TASC 24 – 1 Hour Gate Closure Testing – Draft Report

30/9/2013

SYSTEM OPERATOR

Keeping the energy flowing

TRANSPOWER

Transpower New Zealand Ltd The National Grid

Version	Date	Change
1.0	23-9-13	First rough draft for discussion
1.1	30-9-13	Updated for internal review
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	Name	Date
Prepared By:	Neil Walbran	20-9-13
Reviewed By:	Darren Pat	20-9-13
	Dan Twigg	30-9-13
	Lisa Dhanji	27-9-13
	Caroline Jack	27-9-13
	Lisa Tinkley	27-9-13

	Name	Date
With input from:	Kevin Hounsell	
	Kelvin Thiele	
	Phil Azzato	
	Kiel Adlam - MRP	
	Rick Wellington	

TABLE OF CONTENTS

1 Executive summary

This paper provides an overview of the System Operator's testing and review of whether 1 hour (or shorter) gate closure could be supported by the System Operator (SO) and, if so, what tool and process changes might be needed.

Summary of conclusions

The conclusions from the test are:

- 1 hour gate closure could be supported with minor to moderate tool changes and further training of support energy coordinators (due to changes in responsibilities);
- Implementing such changes will require changes to the Procurement Plan, ancillary service contracts and to the Code;
- Further work is required to scope and cost the tool and training changes;
- There are several matters making a move to ½ hour gate closure challenging, these being around the time needed to perform security assessments after the schedules are published; and
- These challenges for ½ hour gate closure should only be investigated once 1 hour gate closure is bedded in.

2 Testing process

In order to confirm that introducing1 hour gate closure was appropriate and to identify any necessary changes, the SO carried out tests using its test and training simulator environment (TTSE). The testing process included:

- Identification of likely challenges to 1 hour gate closure;
- Identifying possible solutions to these challenges; and
- Testing the practicality of these solutions in the TTSE environment.

2.1 Background – aim of testing

The Electricity Authority asked the SO to investigate whether gate closure could be reduced to 1 hour and if so what changes would be needed to achieve this. Two challenges to 1 hour gate closure were identified along with possible solutions to these challenges. The testing aimed to establish whether the proposed solutions would work and, if so, what changes in process or co-ordination centre roles might be needed to support these changes.

2.1.1 Key issues for 1 hour gate closure

Prior to testing two challenges for 1 hour gate closure were identified:

- Reduced SPD and RMT iterations;
- Frequency Keeper (FK) lock down period.

Reduced SPD/RMT iterations

If a move to 1 hour gate closure is introduced, under current system design, each NRSS/PRSS issued will only have had the benefit of two iterations of RMT and SPD with the final offer set for trading period (TP) 3 of the schedule.

SPD and RMT need a certain minimum number of iterations to give confidence of convergence and that a stable solution has been produced.

Frequency keeper lock down period

With a 1 hour gate closure the SO needs to consider the FK lock down period. The SO currently locks down the FK selection for the current plus two trading periods. This is because the FK can also be the reserve risk setter and a stable selection is required to feed into the SPD/RMT iteration process as above. With 1 hour closure the locked down FK could change its energy offer after lock down which, in turn, might mean the selected FK provider was not, in hindsight, the least cost provider.

2.1.2 Proposals (for testing)

Possible solutions to these two issues were identified, as follows:

Two SPD/RMT iterations per trading period

To be confident of convergence for SPD/RMT it is proposed to undertake two iterations per trading period, i.e. add a second SPD/RMT solve for the NRSS and PRSS at 10 minutes past the TP start. The concern is the extra iteration reduces the time available for security assessment. It is proposed only the second (hopefully stable) solution would be published.

The testing only looked at the process implications of this proposed solution, not the system implications such as computational load, database load etc. These would need to be considered as part of the next stage of investigation.

It should be noted that this solution may conflict with the proposed delays in schedule publication being introduced in the current design of dispatchable demand. See section 6.1 for details.

Decrease frequency keeper lockdown

To avoid the FK selection problem it is proposed to reduce FK lockdown to current plus one trading period.

These two possible solutions were tested in the simulator.

2.1.3 Possible issues arising from proposals

The proposed solutions raise several possible issues for the Energy Co-ordinator's (EC) security assessment process, which could possibly spill over to impact on the Security Co-ordinator (SC) role. They also impact on generators, particularly those which are frequency providers. Possible issues include the following:

Reduced time for security assessment of each NRSS and PRSS

The extra time to process two SPD/RMT iterations will delay availability of the NRSS and SRSS. In turn this would mean the EC has less time to assess any security issues in

each schedule. In the test environment this delay was about 10mins but we expect the final solution and production environment should display a shorter delay.

Increased frequency keeper selection volatility

Reducing the FK lock down to current plus one TP may increase frequency keeper selection volatility. That is, the FK could change more often if the lock down period is reduced. This might then exacerbate RMT/SPD convergence issues and possibly cause issues for the selected frequency keeping generator with respect to getting its plant ready, with possible increase in bona fide issues. Any increased FK volatility may also impact on the time needed for the EC to undertake the security assessment on each NRSS and PRSS.

2.2 Test Scenarios

The test scenarios were as follows:

No.	Name	System Conditions	Event	What aiming to test	Market Offer Response	Comments
1	DC South Pole Trip	High DC south such that HVDC is SI reserve risk setter.	One pole trips	Ability of RMT and SPD to converge within one trading period given proposal to run two SPD/RMT iterations per TP.	None	Do we have a scenario for this already?
2	NI Generator Trip	SPL highly loaded (morning peak?)	Large NI generator SPL trips and causes IL response	When re-offer occurs (1 hour) can EC (and SC) assess impact on security within allotted time, particularly given need to run 2 SPD/RMT iterations per TP.	MRP re-offer in response to high prices	Could we use GEN_SPL_TRIP_PLUS_IL_145? Or GEN_OTC_TRIP_PLUS_IL_120? As base? Ideally don't want to trigger grid emergency as want to test ability to review schedule changes in response to re-offer at 1 hour
3	Frequency keeper change	SPL as frequency keeper and NI risk setter.	SPL bona fides out FK offer, requiring frequency keeper re-dispatch	Ability of RMT and SPD to converge where FK provider is risk setter and	MRP re-offers frequency keeping in response to knowledge that SPL out of market	Similar to scenario 2 but with SPL as frequency keeper
4	Load forecast change within 2 hours	Normal power system operation	Load forecast, or wind offers, change significantly between 1 and 2 hours out from current	Impact on EC of more frequent offer changes.	Generators refine offers in response to change in forecast price.	Do we have a scenario for this already? Suggest include in BAU scenario.

			trading period. Suggest include in BAU scenario.			
5	BAU	Normal power system operation for full 6 hours. Include a morning ramp.	Number of small changes, including but not limited to FK selection change and load forecast changes as above.	Ability of operators to continually handle changes that arise from 1 hour gate closure.	MRP changing offers in response to updated schedules.	Combine with frequency keeper change and load forecast change scenarios (3 and 4 above)

3 Test results

In carrying out these test scenarios we made the following observations on the impact of 1 hour gate closure on our systems and processes:

No.	Name	System Conditions	Event	What aiming to test	Market Offer Response	Results	Observations
1	DC South Pole Trip	High DC south such that HVDC is SI reserve risk setter.	One pole trips	Ability of RMT and SPD to converge within one trading period given proposal to run two SPD/RMT iterations per TP.	None	Couldn't achieve SPD/RMT oscillations as went straight to deficit reserve.	Not impacted by gate closure. Noted that confusing having multiple schedules. Proposed triggering second schedule automatically to maximise time available for assessment. Might need RMT comparison tool to detect oscillation.
2	NI Generator Trip	SPL highly loaded (morning peak?)	Large NI generator SPL trips and causes IL response	When re-offer occurs (1 hour) can EC (and SC) assess impact on security within allotted time, particularly given need to run 2 SPD/RMT iterations per TP.	MRP re-offer in response to high prices	Successful run. No major security issues arose but noted support EC role now needs to be involved more in security assessment of short schedules (NRSS/PRSS).	Not impacted by gate closure. Suggest may need changes to offer changes page to make changes more obvious, e.g. filtering out wind and changes that don't impact schedule. Noted that events that are currently GENs may become WRNs, if code changes to define GEN relative to reduced gate closure time.
3	Frequency keeper change	SPL as frequency keeper and NI risk setter.	SPL bona fides out FK offer, requiring frequency keeper re-dispatch	Ability of RMT and SPD to converge where FK provider is risk setter and	MRP re-offers frequency keeping in response to knowledge that SPL out of market	Successful run, but not able to fully test impact of FK selection volatility as didn't have other FK providers participating. No security issues arising from FK selection change. Observations as above regarding support EC role.	Not impacted by gate closure. Changes in frequency keeper selection did not cause security issues or unduly impact FK provider. Need for security assessment of short schedules (NRSS/PRSS) due to changes not captured in long schedules (NRSL/PRSL). Impacts on duties of EC and support EC. Observations as above regarding need for enhancements to offer comparison page.
4	Load forecast change within 2 hours	Normal power system operation	Load forecast, or wind offers, change significantly between 1 and 2 hours out from current trading	Impact on EC of more frequent offer changes.	Generators refine offers in response to change in forecast price.	Successful run. No security issues arising from load forecast change. Observations as above regarding support EC role.	Not impacted by gate closure. Need for security assessment of short schedules (NRSS/PRSS) due to changes not captured in long schedules (NRSL/PRSL). Impacts on duties of EC and support EC. Observations as above regarding need for enhancements to offer comparison page.

			period. Suggest include in BAU scenario.				
5	BAU	Normal power system operation for full 6 hours. Include a morning ramp.	Number of small changes, including but not limited to FK selection change and load forecast changes as above.	Ability of operators to continually handle changes that arise from 1 hour gate closure.	MRP changing offers in response to updated schedules.	Successful run. No security issues arising from offer changes. Observations as above regarding support EC role.	Not impacted by gate closure. Need for security assessment of short schedules (NRSS/PRSS) due to changes not captured in long schedules (NRSL/PRSL). Impacts on duties of EC and support EC. Observations as above regarding need for enhancements to offer comparison page.

3.1 Summary of test results

Overall the tests showed that the proposed solutions were successful and the possible issues arising from the proposed solutions did not materialise in testing. However some further suggested tool changes were identified.

3.1.1 Reduced time for security assessment of each NRSS and PRSS

The reduced security assessment time for each NRSS and PRSS proved to be manageable. Although, as noted below some further tool enhancements to enhance situational awareness will be required to assist the EC in the security assessment process, see 3.1.3 below.

3.1.2 Increased frequency keeper selection volatility

Increased frequency keeper selection volatility proved not to be a problem in practice.

3.1.3 Improved situational awareness tools

The tests showed a need for improved situational awareness tools to assist the EC carry out the security analysis in a reduced timeframe. This is expanded upon in section **Error! Reference source not found.**.

4 Tool changes required for 1 hour gate closure

The Electricity Authority asked the SO to advise what changes would be needed to achieve a 1 hour gate closure. We identified tool issues relevant to 1 hour gate closure and tested proposed solutions. The proposed solutions were tested in a simulated market environment and further tool and process enhancements identified to support the proposed changes.

Note: scoping and costing of tool changes was outside the remit of this investigation and would form part of an investigation to implement 1 hour gate closure.

4.1 Tools issues relevant to 1 hour gate closure

The technical challenges from moving to 1 hour gate closure include:

- Risk of SPD and RMT not converging;
- FK lockdown; and
- Tools to help awareness of late emerging security issues:
    - enhance offer change screen;
    - add RMT comparison page.

4.1.1 SPD/RMT convergence

Because system frequency response to a reserve event requires non-linear power system equations, and SPD is a linear optimisation process, the reserve requirements are run in a separate reserve modelling tool, RMT. RMT obtains its starting conditions from SPD and feeds its outputs back into SPD. Under certain conditions it can take several iterations before these two processes converge.

This process is iterated until convergence of the two processes occurs. Currently the short schedules (NRSS/PRSS) have four iterations for every set of final offers before a schedule is published. A move to 1 hour gate closure means each NRSS/PRSS issued will have only two iterations of RMT and SPD with the final offer set for the third TP by the time it is issued. SPD and RMT need a certain minimum number of iterations to provide confidence in the schedules having converged and that a stable solution is available.

4.1.2 Frequency keeper lockdown

A move to 1 hour gate closure could reduce confidence in the economic efficiency of the SO's FK selection tool if it is locked down for longer than the gate closure period. The SO currently locks down FK selection for the current plus two trading periods. This is because the frequency keeper can also be the reserve risk setter and stable selection is required to feed into the SPD/RMT iteration process, as above.

If the energy offer gate closure is reduced to 1 hour the locked down FK could change its energy offer after lock down and change the FK constrained on and off amounts, after the selection decision was made. This could mean the FK provider selected was not, in hindsight, the least cost provider.

4.1.3 Situational awareness

Reducing time available for analysis of any security issues with the NRSS/PRSS increases the risk of the EC missing security issues arising from late offer changes. That is the EC may have reduced situational awareness just because of the shorter time available for analysis.

4.2 Proposed solutions

Proposed solutions to these issues are:

4.2.1 SPD / RMT convergence - two SPD/RMT iterations per trading period

To be confident of convergence for SPD/RMT it is recommended that two iterations per trading period are completed. The best way of achieving this has yet to be finalised (see options, below). For the purposes of testing we simply triggered another NRSS/PRSS solve on fixed times (1min and 10min into trading period). However, this is approach may not be the ideal solution as it delays publication of every schedule even when most schedules won't have a convergence problem.

Available options include:

- Auto-triggering pre-run of a shorter (4 TP?) schedule prior to every NRSS/PRSS, which should minimise any possible convergence delay;
- Automatically detecting when a non-convergence (of SPD and RMT) occurs and only triggering a second run when the non-convergence occurs; or
- Including reserve calculations within SPD to remove the need for an iterative process[1].

[1] This would be a significant (and doubtless expensive) change due to the non-linear nature of reserve calculations and the difficulties of including this within a linear solver such as SPD.

If running additional iterations was adopted consideration should be given to publishing both schedules if two schedules are run as this information might be useful to traders.

Further investigation in a suitable IST test environment is required to refine this solution and determine the best way to ensure SPD and RMT convergence. This would be part of an investigation phase of an implementation project.

4.2.2 Frequency keeper lockdown

To avoid the FK selection problems it is recommended FK lockdown be reduced to current plus one trading period.

4.2.3 Situation awareness tool enhancements

Proposed changes to enhance situation awareness include:

- Enhancements to the current offer change screen; and
- Adding an RMT comparison screen.

Enhancements to offer change screen (minor change)

To assist the EC assess the impact of such changes enhancements to the current market system offer change screens are recommended. Easier identification of changes will help the EC know where to look to assess the impact of the changes on the schedules.

It is recommended the offer change screen be enhanced to allow easier identification of changes that impact the next schedule. One option would be to add filters to allow filtering based on:

- Where either the new or old offer price is within the clearing price +/- a configurable threshold; and
- The change in MW quantity is greater than a configurable threshold; and
- Consolidation of wind offer changes to a single North Island and South Island summary figure.

Co-ordinators could then apply these filters to help identify significant offer changes that could impact on the next schedule. A summary of these offer changes should also be available on the co-ordinators' summary page.

This, and the other system changes, will require further investigation to finalise design and cost.

RMT comparison page (moderate change)

A new tool should be available to allow comparison of RMT results between solutions to help identify and diagnose any RMT oscillation issues.

The SPD/RMT oscillation problem (when a DC pole trip occurs on high DC south – this is a long standing issue for the System Operator) often takes time to identify and resolve. With a 1 hour gate closure less time would be available to diagnose an oscillation problem.

It is recommended an RMT comparison display be developed (similar to the co-ordinators' current offer comparison page) to assist with identification and diagnosis of the RMT oscillation issue.

5 Possible staffing and training changes

Changing to a 1 hour gate closure would impact staff responsibilities and require additional staff training. Specific areas of likely attention include:

- Expansion of EC role;
- Greater market emphasis on the warning notice (WRN) process with associated need for better processes for producing WRN notices; and
- Greater emphasis on the timeliness of CAN and excursion notices with associated need for enhanced processes on issuing CAN and excursion notices[2].

5.1 Role of energy co-ordinator expands

Currently the long schedules (NRSL and PRSL) are published every 2 hours and the SC is responsible for reviewing the long schedules. With a move to 1 hour gate closure new offer information would be coming in that affects trading periods in the long schedules but is not taken into account until after those TPs have occurred. This will require the EC to have a greater role in reviewing security issues that arise between long schedules being published, noting that no material change to the current responsibilities of the EC is envisioned.

5.1.1 Possible additional training for EC role

With a 1 hour gate closure there may be more time pressure on the EC to assess the security implications of any changes in constraints arising from late offer changes. It is likely security assessment of late offer changes affecting constraints would become part of the EC role as they would fall into NRSS scheduling time. Assistance would be provided by the SC, as required. The increased role responsibilities for the EC's would require additional security assessment training. This would be one-off training arranged in anticipation of the implementation of reduced gate closure.

5.2 Greater emphasis on WRN notice process

If the code changes to implement 1 hour gate closure (as per section 6.4) also redefine a grid emergency to also align with 1 hour processes then some events currently managed as grid emergencies (GEN process) between 2 and 1 hour out will need to be managed via WRN notices. This would mean the market as a whole will need to place greater value on and attention to the WRN process.

5.3 Timeliness of CAN and excursion notice

Under 1 hour gate closure market participants could respond quicker to market events, probably the material objective of such a market design change. Timely notice of such events via CAN and excursion notices becomes more important as market participants want timely notice so as to be able to respond.

[2] Note: the need for managing security will always requite the System Operator to actively manage the system ahead of and in priority to issuing CANs and notifications; no change in that approach is being recommended).

While this has implications for processes and training of the EC for producing CANs and excursion notices the SO's focus will remain on security with timely issue of market notices remaining on a best endeavours basis.

6 Other issues

6.1 Dispatchable demand – late schedules not compatible with 1 hour gate closure

1 hour gate closure would reduce the time available for security analysis of any changes from offers in the short schedules (NRSS and PRSS) from just under 2 hours to about 50 minutes. It is noted that when dispatchable demand is implemented it is proposed to publish the schedules as late as possible in the trading period, e.g. 10 minutes before the end of the trading period. This would not seem compatible with a change to a 1 hour gate closure as insufficient time would be available to complete the security assessment arising from late offer changes.

There would in practice be only thirty minutes available after a schedule was published to carry out the security assessment. The gate closure testing suggested that thirty minutes would be insufficient time.

It would be necessary to review the current dispatchable demand arrangements if 1 hour gate closure is to be implemented.

6.2 Interaction with other work streams

Further investigation and consideration should be given to the interaction of 1 hour gate closure with other work streams such as:

- Loss tranches in SPD (TASC28), if this impacts on solve time;
- Bid and offer rule revision (TASC37);
- Electronic offers;
- Alignment of forecast and final prices.

6.3 Market system outage planning

Although outside the scope of this investigation it was noted that reducing gate closure to 1 hour could also impact the market system outage planning process (typically, a market system outage requires a minimum period of one hour). This will need further investigation to understand how the implications can be managed appropriately.

6.4 Code review required

This investigation has not reviewed the Code changes required to implement 1 hour gate closure, nor of any other contract issues arising from such change (such as with ancillary service providers).

7 Key issues for ½ hour gate closure

The investigation identified several significant issues with ½ hour gate closure that would need to be resolved before proceeding beyond 1 hour gate closure. These matters have

not been investigated in detail and it is recommended ½ hour gate closure should only be considered in detail once 1 hour gate closure has been implemented effectively and experience gained.

7.1 Insufficient time for completing various security procedures

It is noted that ½ hour gate closure would effectively provide only 15 minutes for the SO to complete security assessments (once the schedules have run, including time to undertake multiple RMT/SPD iterations to get convergence).

Specific SO procedures that could not be carried out in 15 minutes include (but are not limited to):

- PR-DP-264 Manage Insufficient Generation offers
- PR-DP-219 Manage Changes in Reserve Conditions
- GL-SH-202 Guidelines Standby Reserve Shortfall Management
- TI-DP-037 RMT-SPD DCS Oscillations

Means of dealing with each of these situations within 15 minutes would need to be identified and developed before moving to a ½ hour gate closure regime.

7.2 Frequency keeper selection lock down

One specific issue for ½ hour gate closure identified is the frequency keeping selection process.

As noted above the FK needs to be locked down at least 1 trading period ahead of dispatch to allow the reserve risk to be calculated when the frequency keeping provider can be the reserve risk setter. Also the frequency keeping provider is dispatched 15 minutes before the trading period start (to allow it to prepare for frequency keeping). For these reasons, under current arrangements, frequency keeping offers could not currently be reduced below 1 hour gate closure.

However, this need not restrain reducing energy gate closure to ½ hour. However, if energy gate closure was ½ hour and frequency keeping offer gate closure was 1 hour (meaning frequency keeping locked down for 1 hour) then understanding the consequence for constrained on and off payments would be necessary.

7.2.1 Elimination of frequency keeping constrained on assists ½ hour gate closure

Any concerns about the impact of gate closure changes on FK selection would be reduced if the payment of all constrained on and off payments to frequency keepers were eliminated. However, as noted above, bedding in 1 hour gate closure is recommended before any consideration is given to ½ hour energy gate closure.

8 Conclusions

The SO concludes from its investigation that:

- 1 hour gate closure (for energy, reserve and frequency keeping offers) should be feasible for the SO;

- Modest changes to various SO tools would be required to support 1 hour gate closure;
- The change impacts on the responsibilities of the support EC and would require additional implementation training;
- The Electricity Authority will need to:
    - Discuss changes to the Procurement Plan and ancillary service procurement contracts required to support changes to FK gate closure;
    - Undertake a review of the Code to determine the extent and nature of required changes
- Further investigation is required to cost the recommended SO tool changes; and
- Several significant matters have been identified which require examination prior to any consideration of moving to a ½ hour gate closure Code regime.

9 Next Steps

Recommended next steps include:

- Further investigate tool changes required to support 1 hour gate closure including:
    - The best way to run additional SDP/RMT iterations for the first 4 trading periods of the NRSS/PRSS (moderate change);
    - Changes to the lock down period for FK selection (minor change);
    - Enhancement of situational awareness tools (moderate changes) including:
        - Changes to the offer change display to make more visible changes to offers that impact the schedule;
        - Addition of a screen to show RMT changes between solutions;
- Investigate the impact on the EC role and expected training requirements;
- Discussion with the SO's ancillary services procurement team about changes required to the Procurement Plan and frequency keeping ancillary service contracts required to support changes to gate closure on frequency keeping offers; and
- A Code review to identify what changes would be required to implement 1 hour gate closure and any other consequences of such changes.