Australian Energy Market Operator

The Prudential Standard in the National Electricity Market

Final Report

4 August 2010

Contents

Glossary

Abbreviation	Term	Definition
	Additional securities	All forms of security acceptable to *AEMO* to bring *TO* below *TL* before 10.30am, including cash deposits and reallocations
AEMO	Australian Energy Market Operator	The operator of the *NEM*
	Base Case	Relates to the key focus of our results, the event giving rise to a *loss given default*. In this analysis, the *Base Case* occurs when a *Market Participant* is required to provide additional security (*TO*>*TL*)
CTO	Combined Total Outstandings	Used in the analysis and differs from *TO*, in being equal to the sum of *TRO* and *TPO*
	Exceedance	Used interchangeably with *loss given default* in this report
E_L	Expected Load	Used by *AEMO* in its calculation of a *Market Participant's MCL* or *RMCL*. We have substituted an alternative calculation for AEMO's forward looking calculation, removing the potential contribution of divergences between actual and *Expected Load* from our results
	Expected Loss	The mean of the *loss distribution.*
	Exposure	The differences between a *Market Participant's* prudential holdings (*MCL* or *RMCL*) and its *CTO*
	Load Factor	The relationship between a Market Participant's average daily load and its Maximum Daily Load, expressed as a percentage of average daily load. The lower the percentage, the worse the *Load Factor.*
LGD	Loss given Default	Difference between a *Market Participant's* prudential holdings when that participant default occurs and its *CTO*
	Loss Distribution	Statistical representation of losses used in standard credit risk analysis
	Market Participant	As defined in the *NER*
MCL	Maximum Credit Limit	As defined in the *NER*
NEM	National Electricity Market	Operated by *AEMO*
NER	National Electricity Rules	Govern the operation of the *NEM* by *AEMO*
P_t	Average Price	Used by *AEMO* in its calculation of the *RMCL* and the *MCL* and replicated by us in the analysis
PD	Probability of Default	Risk of default by a Market Participant in all

		circumstances. Not restricted to occasions of a *loss given default* reviewed in this report.
PM	Prudential Margin	As defined in the NER, equivalent to 7 days prudential security calculated in line with AEMO's procedures for calculating AP
PR	Prudential Requirements	When capitalized, refers to the security deposits required under the improved calculation methodology discussed in Section 5.
	Reaction Period	That period that is required for *AEMO's* procedures for suspension of a *Market Participant*. In this report the *Reaction Period* is assumed to be a uniform 7 days, including yesterday and today.
RMCL	Reduced Marginal Credit Limit	As defined in the *NER*
	Settlement Cycle	As defined in the *NER*
TL	Trading Limit	As defined in the *NER*
TO	Total Outstandings	As defined in the *NER*
TPO	Total Prospective Outstandings	Refers to the calculation performed in the analysis of the *exposure* that a *Market Participant* would incur over the *Reaction Period*
TRO	Total Retrospective Outstandings	All outstandings incurred by a *Market Participant* included in AEMO's calculation of Participant outstandings at the beginning of the day.
UL	Unexpected Loss	The level beyond which the cost of holding further capital or security is considered to outweigh the benefits. The Unexpected Loss (UL) is statistically derived and indicates the exposure at the desired probability/ confidence level of the loss distribution. The level at which the UL is set is a matter for judgement.
VF	Volatility Factor	A *Volatility Factor* is used by *AEMO* in calculating the *MCL* and the *RMCL*. In recommending modifications to the current process for calculating prudential requirements we have used different *Volatility Factors* to better capture the performance of the market over the *Reaction Period* and the period relating to the Settlement Cycle.

1 Executive Summary

As a result of our review of the performance of the current prudential arrangements, we recommend that the Prudential Standard is amended to expressly adopt a probability that a *loss given default*[1] would occur on no more than 2 percent of days where a Market Participant is unable to provide the cash or other securities required to keep its Total Outstandings within its Trading Limit. This measure has the advantage of mapping onto Australian Energy Market Operator's (AEMO) daily process for assessing participant risk and is readily measured and monitored.

A target for the probability of a *loss given default* of 2 percent or less represents an achievable improvement in the performance of the current prudential arrangements. Measured as an average of the National Electricity Market (NEM) regions' performance, the current prudential arrangements result in a probability of a *loss given default* of around 4 percent measured over the 10 years to the beginning of 2010[2].

The recommended 2 percent target probability for the risk of a *loss given default* can be implemented using improved techniques for its calculation. The results of the improved calculation approach, if compared with the experience of the past 10 years, would have resulted in a decrease in the average *Prudential Requirements* for all regions except Queensland. The average of the maximum *Prudential Requirements* would have also reduced for NSW over the same period and for Tasmania for the period of its membership of the NEM, but increased for other regions. The improved technique has the additional benefit of increased stability of the *Prudential Requirements* from year to year: the change in the *Prudential Requirements* from period to period, comparing the level in a given month with that of the same month from the previous year, would have been a fraction of the changes that on average have been associated with the current arrangements.

If the NEM was to move to a shorter settlement cycle with settlement 5 days in arrears rather than the current 28 day settlement period, then the 2 percent target for probability for the risk of a *loss given default* results in a reduction of between 30 and 50 percent in the maximum level of the *Prudential Requirements* on average in all regions, as well as a further reduction in the average level of the *Prudential Requirements*. There would also be some further reduction in the change in the *Prudential Requirements* from period to period. Importantly, compared with the existing prudential arrangements and the improved calculation methodology, a shorter settlement cycle considerably reduces the frequency of the occasions when participants are required to

[1] See discussion in Section 3.2 and 3.3.5 below for a definition of this term.
[2] For the Tasmanian region the period used is approximately 5 years.

provide additional securities to AEMO to bring their outstandings inside their Trading Limit.

The probability of the risk of a *loss given default* can be furthered reduced to a target of 1.5 percent or less. The cost of this improvement would be an increase in the level of the *Prudential Requirements*, compared with maintaining the target performance for the probability of a *loss given default* at 2 percent.

A significant issue remains with the prudential arrangements, even with the improved calculation methodology and the shorter settlement cycle. Historically, Market Participants have been exposed to a small number of very large potential *loss given default* events. These events are only partly mitigated under both the improved calculation methodology and the shorter settlement cycle. In our judgement, the increase in the Prudential Requirements to cover these events would be so large that no net benefit is likely to result from this approach. Other possible methods for providing protection against these events could be considered and are discussed in Section 6 of this report.

1.1 Interpreting our results

The results presented below and discussed in greater detail in Sections 4 and 5 of this report, relate to key elements of the questions that the AEMO asked us to answer in providing an actuarially sound calculation of the performance of the current prudential arrangements. When we refer to the "prudential arrangements", we mean both the prudential standard defined in the National Electricity Rules (NER) and AEMO's current processes, replicated in our modeling in a slightly simplified manner for the ten years to the beginning of 2010. Section 3.3 outlines our modeling approach, while Appendix A details the Scope of our Work and Appendix B discusses our modeling approach in more detail.

1.1.1. The language and concepts in this report

Sections 3.1 and 3.2 explore the standard analytical framework for credit risk, the difficulties that it presents in analysing the extent of risk retained in the NEM under the existing prudential arrangements and our approach to this issue in this report.

Our report uses the term *loss given default*[3] (LGD) in preference to the more technically exact term, *exceedance.* When we use *loss given default* it refers to the size of the loss that would be incurred if a Market Participant were to default, without taking into account the *Probability of Default* (PD). The *loss given default* is calculated as the difference between *Combined Total Outstandings*[4] and the security held by AEMO under the Maximum Credit Limit

[3] Italicized terms are included in the Glossary and discussed in Section 3.
[4] *Combined Total Outstandings* includes outstandings that accrue in the Reaction Period (*Total Prospective Outstandings*) in addition to *Total Retrospective Outstandings*, which relate to costs already incurred. *Combined Total Outstandings* has been chosen to

(MCL) or the Reduced Maximum Credit Limit (RMCL). Where *Combined Total Outstandings* are greater than the RMCL, for example, then there is a *loss given default*.

Unless otherwise stated, our results are presented at the regional level on the assumption there is a single representative retailer for the region. While this assumption is unrealistic, it is designed to preserve Market Participant's confidentiality.

In using the term *loss given default,* we are calculating our results to assess the value of a loss on the presumption that a default has occurred. Accordingly we are not calculating expected losses going forward. That requires a view on the *Probability of Default* of a Market Participant or a class of Market Participants. This report includes no view on the Probability of Default. The reasons for this approach are discussed in Section 3, but, in brief, neither we nor AEMO has the information required to make a judgement about the probability of default by a (class of) Market Participants. In AEMO's case, this reflects the policy judgements embedded in the NER, which AEMO refers to as "outsourcing credit risk management decisions"[5].

1.1.2. The performance of the Reduced Maximum Credit Limit and the Maximum Credit Limit

Figure 1.1 illustrates the probability of a loss to Market Participants given default, where a Market Participant is required to provide additional cash or other securities to reduce their Total Outstandings to below their Trading Limit (the Base Case).

The results, which show some differences from state to state, are equivalent to an average of a 3.9 percent probability of a *loss given default*, 3.7 percent if the Tasmanian results are excluded.

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represent a Market Participant's expected exposures in the event of a default, but takes no account of amounts that might be owed (or received) as a result of revisions to settlement data occurring after the end of the Reaction Period. This approach assumes that the intention of the Prudential Regime is, to the maximum extent consistent with the NER, to provide protection to Market Participants from the costs of losses in the event of a default.

[5] For example, see the discussion in CEG, *Assessing efficiency in settlement and prudential arrangements for energy markets: A report for AEMO,* January 2010, p12

Figure 1.1 Daily Probability of a *Loss given default*, Base Case, by NEM Region, percent

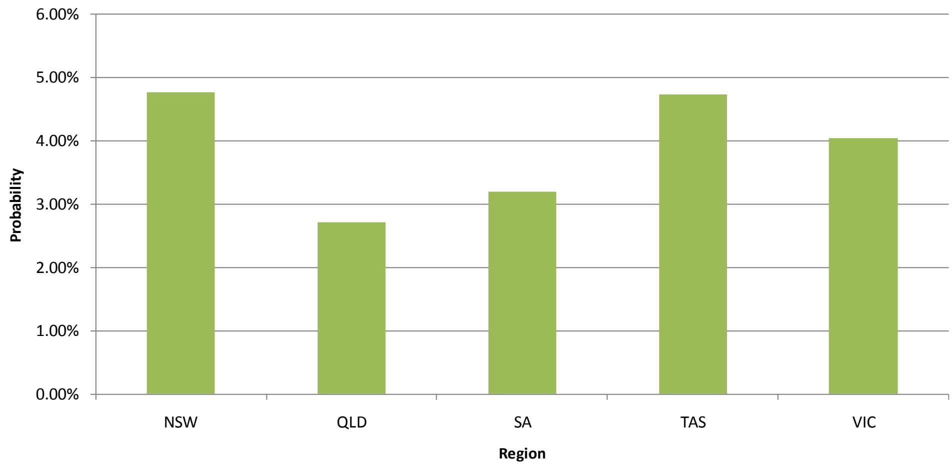

Table 1.1 contains the data behind Figure 1.1, as well as the identical data for the MCL. The MCL's performance is better than the RMCL's: the higher capital requirements of the MCL result in a lower probability of a *loss given default* across all regions[6], although the size of the potential *loss given default* is very similar for both the MCL and the RMCL.

Looking at the RMCL, events of a *loss given default* are clustered, reflecting the behaviour of high price events. The probability of a *loss given default* is also strongly seasonal, with the highest probability of a *loss given default* occurring during the winter months, from May to August (see Section 4.2).

The average *loss given default* is not a good representation of the maximum potential *loss given default*: the distribution of *loss given default* is skewed, characterised by a large number of relatively small losses and a very small number of extremely large losses. As Section 4 discusses, all regional markets have experienced events in the past ten years where the total potential *loss given default* is more than 3 times the average and, in the most extreme case, more than 12 times the average.

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[6] This is as a result of an increased 'buffer' between a participant's *Total Outstandings* and their *Trading Limit* at the time of a potential default event.

Table 1.1 Performance of the MCL and the RMCL, Base Case by NEM Region, percent of total days

		NSW	Qld	SA	Tas	Vic
	Total days	3,653	3,653	3,653	1,583	3,653
		MCL				
CTO > MCL	Days	103	63	70	35	82
Probability	% Total Days	2.8%	1.7%	1.9%	2.2%	2.2%
Average *Loss given default*	$m	104	64	35	20	41
		RMCL				
CTO > RMCL	Days	174	99	117	75	148
Probability	% Total Days	4.8%	2.7%	3.2%	4.7%	4.1%
Average *Loss given default*	$m	92	73	44	14	44

A default by an individual retailer

The average *loss given default* in Table 1.1, unless otherwise specifically identified, is measured at the total regional level – it assumes that the defaulting Market Participant is the sole retailer for the entire relevant market. This approach overstates the likely *loss given default* for a representative participant. More realistically, the *loss given default* should be scaled: the default of a retailer with a load profile reflecting the region as a whole and, say, 25 percent of the total load, would result in a loss of a quarter of these estimates on average.

As Section 4.5 discusses, our results suggest that where a retailer's profile differs from that of the region as a whole, then this simple scalar does not apply. All other things being equal, the worse a retailer's load factor[7], the higher the probability of a *loss given default* and vice versa.

1.1.3. The contribution of additional security to the prudential arrangements

Additional security plays a very significant role in the prudential arrangements. To bring their Total Outstandings back below their Trading Limit, Market

[7] A retailer's load factor is the ratio of maximum half hourly load to average half hourly load. The higher a retailer's maximum load is to its average load, the worse or lower its load factor.

Participants are required to make cash deposits or lodge other securities by 10.30am on the morning that the Total Outstandings first exceed the Participant's Trading Limit. Market Participants have a significant incentive to provide additional security: if a Market Participant fails to provide additional security, then AEMO issues a Call Notice and a significantly higher level of additional security is required to comply with the Rules.

Figure 1.2 below represents the data for Victoria from Table 1.1, with each leg of the decision tree expressed as a percentage of the total days in the data set. On around 22 percent of all days, *Combined Total Outstandings* would be greater than the RMCL without the operation of the cash deposit system. When additional security previously provided to AEMO is taken account of in calculating AEMO's prudential holdings, this percentage reduces to 7.4 percent[8].

Figure 1.2 The Victorian Region, *Combined Total Outstandings* and RMCL, 2000-2010, percent of total days

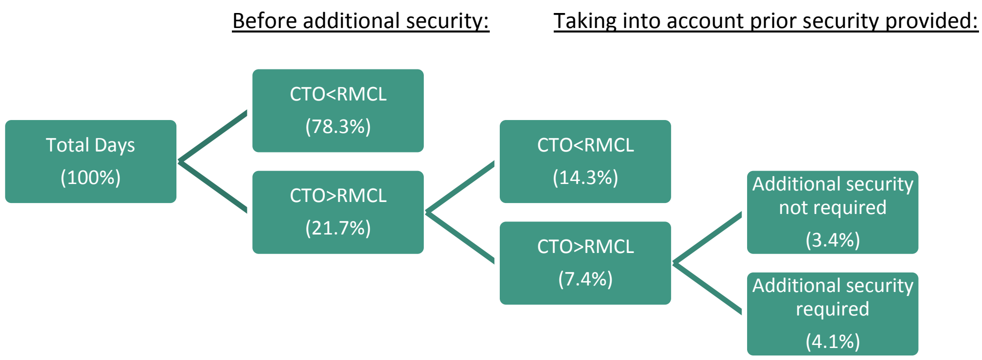

Table 1.2 looks at the reliance on additional security to supplement the prudential arrangements for the RMCL at the regional level. Averaging across the regions, on just over 8 percent of days in the ten years to the beginning of 2010 additional security would have been required. This is equivalent to requiring additional security on around 1 in every 12 days. Additional security deposits are not transitory: additional securities – either new or retained – are required on around 30 percent of all days.

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[8] Our analysis benefits from perfect hindsight. *Combined Total Outstandings* can exceed the RMCL without additional security being required where the Prudential Margin is less than *Total Prospective Outstandings*. See Section 3.3 for further discussion of this point.

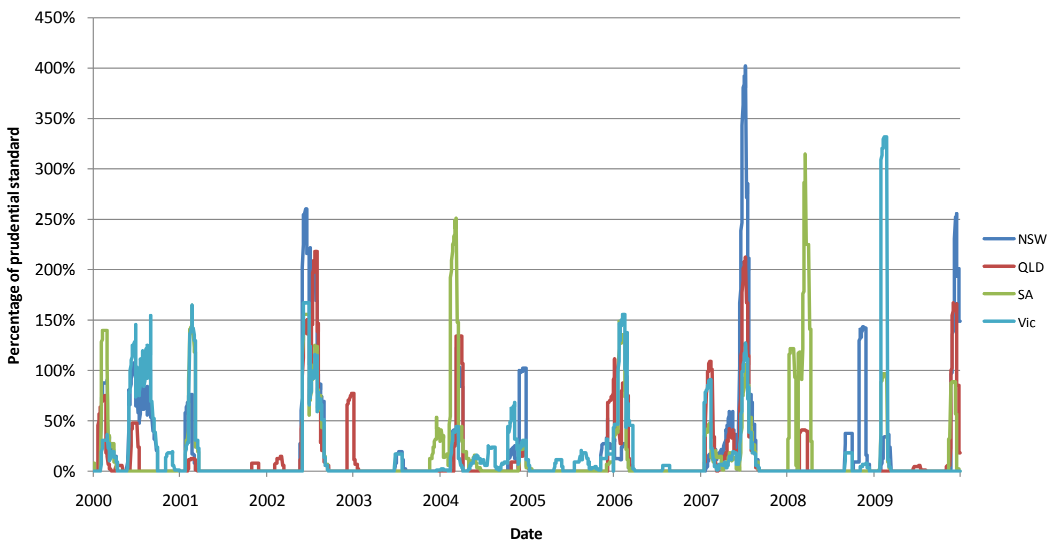
Table 1.2 Additional Security required by number of days required, dollar value and NEM region, Base Case

Region	NSW	Qld	SA	Tas	Vic
Total days	3,653	3,653	3,653	1,583	3,653
Number of days additional security is required	339	241	290	141	350
Percentage of days additional security is required	9.3%	6.6%	7.9%	8.9%	9.6%
Average new security deposit required ($m)	22	15	7	3	10
Total number of days with additional security held	1,121	1,008	1,042	537	1,492
Percentage of days with additional security held	30.7%	27.6%	28.5%	33.9%	40.8%
Average total additional security balance ($m)	195	104	54	23	70

The average additional security requirement understates the contribution of additional securities to the prudential arrangements. Cumulative additional security requirements can be significantly greater than the security held under the RMCL, as illustrated in Figure 1.3, where values on the vertical axis in excess of 100 percent indicate that the dollar balance of cumulative additional securities held on a day are greater than the RMCL, i.e. they represent 50 percent or more of the total security required by AEMO across the market as a whole[9]. Figure 1.3 also illustrates a further important observation about the current prudential arrangements: the requirement for additional securities, like the incidence of potential *losses given default* is strongly seasonal, with summer and winter periods dominating.

[9] As discussed in Section 3, we treat additional security in the same way as AEMO's procedures. The additional security is held until the billing week for which it was required is settled and then released.

Figure 1.3 Additional securities as a share of total prudential requirements, Base Case, percent of RMCL



1.2 Alternatives to the current Prudential Standard

1.2.1. Achieving the desired level of performance: changes to the calculation of the Prudential Standard

The probability of a *loss given default* under the current prudential arrangements displays a strong seasonal pattern. The distribution of events of a possible *loss given default* is also very skewed, with a large number of small events and a very small number of extremely large events. In addition, the prudential requirements for Market Participants differ sharply from season to season and from year to year, imposing some costs on Market Participants in anticipating and meeting the requirements.

A target for the probability of a *loss given default* of 2 percent or less represents an achievable improvement in the performance of the current prudential arrangements. In Section 6, we discuss the process that we followed with AEMO in deciding on the appropriate measure for the performance of the prudential arrangements and in setting the target performance level.

To achieve the target performance level, we have applied an alternative calculation methodology to the Price and Volatility Factors used in the current approach to calculating the prudential requirements. Our approach to improving the performance of the prudential arrangements is discussed in Section 5.1. The improvements in performance have not been optimized for maximum benefit: the changes made to the calculation methodology have been relatively simple and have been designed to reflect issues observed in the performance of the current prudential arrangements. Further improvements may be possible.

Figure 1.4 shows the effects of the revised calculation on the probability of a *loss given default* for the 10 years to the beginning of 2010[10]. The probability of a *loss given default* is reduced in all NEM regions and the average across the regions, calculated as before, is around 2 percent. The improvement in the probability of a *loss given default* is achieved by a reduction in the number of small events: the extremely large occasional events of a *loss given default* have not been eliminated from the results.

Figure 1.4 Probability of a *Loss given default*, Revised Calculations, by NEM Region, probability

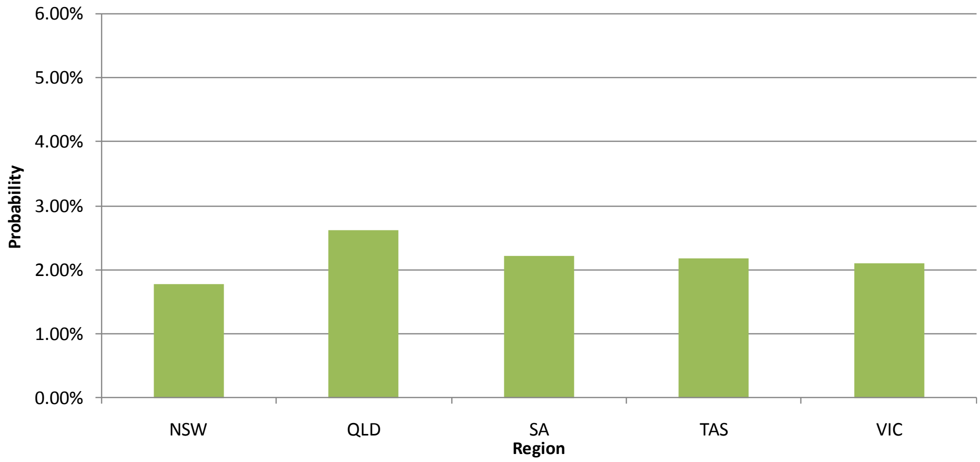


Figure 1.5 contains the results of the improved calculation approach. Compared with the experience of the past 10 years, the improved calculation approach would have resulted in a decrease in the average (or mean) Prudential Requirements for all regions except Queensland. The average of the Maximum Prudential Requirements would have also reduced for NSW over the same period and for Tasmania for the period of its membership of the National Electricity Market (NEM), but increased for other regions. In addition, the change in the Prudential Requirements from period to period, comparing the level in a given month with that of the same month from the previous year, would have been a fraction of the changes that on average have been associated with the current arrangements.

[10] Excluding Tasmania which uses a 5 year period.

Figure 1.5 Prudential Requirements, improved calculation approach vs. current approach, percent of current Prudential Requirements (RMCL)

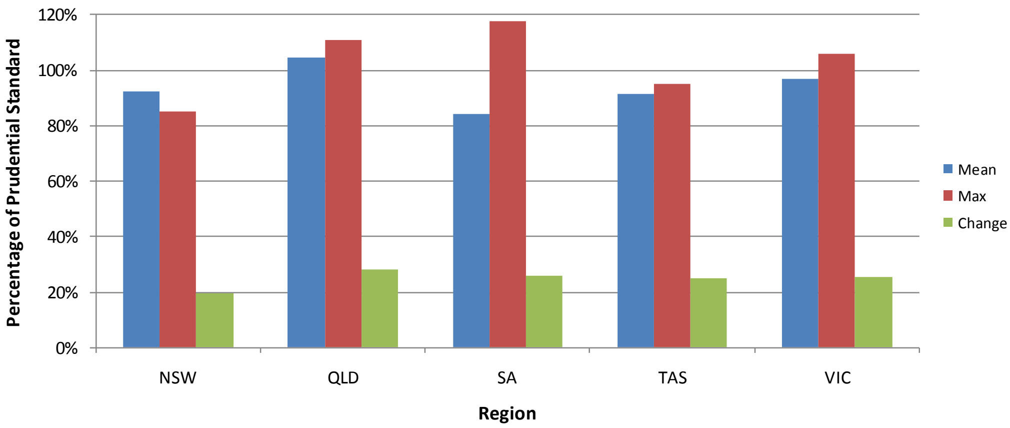


Table 1.3 on the following page provides further comparisons of the average (or mean) prudential requirements for the current prudential arrangements and the improved calculation approach. The results in Table 1.3 show that for the improved calculation approach, the average Trading Limit decreases by approximately 13 percent whilst the average Prudential Margins increases by approximately 14 percent. As a result the proportion of the Prudential Margin relative to the Trading Limit increases from 25 percent to 30 percent. These changes are consistent with the intent of our methodology as outlined in Section 5 which provides for a specific Volatility Factor for the Prudential Margin to reflect the risk associated with potential losses during the Reaction Period.

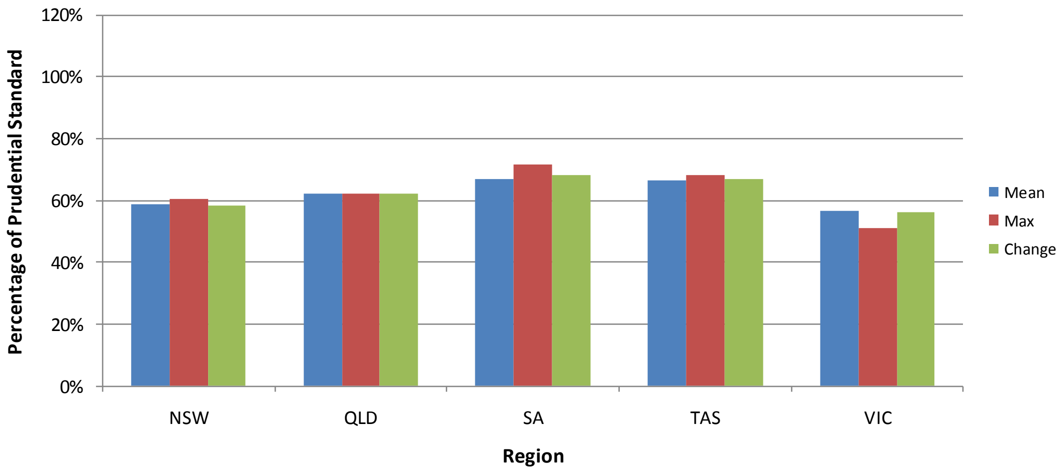
Table 1.3 Comparison of average Prudential Requirements, Trading Limit and Prudential Margin: improved calculation approach vs. current approach, by NEM region

		NSW	Qld	SA	Tas	Vic
Current Approach (RMCL)						
Average RMCL	$ million	478	292	119	83	259
Average Trading Limit	$ million	358	219	90	62	194
Average Prudential Margin	$ million	120	73	30	21	65
Average Prudential Margin (%)	% of RMCL	25%	25%	25%	25%	25%
Improved Calculation Approach						
Average Prudential Requirement	$ million	442	305	100	75	251
Average Trading Limit	$ million	309	205	67	55	179
Average Prudential Margin	$ million	133	100	33	20	71
Average Prudential Margin (%)	% of Prudential Req’t	30%	33%	33%	27%	28%
Percentage of Current Approach						
Average Prudential Requirement	% of current RMCL	92%	104%	84%	91%	97%
Average Trading Limit	% of current TL	86%	94%	75%	89%	92%
Average Prudential Margin	% of current PM	111%	137%	111%	99%	110%

1.2.2. Shortening the settlement cycle: effects on the performance of the Loss given default

At AEMO’s request, we have used the alternative calculation methodology and applied it to a settlement cycle of 12 days (billing period of 7 days, paid 5 days in arrears). Our results are discussed in Section 5.2. Figure 1.6 shows that, combined with the shorter settlement cycle, targeting 2 percent for the probability for the risk of a *loss given default* and using the improved calculation methodology results in a reduction of between 30 and 50 percent in the maximum level of Prudential Requirements on average in all regions, as well as a similar reduction in the average level of the Prudential Requirements. There would also be some further reduction in the change in the Prudential Requirements from period to period.

Figure 1.6 Prudential Requirements, 2 percent target shorter settlement cycle vs. 2 percent target improved calculations current settlement cycle, by NEM Region, percent of 2 percent target requirements on current settlement cycle



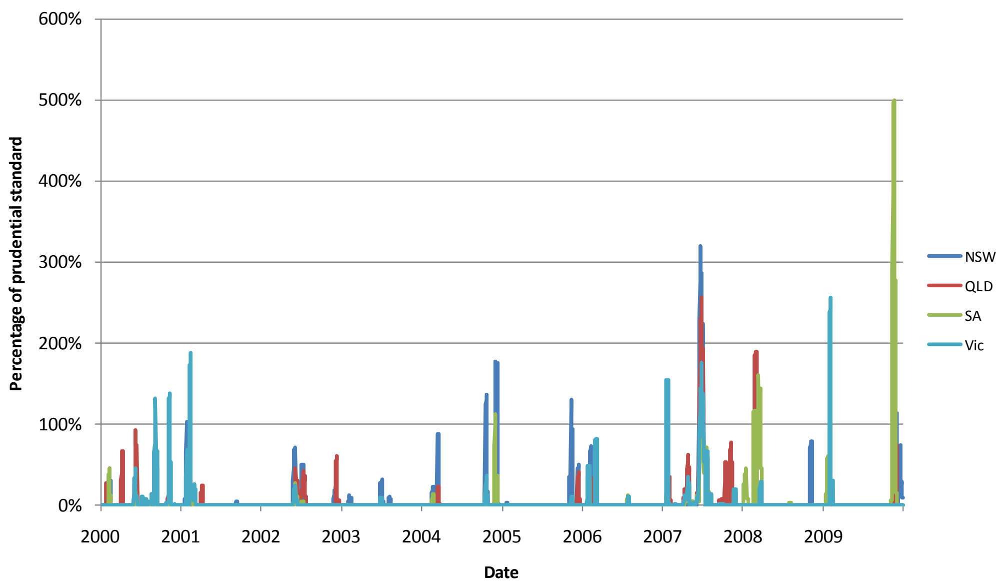
Consistent with Table 1.3, Table 1.4 on the following page provides further detail on the dollar level and comparison of the average (or mean) prudential requirements for the improved calculation approach vs. the improved calculation approach with a shorter settlement cycle. The results in Table 1.4 are incremental to the results in Table 1.3and illustrate that for the shorter settlement cycle the average Trading Limit decreases by on average approximately 47percent, whilst the average Prudential Margins only decreases by 24 percent. As a result the proportion of Prudential Margin relative to Trading Limit increases to approximately 37 percent. This is consistent with the expectation that shortening the settlement cycle would substantially reduce participants' Trading Limits. The Prudential Margin has reduced as a result of our approach to maintaining the 2 percent average probability of loss given default.

Table 1.4 Comparison of average Prudential Requirements, Trading Limit and Prudential Margin: improved calculation approach vs. shorter settlement cycle, by NEM region

		NSW	Qld	SA	Tas	Vic
Improved Calculation Approach						
Average Prudential Requirement	$ million	442	305	100	75	251
Average Trading Limit	$ million	309	205	67	55	179
Average Prudential Margin	$ million	133	100	33	20	71
Average Prudential Margin (%)	% of Prudential Req't	30%	33%	33%	27%	28%
Improved Calculation Approach (Shorter Settlement Cycle)						
Average Prudential Requirement	$ million	260	190	67	50	143
Average Trading Limit	$ million	165	122	43	32	91
Average Prudential Margin	$ million	95	68	25	19	52
Average Prudential Margin (%)	% of Prudential Req't	36%	36%	37%	37%	36%
Percentage of Improved Calculation Approach						
Average Prudential Requirement	% of Prudential Requirement	59%	62%	67%	67%	57%
Average Trading Limit	% of Trading Limit	54%	60%	64%	57%	51%
Average Prudential Margin	% of Prudential Margin	71%	68%	74%	92%	73%

Importantly, as shown in Figure 1.7 compared with the existing prudential arrangements and the improved calculation methodology, a shorter settlement cycle considerably reduces the need for participants to provide cash or other securities to AEMO to bring their outstandings inside their Trading Limit.

Figure 1.7 Additional securities as a share of required prudential holdings, shorter settlement cycle and revised calculations, percent



1.2.3. Adjusting the Prudential Arrangements for anticipated changes in prices and volatility

Section 5 discusses the potential to adjust the improved calculation methodology for the increase in the level of the Value of Lost Load (VoLL), as well as for the potential introduction of a Carbon Pollution Reduction Scheme. Although we have not modeled these events, the methodology can be adapted to anticipate these events and adjusted over time to reflect the actual changes in the market.

1.2.4. The incidence of large losses

Section 5 discusses the improvements to the performance of the prudential arrangements first under the improved calculation approach and then, using a similar approach, under a shorter settlement cycle. However, as the results in Section 5 illustrate, under both alternatives to the current arrangements, each of the regions remain exposed to occasional, very large potential *losses given default*. In our judgement, further improvements to the current approach of protecting market participants against the risk of a *loss given default* are only likely to provide protection on these occasions at the cost of significantly higher prudential requirements.

2 Introduction

2.1 Outline of the Report

This report addresses the Scope of Work detailed in Appendix A that asked for an actuarially sound estimate of the performance of the MCL, RMCL and the PM under the existing prudential arrangements. The results of this work are detailed in Section 4. Our approach to defining and investigating the issues raised by the request are described in Section 3.

Section 5 looks at the other elements of the request from AEMO – developing alternatives to the language that the Prudential Standard is expressed in to more closely reflect its current performance; providing an alternative simplified modeling approach under the current prudential arrangements and assessing its performance; and considering the benefits and costs of changes to the prudential arrangements, as well as possible international learnings.

2.2 Reliances and Limitations

This report has been prepared by Seed Advisory Pty Ltd ("Seed") pursuant to a contract with AEMO dated 9 April 2010 and may only be relied on by AEMO. Seed and its directors, employees and officers otherwise expressly disclaim responsibility to any person other than AEMO from or in connection with this report.

The opinions, conclusions and any recommendations in this report are based on information provided by AEMO to Seed and assumptions and simplifications in the modeling approach made by Seed. The assumptions and simplifications in Seed's modeling approach were discussed and agreed with AEMO prior to finalising this report. Seed expressly disclaims responsibility for any error in, or omission from, this report arising from or in connection with any inaccuracy in the data provided by AEMO to Seed or the assumptions and modeling simplifications made by Seed being incorrect.

During the supply of our services, we may have supplied oral, draft or interim advice, reports or presentations but in such circumstances our written advice or final written report shall take precedence. No reliance should be placed by AEMO on any oral, draft or interim advice, reports or presentations.

We shall not be under any obligation in any circumstance to update any advice or report, oral or written, for events occurring after the advice or report has been issued in final form.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by Seed and the report are excluded unless they are expressly agreed in our contract with AEMO.

3 Analysing the Prudential Arrangements: Frameworks, Language and Approach

The institutional characteristics of the NEM affect the performance of the prudential arrangements. Important differences between the NEM and other markets include:

- The policy decision that no information is collected on the credit quality of NEM participants provided a Market Participant can meet the prudential requirements at NEM entry. This means AEMO has no information on the expected Probability of Default for Market Participants.
- The absence of any pooling of risk – each Market Participant's prudential holdings are required to be sufficient to offset the *loss given default* arising from its default. Unlike many other markets or institutions, the total amount of AEMO's prudential holdings is not a good guide to the adequacy or otherwise of the prudential arrangements: if a single Market Participant's *Combined Total Outstandings* exceed the prudential holdings that Market Participant has lodged with AEMO, then in the event of a default by that participant, other Market Participants, typically generators, will experience a loss.

In this section, to assist in the interpretation of our results, we first discuss the way in which a standard analysis of credit risk would approach the problem and then the differences between our analytical approach and the standard analytical framework.

3.1 The standard framework for analysing credit risk

Figure 3.1 Standard Credit Risk Analytical Framework, schematic

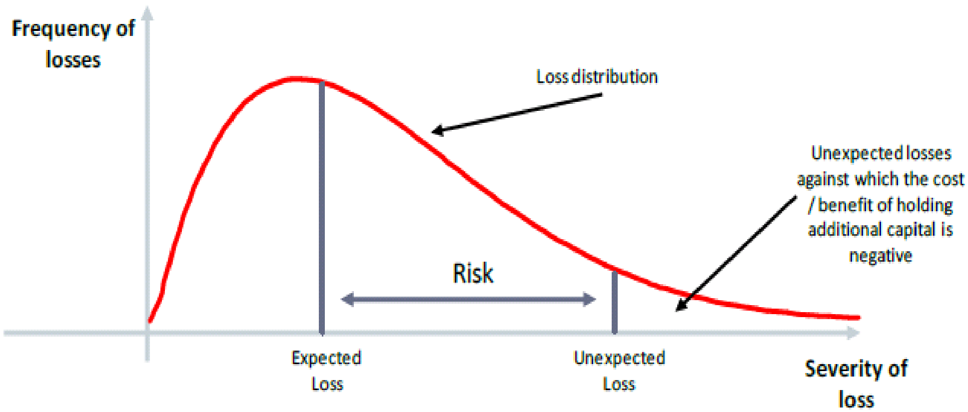


Figure 3.1 is a schematic of the standard analytical framework used for analysing credit risk. The *Unexpected Loss (UL)* is the level beyond which the cost of holding further capital or security is considered to outweigh the benefits. The

Unexpected Loss (UL) is statistically derived and indicates the exposure at the desired probability/confidence level of the loss distribution. The level at which the UL is set is a matter for judgement – in regulated markets by the regulatory authority and for risk management purposes, reflecting the organisation's view of the likely distribution of potential outcomes and the organisation's level of risk aversion. For example, the recent Australian Prudential Regulatory Authority (APRA) Draft Prudential Standard for General Insurance defines the UL as a probability greater than 99.5 percent[11].

In Section 4, following, we discuss the results of our analysis. In considering the concepts of the Expected Loss and the Unexpected Loss in the standard framework and the NEM, some important points should be borne in mind:

- The statistical characteristics of the Loss Distribution can and do differ widely from market to market, making it difficult to apply standards from other markets, such as APRA's 99.5 percent for example, directly to the definition of an Unexpected Loss.
  - Our findings indicate that the distribution of the *loss given default* is very skewed, with the median loss significantly below the average or Expected Loss. Put another way, losses at the right hand side of the distribution are very high relative to the median loss or the average loss, in some cases exceeding 12 times the average: the *loss given default* distribution has a "long tail".
- The standard framework does not mechanically define where, along the continuum of potential losses, the Unexpected Loss should be set. In the case of the NEM, the NER refers to the "reasonable worst case".
  - The distribution of *loss given default* in our results suggests that the size of *loss given default* can be very high at the far right hand side of the distribution.
  - Each region of the NEM has experienced these large potential events of *loss given default*. Given this experience, it is reasonable to suggest that they will continue to be experienced in the future.
- An annual Probability of Default taken from publicly available information, such as those probabilities of default published by ratings agencies, expressed on a daily basis, and applied to AEMO's distribution of the *loss given default* to approximate the standard Loss Distribution cannot be applied to our results.
  - As discussed below, the probability of a *loss given default* resulting from our work is conditional on two events occurring, *Combined Total Outstandings* exceeding the RMCL and a requirement for additional security to be lodged to bring the Participant's Total Outstandings within its Trading Limit.

[11] Australian Prudential Regulatory Authority, *Review of capital standards for general insurers and life insurers: Discussion Paper,* 13 May 2010

- The Probability of Default supplied by a ratings agency is unconditional and, in consequence, will underestimate the probability of a *loss given default* if applied to our results.

3.2 Application of the standard framework to the NEM

In looking at the performance of the prudential arrangements, we have only replicated elements of this framework. In particular:

– Our results focus on the *loss given default* in preference to the *Loss Distribution.* As a result, our results are conditional and should be read as "in the event of a default in specific defined circumstances, then the *loss given default* would be …"
– We provide results for the *Expected* or average *loss given default,* rather than the *Expected Loss* relating to the *Loss Distribution*
– We have not defined *Unexpected Losses*. Our results include all potential losses over the data period considered.
– *Exposure* and the *loss given default* have been measured on a daily basis, reflecting the operation of the prudential arrangements and AEMO's risk, which changes from day to day. For example, all other things being equal, Total Exposures are at their lowest on a Friday immediately following Settlement and at their highest on Saturday, when there are 7 days before the next Settlement[12].

Table 3.1 below looks at the elements of the standard framework in the context of the NEM and our treatment of the issues that arise from these differences.

For a variety of reasons, our results do not reflect AEMO's or its predecessor's experience.

– Our results are based on perfect foresight: they measure the loss that the market would incur in the event of a default, assuming that it takes six days from the beginning of the day on which the event of default occurs for the defaulting participant to be suspended from the market. If a default was to occur, then at that time, AEMO and market participants cannot replicate our calculations, as actual loads and prices over the period before the Market Participant is suspended from the NEM are not known until after the event.
– We have modeled the potential for a *loss given default* on the assumption that AEMO holds no more than the minimum required prudential deposits on any day. Market Participants may lodge more than the minimum required amount for reasons of convenience: for example, bank guarantees are provided for a year and modifying the amount lodged in the course of the year presents no saving to a retailer.

[12] This pattern persists throughout the period modeled, even where an event of a possible *loss given default* occurs in the course of the billing period. The calculation of the cost of a potential *loss given default* is truncated at the end of the Reaction Period, but the market is assumed to continue.

– We have made simplifications in our modeling approach. We have modeled Value of Energy Load as a proxy for the MCL or RMCL. We have not taken account of Reallocations, value of generation or interstate or cross company netting.
– We have not attempted to replicate AEMO's processes for calculating Expected Load from quarter to quarter, substituting actual for Expected Load.

Despite these simplifications, our results represent an actuarially robust approach to measuring the performance of the current NEM prudential arrangements.

Table 3.1 Elements of the Loss Distribution in the NEM

Concept	Relevant Comparison in the NEM	Issues/comments
Exposure	*Combined Total Outstandings*, including all amounts owed from the last settlement up until yesterday (*Total Retrospective Outstandings*) and all amounts that would be incurred by the Market Participant between an event of default (today) and suspension from the NEM in up to a further 6 days (*Total Prospective Outstandings*).	– The length of the settlement period and the time required for Market Suspension are important determinants of the size of the Exposure at any time. – The modeling reflects the settlement cycle, where the period to the next settlement differs depending on the day of the week. – The modeling assumes a standard 6 days from the beginning of the day prior to the day on which the default occurs to Market Suspension, resulting in 7 days exposure in *Total Prospective Outstandings*. – Certain events of default – for example, failure to make a settlement payment – are likely to result in fewer than 7 days exposure. In other limited circumstances – following 3 day weekends, Christmas and Easter – Total Prospective Exposure could reflect a longer period of outstandings than 7 days.
Loss given default	The difference between the total prudential security held, including bank guarantees and cash lodged with AEMO and held in Secure Deposit Accounts (SDAs), and *Combined Total Outstandings*	– The modeling assumes that the *loss given default* is equal to the difference between *Combined Total Outstandings* at the time of the event of default, not allowing for any future recoveries from the residual assets of the defaulting Market Participant or for any adjustments to previous settlements offsetting the Market Participant's obligations. – Given Market Suspension results in a Retailer of Last Resort (ROLR) event shifting the Market Participant's customers to other parties, this

Concept	Relevant Comparison in the NEM	Issues/comments
		assumption is unlikely to critically affect the results as customers are likely to have been the defaulting participant's key asset. – The modeling results in Section 4 reflect the *loss given default* where a Market Participant fails to meet its obligations to keep its Total Outstandings below its Trading Limit and the failure is not subsequently remedied. Other potential events of default – failure to meet a settlement payment – for example, will have their own *loss given default* and are discussed in Section 3.3.1.
Probability of Default	The likelihood that a Market Participant will fail, which includes events of failure outside the NEM (including bankruptcy and administration) and defaults in the NEM (failure to meet settlement obligations, failure to meet maintain Total Obligations within Trading Limit not remedied within the time allowed in AEMO's procedures and failure to meet a Cash Call).	– There have been no events of default in the NEM over its history and only 3 events of default outside the NEM resulting in a Market Participant's suspension from the NEM. – Additionally, AEMO has no insight into the credit quality of Market Participants, other than publicly available ratings where applicable. – References to the Probability of Default in this report, therefore, are based on assumptions about average credit quality and the associated risk of default and do not necessarily reflect the actual Probability of Default for Market Participants.

3.3 Our Approach

The statistical justification for our approach and details of our calculations are included in Appendix B. The following describes the basis for our calculations in general terms.

3.3.1. Events of Default

Our results focus on a specific type of event of default: a default that occurs when a Market Participant is unable to provide funds to keep its Total Outstandings below its Trading Limit by 10.30am on the morning that the obligation first occurs and fails to remedy that failure within the timeline laid out in AEMO's procedures.

3.3.2. Possible Events of Default

Figure 3.2, below, is a schematic of possible events of default in the NEM.

Our modeling initially looks at all occasions where Market Participants would incur a loss in the event of default, that is, where *Combined Total Outstandings* are greater than the prudentials held under the RMCL or the MCL, including all additional securities held by AEMO, regardless of whether an event of default has or could occur. The modeling results discussed in Section 4 indicate that, for Victoria, for example, on 7.4 percent of all days considered, in the event of *any* act of default, *Combined Total Outstandings* would be greater than the prudential security held, assuming that the prudential security is required to cover seven days of outstandings.

In presenting our results, we have concentrated on the specific category, Failure to provide Additional Security, which requires the Market Participant to have failed to meet the requirement to bring its Total Outstandings inside its Trading Limit by 10.30am on the morning of the breach. Again, the results for Victoria indicate that, over the period considered, on 4.1 percent of all days this potential event of default exists. We have assumed that, as Market Participants face a significantly higher requirement to augment their prudential holdings if the request for a cash deposit is not met, the last category in Figure 3.2, Failure to Meet a Call Notice, is a subset of the previous category, Failure to provide Additional Security.

Figure 3.2 Possible Events of Default, schematic[13]

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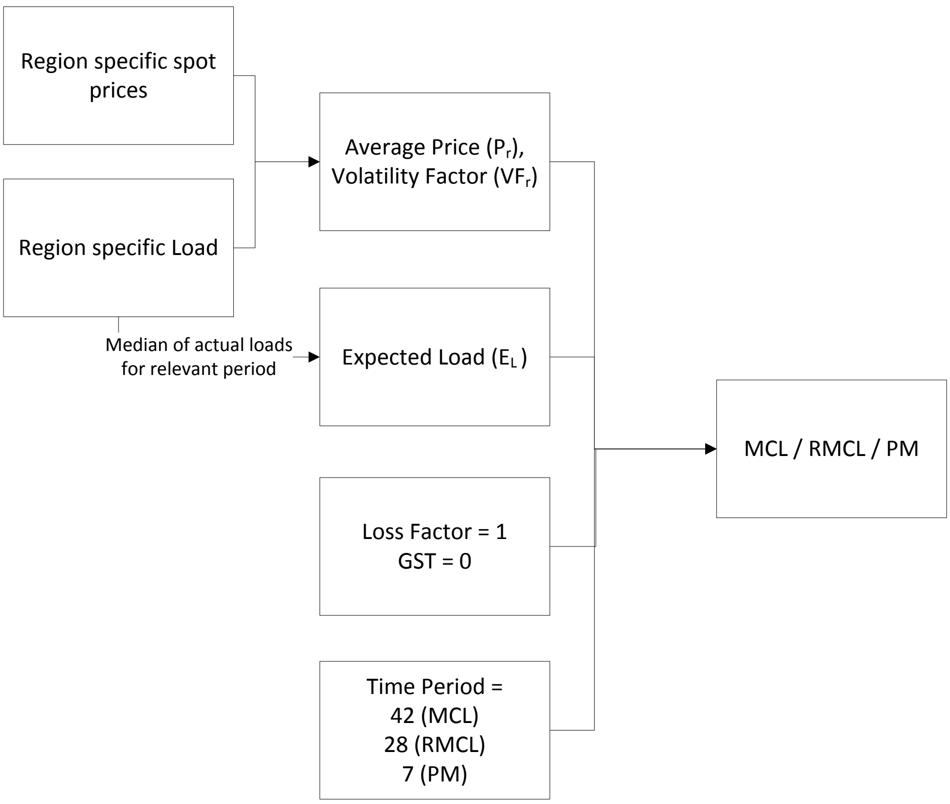
[13] Failure outside the NEM, Failure to meet a Settlement Payment and Failure to Meet a Call Notice are all formal events of default under cl 3.15.21 of the NER. For the purposes of our analysis, the Failure to Provide Additional Security is an effective event of default: Market Participants are required at all times to keep their Total Obligations below their Trading Limit. AEMO has implemented a procedure that notified Market Participants that this obligation is in danger of being breached, as well as establishing a timetable for a remedy to be provided. In the event a Participant fails to meet this obligation, then the Call Notice process would come into effect. Failure to comply with the requirements of the Call Notice would result in an event of default.

3.3.3. Calculating the Maximum Credit Limit and the Reduced Maximum Credit Limit.

Figure 3.3, below, illustrates the components of the MCL and the RMCL. In our calculations we have used region specific spot prices and load data supplied by AEMO to calculate the Average Price and the Volatility Factor. These calculations have been validated against AEMO's calculations for the relevant regional markets. In line with AEMO's approach, the time period used in the modeling of the MCL is 42 days, the RMCL is 28 days and the PM is 7 days.

Figure 3.3 Components of the Maximum Credit Limit and the Reduced Maximum Credit Limit



MCL / RMCL / PM = P_r x VF_r x E_L x Loss Factor x (1 + GST) x Time Period

3.3.4. Distinguishing between the Trading Limit and the Prudential Margin for the MCL and the RMCL

Our calculations replicate Market Participants' outstandings from day to day over the 10 years we have modeled. Figure 3.4 illustrates the relationship between the Billing Week and the Settlement Period and includes the Reaction Period for which the Prudential Margin is intended to provide cover against a potential *loss given default*. *Combined Total Outstandings* show a weekly saw tooth pattern[14], declining when settlement is made and then increasing across the week as outstandings accrue, decreasing again on the next Friday when the next settlement occurs.

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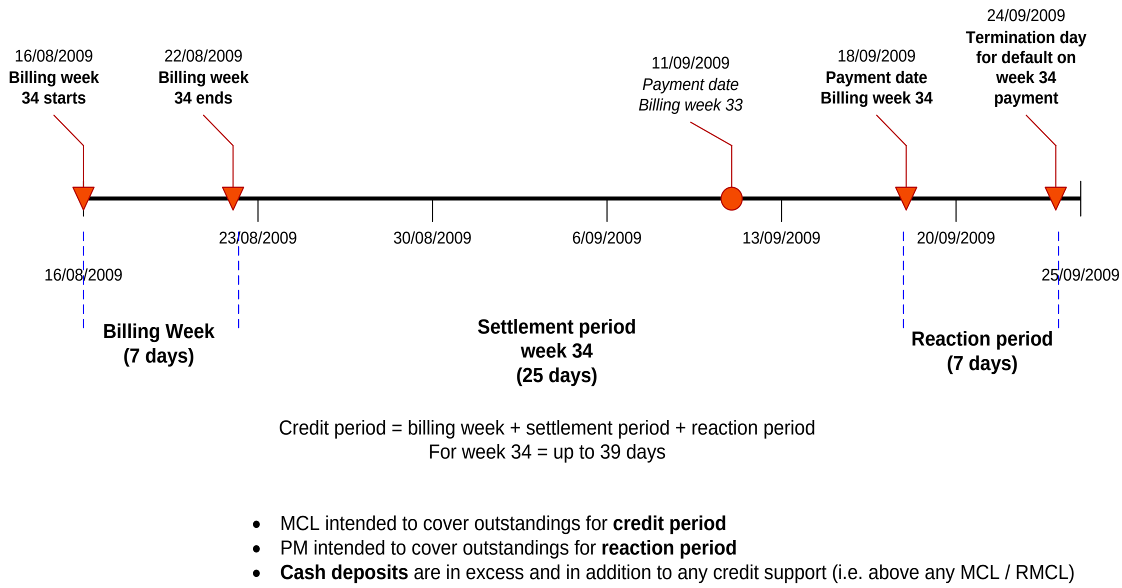
[14] When prices are stable. Where prices are either rising or falling, then the effect of changing prices can override this effect.

Figure 3.4 Illustrative Settlement Cycle, Maximum Credit Limit, Week 34, 2009



Our calculations take account:

- the settlement cycle;
- the daily accrual of Total Outstandings;
- the requirement to provide an additional security where the Trading Limit is breached by Total Outstandings; and
- prior cash deposits lodged.

Yesterday's incremental increase in Total Outstandings is compared with Market Participants' Trading Limits today, following the same timing that AEMO uses. In line with this process, the Reaction Period includes:

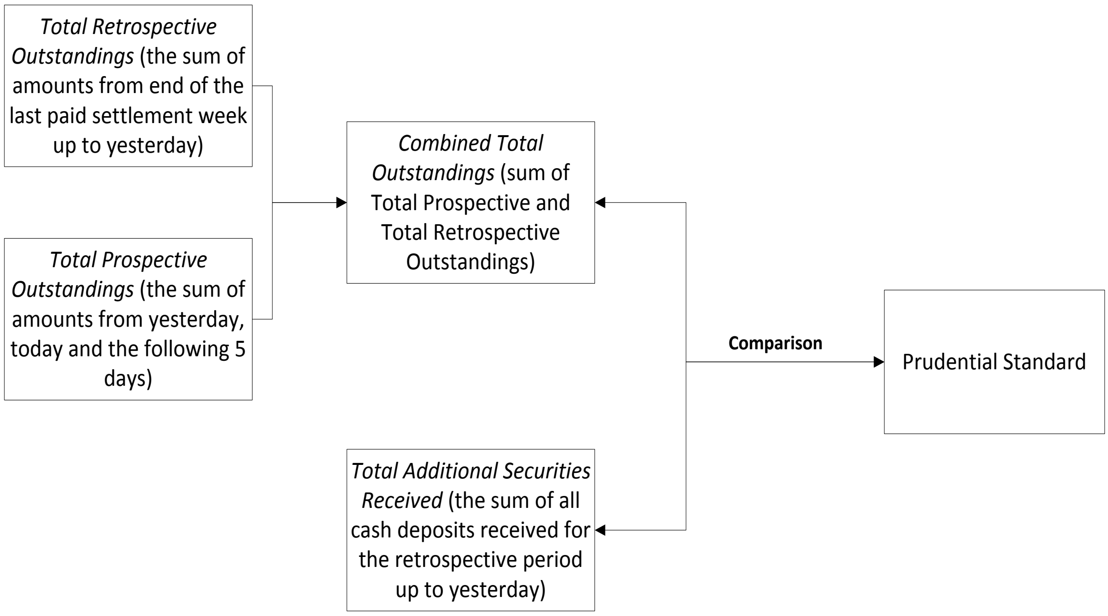
- yesterday's outstandings which would be the basis for any requirement for additional security to be lodged this morning;
- today's outstandings, which may form the basis for a requirement for additional security tomorrow; and
- a further five days' outstandings, reflecting the expected time for a Market Participant to be suspended from the NEM (*Total Prospective Outstandings*).

3.3.5. Comparing Total Outstandings and the Trading Limit and the Prudential Margin for the MCL and the RMCL.

Figure 3.5 illustrates the process that brings together the calculated MCL, RMCL and PM and *Combined Total Outstandings*, giving rise to our results. For the results for the Base Case discussed in this report, we identify a potential *loss given default* where *Combined Total Outstandings*, less the sum of daily cash deposits for the retrospective period up until yesterday, are greater than the calculated MCL or RMCL[15].

[15] We have also performed the same calculations *not taking into account* cash deposits. The results of these calculations are included in Appendix C.

Figure 3.5 Comparing Total Outstandings with the calculated Prudential Requirements



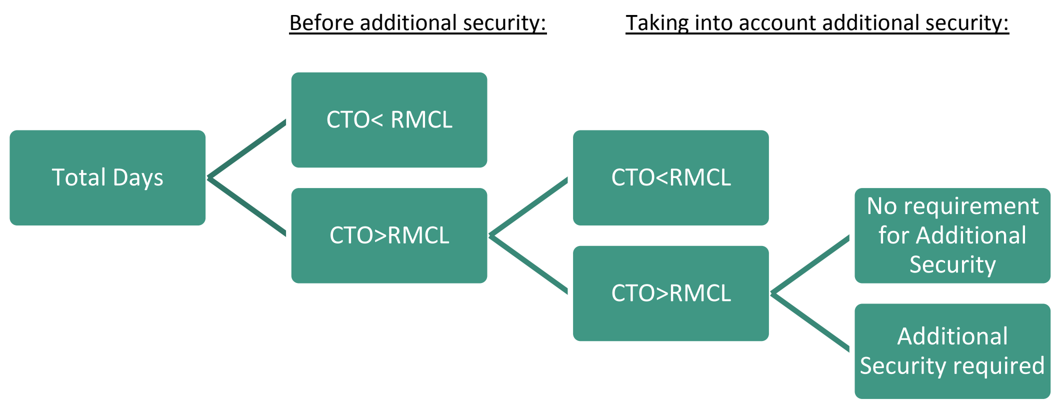
4 The Performance of the Current Prudential Standard Arrangements

4.1 Distinguishing events of a possible *Loss given default*

In this section, we briefly present the overall statistics for the performance of the MCL and the RMCL, looking at the frequency and average size of potential events of *loss given default*. Following the logic of the schematic in Figure 4.1, in Section 4.2 we present three tables of results for the MCL and the RMCL:

– Table 4.1 is based on the scenario where CTO > MCL or RMCL before allowance for any additional security
– Table 4.2 is based on the scenario where CTO > MCL or RMCL after allowance for additional security already provided and is therefore a subset of the results in Table 4.1
– Table 4.3 is based on the scenario where CTO > MCL or RMCL after allowance for additional security already provided and where further additional security is required to bring the Market Participant's Total Outstandings within its Trading Limit. This is a subset of Table 4.2 and represents the *Base Case*.

Figure 4.1 Analysing the RMCL, schematic



A Participant's *Combined Total Outstandings* (CTO) can be greater than the available security from the RMCL but on the day no additional security is required by AEMO. This is where a Market Participant's Total Outstandings (AEMO's definition) is less than its Trading Limit. In this case, our results show those cases where in the course of the Reaction Period, *Total Prospective Outstandings* are sufficiently high that they result in the Participant's total obligations to the market exceeding its prudential holdings. This category is identified in our modeling, but not seen in the market because of the perfect foresight assumed in the modeling. The events captured by this category are a measure of the adequacy of the Prudential Margin in providing cover for the Reaction Period in the event of a default.

Figure 4.2 is the same schematic, looking at Victorian regional level results for the RMCL. The Victorian region has been chosen as it is a region with a diverse number of participants. The RMCL has been chosen because the majority of Market Participants now opt for the RMCL in lodging their prudential cover.

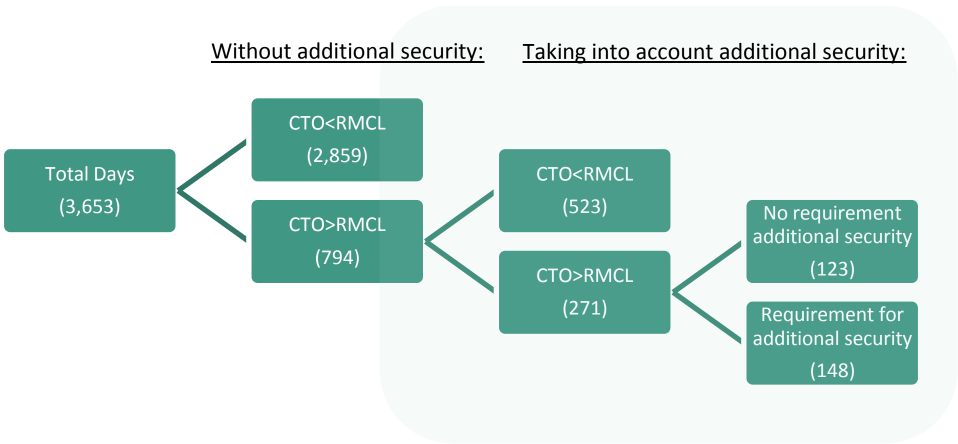
Figure 4.2 looks at the period 1 January 2000 to 31 December 2009 by day and categorises those days (3653 in total) by:

– looking at the relationship between CTO and the RMCL before allowing for additional securities received by AEMO and separating those days where the CTO is less than the RMCL (2859 days) and those days where CTO is greater than the RMCL[16] (794 days).
– for those days where CTO is greater than the RMCL excluding additional securities received, then considering the contribution of additional securities received and separating those days where CTO is less than RMCL after allowing for additional securities previously received (523 days) and those days where CTO is greater than RMCL after allowing for additional securities previously received (271 days);
– finally, for those days where CTO is greater than the RMCL, taking into account additional securities received, then separating those days where a new requirement for additional securities exists on the day (148 days) and those where no new requirement for additional securities exists (123 days).

The last category (148 days) on the right hand side of the schematic, where a requirement for additional security exists and the Market Participant's CTO is greater than the RMCL, represents a significant risk under the current prudential arrangements. *If* a requirement for additional security exists *and* the Market Participant is unable to supply the required security on time[17], then a loss will be incurred by Market Participants. The average size of a loss in that event would be $44 million. This last category on the decision tree is referred to throughout this report as the *Base Case*[18].

[16] Those days where CTO > RMCL are when there is a possibility of an LGD. If CTO < RMCL then there is no risk of an LGD as AEMO has enough security to cover any outstandings.
[17] And also fails to meet the formal Call Notice requirements by the following day. See the discussion in Section 3.3.1.
[18] The Base Case refers to the scenario where CTO > RMCL after allowing for additional security previously provided and a further requirement for additional security exists on the day.

Figure 4.2 The Victorian Region, *Combined Total Outstandings* and the RMCL, 2000 - 2010, number of days



4.2 The Maximum Credit Limit and the Reduced Maximum Credit Limit

Table 4.1 details the performance by NEM region of the MCL and the RMCL, before the requirement for additional security is taken into account. It measures the performance of the adequacy of the calculated MCL and RMCL relative to Market Participants' *Combined Total Outstandings*. Looking at the results for the RMCL, then on average nationally on around 20 percent of all days in the period considered, the RMCL is exceeded by *Combined Total Outstandings* – that is, without any other measures, in the event of a default, the *loss given default* would have been between $30 and $250 million, depending on the region.

Table 4.1 Performance of the MCL, RMCL, by NEM Region, without considering additional security, 2000 - 2010

		NSW	Qld	SA	Tas	Vic
	Total days	3,653	3,653	3,653	1,583	3,653
			MCL			
CTO > MCL	Days	447	344	398	137	381
Probability	% Total Days	12.2%	9.4%	10.9%	8.7%	10.4%
Average *Loss given default*	$m	251	107	60	37	126
			RMCL			
CTO > RMCL	Days	802	574	739	334	794
Probability	% Total Days	22.0%	15.7%	20.2%	21.1%	21.7%
Average *Loss given default*	$m	247	145	66	31	114

As could be expected, the frequency of events of *loss given default* declines significantly when additional security received from Market Participants is taken into account. Additional securities supplement the prudential requirements. However, while additional securities provide short term flexibility in the adjustment of the pre-announced quarterly prudential requirements for actual load and price outcomes, the requirement can also be seen as a measure of the shortfall of the pre-announced prudential requirements given market conditions. Considering Victoria, in the ten years to the beginning of 2010, the frequency with which *Combined Total Outstandings* are greater than the RMCL falls from 794 events to 271 events once additional securities received are taken into account. Similar reductions can be seen in other states.

Table 4.2 Performance of the MCL and the RMCL, including additional securities received, by NEM region, 2000 - 2010

		NSW	Qld	SA	Tas	Vic
	Total days	3,653	3,653	3,653	1,583	3,653
		MCL				
CTO > MCL	Days	204	130	160	62	177
Probability	% Total Days	5.6%	3.6%	4.4%	3.9%	4.8%
Average *Loss given default*	$m	106	51	33	16	52
		RMCL				
CTO > RMCL	Days	306	185	225	123	271
Probability	% Total Days	8.4%	5.1%	6.2%	7.8%	7.4%
Average *Loss given default*	$m	101	73	37	12	49

The frequency of potential events of a *loss given default* falls again, when only those occasions on which a further requirement for additional security exists are considered.

Table 4.3 shows the frequency of potential events of a *loss given default* in Victoria falling from 271 events to 148 events for the same period. A comparison of Table 4.2 and Table 4.3 also illustrates the similarity in the two *loss given default* distributions: the size of the average breach (Expected Loss) changes very little between the two tables, even though the number of events significantly declines. Again, the results for other states show similar outcomes.

Table 4.3 Performance of the MCL and the RMCL, Base Case, by NEM region, 2000 - 2010

		NSW	Qld	SA	Tas	Vic
	Total days	3,653	3,653	3,653	1,583	3,653
			MCL			
CTO > MCL	Days	103	63	70	35	82
Probability	% Total Days	2.8%	1.7%	1.9%	2.2%	2.2%
Average *Loss given default*	$m	104	64	35	20	41
			RMCL			
CTO > RMCL	Days	174	99	117	75	148
Probability	% Total Days	4.8%	2.7%	3.2%	4.7%	4.1%
Average *Loss given default*	$m	92	73	44	14	44

4.2.1. Seasonality, annual trends and skewness in events of Loss given default, RMCL

Figure 4.3 shows the strong seasonal pattern demonstrated by the results. The data on which Figure 4.3 is based is the same as for Table 4.3, but the potential events of a *loss given default* have been grouped by calendar month for the 10 years modeled and the average monthly probability of an event has been calculated. The results show that summer and winter are both characterised by a higher than average probability of an event in all states with the exception of Tasmania[19]. Both summer and winter extend over a number of months: summer commencing late in the calendar year and continuing until February and March and winter commencing in June and continuing until August or September. The shorter shoulder periods show considerably lower probabilities of an event of *loss given default* than either the summer or winter.

[19] In the case of Tasmania, only 5 years data is available, so differences between Tasmania and other states should not be overemphasized.

Figure 4.3 Probability of a *Loss given default*, RMCL, Base Case, by NEM region and calendar month, avg percent

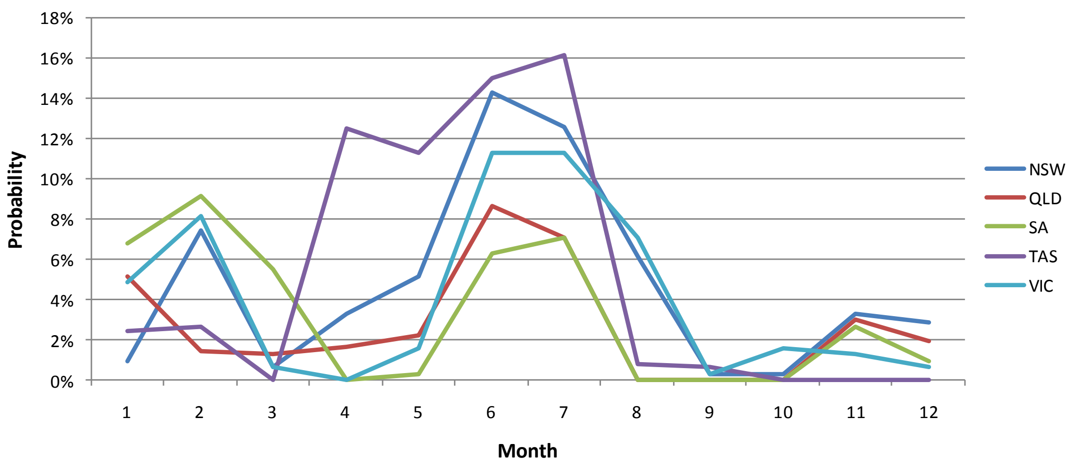


Figure 4.4 shows the impact of the 2007 drought on the annual probability of loss given default. The data on which Figure 4.4 is based is the same as for Table 4.3, but the potential events of a *loss given default* have been grouped by calendar year for the 10 years modeled and the average annual probability of an event has been calculated.

Figure 4.4 Probability of a Loss given Default, RMCL, Base Case, by NEM region and year, avg percent

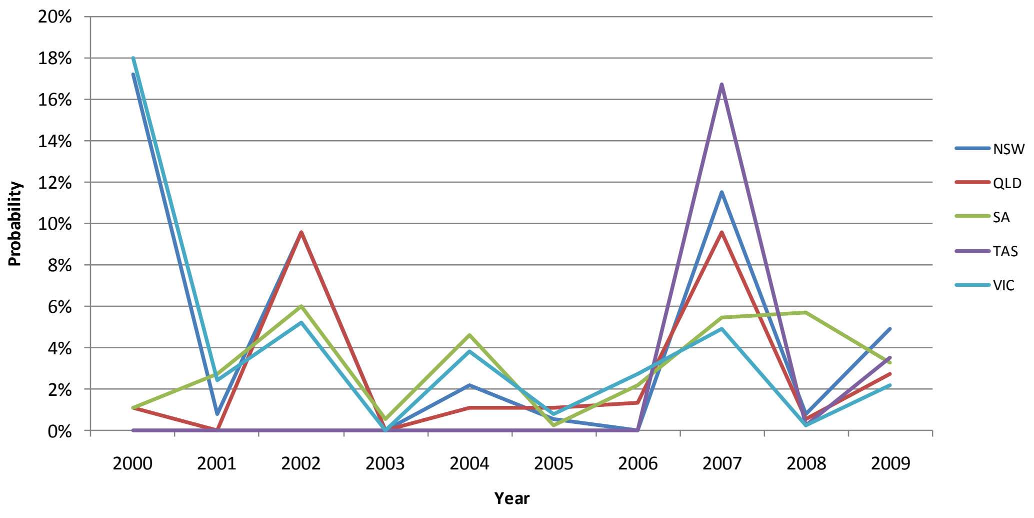
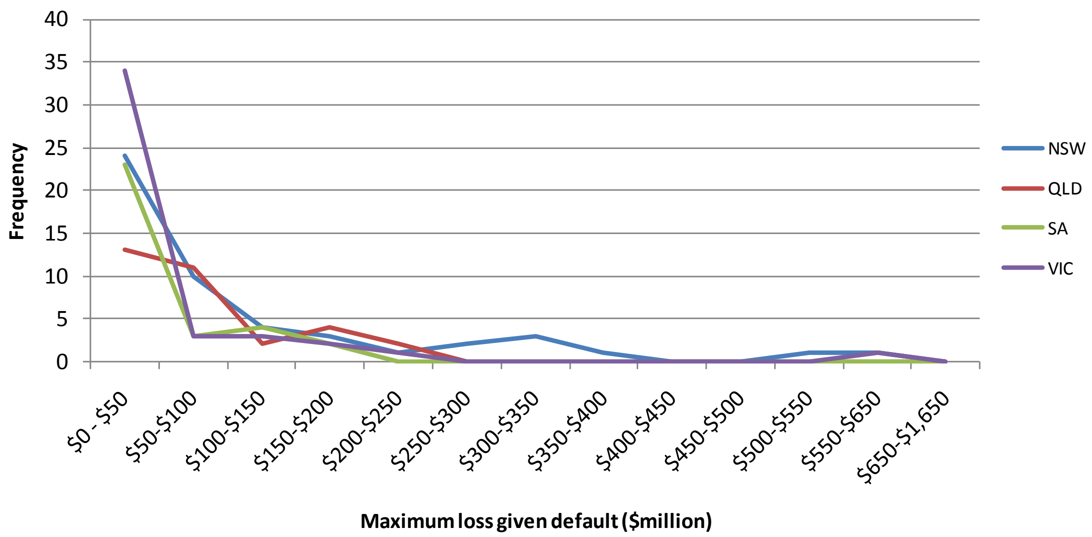


Figure 4.5 shows the skewness in the results for all NEM regions, looking at the distribution of events of *loss given default* by the frequency of the maximum size of the loss for clusters[20] of losses. All regions have experienced events where, at the regional level, in the event of a default, the *loss given default* would have exceeded $200 million and in some regions, the largest events have been significantly in excess of this. Even scaling back these losses to reflect the potential impact of a failure of the largest regional participant results in a significant loss to be borne by Market Participants.

Figure 4.5 Frequency Distribution, Loss given default, RMCL, Base Case, by NEM region and size of loss in $m, no of events



4.2.2. The contribution of additional security arrangements, RMCL

Table 4.4 looks at the reliance on additional security to supplement the prudential arrangements for the RMCL at the regional level. Averaging across the regions, on just over 8 percent of days in the ten years to the beginning of 2010 additional security would have been required. This is equivalent to requiring additional security on around 1 in every 12 days. Additional security deposits are not transitory: additional securities – either new or retained – are required on around 30 percent of all days.

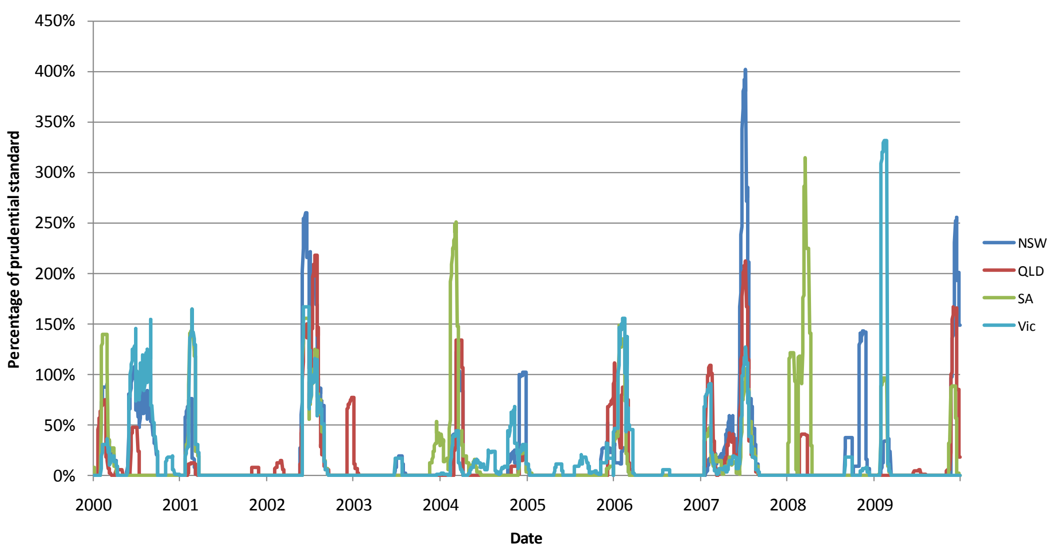
[20] Section 4.3 discusses the concepts of clusters of losses further.

Table 4.4 Additional security required by number of days required and NEM region, Base Case

Region	NSW	Qld	SA	Tas	Vic
Total days	3,653	3,653	3,653	1,583	3,653
Number of days additional security is required	339	241	290	141	350
Percentage of days additional security is required	9.3%	6.6%	7.9%	8.9%	9.6%
Average new security deposit required ($m)	22	15	7	3	10
Total number of days with additional security held	1,121	1,008	1,042	537	1,492
Percentage of days with additional security held	30.7%	27.6%	28.5%	33.9%	40.8%
Average total additional security balance ($m)	195	104	54	23	70

The average additional security requirement understates the contribution of additional securities to the prudential arrangements. Cumulative additional security requirements can be significantly greater than the security held under the RMCL, as illustrated in Figure 4.6, where values on the vertical axis in excess of 100 percent indicate that the dollar balance of cumulative additional securities held on a day are greater than the RMCL, i.e. they represent 50 percent or more of the total security required by AEMO across the market as a whole Figure 4.6 also illustrates a further important observation about the current prudential arrangements: the requirement for additional securities, like the incidence of potential *losses given default* is strongly seasonal, with summer and winter periods dominating.

Figure 4.6 Additional securities as a share of total prudential requirements, Base Case, percent of RMCL



4.3 Events of *loss given default*: Victorian results

Results for each of the NEM regions are included in Appendix C of this report. However, we have chosen the Victorian results to present in the body of the report to provide additional detail into the characteristics of the potential events of *loss given default*. Victoria has been chosen because over the period modeled, there have been no vesting contracts or other contracts with similar effect between the generators and the retailers that have the potential to affect bidding behaviours.

Figure 4.7 looks at the maximum potential *loss given default* for clusters (groups of contiguous periods) of events in Victoria, considering the RMCL for the Base Case, that is, taking into account additional security previously received and those occasions when further additional security is required.

- One important observation is that there are considerably fewer clusters than events, where a single day is counted as an event. Events cluster together, reflecting both the effect of high prices over a period of time longer than one day in both components of the RMCL - the Trading Limit and the Prudential Margin - and the observation that high prices themselves tend to cluster, showing a marked seasonal pattern.
- Secondly, the size of the clusters shows very little trend over time. The distribution is characterised by a large number of relatively small events and a much smaller number of large events, including a single large event in 2008 that, at the region wide level, in the event of default would have imposed a loss of just under $600 million on generators.

Figure 4.7 Maximum Potential Loss given default, Base Case, RMCL, Victoria, 2000 – 2010, $ millions

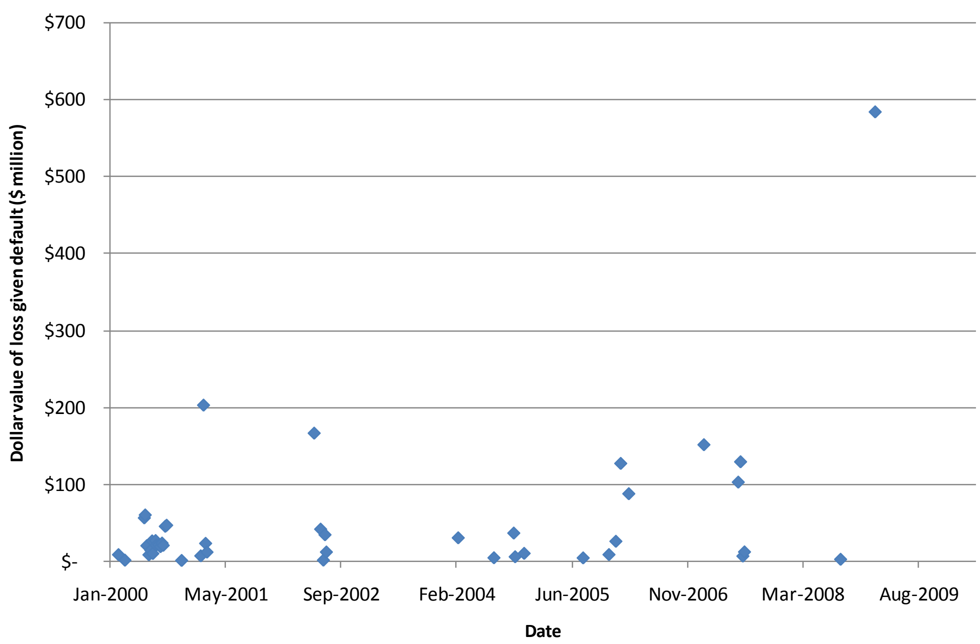


Figure 4.8 is an alternative expression of Figure 4.7, with the cost of a possible *loss given default* expressed in $/MWh (based on annual volumes), which could be understood as the premium that, in the event of a *loss given default* of a given size, generators would

have incurred per annual MWh across the total annual NEM wide load[21]. On this measure the maximum *loss given default* is approximately $3/MWh.

Figure 4.8 Victoria, Base Case, maximum Loss given default, $/MWh per annum

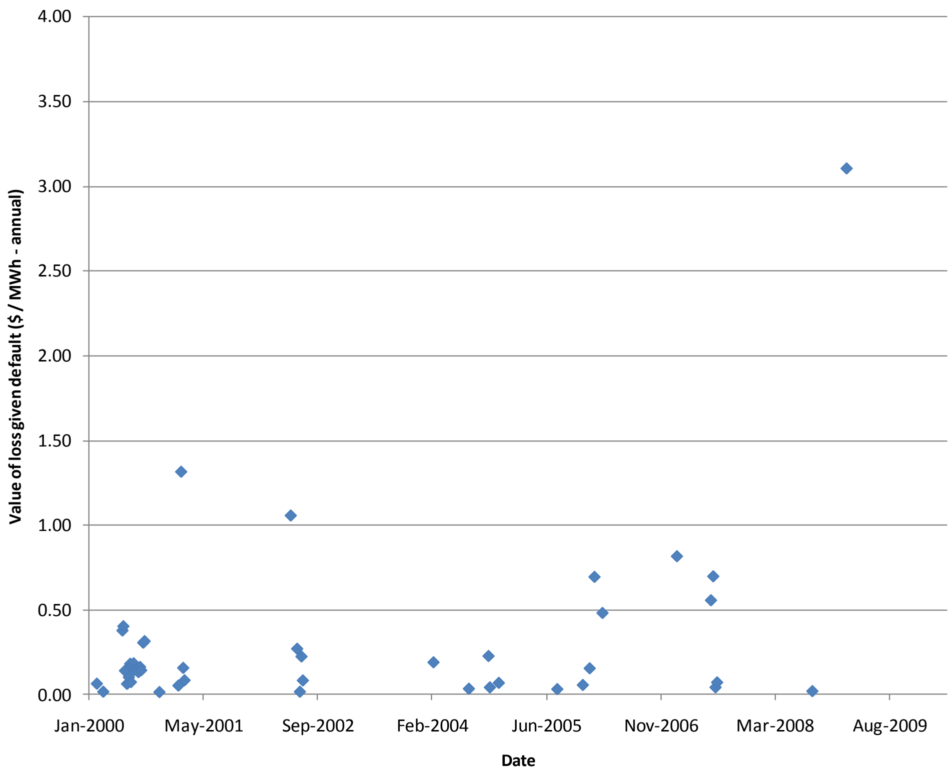
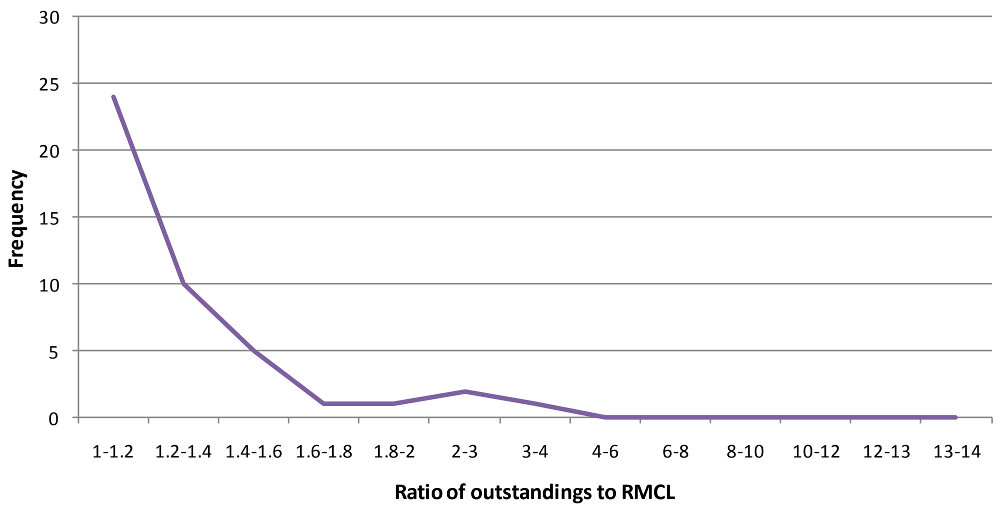


Figure 4.9 looks at the Victorian results that Table 4.3 is based on, representing the clusters as a ratio of the RMCL prevailing at the time of the event. Consistent with Figure 4.5, the largest number of clusters occurs where the potential *loss given default* is small relative to the RMCL (ratio of 1 to 1.2 times). However, there are a small number of events where the ratio of *Combined Total Outstandings* to the RMCL is two or more, that is, where the potential *loss given default* is at least large as the value of prudential holdings, including additional securities previously lodged.

[21] The use of a total NEM load is based on the approach taken in the NER that spreads any shortfall in settlement payments across all generators as opposed to only those in the region which the shortfall occurred.

Figure 4.9 Ratio of Combined Total Outstandings to the RMCL, Base Case, Victoria, number of events by cluster



4.4 The Prudential Margin

We have interpreted the intent of the Prudential Margin as to provide protection against the potential loss during the Reaction Period, while the process of market suspension is being worked through[22]. In circumstances where the Prudential Margin is being relied on, the defaulting Market Participant is unlikely to provide additional funds to meet its obligations in the NEM and the affected Market Participants will have to take their place in the queue with other creditors if there is a shortfall. With the benefit of perfect foresight, our results indicate that around 10 percent of the time[23], the Prudential Margin would be inadequate to cover a full seven days outstandings, *Total Prospective Outstandings* (Table 4.5). The shortfall in the Prudential Margin (the expected loss given default) compared with *Total Prospective Outstandings* ranges from $11 million in Tasmania to $89 million in NSW.

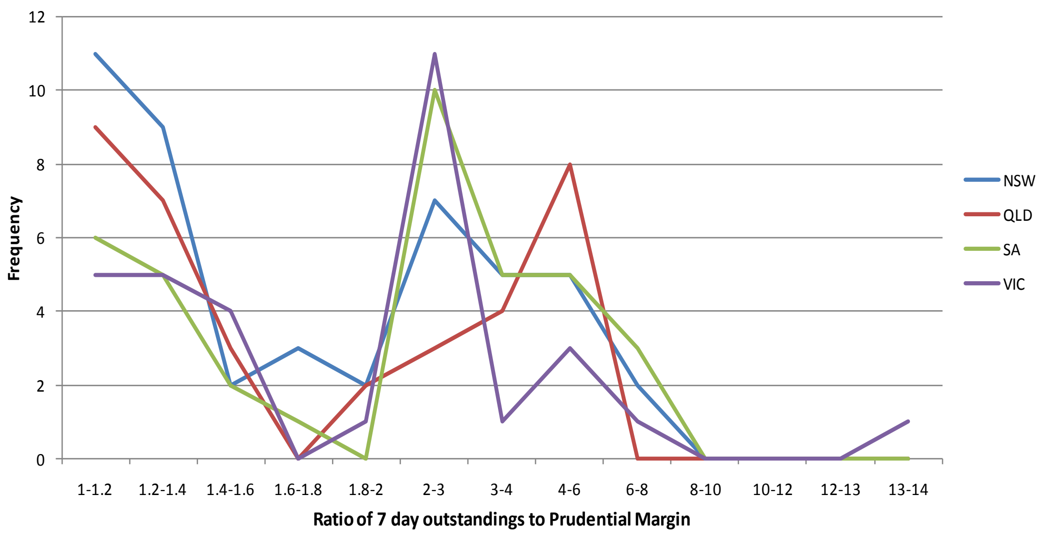
Table 4.5 Performance of the Prudential Margin by NEM region, 2000 - 2010

Region	NSW	Qld	SA	Tas	Vic
Total days	3,653	3,653	3,653	1,583	3,653
TPO > PM (days)	511	316	332	161	394
Probability TPO > PM	14.0%	8.7%	9.1%	10.2%	10.8%
Average loss given default ($m)	89	64	36	11	47

[22] This is also consistent with a number of other similar markets, where this intention is explicitly recognised in setting the equivalent of the Prudential Margin.
[23] Considering all days, not only those days on which additional security is required

Figure 4.10 looks at the results summarised in Table 4.5, expressing the events of a possible *loss given default* as a ratio to the appropriate Prudential Margin. Although the results vary from state to state, they suggest that in a relatively large number of cases, the outstandings for the seven day period could be between two and eight times as large as the prevailing Prudential Margin.

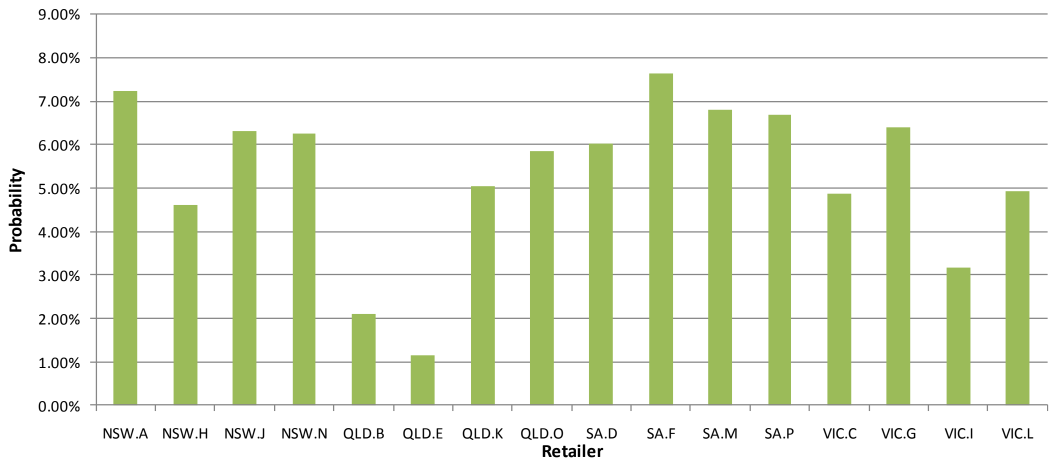
Figure 4.10 Ratio of Total Prospective Outstandings to the Prudential Margin by NEM Region, number of events



4.5 The Performance of representative Market Participants

At our request, AEMO provided us with data for a number of “representative” retailers for each of the NEM regions excluding Tasmania to allow us to identify whether retailers’ specific load characteristics, particularly load factors, were likely to affect the likelihood of an event of a possible *loss given default*. The data was standardised, so as to prevent any individual Market Participant being identified and each “representative” retailer was restricted to a single state. As Figure 4.11 shows, the “representative” retailers differ in their average probability of a *loss given default*, from retailer to retailer and within NEM regions.

Figure 4.11 Representative Retailer, Base Case, Probability of a Loss given default, average probability



A key result is shown in Figure 4.12, below. Looking at the representative retailers, with the exception of Queensland, there is a very strong linear relationship between load factor and the probability of a *loss given default*: the worse (the lower) the load factor, the higher the probability of a *loss given default*.

Figure 4.12 Potential events of a *loss given default*, Base Case, by representative retailer, load factor and NEM region

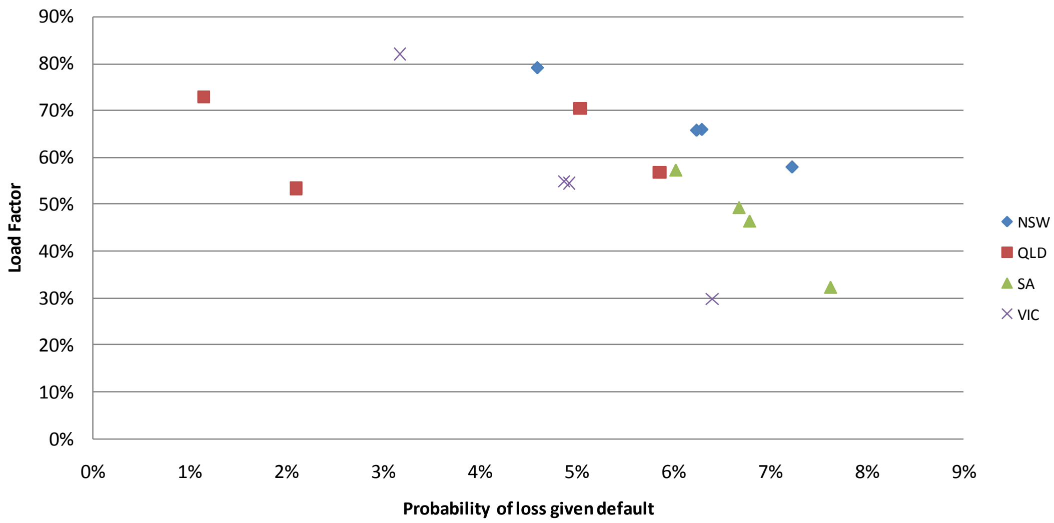
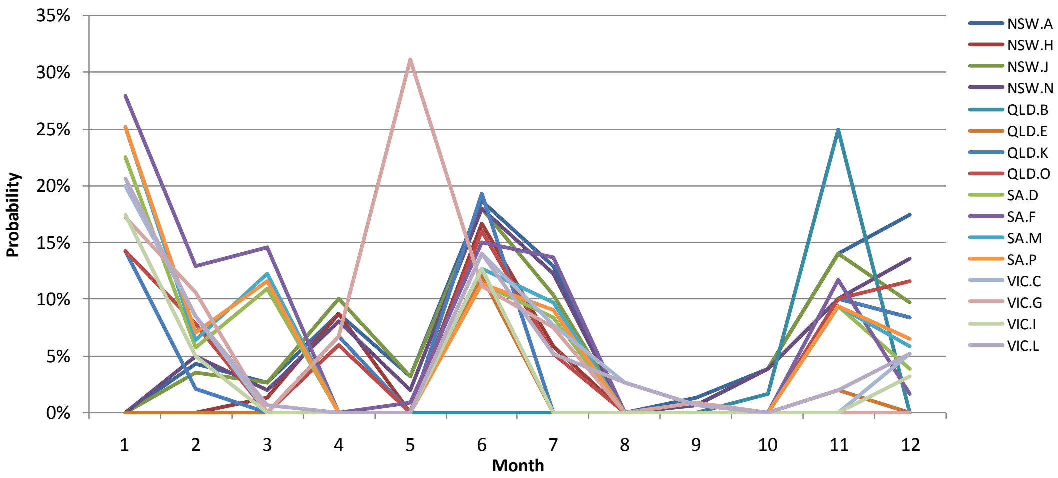


Figure 4.13 is the equivalent of Figure 4.3, showing the average monthly probability of an event of a possible *loss given default* for each of the representative Market Participants included in this study. Similar to Figure 4.3, it shows a strong seasonal pattern, with winter and summer having a significantly higher probability of an event of a possible *loss given default* than the average or the shoulder periods. The level of seasonality evident in the representative retailer results is significantly higher than at the regional level. In addition, unlike the regional results, the representative participant results suggest that for a number of representative participants the probability of an event of a possible *loss*

given default is very high in the summer period and, for these participants, the summer period also continues over a longer period than is evident in the region wide data.

Figure 4.13 Probability of an event of a possible *loss given default*, Base Case, by representative Market Participant and calendar month, avg monthly percent



AEMO's process for calculating Market Participants' prudential requirements does not differentiate between Market Participants, effectively assuming that all Market Participants' load reflects the regional profile[24]. On the basis of these results, the current process is unlikely to adequately capture the difference in the risk of a potential event of a *loss given default* between Market Participants. This failure to differentiate is potentially significant because in the NEM, the summer and the winter months are characterised by high load and high prices. Some retailers are systematically more likely than others to have their *Combined Total Outstandings* exceed their prudential holdings, including other securities lodged at these times, giving rise to a *loss given default* in the event of a default.

[24] After an initial period. New entrants to the NEM are asked to lodge a prescribed level of prudential cover until AEMO forms a view about the new participant's expected load.

5 Improving the Performance of the Prudential Arrangements

This section discusses the results of our modeling looking first at an improved calculation approach for the prudential arrangements in line with the criteria and measurement discussed in Section 6 and then at the effects of combining the improved calculation approach with a shorter settlement cycle.

The improved calculation approach generally results in savings in the Prudential Requirements, measured as the average required over the past ten years, as well as a marked reduction in seasonality. Shortening the settlement cycle adds further improvements, as well as significantly reducing the reliance on additional securities to ensure Market Participants remain within their Trading Limits. However, neither approach eliminates the infrequent but large *loss given default* events observed in every region.

5.1 Improving the Performance of the current Prudential Arrangements: the improved calculation approach

In addition to identifying a number of low probability, large *loss given default* events, our analysis identified that the distribution of *losses given default* under the current prudential arrangements was highly seasonal. At a representative participant level, the level of seasonality was even higher and the probability of a loss given default increased as the representative participant's load factor deteriorated.

Looking at the results, we formed a view that changes to the current process could improve the outcomes. As agreed with AEMO, we restricted our modeling of the alternative process to calculating the prudential arrangements to the Base Case only and for only one prudential standard[25] and, in line with the discussion in Section 6, we targeted a 2 percent probability of the risk of a loss given default as an acceptable and achievable performance standard for the prudential arrangements.

Figure 5.1 highlights that our improved approach to calculating the Prudential Requirements uses a similar formula to the current approach with some modifications to the calculation of key input factors.

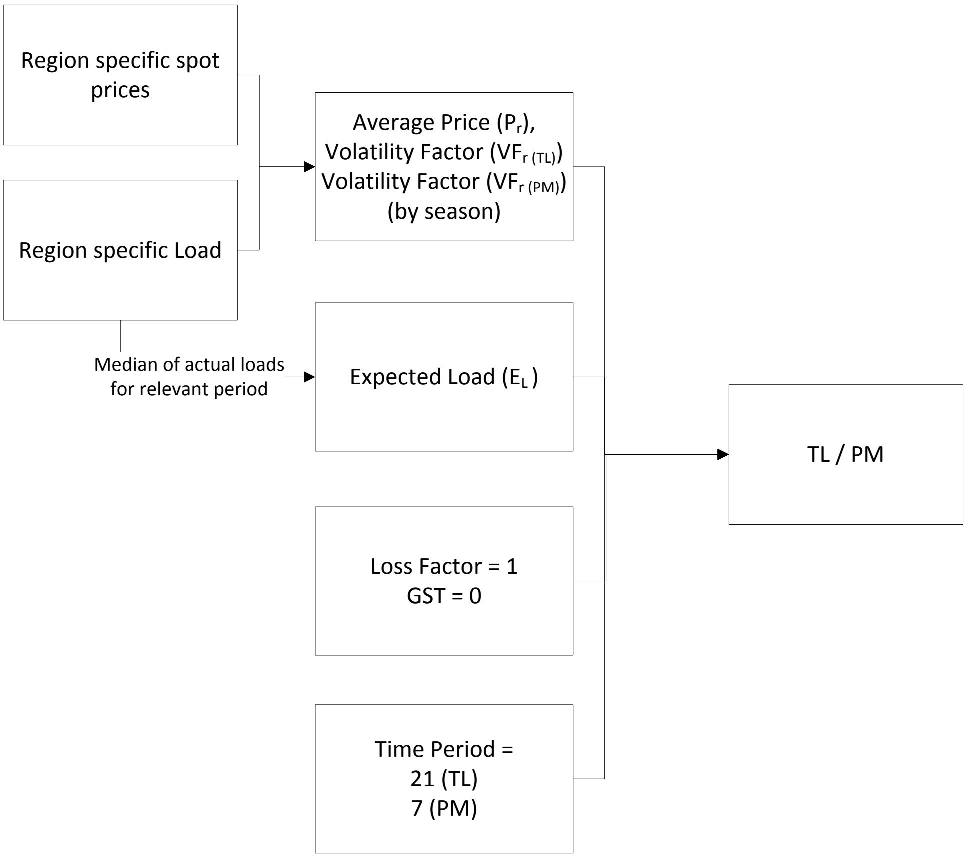
Our changes to the current process involve the following:

- Calculating the Prudential Requirements as the sum of the Trading Limit and Prudential Margin[26]
- Utilising a longer history of data compared with the current process
- Calculating seasonal average prices and seasonal volatility factors using three seasons
  - Summer (December, January, February and March)
  - Winter (May, June, July and August)
  - Shoulder (April[27], September, October and November)

[25] In the future, the objective is that only one Prudential Standard would exist, removing the distinction in the NER at present between the MCL and the RMCL.
[26] This compares to the current approach where the prudential requirement is calculated and then the prudential margin is deducted to leave the trading limit.
[27] We recognise that in treating April in isolation as a shoulder season between summer and winter participants may experience some inconvenience in adjusting their prudential holdings. There are several

– Calculating a separate volatility factor for the Trading Limit and the Prudential Margin, reflecting the number of days that each period is designed to cover and explicitly linking the Prudential Margin to the Reaction Period.

Figure 5.1 Components of the Prudential Requirements, Trading Limit and Prudential Margin, alternative process



$$\mathbf{TL = P_r \times VF_{r(TL)} \times E_L \times Loss\ Factor \times (1 + GST) \times Time\ Period}$$

$$\mathbf{PM = P_r \times VF_{r(PM)} \times E_L \times Loss\ Factor \times (1 + GST) \times Time\ Period}$$

$$\mathbf{PR = TL + PM}$$

Table 5.1 compares the current process with our suggested improved calculation approach.

In presenting our improved calculation approach and its results below we make no claims that the identified process is optimal – changes to the approach we have tested might yield further additional benefits in matching the required prudential holdings to the performance of the regional markets. For example:

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possibilities for addressing this, including treating April as either part of summer or winter, whichever presents the better result. However, this treatment has its own issues, particularly for those participants providing cash or other securities to AEMO rather than relying on bank guarantees.

- We have not adjusted the methodology used by AEMO to calculate expected load. There is potential for further improvements to the performance of the prudential arrangements through improvements in the accuracy of the expected load forecasts.
- We have not compared the approach taken here with suggestions that inclusion of the relevant regional futures price presents a viable alternative. Our view is that previous testing of the prudential arrangements showed an improvement compared with the existing arrangements as a result of the improved seasonality that the futures price introduced. However, our results also suggest that the seasons are not neatly captured by calendar quarters, so it is unclear in our view whether substituting the futures price for the historic price, calculated as below, will present a further improvement[28].

Nor are we representing that the identified changes will provide persistent benefits – changes to generator bidding patterns, structural changes to regional markets or extreme events, such as a reoccurrence of the 2007 drought, may require further changes to AEMO's processes and the methodology should be tested annually to identify any emerging systematic issues that would suggest a change in approach might be necessary.

- The improved calculation approach can be adapted to capture known and expected market changes. For example, we believe, but have not trialed, an approach that adjusts or scales historic high price events to reflect the increase in VoLL will be capable of adjusting the prudential requirements to changing market conditions. This approach could involve a simple approach, for example, that increases all prices above say $500 / MWh by the ratio of the new VoLL to the old VoLL. This is based on the assumption that is prices are above $500 / MWh then they are more likely to reach VoLL. As actual prices under the higher VoLL regime are experienced the adjustment or scaling of historic prices can be amended to reflect actual experience as opposed to the simplifying assumption.
- Further, we believe that adjustments to the average price would be capable of capturing the expected impact of any future Carbon Pollution Reduction Scheme (or other carbon price) on market prices. For example this could be achieved through a one off increase (by region) of the average price input into the TL and PM calculation. Again as actual experience of the Carbon Pollution Reduction Scheme's impact on market prices arises the adjustment factor can be amended to reflect actual experience.

[28] Given issues with the liquidity of the Futures Contracts outside NSW, Victoria and potentially Queensland, we also believe that the introduction of Futures Contract prices introduces significant administrative complexities for AEMO, which may not be justified given the extent of potential improvement over the use of the historic data.

Table 5.1 Improved Calculation Approach: changes to current approach and rationale

Component	Current treatment	Alternative modeling approach
Volatility Factor	Calculated as an annual value using the 11 months data prior to the beginning of the month when AEMO calculates the revised prudential requirements. A common volatility factor calculated for Prudential Margin and Trading Limit. Based on the ratio of maximum 42 day rolling outstandings to the average 42 day rolling outstandings.	Seasonal volatility factors were calculated using the full series of available data from the beginning of 2000. (In Tasmania's case, the data covers only a 5 year period.) A specific volatility factor is calculated for the Prudential Margin and for the Trading Limit. Reflecting the different period covered by each element of the Prudential Standard, a specific volatility factor better captures the performance of the underlying data. The VF(TL) is based on a ratio of the percentile of the 35 day rolling outstandings to the average 35 day rolling outstandings that results in a performance of the prudential arrangements in total (PM plus TL) at the desired 2 percent target level, in this case, the 96th percentile. The VF(PM) is based on a ratio of the percentile of the 7 day rolling outstandings to the average 7 day rolling outstandings consistent with the desired performance of the prudential arrangements in total (PM + TL) at the 2 percent level, in this case the 96th percentile.
Average Price	Calculated using the 11 months data prior to the beginning of the month when AEMO calculates the revised prudential requirements.	Seasonal average prices using the four previous years' data for the corresponding months. The data of average prices appears to display an underlying cycle of between 18 months and two years in all the regions, suggesting a time period of historic data to be used should be consistent with this cycle. Low frequency, large potential loss given default events occur roughly every three years in the regions, suggesting that a period of at least 3 years was desirable. Given these two considerations, a 4 year period was

Component	Current treatment	Alternative modeling approach
		chosen.
Expected Load	AEMO uses a forward looking estimate for Expected Load for each Market Participant. In modeling the performance of the existing arrangements, we have used the median of actual loads for the relevant quarter.	Unchanged. The median of actual loads for the relevant quarter has been used.
GST	AEMO provides for GST at the appropriate rate. We have not included GST in our results.	GST not included in our results
Loss Factor	AEMO applies the relevant regional loss factor. We have not included a loss factor in our results.	A loss factor is not included in our results
Time period	28 days	21 days for Trading Limit 7 days for Prudential Margin See discussion relating to the Volatility Factor, above
Participant Specific Factor (based on load factor)	Not used in current process	Given the relationship with a participant's load factor and probability of LGD it is expected to be beneficial to include a scaling factor to account for the changing risk profile of participants[29].

[29] For example, those participants with a load factor that is worse (lower) than the average for the region the factor would be greater than 1 to increase the RMCL and for those participants with a load factor that is better (higher) than the average for the region the factor would be less than 1.

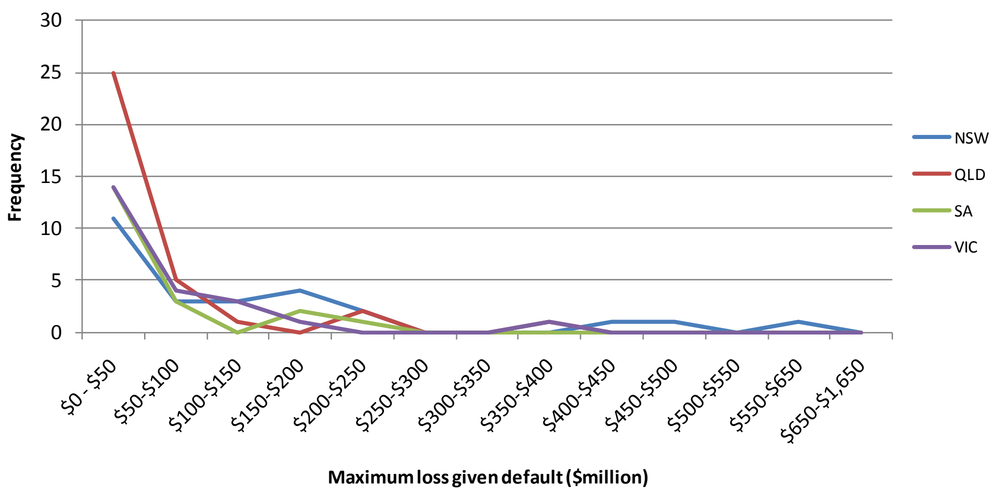
5.1.1. Achieving the desired level of performance, impact on loss given default

Table 5.2 Performance of the Prudential Standard, improved calculation approach, by NEM region, 2000 - 2010

		NSW	Qld	SA	Tas	Vic
	Total days	3,653	3,653	3,653	1,583	3,653
		Prudential Standard				
CTO > Prudential Standard	Days	65	96	81	30	77
Probability	% Total Days	1.8%	2.6%	2.2%	2.2%	2.1%
Average *Loss given default*	$m	146	62	53	17	59

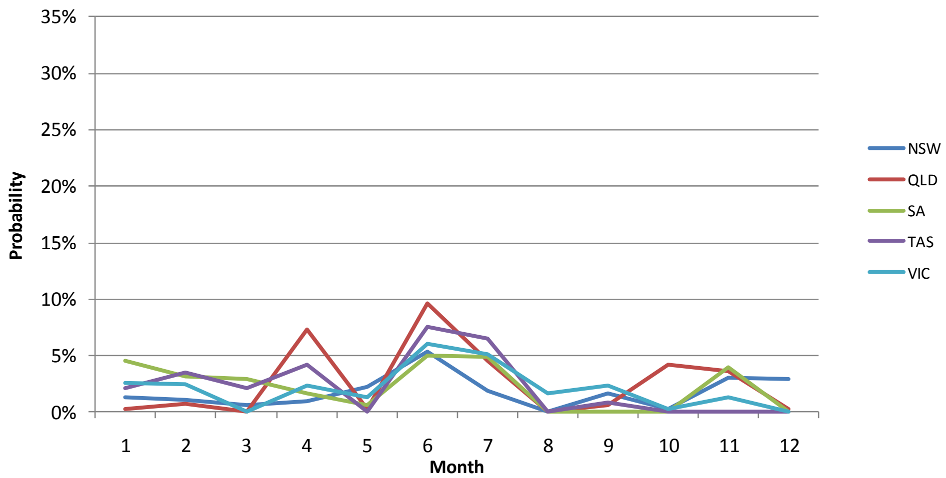
In reducing the probability of a *loss given default* for all NEM regions to the targeted 2 percent, our alternative methodology would, on average, increase the average loss given default. This is as expected. As Figure 5.2 highlights, the improvement in the probability of *loss given default* are due to a reduction in the number of small loss events with minimal change in the large events and as a result the average value of an event rises.

Figure 5.2 Frequency of the maximum loss given default in $ mill, improved calculation approach, by NEM region, number of events



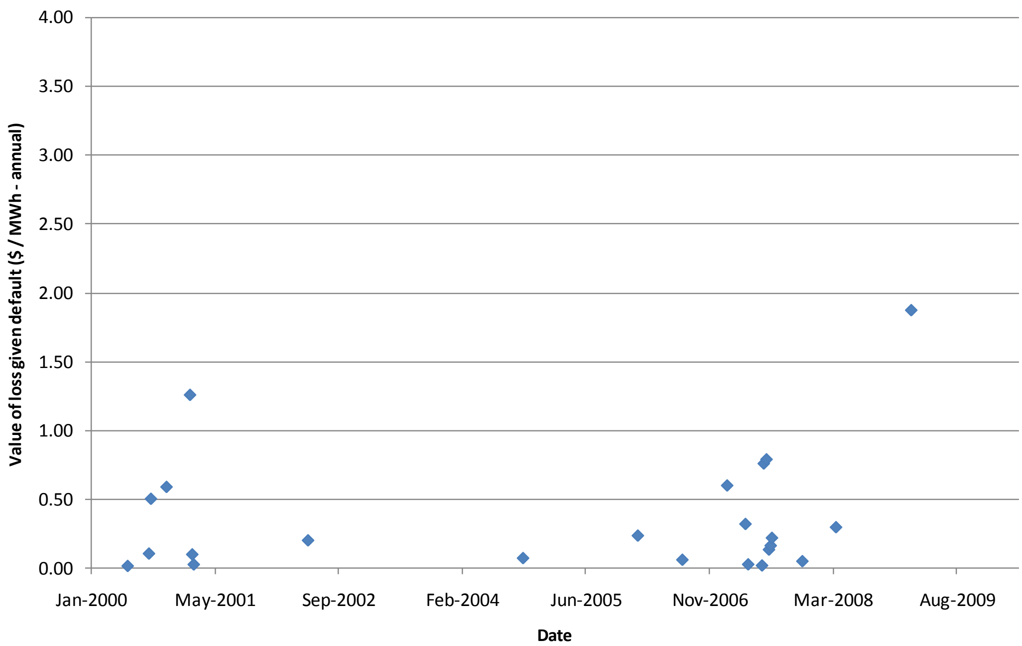
The improved calculation methodology also results in a reduction in the seasonality displayed by the probability of a loss given default, as shown in Figure 5.3, below.

Figure 5.3 Improved calculation approach, probability of a loss given default, Base Case, percent by month



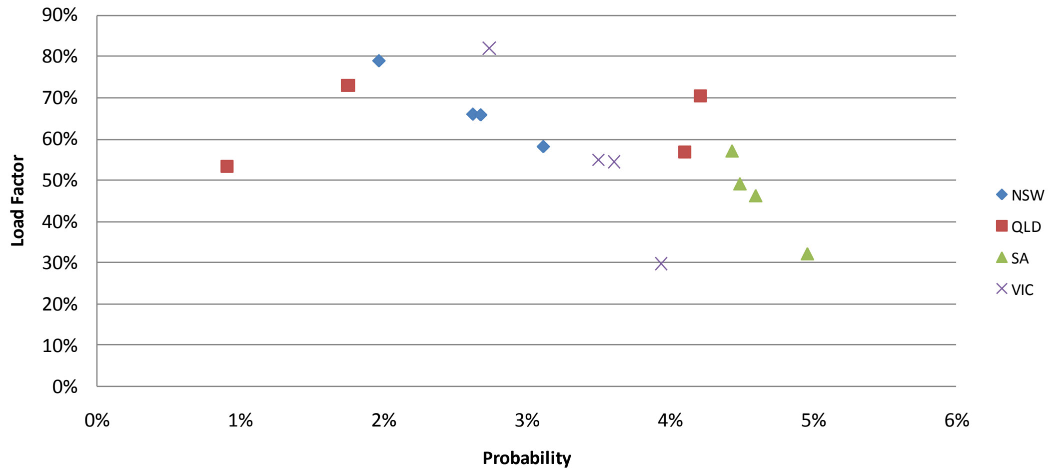
Looking at the results on expressed in $/MWh as in Section 4, the Victorian results expressed in $/MWh are presented in Figure 5.4. Again, the higher value *losses given default* in $/MWh are largely unchanged, but there is a reduction in the number of smaller value *losses given default*.

Figure 5.4 Base Case, improved calculation approach, maximum loss given default, $/MWh per annum



For the improved calculation approach, the relationship between a participant's load factor and the probability of a *loss given default* still holds: the worse (the lower) the load factor, the higher the probability of a *loss given default*. The results are illustrated in Figure 5.5.

Figure 5.5 Potential events of a loss given default, improved calculation approach, by representative retailer, load factor and NEM region



5.1.2. Implications for Prudential Requirements

The improved calculation approach has also resulted in a reduced Prudential Requirements compared with the current process.

Compared with the RMCL, the 2 percent target probability for the risk of a *loss given default* can be achieved with a decrease in the average Prudential Requirements for all regions except Queensland when considered over 10 years. As Figure 5.6 shows, the Maximum Prudential Requirements would have also reduced for NSW and Tasmania over the period but increased for other regions. In addition, the change in the Prudential Requirements, measured by comparing the level in a given month with that of the same month from the previous year, would have been a fraction of the changes that on average have been associated with the current arrangements.

Figure 5.6 Improved calculation approach of Prudential Standard vs. RMCL, Base Case, percent of current RMCL

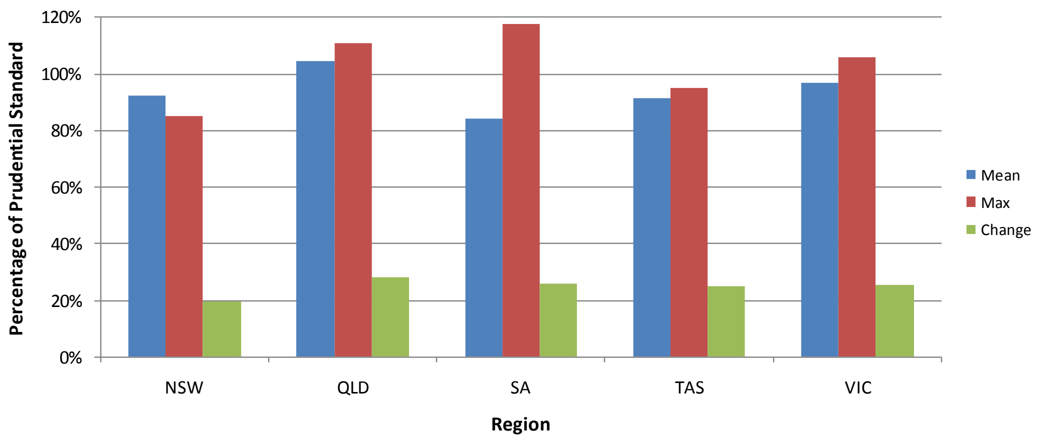


Table 5.2 on the following page compares the average (or mean) Prudential Requirements for the current prudential arrangements and the improved calculation approach. It includes a breakdown by Trading Limit and Prudential Margin. The results in Table 5.2 illustrate that, for the improved calculation approach, the average Trading Limit decreases by approximately 13 percent, whilst the average Prudential Margin increases by approximately 14 percent. As a result the proportion of Prudential Margin relative to Trading Limit increases from 25 percent to 30 percent. These changes are consistent with the intent of our methodology which provides for a specific and more appropriate Volatility Factor for the Prudential Margin, to reflect the risk associated with potential losses during the reaction period.

Table 5.3 Comparison of average Prudential Requirements, Trading Limit and Prudential Margin: improved calculation approach vs. current approach, by NEM Region

		NSW	Qld	SA	Tas	Vic
Current Approach (RMCL)						
Average RMCL	$ million	478	292	119	83	259
Average Trading Limit	$ million	358	219	90	62	194
Average Prudential Margin	$ million	120	73	30	21	65
Average Prudential Margin (%)	% of RMCL	25%	25%	25%	25%	25%
Improved Calculation Approach						
Average Prudential Requirement	$ million	442	305	100	75	251
Average Trading Limit	$ million	309	205	67	55	179
Average Prudential Margin	$ million	133	100	33	20	71
Average Prudential Margin (%)	% of Prudential Req’t	30%	33%	33%	27%	28%
Percentage of Current Approach						
Average Prudential Requirement	% of current RMCL	92%	104%	84%	91%	97%
Average Trading Limit	% of current TL	86%	94%	75%	89%	92%
Average Prudential Margin	% of current PM	111%	137%	111%	99%	110%

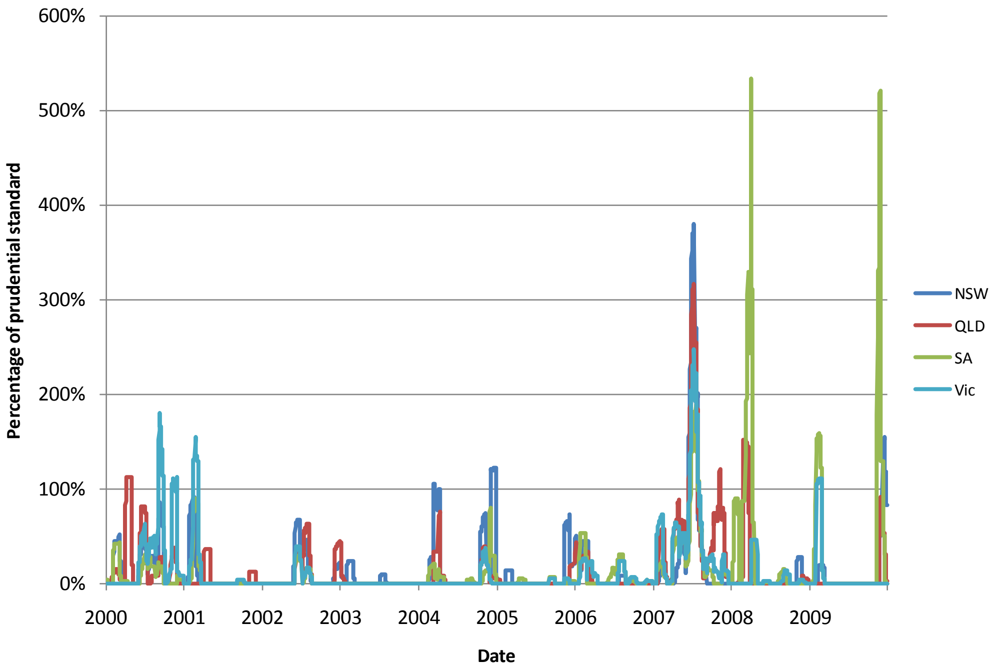
Table 5.4 looks at the reliance on additional security to supplement the revised prudential arrangements at the regional level. Averaging across the regions, improving the calculation approach does not materially impact the reliance on additional securities as compared to the results in Table 4.4.

Table 5.4 Additional Security required by number of days required and NEM region, improved calculation approach

Region	NSW	Qld	SA	Tas	Vic
Total days	3,653	3,653	3,653	1,583	3,653
Number of days additional security is required	293	303	305	133	287
Percentage of days additional security is required	8.0%	8.0%	8.3%	9.7%	7.9%
Average new security deposit required ($m)	23	13	7	3	11
Total number of days with additional security held	1,145	1,163	1,388	659	1,210
Percentage of days with additional security held	31.3%	31.8%	38.0%	48.1%	33.1%
Average total additional security balance ($m)	174	101	44	15	79

Figure 5.7 illustrates the relationship between the additional security requirements as a percentage of the prudential arrangement under the improved calculation approach. When compared to Figure 4.6 there is no material change in the seasonality, however for some regions there is an increase in the percentage level as a proportion of the underlying prudential standard which is driven by a reduction in the average dollar level of the prudential standard.

Figure 5.7 Additional securities as a share of total Prudential Requirements, improved calculation approach, percent of prudential standard



5.1.3. Considering the incremental benefits and costs of further improving the current prudential arrangements

The improvements in the performance of the prudential arrangements under the alternative approach have been achieved largely within the envelope of the existing prudential requirements, resulting in some reduction generally in the average net cost of the required prudential holdings. This result represents an unambiguous improvement for Market Participants compared with the current arrangements.

These results, however, may not represent the full extent of the available improvements. Changing the seasonal pattern; revising the approach to calculating the expected load, substituting futures prices for historical prices or supplementing the alternative approach with futures prices; and other variations to the alternative approach may yield further benefits to Market Participants.

5.2 Improving the Performance of the Prudential Arrangements: Shortening the Settlement Cycle

At AEMO's request, we have used the improved calculation methodology and applied it, with appropriate adjustments[30], to a settlement cycle of 12 days (billing period of 7 days, paid 5 days in arrears). In undertaking our analysis we have based our analysis on maintaining the probability of a *loss given default* at 2%[31], this enables participants and

[30] Adjusting the Volatility Factors to reflect the different periods of time included in the Trading Limit and the Prudential Margin.

[31] To achieve a 2% average probability of loss given default we have adjusted the percentile used in determining the Volatility Factors to 93% (from 96%). If a 96th percentile for the Volatility Factor was used this would result in an average probability of loss given default of approximately 1.5% and make

AEMO to better understand the impact of moving to a shorter settlement cycle whilst maintaining the same level of prudential standard.

5.2.1. Shortening the settlement cycle, impacts on loss given default

Table 5.5 shows that shortening the settlement cycle whilst maintaining the probability of a *loss given default* for all NEM regions at the targeted 2 percent, would, on average, not materially change the average loss given default. This is consistent with the results highlighted in Figures 5.10 and 5.11, as the primary improvements in shortening the settlement cycle are a reduction in the reliance on additional securities and a reduction in the overall level of prudential requirements.

Table 5.5 Performance of the Prudential Standard, improved calculation approach and shorter settlement cycle with 2% probability of loss given default, by NEM region, 2000 - 2010

		NSW	Qld	SA	Tas	Vic
	Total days	3,653	3,653	3,653	1,583	3,653
		Prudential Standard				
CTO > Prudential Standard	Days	88	82	78	16	74
Probability	% Total Days	2.4%	2.2%	2.1%	1.2%	2.0%
Average *Loss given default*	$m	121	66	53	27	64

The shorter settlement cycle also results in a further reduction in the seasonality displayed by the probability of a loss given default, as shown in Figure 5.8, below.

comparisons with the approved approach more difficult. Appendix C contains some results for the shorter settlement cycle and a 1.5% probability of loss given default.

Figure 5.8 Shorter settlement cycle (2% probability of loss given default), improved calculation approach, probability of a loss given default, Base Case, percent by month

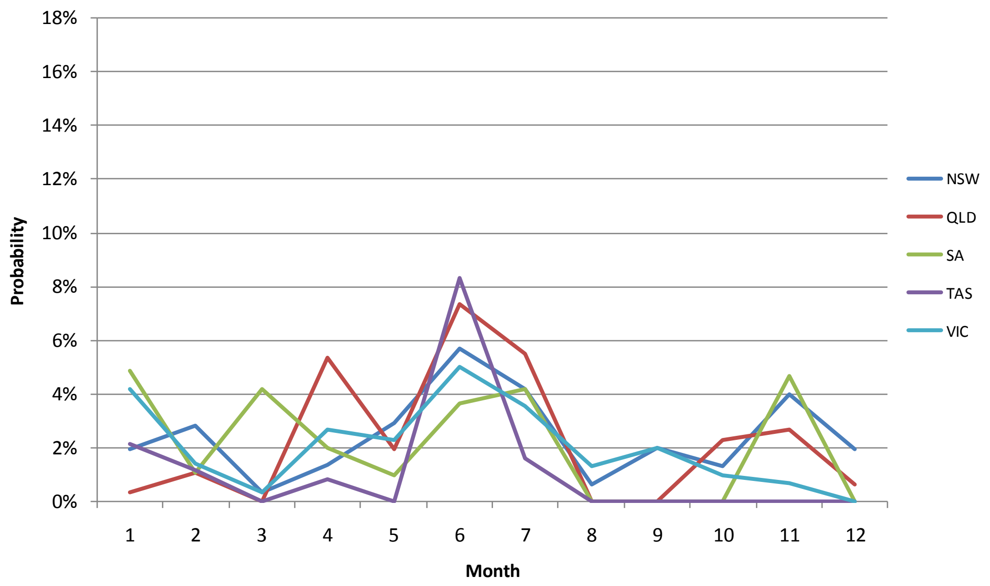


Figure 5.9 Victoria, shorter settlement cycle and improved calculation approach (2% probability of loss given default), Base Case, maximum loss given default, $/MWh p.a.

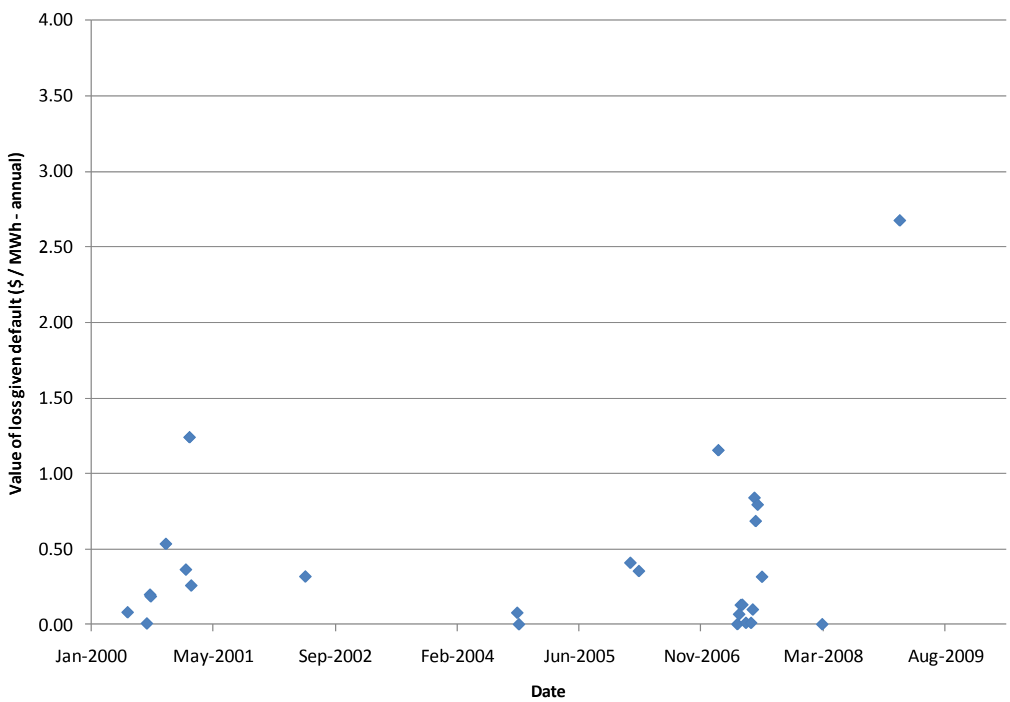


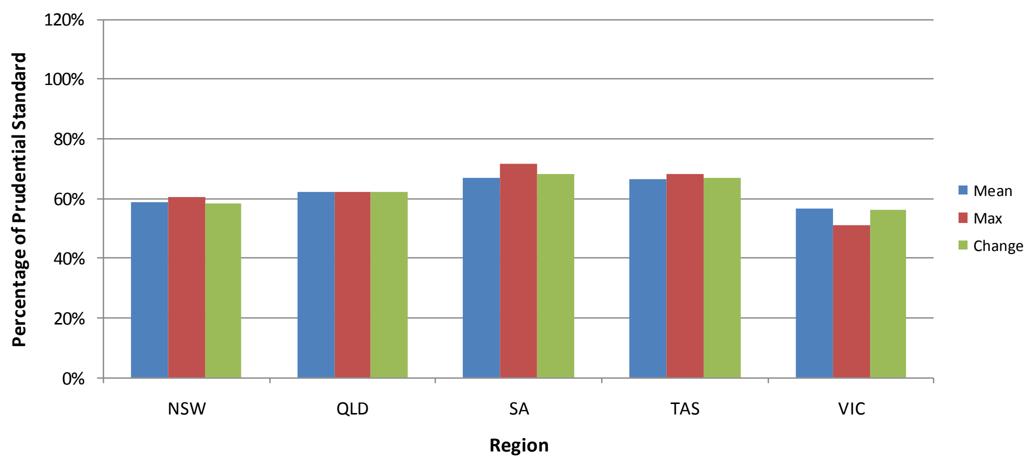
Figure 5.9 above shows the results for Victoria, expressed in $/MWh per annum as before. Compared with the results in Figure 4.8 there has been a reduction in the cost of the potential maximum *loss given default*, but the outlying figure is essentially unchanged.

5.2.2. Shortening the settlement cycle, implications for the Prudential Requirements

Briefly, relative to just the improved calculation methodology, shortening the settlement cycle provides a further reduction in the required prudential requirements. This is illustrated in Figure 5.10 which shows the reductions in the average maximum and mean prudential holdings for the shorter settlement cycle compared with the improved calculation approach.

There are significant further reductions in prudential holdings occurring in all NEM regions, measured either as the maximum or average holdings, and there is some additional benefit in reductions in the change in the Prudential Requirements from period to period, similar to those achieved in moving from the RMCL to the Prudential Requirements calculated under the alternative approach.

Figure 5.10 Shorter settlement cycle (2% probability of loss given default) prudential requirements as a proportion of prudential requirements, improved calculation approach, percent of total prudential holdings



Consistent with Table 5.2, Table 5.5 compares the average (or mean) prudential requirements for the improved calculation approach and the improved calculation approach with a shorter settlement cycle. The results in Table 5.5 are incremental to the results in Table 5.2 and illustrate that for the shorter settlement cycle the average Trading Limit decreases by approximately 47 percent, whilst the average Prudential Margin only decreases by 24 percent. As a result, the proportion of Prudential Margin relative to Trading Limit increases to approximately 37 percent. This is consistent with the impact of the shorter settlement cycle on reducing participants' Trading Limits. The Prudential Margin has reduced as a result of our approach to maintaining the 2 percent average probability of *loss given default*, which as outlined in this Section requires a change in methodology to calculating the Volatility Factor that will reduce the level of the Prudential Margin[32].

[32] AEMO is considering reducing the Reaction Period. In these circumstances, we would expect some reduction in the required Prudential Margin, although we have not tested for the amount that could be achieved.

Table 5.6 Comparison of average Prudential Requirements, Trading Limit and Prudential Margin: improved calculation approach vs. shorter settlement cycle, by NEM Region

		NSW	Qld	SA	Tas	Vic
Improved Calculation Approach						
Average Prudential Requirement	$ million	442	305	100	75	251
Average Trading Limit	$ million	309	205	67	55	179
Average Prudential Margin	$ million	133	100	33	20	71
Average Prudential Margin (%)	% of Prudential Req’t	30%	33%	33%	27%	28%
Improved Calculation Approach (Shorter Settlement Cycle)						
Average Prudential Requirement	$ million	260	190	67	50	143
Average Trading Limit	$ million	165	122	43	32	91
Average Prudential Margin	$ million	95	68	25	19	52
Average Prudential Margin (%)	% of Prudential Req’t	36%	36%	37%	37%	36%
Percentage of Improved Calculation Approach						
Average Prudential Requirement	% of Prudential Requirement	59%	62%	67%	67%	57%
Average Trading Limit	% of Trading Limit	54%	60%	64%	57%	51%
Average Prudential Margin	% of Prudential Margin	71%	68%	74%	92%	73%

Another significant result from shortening the settlement cycle is the reduction in the resort to additional securities to ensure that the prudential holdings are at least as large as Total Outstandings. Figure 5.11 below shows the requirements for additional securities as a proportion of total prudential holdings, based on the alternative calculation methodology and a shorter settlement cycle (at a 2% target level of probability of loss given default). Comparing the results in Figure 5.11 to Figure 4.6 illustrates the very significant reduction in the proportion of additional securities between the Base Case and this shorter settlement cycle, improved calculation approach case.

Figure 5.11 Additional securities as a share of required prudential holdings, shorter settlement cycle and improved calculation approach (2% probability of loss given default), percent

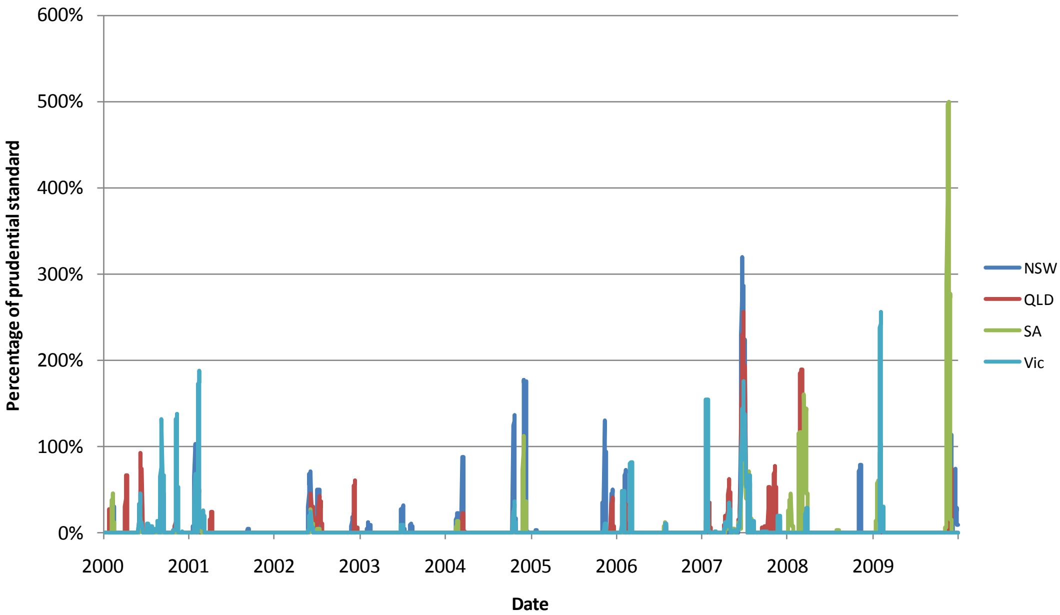


Table 5.7 looks at the reliance on additional security to supplement the prudential arrangements for the shortened settlement cycle at the regional level. Shortening the settlement cycle significantly reduces the reliance on additional security against all key measures relative to those illustrated in Table 5.3.

Table 5.7 Additional security required by number of days required and dollar values by NEM region, shortened settlement cycle (2% probability of loss given default)

Region	NSW	Qld	SA	Tas	Vic
Total days	3,653	3,653	3,653	1,583	3,653
Number of days additional security is required	161	137	154	27	137
Percentage of days additional security is required	4.4%	3.8%	4.2%	2.0%	3.8%
Average new security deposit required ($m)	32	18	8	5	17
Total number of days with additional security held	447	369	409	96	418
Percentage of days with additional security held	12.2%	10.1%	11.2%	7.0%	11.4%
Average total additional security balance ($m)	107	64	28	14	48

6 The Prudential Standard in the National Electricity Rules

6.1 Measuring the performance of the Prudential Arrangements

We were asked by AEMO to measure the performance of the current prudential arrangements and, if appropriate, to propose an alternative standard and suggest an alternative for the wording of the NER relating to the Prudential Standard. This section outlines our approach to these tasks and discussions a number of important differences between the prudential regime in the NEM with that in other similar markets.

Neither the alternative calculation approach trialed nor the shorter settlement cycle eliminates those events over the past 10 years where, in the event of a default, an extremely large potential loss would have been borne by Market Participants. Other approaches that could address these issues are briefly discussed, but we have not investigated their effectiveness in providing protection to Market Participants from very large losses or the cost of providing this protection.

6.1.1. Agreed criteria

In considering how to assess the performance of the current prudential arrangements and any alternative identified, we agreed a number of criteria with AEMO, given in Table 6.1 below.

Table 6.1 Criteria for assessing the prudential arrangements

Criteria	Description
Provides desired/agreed level of participant protection in the event of default	• Minimum requirement for prudential standard[33]
Transparency	• Desirable. Existing and potential market participants should be able to anticipate their prudential requirements.
Distinguishes appropriately between Market Participants on basis of relative riskiness	• Evidence suggests that market participants' load characteristics are related to the likelihood of a *loss given default*. Equity considerations would suggest that different levels of risk should be differently treated.
Level of prudential coverage adjusts to reflect changing market conditions	• Short term transitory market disruptions and longer term market shifts should be appropriately reflected in the level of cover resulting from the prudential standard

[33] AEMO's approach to the Scope of Work for this assignment was to establish the achievable performance of the prudential arrangements from the evidence of the performance to date, in preference to discussing the intention of the current Prudential Standard or adopting minimum requirements in the absence of any evidence of their achievability.

Table 6.1, cont

Criteria	Description
Calculation can be replicated	• Desirable for both audit and competition policy purposes that the calculation can be replicated
Resulting formula easy to calculate and apply	• Ease of implementation is an important operational criterion for AEMO and, if properly implemented, should limit the time required between calculation and adjustment
Stable and predictable	• Participants have expressed a desire for the level of the prudential requirements to be predictable, removing the need to make significant adjustments in the level of prudential holdings lodged at short notice. • Stability from period to period also reduces participants' costs, incurred either in changing the level of the bank guarantees required or in providing for and managing working capital levels in order to be able to respond to changes to the prudential requirements from period to period.

As a first step in the process of measuring the performance of the current prudential arrangements, in discussion with AEMO we identified three possible alternative performance measures from a range of potential measures[34] to address the first of the agreed criteria, that the prudential arrangements should provide the agreed level of participant protection in the event of default. Having agreed the measures, detailed below, we then calculated the performance of the prudential arrangements under each of the measures.

6.1.2. Assessment measures considered

The alternative measures considered were:

- **Option A**: the probability that the *loss given default* is greater than zero.
- **Option B**: the probability that the *loss given default* is greater than a given percentage of payments due to generators expressed as a share of total payments due to generators in the region for the payment week in which the security deposit request occurs, that is, incurred in the week when the request for the security deposit occurred, but due to be paid in about 4 weeks.
- **Option C**: the probability the total of all *losses given default* over the previous 365 days amounts to a given percentage of payments due to generators in the region

[34] Other measures considered but not investigated in detail included: a "worst case scenario", based either on an administered price cap experience or on an historic definition "contiguous worst days"; or building in an explicit buffer to the prudential requirements, to allow for higher than usual prices during the both the Reaction Period and the Settlement Period.

expressed as a share of total payments due to generators in that region over a year. The last of the 365 days is the day when the request for the security deposit occurred.

Following discussions with AEMO, Option A was adopted as the preferred basis for expressing the Prudential Standard for a variety of reasons including:

- *Ease of interpretation*: the interpretation of the probability value in the standard is only straightforward if the time period is a single day. This is a consequence of the way AEMO's processes work – the result of a company's failure is a default on a single day and a company cannot default more than once.
- *Stability of the results*: the results for Options B and C, below, show that the probability of a *loss given default* is very sensitive to the performance target chosen. Small changes over time in the level of *losses given default* could have a large effect on the probability of a *loss given default*, with the result that the prudential arrangements could fail to meet the desired standard, although the arrangements could be performing within expected range of statistical performance.
- *Trading off performance and potential risk*: The potential advantage of Option C over the alternatives is that it gives an indication of the "average" level of the *loss given default*. With a performance target sufficiently below the average level, say at 5 percent of weekly revenues, the probability of a *loss given default* is high. With a performance target sufficiently above the average level, say at 15 percent of weekly revenues, the probability of a *loss given default* is low. The advantage of Option A, by contrast, is that all *losses given default* are equally weighted in assessing the performance of the prudential arrangements – any *loss given default* represents a failure of the prudential arrangements[35].
- *Performance of the prudential arrangements:* The attractiveness of Option B is that it has the potential to exclude from the performance of the prudential arrangements small *losses given default* that would not have a material effect on Market Participants in the event of a default[36]. However, the results show that the choice of a performance target value of 10 or 20% of a week's payments has only a relatively small effect on the probability of a *loss given default*, reducing it from around 3.5 percent to 3 percent. Adopting a higher performance target, say 50 percent of weekly payments, reduces the probability of a *loss given default* significantly, but does so at the cost of ignoring the potentially significant cost of the *losses given default* below the threshold for the performance target.

6.1.3. Performance against the agreed measures

Figure 6.1 looks at the performance of the Base Case under Options A and B, with Option B expressed on a daily basis. Option A is measured on the vertical axis: the average across the regions of 4 percent is roughly the centre of the spread of points on the vertical axis. Option B is measured along the horizontal axis. The probability of a *loss given default* of a given size, expressed as a share of generator payments, declines as you

[35] This is particularly important when generators' diverse dispatch characteristics are considered. For some generators – rarely dispatched, but generally dispatched during high price periods – the cost of losses incurred as a result of a default during a high price period could be disproportionately large relative to total annual revenues. Similar issues affect Option B. Any measure that considers generator payments as a proxy for generator revenues will result in inequities between different types of generators at different periods of the year.

[36] See comments above.

move along the horizontal axis, so that there is roughly a 3 percent probability of a *loss given default* under the Base Case of 20 percent of generator weekly payments. There is a small, but non zero probability of a *loss given default* of 100 percent of generator weekly payments.

Figure 6.1 Performance of Base Case under Options A, B, probability of a *loss given default*, percent per day[37]

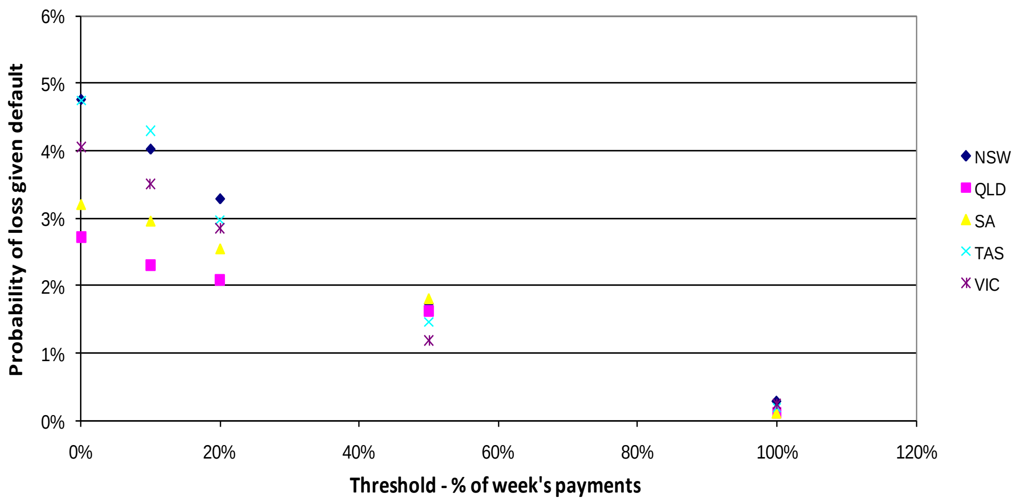
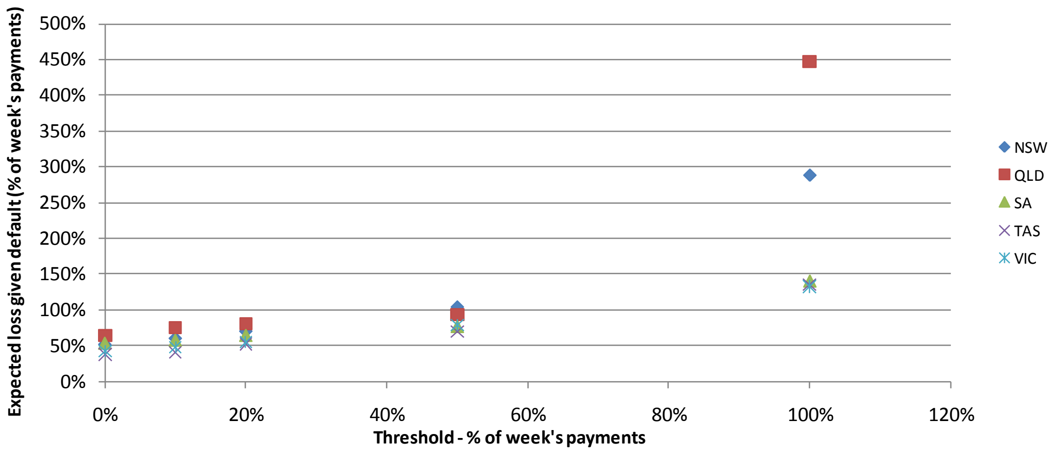


Figure 6.2 looks at the question, how serious would the remaining losses have been over the past 10 years if you had agreed a performance target of, say, 20 percent for the successful performance of the prudential arrangements? Acceptable performance would be to restrict the probability of a *loss given default* of up to 20 percent of payments to generators in the relevant payment week to a very small number, while not targeting losses in excess of this amount. Reflecting the characteristics of the *loss given default* distribution, Figure 6.2 suggests that the remaining losses could be very significant relative to the target.

Setting the performance target at a less onerous level – at, say, 50 percent for example, so that the prudential arrangements would be designed to address potential losses of up to 50 percent of a week's payments - then the remaining losses the prudential standard would not aim to address would be in the order of 100 percent of a week's payments. Setting the prudential standard even higher does not eliminate the potential for extremely large losses. At a threshold of 100 percent, depending on the region, the residual losses vary from 150 percent of a week's payments to 450 percent (not shown in Figure 6.2).

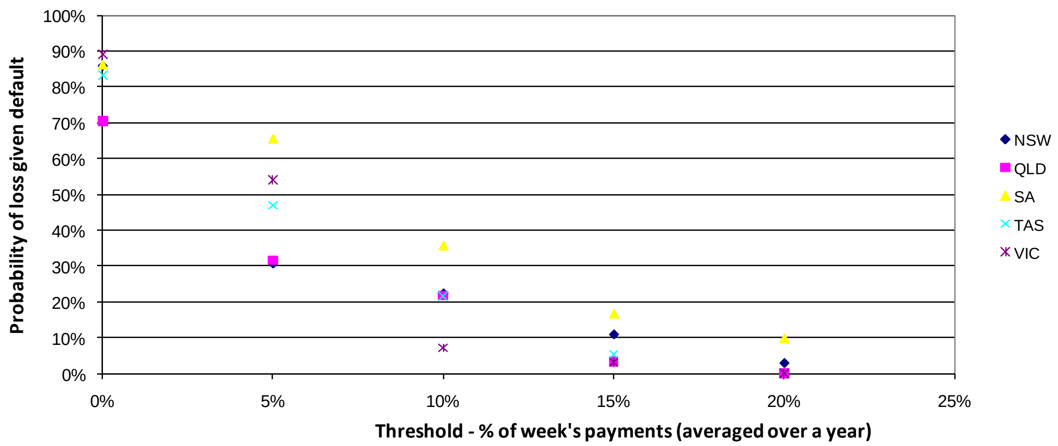
[37] In Figure 6.1, Figure 6.2 and Figure 6.3, the loss given default has been expressed as a share of regional generator revenues for the relevant region. This is strictly inconsistent with the application of the NER, but has the advantage of highlighting the different performance of the different regions.

Figure 6.2 *Loss given default* for events over the agreed threshold as a share of weekly generator revenues by NEM region, share of weekly generator revenues



Finally, Figure 6.3 looks at the performance of the Base Case under Option C, expressed on a weekly basis to maintain comparability with Figure 6.2. Consistent with the message of the previous charts, the higher the share of annual revenues at risk adopted as the performance target, the lower the probability of a *loss given default*. Assuming a target for successful performance of a probability of a *loss given default* of 10 percent of weekly revenues, then under the current prudential arrangements there is around a 20 percent probability of a *loss given default* of this size. Scaled to a quarter of this amount to represent the risk of the largest participant in a regional market failing, these results suggest that there is a 20 percent probability of a *loss given default* of 2.5 percent of weekly revenues under the Base Case under the current prudential arrangements.

Figure 6.3 Probability of *Loss given default* as a share of annual generator payments, by NEM region, probability



6.1.4. Expressing the current performance in the Prudential Standard

If the performance of the current prudential arrangements under Option A was adopted as the basis for the Prudential Standard, a revised Prudential Standard would substitute for the words "reasonable worst case estimate" in clause 3.3.8(b) of the NER:

> "The *maximum credit limit* for a *Market Participant* is a dollar amount determined by *AEMO* applying the principles set out in schedule 3.3, being an amount determined by *AEMO* **on the basis such that on days where a *Market Participant* is required to provide additional *credit support* the probability of a *Loss given default is* 2 percent or less for the *Market Participant*** based on the aggregate payments for *trading amounts* (after reallocation) to be made by the *Market Participant* to *AEMO* over a period of up to the credit period applicable to that *Market Participant*."

Loss given default would be defined in the NER as:

> **"The dollar amount by which aggregate payments for *trading amounts* exceed the *maximum credit limit* for a *Market Participant* in the event of a *Market Participant* being suspended from the market for failing to provide additional *credit support* as provided by Clause 3.3.18 of the *NER* or failing to provide additional security as required by a *Call Notice*."**

6.2 Assessing the Performance of the Prudential Arrangements

We have not been asked to consider whether the current performance of the prudential arrangements is satisfactory, but rather to consider what insights could be applied from other markets, energy and otherwise, as well as considering the marginal benefits and costs from improving the current arrangements.

6.2.1. Comparisons with approaches in other markets

AEMO's current prudential arrangements are not easily compared with those in other energy markets or other markets. Unlike a number of other commodity and energy markets we have considered:

– AEMO's current prudential arrangements explicitly contemplate a loss to Market Participants as consistent with the expected performance of the Prudential Standard in the use of the "reasonable worst case scenario" in the NER.
  - Although other markets have experienced failures by market participants – energy markets in the USA for example, having been affected by most recently by the failures of Lehman Brothers – we have not found another market that explicitly recognises the potential of a loss[38].
  - We have identified a number of markets where the objective of the market operator – generally, although not always, a privately owned exchange – is that no

[38] The discussion in the attachments to *PJM Credit and Clearing Analysis Project: Market Credit Comparison*, Market Reform, June 2008 is particularly interesting in this regard. In several markets, the response to the survey undertaken indicates that the Market Operator is concerned that, as a result of less than well defined procedures for the transfer of customers in the event of a default, a loss is likely. However, survey respondents do not plan for a loss, unlike the current NER Prudential Standard. See, for example, the discussion by Exelon, the UK Balancing Market Operator on its procedures and, in particular, the effects of a participant default, pps 34 -36.

loss will be incurred. In these circumstances, the market owners' capital is at risk in the event of a loss following a participant default.

- AEMO's approach to the credit worthiness of Market Participants is markedly different from that taken across a range of other markets, even where the market operator's objectives are to enhance competition by ensuring minimum barriers to market entry.
  - Markets use a range of measures to assess and monitor participants' credit worthiness, from using specialist outsourced credit checking processes through to refusing any credit at all, requiring the participant to provide adequate prudential holdings to cover the exposure from scheduled future trades. In the UK gas market, for example, potential trades that would take a participant outside its credit limit are refused until additional security is provided[39].
  - These processes have not been universally successful in their objective of distinguishing more or less credit worthy participants from each other, as acknowledged by the Federal Energy Regulatory Commission (FERC) in its 2009 Technical Conference on Credit and Capital Issues Affecting the Electric Power Industry[40]
- Relative to the portfolio risk monitoring and measurement processes adopted in other markets – many of which allow for a variety of instruments and markets to be traded – the approach to participant risk is relatively straightforward.
  - Under the current prudential processes, AEMO assumes that all participants are present a similar level of risk, regardless of their load or other characteristics.
  - AEMO also allows Market Participants with different physical portfolios (cross border or vertically integrated) to offset these positions against each other and, in certain circumstances, contracts formed outside the spot market can be used to offset payments, provided both parties consent. These netting arrangements are based on the assumption that Market Participants' risks are unchanged as a result of these transactions.

One international trend relevant to AEMO is a trend towards shorter settlement periods and reduced overall exposure for market participants. In the US market, FERC is currently proposing a shift in 2011 to 7 day billing periods, with settlement 7 days in arrears, followed by a further shift in 2012 to daily settlement[41]. As shown in Figure 6.4, this represents a significant shift in historic billing and settlement practices among the US Independent System Operators regulated by FERC[42].

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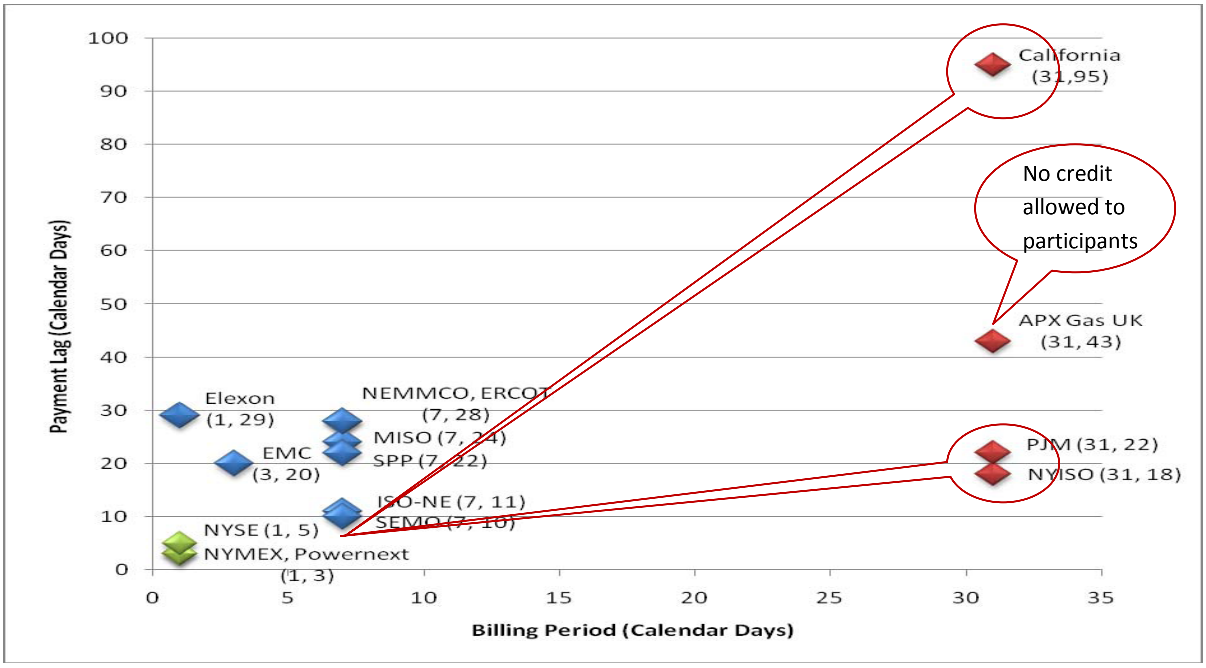
39 *PJM Credit and Clearing Analysis Project: Market Credit Comparison*, Market Reform, June 2008, pps 23 - 26

40 See the discussion at FERC Technical Conference

41 FEDERAL ENERGY REGULATORY COMMISSION, 18 CFR Part 35 Docket No. RM10-13-000, *Credit Reforms in Organized Wholesale Electric Markets*, (Issued January 21, 2010). FERC is also proposing significant reductions in the extent of unsecured credit offered to market participants in each of the ISOs it regulates. FERC's proposal represents a significant shift in regulatory sentiment over a relatively short period of time. PJM's Credit and Clearing Analysis Project recommendation for a shorter billing period and settlement period was earlier rejected by an internal committee, concerned about FERC's response to what was anticipated would be seen as an anti-competition move, restricting the ability of a wide number of parties to participate in the ISO's markets. See the discussion in PJM, *Credit Risk Management Steering Committee Recommendations to the PJM Members Committee, 2008* and the subsequent decision on PJM's website.

42 Some reductions in settlement cycles and billing periods have already occurred, with the California ISO (CAISO) and PJM reducing the settlement cycle times shown to 25 days (CAISO) and PJM reducing its billing period to 7 days.

Figure 6.4 Cash Market Billing and Settlement Periods, International Energy Markets



Source: *PJM Credit and Clearing Analysis Project: Market Credit Comparison*, Market Reform, June 2008; updated for FERC proposals; Seed analysis

This shift in policy is a response to the significant losses borne by market participants in a number of US energy markets as a result of participant failures in 2008, following the global financial crisis and represents a change in emphasis from earlier periods, where unsecured credit limits were set at relatively generous levels for market participants with investment grade credit ratings or better.

6.2.2. Considering the benefits and costs of the current prudential arrangements

If we look at the characteristics of the results of our findings on the current prudential arrangements, then it should be acknowledged that, for a large number of potential *loss given default* events that have been identified in the data for the past decade, improvements to the calculation approach for the prudential requirements are capable of simultaneously improving the performance of the prudential arrangements without increasing the cost to Market Participants of providing credit support. Depending on the region and the precise measures adopted, at the regional level the cost of providing credit support could fall. For specific participants, if the recommendation to introduce a factor relating to the participant's load profile is introduced, then the affected participants could experience an increase in the costs of providing credit support.

The remaining issue for Market Participants is the small number of events of a *loss given default* that would result in an extremely large loss to relevant generators. These events have been evident in the data for all NEM regions in the ten years to the beginning of 2010. Even scaled to represent a large market participant, the potential *loss given default* in some regions could be in excess of $100 million.

These large, low probability events present an issue for the prudential arrangements in managing their impact.

- In our judgement and reflecting the results of our alternative modeling approach below, increasing prudential holdings to address the possibility of these events is likely to be extremely costly, considering the net cost to the retailers of their prudential deposits and the low likelihood of the event occurring.

Treating these potential *losses given default* as an insurable event offers an alternative perspective on managing the potential risk, as well as in identifying and evaluating the benefits and costs[43].

- Looking first at the costs, either the cost of the necessary insurance could be obtained from a third party and then considered in the context of the protection provided, or, alternatively, AEMO could calculate the effective insurance premium it would need to collect to provision against the occurrence of a large, low probability *loss given default*[44].
- On the benefit side, the net cost of the incremental increase in prudential holdings could be calculated. Alternatively, if as we argue, increasing the prudential holdings is not regarded as appropriate, then AEMO could consider the aggregate of the costs to generators individually of procuring the necessary insurance, compared with the costs of providing the insurance to the market as a whole and, to the extent that the market's costs are lower, this would represent the benefit.

[43] This calculation of the benefits and costs departs from the framework proposed by CRG. Even if CRG's framework is accepted, quantifying the benefits and costs of changes to the prudential arrangements under CRG's proposed framework is extremely difficult.

[44] We understand that AEMO has unsuccessfully previously sought to insure against default risk in the NEM. However, we understand that the protection in question may have related to a replacement for the current prudential arrangements and not, as we envisage, a supplement to the current arrangements to address specific risks.

A. Scope of Work

Required Advice

AEMO is seeking reasoned advice on the following matters:

1. **In Respect of MCLs:** Based on an actuarially robust approach, what level of prudential confidence was being provided for each region in the NEM by the MCLs determined by NEMMCO / AEMO during the period from January 2000 to December 2009:

   a. Under the default (42 day credit period) MCL methodology; and

   b. Under the reduced (28 day credit period) MCL methodology.

This assessment should be carried out on at least a quarterly basis.

2. **In respect of the Prudential Margin:** Based on the same actuarially robust approach as that used in 1, what level of confidence was being provided by the prudential margin for each region in the NEM during the period from January 2000 to December 2009? To be clear, this assessment should provide information on the level of confidence that the collateral held in respect of the prudential margin would cover the trading obligations of a participant for a period of seven days from the time they fail to meet their daily prudential obligations. Seven days is the period that is currently allowed for default proceedings and activation of the Retailer of Last Resort (RoLR) mechanism.
3. **Standards of cover used elsewhere:** What levels of prudential cover are commonly used in other relevant markets (not necessarily energy markets)? What are the factors to be considered in whether AEMO and stakeholders should consider applying these standards in the NEM in place of the level of cover found in 1 and 2? This discussion is to include a comparison between the nominated markets and the NEM in relation to factors such as volatility of price and time to respond, and a consideration of the impact of these differences or similarities for prudential purposes.

   a. It has been suggested that it is most efficient to set the prudential standard at a level such that the incremental benefit of increasing the standard would begin to be outweighed by the incremental cost of doing so[5]. Discuss whether a practical approach to this might be feasible, and if so, the factors and approach that could be used[45].

4. **Seasonal variations:** As part of the above analysis and commentary, the consultant is to consider and discuss the implications of seasonal variations in NEM price and demand volatility. For example, if current practice is found to provide MCL cover that does not ideally match seasonal variations in price and demand, then implications of those findings for matters such as the cost of capital tied up and prudential cover provided are to be articulated and discussed.

[45] AEMO has received economic advice referring to this notion from the Competition Economic Group (CEG). That advice has not been published at this stage, but it can be provided on request. This matter is discussed in the CEG Report at paragraph 57.

5. Taking the above analysis and observations into account, recommend:

   a. Whether the terminology in which the prudential standard is currently expressed in the National Electricity Rules can be improved on to aid interpretation, and if so, the recommended approach;

   b. A practical numerical methodology that could be readily used by AEMO to calculate the MCL and Prudential Margin for a participant, consistent with the approach in (a). Demonstrate the performance of this approach by applying it to the period from January 2000 to December 2009 at the regional level, in a form that can be operated by AEMO – e.g. spreadsheet form.

      i. Comment on how AEMO would cater for anticipated changes in the forward environment (eg increased electricity prices due to a price being placed on carbon) while using the recommended methodology.

   c. What level the prudential standard should be set at for the prudential margin and for MCLs using the terminology recommended in (a). Give reasons.

Core Data Available from AEMO

AEMO is anticipating that the analysis required for the consultancy can be carried out using half hourly demand and price data for each region in the NEM. AEMO can provide that data to the consultant for the study period or for a longer period if required. It should be noted however that data for the NEM commenced in December 1998, so only a limited amount of data is available.

Additions to the Scope of Work

Modeling Representative Participants

AEMO accepted our recommendation that the analyses required for Items 1, 2 and 4 of AEMO's work program were supplemented by the same analyses undertaken at the individual Market Participant level. We agree with AEMO that the data provided to us would effectively disguises the participants' identities, allowing us to present the results of the analyses without AEMO or others being party to the participants' identities.

This approach was recommended because:

- The risk of default and, therefore, the risk of a *loss given default*, is a participant specific risk, not a generic market wide risk. The pooling arrangements for payment in the event of a *loss given default* smear the risks of participant failure across the relevant generators. However, the risk of participant failure and the potential for a loss in the event of a failure are non diversifiable and participant specific: the risks are not altered by the requirement for all Market Participants to provide security.
- In the event that a Market Participant was to fail, then, regardless of the total level of security held, generators in the relevant regional pool(s) will experience a loss to the extent that the failed Market Participant's exposures exceeds its MCL.
- To the extent that participants' characteristics differ from those of the market as a whole, then focusing on the market-wide risks and market wide security is likely to misrepresent the risks to the market. In traded North American energy markets, events of default are more frequent where unanticipated extreme weather gives rise to extreme price events. If we assume that NEM Market Participants are similarly more at risk when high demand and high prices coincide, then we can also assume

that Market Participants whose load profiles vary sharply as a response to weather are likely to have a systematically higher risk of default than Market Participants with less weather sensitive portfolios. Again, looking at the market-wide results of the proposed analyses will not identify this effect.

Modeling the shorter settlement cycle

At AEMO's request, we modeled the effects of a shorter settlement cycle in line with discussions we understand are taking place between AEMO and stakeholders about the possibility of reducing the settlement cycle to 12 days – a billing period of 7 days, billed 5 days in arrears.

B. Modeling methodology and Assumptions

Analysing Historical Performance of the Current Process

The main objective of the analysis of 10 years of historical data was to estimate the probability of a *loss given default*, with a secondary objective of estimating some measures of severity of the loss. To do this, it was necessary to develop a model of the total outstandings under the current process that was sufficiently detailed to provide a reasonable estimate but necessarily simplified to reflect the information available and what would have a material effect. This model is deterministic – it is intended to provide a number of scenarios that represent what would have happened historically if a particular set of assumptions were applied.

The model of the settlement cycle is described in Section 3.3. The main assumptions in this model are:

1. The settlement process has been unchanged over the past 10 years and uses the number of days in each part of the cycle as described in Figure 3.4, including a Reaction period of 7 days.
2. The process of setting a new MCL is done one month prior to the start of the quarter, and the previous 11 months of data is used in determining the average price and volatility for the MCL calculation.
3. Using the median load for a year centered on the quarter in the MCL calculation is a reasonable approximation to the method used in the past – a combination of projection of past loads and discussion with retailers.
4. Default can only occur once a day. This reflects the current process of assessing total outstandings once a day.
5. Default can occur on any day, including weekends and on public holidays. This simplification is unlikely to be material because the load and price on weekends are generally much lower than weekdays so the likelihood of a loss given default on the weekend is relatively low.

Under these assumptions, a suitable estimator of the probability of loss given default is the proportion of days over the 10 years when a loss would have occurred if there had been a default on that day. It is clear from the historical data that the probability will depend on the month of the year, so this estimate is an average probability over a year. Given the large amount of variability between years, there is little to be gained by basing the estimate on fewer than 10 years – while shorter periods will undoubtedly give different estimates, they are unlikely to be significantly different in a statistical sense. Even if there have been material changes in the probability over this period (other than the dependence on month), it is not possible to reliably estimate those changes. We have also estimated the probability for each month (e.g. all Januaries) based on the proportion of days in the same way, but this should be taken as a qualitative indication only, due to the small number of events potentially giving rise to losses.

Ideally, we should give some quantitative assessment of the uncertainty of these estimates (in statistical terminology, a standard error). This would allow us to draw conclusions about whether there had been changes over time, or differences between months, in the probability of loss given default. However, this is not possible without a probabilistic model, and such a model would need to be very complex to model such factors as how the weather and seasons affect electricity loads and prices. The difficulty stems from the dependencies between events on successive days. This is due to a number of factors: for example, a single high cost day can affect many days' probability of loss given default; there are seasonal effects; and there is a tendency for very hot or very cold days to occur in groups.

We can see the range of possibilities by considering two extremes.

- If we assume there is no dependency between days and a constant probability of loss given default of 4%, the standard error of an estimate based on 3,653 days is 0.3% (based on the square root of(0.04*0.96/3,653)).
- Alternatively, if we assume the dependency is so great that we effectively only have 10 independent data points – the estimates of the probability for each year – then the standard error is 1.3% (0.04/square root of(10)).
- Given the observation that the average size of clusters of loss days is 3-4, a reasonable estimate of the standard error is about 0.6%. Note that this estimate does not allow for the simplifications made in the model, or for the possibility that the probability is changing over time.

Our original intention was to fit a probability distribution to the total outstandings (using the Peaks Over Threshold (POT) method for fitting the "tail" of a distribution), then to use this distribution to estimate the probability of exceeding the MCL. However, the requirement to estimate this probability conditional on there also being a margin call meant that the problem now involves two highly correlated variables, so the POT method would no longer give a reasonable estimate.

Design of the Proposed New Process

Due to the complexity of the model of loss events, it is not possible to produce a formula that will give a specified probability of *loss given default*. Instead, it is necessary to propose an approach, and test it on historical data to estimate the resulting probability. There are thus no strict rules on how the various components of the prudential standard must be estimated, within the general principles proposed of seasonality in price and volatility, and allowance for load volatility.

The method of estimation of price described in Section 5.1 is chosen to give a balance of simplicity, accuracy and stability. It would be possible to improve the accuracy and stability by using any simple forecasting method. One example is the stl method, which decomposes a time series into seasonal, trend and irregular components and is robust to outliers (available as a free R software package).

Similarly, the accuracy and stability of volatility estimation could be improved at the cost of simplicity by using the stl method to "fit" an average cost to each season, allowing for seasonality and trend.

C. Detailed results

This Appendix contains additional detailed results for NSW, SA, QLD and Tasmania that were not covered in the body of this report. They are separated into the same categories of results as the body of the report:

- Base case
- Improved calculation approach
- Shorter settlement cycle (2% probability of loss given default).

In addition this Appendix outlines key results for the shorter settlement cycle scenario using a 1.5% probability of loss given default to illustrate the potential costs (through increased prudential requirements) of reducing the loss given default from 2% to 1.5%.

Base Case Results

Figures C.1 – C.4 illustrate the equivalent results to Figure 4.7 and highlight the maximum potential loss given default on a total dollar basis for NSW, Queensland, South Australia and Tasmania respectively. New South Wales exhibits similar size extreme events as Victoria. However, the other regions exhibit smaller losses due to their smaller size.

Figure C.1 Maximum Potential *Loss given default*, Base Case, RMCL, NSW, 2000 – 2010, $ millions

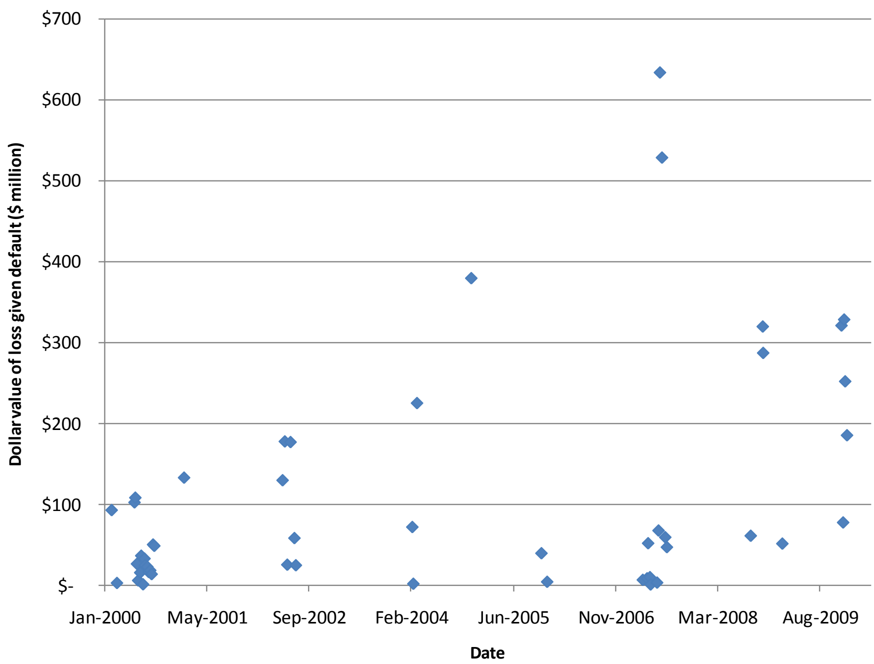


Figure C.2 Maximum Potential *Loss given default*, Base Case, RMCL, Queensland, 2000 – 2010, $ millions

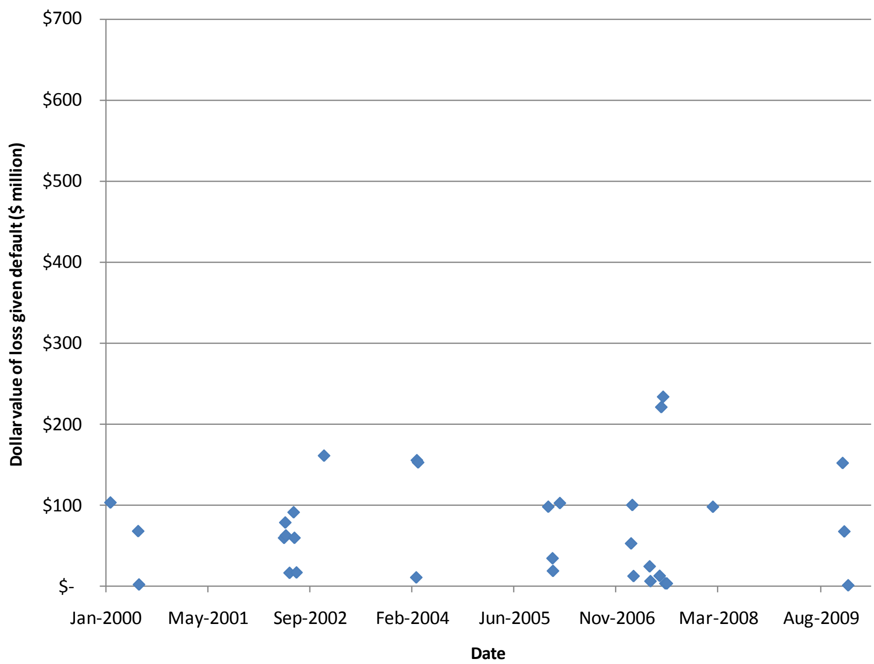


Figure C.3 Maximum Potential *Loss given default*, Base Case, RMCL, South Australia, 2000 – 2010, $ millions

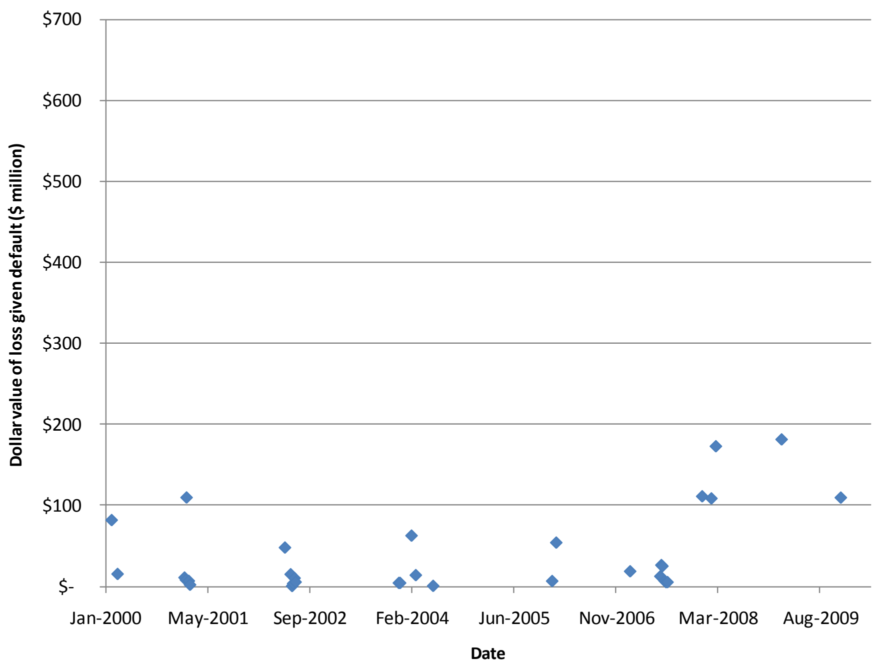
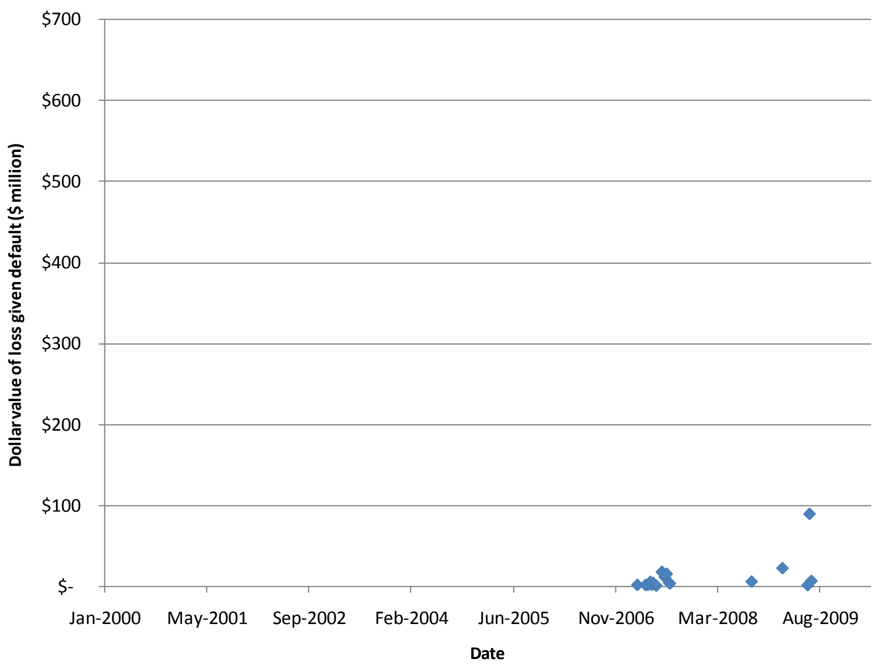


Figure C.4 Maximum Potential *Loss given default*, Base Case, RMCL, Tasmania, 2005 – 2010, $ millions



Figures C.5 – C.8 illustrate the equivalent results to Figure 4.8 and highlight the maximum potential loss given default on a $/MWh basis (using NEM wide volumes) for NSW, Queensland, South Australia and Tasmania respectively. New South Wales exhibits similar size extreme events as Victoria. However, the other regions exhibit smaller losses due to their smaller dollar value losses being divided by the NEM wide volume.

Figure C.5 NSW, Base Case, maximum *Loss given default*, $/MWh per annum

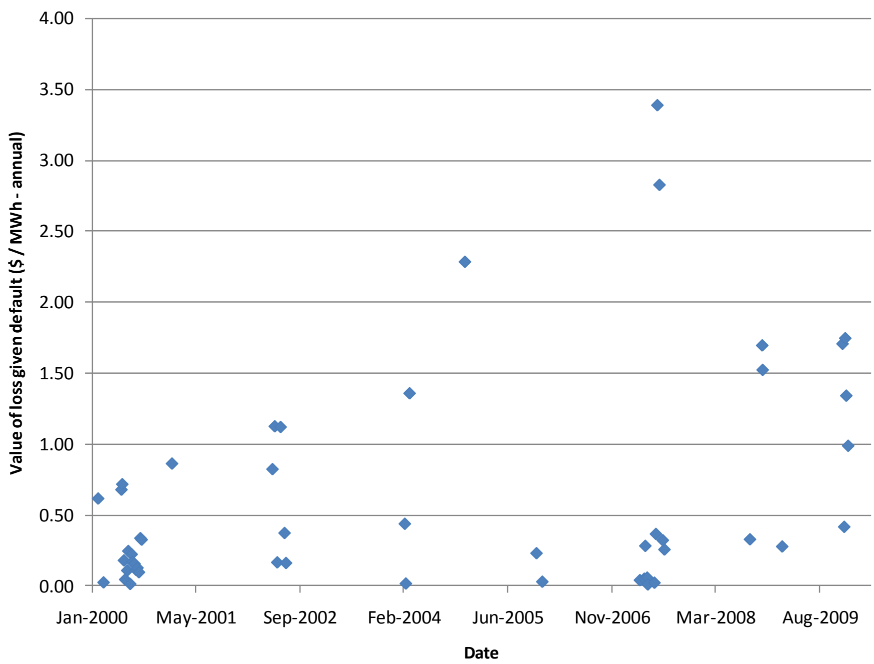


Figure C.6 Queensland, Base Case, maximum *Loss given default*, $/MWh per annum

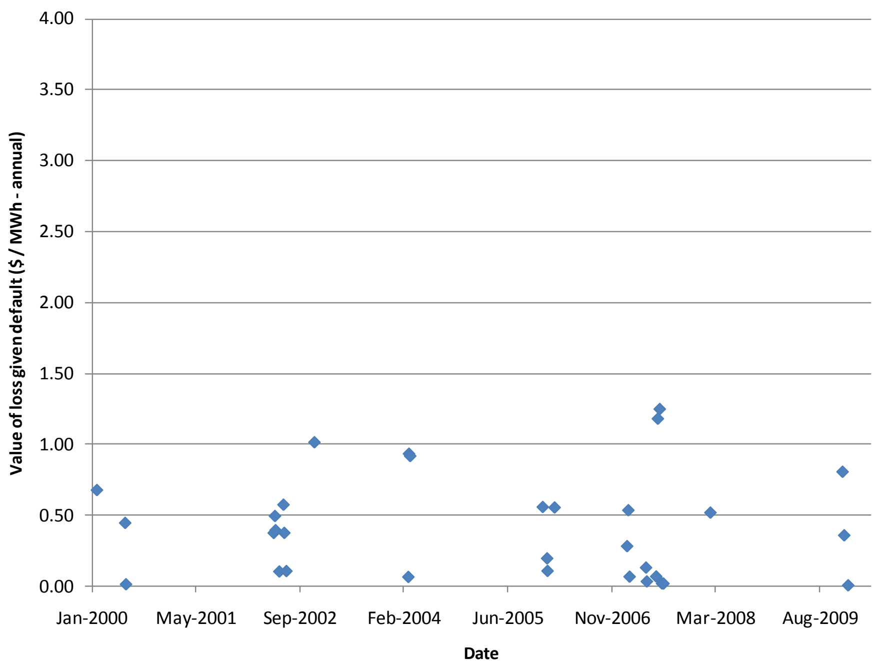


Figure C.7 South Australia, Base Case, maximum *Loss given default*, $/MWh per annum

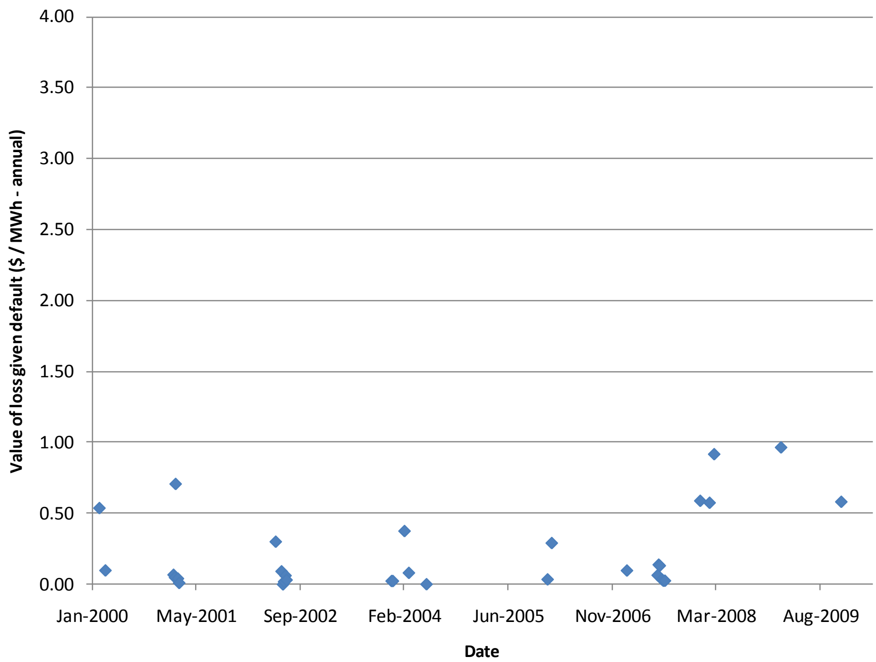
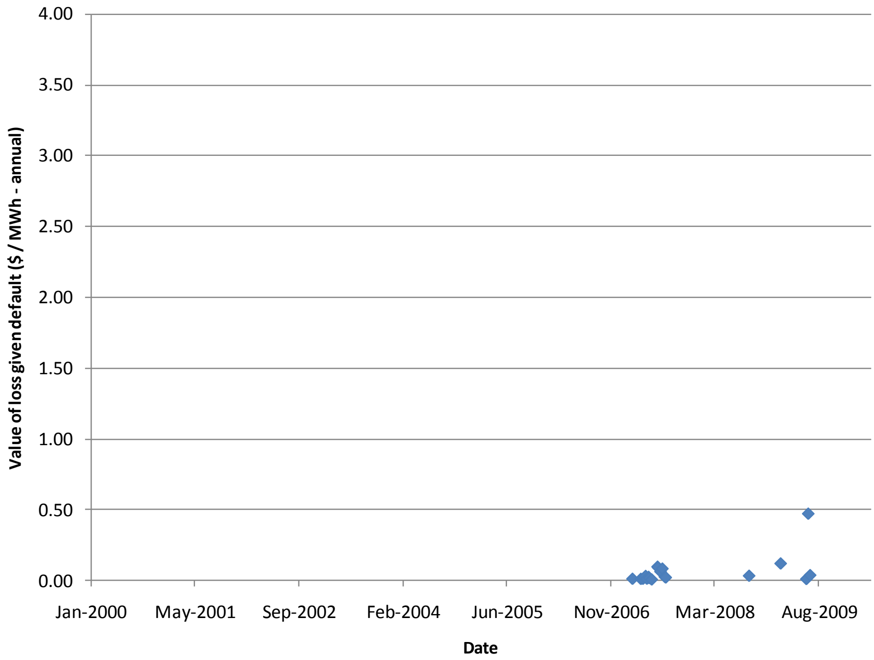


Figure C.8 Tasmania, Base Case, maximum *Loss given default*, $/MWh per annum



Figures C.9 – C.12 illustrate the equivalent results to Figure 4.9 and highlight the frequency distribution of the ratio of the maximum potential loss given default as a proportion of the underlying prudential standard (in this case the RMCL) for NSW, Queensland, South Australia and Tasmania respectively. Similar to Figure 4.9 each region has historical maximum potential loss given default events that could be at least 100% or up to 200% of the underlying prudential standard.

Figure C.9 Ratio of *Combined Total Outstandings* to the RMCL, Base Case, NSW, number of events by cluster

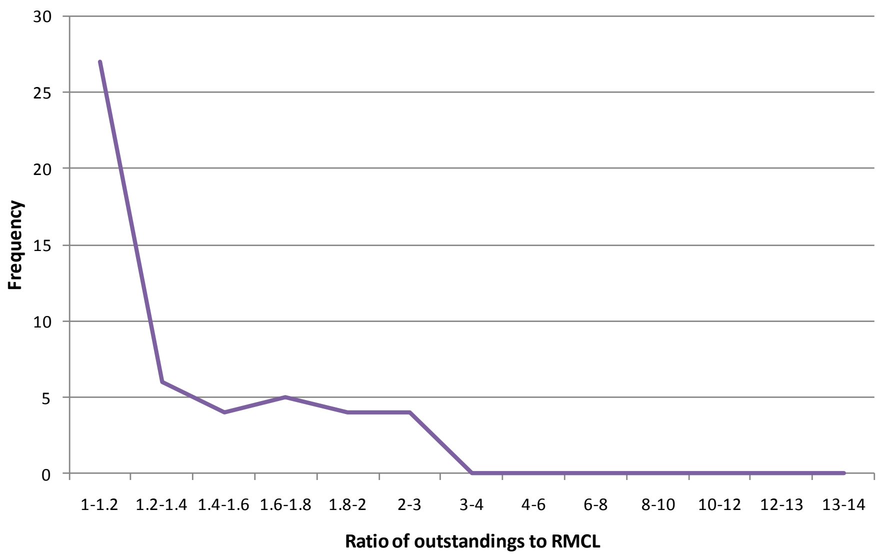


Figure C.10 Ratio of *Combined Total Outstandings* to the RMCL, Base Case, Queensland, number of events by cluster

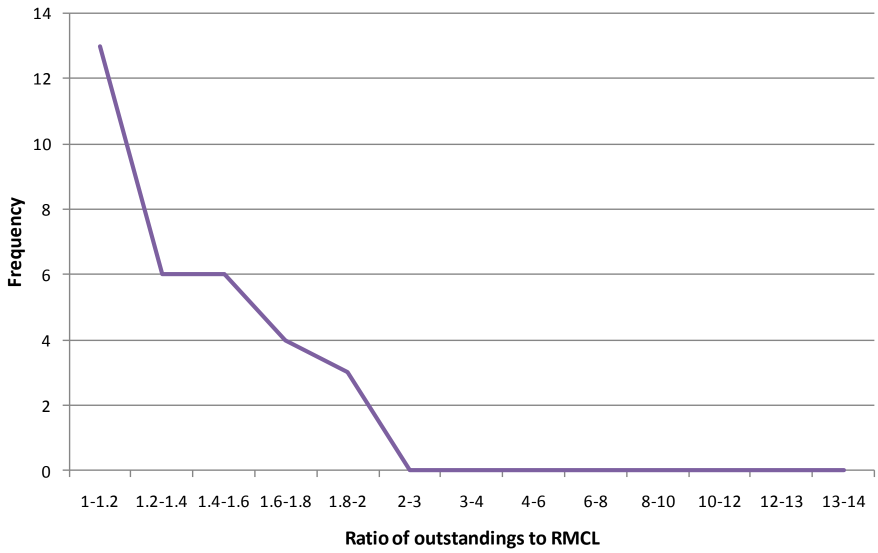


Figure C.11 Ratio of *Combined Total Outstandings* to the RMCL, Base Case, South Australia, number of events by cluster

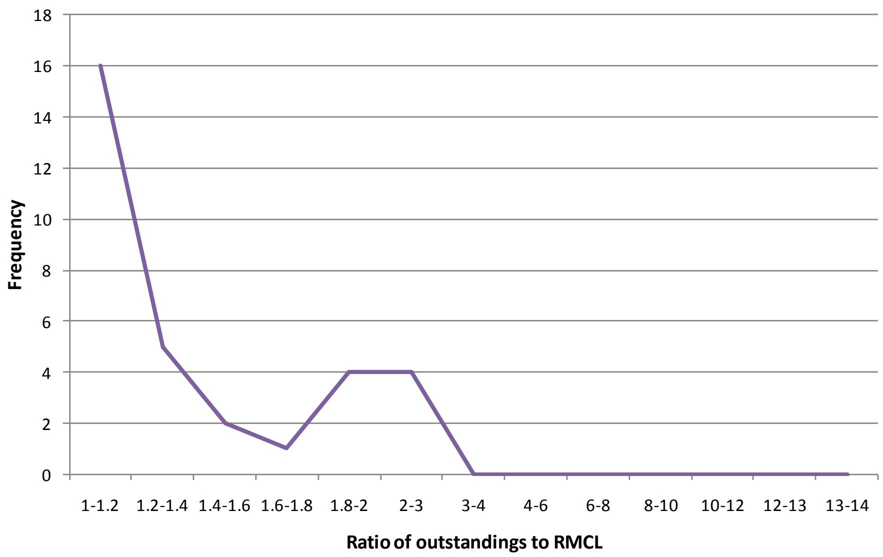
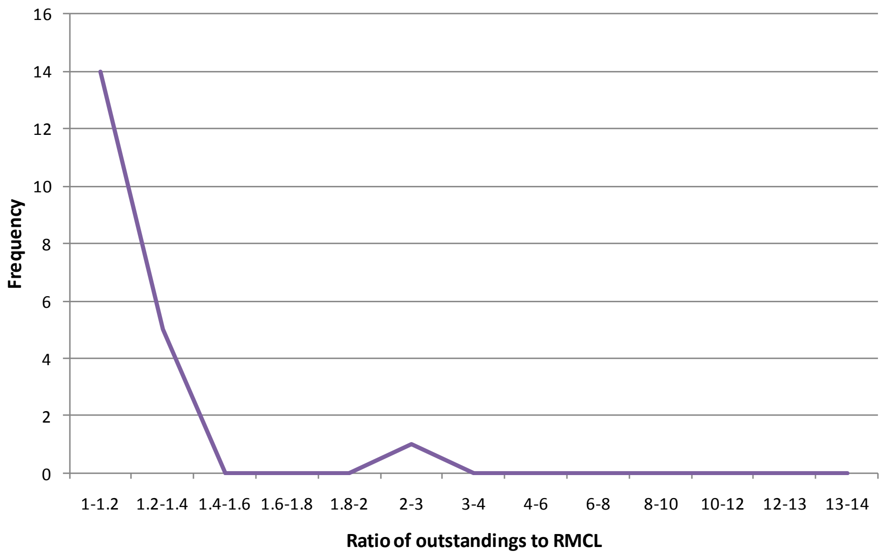


Figure C.12 Ratio of *Combined Total Outstandings* to the RMCL, Base Case, Tasmania, number of events by cluster



Improved calculation results

Figures C.13 – C.16 illustrate the equivalent results to Figure 5.4 and highlight the maximum potential *loss given default* on a $/MWh basis for NSW, Queensland, South Australia and Tasmania respectively. New South Wales exhibits similar size extreme events as Victoria. However, the other regions exhibit smaller losses due to their smaller size.

Figure C.13 NSW, Base Case, improved calculation approach, maximum *loss given default*, $/MWh per annum

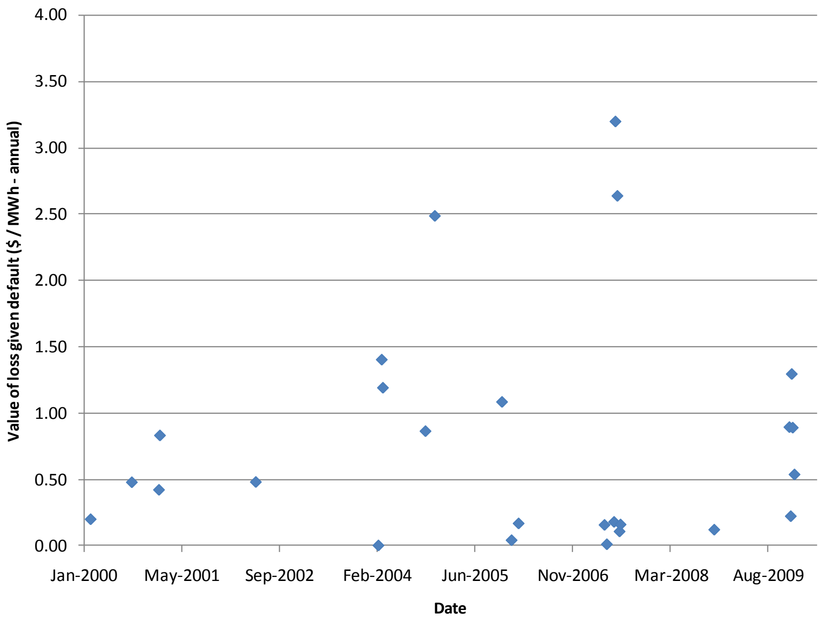


Figure C.14 Queensland, Base Case, improved calculation approach, maximum *loss given default*, $/MWh per annum

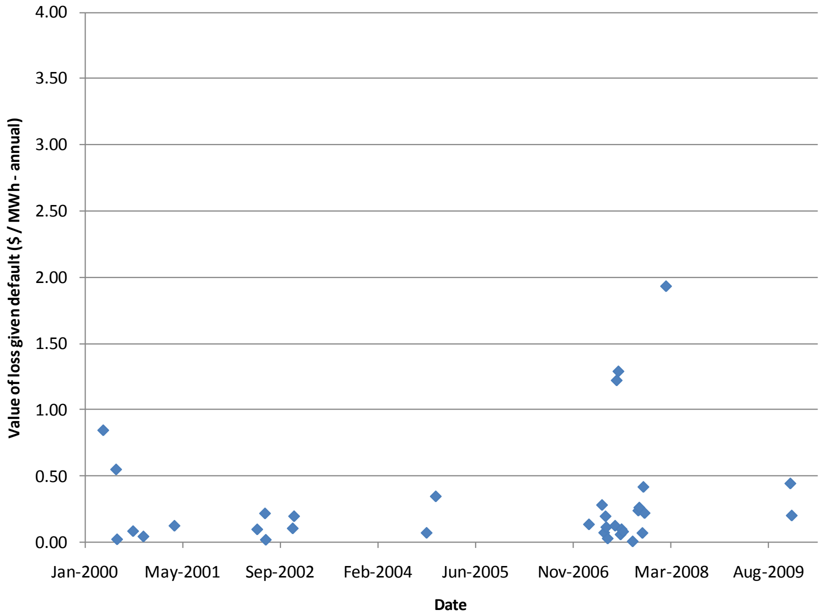


Figure C.15 South Australia, Base Case, improved calculation approach, maximum *loss given default*, $/MWh per annum

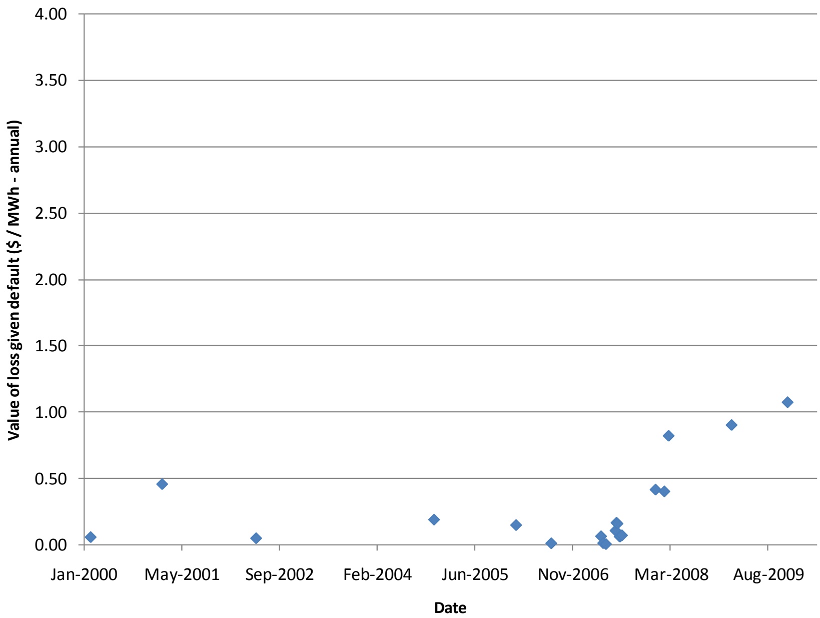
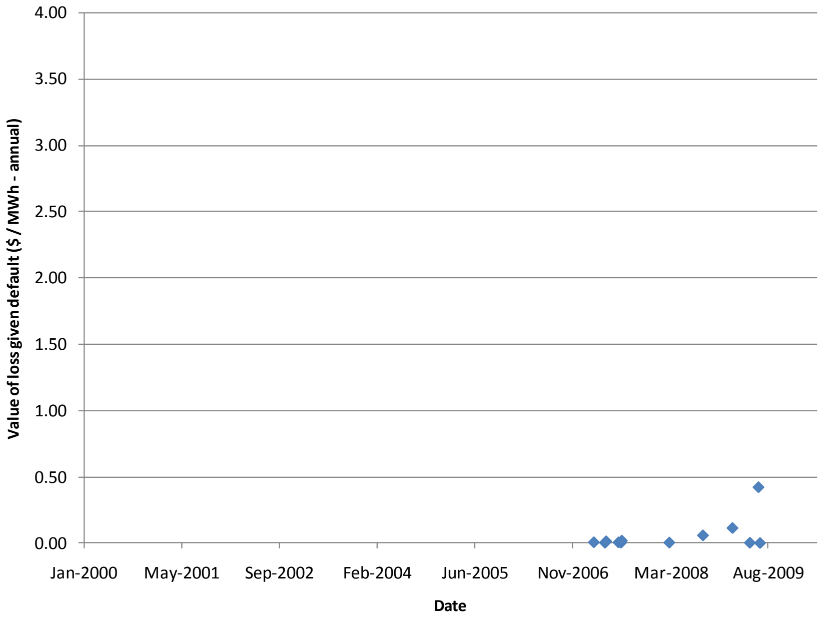


Figure C.16 Tasmania, Base Case, improved calculation approach, maximum *loss given default*, $/MWh per annum



Shorter settlement cycle results – 2% probability of loss given default

Figures C.17 – C.20 illustrate the equivalent results to Figure 5.9 and highlight the maximum potential *loss given default* for the shorter settlement cycle with a 2 percent target *loss given default* on a $/MWh basis for NSW, Queensland, South Australia and Tasmania respectively. New South Wales exhibits similar size extreme events as Victoria. However, the other regions exhibit smaller losses due to their smaller size. As is the case for the Victorian results, the more extreme results are not eliminated as a result of moving to the shorter settlement cycle.

Figure C.17 NSW, shorter settlement cycle and improved calculation approach (2% probability of loss given default), Base Case, maximum *loss given default,* $/MWh p.a.

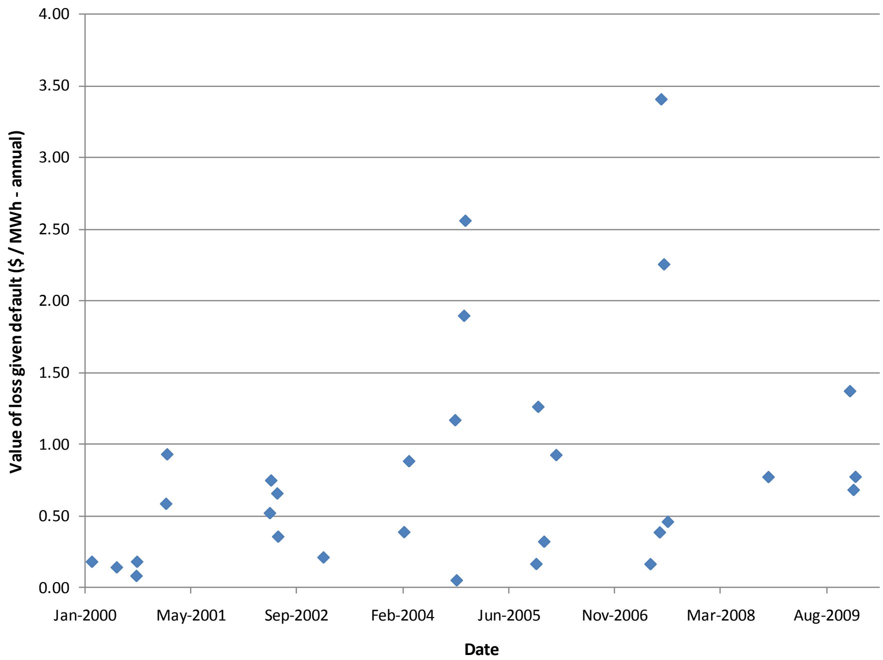


Figure C.18 Queensland, shorter settlement cycle and improved calculation approach (2% probability of loss given default), Base Case, maximum *loss given default,* $/MWh p.a.

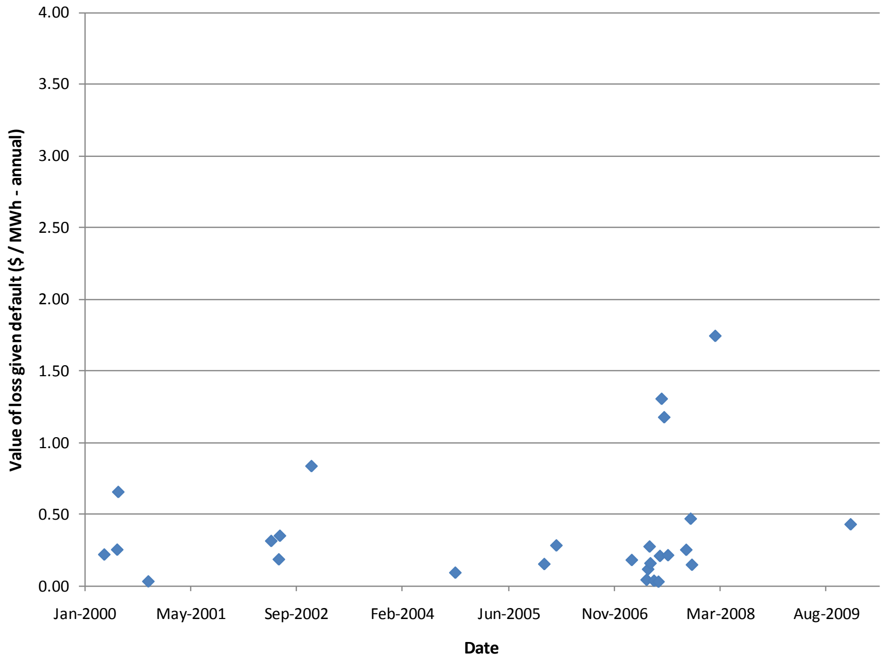


Figure C.19 South Australia, shorter settlement cycle and improved calculation approach (2% probability of loss given default), Base Case, maximum *loss given default,* $/MWh p.a.

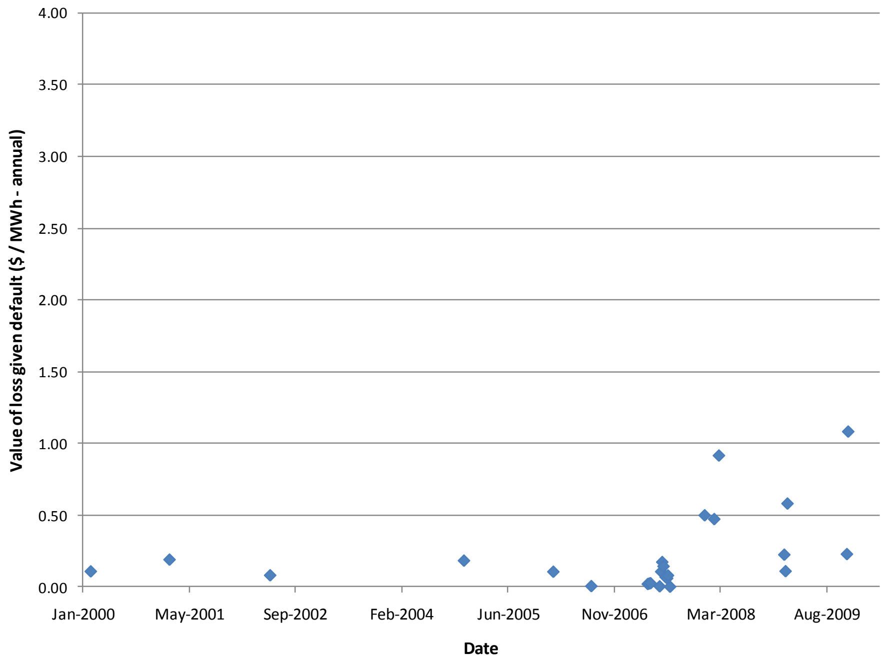
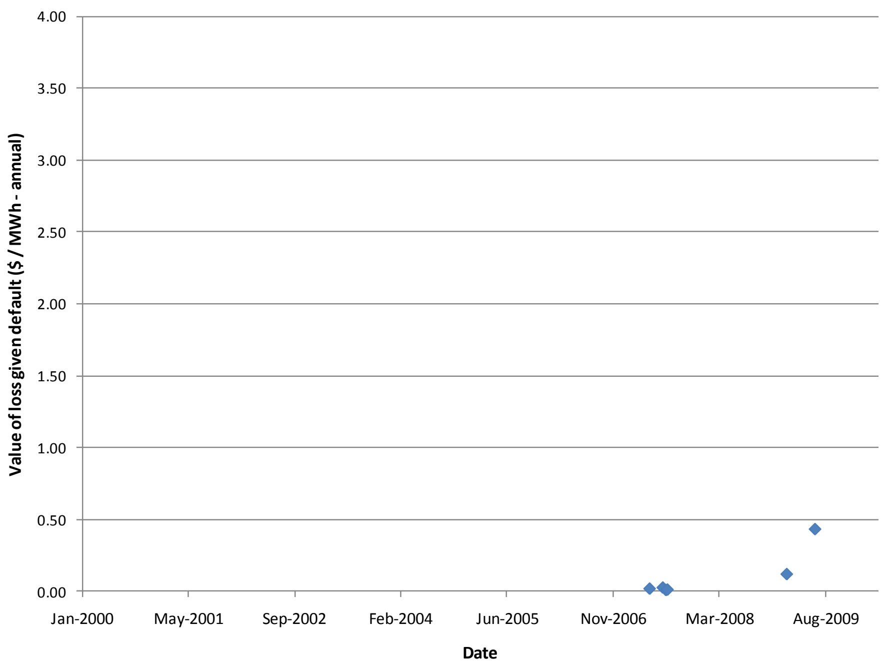


Figure C.20 Tasmania, shorter settlement cycle and improved calculation approach (2% probability of loss given default), Base Case, maximum *loss given default,* $/MWh p.a.



Shorter settlement cycle results – 1.5% probability of default

The tables below contain similar results as Table 5.5 and Table 5.6 and Figure 5.10 and Figure 5.11 and demonstrate the effects of adopting a tighter performance standard – 1.5 percent in place of the 2 percent used in the body of this report – on the Prudential Requirements.

Compared with Table 5.5, the Prudential Requirements would increase by 17 percent on average as a result of the tighter performance standard. The Prudential Margin would increase by 20 percent and the Trading Limit by 15 percent.

Table C.1 Comparison of average prudential requirements, trading limit and prudential margin: improved calculation approach shorter settlement cycle 2% vs. improved calculation method shorter settlement cycle 1.5%, by NEM Region

		NSW	Qld	SA	Tas	Vic
Improved Calculation Approach (Shorter Settlement Cycle – 2% probability of loss given default)						
Average Prudential Requirement	$ million	260	190	67	50	143
Average Trading Limit	$ million	165	122	43	32	91
Average Prudential Margin	$ million	95	68	25	19	52
Average Prudential Margin (%)	% of Prudential Req’t	36%	36%	37%	37%	36%
Improved Calculation Approach (Shorter Settlement Cycle – 1.5% probability of loss given default)						
Average Prudential Requirement	$ million	319	229	79	53	170
Average Trading Limit	$ million	202	146	47	33	106
Average Prudential Margin	$ million	117	83	32	20	64
Average Prudential Margin (%)	% of Prudential Req’t	37%	36%	40%	37%	38%
Percentage of Improved Calculation Approach (Shorter Settlement Cycle – 2% probability of loss given default)						
Average Prudential Requirement	% of Prudential Requirement	123%	121%	117%	105%	119%
Average Trading Limit	% of Trading Limit	123%	120%	110%	105%	116%
Average Prudential Margin	% of Prudential Margin	123%	121%	128%	106%	123%

Table C.2 Additional security required by number of days required and dollar values by NEM region, shortened settlement cycle (1.5% probability of loss given default)

Region	NSW	Qld	SA	Tas	Vic
Total days	3,653	3,653	3,653	1,583	3,653
Number of days additional security is required	114	119	130	22	105
Percentage of days additional security is required	3.1%	3.3%	3.6%	1.6%	2.9%
Average new security deposit required ($m)	37	16	9	5	18
Total number of days with additional security held	315	324	321	84	315
Percentage of days with additional security held	8.6%	8.9%	8.8%	6.1%	8.6%
Average total additional security balance ($m)	122	58	32	15	53

Figure C.21 Additional securities as a share of required prudential holdings, shorter settlement cycle and improved calculation approach (1.5% probability of loss given default), percent