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Notice of Market Rules Modification

Paper No.:	EMC/RCP/38/2008/278
Rule reference:	Chapter 7 Sec 7.2, 7.4, 7.5, 7.7 & Chapter 3 Section 7.3
	Market Operation Market Manual Version 10 September 2008 Sec 2 & 4
Proposer:	Market Admin, EMC
Date received by EMC:	30 May 2008
Category allocated:	2
Status:	Not Approved by EMA
Effective Date:	N/A

Summary of proposed rule modification:

The current prudential methodology measures the MP/MSSL's exposure using the estimated net exposure (ENE), given by the equation below. However, it does not account for electricity price volatility.

ENE = Current Exposure + (20-X)*Average Daily Exposure – Prepayment

The proposed prudential methodology measures a MP/MSSL's exposure using the credit risk exposure (CRE) given by the equation below. It accounts for electricity price volatility by using the Generalised Extreme Value (GEV) distribution, reflected through component B. It also uses a 30-day trading exposure (20-day period and 10-day suspension process) instead of the 20-day period under the current methodology.

$$CRE = \underbrace{CE + (30 - X)(ADE) \text{ - } Prepayment}_{\text{Component A}} + \underbrace{[(18)^{\xi} \times \psi \times (NVE)]}_{\text{Component B}}$$

See Section 3 of the attached paper for details on the proposed methodology.

Date considered by Rules Change Panel:	1 July 2008
Date considered by EMC Board:	31 July 2008
Date considered by Energy Market Authority:	15 April 2009

Proposed rule modification:

See attached paper.

Reasons for EMA's Decision Not to Approve the Rule Change

There are 2 reasons cited for the non-approval of this rule change, namely an adequate prudential regime is already in place, and higher costs placed on consumers as described below.

EMA stated that "EMC currently has in place a prudential requirement methodology to ensure that Market Participants (MP) and the Market Support Services Licensee (MSSL) provide adequate credit support." In addition, "EMC performs daily checks to check whether MPs or MSSL have sufficient credit support, and the relevant MPs or MSSL are required to top-up their credit support, where applicable".

Although the proposed new prudential methodology takes extreme price volatility into account, EMA notes that extreme price spikes are remote possibilities. The proposed methodology is expected to result in "higher prudential requirements and additional costs for the gencos and retailers, and would likely translate to higher electricity prices to consumers." In essence, the current credit support provisions are already robust and provide a reasonable safeguard against potential defaults by MPs or MSSL.

PAPER NO.	:	**EMC/BD/04/2008/**
RCP PAPER NO	:	**EMC/RCP/38/2008/278**
SUBJECT	:	**PROPOSED PRUDENTIAL METHODOLOGY USING THE GENERALISED EXTREME VALUE (GEV) DISTRIBUTION**
FOR	:	**DECISION**
PREPARED BY	:	**NERINE TEO** **ECONOMIST**
REVIEWED BY	:	**PAUL POH LEE KONG** **SVP, MARKET ADMINISTRATION**
DATE OF MEETING	:	**31 JULY 2008**

Executive Summary

The proposed prudential methodology for the Singapore Wholesale Electricity Market (SWEM) uses the 'Generalised Extreme Value' (GEV) model, as proposed by a consultant, Dr Ng Kah Hwa of NUS Centre for Financial Engineering. Compared to the current methodology, the proposed methodology is more robust because it accounts for extreme price movements.

The RCP tasked EMC was to conduct a 6-month trial that ran in parallel with the current methodology. This trial ran from 10 September 2007 to 6 March 2008.

The RCP, having considered the results of the trial, by majority vote, have supported the implementation of the proposed methodology at the 37th RCP meeting.

The proposed rule modifications required to implement the proposed prudential methodology were then presented at the 38th RCP meeting.

The RCP, by majority vote, recommend that the EMC Board adopt this proposal.

1. Introduction

During the RCP work plan prioritisation exercise in January 2006, a market participant (MP) had requested for a review of prudential requirements for SWEM to be included in the work plan. That MP was concerned if the EMC currently holds sufficient credit support to safeguard against default payment, in light of a proposal to change the bearer of default risk from non-defaulting MPs to net creditors only.

The EMC Board had also raised a similar concern over the adequacy of the credit support currently held by the EMC, particularly in guarding against sustained price spikes.

EMC then engaged a consultant, Dr Ng Kah Hwa of NUS Centre for Financial Engineering, to conduct the review and propose a new prudential methodology for the Singapore Wholesale Electricity Market (SWEM).

The RCP, having considered the proposed prudential methodology in September 2006, agreed to EMC's recommendations to test this new methodology in parallel with the existing prudential methodology. This trial ran from 10 September 2007 to 6 March 2008.

This paper first gives a description of the current and proposed methodology followed by a report on the results of the trial. The RCP considered the results of the trial at the 37th RCP meeting on 13 May 2008 and, by majority vote, supported the implementation of the proposed prudential methodology. This paper includes the relevant rule changes required in the implementation of this methodology as set out in Annex 3.

2. Background

2.1 Current methodology on prudential requirements

A MP or Market Support Service Licensee (MSSL) is required to provide the EMC with credit support worth at least 30 days of its trading exposure. The 30-day requirement is to provide cover for a 20-day MP's payment cycle and a 10-day MP's suspension process[1]. The suspension process stretches from the time the EMC identifies a default event to the time the Market Surveillance and Compliance Panel (MSCP) issues a suspension order to the MP. Figure 1 below illustrates this.

Figure 1

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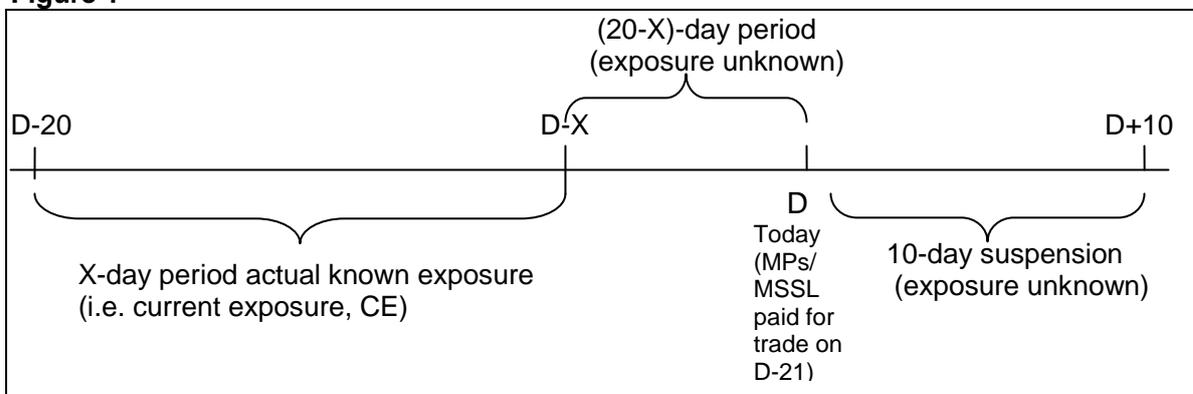
[1] The market rules require MPs to pay for transactions 20 calendar days after the transaction date and to meet margin calls. If a MP persists in non-payment, a default process is initiated and it would take at least 10 days to suspend that MP.

Following the study by Dr Ng, changes were made on 10 September 2007 to the methodology[2] used to calculate the amount of credit support that a MP/MSSL must provide to the EMC. Therefore, some differences can be observed between the current methodology and the previous methodology that was used in Dr Ng's study (see Annex 1 for the report of Dr Ng's study). The current methodology is:

Credit Support Value = 30 days x Estimated Average Daily Exposure --- Equation (1)

where:

Estimated Average Daily Exposure (ADE) = -1 x simple average of net settlement amounts set out on the 90 most recently available preliminary settlement statements (PSS) or corresponding final settlement statements (FSS) if available

The current methodology is intended to ensure there is sufficient credit support[3] to cover a MP's/MSSL's normal trading exposure over 30 days. The 90-day average is used to mitigate any outlier effects. When the wholesale electricity prices (WEPs[4]) remain relatively stable[5], the amount of credit support required by this methodology would be adequate.

2.2   Margin Call

Under the current methodology, the EMC is required to issue a margin call to a MP/MSSL if its estimated net exposure (ENE) equals to or exceeds 70% of the value of its credit support (CS). ENE is an estimate of a MP's 20-day exposure on a given day and is shown in Equation 2 below:

ENE = Current Exposure + (20-X)*ADE – Prepayment   --- Equation (2)

where:

Current Exposure (CE) = -1* aggregate net settlement amounts set on all of the MP's PSS or FSS if available that are not yet due for payment on that given day.

X = Number of *trading days* to which the *market participant's* CE on the given day relate.

In the event of a margin call where the ENE is equals to or exceeds 70% of the value of its CS, the MP/MSSL is required to either increase its credit support or make prepayments such that its ENE is less than or equal to 50% of its credit support.

2.3   Shortcoming of current prudential methodology

The current methodology uses past trade amounts (and hence, historical prices) to determine ADE and hence estimate the credit support value based upon which a MP places credit support. This methodology therefore raises a question of whether the credit support would be adequate if unexpected large price spikes occur in the (30-X) days of unknown exposure. The

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[2]See paper 267 'Discretion to Revoke/Revise Margin Call in the Presence of Manifest Errors' for the relevant rule change paper on changes to the definition of credit support, estimated net exposure and current exposure. The fixed 12 days of actual exposure was also replaced with a more accurate 'X'-days. This is because these days of actual exposure may range from 8 to 12 depending on the number of public holidays or weekends.
[3] An MP/MSSL is required to provide credit support which is at least equal to its credit support value.
[4] WEP is the net purchase price paid by retailers and consists of USEP, AFP, HEUC, MEUC, EMC and PSO fees.
[5] However, the credit support required by the current methodology would not be adequate when they are unexpected large price spikes.

bearer of default risk, in particular, will be concerned if the EMC currently holds enough credit support to safeguard against default payment.

3 Proposed methodology for prudential requirements

3.1 Proposed prudential methodology

Dr. Ng proposed a new methodology for determining prudential requirements in SWEM. Under the proposed methodology, the credit risk exposure of a MP/MSSL comprises two components (A and B) as explained below.

Component A: Covers 30-day trading exposure assuming stable prices

Component A captures the 30-day trading exposure of a MP/MSSL, assuming relatively stable WEPs. This comprises: (i) X days of actual known exposure (CE), and (ii) (30-X) days of unknown exposure. The (30-X) days of unknown exposure is estimated using past average daily exposure (ADE).

Hence,

$$\text{Component A} = CE + (30-X)(ADE) \ - \text{Prepayment} \qquad \text{--- Equation (3)}$$

The proposed methodology calculates average daily exposure by averaging the actual trade of the past 90 days (instead of past X days). A 90-day average is used to mitigate any 'outlier' trade amounts[6] which can over-inflate (or under-estimate) the (30-X) days of unknown exposure of a MP/MSSL. Consequently, this can lead to too high (or too low) an amount of credit support being required. This 90-day average is also used in the current methodology to calculate ADE as discussed in section 2.1 above.

Conceptually, equation (3) is similar to equation (2). They both contain 'CE' and use past 90-day average daily exposure to estimate the unknown exposure of a MP/MSSL. The only difference between them lies in the number of days of unknown exposure. Unlike the current methodology which uses (20-X) days of unknown exposure, the proposed methodology captures the 10-day suspension of unknown exposure as well.

Component B: Covers exposure due to extreme price volatility

Component A is determined assuming stable WEPs. However, actual prices could be volatile for the (30-X) days of unknown exposure. Hence, another component (Component B) is needed to capture the additional exposure arising from potential price volatility in the (30-X) days of unknown exposure.

To estimate Component B, a statistical distribution that characterizes WEP movements is required. An analysis of historical WEPs showed that they exhibit the following characteristics:

- They can be extremely volatile, with sudden price spikes reaching maximum USEP of $4500 sometimes; and

- Price spikes are of short duration, i.e. they revert to normal level rapidly.

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[6] An outlier trade amount refers to an usually high or low amount incurred by a MP/MSSL which is one-off or only transitory in nature. This can be caused by temporary or one-off price spikes.

Given these, the conventional approach of using the normal distribution to model price volatility is inadequate and misleading.[7] In his study, Dr. Ng uses the 'Generalised Extreme Value' (GEV) distribution instead. This distribution better reflects electricity price movements and hence, is more appropriate than the normal distribution for modeling electricity price volatility.

The GEV distribution function is given as:

$$H(X;\mu,\sigma,\xi) = \exp\{-[1+\xi(\frac{X-\mu}{\sigma})]^{-1/\xi}\}$$ --- Equation (4)

where:

X represents the highest daily electricity price changes over n trading days[8];

ξ is a shape parameter which captures the 'fatness' of the tail distribution. A fat tail at the extreme end of the distribution indicates the probability of extreme price movement is higher than suggested by a normal distribution;

σ is the scale parameter which captures volatility in extreme price movements of electricity

and

μ is the location parameter which represents the average value of the extremes, X in the GEV distribution.

Modelling WEPs based on the GEV distribution requires an estimation of the three parameters --- ξ, σ, and μ. A fourth parameter, ψ, is also estimated based on the estimated values of the three parameters with a given confidence level[9].

The model based on the GEV distribution produces a price volatility factor which captures the impact of price volatility on a MP's/MSSL's (30-X)-day unknown exposure. This factor is given as: $[(18)^{\xi} \times \psi]$. 18 is used in the factor because X, the number of days that CE relates to (i.e, days of known exposure), is usually 12. In the prudential trial, X=12 occurred about 83% of the time. This would give (30-12) =18 days of unknown exposure.

However, not all of a MP's/MSSL's trade in that 18-day period will be subject to price volatility due to vesting contracts. With vesting contracts, a portion of a MP's/MSSL's trade is vested and effectively settled at a fixed hedge price. Thus, this portion of the trade is not subject to price volatility.

Price volatility affects only the non-vested portion of a MP's/MSSL's trade (we call this 'Non-vested Exposure' or 'NVE'). Hence, the Price Volatility Factor (PVF) applies only to the NVE of a MP/MSSL. This gives the exposure arising from price volatility as:

Component B = $\{(18)^{\xi} \times \psi \times (NVE)\}$ --- Equation (5)

$\underbrace{\qquad\qquad}$

PVF

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[7] The electricity price movements are not characterized by normal distribution. Unlike normal distribution, the distribution of the energy prices is fat-tailed and non-symmetrical. (See the Appendix of Annex 1 for details.)
[8] In this study, we set n = 18 days. This is because the GEV distribution is used to analyze price volatility in the 18-day period where a MP's/MSSL's exposure is unknown to EMC.
[9] Confidence level measures the probability where the collaterals (credit support) set using the GEV model will be sufficient to cover the 30-day credit risk exposure of a MP/MSSL.

3.1.1   Credit risk exposure of a MP/MSSL

Combining Components A and B gives us the 30-day credit risk exposure (CRE) of a MP/MSSL:

$$CRE = \underbrace{CE + (30 - X)(ADE) \text{ - } Prepayment}_{\text{Component A}} \underbrace{+ [(18)^{\xi} \times \psi \times (NVE)]}_{\text{Component B}} \quad \text{--- Equation (6)}$$

In the prudential trial, EMC set Component B based on a 99% confidence level, i.e. α=0.01.

To recap,

- Component A captures the 30-day trading exposure of a MP/MSSL assuming relatively stable prices; and

- Component B captures the additional exposure of a MP/MSSL arising from price volatility which impacts only on the non-vested portion of that MP's/MSSL's trade.

(See section 2.1 of Annex 1 for details on the computation of credit risk exposure.)

3.1.2   Credit support required from a MP/MSSL

Similar to the current methodology, the proposed methodology will require a MP/MSSL to provide the EMC with enough credit support to cover for at least 30 days of its credit risk exposure.

The EMC will determine the credit risk exposure of a MP/MSSL for each business day based on Equation (6).

The EMC will notify a MP/MSSL when its credit risk exposure reaches 90% of its credit support. This is to alert the MP/MSSL that it could be issued with a margin call soon. To avoid a margin call, a MP/MSSL can voluntarily top-up its credit support or pre-pay part of its debt currently owed to the EMC.

3.2   Margin call

Under the proposed methodology, the EMC shall issue a margin call to a MP/MSSL if that MP's/MSSL's credit risk exposure is equal to, or exceeds, its credit support.

A MP/MSSL who is issued a margin call must, within two business days following the date of the margin call,

(i) Reduce its credit risk exposure by prepaying part of its debt currently owed to the EMC; and/or
(ii) Increase its credit support[10];

to the extent that its credit risk exposure is less than or equal to 80% of its credit support.

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[10] Under Chapter 2, Section 7.6.2 of the Market Rules, an MP/MSSL can increase its credit support in the form of a guarantee or irrevocable commercial letter of credit from an acceptable financial institution, cash deposits or Singapore Government Treasury Bills.

3.2.1 Rationale for margin call requirement under the proposed methodology

The proposed methodology deviates from the current methodology in terms of the level and top-up requirements in the event of a margin call.

As discussed in Section 2.2 above, a margin call is issued if a MP's ENE reaches 70% or more than its credit support. The margin call requirement is such that the MP must reduce its ENE through prepayment, or increase its credit support, such that the ratio (ENE/credit support) is 50% or lower.

To maintain the same level of margin call requirement for the proposed methodology on a _proportionate_ basis:

70% $\rightarrow$ 50%   (Based on existing rules, a MP/MSSL is required to reduce its ENE /Credit support ratio from 70% to 50%),

100% $\rightarrow$ $\dfrac{100}{70} \times 50\%$

= <u>71.43%</u>   (Based on proposed methodology, a MP/MSSL is theoretically required to reduce its CRE/Credit Support ratio from 100% to 71.43% to maintain the same proportion)

Therefore, under the proposed methodology, a MP/MSSL is required to reduce its credit risk exposure or increase its credit support such that the ratio (CRE/Credit Support) decreases from 100% to 71.43% to maintain the same proportion of margin call requirement.

The proposed methodology for determining credit risk exposure already provides for a more accurate and robust safeguard of prudential required by accounting for extreme price volatility through PVF (while the current method of prudential requirement does not). Therefore, we do not require MP/MSSL to reduce its ratio (CRE/CS) to 71.43%. Instead, we recommend a ratio of <u>80%</u>, reducing the margin call requirement.

3.2.2 Comparison of the impact of the margin call requirement between current methodology and proposed methodology

Table 1 compares the margin call requirement between current methodology and proposed methodology.

Table 1

	Current Methodology	**Proposed Methodology**
Criterion for Margin Call	$\dfrac{ENE}{CS} \geq 70\%$	$\dfrac{CRE}{CS} \geq 100\%$
In event of margin call, MP/MSSL should prepay or increase its CS until:	$\dfrac{ENE}{CS} \leq 50\%$	$\dfrac{CRE}{CS} \leq 80\%$
Additional prepayment as a % of total credit support in the event of a margin call	20%	20%

	Current Methodology	Proposed Methodology
Additional credit support as a % of total credit support in the event of a margin call	40%	25%

The last two rows in Table 1 compares the differences between the two methods of meeting margin call requirements - prepayment or additional credit support.

The example below illustrates how the percentages in Table 1 for the two methods of meeting margin call requirements were obtained.

Example:

Suppose Retailer A has a credit support of $1,000,000.

Under the current methodology:

Suppose that Retailer A incurs an ENE of $700,000.

The retailer would hit a margin call since $\frac{ENE}{CS} = \frac{\$700,000}{\$1,000,000} \times 100\% = 70\%$, which is the criterion for a margin call under the current methodology.

Recall from equation (2) that:

ENE = Current Exposure + (20-X)*ADE – Prepayment

In the event of a margin call, the retailer can choose to either:

(1) Prepay $200,000, which would reduce ENE according to Equation (2).
Hence this would decrease the numerator in the margin call ratio, $\frac{ENE}{CS}$, such that this ratio reduces from:

$$\frac{ENE}{CS} = \frac{\$700,000}{\$1,000,000} \times 100\% = 70\% \qquad \text{to}$$

$$\frac{ENE}{CS} = \frac{(\$700,000 - \$200,000)}{\$1,000,000} \times 100\% = 50\%$$

to meet the margin call requirement. This amount of $200,000 is <u>20%</u> of the credit support of $1,000,000, or

(2) Increase its credit support by $400,000 from $1,000,000 to $1,400,000.
Hence, this would increase the denominator in the margin call ratio, $\frac{ENE}{CS}$, such that this ratio reduces from:

$$\frac{ENE}{CS} = \frac{\$700,000}{\$1,000,000} \times 100\% = 70\% \quad \text{to}$$

$$\frac{ENE}{CS} = \frac{\$700,000}{\$1,000,000 + \$400,000} \times 100\% = 50\%$$

to meet the margin call requirement. This amount of $400,000 is <u>40%</u> of the credit support of $1,000,000.

<u>Under the proposed methodology,</u>

Suppose that Retailer A incurs a CRE of $1,000,000

Recall from Equation (6) that:

$$CRE = CE + (30 - X)(ADE) \text{ - } \textit{Prepayment} \; + [(18)^{\xi} \times \psi \times (NVE)]$$

The retailer would hit a margin call since $\frac{CRE}{CS} = \frac{\$1,000,000}{\$1,000,000} \times 100\% = 100\%$, which is the criterion for a margin call under the proposed methodology.

In the event of a margin call, the retailer can choose to either:

(1) Prepay $200,000, which would reduce CRE according to Equation (6). Hence this would decrease the numerator in the margin call ratio, $\frac{CRE}{CS}$, such that this ratio reduces from:

$$\frac{CRE}{CS} = \frac{\$1,000,000}{\$1,000,000} \times 100\% = 100\% \qquad \text{to}$$

$$\frac{CRE}{CS} = \frac{(\$1,000,000 - \$200,000)}{\$1,000,000} \times 100\% = 80\%$$

to meet the margin call requirement. This amount of $200,000 is <u>20%</u> of the credit support of $1,000,000, or

(2) Increase its credit support by $250,000 from $1,000,000 to $1,250,000. Hence, this would increase the denominator in the margin call ratio, $\frac{CRE}{CS}$, such that this ratio reduces from:

$$\frac{CRE}{CS} = \frac{\$1,000,000}{\$1,000,000} \times 100\% = 100\% \quad \text{to}$$

$$\frac{CRE}{CS} = \frac{\$1,000,000}{\$1,000,000 + \$250,000} \times 100\% = 80\%$$

to meet the margin call requirement. This amount of $250,000 is <u>25%</u> of the credit support of $1,000,000.

The additional prepayment as a percentage of credit support to meet the margin call requirements remains the same between the proposed and the current methodology at 20%. The additional credit support as a percentage of total credit support, however, in the current methodology is higher than that of the proposed methodology by 15%.

3.3 Summary of similarities and differences between the current methodology and proposed methodology

Table 2 below compares the similarities and differences between the current and proposed methodology. The main differences arise from the methodology used to measure exposure, the margin call requirements and the relevant amount of credit support required following a margin call.

Table 2

	Current Methodology	Proposed Methodology
Minimum Credit Support Required	$CS = 30*(ADE)$	
ADE	-1 x simple average of net settlement amounts set out on the 90 most recently available preliminary settlement statements (PSS) or corresponding final settlement settlements (FSS) if available	
Methodology to Measure Exposure	$ENE = CE + (20-X)(ADE) -$ Prepayment	$CRE = CE + (30-X)(ADE) -$ Prepayment + $\{(18)^{\xi} \times \psi \times (NVE)\}$
Current Exposure (CE)	-1* aggregate net settlement amounts set on all MP's PSS or FSS if available that are not yet due for payment on a given day.	
Criteria for Margin Call	$\dfrac{ENE}{CS} \geq 70\%$	$\dfrac{CRE}{CS} \geq 100\%$
In event of margin call, MP/MSSL should prepay or increase its CS until:	$\dfrac{ENE}{CS} \leq 50\%$	$\dfrac{CRE}{CS} \leq 80\%$

3.4 Impact analysis of proposed methodology for prudential requirements

Compared to the current methodology, the proposed methodology is more robust since it accounts for extreme price movements. Table 3 below summarizes the strengths and weaknesses of both methodologies.

Table 3

	Current Methodology	**Proposed Methodology**
Strengths	- Does not use a statistical model, so it is simple to apply and which MPs can easily calculate at their end.	- Models tail-end losses so that in the event of default under extreme upward price movements, the collateral set will be sufficient to cover for potential credit losses. - The collateral set is linked to market price movements and is therefore responsive to market price volatility.
	Current Methodology	**Proposed Methodology**
Weaknesses	- Does not account for potential large fluctuations in electricity prices. In respect of the (30-X) days of unknown exposure, the collateral set may be insufficient to cover potential credit loss when there are extreme upward price movements.	- On average, credit risk exposure is higher; thus collaterals required from MP/MSSL under the proposed methodology are higher.

3.5   Results of the trial of the proposed methodology

EMC conducted a trial of the proposed methodology from 10 September 2007 to 6 March 2008, which ran parallel to the current methodology. Market participants were issued a daily report of their prudential requirements based on the proposed methodology during this period.

The report of the trial below entails 3 sections. Section 4.1 compares the current and proposed methodology in terms of credit risk exposure (CRE) and the number of margin calls for the MP/MSSL, based on different confidence levels of 99% (i.e. $\alpha=0.01$) and 99.5% (i.e. $\alpha=0.005$). Section 4.2 compares the difference in PVFs between the two confidence levels, where $\alpha=0.01$ and $\alpha=0.005$. Section 4.3 reports CRE by replacing the WEP on 6 Mar with high simulated values for sensitivity analysis.

These results will facilitate the analysis of the impact of the proposed methodology.

3.5.1   Comparison of CRE, Margin Calls for $\alpha = 0.01$ and $\alpha = 0.005$

Table 4 shows the minimum, maximum and average CRE for a MP/MSSL under the current and proposed methodology using confidence level of 99% i.e. $\alpha=0.01$. Table 5 shows the same set of data with an increased confidence level of 99.5% i.e. $\alpha=0.005$.

The last column in both tables shows the number of times that the MP/MSSL has been issued a margin call. However, these figures should only be used for general reference rather than a true reflection of the number of margin calls that will likely be invoked due to two reasons:

a) MPs provided credit support based on the current credit support requirements (Eq. 2), rather than the proposed requirements (Eq. 6)These margin call figures were based on the credit support provided under the current methodology (i.e. actual credit support).

b) In the event of a margin call under the proposed methodology during the trial, the retailer was not required to provide EMC with credit support or prepay its settlement amounts to reduce its exposure.

For example, Retailer A may be hit with a margin call on settlement date, T.
In this instance, the retailer was required under the proposed methodology to put up more credit support or increase its prepayment such that its $\frac{CRE}{CS} \leq 80\%$.

However, under the trial, the actual prepayment or increase in credit support was not required. Therefore, the margin call may persist for a few settlement dates. Essentially, these consecutive margin calls point to the same episode of a shortfall in exposure against credit support.

Hence, these figures should only be used as a general reference.

Table 4: $\alpha = 0.01$

Retailer	Methodology	Credit risk exposure (CRE)[11]			No of Margin Calls
		Minimum	**Maximum**	**Average**	
Retailer 1	Proposed	-4,950,015.96	-19,937,922.87	-11,395,667.50	0
	Current	-4,735,949.03	-19,159,544.07	-10,907,684.03	0
	% Change	4.52%	4.06%	4.47%	-
Retailer 2	Proposed	-40,141,709.86	-54,722,755.09	-46,068,207.95	1
	Current	-38,460,326.4	-52,718,718.66	-44,274,944.75	0
	% Change	4.37%	3.80%	4.05%	-
Retailer 3	Proposed	-3,757,248.97	-5,438,154.90	-5,055,838.65	0
	Current	-3,582,049.96	-5,241,022.37	-4,853,876.74	0
	% Change	4.89%	3.76%	4.16%	-
Retailer	Proposed	-4,243,020.78	-5,952,821.04	-5,523,420.39	0

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[11] CRE under the proposed methodology = $CE + (30 - X)(ADE) \textit{- Prepayment} + [(18)^{\xi} \times \psi \times (NVE)]$

CRE under the current methodology = CE + (20-X)*ADE – Prepayment + 10*ADE = ENE + 10*ADE. 10*ADE was added to ensure that the 20-day period used to determine ENE (current methodology) is comparable to the 30-day period used to determine CRE (proposed methodology). Therefore, the main difference between CRE and (ENE +10*ADE) would be the PVF.
(-) sign for CRE indicates that a MP/MSSL has the liability to pay
"Minimum" refers to the minimum amount of exposure for a MP/MSSL over the 6-month trial period.
"Maximum" refers to the maximum amount of exposure for a MP/MSSL over the 6-month trial period.
"% Change" refers the change in percentage between the CRE for the respective "Minimum", "Maximum" and "Average" amount of risk exposure from the current methodology to the proposed methodology.

4	Current	-4,031,949.93	-5,727,325.67	-5,305,512.54	0
	% Change	5.23%	3.94%	4.11%	-
Retailer 5	Proposed	-3,369,550.01	-71,406,100.21	-25,941,159.90	4
	Current	-3,201,648.04	-68,860,679.48	-24,682,658.78	0
	% Change	5.24%	3.70%	5.10%	-
Retailer 6	Proposed	-183,323,725.38	-203,458,853.74	-195,545,965.22	0
	Current	-183,323,725.38	-203,458,853.74	-195,545,965.22	0
	% Change	-	-	-	-

Table 5: α **= 0.005**

| Retailer | Methodology | Credit risk exposure (CRE) | | | No of Margin Calls |
		Minimum	Maximum	Average	
Retailer 1	Proposed	-5,032,133.07	-20,246,859.71	-11,580,609.10	0
	Current	-4,735,949.03	-19,159,544.07	-10,907,684.03	0
	% Change	6.25%	5.68%	6.17%	-
Retailer 2	Proposed	-40,785,530.56	-55,509,664.52	-46,750,040.19	6
	Current	-38,460,326.4	-52,718,718.66	-44,274,944.75	0
	% Change	6.05%	5.29%	5.59%	-
Retailer 3	Proposed	-3,820,394.12	-5,507,313.90	-5,132,609.91	0
	Current	-3,582,049.96	-5,241,022.37	-4,853,876.74	0
	% Change	6.65%	5.08%	5.74%	-
Retailer 4	Proposed	-4,323,381.36	-6,038,862.03	-5,606,260.90	0
	Current	-4,031,949.93	-5,727,325.67	-5,305,512.54	0
	% Change	7.23%	5.44%	5.67%	-
Retailer 5	Proposed	-3,425,017.22	-72,299,097.17	-26,416,127.87	5
	Current	-3,201,648.04	-68,860,679.48	-24,682,658.78	0
	% Change	6.98%	4.99%	7.02%	-
Retailer 6	Proposed	-183,323,725.38	-203,458,853.74	-195,545,965.20	0

	Current	-183,323,725.38	-203,458,853.74	-195,545,965.22	0
	% Change	-	-	-	-

3.5.2 Observations from Tables 4 and 5

Given that a MP/MSSL is required to provide EMC with at least enough credit support to cover its credit risk exposure (CRE), we can approximate the minimum CRE, maximum CRE and average CRE in the tables above as the amount of credit support or collaterals required.

Table 6 summarises Tables 4 and 5 by displaying the range of percentage change between the current methodology and the proposed methodology for all the retailers. For example, the smallest percentage change between the current methodology and proposed methodology under "Minimum CRE" for α = 0.01 is 4.37% (Retailer 2) and the highest percentage change is 5.24% (Retailer 5).

Table 6: Range of % for α = 0.01 and α = 0.005

For Retailers 1-5[12]	α=0.01	α=0.005
Range of % for all retailers under "Minimum CRE"	4.37% - 5.24%	6.05% - 7.23%
Range of % for all retailers under "Maximum CRE"	3.70% - 4.06%	4.99% - 5.68%
Range of % for all retailers under "Average CRE"	4.05% - 5.10%	5.59% - 7.02%

Table 6 reveals 3 general observations:

(a) CRE, and hence collaterals required, in both scenarios (i.e. α = 0.01 and α = 0.005) are generally higher in the proposed methodology as compared to the current methodology. This is shown by positive percentage range from the current methodology to the proposed methodology for all three categories of "Minimum CRE", "Maximum CRE" and "Average CRE".

This increase is due to the addition of PVF to the current prudential methodology, which will increase the collaterals required to safeguard against potential extreme price volatility.

(b) The average percentage change for the "Average CRE' across the retailers is close to that of PVF.
Table 6 shows that the "Average CRE" for α = 0.01 for all the retailers ranges from 4.05% - 5.10% and averages about 4.38%[13] per retailer.

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[12] Retailer 6 was not included because it currently does not have a non-vested exposure (NVE), the only component affected by PVF. Therefore, it is currently not impacted by the change from the current methodology to proposed methodology.

This percentage, if examined with that of PVF, further proves the above observation that the increase in collaterals is due to PVF. PVF averages about 1.23 for α = 0.01 (see Figure 1 below), which implies collateral covering an additional 1.2 days of trade required due to price volatility. This is about 4.1% of the 30 days of trading exposure, which is close to 4.38%.

(c) The range of percentage change for α = 0.005 is generally higher than that of α = 0.01 across all three categories.

This difference is attributed to tests of significance. A confidence level of 99% implies that there is a 1% chance that the CS under the proposed methodology is insufficient in covering the CRE, as explained in Section 3.1 of Annex 1. Similarly, a confidence level of 99.5% implies that there is 0.5% that the CS under the proposed methodology is insufficient in covering the CRE. Therefore, a smaller probability of 0.5% over 1% imposed on tests of significance implies a stricter criteria set, which accounts for the higher range of percentage change under α = 0.005.

As a retailer would usually put up credit support enough to cover its maximum credit risk exposure, its main concern would then be how this proposal affects the maximum CRE. The percentage change for "Maximum CRE" across retailers in Table 6 can provide an insight on the impact of the proposed methodology on the additional collaterals required. This percentage ranges from 3.70 to 4.06% for α = 0.01, depending on the retailer in question.

3.5.3 Comparison of Price Volatility Factors between α = 0.01 and α = 0.005

Figure 2 below shows the difference in PVFs between the two confidence levels of 99% (α=0.01) and 99.5% (α=0.005) from 10 September 2007 to 6 March 2008.

Figure 2: Difference in PVFs between α = 0.01 and α = 0.005
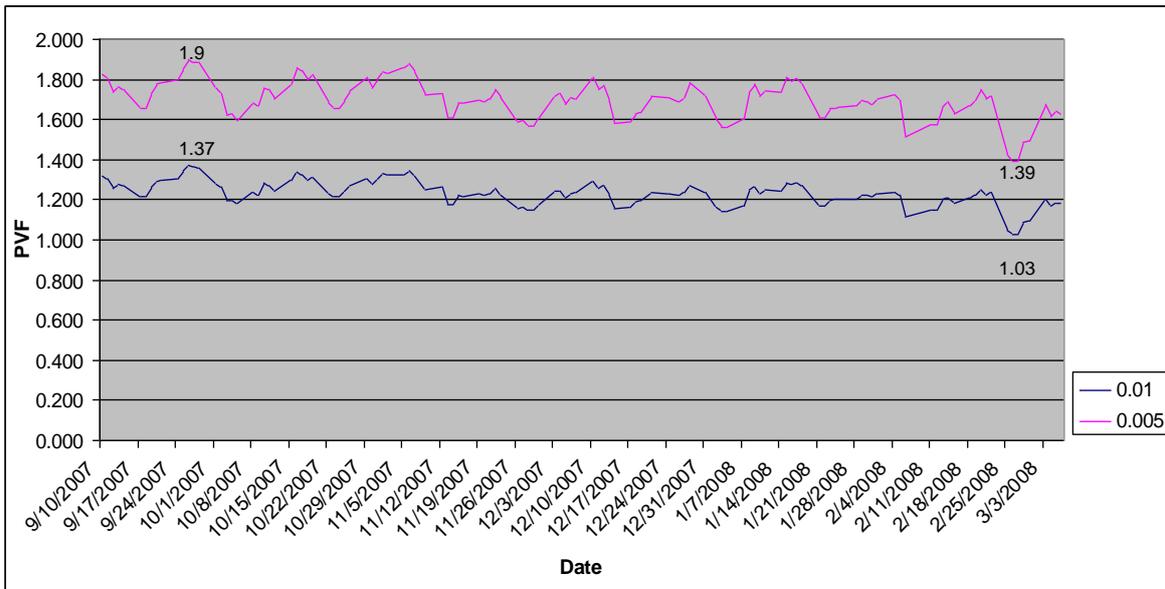
3.5.4 Observations on PVFs

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[13] Average % change of "Average CRE" per retailer:

$$\frac{Sum\ of\ Percentage\ change\ of\ "Avg\ CRE"\ of\ all\ retailers}{5} = \frac{4.47\% + 4.05\% + 4.16\% + 4.11\% + 5.10\%}{5} = 4.378\%$$

As discussed in Section 3.1, the PVF is represented by the $(18)^{\xi}$ X ψ. This factor does not vary with individual MP/MSSL and applies equally to their non-vested portions. The factor changes daily when the historical prices used to model the PVF are updated with the latest average daily WEP available to track the varying daily WEP.

Figure 1 show that PVF using a confidence level of 99% averaged at about 1.23. This would mean an additional 1.23 days of trade worth of collaterals. It ranged from 1.03 to 1.37 over the 6-month trial period. Conversely, PVF using a confidence level of 99.5% averaged at about 1.7 and ranged from 1.39 to 1.90 over the 6-month trial period.

The difference in PVFs can also be attributed to the tests of statistical significance discussed in Section 4.1.1. Essentially, α = 0.005 imposes a stricter criteria on the proposed methodology.

EMC recommends using a 99% confidence level, i.e. α = 0.01, in line with Dr Ng's proposal.

3.5.5 Simulation Tests on CRE

Simulation tests were conducted to examine the impact of electricity price spikes on the PVF and hence the CRE. These results are obtained through the replacement of the latest average daily WEP available ($155.01) on 6 March 2008 with wholesale electricity prices (WEP) ranging from $600 to $2400 to the relevant 18-day block.

The values $600, $1200, $1800 and $2400 were chosen because the highest daily WEP that has occurred since the market started was on 29th June 2004 at $366. This was about 4.5 times the typical average daily WEP of $85 then. Based on this observation, we have assumed this "worst case scenario" for the first simulation test, which is $130*4.5 $\approx$ $600 for a typical daily WEP of about $130 in the 6-month trial period. The remaining 3 simulation tests are based on a situation which is two, three and four times that of the "worst case scenario".

A high WEP would also affect CE and ADE of the CRE because a spike in WEP can be attributed to the various components that affect it, such as the USEP, AFP, HEUC, MEUC, etc. A spike in any of these components would cause a spike in both the WEP and the net settlement amounts of a MP/MSSL. We recognize that the latter is reflected in a MP/MSSL's CE and ADE. However, this effect of a high WEP on CE and ADE was not modeled into our simulation tests due to two reasons:

  a) Although all MP/MSSL pay the same charges for the components that make up the MEP, the quantity used by each of these retailers will be different. Therefore, it would be difficult to allocate a change in WEP to the CE and ADE accurately.

  c) Even if it were possible to model the simulations into the CE and ADE accurately, it does not contribute significantly to the aim of these simulations because the main aim of these simulations is to examine the impact on PVF, which is the key difference between the current methodology and the proposed methodology in the event of determining a margin call.

Table 7 shows the simulation tests on CRE on the proposed methodology for α =0.01.

Table 7: Effect of high WEP on PVF and CRE for a given level of CE and ADE

Retailer	Credit Risk Exposure (CRE)				
	WEP=$155.01 (WEP on 6 March 2008)	WEP = $600	WEP=$1200	WEP= $1800	WEP=$2400
Retailer 1	-6,087,459.23	-6,102,287.44	-6,139,740.32	-6,162,179.93	-6,178,112.37
Retailer 2	-52,450,616.68	-52,595,023.97	-52,959,765.78	-53,178,298.05	-53,333,459.03
Retailer 3	-4,701,022.49	-4,714,042.15	-4,746,927.20	-4,766,629.74	-4,780,618.95
Retailer 4	-5,911,661.81	-5,927,186.20	-5,966,397.49	-5.989.890.64	-6.006.571.10
Retailer 5	-4,370,197.39	-4,381,860.75	-4,411,319.91	-4,428,970.14	-4,441,502.06
Retailer 6	-203,458,853.74	-203,458,853.74	-203,458,853.74	-203,458,853.74	-203,458,853.74
PVF	**1.18**	**1.27**	**1.49**	**1.62**	**1.72**

3.5.6 Observation of the Effect of WEP on CRE and PVF

Table 7 shows an increasing CRE, and hence collaterals required, with increases in average daily WEP from $600 to $2400.

The PVF increased from 1.18 to 1.72 when WEP increased from $155.01 to the highest WEP spike of $2400, which implies an additional 0.54 days of collaterals arising from extreme price movements.

3.5.7 Other concerns arising from the trial

Over the 6-month prudential trial period, retailers have voiced their concerns over the complex methodology in calculating the variables such as ξ, ψ, σ and μ, which are essential in determining the PVF. The current methodology enables MPs to do an independent and simple estimation of the collaterals required prior to the actual receipt of EMC's preliminary settlement statements. This gives the MP/MSSL more time to prepare enough collateral or undertake prepayment such that they do not hit a margin call.

We understand these difficulties and propose that MP/MSSL have the option of building a prudential calculator. However, the MP/MSSL would have to bear the cost of the building and maintenance of this calculator. MPs can use their own vendors or choose from a list of vendors that EMC will provide. EMC will provide the MPs/MSSL's appointed vendors with the necessary specifications and historical data.

3.5.8 Decision of the RCP at the 37th RCP meeting on 13 May 2008

The RCP, having considered the results of the trial and the implementation cost and timeframe by majority supported that the proposed methodology be implemented.

The following Panel members VOTED to support the implementation:

Mr. Robin Langdale
Mr. Ng Meng Poh
Mr. Michael Lim
Mr. Henry Gan
Dr. Goh Bee Hua

The following Panel members voted not to support the implementation:

Mr. Philip Tan
Mr. Tay Swee Lee
Ms. Annie Tan

The following Panel members ABSTAINED:

Dr. Daniel Cheng
Dr. Kang Cheng Guan
Mr. Low Boon Tong

3.6   Proposed Rule Changes

Table 8 shows a list of proposed changes required to the Market Rules and Market Manual to implement the proposed methodology.

Sections of the Market Rules	Purpose of Rule	Proposed Changes and Reasons
Chapter 2, Section 7.2.2	- States that EMC shall determine ENE every business day - Directs the equation for determining the ENE in dollar amount to the market manual	Proposed Change: - Replace the term "Estimated Net Exposure" with "Credit Risk Exposure" Reason: -The proposed methodology uses CRE to determine exposure instead of ENE
Chapter 2, Section 7.4.1, 7.4.2, 7.5.1	- States that EMC will notify a MP/MSSL when its ENE/CS = 60% and will issue a margin call when ENE/CS ≥ 70% In this event of a margin call, the MP/MSSL has to increase its credit support or make prepayments such that ENE/CS ≤ 50%.	Proposed Change: - Replace the term "Estimated Net Exposure" with "Credit Risk Exposure"- Replace "60%" with "90%" - Delete "70%" - Replace "50%" with "80%" Reasons: - The proposed methodology uses CRE to determine exposure instead of ENE - The proposed methodology notifies a MP/MSSL when its CRE/CS reaches 90%, instead of 60% under current methodology of using ENE/CS. A margin call is issued when CRE=CS and an MP/MSSL has to reduce

<table>
<tr>
<td></td>
<td></td>
<td>CRE/CS ≤ 80%

The difference arises because the proposed methodology uses a 30-day period when determining CRE, while the current methodology uses a 20-day period when determining ENE.</td>
</tr>
<tr>
<td>Chapter 2, Section 7.4.3, 7.4.4, 7.4.5</td>
<td>- Sets out the various criteria and procedures for
a) a market participant to request a reassessment of its ENE if there are manifest errors,
b) EMC to revise or revoke a market participant's margin calls</td>
<td>Proposed Change:
- Replace the term "Estimated Net Exposure" with "Credit Risk Exposure"
Reason:
- The proposed methodology uses CRE to determine exposure instead of ENE</td>
</tr>
<tr>
<td>Chapter 2, Section 7.7.5</td>
<td>Allows EMC to use the MP's credit support for the settlement of
(i) the component parts of the MP's ENE;
(ii) interest on those component parts; and
(iii) any costs, charges etc,
regardless of any specific directions from the MP as to how the credit support should be used.</td>
<td>Same as above</td>
</tr>
<tr>
<td>Chapter 3, Section 7.3.15.1</td>
<td>- States that as a condition for lifting a suspension order on an MP/MSSL, this MP/MSSL may have to establish a lower ENE/CS percentages than that stated in Chapter 2, Section 7.4.</td>
<td>Same as above</td>
</tr>
<tr>
<td>**Sections of the Market Manual "Prudential Requirements"**</td>
<td>**Purpose of Section**</td>
<td>**Proposed Changes and Reasons**</td>
</tr>
<tr>
<td>Section 1.2</td>
<td>To make clear and be consistent with section 7.1.4 of Chapter 2 of the market rules, that the references to the 'MP' in this market manual will include references to the MSSL</td>
<td>New Section</td>
</tr>
<tr>
<td>Section 1.3</td>
<td>To reflect that the term 'MP' in this market manual does not refer to the transmission licensee.</td>
<td>New Section</td>
</tr>
</table>

Section 2.2	- Defines the ENE as an estimate of an MP/MSSL's 20-day exposure - States the equation used to determine the ENE in dollar amount	Proposed Change: - Replace the term "Estimated Net Exposure" with "Credit Risk Exposure" - Replace the equation used to determine ENE with that of CRE - Amend "20-day" exposure to "30-day" exposure Reason for Change: - The proposed methodology uses CRE to determine exposure instead of ENE - CRE is calculated using a 30-day period instead of a 20-day period.
Sections 2.3, 2.4 and 2.5	- Introduces the price volatility component for both the MPs and MSSL and the GEV Distribution	Proposed Change: - New sections Reason for Change: - To explain how the price volatility component and GEV distribution is used in the determination of CRE
Section 4.4	- States the procedures for submitting a request for the reassessment of ENE	Proposed Change: - Replace the term "Estimated Net Exposure" with "Credit Risk Exposure" Reason for Change: - The proposed methodology uses CRE to determine exposure instead of ENE

4.   Conclusion

The proposed prudential methodology is able to track the credit risk exposure more accurately as compared to the current methodology because it is tied to electricity price volatility.

The trial shows that higher collaterals are required under this proposed methodology. This is owed to the added element of accounting for price volatility, providing a greater safety net in the event of a default risk.

EMC recommends that the proposed prudential methodology be implemented.

5.   Impact on market systems

There are three aspects to the impact of the above prudential requirements on market systems.

1. EMC's Systems

    The actual production implementation of this proposed prudential methodology will impact EMC's systems. This entails complex system changes. However, given that some parts of the current prudential prototype used in the trial will be mapped over to the production system, EMC's focus would be towards robustness and compliance with the current NEMs architecture and security requirements.

The scope of work to be done on EMC's systems includes:

a) Rolling out the current Prudential Engine, which was built as part of the prototype, to production with performance tuning and any minor bug fixes
b) Migrating the Front-end screens to NEM application
c) Sending the prudential report to MPs/MSSL via secure email
d) Providing the necessary historical data to the MPs/MSSL who which to have their own prudential calculator
e) Capability of "What-If" analysis for the EMC Settlements team
f) External Audit of the System

2. Prudential Calculator for MPs (optional)

MPs have the option of building a prudential calculator to address the concerns discussed in Section 4.4.

The basic functions of this calculator include:

a) Validating EMC's margin calls
b) Simulating the impact of increasing WEPs on the prudential required.

This would enable them to estimate the impact of a high WEP on the prudential required, and consequently the credit support required.

Although EMC will be able to recommend MPs a list of suitable vendors, MPs are required to decide on a vendor which can build and maintain this calculator for them at their own cost. This is to ensure that the prudential calculator is tailored to suit each MP's needs, especially if the MP requires additional functions other than the 2 basic functions listed above. Also, not all the MPs may want the calculator. Thus, each MP should pay if they want the system.

3. Provision of an Application Program Interface (API) for MPs to download necessary data (optional)

The prudential calculator built by MPs would need to be updated daily with data necessary to calculate the CRE under the proposed methodology. EMC would be able to provide an API for MPs, such that they would be able to download the necessary data such as WEP, X, etc, daily.

6. Implementation process

The time and cost estimates for the 3 aspects are as follows:

1. EMC's Systems

The time taken to implement the proposed prudential system is 7 months. The resource required is about 15 man-months at an estimated cost of $165,000.

The effort (in man-months) and cost breakdown for EMC System changes are:

Effort Required	
Analysis, Design & Development	9 man-months
Code Review	1 man-month
System Integration Testing	1.5 man-month
UAT	1.5 man-month
Documentation	1 man-month
Contingency	1 man-month
Total Effort	15 man-months
Cost	
15 man-months of effort at $8000 a month	15 x $8000
Audit	$45,000
Total Cost	$165,000

2. Prudential Calculator for MPs (optional)

The time taken to implement the prudential calculator will be 3 months at an estimated cost of $48,000 (6 man-months of effort x $8000).The actual cost is to be agreed upon between each MP/MSSL and their vendor.

3. Provision of an Application Program Interface (API) for MPs to download necessary data (optional)

The implementation of this API will be incorporated into that of EMC systems. The estimated cost of this API is $16,000 (2 man-months x $8000).

7.   Consultation

The proposed prudential methodology was first published for comments on 1 August 2006. Comments were received from Senoko Power and PowerSeraya. These comments and the responses to them were considered by the RCP at its 28th meeting on 5 September 2006 date. The comments and EMC's response are provided in Annex 2.

Following the decision of the RCP on 13 May 2008, the rule modification proposal was published for comments. The following comments were received from Seraya Energy.

Seraya Energy

1) We feel that the paper does not appear (to) ascertain whether the concerns of the MP and EMC Board are genuine or not.

Seraya requests that EMC:

a) Ascertain whether the current prudential methodology has failed to safeguard against default payment since market opening;

b) Ascertain under what circumstance will the current prudential methodology failed to safeguard against default payment (if any);Note: The examples in the paper merely simulate extreme scenarios and does not use the actual wholesale prices of the preceding year in 2007-2008)

EMC's response

This comment is similar to that submitted in August 2006 (see Annex 2) which the RCP has already taken into account in its decision to trial the proposed prudential methodology. In essence, it is not possible to predetermine the circumstances that will lead to a default payment. This is because a default will depend on the electricity price volatility in the market then and the credit worthiness of the MPs.

Although there have been no defaults since market opening, it would be too hasty to equate this observation to the adequacy of the current methodology. This is because the current methodology does not take into account future volatility of the electricity market prices, while the proposed methodology addresses this.

Seraya Energy

2) EMC accepted that the new methodology is overtly complex. This makes it difficult for MPs to calculate variable such as ξ and Ψ as opposed to the current methodology. In the current climate whereby all the major gencos and MPs are in the midst of divestment, it is not reasonable to have an overly 'flexible credit support' mechanism which demands a credit top up at short notice as cashflow becomes more of an issue with new shareholders. Additionally, in a market where there is a very low risk of default, it is not practical for MPs to regularly top-up/update their credit support in the event where there is a prolonged period of price volatility. There is no criteria as to what is deemed 'acceptable' and at this stage, MPs like ourselves are not clear as to how to ascertain the credit support level based on the new formula whereas under the current methodology, MPs can make an independent and simple estimation of credit support a and when required.

EMC's Response

The proposed methodology simply extends the current methodology to include the price volatility component and hence, would not be considered as an "overly flexible credit support' There are no changes to the timeframe for top-ups.

Although the current market has a very low risk of default, it would be hard to predict future market conditions.

We note Seraya Energy's concern on the inability to independently estimate the credit support due to the complex nature of the methodology. It is for this very reason that we gave market participants the option to build their own prudential calculator.

Seraya Energy

3) MPs would have to bear the cost for building & maintenance of this calculator. While optional, it does not make economic sense for us to build their own calculator as eventually, the credit support that MPs will issue would be based on EMC's calculation (which again, the MPs are unable to verify or ascertain). Since EMC mentioned that it will provide MPs an API to allow MPs to download daily the necessary data to calculate the CRE such as WEP, X, etc, it is suggested that EMC likewise provide MPs the software for the prudential calculator. It would make common sense for all MPs to operate through EMC's prudential calculator through a common interface as opposed to having our own calculator.

EMC's Response

MPs are required to build and maintain the calculator at their own cost as they might want to tailor the calculator to suit their own needs, as reflected in the paper. Also, it would seem more logical if MPs use their own calculator to verify EMC's calculation, instead of using EMC's prudential calculator to verify EMC's calculation.

<u>Seraya Energy</u>

4) Seraya requests for EMC to continue to fine tune and conduct training for the relevant MPs if indeed, the rule has come to pass following RCP's final deliberation. Otherwise, we suggest for EMC to trial the proposed methodology and monitor its performance before casting the policy in stone.

EMC's Response

EMC would address queries, and provide training on this proposed methodology if it is passed. However, there is no need to put this proposed methodology for trial again as this has already been done from 10 September 2007 to 6 March 2008.

<u>Tuas Power</u>

We refer to the proposed rule change on Proposed Prudential Methodology using the Generalised Extreme Value (GEV) Model.

In order to facilitate the MPs in their daily routine task of verifying the prudential methodology, we would like to suggest to you that the price volatility factor (PVF) be computed and fixed as a constant, published prior to the start of the quarter, to be applicable for the whole of the next quarter.

The suggested principle of fixing the PVF is very much similar to that of the vesting price determination by EMA for every quarter.

In line with this suggestion, the MPs could perform the daily tasks of prudential verification with ease, even without having to build the prudential calculator/API. Thus EMC would be able to achieve cost saving in its implementation ie. less the cost of building the prudential calculator for MPs and the API.

In view of the above, we request EMC to consider the suggested enhancement to your proposed prudential methodology rule change proposal.

EMC's Response

Fixing the PVF for each quarter or any other length of time is analogous to presuming that electricity price volatility will remain constant for that length of time. That defeats the essence of the proposed prudential methodology which is to take into account the changing volatility of prices.

8. Legal Sign-off

Text of the rule modification has been vetted by EMC's external legal counsel whose opinion is that the modification reflects the intent of the rule modification proposal as expressed in Annex 3 of this paper.

9.   Deliberation by the RCP

At its 38th meeting the RCP considered the proposed rule modifications arising from the implementation of the proposed prudential methodology. By majority vote, the RCP supported the proposed rule modifications.

The following Panel members VOTED to support the implementation:

Mr. Robin Langdale
Mr. Dallon Kay
Mr. Michael Lim
Mr. Henry Gan
Dr. Goh Bee Hua

The following Panel members voted not to support the implementation:

Mr. Low Boon Tong
Mr. Tay Swee Lee

The following Panel members ABSTAINED:

Dr. Daniel Cheng
Dr. Kang Cheng Guan
Mr. Lawrence Lee
Ms. Annie Tan

10.   Recommendations

With a vote of 5 for and 2 against, the RCP, recommends by majority that the EMC Board:

   a.   **adopt** the rule modification proposal as set out in Annex 3;

   b.   **seek** EMA's approval of the rule modification proposal; and

   c.   **recommend** that the rule modification proposal come into force **7 months** after the date on which the approval of the Authority is published by the EMC

Annex 1

The following report by Dr Ng Kah Hwa was submitted to EMC in 2006. In September 2007, changes[14] to some aspects of the prudential methodology were implemented and these changes are reflected in the main paper above. Therefore, there will be slight differences between Dr Ng's paper below and the main paper above in the definitions of CRE and CE.

Report on New Collateral System for EMC

By: Dr Ng Kah Hwa

This report contains 4 sections and an Appendix.

1. GENERALIZED EXTREME VALUE (GEV) DISTRIBUTION

An analysis of historical wholesale electricity prices (WEP) showed that the prices exhibit the following characteristics:

- The energy prices be extremely volatile, with instances of sudden spikes in prices sometimes reaching USEP price cap of $4500; and

- These price spikes are of short duration and they revert to normal levels rapidly.

Figure 1 and Table 1 in the Appendix show that the wholesale electricity price movements are not characterized by normal distribution. Both the skewness and the excess kurtosis indicators confirm that the distribution of electricity prices is non-normal. Large electricity price movements can occur more frequently than predicted by the normal distribution. The tail-end of the empirical distribution is thicker than the tail-end of the normal distribution.

The Generalized Extreme Value (GEV) distribution provides a better characterization of the electricity price movements than the normal distribution and puts more emphasis on the tail areas of the observed frequency distribution.

Tail events are extreme price movements that occur rarely but will result in large credit losses in the event of a default in payments. The GEV method enables us to capture such events and set the required collateral sufficient to cover such tail losses.

We suggest using the Generalised Extreme Value (GEV) model to model price volatility for electricity. The GEV model is able to capture the characteristics of the electricity price movements more accurately. It also produces a better fit than normal distribution when we compare the normal distribution and the GEV distribution against the empirical distribution of WEP.

Recent financial studies have applied the GEV method to determine the margin requirements for futures contracts traded on Futures Exchanges. These studies have shown that margin requirements that are set based on GEV method are sufficient to cover the losses on the futures contracts. However, if margin levels are set based on normal distribution, there tend to be underestimation of required margins.

The statistical theory of extremes based on GEV has also been used by financial institutions to estimate the unexpected losses in a credit portfolio where the loss distribution is typically negatively skewed and hence the use of normal distribution is not appropriate.

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[14] See paper 267 "Discretion to Revise / Revoke Margin Call Requirements in the Presence of Manifest Error(s)".

The use of theory of extremes assumes that the tail behaviour of the distribution of price changes during periods of extreme market volatility can be better approximated by the asymptotic distribution of the maximum of the price series.

1.1 Estimation of Parameters of GEV

Let $X_1, X_2, \ldots\ldots X_n$ be a sequence of electricity price changes on days 1,2,…,n. Extremes are defined as the maxima of the n random variable $X_1, X_2, \ldots\ldots X_n$. Let X represents the highest daily price changes over the n trading days. (In the study n = 18 days, i.e. it relates to the 18-day period where a MP's/MSSL's exposure is unknown.)

$$X = \max(X_1, X_2, \ldots. X_n)$$

The GEV distribution function of X is given by:

$$H(X; \mu, \sigma, \xi) = \exp\{-[1 + \xi(\frac{X - \mu}{\sigma})]^{-1/\xi}\}$$

ξ is the shape parameter which reflects the weight of the tail of the distribution of X,
σ is the scale parameter represents the volatility of the extremes and
μ is the location parameter represents the average of the extremes.

Modelling electricity prices using GEV involves estimating the above 3 parameters ,and the threshold parameter, ψ ,which will depend on the estimated values of 3 parameters and a given confidence level.

From the density function, we can derive the log-likelihood function and hence estimate the above 3 parameters using the maximum likelihood method.

Our risk model based on GEV, determines a threshold parameter, ψ (which is used to set the collateral), with a confidence level of 99%. This means with a given time period of 1 day and a given probability of 1 %, the occurrence of margin violation due to extreme price movements over 1 day is less than 1 % of the time.

We report the results of the estimated parameters below.

GEV Estimated Parameters

	Sample Period	Block Length	ξ	σ	μ
Current Estimated Value	01/01/2003-30/06/2005	18 days	0.393811	0.169566	0.174479

From the 3 GEV parameters estimated, we can calculate the threshold parameter, based on 99 % confidence level (α = 1 %), from the following formula:

Estimation of Threshold: $(\psi \quad \alpha_N = 0.01)$

$$\psi = \mu + (\sigma/\xi) * \{[-\ln(1 - \frac{\alpha N}{n})]^{-\xi} - 1\}$$

$$\psi(Current) = 0.5532$$

2.   PROPOSED PRUDENTIAL METHODOLOGY

2.1   Credit Risk Exposure of MP/MSSL

To determine the amount of credit support required, we need to first estimate the credit risk exposure of a MP/MSSL. One way to improve the current prudential requirements is to ensure we capture the credit risk exposure of MP/MSSL more accurately.

Under the proposed methodology, the credit risk exposure of a MP/MSSL will still be based on 30 days of trading exposure a MP/MSSL. It will comprise:

(1)   the 12-day of actual exposure ('CE'), since this represents the actual trade amount a MP/MSSL currently owed to the EMC; and

(2)   the 18-day of unknown exposure, which has to be estimated. We propose to estimate it as follows:

(a) First, we estimate the 18-day trading exposure of a MP/MSSL, assuming relatively stable prices.

Since this is an expectation, the best estimate is to simply take the average past daily trading amounts incurred by a MP/MSSL (call this the 'Average Daily Exposure' or 'ADE').

A 90-day simple average is chosen for the ADE. This is to mitigate the effect of any 'outlier' trade amount (i.e. an unusually high or low amount incurred which is only transitory in nature).

Thus, the total trade amount which we expect a MP/MSSL to incur in the 18-day period is given as 18*ADE.

(b) Next, another component is included to capture price volatility in that 18-day period.

Since (18*ADE) does not account for any potential price volatility (as it assumes relatively stable prices), we need an additional component to account for price volatility. To do this, we will have to model electricity prices using the GEV model.

The model based on the GEV distribution has a price volatility factor which captures the impact of price volatility on a MP's/MSSL's 18-day unknown exposure. This is given as: $[(18)^{\xi} \times \psi]$.

However, not all of a MP's/MSSL's trade in that 18-day period will be subject to price volatility due to vesting contracts. The vested portion of a MP's/MSSL's trade will effectively settle at the hedge price (and hence, would not be affected by extreme price volatility). This means only the non-vested portion of a MP's/MSSL's trade will be subject to extreme price volatility (call this 'Non-Vested Exposure' or 'NVE').

Thus, the GEV applies only to the NVE. This gives the exposure arising from price volatility as $\{(18)^{\xi} \times \psi \times (NVE)\}$.

Put together, the 30-day credit risk exposure (C) of <u>a MP (or MSSL)</u> on any given day is determined as follows:

$$C = CE + 18(ADE) + [(18)^{\xi} \times \psi \times (NVE)]$$

We explain how each component is calculated below.

- CE = Current Exposure

    The EMC shall calculate the CE of a MP (or MSSL) on a given day D, by aggregating the actual <u>net</u> outstanding settlement amounts currently owe to EMC by a MP (or MSSL) for the relevant trading days. The calculation will net off any prepayment amount paid to the EMC by a MP (or MSSL) for the relevant trading days.

- ADE = Average Daily Exposure

    This is determined by taking a simple average of 90 most recent SA (i.e. $\dfrac{\sum SA}{90}$).

    [Note: This represents the average daily net settlement amount of a MP or MSSL. By taking a 90-day moving average, we mitigate any outlier trade amount that is unusually high or low on a particular day, i.e. we mute the pronounced effect of any 'outlier' trade amount.]

- ξ = Estimated parameter (tail index) of Generalised Extreme Value (GEV) model
    [This is determined daily using the GEV model. See section 1.1.]

- ψ = Estimated threshold based on a certain confidence level of the GEV model
    [This is determined daily using the GEV model. See section 1.1.]

- NVE = Non-Vested Exposure (i.e. gives the amount of trade that is not subject to vesting contracts)

    This is determined as follows:

    For a MP:

    NVE = $\max\left(0, \dfrac{\sum\limits_{t}[SA_t - VP_t]}{90}\right)$

    where:

    t = trading days for which the most recent 90 SA are available
    VP = vesting portion, given by sum of (HP x HQ) for each settlement period in a trading day; HQ = Hedge Quantity of Vesting Contract; HP = Hedge Price of Vesting Contract

    For MSSL:

NVE = $\min(0, \dfrac{\sum\limits_{t}[SA_t + \sum\limits_{a} VP_t^a)}{90})$

where:

t   = trading days for which the most recent 90 SA are available

a   = a MP's account

2.2   Credit support from MP/MSSL

The EMC will determine the credit risk exposure (C) of a MP/MSSL daily.

On any given day, a MP (or MSSL) must provide the EMC with credit support no less than its credit risk exposure (C).

The EMC shall notify a MP/MSSL when that MP's/MSSL's credit risk exposure (C) reaches 90% of its credit support.

2.3   Margin call

The EMC shall issue a margin call to a MP/MSSL if that MP's/MSSL's credit risk exposure (C) is <u>equal to, or exceeds,</u> its credit support.

A MP/MSSL, who is issued a margin call, must within one business day following the date of the margin call:

(1) reduce its credit risk exposure (C) by prepaying the debt currently owed to the EMC; and/or

(2) increase its credit support;

to the extent that its credit risk exposure (C) is $\leq$ 80% of its credit support[15].

3.   COMPARING PROPOSED PRUDENTIAL METHODOLOGY AND THE CURRENT ONE

There are 2 major differences between the proposed methodology and the current one.

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[15] Based on current rules, there is an extra 'buffer' built in for margin call requirement. Currently, a margin call is issued if a MP's ENE reaches 70% or more than its credit support. The margin call requirement is that the [15] MP must reduce its ENE, or increase it credit support, so that the ratio (ENE/credit support) is < 50%). If we were to maintain the 'same buffer' for our proposed method on a _proportionate_ basis, we have:
70% $\rightarrow$ 50% (based on existing rules),
100% $\rightarrow$ (100 x 50)/70 = 71.43% ($\approx$ 70%).
In other words, under our proposed method, we will require MP/MSSL to reduce its C or increase its credit support so that the ration (C/Credit Support) is < 70%. However, in view that the proposed method for determining credit risk exposure already incorporates potential extreme price volatility (whereas the current method of prudential requirement does not), requiring MP/MSSL to keep its ratio (C/Credit Support) to 70% is too excessive. Hence, we recommend asking only for 80%.

First, the proposed methodology has an extra component, $\{(18)^{\xi} \times \psi \times (NVE)\}$, which captures the impact of price volatility on a MP's/MSSL's credit risk exposure (via the non-vested portion of trade).

Second, the ADE calculated under the 2 methods is different[16].

Compared to the current methodology, the proposed methodology is more robust since (i) it accounts for extreme price movements, and (ii) it does not over-inflate the estimated exposure of a MP/MSSL if there is an outlier trade amount. We elaborate on the strengths and weaknesses of both methods below.

3.1 Strengths and Weaknesses

Current Prudential Methodology

Strengths

1.   As the current system does not depend on a statistical model, it is simple to use and apply.

Weaknesses

1.   Does not recognize potential future large fluctuations in electricity prices. The electricity prices can be very volatile.

2.   In particular, for the additional future 18-day exposure which includes the 10-day period of potential default, the collateral should be more credit sensitive by linking to the increase likelihood of default with increase in price volatility and upward spike in the electricity prices.

Proposed Prudential Methodology

Strengths

1.   It focuses on the tail end losses, so that in the event of default under extreme upward price movements, the collateral set will be sufficient to cover the potential credit loss.

2.   As the collateral is linked to the market price movements, the collateral set is flexible and adjusts accordingly to the market conditions. Hence there are potential cost savings for customers in posting of a more flexible credit support.

Weaknesses

1.   As a statistical model is used, sufficient sample size on prices is needed. However, the current sample available in the database is sufficient. Going forward, with more price data, sample size will not even be an issue.

Given the pros and cons discussed, in my opinion, the new proposed methodology is superior to the present one, as credit risk exposure is linked to the market price movements and will lead to a more flexible and competitive collateral setting system

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[16] The reason why there is a difference is that the 18-day unknown exposure is estimated using most recent known 12 trade values under the current methodology, while such exposure using the past 90 day trade values (to mute any outlier amounts) under the proposed methodology.

4. EMPIRICAL RESULTS

4.1 Comparison of Estimated Credit Exposure for Retailers (excluding MSSL) for Year 2003 and Year 2004

Tables 1-2 below compare the credit exposures retailers (excluding MSSL) for 2003 and 2004.

Generally, the average credit exposures under the new method on the average are higher than the current method, reflecting the fact that there is a third component using GEV.

However, the results for the maximum credit exposures are reversed with the current method using the theoretical calculation higher. This reflects that an outlier trading amount could over-inflate (or under-estimate) a MP's estimated exposure, leading to higher (or lower) extreme value of credit support required.

Table 1 (Credit Exposure - Year 2003)

Period		Credit Exposure		
		Min	Max	Ave
01/04/03-31/12/03	Retailer 1 proposed	-8,827,105.82	-16,927,746.58	-12,465,210.22
	current	-4,704,169.37	-17,915,386.63	-11,058,425.62
	Retailer 3 proposed	-23,254,737.05	-34,734,383.28	-28,329,717.90
	current	-16,837,036.23	-37,524,906.64	-26,662,586.37
	Retailer 4 proposed	-1,353,966.06	-3,179,317.94	-2,074,093.45
	current	-546,331.12	-3,924,467.20	-2,004,420.56
	Retailer 5 proposed	-768,520.19	-2,490,917.83	-1,350,070.88
	current	-185,362.10	-1,953,319.28	-777,986.31
	Retailer 6 proposed	-12,510,456.41	-32,277.987.80	-20,000,101.21
	current	-16,646,061.95	-38,696,576.89	-28,667,095.33

Note: 'Current' refers to the current methodology using [credit risk exposure = 30 *(CE/12)].
While 'proposed' refers to the proposed methodology using

$$[CreditRiskExposure = CE + 18(ADE) + [(18)^{\xi} \times \psi \times (NVE)]]$$

Table 2 (Credit Exposure - Year 2004)

Data Period		Credit Exposure		
		Min	Max	Ave
01/01/04-31/12/04	Retailer 1 proposed	-8,374,867.44	-14,234,516.83	-10,472,756.76
	current	-4,717,912.00	-16,590,492.63	-9,615,246.43
	Retailer 3 proposed	-19,376,142.74	-34,999,952.22	-25,911,714.58
	current	-9,841,142.28	-36,867,710.10	-23,267,804.72
	Retailer 4 proposed	-2,005,590.53	-3,211,395.27	-2,552,340.44
	current	-1,231,760.70	-3,723,056.00	-2,320,090.89
	Retailer 5 proposed	-1,601,776.64	-2,280,936.53	-1,955,093.45
	current	-1,023,885.20	-2,655,012.18	-1,759,692.20
	Retailer 6 proposed	-23,025,097.04	-49,431,300.80	-32,785,314.07
	current	-12,581,863.73	-57,998,704.35	-30,482,597.04

In Table 3 below, for the Year 2003, both the Average Credit Support and Maximum Credit Support Required are lower for the proposed methodology.

Table 3 (Credit Support – Year 2003)

Data Period	Customers (with no vesting contract)	Margin Calls Times	Credit Support		
			Min	Max	Ave
01/04/03-31/12/03	Retailer 1 Proposed	1	-16,336,160.55	-20,050,236.47	-19,307,421.29
	Theoretical CSV	0	-21,352,700.00	-21,352,700.00	-21,352,700.00
	Retailer 3 proposed	2	-30,940,009.03	-41,117.136.35	-36,241,201.92
	Theoretical CSV	1	-29,280,981.60	-41,579,236.40	-39,074,864.51
	Retailer 4 Proposed	2	-2,927,507.97	-3,917,457.47	-3,063,852.04
	Theoretical CSV	1	-2,918,000.00	-4,469,742.67	-3,995,755.82
	Retailer 5 Proposed	7	-1,156,404.93	-3,071,644.94	-1,721,725.75
	Theoretical CSV	0	-4,411,440.00	-4,411,440.00	-4,411,440.00
	Retailer 6 Proposed	6	-18,196,618.49	-38,710,532.11	-24,991,796.47
	Theoretical CSV	1	-34,112,831.42	-49,892,413.18	-42,088,692.74

In Table 4 below, for the Year 2004, the Maximum Credit Support required are lower for the proposed methodology but the results for Average Credit Support are mixed.

Table 4 (Credit Support – Year 2004)

| Data Period	Customers (with no vesting contract)	Margin Calls Times	Credit Support		
			Min	Max	Ave
01/01/04-31/12/04	Retailer 1 Proposed	2	-13,151,143.84	-17.608,508.13	-14,286,386.95
	Theoretical CSV	2	-9,758,208.95	-20,518,579.43	-12,505,170.47
	Retailer 3 Proposed	1	-38,733,753.02	-43,749,940.28	-39,062,683.34
	Theoretical CSV	1	-27,087,466.70	-39,648,197.47	-33,402,151.02
	Retailer 4 Proposed	1	-3,508,459.86	-3,970,493.31	-3,550,118.61
	Theoretical CSV	1	-2,655,238.00	-4,545,214.63	-3,610,554.06
	Retailer 5 Proposed	0	-2,813,956.42	-2,813,956.42	-2,813,956.42
	Theoretical CSV	1	-2,097,044.48	-3,374,775.93	-2,742,892.34
	Retailer 6 Proposed	3	-40,313,610.06	-61,121,845.07	-44,660,304.37
	Theoretical CSV	2	-32,014,357.30	-67,486,252.40	-41,274,071.62

The results indicate that the proposed methodology need not necessarily result in a higher required Credit Support (in terms of extreme values).

With the exception of Retailer 5 & 6 in 2003, the number of margin calls is within 1 % of sample size for both 2003 and 2004. (The confidence level is 99 %, i.e. there is only 1 % probability of exceeding the threshold).
**Why is the number of margin calls for the proposed methodology much higher than the theoretical one for Retailer 5 in year 2003 in Table 3?**

 The 'Current Exposure' is the main cause.

- The first reason is that we calculate the Credit Exposure from 1 April, 2003 (**91**th days in the chart) to the end of 2003 for the proposed methodology. The current method starts from the beginning of year 2003. From the chart below, we can see there's a much higher point for Current Exposure before 1 April, 2003, so the Credit Support has been topped up to a higher level. Therefore less margin Calls will happen in the following days.

- Another reason is that the Current Exposure roughly goes up in the chart over the time scale, accordingly the Margin Call happen frequently.

Retailer 5 (Year 2003)
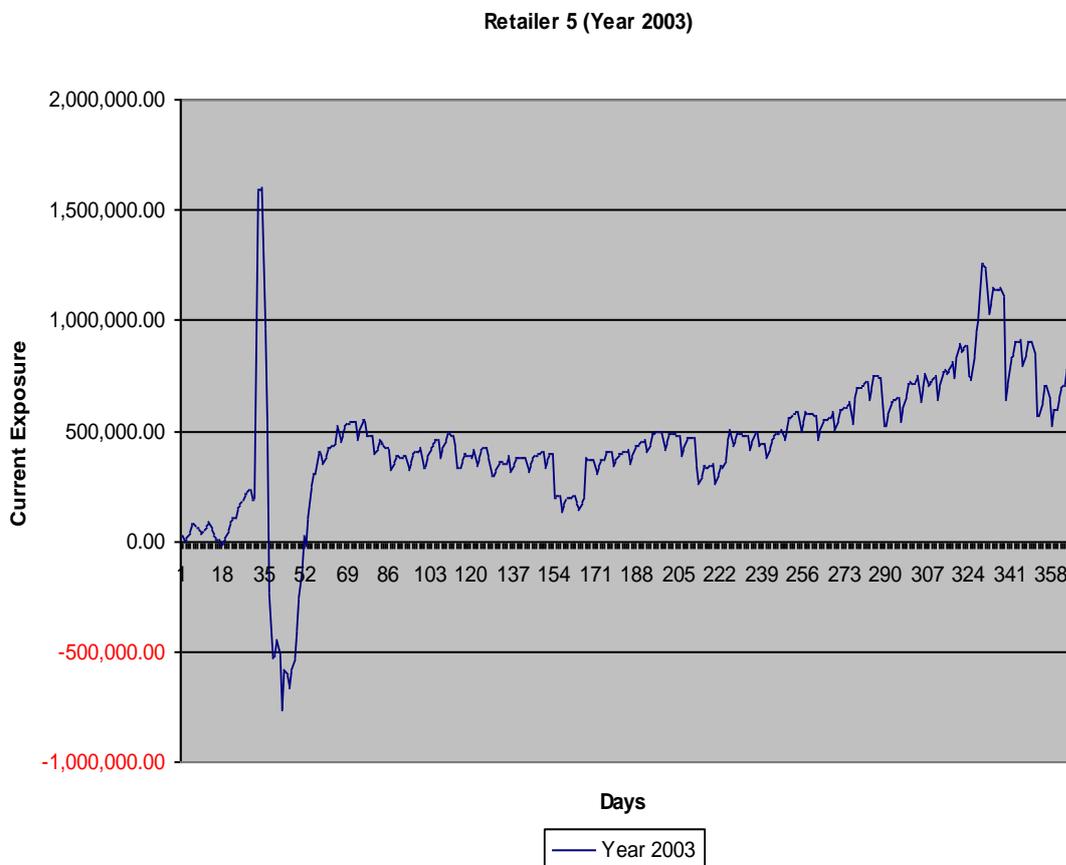
Retailer 6
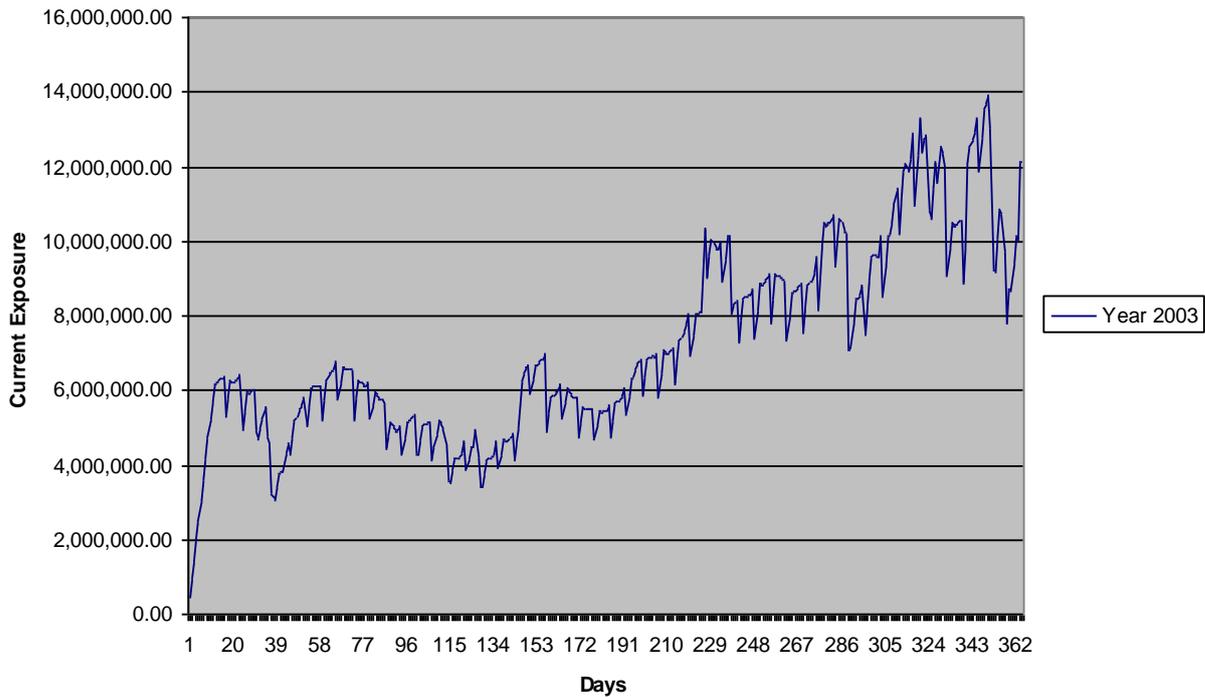
4.3 Estimated credit exposure and credit support for MSSL (with Vesting Contract) for Year 2004

In the case of vesting contract for MSSL, we only have 2004 data (vesting contract started only in 2004) under the current method for comparison.

Both the credit exposure and credit support for the proposed new method are higher than the current theoretical method. There is 1 margin call which is within the 1 % sample size, as compared to none under the current method.

From the results in Section 4.2, there are no clear patterns to indicate that any method will result in a higher credit support or credit exposure. This could be explained by the fact that the 2 methodologies differ in the determination of ADE and the rules for margin calls.

However, the empirical study also indicates that under the proposed methodology the collateral set in terms of credit support is adequate to cover credit exposure and sufficient to cover extreme price movements with 99 % confidence. This proposed methodology also need not result in a higher required credit support.

Table 5 (Credit Exposure – Year 2004)

Data Period	MSSL with vesting contract)	Credit Exposure		
		Min	Max	Average
01/04/2004-31/12/2004	*Proposed*	-115,022,560.11	-140,758,860.40	-131,232,745.31
	Current	-86,857,655.60	-145,087,136.10	-126,803,769.39

Table 6 (Credit Support – Year 2004)

Data Period	MSSL with vesting contract	Margin Calls	Credit Support		
		Times	Min	Max	Average
01/04/2004-31/12/2004	*Proposed*	1	-150,848,409.70	-170,219,977.71	-169,022,462.60
	Theoretical CSV	0	-159,696,722.37	-159,696,722.37	-159,696,722.37

4.4 Estimated credit exposure and credit support for Retailers (including MSSL) for Year 2005

Table 7 – Credit Support

Data Period	Retailer	Methodology	Credit Support(i.e. collaterals required)^		
			Min	Max	Ave
01/01/05 to 31/12/05	Retailer 1	Proposed	-13,412,119.03	-17,196,390.27	-14,417,802.07
	Retailer 1	Current	-8,140,662.73	-22,952,932.07	-16,041,928.55
	Retailer 3	Proposed	-35,292,147.24	-44,509,755.59	-37,564,982.17
	Retailer 3	Current	-21,593,852.23	-49,399,809.93	-35,654,697.40
	Retailer 4	Proposed	-3,421,028.19	-5,601,192.61	-4,348,981.39
	Retailer 4	Current	-2,323,625.75	-7,271,794.03	-5,336,103.93
	Retailer 5	Proposed	-2,499,020.49	-6,323,551.88	-4,410,649.23
	Retailer 5	Current	-1,710,222.15	-7,706,559.30	-4,905491.75
	Retailer 6	Proposed	-47,844,727.88	-76,518,544.45	-59,071,561.58
	Retailer 6	Current	-29,339,559.00	-94,133,715.87	-65,934,448.32
	MSSL	Proposed	-161,332,878.42	-202,089,474.84	-169,037,550.07
	MSSL	Current	-122,936,530.13	-249,386,531.33	-178,910,199.75

Table 8 – Credit Exposure

Data Period	Retailer	Credit Exposure		
		Min	Max	Ave
01/01/05-31/12/05	*Retailer 1 proposed*	-8,092,528.76	-16,008,630.19	-11,052,403.25
	Retailer 1 current	-5,320,138.43	-20,292,233.00	-10,011,273.76
	Retailer 3 proposed	-19,561,757.93	-40,535,249.66	-27,708,489.30
	Retailer 3 current	-12,608,663.33	-44,524,293.12	-24,273,321.50
	Retailer 4 proposed	-2,444,278.90	-5,064,406.06	-3,629,697.85
	Retailer 4 current	-1,666,558.38	-5,630,299.78	-3,315,994.56
	Retailer 5 proposed	-1,999,216.39	-6,323,551.88	-3,473,610.44
	Retailer 5 current	-1,666,558.38	-6,241,702.88	-3,168,325.38
	Retailer 6 proposed	-34,460,792.15	-63,512,228.65	-45,425,711.78
	Retailer 6 current	-23,732,092.28	-77,948,933.25	-41,339,790.55
	MSSL proposed	-117,931,513.54	-172,989,468.08	-141,682,734.56
	MSSL current	-83,647,336.90	-187,039,898.50	-138,670,784.66

Table 9: Margin Call

| Data Period	Retailer	Margin Calls
01/01/05 to 31/12/05	*Retailer 1 proposed*	1
	Retailer 1 current	3
	Retailer 3 proposed	1
	Retailer 3 current	2
	Retailer 4 proposed	2
	Retailer 4 current	3
	Retailer 5 proposed	4
	Retailer 5 current	4
	Retailer 6 proposed	2
	Retailer 6 current	3
	MSSL proposed	*1*
	MSSL current	2

Conclusion:

Point 1: The rule of Credit Exposure 2005 is consistent with Credit Exposure 2004. Credit Exposure for the proposed new method has lower maximum, higher minimum and average as compared with the current method.

Point 2: Credit Support for the proposed new method has lower maximum, higher minimum as compared with the current method. But average for proposed method is not necessarily higher than current one.

Point 3: There are more margin calls for year 2005 than year 2004. That means the Credit Exposure is more volatile for year 2005 than year 2004. However, the number of margin calls is within 1% of the sample size.

(Below is the Current Exposure for retailer 5 in year 2004 and 2005)

Retail 5
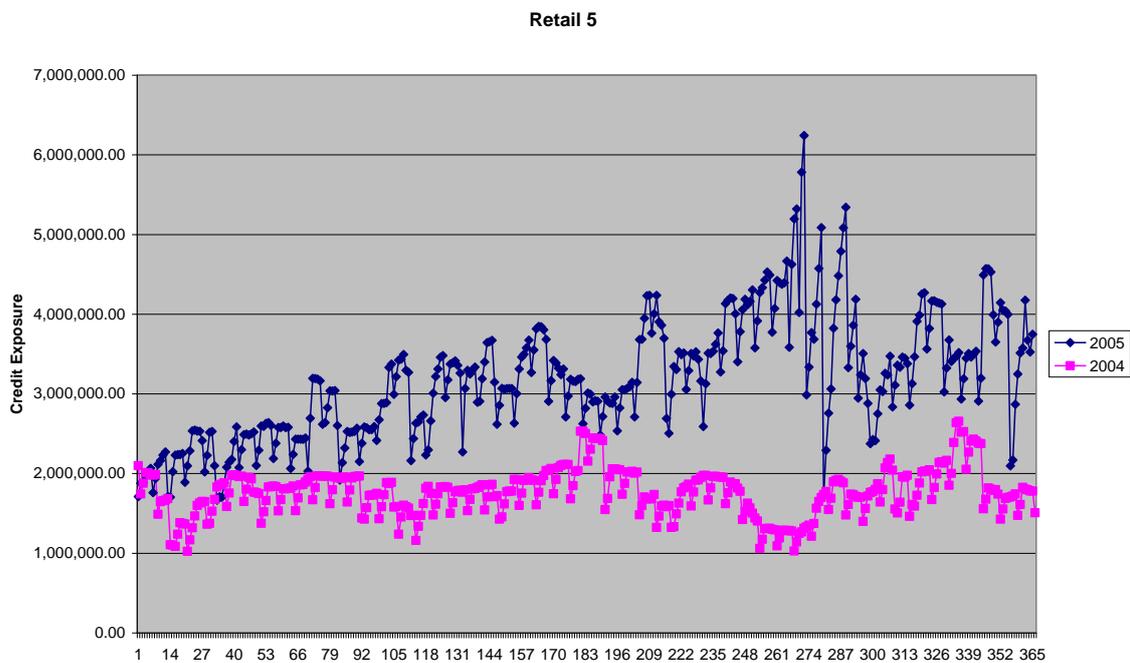
Appendix

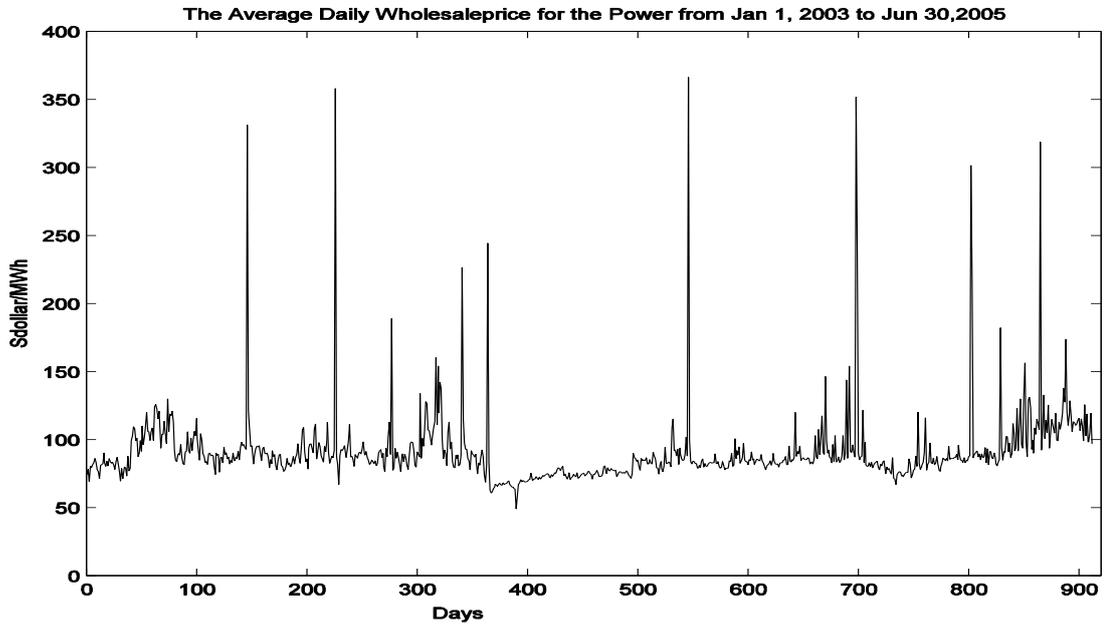**Figure 1 Daily Price Fluctuation from Jan 1, 2003 to Jun 30, 2005**

Table 1 below provides a statistical summary of the average daily electricity price movements over the period January 1, 2003 to June 30, 2005

Table 1: Statistical Summary for price, log price and log price changes of average daily electricity price

	Price Level	Log Price	Log Price changes
Mean	90.87	4.48	0.000292
Median	85.77	4.45	0.000672
Standard Deviation	49.05	3.89	-1.41
Minimum	366.10	5.90	1.43
Maximum	26.90	0.20	0.19
Skewness	6.15	2.85	0.57
Excess Kurtosis	50.84	14.92	24.62

Annex 2

Comments from MPs and EMC's Response

Senoko Power

Senoko's comments are summarized as follows:

Senoko would like EMC to establish the nature and extent of the "problem'. It is of the view EMC already has mechanisms in place (e.g. margin calls) to minimize its exposure to default risks. Senoko is asking if the current prudential methodology is lacking, and whether it would be easier to improve on the current methodology, rather to implement a new methodology which has unknown implementation costs and impact on market and market participants. Senoko would like to know in what ways (e.g. in terms of cost, efficiency, etc.) are the proposed solution superior to the current methodology.

PowerSeraya

Seraya's comments are summarized as follows:

Seraya feels that the paper does not appear to have ascertained whether the concerns of the MP and EMC Board are genuine or not. Seraya would like to know the level of risk that the market is exposed to with the current prudential methodology, before EMC proposes changes to the current methodology. Specifically, Seraya would like EMC to:

o Ascertain whether the current prudential methodology has failed to safeguard against default payment since market opening;
o Ascertain under what circumstance will the current prudential methodology failed to safeguard against default payment (if any);
o To conduct a review of prudential requirement arrangements in other markets;
o To conduct a cost-benefit analysis before deciding on the new methodology.

EMC's response

To a large extent, both Senoko Power and PowerSeraya shared similar concerns. They are encapsulated in these two issues:

- What are the shortcomings of the existing prudential methodology, and how big a risk does the current methodology pose to the market?

- Should the proposed methodology be implemented? If so, on what grounds, and what are the cost-benefit associated with it? Also, what are the practices in other jurisdictions?

We will address these two issues in turn.

Shortcomings of the existing methodology and the risk it poses

The current prudential methodology uses past 12 days' trade amounts (and hence, historical prices) to determine the amount of credit support required from a MP to cover that MP's 30-day credit risk exposure (i.e. $CS = [CE/12]*30$).

The amount of credit support determined under this methodology will be sufficient if the average of past 12 days' prices is fairly close to the average of the 18 days' prices.[17]

However, there can be situations where the average of past 12 days' prices can deviate significantly from the average of the 18-days' prices. These situations can be due to:

(a) 'abnormal' (but transient) prices which had occurred in the 12-day period; or

(b) sustained price spikes or greater price volatility in the 18-day period (in prospect, this will be unknown to the market).

Under (a), the transient abnormal prices will lead to outlier trade amounts. Through the outlier trade amounts, the credit risk exposure of a MP will be over- (or under-) estimated. Hence, the amount of credit support required from that MP will be too high (or low).

Under (b), the sustained price spikes or greater price volatility will lead to greater credit risk exposure of a MP in that 18-day period. However, the increase in the credit risk exposure will not be captured under the current methodology (which estimates the credit risk exposure using past 12day's trade amounts). Hence, the amount of credit support required from a MP will be too low.

The above situations will lead to undesirable outcome for the market where too low (or too high) an amount of credit support is being required from a MP.

When too high an amount of credit support is being asked for, it will impose unnecessary high costs on a MP.

Conversely, when too low an amount of credit support is being asked for, a MP is not giving enough credit support to match its credit risk exposure. Consequently, that will impose a high default risk on other MPs. In other words, that MP is not bearing the cost of the risk it imposes and other parties will be made to bear that risk. This is undesirable from the 'causer-pay' principle.

EMC is unable to ascertain the size of the default risk. This will depend on price volatility (i.e. the frequency and extent of price spikes) and the credit worthiness of MPs. However, given that price spikes in the spot market can be about 35 times more than the normal prices, the amount involved can potentially be very large. Additionally, we can expect there will be increase in the credit risk exposure of a MP arising from greater price volatility when vesting contract level is gradually rolled back.

Should we implement the proposed system? On what grounds, and what are the cost-benefit associated with it? Also, what are the practices in other jurisdictions?

EMC is supportive of the proposed methodology.

The proposed methodology rectifies the deficiencies inherent in the current methodology. Under the proposed methodology,

- problems arising from (a) are now addressed through 'Component A' which calculates the average daily exposure using past 90 days' (instead of past 12 days') trade amounts. This will mitigate any 'outlier' trade amounts due to abnormal transient prices; and

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[17] We assume the quantity consumed remains fairly stable for a MP in most circumstances.

- problems arising from (b) are now addressed through 'Component B' which captures the increase in credit risk exposure of a MP arising from potential price volatility in the 18-day period using the GEV model. The GEV model gives us an estimation of the potential price volatility which then allows us to capture the impact of price volatility on a MP's 18-day unknown exposure.

The proposed methodology is not a complete revamp of the current methodology. Rather, it is augmentation of the existing methodology.

Overall, the proposed methodology yields more robust and optimal results. The amount of credit support required under this methodology will better reflect the credit risk exposure of a MP. The proposed methodology adheres to the 'causer-pay' principle where the costs a MP needs to bear (through provision of credit support) are aligned with the credit risk exposure it carries.

EMC understands the proposed methodology will entail significant rule and system changes. Hence, we are not recommending it to be implemented right away at this stage. Instead, we suggest to trial the proposed methodology and monitor its performance more closely for a period of time. EMC will then report to the RCP on the test results and make the final recommendations.

The costs of the prudential trial are within EMC's approved capital budget should external resource be used. As for the costs of actual implementation, EMC will inform the RCP in due course when it tables the final recommendation.

Based on the 'Electricity Market Operation Benchmarking Survey' conducted by the EMC for 2005, we gathered the value of collateral a MP needs to place in relation to its settlement payment period (or cycle) in the various exchanges. The table below gives a summary:

	How often does settlement of trades take place?	How long after each settlement is payment required to be made?	Value of Collateral Held
AESO	Monthly	20 business days after month end	60 (2 months settlement) times the day's trade value
CAMMESA	Monthly	40 calendar days	NA (MPs not required to place collaterals)
ELEXON	Daily	29 calendar days	Approximately 200 times the day's transaction value
EMC	Daily	20 calendar days	30 times the day's trade value
KPX	Daily	22 calendar days	NA (MPs not required to place collaterals)

	How often does settlement of trades take place?	How long after each settlement is payment required to be made?	Value of Collateral Held
M-co NZ	Monthly	Amounts payable are determined by the 9th business day and payment occurs on the 20th calendar day of the month following the trading month.	Approximately 2 months of estimated exposure held at all times
Nord Pool	Daily	1-3 business days	7 times the day's trade value
XM	Monthly	Approximately 18 calendar days	30 times the day's trade value

We understand that most exchanges set the collaterals required based on past trade values and the settlement cycle (i.e. when a MP has to make payment). In this regard, EMC's current practice is no different from the practices in those exchanges. The current collateral EMC requires is equal to the average daily exposure (i.e. average of past trade values) x 30 days (i.e. the 20-day settlement cycle plus a 10-day suspension period).

To reiterate, the proposed methodology is an augmentation of the current methodology. The collateral required under the proposed methodology is still based on past trade values, except that (1) we have mitigated the adverse impact which any outlier past trade value will have on the collateral required, and (2) we have accounted for potential price volatility so that the collateral required will better reflect the credit risk exposure of a MP/MSSL in the 18-day period (where prices will be unknown to the market in prospect.)

Annex 3

Existing Market Rules (Release: 1 April 2008)	Proposed Rules Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Rule Changes
Chapter 2	**Chapter 2**	**Chapter 2**
7.2 **CURRENT EXPOSURE AND ESTIMATED NET EXPOSURE** 7.2.1 A *market participant's* current exposure shall be determined by the *EMC* each *business day* and shall be a dollar amount determined in accordance with the procedure specified in the *market manual*.	**7.2** **CURRENT EXPOSURE AND ~~ESTIMATED NET EXPOSURE~~ CREDIT RISK EXPOSURE** 7.2.1 A *market participant's* current exposure shall be determined by the *EMC* each *business day* and shall be a dollar amount determined in accordance with the procedure specified in the *market manual*.	Amendment to the heading of section 7.2 by replacing "Estimated Net Exposure" with "Credit Risk Exposure".
7.2.2 A *market participant's* estimated net exposure shall be determined by the *EMC* each *business day* and shall be a dollar amount determined in accordance with the procedure specified in the *market manual*.	7.2.2 A *market participant's* ~~estimated net exposure~~ credit risk exposure shall be determined by the *EMC* each *business day* and shall be a dollar amount determined in accordance with the procedure specified in the applicable *market manual*.	Replace "estimated net exposure" with "credit risk exposure". Amendment for consistency with section 7.4.3 of Chapter 2.
7.4 **MARGIN CALLS** 7.4.1 The *EMC* shall notify a *market participant* when the estimated net exposure of the	**7.4** **MARGIN CALLS** 7.4.1 The *EMC* shall notify a *market participant* when the ~~estimated net exposure~~ credit risk exposure of	Replace "estimated net exposure" with "credit risk

Existing Market Rules (Release: 1 April 2008)	Proposed Rules Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Rule Changes
market participant reaches sixty percent of the value of the *credit support* currently provided by that *market participant*.	the *market participant* reaches ~~sixty~~ <u>ninety</u> percent of the value of the *credit support* currently provided by that *market participant*.	exposure". Replace the "sixty percent" threshold with "ninety percent" threshold.
7.4.2 The *EMC* shall issue a margin call to a *market participant* when the estimated net exposure of the *market participant* reaches a value equal to or greater than seventy percent of the value of the *credit support* currently provided by that *market participant*.	7.4.2 The *EMC* shall issue a margin call to a *market participant* when the ~~estimated net exposure~~ <u>credit risk exposure</u> of the *market participant* reaches a value equal to or greater than ~~seventy percent of the value~~ <u>that</u> of the *credit support* currently provided by that *market participant*.	Replace "estimated net exposure" with "credit risk exposure". Replace the "seventy percent" threshold with a threshold equal to the value of the market participant's credit support currently provided.
7.4.3 Upon a *market participant's* receipt of a margin call under section 7.4.2, if such *market participant* has a reasonable basis for believing that there is a manifest error in the determination of its estimated net exposure by the *EMC* for the purposes of section 7.4.2 and that such error if absent,	7.4.3 Upon a *market participant's* receipt of a margin call under section 7.4.2, if such *market participant* has a reasonable basis for believing that there is a manifest error in the determination of its ~~estimated net exposure~~ <u>credit risk exposure</u> by the *EMC* for the purposes of section 7.4.2 and that such error if absent,	Replace all references to "estimated net exposure" with references to "credit risk exposure" instead.

Existing Market Rules (Release: 1 April 2008)	Proposed Rules Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Rule Changes
7.4.3.1 would not have required the issuance of such margin call by the *EMC* under section 7.4.2; and/or 7.4.3.2 would have resulted in its estimated net exposure (if correctly determined) to be either greater than 110%, or lesser than 90%, of its estimated net exposure originally determined for the purposes of section 7.4.2, that *market participant* may request the *EMC* to reassess its estimated net exposure. Such request for reassessment shall be made in such form as may be specified in the applicable *market manual* and shall clearly state, with supporting material, the nature of such error and the proposed correction to the relevant estimated net exposure. All requests for reassessments shall be made to the *EMC* no later than 12pm on the first *business day* following the date of such margin call issued by the *EMC* under section 7.4.2.	7.4.3.1 would not have required the issuance of such margin call by the *EMC* under section 7.4.2; and/or 7.4.3.2 would have resulted in its ~~estimated net exposure~~ credit risk exposure (if correctly determined) to be either greater than 110%, or lesser than 90%, of its ~~estimated net exposure~~ credit risk exposure originally determined for the purposes of section 7.4.2, that *market participant* may request the *EMC* to reassess its ~~estimated net exposure~~ credit risk exposure. Such request for reassessment shall be made in such form as may be specified in the applicable *market manual* and shall clearly state, with supporting material, the nature of such error and the proposed correction to the relevant ~~estimated net exposure~~ credit risk exposure. All requests for reassessments shall be made to the *EMC* no later than 12pm on the first *business day* following the date of such margin call issued by the *EMC* under section 7.4.2.	

Existing Market Rules (Release: 1 April 2008)	Proposed Rules Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Rule Changes
Explanatory Note: Manifest errors in the determination of a market participant's estimated net exposure can be caused by metering, human input or system calculation errors.	**Explanatory Note: Manifest errors in the determination of a market participant's ~~estimated net exposure~~ <u>credit risk exposure</u> can be caused by metering, human input or system calculation errors.**	
7.4.4 The *EMC* shall consider the merits of each request for reassessment of estimated net exposure made to the *EMC* in accordance with section 7.4.3, and notify the *market participant* to which such request relates, by no later than the end of the first *business day* following the date of the relevant margin call issued by the *EMC* under section 7.4.2 to which such request for reassessment relates, that: 7.4.4.1 such margin call is revoked, if the *market participant's* reassessed estimated net exposure is less than seventy percent of the value of the *credit support* currently provided by the *market participant*; 7.4.4.2 (except where section 7.4.4.1 applies) such margin call is to be revised	7.4.4 The *EMC* shall consider the merits of each request for reassessment of ~~estimated net exposure~~ <u>credit risk exposure</u> made to the *EMC* in accordance with section 7.4.3, and notify the *market participant* to which such request relates, by no later than the end of the first *business day* following the date of the relevant margin call issued by the *EMC* under section 7.4.2 to which such request for reassessment relates, that: 7.4.4.1 such margin call is revoked, if the *market participant's* reassessed ~~estimated net exposure~~ <u>credit risk exposure</u> is less than ~~seventy percent of~~ the value of the *credit support* currently provided by the *market participant*; 7.4.4.2 (except where section 7.4.4.1 applies) such	Replace all references to "estimated net exposure" with references to "credit risk exposure" instead. Replace the "seventy percent" threshold with a threshold equal to the value of the market participant's credit support currently provided.

Existing Market Rules (Release: 1 April 2008)	Proposed Rules Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Rule Changes
(together with the particulars of such revision) if the *market participant's* reassessed estimated net exposure is either greater than 110%, or lesser than 90%, of its estimated net exposure originally determined for the purposes of section 7.4.2; or 7.4.4.3 the *EMC* will take no further action and such margin call shall continue to apply if neither section 7.4.4.1 nor section 7.4.4.2 applies. In this case, the *EMC* shall not be obliged to carry out any further reassessment of such estimated net exposure.	margin call is to be revised (together with the particulars of such revision) if the *market participant's* reassessed ~~estimated net exposure~~ <u>credit risk exposure</u> is either greater than 110%, or lesser than 90%, of its ~~estimated net exposure~~ <u>credit risk exposure</u> originally determined for the purposes of section 7.4.2; or 7.4.4.3 the *EMC* will take no further action and such margin call shall continue to apply if neither section 7.4.4.1 nor section 7.4.4.2 applies. In this case, the *EMC* shall not be obliged to carry out any further reassessment of such ~~estimated net exposure~~ <u>credit risk exposure</u>.	
7.4.5 Where the *market participant's* estimated net exposure is reassessed, and consequently, its margin call is also revised by the *EMC,* under section 7.4.4.2, then all references in section 7.5.1 to "estimated net exposure" and "estimated net exposure, determined at the time the margin call was issued" in respect of that *market participant* shall be deemed to be references to the estimated net exposure as so	7.4.5 Where the *market participant's* ~~estimated net exposure~~ <u>credit risk exposure</u> is reassessed, and consequently, its margin call is also revised by the *EMC,* under section 7.4.4.2, then all references in section 7.5.1 to "~~estimated net exposure~~ <u>credit risk exposure</u>" and "~~estimated net exposure~~ <u>credit risk exposure</u>, determined at the time the margin call was issued" in respect of that *market participant* shall be deemed to be references to the ~~estimated~~	Replace all references to "estimated net exposure" with references to "credit risk exposure" instead.

Existing Market Rules (Release: 1 April 2008)	Proposed Rules Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Rule Changes
reassessed under section 7.4.4.	~~net exposure~~ credit risk exposure as so reassessed under section 7.4.4.	
7.5 MARGIN CALL REQUIREMENTS 7.5.1 Subject to section 7.4.5, a *market participant* must satisfy a margin call (if not revoked by the *EMC*) within the time prescribed in section 7.5.2 by 7.5.1.1 providing to the *EMC credit support* or additional *credit support* in the form as specified in section 7.6.2 such that the *market participant*'s estimated net exposure determined at the time the margin call was issued is no greater than fifty percent of the total value of the *credit support* provided to the *EMC* by the *market participant*; or 7.5.1.2 prepaying such amount to the *EMC* as would be sufficient to reduce the *market participant's* estimated net exposure to a value no greater than fifty percent of the value of the existing *credit support* provided to the *EMC* by that *market participant*.	**7.5 MARGIN CALL REQUIREMENTS** 7.5.1 Subject to section 7.4.5, a *market participant* must satisfy a margin call (if not revoked by the *EMC*) within the time prescribed in section 7.5.2 by 7.5.1.1 providing to the *EMC credit support* or additional *credit support* in the form as specified in section 7.6.2 such that the *market participant*'s ~~estimated net exposure~~ credit risk exposure determined at the time the margin call was issued is no greater than ~~fifty percent~~ eighty percent of the total value of the *credit support* provided to the *EMC* by the *market participant*; or 7.5.1.2 prepaying such amount to the *EMC* as would be sufficient to reduce the *market participant's* ~~estimated net exposure~~ credit risk exposure to a value no greater than ~~fifty percent~~ eighty percent of the total value of the existing *credit support* provided to the *EMC* by that *market participant*.	

Existing Market Rules (Release: 1 April 2008)	Proposed Rules Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Rule Changes
7.7 EXERCISE OF RIGHTS TO CREDIT SUPPORT … 7.7.5 Except as may otherwise be provided in section 9.8, all monies received by the *EMC* in respect of the realisation of the *credit support* provided by a *market participant* may, notwithstanding any appropriation by the *market participant* or any other person, be appropriated by the *EMC* to such parts of the component parts of the *market participant's* estimated net exposure, any interest thereon owing pursuant to these *market rules* or any costs, charges, expenses and fees referred to in section 7.7.3 and in such order as the *EMC* determines appropriate.	**7.7 EXERCISE OF RIGHTS TO CREDIT SUPPORT** … 7.7.5 Except as may otherwise be provided in section 9.8, all monies received by the *EMC* in respect of the realisation of the *credit support* provided by a *market participant* may, notwithstanding any appropriation by the *market participant* or any other person, be appropriated by the *EMC* to such parts of the component parts of the *market participant's* ~~estimated net exposure~~ <u>credit risk exposure</u>, any interest thereon owing pursuant to these *market rules* or any costs, charges, expenses and fees referred to in section 7.7.3 and in such order as the *EMC* determines appropriate.	Replace "estimated net exposure" with "credit risk exposure".

Existing Market Rules (Release: 1 April 2008)	Proposed Rules Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Rule Changes
Chapter 3	**Chapter 3**	

7.3   SUSPENSION ORDERS
 	
…
 	
7.3.15 The *market surveillance and compliance panel* may lift a *suspension order* if the event that triggered its issuance is remedied and there are no other *events of default* in existence with respect to the *suspended market participant* and may, as a condition of lifting a *suspension order*, impose such conditions on the *suspended market participant's* registration as a *market participant* as the *market surveillance and compliance panel* determines appropriate, including:
 	
    7.3.15.1   establishing a lower percentage of *estimated net exposure* for the purpose of notifying a *market participant* or issuing a *margin call* to a *market participant* than would otherwise be the case under
	7.3 SUSPENSION ORDERS
	
	…
	
	7.3.15 The *market surveillance and compliance panel* may lift a *suspension order* if the event that triggered its issuance is remedied and there are no other *events of default* in existence with respect to the *suspended market participant* and may, as a condition of lifting a *suspension order*, impose such conditions on the *suspended market participant's* registration as a *market participant* as the *market surveillance and compliance panel* determines appropriate, including:
	
	    7.3.15.1 establishing a lower percentage of ~~*estimated net exposure*~~ <u>credit risk exposure</u> for the purpose of notifying a *market participant* or issuing a *margin call* to a *market participant* than would otherwise be the case under section 7.4 of Chapter 2; and
	
	    7.3.15.2 imposing more stringent prudential requirements than would otherwise be
		Replace "estimated net exposure" with "credit risk exposure".

Existing Market Rules (Release: 1 April 2008)	Proposed Rules Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Rule Changes
7.3.15.2 section 7.4 of Chapter 2; and imposing more stringent prudential requirements than would otherwise be the case under section 7 of Chapter 2, and shall notify the *market participant*, the *EMC*, the *PSO*, the *Authority* and, where the *market participant* is a contestable *consumer* or *retail electricity licensee*, the applicable *market support services licensee* accordingly.	the case under section 7 of Chapter 2, and shall notify the *market participant,* the *EMC*, the *PSO,* the *Authority* and, where the *market participant* is a contestable *consumer* or *retail electricity licensee*, the applicable *market support services licensee* accordingly.	

Existing Market Manual (Release: 10 September 2007)	Proposed Market Manual Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Changes to Market Manual
PRUDENTIAL REQUIREMENTS MARKET MANUAL (Chapter 2 Market Rules)	PRUDENTIAL REQUIREMENTS MARKET MANUAL (Chapter 2 Market Rules)	
[New section]	**1.2 Applicability to Market Support Services Licensee** In this *market manual*, unless the context otherwise requires, all references to "*market participant*" shall include references to a *market support services licensee* that has been granted authorisation to participate by the *EMC* pursuant to section 3 of Chapter 2 of the *market rules.*	To make clear, consistently with section 7.1.4 of Chapter 2 of the market rules, that the references to "market participant" in this market manual will be understood to include references to certain market support services licensees.
[New section]	**1.3 Non-applicability to Transmission Licensee** In this *market manual*, unless the context otherwise requires, all references to "*market participant*" shall not include any reference to the *transmission licensee.*	To make clear, consistently with section 7.1.3 of Chapter 2 of the market rules, that all references to "market participant" in this market manual will not include any reference to the transmission licensee.

Existing Market Manual (Release: 10 September 2007)	Proposed Market Manual Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Changes to Market Manual
2. Current Exposure & Estimated Net Exposure **2.2 ESTIMATED NET EXPOSURE** The estimated net exposure of each *market participant* on a given day represents an estimate of the *market participant*'s 20-day exposure and shall be determined in accordance with the following formula: Estimated Net Exposure = Current Exposure + (20-X)(Estimated Average Daily Exposure) – Prepayment Amount where: 1. Prepayment Amount = the sum of: (a) the aggregate prepayments paid to the *EMC* by the *market participant* under section 5.9.2 of Chapter 7 of the *market rules*; and (b) the aggregate prepayments paid to the *EMC* by the *market participant* under section	**2. Current Exposure & ~~Estimated Net Exposure~~ Credit Risk Exposure** **2.2 ~~ESTIMATED NET~~ CREDIT RISK EXPOSURE** The ~~estimated net exposure~~ credit risk exposure of each *market participant* on a given day represents an estimate of the *market participant*'s 30~~20~~-day exposure and shall be determined in accordance with the following formula: ~~Estimated Net Exposure~~ Credit Risk Exposure = Current Exposure + (3~~2~~0-X)(Estimated Average Daily Exposure) – Prepayment Amount + Price Volatility Component where: 1. Prepayment Amount = the sum of: (a) the aggregate prepayments paid to the *EMC* by the *market participant* under section 5.9.2 of Chapter 7 of the *market rules*; and	Amendment to the headings of sections 2 and 2.2 by replacing "Estimated Net Exposure" with "Credit Risk Exposure". Replace all references to "estimated net exposure" with references to "credit risk exposure" instead. Amend "20-day" exposure to "30-day" exposure. See Concept Paper on Report for Trial of Prudential Methodology for discussion on changes

Existing Market Manual (Release: 10 September 2007)	Proposed Market Manual Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Changes to Market Manual
7.5.1.2 of Chapter 2 of the *market rules*. 2. 'X' refers to the number of *trading days* to which the *market participant's* current exposure on the given day relate. **Explanatory Note:** **The estimated net exposure is used by the EMC to (among other things) determine if a margin call should be issued to a market participant under section 7.4.2 of Chapter 2.** **By convention, a positive estimated net exposure of a market participant indicates that the market participant has, or may have, payment liability to the EMC, while a negative estimated net exposure indicates that the market participant has, or may have, a right to payment from the EMC. By convention, the value of credit support held by the EMC is also reflected as a positive number.** **Consistently with the above conventions, a negative estimated net exposure of a market**	(b) the aggregate prepayments paid to the *EMC* by the *market participant* under section 7.5.1.2 of Chapter 2 of the *market rules*. 2. 'X' refers to the number of *trading days* to which the *market participant's* current exposure on the given day relate. 3. <u>Price Volatility Component is determined in accordance with section 2.3 (in the case of *market participants*, other than *market support services licensees* to whom section 1.2 applies) or section 2.4 (in the case of a *market support services licensee* to whom section 1.2 applies).</u> **Explanatory Note:** **The ~~estimated net exposure~~ <u>credit risk exposure</u> is used by the EMC to (among other things) determine if a margin call should be issued to a market participant under section 7.4.2 of Chapter 2.** **By convention, a positive ~~estimated net exposure~~ <u>credit risk exposure</u> of a market participant**	to this formula.

Existing Market Manual (Release: 10 September 2007)	Proposed Market Manual Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Changes to Market Manual
participant would thus always be less than any positive value of the credit support of the market participant for the purposes of section 7.4.2 of Chapter 2 and thus would not require any margin calls to be issued to the market participant under that section.	indicates that the market participant has, or may have, payment liability to the EMC, while a negative ~~estimated net exposure~~ credit risk exposure indicates that the market participant has, or may have, a right to payment from the EMC. By convention, the value of credit support held by the EMC is also reflected as a positive number. Consistently with the above conventions, a negative ~~estimated net exposure~~ credit risk exposure of a market participant would thus always be less than any positive value of the credit support of the market participant for the purposes of section 7.4.2 of Chapter 2 and thus would not require any margin calls to be issued to the market participant under that section.	
(No Existing Provision)	**2.3** **PRICE VOLATILITY COMPONENT IN RESPECT OF A MARKET PARTICIPANT** **Explanatory Note:** **The price volatility component in respect of a**	

Existing Market Manual (Release: 10 September 2007)	Proposed Market Manual Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Changes to Market Manual
	given market participant on a given day captures the impact of potential price volatility on that market participant's Non-Vested Exposure (NVE) (if any), using the Generalised Extreme Value (GEV) distribution. The price volatility component in respect of a given *market participant* (other than a *market support services licensee* to whom section 1.2 applies) on a given day shall be determined in accordance with the following formula: Price Volatility Component = $(18)^{\xi} \times \psi \times$ (NVE) where: 1. ξ is the shape parameter which captures the weight of the tail of the GEV distribution. 2. ψ is the threshold parameter determined using the GEV distribution with a 99% confidence level. ψ is determined in accordance with the following formula: $$\psi = \mu + (\sigma/\xi) \times \{[-\ln(1 - \frac{\alpha N}{n})]^{-\xi} - 1\}$$	

Existing Market Manual (Release: 10 September 2007)	Proposed Market Manual Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Changes to Market Manual
	where: (a) μ, σ and ξ are respectively determined as set out in section 2.5 of this *market manual*. (b) $\alpha = 0.01$ based on a 99% confidence level. (c) N = 1080 (d) n = 60 3. "NVE" or "Non-Vested Exposure" of that given *market participant* on that given day, is determined (using the 90 most recently available *preliminary settlement statements* (or corresponding *final settlement statements* if available) of that *market participant* which have been issued on or before that given day) as follows: $$NVE^a =$$	

Existing Market Manual (Release: 10 September 2007)	Proposed Market Manual Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Changes to Market Manual
	$$\max\left(0, \frac{\sum_{t=1}^{90} - (\text{net } settlement \ amount_t^{\ a} - \text{Vesting Portion}_t^{\ a})}{90}\right)$$ where: (a) a = each *settlement account* associated with the given *market participant* (b) t = the tth *trading day*, where t=1 to 90, representing each one of the 90 *trading days* to which the aforesaid 90 most recently available *preliminary settlement statements* (or corresponding *final settlement statements* if available) relate. (c) "Vesting Portion" in respect of that *market participant* for *trading day* t is calculated by the sum of (HP x HQ) for all *settlement intervals* in that *trading day*, where: (i) HQ = hedge quantity (in MWh) for a given *settlement interval* in that *trading day* under any given v*esting*	

Existing Market Manual (Release: 10 September 2007)	Proposed Market Manual Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Changes to Market Manual
	contract to which that *market participant* is a party; and (ii) HP = hedge price (in $/MWh) for that given *settlement interval* under that given *vesting contract*.	
(No Existing Provision)	**2.4 PRICE VOLATILITY COMPONENT IN RESPECT OF A MARKET SUPPORT SERVICES LICENSEE** The price volatility component in respect of a given *market support services licensee* (to whom section 1.2 applies) on a given day shall be determined in accordance with the following formula: Price Volatility Component = $(18)^{\xi} \times \psi \times (NVE)$ where: 1. ξ and ψ shall have the meanings respectively ascribed to them in section 2.3 above. 2. "NVE" or "Non-Vested Exposure" in respect of	

Existing Market Manual (Release: 10 September 2007)	Proposed Market Manual Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Changes to Market Manual
	that given *market support services licensee* on that given day is determined (using the 90 most recently available *preliminary settlement statements* (or corresponding *final settlement statements* if available) of that *market support services licensee* which have been issued on or before that given day) as follows: $$\text{NVE}^{\text{MSSL}} =$$ $$-1 \times \min\left(0, \frac{\sum_{t=1}^{90}(\text{net } \textit{settlement amount}_t^{\text{MSSL}} + \sum_a \text{Vesting Portion}_t^{\ a})}{90}\right)$$ where: (a) t = the t$^{\text{th}}$ *trading day*, where t=1 to 90, representing each one of the 90 *trading days* to which the aforesaid 90 most recently available *preliminary settlement statements* (or corresponding *final settlement statements* if available) relate. (b) "Vesting Portion" for *trading day* t, in respect of each *settlement account* of a	

Existing Market Manual (Release: 10 September 2007)	Proposed Market Manual Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Changes to Market Manual
	given *market participant* with whom that *market support services licensee* has entered into a *vesting contract*, is the Vesting Portion (as determined under section 2.3) for *trading day* t in respect of that *market participant*. (c) a = each *settlement account* associated with each given *market participant* with whom that *market support services licensee* has entered into a *vesting contract*.	

Existing Market Manual (Release: 10 September 2007)	Proposed Market Manual Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Changes to Market Manual
(No Existing Provision)	**2.5 GENERALISED EXTREME VALUE (GEV) DISTRIBUTION** The GEV distribution is determined by the following function: $$H(X; \mu, \sigma, \xi) = \exp\{-[1 + \xi(\frac{X - \mu}{\sigma})]^{-1/\xi}\}$$ where: 1. 'X' is the maximum daily average wholesale electricity price changes over 18 *trading days* and is defined as follows: $X_i = \max (Y_1, Y_2, Y_3, \ldots Y_{18})$ for i = 1 to 60 where: (a) $Y_1, Y_2, Y_3, \ldots Y_{18}$ is a sequence of the natural log of daily average wholesale electricity price relatives	

Existing Market Manual (Release: 10 September 2007)	Proposed Market Manual Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Changes to Market Manual
	Explanatory Note: **The natural log of daily average wholesale electricity price relatives for a given day means the natural log of the ratio of that given day's daily average wholesale electricity price to the previous day's daily average wholesale electricity price.** **For example,** **Daily average WEP on 12 May = $X** **Daily average WEP on 11 May =$Y** **Natural log of daily average WEP price relative on the 12 May = ln ($X/$Y)** **X_i is one block in a series of 60 blocks representing 60 data points that are used in the estimation of the GEV parameters μ, σ and ξ.** (b) daily average wholesale electricity price is determined as follows:	See Concept Paper on Report for Trial of Prudential Methodology for further details.

Existing Market Manual (Release: 10 September 2007)	Proposed Market Manual Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Changes to Market Manual
	$$\frac{\sum_{h=1}^{48} WEP_h}{48}$$ where: (i) $WEP_h = (USEP_h + AFP_h + HEUC_h + MEUC_h + PSOA_h + EMCA_h)$ (ii) h is a *settlement interval* 2. ξ shall have the meaning ascribed to it in section 2.3 above. 3. σ is the scale parameter which captures volatility of X in the GEV distribution. 4. μ is the location parameter which represents the average value of X, in the GEV distribution. **Explanatory Note:** **The GEV distribution provides a better characterisation of the extreme electricity price movements that will result in large credit losses**	

Existing Market Manual (Release: 10 September 2007)	Proposed Market Manual Changes (Deletions represented by strikethrough text and additions represented by double underlined text)	Remarks on Changes to Market Manual
	compared to the normal distribution. **The 3 parameters µ, σ and ξ, estimated under this GEV distribution are used to determine the threshold parameter ψ based on a 99% confidence level. This means that with a given time period of 1 day and a given probability of 1%, the occurrence of margin violation due to extreme price movements over 1 day is less than 1% of the time.**	
4. Format of Request for Reassessment of Estimated Net Exposure A *market participant*, who wishes to submit a request for reassessment of its estimated net exposure under section 7.4.3, Chapter 2 of the *market rules*, shall submit a duly completed Request for Reassessment of Estimated Net Exposure in the form set out below, together with all relevant supporting materials, to the *EMC* at the following email address: settlement@emcsg.com.	**4. Format of Request for Reassessment of ~~Estimated Net Exposure~~ Credit Risk Exposure** A *market participant*, who wishes to submit a request for reassessment of its ~~estimated net exposure~~ credit risk exposure under section 7.4.3, Chapter 2 of the *market rules*, shall submit a duly completed Request for Reassessment of ~~Estimated Net Exposure~~ Credit Risk Exposure in the form set out below, together with all relevant supporting materials, to the *EMC* at the following email address: settlement@emcsg.com.	Amendment to the heading of section 4 by replacing "Estimated Net Exposure" with "Credit Risk Exposure". Replace all references to "estimated net exposure" with references to "credit risk exposure" instead.

Request for Reassessment of ~~Estimated Net Exposure~~ <u>Credit Risk Exposure</u>

Date : [   ]

Submitted by : [   ]

Company : [   ]

Settlement A/C : [   ]

Settlement Date : [   ]   **Date of Margin Call Issued by the EMC:** [   ]

Reason(s) for Reassessment

We are submitting this Request for Reassessment of ~~Estimated Net Exposure~~ <u>Credit Risk Exposure</u> in accordance with Section 7.4.3, Chapter 2 of the Market Rules as we have a reasonable basis to believe that there is a manifest error in the estimation of our ~~estimated net exposure ("ENE")~~ <u>Credit Risk Exposure ("CRE")</u> by the EMC under section 7.4.2 and that the absence of such error:

[   ]   would not have required the making of any margin call by the EMC under section 7.4.2 of Chapter 2 of the Market Rules; AND/OR

[   ]   would have resulted in our ~~ENE~~ <u>CRE</u> (if estimated correctly) to be either greater than 110%, or lesser than 90%, of the ~~ENE~~ <u>CRE</u> presently determined by the EMC for the purposes of section 7.4.2 of Chapter 2 of the Market Rules.

Proposed Adjustment to ~~ENE~~ <u>CRE</u>

[*Please state the nature of the error, the proposed correction to* ~~ENE~~ <u>CRE</u> *- with the mathematical working*]

Market Participant must provide supporting materials to support the abovesaid request for re-assessment of ~~ENE~~<u>CRE</u>.

EMC Internal Use:
(*This Form (duly completed) must be received by the EMC no later than 12pm on the first business day following the date of the margin call issued by the EMC.*)
Date
Receipt   : _____   Received by   : _____