/Constraint-Naming-Guidelines

- Congestion information resource (CIR): http://www.aemo.com.au/Electricity/Market-Operations/Congestion-Information-Resource

- Transmission Equipment Rating (TER): http://aemo.com.au/Electricity/Data/Network-Data/Transmission-Equipment-Ratings

5 Close Looping

5.1 Current Process

The first stage of the constraint automation was commissioned on 21st December 2007. The primary aim of this stage was to allow on-line staff to create thermal overload constraint equations for power system conditions where there were no existing constraint equations or the existing constraint equations did not operate correctly.

The second stage delivered incremental improvements to help support further automation. These changes included: operating margins set to *AEMO* standard for region and voltage level or per element, sub-regional loads in Pre-dispatch, RHS scaling factor thresholds (to support the constraint formulation guidelines) and improved synchronisation of SPD IDs between EMS and *AEMO*'s market management system (MMS).

In both these stages there are a number of manual steps: from manually copying a study case, selection of contingency analysis violations to convert into constraint equations, sending to *AEMO*'s market systems and invoking the new constraint set. The following figure details the current workflow for the constraint automation.
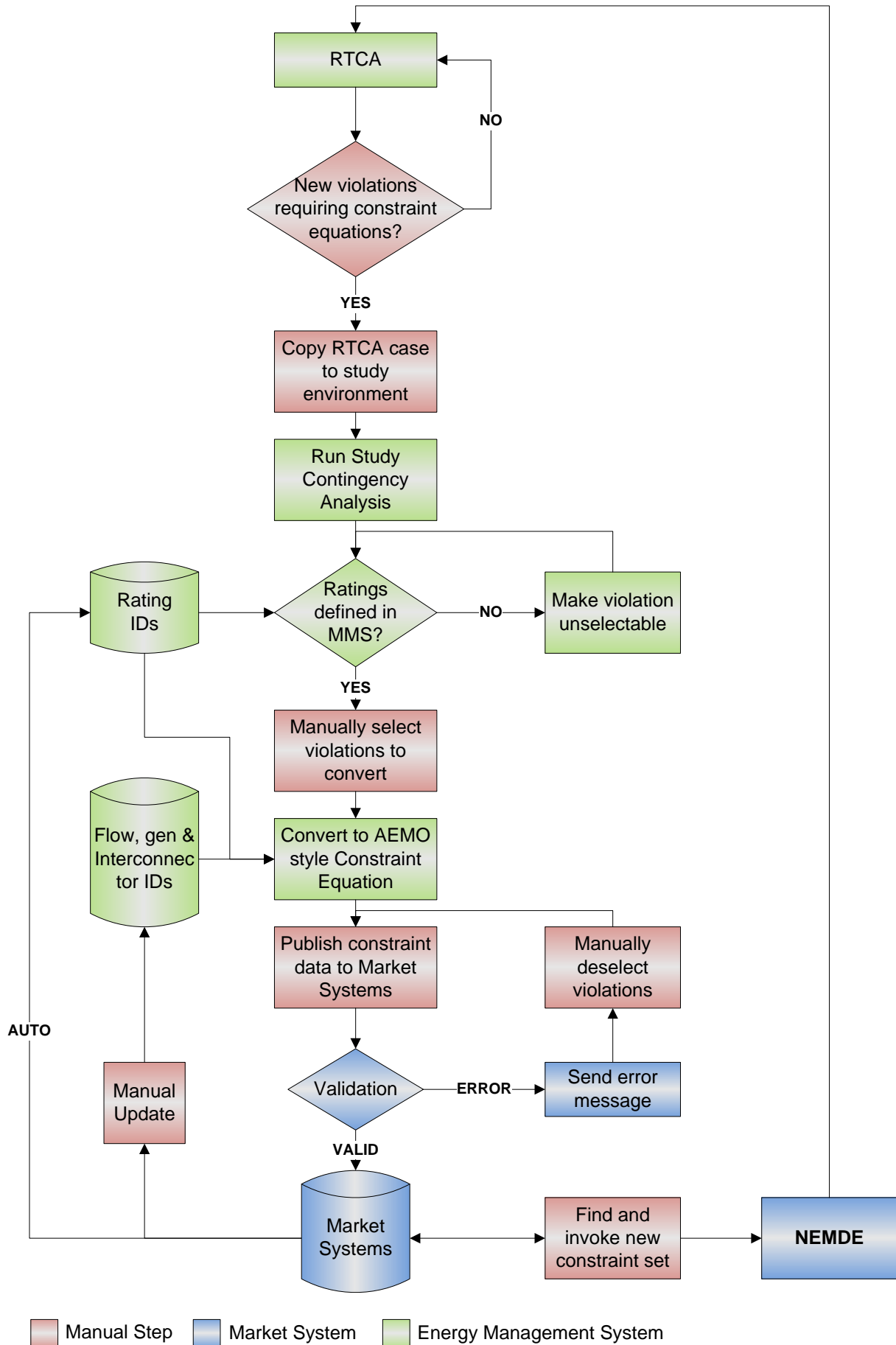
Figure 1 - Current Constraint Automation Process

5.2 New Process

The proposed third stage of the constraint automation will remove most of the existing manual steps (indicated in red boxes in Figure 1). These changes will allow the creation, updating, activation and deactivation of constraint equations to be automated in Dispatch. The core element to the removal of the manual steps is the watch list which will force creation and updating of constraint equations and block their creation for cases where the constraint automation is not effective.

Figure 2 and the following sections describe the changes for the new process in detail. The remaining manual processes will be the maintenance of the white/black/auto approve lists (5.4) and activation, by *AEMO*'s control room, of constraint equations that do not appear in any of the white, black or approve lists

Figure 2 details the process for a single violation from *AEMO*'s real time contingency analysis (RTCA). For multiple violations the process is run multiple times. "STOP" indicates the violation being processed is stopped, no constraint equation or set changes are made and then the next violation (if any) is processed.

Constraint equations produced by the constraint automation will be published via the same MMS data model as existing manually constructed constraint equations.
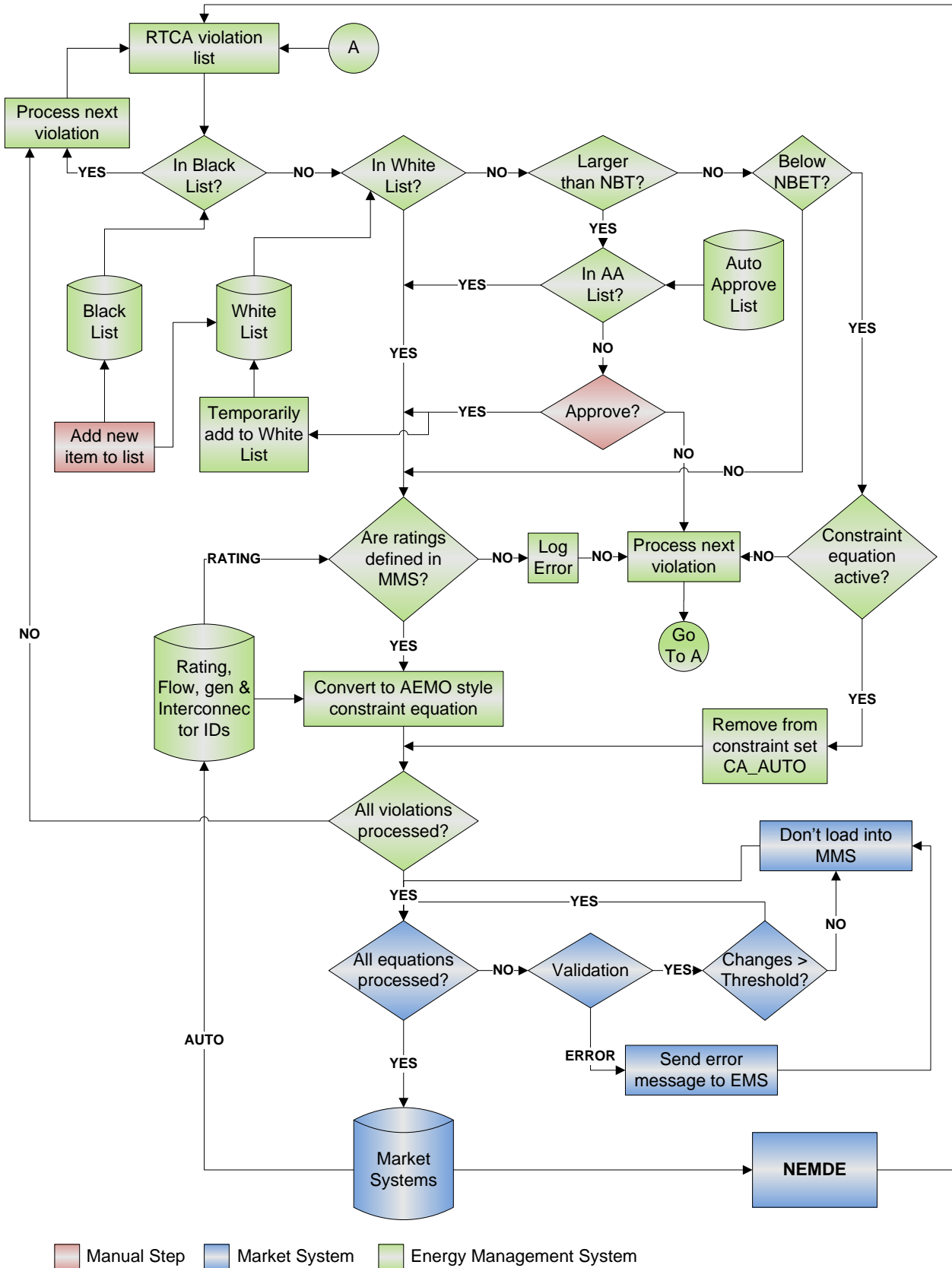
Figure 2 - New Constraint Automation Process

5.3   Constraint Equation IDs

To provide better information to both AEMO staff and participants, automatically built and updated constraint equations IDs will be based on identifiers for the tripped and managed elements. The IDs will then be consistent across any number of network conditions.

Unlike manually built constraint equation IDs the constraint automation will not include information on whether the constraint equation is for system normal or outage conditions. It is impractical to try and identify the outage(s) as a part of the constraint equation IDs created by the constraint automation. This information is better obtained from the network outage schedule (NOS).

The IDs will be prefixed with a single character representing the regional location of the sending end of the monitored element. Lastly the ID will only contain a single ">" character so that the ID can remain consistent even if the interconnectors and generators move on and off the LHS with changing network conditions.

The general form of the constraint equation ID will be:

Region ID > Tripped Element ID "_" Monitored Element ID

1) *The Region ID is a single character representing the regional location of the sending end of the monitored element*

2) *Each element ID is made up of 2 or 3 character identifier for each substation in the positive direction of flow (for example for flow from Murray to Upper Tumut is MSUT). These IDs are consistent with AEMO's constraint naming guidelines.*

3) *For no element trip the tripped element ID is "NIL"*

4) *Transformers include a TX after the substation ID followed by a single character indicating the receiving end winding. "H" is used for the high voltage winding and "L" for the low voltage winding.*

5) *Where there are 2 or more elements between substations these will include the element number after the element ID*

    a. *When the constraint equation ID has greater than 20 characters the element numbers will not be included*

6) *Tee'd lines are identified as if they were separate lines and the tee point having its own ID (for example Liapootah to Cluny tee section is LICL and the Cluny tee to Chapel St section is CLCS)*

7) *Where Yallourn W1 appears on the LHS two constraint equations are created for the two different modes. These have a suffix of "_A" for Yallourn W1 switched to the 500 kV and a suffix of "_B" for 220 kV*

Table 1 - Example Constraint Equation IDs

ID	EXPLAINATION
N>LDNC_LDTM	Trip of Liddell to Newcastle (81) line, avoid overload of Liddell to Tomago (82) line
V>NIL_SMTXL_A	South Morang F2 transformer overload on no line trips, Yallourn W1 switched to the 500 kV
T>SHGT1_PMSH	Trip of Sheffield to Georgetown, avoid overloading Palmerston to Sheffield
Q>CLWU_CLST	Trip of Calvale to Wurdong (871), avoid overloading Calvale to Stanwell (855)
S>SETXH1_SETXH2	Trip of one South East transformer, avoid overloading on the remaining South East transformer
V>DDMS1_DDMS2	Trip of Dederang to Murray #1 line, avoid overloading Dederang to Murray #2

5.3.1 Constraint Sets

The constraint automation will add constraint equations to a single constraint set called CA_AUTO which will remain permanently invoked.

5.3.2 IDs for Manually Activated Constraint Automation

To avoid overwriting the automatically built and updated constraint equations the existing manually activated constraint automation will not follow the rules outlined above for IDs. Instead the IDs will retain the existing prefix of "CA" followed by unique IDs for each selected tripped/managed element as the existing system (for example: CA_BPS_3C1D7AE0_01, CA_BPS_3C1D7AE0_02).

5.4 The Watch List

The watch list provides the core functionality for the 3 main lists that determine which constraint equations are created by the constraint automation. Each of the three lists (white, black and auto approve) are mutually exclusive lists of tripped/monitored elements.

5.4.1 White List

The white list is a list of tripped/monitored element pairs which will always have constraint equations active in NEMDE and updated based on the current network topology. Updates will occur no matter if they are exceeding ratings (pre or post contingent) in *AEMO*'s real time contingency analysis or not. This will allow the non-binding interconnector limits to be set correctly even as is currently done with the manually built constraint equations.

AEMO's constraint builders will test and provide a default list of tripped/monitored elements. It is expected this will be a small list compared to the current system normal list.

AEMO's control room will also have the facility to temporarily add tripped / monitored elements to the white list.

5.4.2 Black List

The Black list is a list of tripped/monitored elements that are not to be created by the constraint automation, no matter the results presented in *AEMO*'s RTCA. This will primarily be used for cases where constraint automation cannot create appropriate constraint equations (for example due to control schemes, the Tasmanian network control special protection scheme (NCSPS), generator contingencies or automatic switching between 15 min and 30 min ratings) and a manually built constraint equation is required.

The tripped/monitored elements in the black list will be managed by current processes such as: manually constructed constraint equations, control schemes or network switching.

AEMO's control room will also have the facility to temporarily add tripped / monitored elements to the black list.

5.4.3 Near Binding Threshold

To ensure constraint equations are activated before there is binding or violating conditions in NEMDE, the constraint automation will flag new thermal overloads (that is those not currently in the white list) before the element rating is exceeded. The flagging will occur once the pre or post-contingent flow on the managed element exceeds a percentage of the monitored element rating. This threshold is known as the near binding threshold (NBT).

The NBT will not be hard coded in the constraint automation software and will be configurable via the existing constraint automation parameters display in EMS. Similar to other configurable parameters (such as LHS and RHS thresholds) this will only be able to be modified by EMS staff. It is not intended for the NBT to be used to manually force the creation and invocation of constraint equations in real time, as this functionality will be provided by the white list.

Initially the NBT will be set to 90% of the monitored element rating and the appropriateness of this value will be confirmed through the NEM Simulator and Pre-Production testing phases. If individual cases require a lower NBT then these will be handled by adding the monitored/tripped lines to the white list.

5.4.4   Near Binding Exit Threshold

To ensure that constraint equations that are no longer required to manage thermal overloads are deactivated appropriately the constraint automation uses another threshold, the near binding exit threshold (NBET). Once the pre or post contingent flow on the monitored element falls below the threshold for a sustained period of time (the NBET time threshold) the constraint equation is automatically deactivated, no approval from *AEMO*'s control room staff is required.

Similar to the NBT, the NBET and the NBET time threshold will be configurable via the constraint automation parameters display. The NBET will initially be set to 85% of the monitored element rating. The NBET time threshold will initially be set to 15 minutes. Both values will be confirmed through NEM Simulator and Pre-Production testing.

5.4.5   Auto Approve List

This list contains the tripped/monitored elements that the constraint automation will automatically create and invoke constraint equations once certain thresholds (described in the next section) are exceeded. This list will be maintained and modified by *AEMO*'s constraint builders.

Only the tripped/monitored elements that are in the auto approve list will have constraint equations automatically created and invoked once the NBT is exceeded. Where the tripped/monitored element is not in the auto approve or black list *AEMO*'s control room staff will be alerted and will need to approve the creation and activation of the new constraint equation. The monitored/tripped element will remain approved (so that *AEMO*'s control room is not continually approving the same constraint equation) until the post contingent flow on the monitored element falls below the near binding exit threshold (see 5.4.4).

The manual approval step will not stop updates of constraint equations generated by the white list or auto approve list.

When constraint equations are manually approved, AEMO's constraint builders will assess whether or not the tripped/monitored elements should be added to either the white or auto approve lists.

5.4.6   Stopping Updates

There are cases (such as bushfires and storms) where there is a large number of trip and reclose events in a short period of time and it is possible that constraint automation could produce constraint equations which are no longer valid. *AEMO*'s control room staff will be able to manually, via the watch list, pause updating / creating new constraint equations either on an individual basis, regional or NEM wide.

5.5   Smart Updating

Constraint equations that are generated due to the tripped / monitored element pair being in the white list will be automatically updated when power system conditions change. Changes will only occur when there is a large enough change on either the LHS or RHS. This is simply a practical matter as otherwise there will be new versions of each constraint equation every 5 minutes.

As large enough changes would generally indicate network topology changes this will allow *AEMO* and participants to see this via new versions of constraint equations.

Thresholds that will trigger a new version:

- A LHS or RHS factor changes by more than 5%. This value will be configurable in the application settings and will only be able to be modified by MMS staff. The value will be

confirmed through testing. Terms that will have their factors monitored include: generator MW, interconnector flow, line flow and transformer flow.

- Terms move from LHS to RHS (or vice versa). This will also be governed by a threshold value so to avoid constraint equation changes when there are only very small changes in the factor (such as 0.072 to 0.068). This threshold value will work similarly to the factor changes and will initially be set at 0.005
- New generators / interconnectors appear or are removed from the LHS or RHS (for example when a new generator is registered or de-registered)

5.5.1   Constraint Set

The constraint set (CA_AUTO) is only to be changed in the MMS if constraint equations are added or removed from the set.

5.6   Failure Modes

The constraint automation relies on the state estimator to calculate the coefficients and SCADA data to supply the RHS of constraint equations. In general the change to the constraint automaton running in closed loop mode does not change the way these failure modes work for the existing constraint automation or manually constructed constraint equations.

If either state estimator or SCADA fail the following actions are followed:

- SCADA failure at one end of a transmission element. The constraint automation would continue to operate. There are approximately 50 of these a year and they have a low impact due to the following measures:
    - Most of the line-flows used by constraint equations (whether manually constructed or built by the existing constraint automation) use a data point from EMS that will use the remote end of the line flow on failure of the primary end
    - Last good value. When a point goes bad the MMS uses the last good value.
    - State estimator replaced. This is done manually by the *AEMO* control room and in general for a single failure point the state estimator will most likely be able to estimate the flow.
- State estimator fails to solve. The constraint automation relies on the results of the state estimator so no constraint equations will be built or updated with a failed state estimator. The existing constraint equation versions will remain active in the MMS. Failures of the state estimator are unlikely and only occur 4 or 5 times per year. As the state estimator is used by *AEMO*'s control room for many of the monitoring tools (such as the contingency analysis) these failures are quickly reported and rectified.
- SCADA failure in an entire region. State estimator will fail to solve as there is a requirement for 65% good SCADA in a region. Similarly to the dot point above, this will stop the constraint automation updating constraint equations that have tripped or monitored lines in that region. These failures occur, on average, 5 or 6 times per year and for several minutes at a time. These normally occur when TNSPs and *AEMO* are doing an EMS database failover.

6   Effect on Manually Built Constraint Equations

The constraint automation will not be able to create all thermal overload constraint equations (see examples in 5.4.2). Manually built thermal overload constraint equations will initially be applied alongside those created by the constraint automation until *AEMO* is confident constraint automation can reliably determine thermal overload constraint equations for the NEM.

As this stage the constraint automation will only implement constraint equations in the Dispatch timeframe, Pre-dispatch and PASA thermal overload constraint equations will continue to be maintained by the existing manual process.

6.1   Pre-dispatch accuracy

Currently *AEMO* monitors the performance of the Dispatch and Pre-dispatch RHSs of constraint equations (both 0 and 4 hours out). When the constraint automation is implemented in closed loop mode the constraint equation IDs will be mismatched (dispatch will use the constraint automation created ones whereas Pre-dispatch will use manually constructed ones). *AEMO* will investigate ways of measuring the performance of the Dispatch / Pre-dispatch constraint equations following the implementation of the constraint automation.

6.2   System Normal or Outage

The constraint automation produces constraint equation IDs that do not identify whether the constraint equation is for system normal or outage (see 5.3). As constraint equations are only updated when there is a material change to the constraint equation factors (see 5.5), the "LastChanged" field in GENCONDATA can be combined with NOS data or constraint set invocations to identify whether a constraint equation is under outage or system normal conditions.

- Identify the region from the first character of the constraint equation ID
- Obtain the NOS data for that region (there is more data in NOS on outages as some outages do not have constraint sets invoked)
- Compare with the "LastChanged" field in GENCONDATA for the constraint equation. There may be a difference of up to 6 minutes as the RTCA may not have run exactly when the outage started or ended
- If the constraint equation changed after an outage started and before the region outages have finished then the constraint equation change is for an outage, otherwise it is for system normal.

7   Implementation

The constraint automation is being implemented through a staged process across testing, Pre Production and Production. The timeframes for each of these stages are flexible and *AEMO* will halt or extend as required.

At each stage *AEMO* will communicate with participants (via *AEMO* Communication and on the Congestion Information Resource) the results of any tests or changes to the timing of implementation.

7.1   NEM Simulator Testing

AEMO's NEM simulator was used to test the constraint automation with various scenarios detailed below. The results of these were be compared with manually built constraint equations to ensure the automated constraint equations were being formulated correctly.

- High regional demands
  - NSW and Qld summer demand
  - Victoria and SA summer demand
  - Tasmanian winter demand
- Major Incidents (modelled on current power system model)
  - Line trips similar to the Bayswater CT explosion on 2nd July 2009
  - Victorian bushfires in January 2009

This testing was successfully completed in late 2012.

7.2   Pre-production Trial

The Pre-production trial commenced prior to the 2012/13 summer period and consisted of 3 phases. The results from each phase was monitored and compared with manually built constraint equations.

In the first month the constraint automation was restricted to updating 1 constraint equation per region and new constraint equations will not be implemented. The tripped / monitored elements that will be added to the white list for this phase will be:

- South Morang F2 transformer overload on no contingencies
- Brunswick to Richmond 220 cable overload on no contingencies
- Trip of Liddell to Newcastle (81), overload of Liddell to Tomago (82) line
- Trip of Calvale to Stanwell (855) line, overload of Calvale to Wurdong (871) line
- Trip of a Sheffield to Georgetown line, overload of Palmerston to Sheffield line
- Trip of a South East transformer, overload of remaining South East transformer

This phase will not occur over summer (if possible).

The second phase (2 months) added more contingencies to each region.

The third phase involved activating the functionality to add new violations automatically.

This trial is due to be completed by the end of March 2013.

7.3   Production

The roll out of the constraint automation into *AEMO*'s Production market systems will mirror the Pre-Production phases.

The proposed implementation timetable is as follows:

Tuesday 9 April:

- Enable sending of Constraint Automation constraint equations to the electricity market systems for a single contingency / monitored line per region only
- *AEMO*'s electricity control room to invoke the CA_AUTO constraint set

Tuesday 16 April:

- Enable a larger group of contingencies (4 to 5 per region) to be covered by Constraint Automation

Tuesday 23 April:

- Enable *AEMO*'s control room to be able to activate new contingencies via the auto list functionality

May 2013

- Review removing the dispatch RHSs of manually constructed constraint equations modelled by Constraint Automation

7.4   Post Production Review

Manually built thermal overload constraint equations will continue to be required for future timeframes (Pre-dispatch and PASA). Once the constraint automation has been running in close loop for some time, *AEMO*'s constraint builders will assess whether removing the manually created thermal overload constraint equations is warranted.

8   Future Stages

AEMO's plan is for further stages to extend the coverage of constraint automation into 5 minute Pre-dispatch, 30 minute Pre-dispatch and possibly ST PASA. As this requires solving loadflows for a number of intervals into the future it is a larger technical challenge than implementing for the Dispatch timeframe.

During the planning and design phase for stage 3 *AEMO* will determine what changes are needed to extend into Pre-dispatch (both 5 and 30 minute) and ensure design decisions take into account the goals for future stages.

AEMO's EMS team are planning to deliver a 1 hour look-ahead RTCA. This contingency analysis will include all outages programmed into NOS 1 hour ahead. It is intended to use this as the basis to for future stages of the constraint automation.

Both the NBT and NBET will have separate values for Pre-dispatch.

Appendix 1: Plain English examples

Constraint: V>NIL_SMTXL_B

Constraint type: LHS<=RHS
Effective date: 26/03/2013
Author: BATCH
Version No: 1
Weight: 360
Constraint active in: Dispatch and DS PASA
5 Min Predispatch RHS:

Constraint description: Constraint Automation, O/L SMTS   TRANSF
   F2TR_330 for Nil Trip Base Case. Generated by RTCA[EMS] Host
   MANVPEMP1(PP)
Impact: Victorian Generation + Interconnectors
Source: Constraint Automation
Limit type: Thermal
Reason: Nil Trip
Modifications: New
Additional Notes: Generated by RT CJD

LHS=

-0.9961 x Murray hydro (14 aggregated units)
0.5213 x Anglesea
0.4295 x Laverton North GT (2 aggregated units)
-0.7341 x Dartmouth hydro
-0.2542 x Eildon hydro unit 1
-0.2542 x Eildon hydro unit 2
 - Hume (Vic) hydro
0.477 x Hazelwood unit 1
0.477 x Hazelwood unit 2
0.477 x Hazelwood unit 3
0.477 x Hazelwood unit 4
0.477 x Hazelwood unit 5
0.4201 x Hazelwood unit 6
0.4201 x Hazelwood unit 7

0.4201 x Hazelwood unit 8
0.4201 x Jeeralang A GT unit 1
0.4201 x Jeeralang A GT unit 2
0.4201 x Jeeralang A GT unit 3
0.4201 x Jeeralang A GT unit 4
0.477 x Jeeralang B GT unit 1
0.477 x Jeeralang B GT unit 2
0.477 x Jeeralang B GT unit 3
0.5499 x Loy Yang A unit 1
0.5498 x Loy Yang A unit 2
0.5498 x Loy Yang A unit 3
0.5498 x Loy Yang A unit 4
0.5498 x Loy Yang B unit 1
0.5498 x Loy Yang B unit 2
0.5498 x Valley Power GT (6 aggregated units)
0.6172 x Mortlake GT unit 1
0.6172 x Mortlake GT unit 2
-0.7341 x McKay Creek (units 1-6) plus Bogong hydro (units 1-2) aggregate
0.4201 x Morwell unit 4
0.4201 x Morwell unit 5
0.4201 x Morwell (units 1, 2 & 3 aggregated)
0.4201 x Bairnsdale GT unit 1
0.4201 x Bairnsdale GT unit 2
0.183 x Newport GT
0.4373 x Oaklands Hill Wind Farm
-0.3074 x Somerton GT (4 aggregated units)
-0.7341 x West Kiewa hydro (units 1 & 2 aggregated)
-0.7341 x West Kiewa hydro (units 3 & 4 aggregated)
0.3709 x Yallourn W unit 1
0.3709 x Yallourn W unit 2
0.3709 x Yallourn W unit 3
0.3709 x Yallourn W unit 4
0.5498 x MW flow north on the Basslink DC Interconnector
0.2457 x MW flow west on the Murraylink DC Interconnector
-0.6172 x MW flow west on the Vic-SA AC interconnector
0.9849 x MW flow north on the Vic to NSW AC Interconnector

RHS

Default RHS value= 10000

Dispatch RHS=
3.1454 x **(** MVA on South Morang 500/330kV (F2) transformer, Line end
    switched MW
+ South Morang 500/330 kV (F2) transformer Continous Rating
- 35 {Margin}**)**
+ 0.5499 x [Loy Yang A unit 1]
+ 0.5498 x [Loy Yang A unit 3]

+ 0.5498 x [Loy Yang A unit 4]
+ 0.5498 x [Loy Yang A unit 2]
+ 0.5498 x [Loy Yang B unit 1]
+ 0.5498 x [Loy Yang B unit 2]
+ 0.3709 x [Yallourn W unit 2]
+ 0.3709 x [Yallourn W unit 3]
+ 0.3709 x [Yallourn W unit 4]
+ 0.477 x [Hazelwood unit 1]
+ 0.477 x [Hazelwood unit 2]
+ 0.477 x [Hazelwood unit 3]
+ 0.477 x [Hazelwood unit 4]
+ 0.477 x [Hazelwood unit 5]
+ 0.4201 x [Hazelwood unit 6]
+ 0.4201 x [Hazelwood unit 7]
+ 0.4201 x [Hazelwood unit 8]
+ 0.477 x [Jeeralang B GT unit 1]
+ 0.477 x [Jeeralang B GT unit 2]
+ 0.477 x [Jeeralang B GT unit 3]
+ 0.4201 x [Jeeralang A GT unit 1]
+ 0.4201 x [Jeeralang A GT unit 2]
+ 0.4201 x [Jeeralang A GT unit 3]
+ 0.4201 x [Jeeralang A GT unit 4]
+ 0.183 x [Newport GT]
- 0.2542 x [Eildon hydro unit 1]
- 0.2542 x [Eildon hydro unit 2]
+ 0.4201 x [Morwell unit 4]
+ 0.4201 x [Morwell unit 5]
+ 0.5213 x [Anglesea]
+ 0.6172 x [Mortlake GT unit 1]
+ 0.6172 x [Mortlake GT unit 2]
+ 0.4201 x [Bairnsdale GT unit 1]
+ 0.4201 x [Bairnsdale GT unit 2]
+ 0.4373 x [Oaklands Hill Wind Farm]
+ 0.5498 x [MW flow north on the Basslink DC Interconnector]
+ 0.2457 x [MW flow west on the Murraylink DC Interconnector]
+ 0.3709 x [Yallourn W unit 1]
+ 10000 x [Yallourn unit 1 status (=1 in 500kV mode, =0 otherwise)]
- 0.7341 x [Dartmouth hydro]
- Hume (Vic) hydro
- 0.6172 x [MW flow west on the Vic-SA AC interconnector]
+ 0.9849 x [MW flow north on the Vic to NSW AC Interconnector]
- 0.7341 x [McKay Creek (units 1-6) plus Bogong hydro (units 1-2) aggregate]
- 0.7341 x [West Kiewa hydro (units 1 & 2 aggregated)]
- 0.7341 x [West Kiewa hydro (units 3 & 4 aggregated)]
+ 0.4201 x [Morwell (units 1, 2 & 3 aggregated)]
- 0.3074 x [Somerton GT (4 aggregated units)]
+ 0.4295 x [Laverton North GT (2 aggregated units)]
+ 0.5498 x [Valley Power GT (6 aggregated units)]
- 0.9961 x [Murray hydro (14 aggregated units)]

Constraint: Q>CLST_CLWU

Constraint type: LHS<=RHS
Effective date: 25/03/2013
Author: BATCH
Version No: 3
Weight: 20
Constraint active in: Dispatch and DS PASA
5 Min Predispatch RHS:

Constraint description: Constraint Automation, O/L 275KV_871
@H24_CALV for CTG LQIP on trip of 855 H24_CALV-H29_STAN 275KV
LINE. Generated by RTCA[EMS] Host MANVPEMP1(PP)
Impact: Qld Generation + Interconnectors
Source: Constraint Automation
Limit type: Thermal
Reason: Trip of 855 H24_CALV-H29_STAN 275KV LINE
Modifications: New
Additional Notes: Generated by RT CJD

LHS=

-0.6781 x Barcaldine GT
0.1176 x Millmerran unit 1
0.1176 x Millmerran unit 2
-0.8021 x Barron Gorge hydro unit 1
-0.8021 x Barron Gorge hydro unit 2
0.1365 x Braemar 1 GT unit 1
0.1365 x Braemar 1 GT unit 2
0.1365 x Braemar 1 GT unit 3
0.1365 x Kogan Creek
0.1365 x Braemar 2 GT unit 5
0.1365 x Braemar 2 GT unit 6
0.1365 x Braemar 2 GT unit 7
0.1365 x Darling Downs GT
 + Callide B unit 1
 + Callide B unit 2
 + Callide C unit 3
 + Callide C unit 4
0.1588 x Condamine CCGT
-0.8016 x Townsville GT (Yabulu) unit 2
-0.93 x Gladstone unit 1
-0.93 x Gladstone unit 2
-0.9611 x Gladstone unit 3
-0.9611 x Gladstone unit 4

-0.93 x Gladstone unit 5
-0.93 x Gladstone unit 6
-0.8021 x Kareeya hydro unit 1
-0.8021 x Kareeya hydro unit 2
-0.8021 x Kareeya hydro unit 3
-0.8021 x Kareeya hydro unit 4
-0.7975 x Mackay GT
-0.8015 x Mt Stuart GT unit 1
-0.8015 x Mt Stuart GT unit 2
-0.8015 x Mt Stuart GT unit 3
0.1042 x Oakey GT unit 1
0.1042 x Oakey GT unit 2
0.1588 x Roma GT unit 7
0.1588 x Roma GT unit 8
-0.8506 x Stanwell unit 1
-0.8506 x Stanwell unit 2
-0.8506 x Stanwell unit 3
-0.8506 x Stanwell unit 4
0.1588 x Tarong North
0.1588 x Tarong unit 1
0.1588 x Tarong unit 2
0.1588 x Tarong unit 3
0.1588 x Tarong unit 4
-0.8017 x Townsville GT (Yabulu) unit 1
0.1227 x MW flow north on the QNI AC Interconnector

RHS

Default RHS value= 10000

Dispatch RHS=
2.8094 x **(** -1 x [MVA on 871 275kV feeder from Calvale, Line end switched
    MW]
- 0.6531 x [MW flow on 855 275kV feeder at Calvale, Line end switched MW]
+ Qld: 871 Calvale to Wurdong 275kV Emergency Rating
- 35 {Margin}**)**
+ 0.1176 x [Millmerran unit 1]
+ 0.1176 x [Millmerran unit 2]
+ 0.1365 x [Braemar 1 GT unit 1]
+ 0.1365 x [Braemar 1 GT unit 2]
+ 0.1365 x [Braemar 1 GT unit 3]
+ 0.1365 x [Braemar 2 GT unit 5]
+ 0.1365 x [Braemar 2 GT unit 6]
+ 0.1365 x [Braemar 2 GT unit 7]
+ 0.1588 x [Roma GT unit 7]
+ 0.1588 x [Roma GT unit 8]
+ 0.1588 x [Tarong unit 1]
+ 0.1588 x [Tarong unit 2]

+ 0.1588 x [Tarong unit 3]
+ 0.1588 x [Tarong unit 4]
- 0.6781 x [Barcaldine GT]
- 0.93 x [Gladstone unit 1]
- 0.93 x [Gladstone unit 2]
- 0.9611 x [Gladstone unit 3]
- 0.9611 x [Gladstone unit 4]
- 0.93 x [Gladstone unit 5]
- 0.93 x [Gladstone unit 6]
- 0.8021 x [Kareeya hydro unit 1]
- 0.8021 x [Kareeya hydro unit 2]
- 0.8021 x [Kareeya hydro unit 3]
- 0.8021 x [Kareeya hydro unit 4]
- 0.8015 x [Mt Stuart GT unit 3]
- 0.8015 x [Mt Stuart GT unit 1]
- 0.8015 x [Mt Stuart GT unit 2]
- 0.7975 x [Mackay GT]
- 0.8017 x [Townsville GT (Yabulu) unit 1]
+ 0.1365 x [Kogan Creek]
+ 0.1042 x [Oakey GT unit 1]
+ 0.1042 x [Oakey GT unit 2]
+ 0.1588 x [Tarong North]
+ Callide B unit 1
+ Callide B unit 2
+ Callide C unit 3
+ Callide C unit 4
- 0.8506 x [Stanwell unit 1]
- 0.8506 x [Stanwell unit 2]
- 0.8506 x [Stanwell unit 3]
- 0.8506 x [Stanwell unit 4]
- 0.8021 x [Barron Gorge hydro unit 1]
- 0.8021 x [Barron Gorge hydro unit 2]
- 0.8016 x [Townsville GT (Yabulu) unit 2]
+ 0.1227 x [MW flow north on the QNI AC Interconnector]
+ 0.1588 x [Condamine CCGT]
+ 0.1365 x [Darling Downs GT]