Recommended Values for I-SEM Credit Cover Parameters

Report to the Regulatory Authorities

Version 1.0 02/02/2017

Contents

1. SEMC Policy and Trading & Settlement Code Obligations

1.1 Overview of the SEM

With the introduction of I-SEM, Participants will have the opportunity to trade in multiple timeframes. Participants will have the option to buy and sell energy in the day-ahead market and the intraday market, with generators having bids or offers accepted in the balancing market based on commercial offers for deviations from their physical notifications as provided to the System Operators (SOs). Settlement for trading energy outlined in new draft of the Trading & Settlement Code covers both balancing actions taken by the SOs and an imbalance settlement requirement which intends to true up Participants' aggregate market positions based on activity in the day-ahead, intraday and balancing markets against their actual (or deemed, in the case of Assetless Units and DSUs) metered positions. In addition to these markets for trading energy, the I-SEM includes a Capacity Market (CM) based on Reliability Options.

The I-SEM decisions allow the TSOs to take actions for non-energy reasons (such as system requirements like voltage support, reserve provision etc.), and to take actions for energy reasons (i.e. maintaining the balancing between demand and supply), using the commercial data submitted for the balancing market. These actions and any differences between traded positions and metered output or consumption are settled through the imbalance settlement processes.

Capacity payments will be made to Participants who have succeeded in a capacity auction, recovered through capacity charges on suppliers. As part of the capacity mechanism, those units who are being paid a capacity payment are also exposed to difference charges if the relevant market reference price exceeds a strike price, with Supplier Units being eligible for difference payments in these scenarios.

In the ex-ante market timeframes, the NEMO is responsible for the financial management of the cross border exchanges that result from these trades as well as all local trades. As such, credit arrangements relating to the settlement components in these marketplaces are not considered in scope for this document.

The credit arrangements relating to the settlement components in terms of balancing market, imbalances, and capacity market settlement are considered in scope for the credit arrangements within in this document. The balancing market, imbalance and capacity settlement arrangements will be based on trust arrangements similar to those currently in place in the SEM.

Timeframes for imbalance settlement are longer than the ex-ante markets, i.e. weekly rather than daily, the same as existing SEM timelines for trading payments and charges. Settlement amounts may generally be smaller than existing SEM amounts, since not all energy trades will be settled through this market but rather just

those related to balancing actions and imbalances. However, the imbalance settlement calculations are more complicated, with the need to consider meter data, dispatch instructions, bid-offer acceptances, uninstructed imbalances, testing charges, contracted volumes from the ex-ante markets, etc. Also, as the I-SEM design separates the responsibility for spot market trading from balancing market actions, this has the effect of splitting cash flows that are currently aggregated in the SEM.[1] This will increase the collateral requirement for generators who are frequently constrained down from their spot market positions. Credit management for the imbalance settlement could be higher risk than in the existing SEM, where a Participant not trading in the ex-ante markets will result in all volumes falling into the imbalance market, and no ability to exclude suppliers from purchasing from this timeframe quickly because of the need to reassign their end use customers:

- If a Participant gets into financial difficulties they will very quickly be stopped from trading in the ex-ante markets when they reach their credit limits. As a result, the risk of payment shortfalls due to a default in the ex-ante markets is minimised by the NEMO;
- The same cannot be done in the balancing market where purchases driven by end customer consumption cannot be stopped immediately, due to the time lag in moving customers to a new supplier or Supplier of Last Resort (SOLR). This means where a supplier is in financial difficulties they will continue to purchase from the balancing market until their customers can be transferred to the SOLR. During this same period all of their purchases of power will likely occur in the balancing market since if they are in genuine financial difficulties it is likely they would have also defaulted and been locked out of ex-ante market trading;
- Hence, in the I-SEM, their entire debt will likely fall into the balancing market when they are in financial difficulties;
- It is on this basis that Supplier Unit undefined exposure is based on forecast Metered Quantities and Imbalance Settlement Prices, rather than based on analysis of historic imbalance settlement.

Settlement of capacity market amounts which are related to energy market activity, i.e. the settlement of Difference Charges and Difference Payments which are based on prices and quantities in the day-ahead, intraday and balancing markets, will be settled to the same timeframes as energy amounts and will be considered trading charges or payments, i.e. weekly. Capacity market amounts related to capacity payments and charges will be settled monthly.

For the I-SEM, a single Settlement Document will be issued to a Participant covering all payments and charges in respect of their Generator Units and Supplier Units for

[1] SEMO currently settles both the spot market (being payments relating to Market Schedule Quantities) and constraint actions by the SOs. In the I-SEM, the NEMO will settle the spot market amounts while constraint actions (which would appear as non-energy SO balancing actions) are settled by SEMO.

imbalance settlement and capacity market settlement. It is intended that this will also cover initial settlement and any settlement re-runs that are due for billing on the same day. Each payment or charge will be summed to a single line item. The Settlement Document will be the document against which payments must be made by Participants and the Market Operator (MO). This means that the amount issued for settlement will include automatic netting where a Participant has both supplier and Generator Units registered. Based on all of this, a single collateral solution has been implemented for the settlement of Trading Payments and Charges, and Capacity Payments and Charges.

1.2 Credit Cover Requirements in the I-SEM

Credit Cover Obligations refer to the obligations on Participants in respect to collateral that they are required to post. In the I-SEM there are a number of separate market timeframes that require credit management functions.

In the ex-ante markets (the day-ahead and intraday), Participants will be using centralised platforms for submitting their commercial offer data to the Nominated Electricity Market Operator (NEMO). In the balancing market, Participants offer balancing energy to the SOs who are responsible for maintaining system balance at all times.

The intent of the I-SEM design is that all exposures should be covered by collaterals and this has been implemented in the Trading and Settlement Code, calculating exposures relating to the following:

- Fixed Credit Requirement;
- Amounts billed not paid;
- Amounts settled not billed;
- Amounts traded but not delivered; and
- Amounts relating to undefined exposure.

Forecasting is required to determine the undefined exposure elements in the Trading and Settlement Code. It is for use in this forecasting process that a number of the parameters determined through these methodologies are required.

A forecast price is required for calculation of exposures in the Undefined Exposure Period. This is known as the Credit Assessment Price (PCA_g) for the Undefined Exposure Period, g, which is calculated based on a historical analysis of average past Imbalance Settlement Prices. This price is required for the calculation of exposures relating to Trading Charges for Supplier Units, exposures relating to Trading Charges for New Participants for Generator Units, Supplier Units or Assetless Units, exposures relating to Trading Charges for Adjusted Participants for Supplier Units, and exposures relating to volumes traded not yet delivered for Generator Units, Supplier Units and Assetless Units.

A forecast of a Supplier Unit's Metered Quantity is required to determine their exposure in the Undefined Exposure Period. This is known as the Billing Period Undefined Potential Exposure Quantity ($QUPEB_{pg}$) for a Participant, p, for an Undefined Exposure Period, g, which is calculated based on a historical analysis of

average past Metered Quantities for that Participant. This quantity is required for the calculation of exposures relating to Trading Charges and Capacity Charges for a Participant, Adjusted Participant or New Participant for Supplier Units.

A forecast of a Generator Unit's balancing market settlement amounts is required to determine their exposure in the Undefined Exposure Period, in particular for the calculation of Billing Period Undefined Potential Exposure ($EUPEG_{pg}$) for a Participant, p, in relation to its Generator Units and Assetless Units for Undefined Exposure Period, g. This is calculated based on a historical analysis of past Billing Period Cash Flows (CUB_{pg}), relating to average past Total Daily Amounts.

Since these forecasts are based on statistical analysis of historic Sample Undefined Exposure Periods, parameters required as input into this process include the number of days in the Historical Assessment Period (DINHAP), the Analysis Percentile Parameter (AnPP), and the number of days in the Undefined Exposure Period ($UEPBD_g$).

1.3 Parameters for Credit Cover Calculations

Under section G.10 of the new draft market rules, the MO is required to report to the Regulatory Authorities proposing parameters to be used in the calculations of Required Credit Cover at least four months before the start of the Trading Year. This document provides the MO's recommendations, and the rationale used in determining the MO's recommendations, for the following parameters considered under section G.10 of the new draft market rules:

- Fixed Credit Requirement;
- Historical Assessment Period;
- Analysis Percentile Parameter;
- Credit Cover Adjustment Trigger;
- Level of the Warning Limit; and
- Level of the Breach Limit.

Under paragraph G.9.1.14 of Part B of the Code, the MO shall determine the Undefined Exposure Period in respect of Billing Period payments and charges from time to time. This document provides the MO's determinations for the Undefined Exposure Period.

In all cases, any changes in context between the SEM and I-SEM arrangements were considered in developing these recommendations.

Where no change to the current values was suggested through the analysis and consideration of a parameter, it has been recommended in this report that the previous value used in the SEM should be maintained until such a time as any further analysis or considerations of new context indicate otherwise. This was the case with the Fixed Credit Requirement parameters and the number of days in the Undefined Exposure Period parameter. Where analysis and considerations has identified a potential need to change values from those currently used in the SEM, the rationale for these recommendations has been outlined. This was the case with the number of days in the Historical Assessment Period, the Analysis Percentile

Parameter, the Credit Cover Adjustment Trigger, the level of the Warning Limit, and the level of the Breach Limit.

The following roles and entities are relevant in the operation of credit cover considered in scope of this document:

- Market Operator – the MO will be responsible for the calculation of required credit cover for Participants in the I-SEM balancing market, imbalance and capacity market settlement arrangements. In relation to the I-SEM Balancing and Capacity Market settlement arrangements, the MO will issue reports to Participants on their level of posted credit cover, their level of required credit cover, whether Participants are in breach of any warning or trading limits, credit cover increase notices as required and will manage posted credit cover with the SEM bank;
- Participant – Participants are required to post credit cover as per the calculations carried out by the MO;
- Credit Cover Provider – Credit Cover Providers are approved banks that can provide an irrevocable Letter of Credit that can be drawn down according to the timings required by the market rules;
- SEM Bank – Participants can lodge cash collaterals in a Collateral Reserve Account with the SEM Bank to cover their credit cover obligations.

1.4 Overview of Data for Analysis

The daily settlement amounts, average System Marginal Prices (SMP), and Metered Demand for a “steady supplier” unit from November 2007 through to November 2016 were used for the analysis of the number of days in the Historical Assessment Period, the Analysis Percentile Parameter, the Credit Cover Adjustment Trigger, the level of the Warning Limit, and the level of the Breach Limit. While historical data was used as the starting basis for the analysis, the actual values were adjusted slightly by random multipliers in order to create anonymity, while maintaining the general trends.

A brief analysis of this data was carried out to determine whether there were any patterns in the data that may affect the results depending on the methodology used. The normalised amount of the daily settlement for the full data period was calculated by using the absolute value divided by the average of the entire 9 year data set. Notably, seasonal patterns are evident in the data with a marked drop in settlement amounts over the Christmas/New Year period. There is an associated increase in the variance of settlement amounts in December as well. Also noticeable, is an overall increase in settlement amounts since April 2015, with 2016 showing further increases. This can be seen in Figure 1.

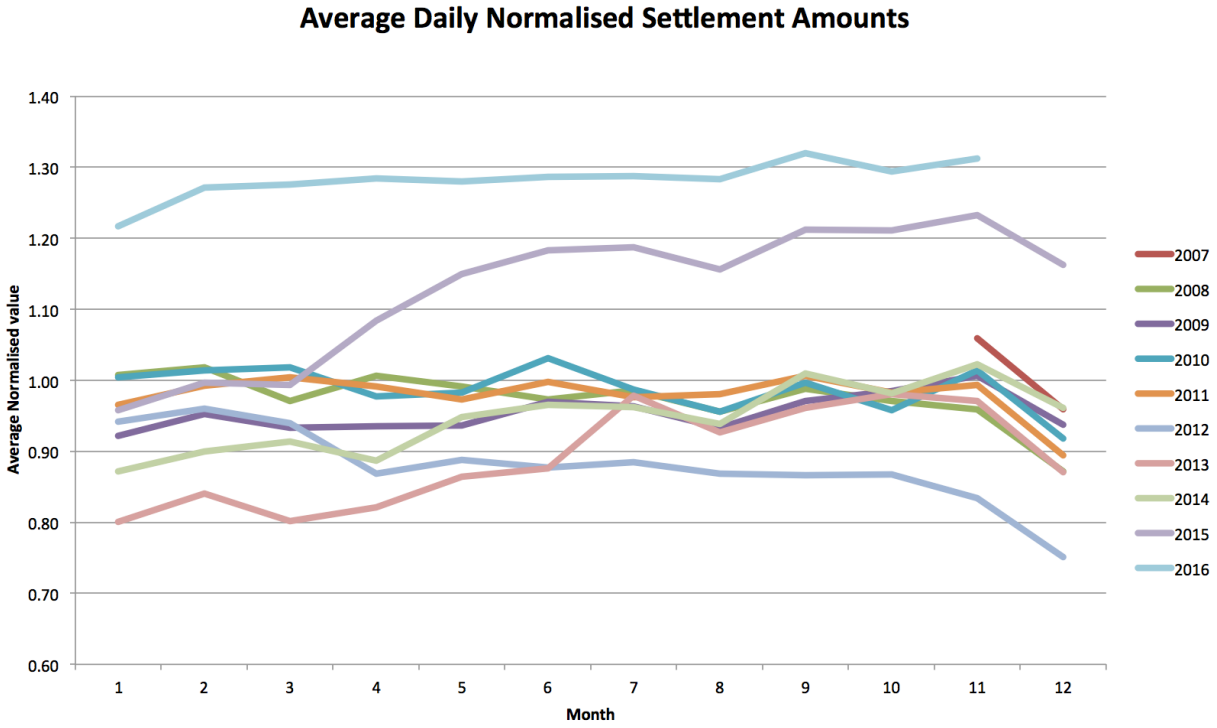

Figure 1: Average Daily Normalised Settlement Amounts by Month and Year

It is intended that the parameters will be reviewed on an annual basis based on the data from the previous year. For the analysis undertaken as part of this report, a one-year period of data was selected from 1 November 2015 through to 31 October 2016. This is the most recent full year of the data supplied for which the necessary forward looking calculations of realised exposure can be calculated. Unlike a calendar year, the sample also has the advantage of being able to model the end of year dip in the interior of the sample, rather than at a boundary of the sample which would potentially interrupt some adjustment mechanisms.

Figure 2 shows the metered demand and associated settlement amounts over the data period used in determination of the credit cover parameters. The metered demand is fairly constant showing a weekly cycle as expected from the steady state supplier data. The dip over the Christmas and New Year period is also clearly shown to be related to volume and not price. The settlement amounts on the other hand show more variation due to the effect of both price and volume. While there is a drop over the Christmas period it is not as marked. There is a definite increase from October onwards implying higher prices in the market.

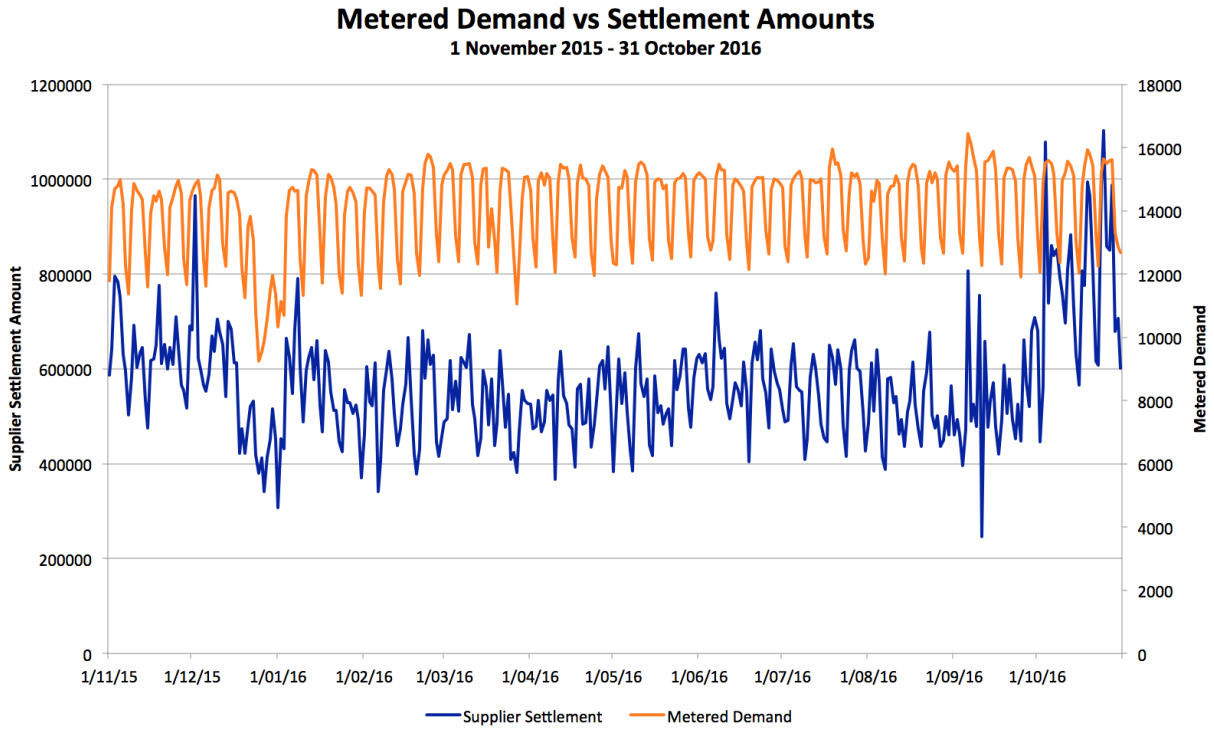

Figure 2: Metered Demand vs Settlement Amounts

Figure 3 shows the effect of the higher settlement amounts on the Daily Undefined Exposure with a significant jump in exposure levels.

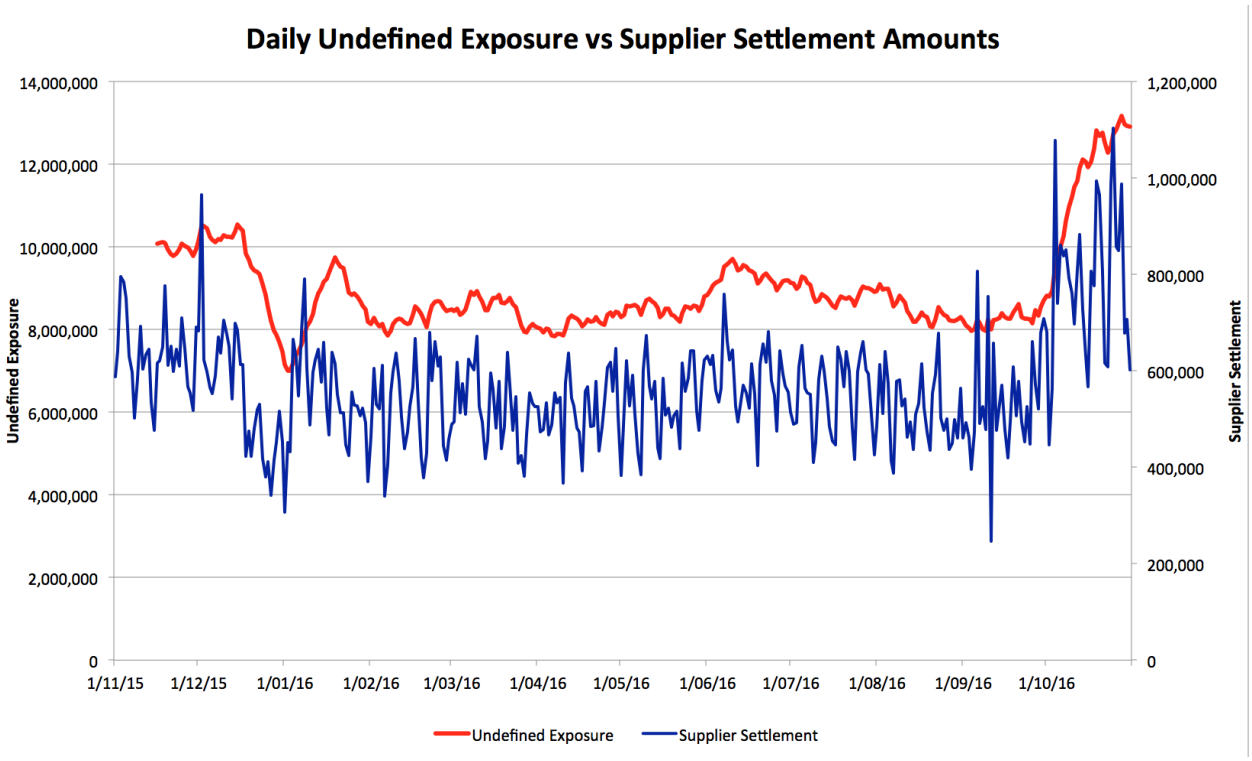

Figure 3: Daily Undefined Exposure vs Supplier Settlement Amounts

The key observation is that settlement amounts, and therefore Undefined Exposure are dependent on both volume and price variation. Importantly, the sample data year has episodes of each with volume reductions driving the end of year dip in settlement amounts, and price increases driving the end of sample increase in settlement amounts.

The methodology for analysing many of the parameters in this report rely on comparisons between the realised Undefined Exposure (calculated retrospectively once actual settlement amounts are available) with the estimated Undefined Exposure calculated using the different options for the parameter in question. This difference is known as the Undefined Exposure Variance. This is not a Code term, but is can be a comparison between the estimated Undefined Exposure and realised Undefined Exposure in a period, and can be calculated as the percentage difference between the estimated Undefined Exposure (as defined in the credit cover calculations) and the realised Undefined Exposure.

The important aspects of the Undefined Exposure Variance comparison value are:

- Where the Undefined Exposure Variance percentage is > 0%, or the estimated Undefined Exposure is greater than the realised Undefined Exposure, it is an indication that the calculation of Credit Cover for the Participant would have been over estimated;
- Where the Undefined Exposure Variance percentage < 0%, or the estimated Undefined Exposure is less than the realised Undefined Exposure, it is an indication that the calculation of Credit Cover for the Participant would have been under estimated.

Figure 4 shows the Undefined Exposure Variance for the “steady supplier” whose data was used for this analysis over the sample period with the recommended values for the Credit Cover Parameters. This shows the maximum credit cover shortfalls of approximately 30%, and maximum credit cover surplus of approximately 50%, would have occurred in the sample year using these settings. The maximum shortfall was primarily driven by a period of prolonged increases in SMP, while the maximum surplus was primarily driven by a decrease in the demand for the supplier.

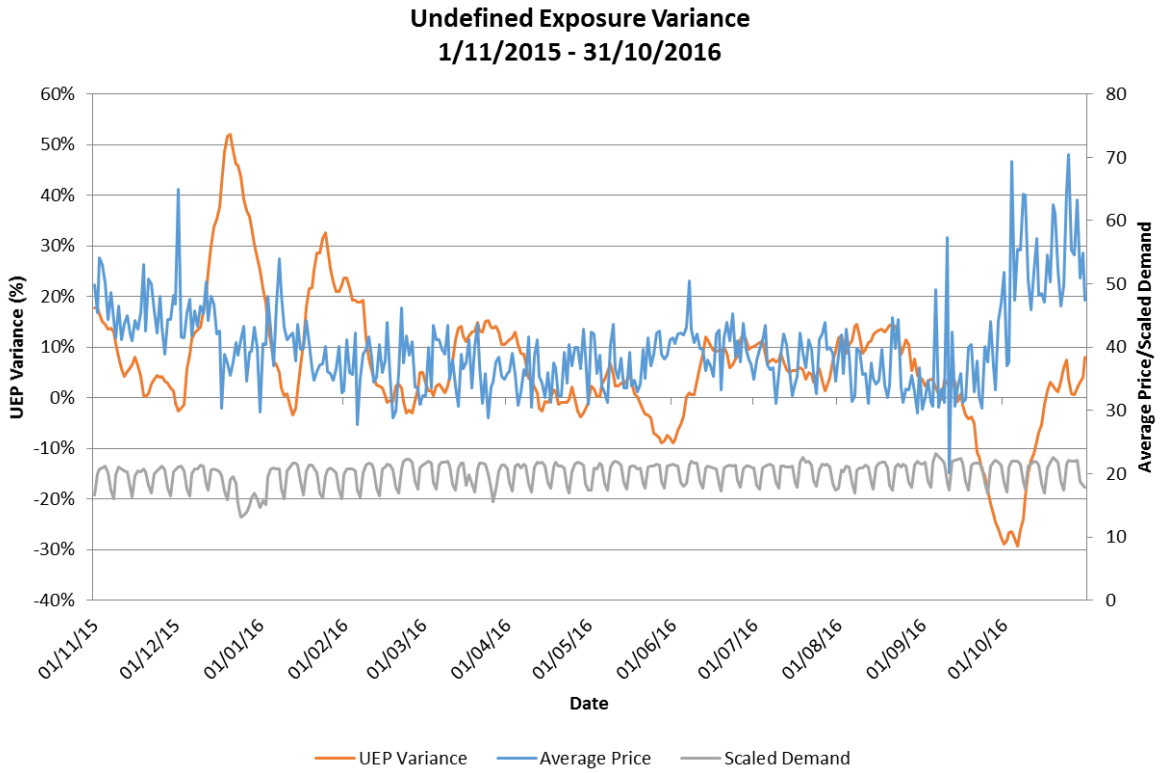

Figure 4: Undefined Exposure Variance for "Steady Supplier" using Recommended Parameter Values

The Trading and Settlement Code equation for the calculation of forecast amounts has two components, the "Point Estimate Component" and the "Deviation Component", as highlighted below taking the equation in the draft Code for the Billing Period Undefined Exposure Quantity calculation for Supplier Units (section G.17.7.6):

"G.17.7.6 The Billing Period Undefined Potential Exposure Quantity ($QUPEB_{pg}$) to be applied for Participant p in respect of its Supplier Units for the Undefined Exposure Period g shall be calculated as follows:

$$QUPEB_{pg} = QMBM_{pg} + AnPP\left(QMBSD_{pg}\right)$$

where:

(a) $QMBM_{pg}$ is the mean of the Billing Period Metered Demand for Participant p in respect of its Supplier Units to be applied for the Undefined Exposure Period g for all Undefined Exposure Periods in the Historical Assessment Period as calculated in accordance with paragraph G.14.7.4;

(b) AnPP is the Analysis Percentile Parameter applicable for Undefined Exposure Period g; and

(c) $QMBSD_{pg}$ is the standard deviation of the Billing Period Metered Demand for Participant p in respect of its Supplier Units for all Sample Undefined Exposure Periods ω in the Historical Assessment Period to be applied for

Undefined Exposure Period g as calculated in accordance with paragraph G.14.7.5."

In this example, the "Point Estimate Component" is $QMBM_{pg}$, and it is an estimate of a single value of the quantity based on the average over a number of previous samples. The "Deviation Component" in the example is $AnPP(QMBSD_{pg})$, and it is an addition to the point estimate to ensure the estimate covers statistically likely values (through the standard deviation calculation) to a certain confidence level (through the Analysis Percentile Parameter). The values of each of these two components for different options for the parameter in question can be used in comparisons to determine the most appropriate value for the parameter.

2. Fixed Credit Requirement Parameter

2.1 Background

The Fixed Credit Requirement for a Participant in a Year (known as FCR_{py} in the Trading and Settlement Code) is part of the current SEM design and is considered the minimum credit cover requirement for any Participant. While the other components of the credit cover calculation relate to recent short-term activity, and the undefined exposure is a statistical estimate of future risk, changes relating to month+4 and month+13 Settlement Reruns (for periods for which resettlement has not yet happened) are not captured in this approach. Also, the statistical approach only provides an estimate of possible exposure and can be susceptible to significant swings in demand or price which make its results inaccurate, as does the transition between different seasons (where the summer load is used in the estimate of exposure into the autumn period). These inaccuracies are taken into account in the development of the Fixed Credit Requirement. This is a value which is calculated for each Generator Unit and Supplier Unit separately. A value will be required for all trading unit types, including Assetless Units and Trading Units.

2.2 Considerations

The Fixed Credit Requirement is based on the total resettlement amounts in M+4 and M+13 timeframes, as the FCR is intended to cover the potential amounts arising in resettlement. In the SEM, the potential amounts arising from resettlement are assessed based on past total resettlement amounts in those timeframes to ensure that the amount of this credit cover present is sufficient to cover the resettlement amount in a majority of cases. This is because the aspects which drive resettlements in the SEM are largely the same year-on-year. However there are differences in the structure of the market, and in the data whose changes could result in payments arising in Settlement Reruns, which would mean that a using current market data may not be an appropriate reflection of the I-SEM arrangements required in an analysis of Fixed Credit Requirement.

It would be possible, with operational data, to carry out an analysis which would more accurately determine the typical payments arising from Settlement Reruns for different categories of Participant, and from this to determine a Fixed Credit Requirement which can meet the trade-off of being sufficient to cover most of these cases without being so high that it becomes an onerous financial burden. However, in the absence of operational data, it may be more appropriate to retain the current values. There has been operational experience to date of these values being sufficient to cover typical payments arising from Settlement Reruns without being overly burdensome, and as many of the drivers for these payments remain the same in the I-SEM the current values may be sufficient to maintain the incentives in the I-SEM. Once more operational experience of the I-SEM has been gained, it may be possible to tweak these values to reflect the other drivers of payments arising in Settlement Reruns.

Generator Units would have potential data changes in items such as metered quantity and dispatch instructions which would not be experienced by Assetless Units and Trading Units. However all of these units share a source for potential changes between settlement runs in ex-ante market trade data. This means that Trading Units and Assetless Units are seen as largely the same, when considering their potential for payments due to Settlement Reruns. The payment amounts which could potentially arise from Settlement Reruns would also be of a similar magnitude to that of Generator Units due to similar sources of data. Ex-ante market trade data changes would likely be large volume differences, given the potential reasons for the values of the contracted quantities used to calculate it being incorrect, including missing files, incorrect application of contract rejection functionality, etc. Therefore for the first year of operation all Generator Units, including Assetless Units and Trading Units, could be considered as the same in terms of the value of Fixed Credit Requirement. In future years, with operational data, it may be possible to refine the values required for specific types of units.

It is uncertain if a Fixed Credit Requirement is necessary for Capacity Market Units. The potential requirement for fixed credit cover for a Capacity Market Unit would be if a change in Difference Charges were to arise from a Settlement Rerun. In most situations, a Capacity Market Unit and a Generator Unit would be the same physical entity. Therefore it may be sufficient to consider the requirement under the Generator Unit amounts. In the absence of operational data it is difficult to know if this would require an increase in the amount, however not all Generator Units will be Capacity Market Units actively receiving Capacity Payments. Therefore it may be unfair to increase the Generator Unit requirement to account for Difference Charges as it does not apply to all units.

The potential magnitude for amounts arising from Difference Charges is also quite large, therefore if a change in the charge were to arise from a Settlement Rerun the amount could be large. However, the likelihood of events where Difference Charges arise (i.e. where the prices of the reference markets rise above the Strike Price) are expected to be low. The likelihood of changes arising from Settlement Reruns may also be low considering that a large proportion of changes from Settlement Reruns arise from changes in metered quantities, while Difference Charges are primarily driven by traded quantities and prices. Therefore to have a large Fixed Credit Requirement for a Capacity Market Unit relative to the potential magnitude may be disproportionate to the likelihood of the event arising.

2.2.1 Gap Analysis

As this methodology is based on methodologies previously used for the determination of these parameters, the following table considers potential changes to the methodology to accurately incorporate any new context:

Current Approach	New Context	Change Required and Impact
Consider FCR separately for Supplier Unit, Generator	No longer have Interconnector Unit or Netting Generator Unit in design. Could	For the first year, consider Trading Unit and Assetless Unit as the same as Generator Units, in future years when analysing operational data they could be considered separately to see if a

Current Approach	New Context	Change Required and Impact
Unit, Netting Generator Unit, and Interconnector Unit	consider Trading Unit or Assetless Unit as new aspects of Energy Trading Arrangements design. Could also consider Capacity Market Unit as new aspect of the Capacity Market design.	different value could apply to units of that type. Further consideration of Capacity Market Units can be carried out when operational data becomes available.

2.3 Recommendation

The following reflect the recommendations of values for the Fixed Credit Requirement of different Participant types for go-live of the I-SEM:

- For Supplier Units the Fixed Credit Requirement should be calculated by using a rate of €8.77/MWh multiplied by the average daily demand of each unit subject to a minimum value of €1,000 and a maximum of €15,000;
- For Generator Units the Fixed Credit Requirement value of €5,000 should be maintained. This includes all units considered as Generator Units in the draft Trading and Settlement Code, including Assetless Units and Trading Units.

Analysis and operational experience in the SEM to date demonstrate that these parameters provide a balance between maintaining a low level of risk of bad debt while not over burdening Participants with credit cover requirements which could be seen as a barrier to entry or a barrier to continuation of trade.

It has not yet been determined if a separately defined Fixed Credit Requirement for Capacity Market Units would be necessary. As there is no operational experience with such a unit, for the first year of the operation of the I-SEM arrangements it is proposed that a value of zero is used, and this may be further considered with analysis of operational data. Feedback from Participants is welcome on this topic.

3. Number of Days in the Undefined Exposure Period

3.1 Background

The number of days in the Undefined Exposure Period, g (known as the parameter $UEPBD_g$ in the Trading and Settlement Code) is the period for which settlement amounts are not known, but where Participants are, or have the ability of, incurring further liability until they are removed from the market. It is used to determine the unknown element of a Participant's liability for the calculation of their Required Credit Cover.

3.2 Considerations

This parameter therefore needs to take into account all times where the liability of a Participant is not known at the time of carrying out a credit assessment, which can be summarised into the following two periods:

- The days in the future after the unit has been suspended from the market (which could arise following a credit assessment which indicates that the Participant's posted credit cover is insufficient to cover their Required Credit Cover, and the Participant fails to rectify this following issuance of a Credit Cover Increase Notice) where the unit could be still trading in the market until they have been removed from the market. The length of this period of time is considered in the Supplier Suspension Delay Period (SSDP) and Generator Suspension Delay Period (GSDP) parameters. The latest decision on these parameters is that the SSDP shall be 14 days, and the GSDP shall be 7 days (AIP-SEM-07-460).
- The days in the past for which Settlement Statements are not available at the time of carrying out the credit assessment. Initial settlement for a settlement day is carried out the following day (D+1) when metering data becomes available. When carrying out the credit assessment for any given Trading Day, a settlement statement is not available for that day or the previous day, as the latest day for which meter data is available is two days previous, therefore the Undefined Exposure Period must consider those days so that their exposure is included in the estimate.

A change in the timing of either of these components would drive a consideration for whether the Undefined Exposure Period needs to change. The rules design in the draft Trading and Settlement Code is based on an approach of a single Undefined Exposure Period for all units, which reflects the approach existing in the current SEM. Since a single value for all Participants is required, in order to ensure the market is as close to full collateralisation as possible it needs to consider the maximum of the lengths of time it takes to remove a Participant from the market.

This will ensure that collateral requirements for those Participants will not be intentionally underestimated, but may result in overcollateralisation of Participants who can be removed from the market quicker than the maximum amount of time required.

3.3 Recommendation

The number of days in the Undefined Exposure Period from go-live of the I-SEM is determined to be 16 days, maintaining the value from the current SEM.

4. Number of Days in the Historical Assessment Period

4.1 Background

The number of days in the Historical Assessment Period (known as the parameter DINHAP in the Trading and Settlement Code) is the number of days prior to the day of the issue of the latest relevant Settlement Document over which a statistical analysis of a Participant's incurred liabilities shall be undertaken in order to support the forecasting of undefined liabilities for that Participant. This will be the number of historical days over which the analysis of quantities, prices, or settlement values will be carried out for the purposes of forecasting values for the calculation of exposure over the Undefined Exposure Period, eventually used to determine the level of Required Credit Cover for each Participant.

As the credit cover arrangements for trading amounts and capacity amounts are aligned, a single Historical Assessment Period is used for both. Under the previous approach for credit cover for capacity amounts the assessment was based on past settlement amounts, and therefore a separate Historical Assessment Period to trading amounts was required in order to ensure the most accurate forecast of these amounts could be calculated given the different settlement timescales (i.e. monthly for capacity versus weekly for trading). However under the new approach for credit cover for capacity amounts the assessment is based on past metered demand quantities, the same metric used for the assessment of trading amounts, the accurate forecast of which is required to be the same for both and which is independent of the timing for settlement of capacity or trading amounts.

4.2 Considerations

The Analysis Percentile Parameter and DINHAP settings work together to provide an estimate of the Undefined Exposure, and by extension the Undefined Exposure Variance. The value for the number of days in the Historical Assessment Period is a driver of the Undefined Exposure Variance, as it determines the number of samples used for the forecast of liabilities and the number of samples used influences the accuracy of how the estimated Undefined Exposure mirrors the realised Undefined Exposure. Therefore the Undefined Exposure Variance will be used to assess the value to be proposed for the number of days in the Historical Assessment Period. To eliminate the effects of variations in demand, the analysis of this metric is carried out for a "steady supplier". This is a typical Supplier in the SEM with steady demand (i.e. demand which on average has not fluctuated over the course of the study period being considered).

The accuracy of the estimated Undefined Exposure calculated (i.e. the closer to zero the variance is), and cases where it results in a negative variance (i.e. difference between the two which is such that the Undefined Potential Exposure is less than the actual Undefined Exposure, indicating that there was insufficient credit to cover the

actual liability), can be compared between the different options to determine which is the most appropriate.

There may be trade-offs to consider – in ensuring the estimated Undefined Exposure is most accurate most of the time, this may result in more instances where the Undefined Potential Exposure is less than the actual Undefined Exposure which results in higher risk. If the instances where the estimated Undefined Exposure is less than the realised Undefined Exposure are minimised, this may result in other instances where the estimated Undefined Exposure does not accurately reflect the realised Undefined Exposure, resulting in Participants having to post more credit cover than they could otherwise have been required.

4.2.1 Gap Analysis

As this methodology is based on methodologies previously used for the determination of these parameters, the following table considers potential changes to the methodology to accurately incorporate any new context:

Current Approach	New Context	Change Required and Impact
Base analysis on single "steady supplier" only on the assumption that most of the time a Supplier Unit would be owing to the market.	Credit Cover requirements will influence Generator Units more than it has in the past.	No change needed for the first year following I-SEM go-live, as there is insufficient data for the calculation of the equivalent to estimated Undefined Exposure for Generator Units under the draft Code approach. However in future years potential changes to the methodology should be considered, where a Generator Unit component of the assessment is added, when there is sufficient data available of historic settlement amounts to draw analysis on the relationship between different lengths of the Historical Assessment Period and the accuracy in forecasting these amounts.
Compare estimated Undefined Exposure with realised Undefined Exposure which occurred to assess different options.	Estimated Undefined Exposure is no longer reflective of actual settlement amounts, it is reflective of what settlement amounts would be if all settlement were to occur in the imbalance	While the basis for the credit cover calculation is changing (from assessing past settlement amounts to assessing past quantities and prices), both the current and the future approaches try to represent the same thing. In the SEM, all supplier settlement is through the one market and so an assessment of past settlement amounts is appropriate to capture all potential future settlement amounts. In the I-SEM, the intention is also to capture all potential future settlement amounts in the Undefined Exposure Period which would arise if a Supplier Unit was settled entirely in the imbalance arrangements. However since in reality some of the unit's settlement could be through the ex-ante markets, an assessment of past settlement amounts would not indicate all potential future settlement amounts which would

Current Approach	New Context	Change Required and Impact
	arrangements.	arise if the unit was settled entirely through the imbalance arrangements. What this settlement would look like is represented by historical analysis of metered demand quantities and imbalance settlement prices, which in combination with fixed annual prices are used to determine all potential settlement amounts in the Undefined Exposure Period if the unit were to be settled entirely through the imbalance arrangements. As both approaches are trying to represent the same thing, it is reasonable for the parameters for the first year following I-SEM go-live to be determined based on the same methodology as currently used for Historical Assessment Period for Billing Periods. Future iterations of this analysis will need to compare the estimated Undefined Exposure (i.e. in new code parlance, the Exposure for Trading Payments and Charges) with what the Undefined Exposure would have been had all settlement occurred through imbalance arrangements, rather than compare estimated Undefined Exposure with realised Undefined Exposure from actual settlement amounts. This could also be done by separately analysing the components of the Undefined Potential Exposure – for Supplier Units, the accuracy of forecasting the metered demand quantities, for Generator Units the accuracy of forecasting the settlement amounts, and for all units, the accuracy of forecasting the Imbalance Settlement Prices.
Have two values separate values for considering energy and capacity amounts	Credit Cover approach is aligned for energy and capacity, therefore only require one value	A historical assessment of past settlement amounts, which represent all energy settlement amounts of a Supplier Unit, is analogous to a historical assessment of past metered demand quantities and Imbalance Settlement Prices for the calculation of what the energy settlement amounts of a Supplier Unit would have been had all settlement been through the Imbalance Arrangements. The only forecast element used in the calculation of credit cover in respect of capacity charges in the new arrangements is the metered demand. As this is implicitly determined through the historical

Current Approach	New Context	Change Required and Impact
		assessment of past settlement amounts which represent all energy settlement amounts of a Supplier Unit, it is proposed that for year one after I-SEM go-live a single approach, based on the current approach for determining the Historical Assessment Period for Billing Periods (as this is related to energy settlement) is sufficient for the determination of the length of the Historical Assessment Period on determining the Undefined Exposure Variance for aspects relating to capacity.

4.3 Results and Analysis

Of the two components the deviation component is by far the smaller, as shown in Figure 5 and Figure 6. The standard deviation on which this is based is defined as the standard deviation of all Sample Undefined Exposure Periods within the Historical Assessment Period. As explained earlier, for small DINHAP values this results in poor (and generally low) estimates of the standard deviation. Larger DINHAP results in more samples and in more consistent (and generally larger) estimates of the standard deviation. As shown in Figure 5 and Figure 6 the increase of DINHAP from 20 days to 90 days results in significantly greater deviation components in the estimated Undefined Exposure.

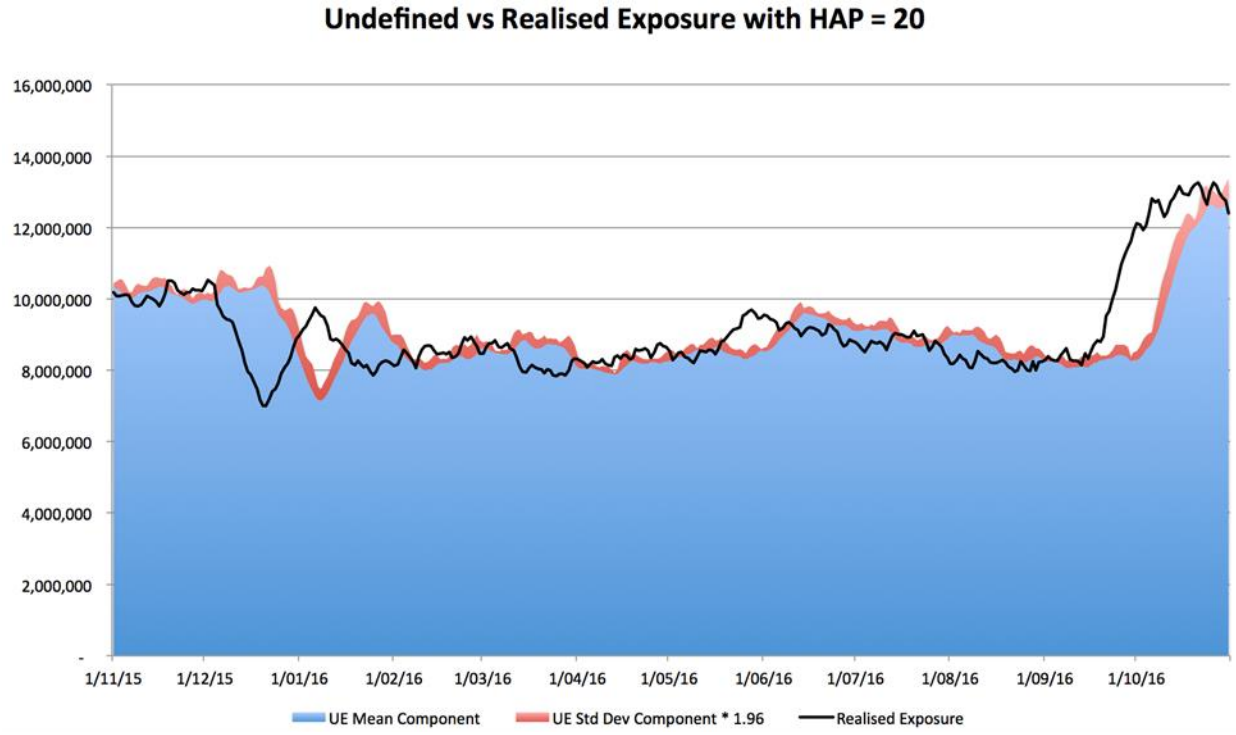

Figure 5: Estimated Undefined Exposure vs Realised Undefined Exposure with DINHAP = 20

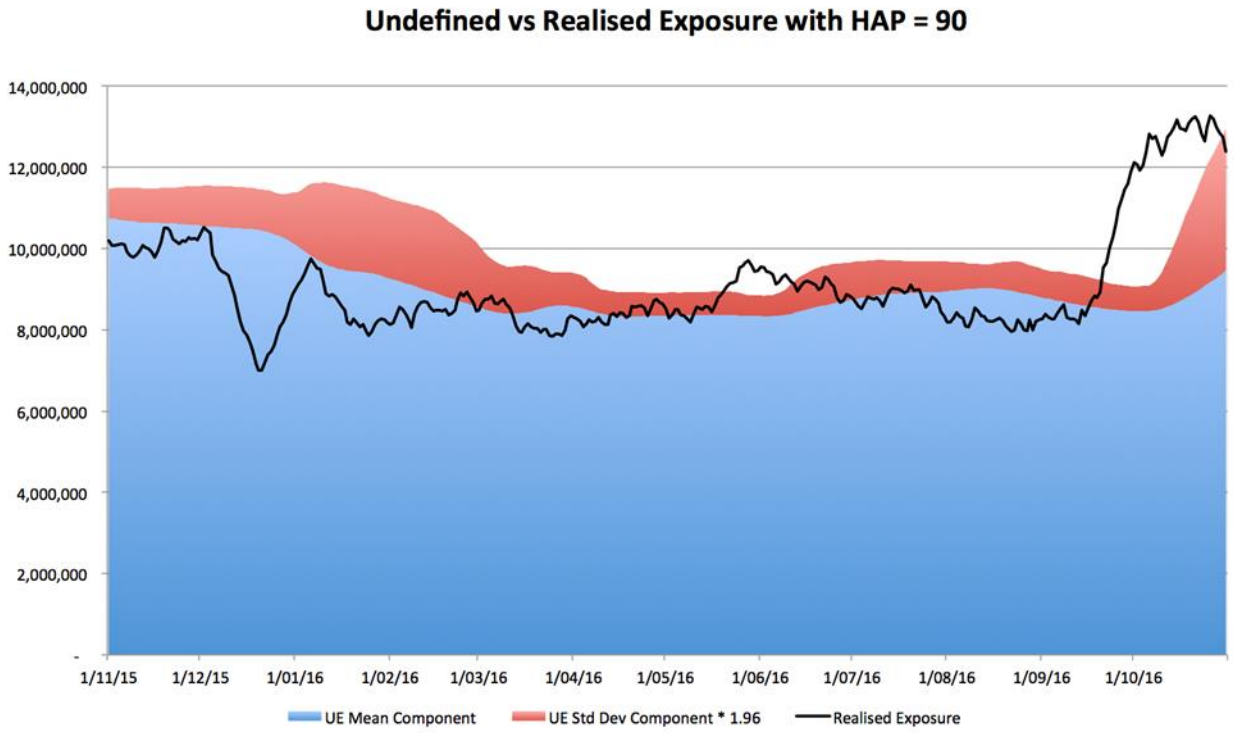

Figure 6: Estimated Undefined Exposure vs Realised Undefined Exposure with DINHAP = 90

One of the disbenefits of this approach is seen in the second chart. The application of the standard deviation is in some instances counter-intuitive to the construction of estimated Undefined Exposure, for example around the Christmas period, when settlements drop significantly, the deviation component increases so that the actual level of credit cover required increases when settlement amount are dropping. On this occasion the problem is short lived, but such an effect is possible at other times of the year also.

DINHAP reflects the number of periods for which the sample undefined exposure and its standard deviation are calculated. As DINHAP is increased the estimate of the standard deviation of undefined exposure improves, and generally grows larger, as correlation over small samples is more influential in reducing the estimate of the standard deviation. Conversely, the longer DINHAP is, the slower the system reacts to changes in the market.

From the perspective of credit cover, a faster adjustment speed to changing market realities will reduce under collateralisation when settlement amounts increase quickly. Setting DINHAP at a value of 20 days, with AnPP fixed at 2.33 (reflecting the recommended value for the parameter outlined in Section 5), yields Figure 7, which shows the evolution of estimated Undefined Exposure against realised Undefined Exposure for these settings.

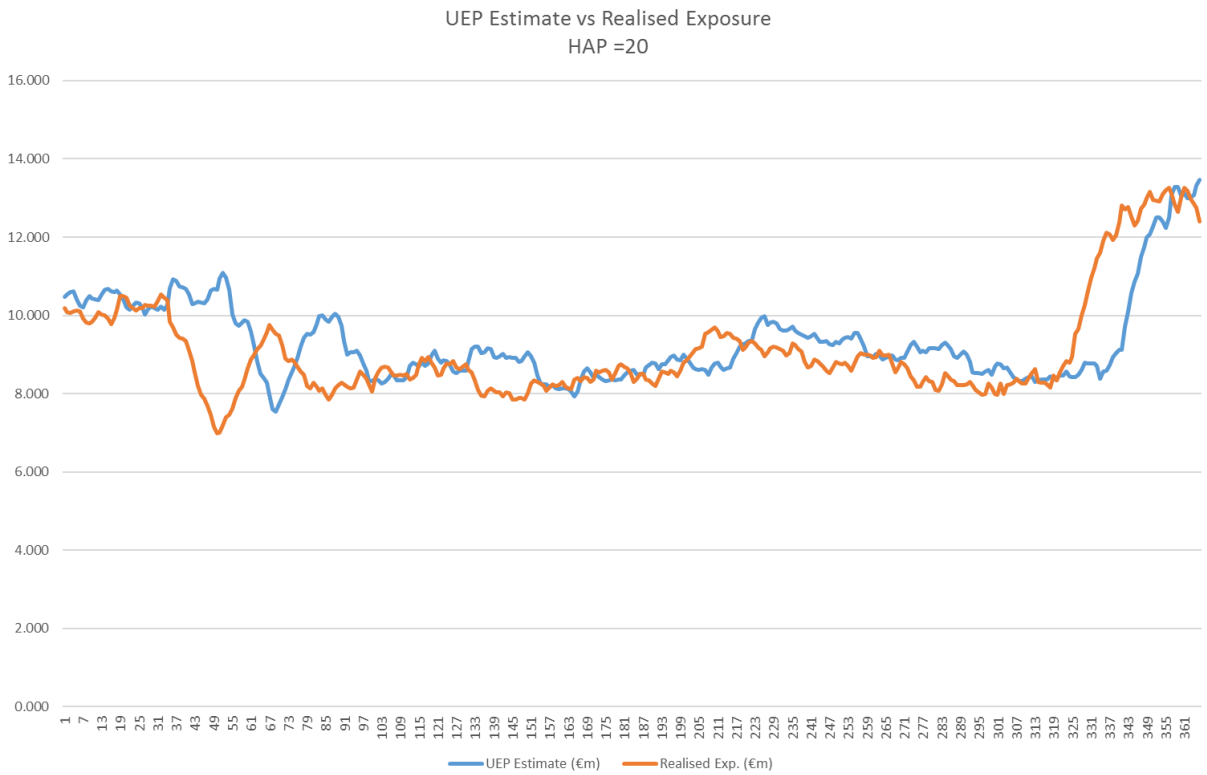

Figure 7: Estimated Undefined Exposure vs Realised Undefined Exposure over the Study Year in €m with DINHAP = 20

While a DINHAP setting of 20 days ensures the Undefined Exposure point estimate is responsive, the standard deviation that corresponds with a DINHAP of 20 days is very small, as would be expected for the variance between five correlated sums.

Examining a DINHAP setting of 30 days yields Figure 8.

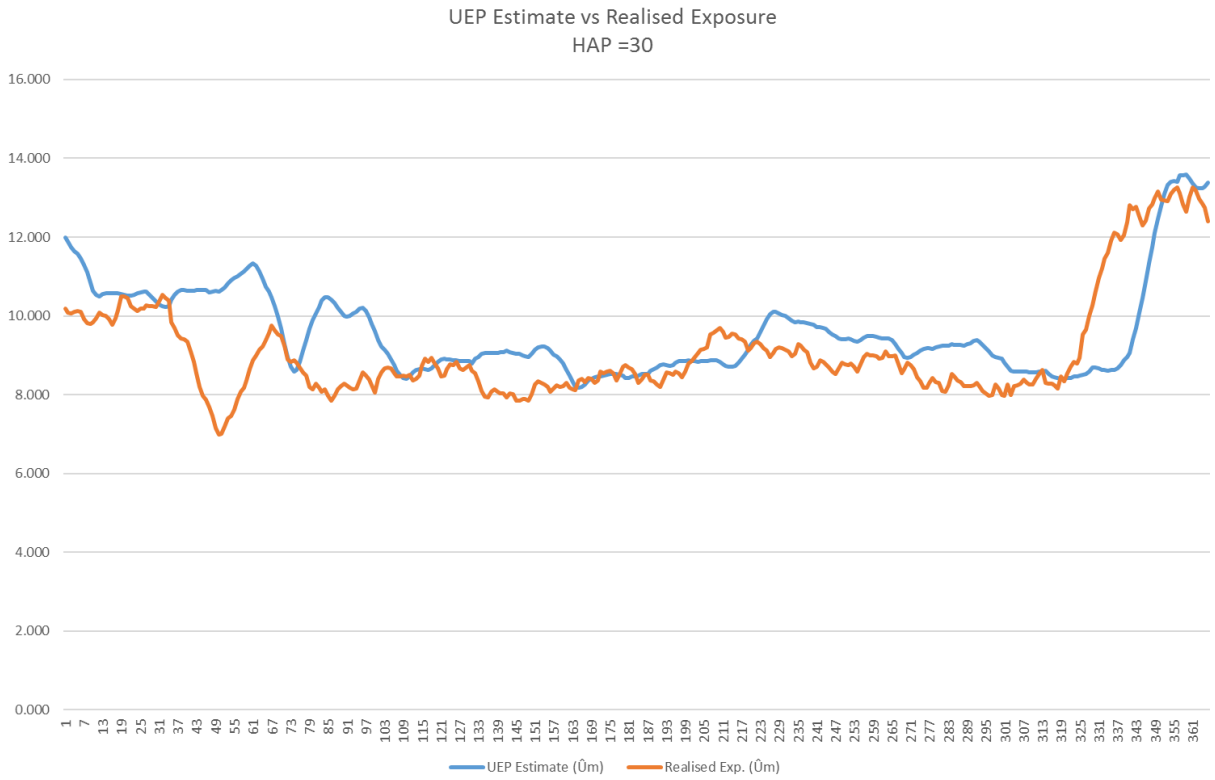

Figure 8: Estimated Undefined Exposure vs Realised Undefined Exposure over the Study Year in €m with DINHAP = 30

As shown in Figure 8, increasing the DINHAP setting to 30 days reduces the responsiveness of the Undefined Exposure point estimate. The estimated Undefined Exposure is naturally smoother and generally provides more coverage on account of the higher standard deviation estimate associated with it. However there is a delay in the response to the price related change in settlement amounts at the end of the year.

Examining a DINHAP setting of 45 days yields Figure 9.

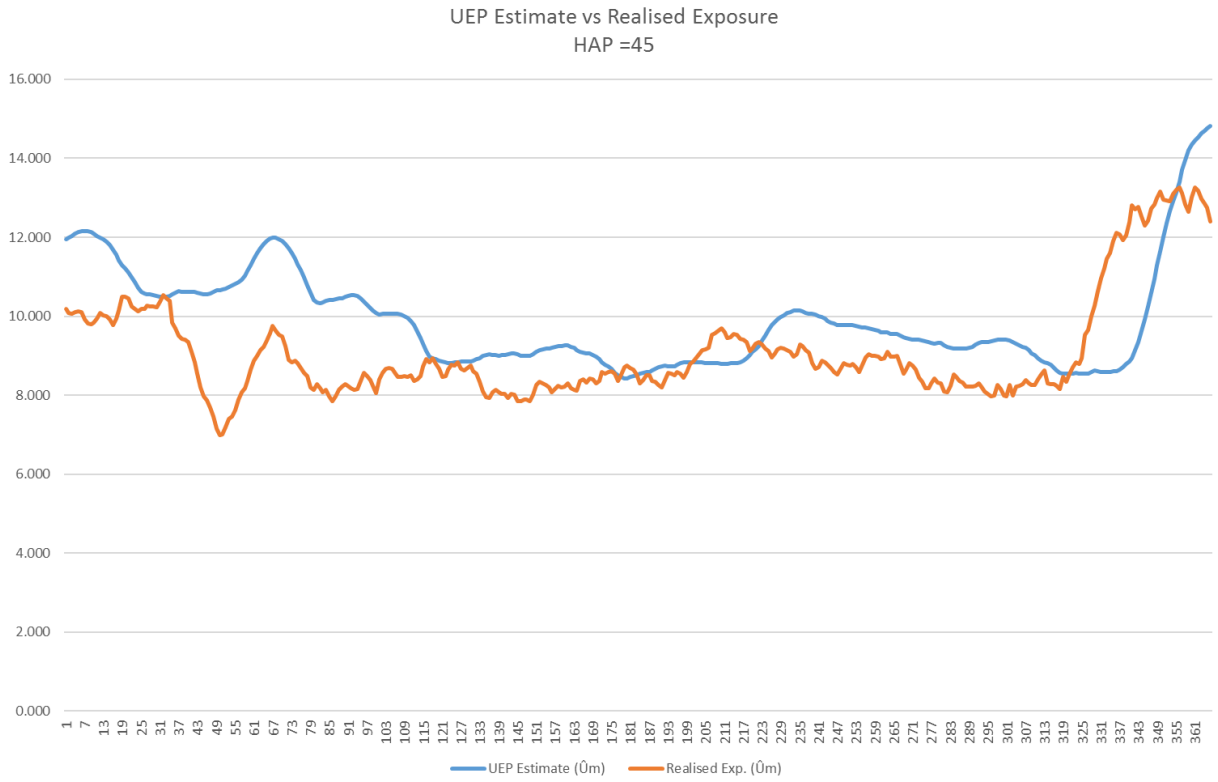

Figure 9: Estimated Undefined Exposure vs Realised Undefined Exposure over the Study Year in €m with DINHAP = 20

As shown in Figure 9, increasing the DINHAP setting to 45 days further reduces the responsiveness of the Undefined Exposure point estimate. Offsetting that is an additional increase in the standard deviation estimate. This increase is causing a noticeable increase in collateralisation requirements throughout the year except when most required.

Of the three options for DINHAP investigated:

- 20 days had the largest level of total undercollateralisation over the study period, while 30 days had the smallest; and
- 45 days had the largest peak daily undercollateralisation over the study period, while 20 days had the smallest (with 30 days being marginally larger).

There are limitations to this approach as the longer the DINHAP the more each measure becomes data dependent. In this case, longer DINHAP stretching back through the year incorporate other high price periods which improve the estimated Undefined Exposure when prices rise towards the end of the sample. However, in cases where prior prices were lower, these measures would accentuate the effect. Accordingly, this approach for determining DINHAP is best employed for DINHAP in which there is stability prior to the particular event or market shock that drives assessment of parameter performance.

Aside from the influence of past data, there is a conceptual trade-off in DINHAP selection between quicker adjustment of Undefined Exposure estimates and better

Undefined Exposure standard deviation measures, with diminishing returns to scale in terms of the quality of the standard deviation estimate. In practice, the minimum peak undercollateralisation was achieved with DINHAP of 20 days, although this resulted in a poor standard deviation estimate and higher total undercollateralisation. Increasing to a DINHAP of 30 days improved the standard deviation estimate at the expense of a quicker adjustment. Going further, to 45 days provided no further benefit. Beyond that, the influence of data clouds the issue, but slower adjustment is not likely to improve either the peak or total undercollateralisation.

4.4 Recommendation

The number of days in the Historical Assessment Period from go-live of the I-SEM is recommended to be 30 days, representing a compromise between quicker adjustments and robust standard deviation estimates.

5. Analysis Percentile Parameter

5.1 Background

The Analysis Percentile Parameter (known as the AnPP in the Trading and Settlement Code) sets the percentile confidence value in the statistical analysis for determining the Undefined Exposure of a Participant. The Analysis Percentile Parameter is the z score taken from the standard normal distribution that corresponds to the Analysis Percentile, representing the number of standard deviations from the mean taken in the statistical analysis (i.e. a value of 1.96 is equivalent to 95% confidence).

5.2 Considerations

The value for the Analysis Percentile Parameter is a driver of the Undefined Exposure Variance, as it determines the degree of statistical confidence that the forecast values used to calculate the forecast liabilities (or the estimated Undefined Exposure) will cover the actual liabilities (or the realised Undefined Exposure). The value chosen for the Analysis Percentile Parameter therefore must consider a trade-off between the level of risk being taken in ensuring that credit cover is always sufficient to match potential liabilities, and the accuracy of how the estimated Undefined Exposure mirrors the realised Undefined Exposure. Therefore the Undefined Exposure Variance will be used to assess the value to be proposed for the number of days in the Historical Assessment Period.

5.2.1 Gap Analysis

As this methodology is based on methodologies previously used for the determination of these parameters, the following table considers potential changes to the methodology to accurately incorporate any new context:

Current Approach	New Context	Change Required and Impact
Base analysis on single “steady supplier” only on the assumption that most of the time a Supplier Unit would be owing to the market.	Credit Cover requirements will influence Generator Units more than it has in the past.	Same note as under Section 4.2.1.
Compare estimated Undefined Exposure with realised Undefined Exposure which occurred to assess different options.	Estimated Undefined Exposure is no longer reflective of actual settlement amounts, it is reflective of what settlement amounts would be if all settlement were to occur in the imbalance arrangements.	Same note as under Section 4.2.1.

5.3 Results and Analysis

The "Point Estimate Error" is calculated as the difference between the Point Estimate Component of the calculated Undefined Exposure and the realised Undefined Exposure. This error can then be compared with the Deviation Component to see the extent to which it adequately covers the range of statistical possibilities so that it offsets any shortfalls in the Point Estimate Component. The performance of different values of AnPP can then be compared, as AnPP should be set to provide enough cover to allow for imperfection in the Undefined Exposure point estimate.

In examining the various options for the choice of AnPP, it became clear that the settings make little difference to either the Undefined Exposure Variance, or the amount of collateral that Participants would be required to provide. Analysis in previous years (for example as outlined in the report SEM-16-057d) highlighted this point. As it is the goal of the AnPP setting to mitigate the difference between the point estimate of undefined exposure and the realised exposure, it is important to set a value that achieves this outcome. A higher value than that currently used in the SEM could improve this outcome of mitigating against shortfalls created by estimating error, while not creating a burdensome increase in the credit cover required by a Participant. Therefore out of the options analysed in previous years as options for AnPP, the maximum, 2.33 (representing a 98% percentile confidence), should be used.

Figure 10 shows the extent to which the AnPP multiplied by the standard deviation of sample undefined exposure achieves this goal if we consider a Historical Assessment Period of 90 days, representative of today's Historical Assessment Period length.

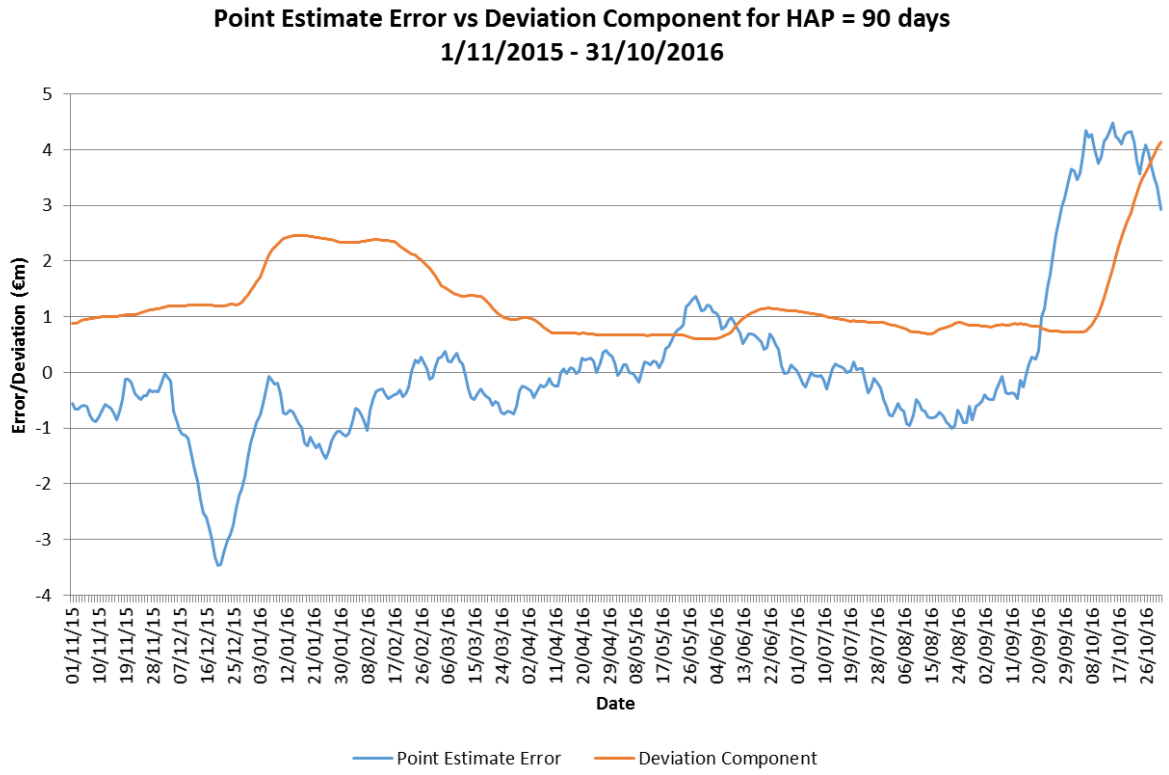

Figure 10: Point Estimate Error vs Deviation Component with DINHAP = 90 days

Figure 11 shows the extent to which the AnPP multiplied by the standard deviation of sample undefined exposure achieves this goal if we consider a Historical Assessment Period of 30 days, the proposed length of this period.

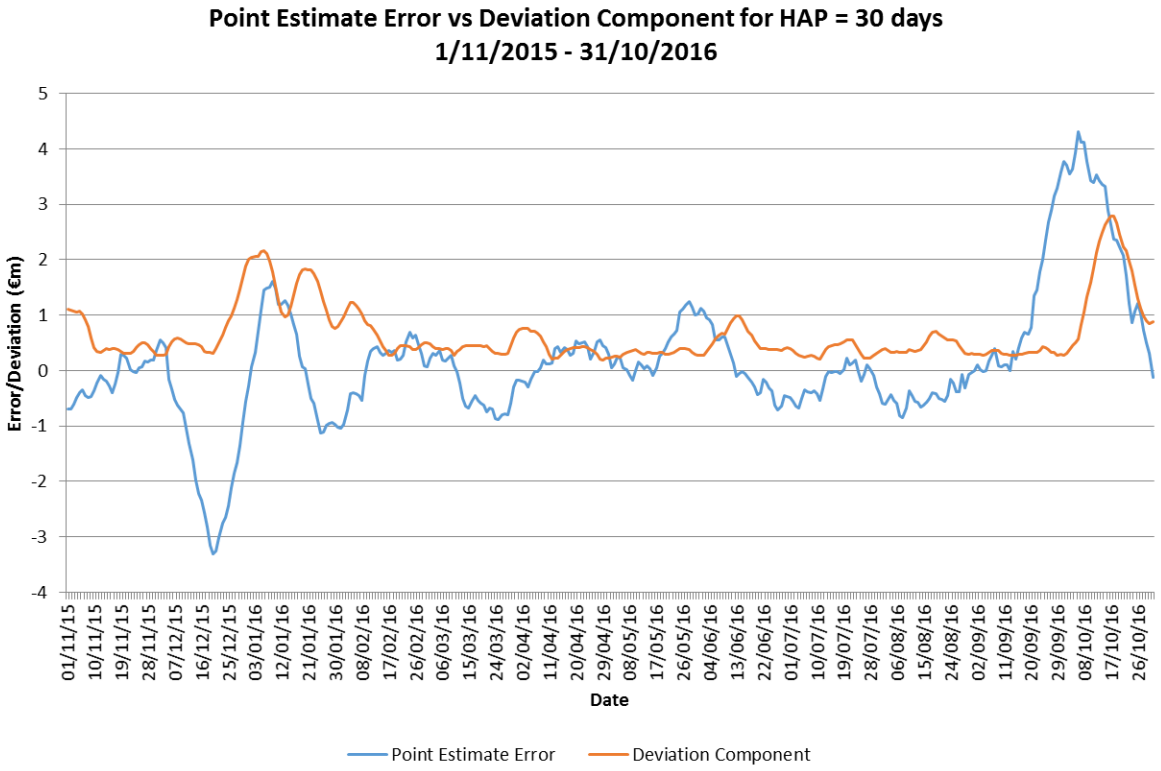

Figure 11: Point Estimate Error vs Deviation Component with DINHAP = 30 days

As can be seen from Figure 10 and Figure 11, the influence of the AnPP setting, even at this higher value, is sufficient to accommodate the standard fluctuations that occur in the middle of the sample, but it is insufficient to address more serious fluctuations such as occur near the start of the sample. Choosing a lower value would result in more exposure in those periods where credit cover is most likely to called upon. Although the performance of the AnPP is improved over the longer Historical Assessment Period, as the standard deviation is larger, the parameter setting is still inadequate during those periods when it is required the most, and there is therefore little scope for consideration of a lower setting for the same reason discussed above.

5.4 Recommendation

A value of 2.33 is recommended for the Analysis Percentile Parameter from go-live of the I-SEM, as it would improve the mitigation against shortfalls between estimated and realised Undefined Exposure created by estimating error, while not creating a burdensome increase in the credit cover required by a Participant.

6. Credit Cover Adjustment Trigger

6.1 Background

The Credit Cover Adjustment Trigger is the expected percentage change (increase or decrease) in future generation or demand above which a Participant is required to report to SEMO that it should become an Adjusted Participant, rather than a Standard Participant and have its Credit Cover requirements calculated on the basis of its forecasts of future demand or generation. While in the I-SEM it is expected that more volumes will be traded in the ex-ante markets, it is still feasible that a Participant can deliberately leave a portion of its trading to the imbalance arrangements. Use of the Credit Cover Adjustment Trigger will reduce the need for sudden Credit Cover Increase Notices when a Participant's level of exposure rises unexpectedly.

The statistical calculations for Standard Participants as set out in the draft market rules assume a normal distribution and, as such, work to a reasonable effectiveness when Participant volumes of trade are not subject to major fluctuations. However, this assumption is not maintained under certain market conditions. The statistical calculations are intended to accommodate small changes in Participants demand/generation profiles, and therefore where a step change in the demand/generation profile occurs, the statistical basis will not be effective. A step change in the demand/generation profile of a Participant may be caused by a number of events including but not limited to:

- acquisition of new assets;
- winning significant new customers in the retail market; or
- significant generator planned outage.

6.2 Considerations

This parameter is required as an indication of what is the acceptable level of inaccuracy in the estimated Undefined Exposure to try and match the realised Undefined Exposure. Like with other parameters, the assessment of this parameter is subject to comparison of trade-offs. The lower the value of this parameter, the more accurate the estimated Undefined Exposure will be in matching the realised Undefined Exposure, dependant on how accurate the Participant's forecast of the change in their generation/demand profile is. However it would result in greater instances of deviating from the standard credit cover approach, increasing the workload for Participants in having to regularly submit forecasts of demand/generation profiles for what may be a small benefit. This could have a disproportionate impact on smaller Participants, for whom a percentage change in their profile could result from a relatively small increase or decrease in the number of their retail customers.

The higher the value for this trigger, the more the standard process for determining credit cover will be used and therefore the burden of requiring submission of forecast changes is reduced. However it would result in more time, and for larger amounts,

where there are differences between the estimated Undefined Exposure and the realised Undefined Exposure. This could result in a Participant being over-collateralised in cases where their change was for a reduction in their settlement amounts (resulting from a reduction in their demand or generation), and being under-collateralised (and therefore resulting in increased market risk) in cases where their changes was for an increase in their settlement amounts (resulting from an increase in their demand or generation).

There appears to be two types of analysis which could be carried out to determine the value of this parameter:

- Analyse the instances in the past where changes in settlement amounts for a unit over the period considered for the Credit Cover Adjustment Trigger would have resulted in a requirement for them to declare themselves as an Adjusted Participant, for each option of the Credit Cover Adjustment Trigger being considered; and
- Analyse the Undefined Exposure Variance which would have occurred if the realised Undefined Exposure was greater than (to assess potential for under-collateralisation and market risk) or less than (to assess potential for overcollateralization and Participant burden) the estimated Undefined Exposure by the value of each option of the Credit Cover Adjustment Trigger being considered.

6.2.1 Gap Analysis

As this methodology is based on methodologies previously used for the determination of these parameters, the following table outlines any gaps which have arisen and need to be considered in potential changes to the methodology to accurately incorporate any new context:

Current Approach	New Context	Change Required and Impact
For both suppliers and generators the Credit Cover Adjustment Trigger is based on an expected change of Metered Quantities.	For suppliers, the trigger is based on expected changes in metered demand quantity, for generators it changes to being based on changes of settlement amounts.	Changes in settlement amounts for Generator Units can result from a broader base of reasons than changes in metered quantities, including: - Changes in metered quantities (due to the reasons such as prolonged outages and changes in assets); - Changes in traded quantities (and therefore level of potential imbalance when considered against changes in metered quantities); - Changes in Imbalance Settlement Prices; - Change in quantities and prices associated with Bid Offer Acceptances in the balancing market. A change in these components does not

Current Approach	New Context	Change Required and Impact
		necessarily result directly in a change in the settlement amounts. For example the increase in metered generation could be matched by the increase in traded quantities so that there is no imbalance and therefore no settlement amounts, resulting in no change. Bearing this in mind, a Participant should be able to forecast for certain circumstances where their settlement amounts are likely to change, for example if the unit has been the subject of many imbalance charges or payments for the past few weeks, and then was going on a prolonged outage, it is likely to stop being subject to these payments and charges. However in other circumstances it may not be able to forecast this, for example where a change in the offer prices of the generator submitted results in a change to the imbalance prices, bids and offers accepted, and premium/discount payments. Therefore an approach for determining a value for this parameter based on relative changes to settlement amounts has less importance for Generator Units – an approach which analyses situations where, based on past settlement amounts, the Participant would have had to declare itself as an Adjusted Participant in respect of its Generator Units would be more suitable, as this may pick up on situations where unexpected imbalances occurred, changes in the amount of times the unit was inc'd or dec'd, price changes, etc. Therefore the approach of calculating Undefined Exposure Variance for changes in realised Undefined Exposure to the amounts considered by Credit Cover Adjustment Triggers is more important for the analysis to consider Supplier Units, as a change in metered amounts will change the amounts considered for the calculation of required credit cover. The previous market approach analysed changes in settlement amounts as a proxy for changes in metered quantities. The basis of credit cover is the same for suppliers in the future, therefore this approach is applicable for the calculation of values for the first year following I-SEM go-live. For years

Current Approach	New Context	Change Required and Impact
		following that, the approach must adjust (as it needs to also for the number of days in the Historical Assessment Period, and the Analysis Percentile Parameter) to instead analyse changes in what the settlement amounts would have been had all settlement been through the imbalance arrangements.

6.3 Results and Analysis

The underlying basis of the credit cover parameter design is to develop an estimated Undefined Exposure based on statistical analysis and then deal by exception with discrete changes in the market, such as those that may result from takeovers, new entrants, or long term generator outages, for example. It is recognised that these events should not be covered by the standard parameters. With that in mind, the Credit Cover Adjustment Trigger (CCAT) is defined as a percentage change threshold, so that Participants anticipating a change beyond the CCAT must notify the market to become an adjusted Participant. The setting of the parameter is achieved by considering a time period with minimal seasonality and examining the implications of such a change. The criteria for setting the parameter are the maximum under collateralisation and the time taken to achieve cover after such an adjustment.

Figure 12 shows the effect of a CCAT event increasing metered demand by 30% (creating the Adjusted Demand) from the 15/07/2016 onwards, creating adjusted results for the estimated Undefined Exposure and the realised Undefined Exposure.

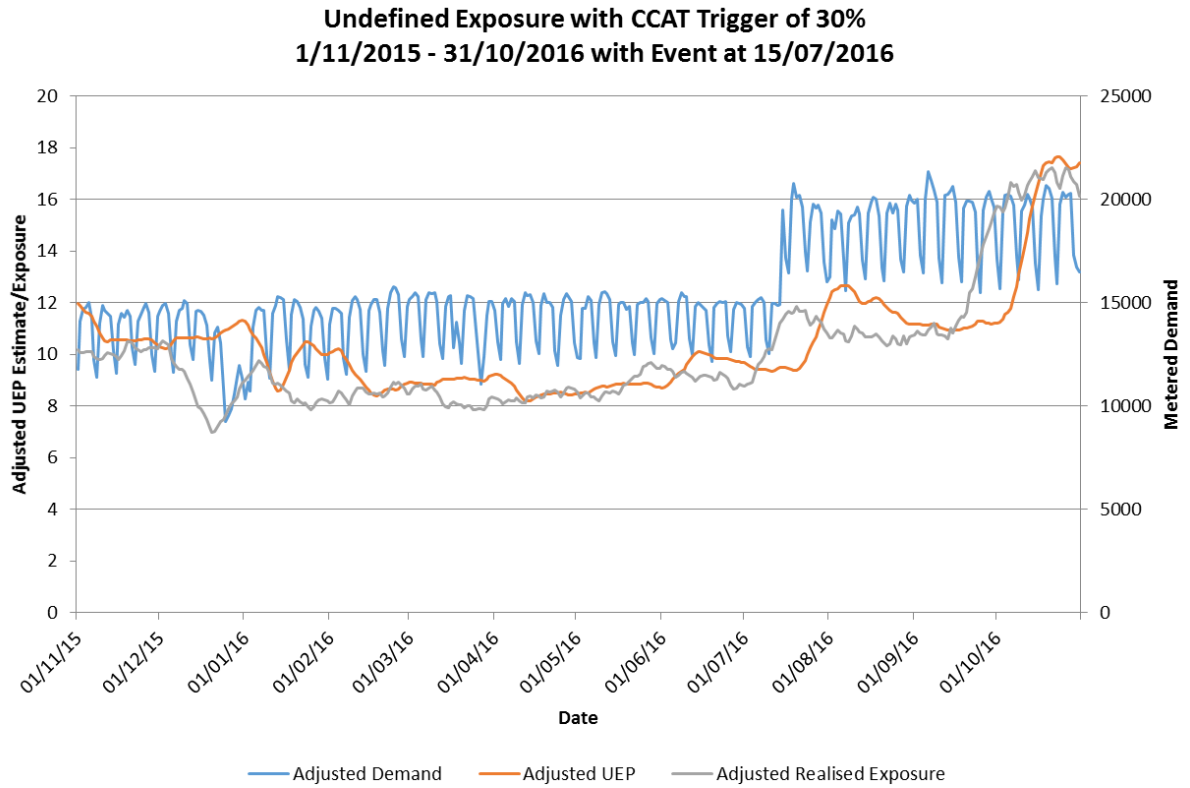

Figure 12: Undefined Exposure with CCAT Event of 30%

Demand increases instantaneously and is followed by Realised Exposure. The Adjusted Undefined Exposure follows at a lag, determined by the influence of previous parameter settings (AnPP = 2.33, DINHAP = 30) on the point estimate and standard deviation of Undefined Exposure. The under-collateralisation is significant in size and it takes almost a month to return to positive collateralisation, as we would expect with a Historical Assessment Period of 30 days, mitigated only slightly by the increase in estimated Undefined Exposure standard deviation that results from the CCAT event. The purpose of the CCAT is to separate out those events that may be considered “standard”, for which the usual parameters will suffice, and those that require specific adjustment or intervention. On that basis the setting is a threshold between standard and non-standard events, and the setting shown in Figure 12 is quite high.

We now consider a setting of 20%.

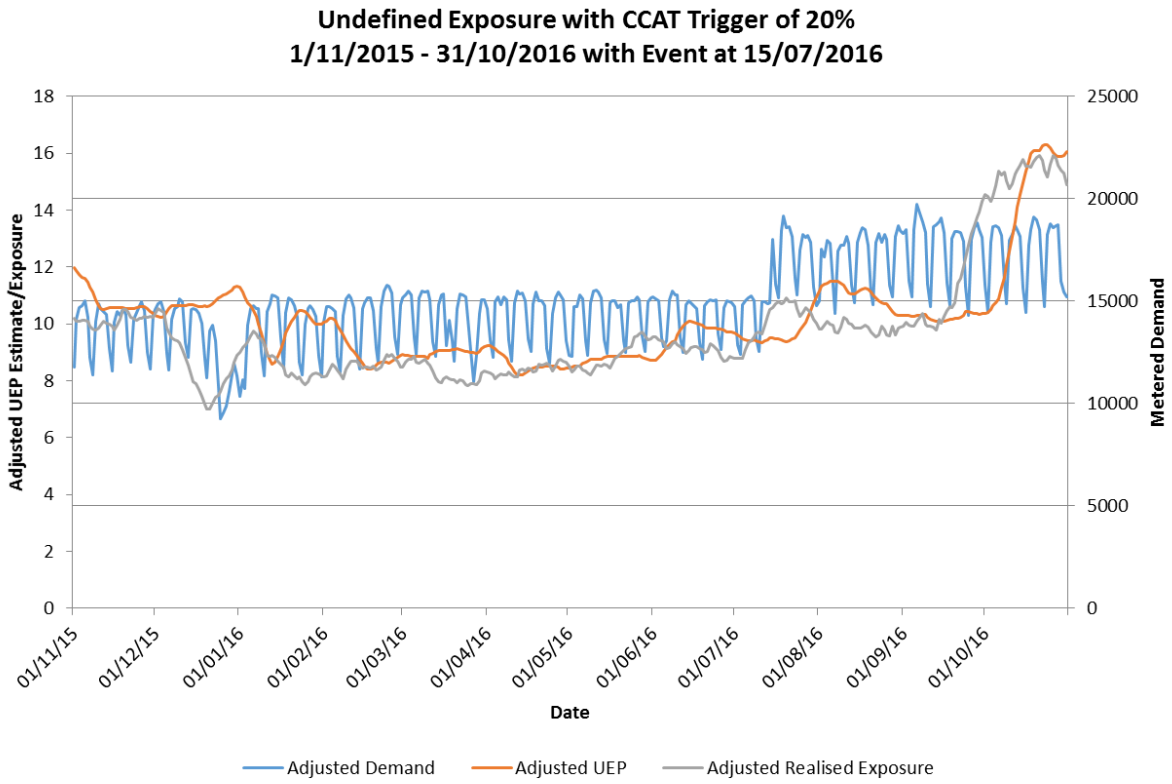

Figure 13: Undefined Exposure with CCAT Event of 20%

While less severe, the setting 20% setting shown in Figure 13 is again quite high and well outside the typical norms of fluctuation in the series.

Finally, in Figure 14, we consider an adjustment of 10%.

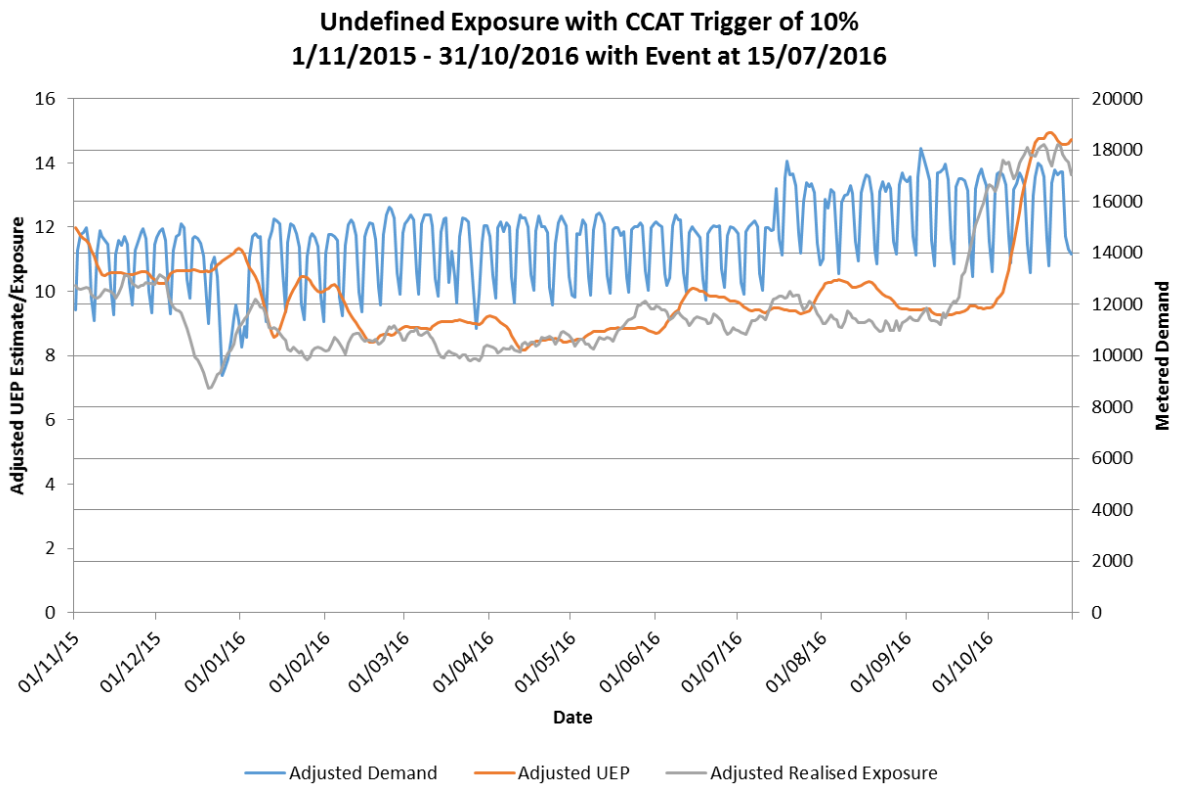

Figure 14: Undefined Exposure with CCAT Event of 10%

While still noticeable, the period and size of under-collateralisation is no larger than that which occurred in June. Lower levels of CCAT would improve that characteristic further but as the event is characterised by adjustment that is experienced in the normal course of trading there is no need to lower the threshold. Further, lowering the threshold would unnecessarily increase the frequency of adjustments required.

6.4 Recommendation

A value of 10% is recommended for the Credit Cover Adjustment Trigger from go-live of the I-SEM. Analysis indicates that this value would be low enough to reduce the potential impacts of shortfalls between estimated and realised Undefined Exposure created by discrete increases in the variables driving the calculation of estimated Undefined Exposure, while not being so low that it would disruptively increase of frequency in the use of alternative credit cover calculations.

7. Level of the Warning Limit

7.1 Background

The Warning Limit is a new parameter to be applied for I-SEM. While the current design of the SEM contains a Warning Limit, this is set to a limit of 75% within the Code itself with individual Participants permitted to set this at different levels as they see fit. In the current market, it is intended to allow Participants set an "early warning" level on their Posted Credit Cover which will allow them take mitigation actions earlier in the event that they are approaching; however, it is a non-binding value and does not require any specific action.

7.2 Considerations

To take account of changes to the Credit Cover policies for the new market arrangements, particularly with respect to the interaction between different sub-markets, the Warning Limit has been moved into the parameter space. While its application in the calculations is the same as per the current market design, it is considered that by parameterising this value, this allows additional meaning to be applied to this value. This is not set out in any design at this point but it may be included in NEMO rules should there be a view that an approach similar to the BETTA market (with level 1 and level 2 Credit Default) could be applied.

7.2.1 Gap Analysis

The following table outlines any gaps which have arisen and need to be considered in potential changes to the methodology to accurately incorporate any new context.

Current Approach	New Context	Change Required and Impact
Warning Limit is set at default level of 75% with Participant capability to set to other value if required.	There is no proposal to allow Participants configure their own Warning Limit; however, the default value will be set as a parameter.	Process change only – Participants cannot request alternative values. Potentially requires more work in determining a warning limit that is of some value.

7.3 Results and Analysis

Both the Warning and Breach Limits are designed to respectively provide notice to Participants that they are within range of limits, or very close to limits and might breach their posted credit cover.

These limits apply to the ratio of the Required Credit Cover (taking into account all exposures) and the Posted Credit Cover for a Participant. Figure 15 shows the components that make up the total credit exposure for a Participant. The green area relates the account balance and follows directly from settlement and billing processes. This results in a very distinctive saw tooth pattern.

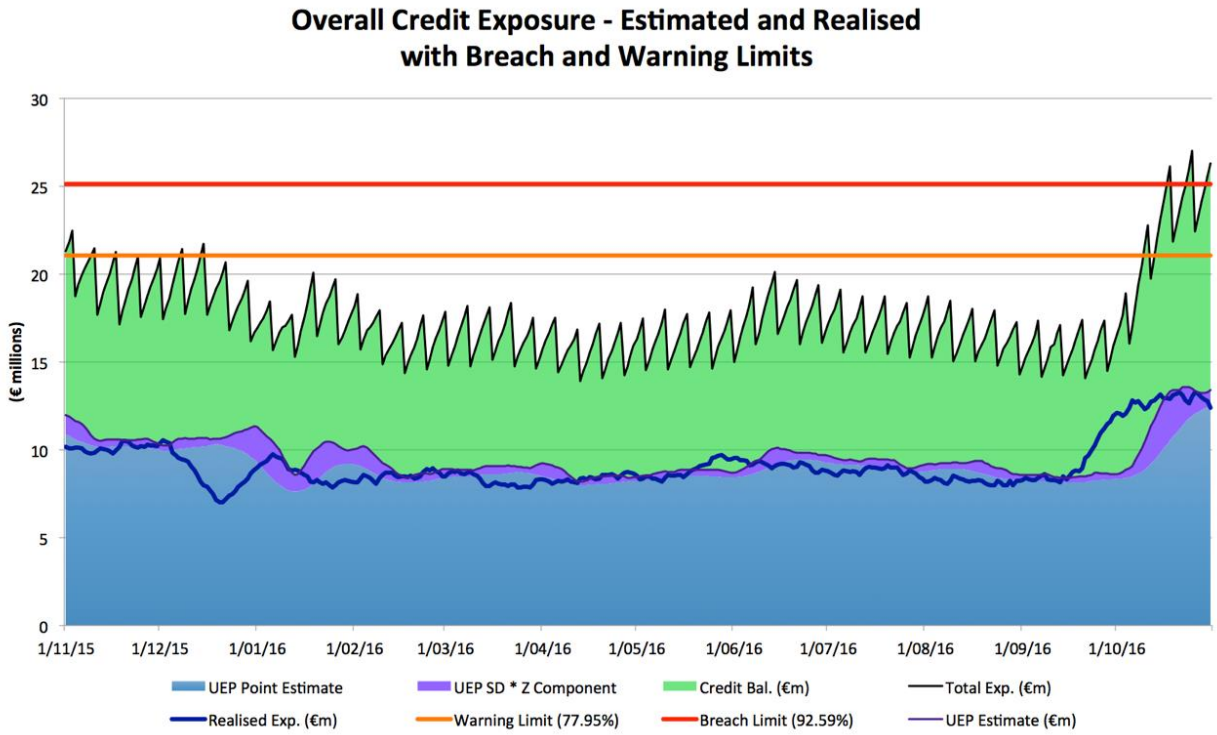

Figure 15: Components of Total Exposure

Assuming a maximum Posted Credit Cover required over the study period equal to the maximum Required Credit Cover over the study period (shown in Figure 15 at the point of the green shaded area with the highest value), the ratio of Required Credit Cover to Posted Credit Cover on this date would be 100%. The value for the Required Credit Cover number of days prior to the day with the maximum can be used to arrive at a warning level by expressing it as a percentage of the Maximum Posted Credit Cover. The warning level implicitly defines the speed at which a Participant approaches their Maximum Posted Credit Cover, so that whenever that threshold is crossed the Participant may take action or make adjustments to ensure that the level of Required Credit Cover does not exceed Posted Credit Cover. That speed limit is effectively set by using a single sample, that being the approach to the maximum exposure in the sample period.

Using the results outlined in Figure 15, the level of warning limit implied by allowing twelve days warning before the date when the ratio of Required Credit Cover to Posted Credit Cover equals 100% (assuming ten days warning before reaching the breach limit, and two days between the breach limit and the ratio reaching 100%) gives a level of warning limit of 77.95%. This is the line shown in orange in Figure 15. With this setting, a total of 28 warning notices would have been issued to the "steady supplier" unit used for this analysis throughout the sample year.

The value for this limit which would nominally give ten days' notice was chosen based on what could be perceived as adequate time to respond to the warning to ensure Posted Credit Cover meets maximum Required Credit Cover. However, as the Warning Limit notice is primarily for information purposes for Participants to ensure they can respond in time before being issued with Credit Cover Increase Notices, the values which are of most use to Participants in their standard processes for responding to such notices should guide the final decision on this value. For this purpose, Figure 16 outlines a range of values for different number of days of warning, and feedback from Participants on the value which would be of most use to them would be welcomed.

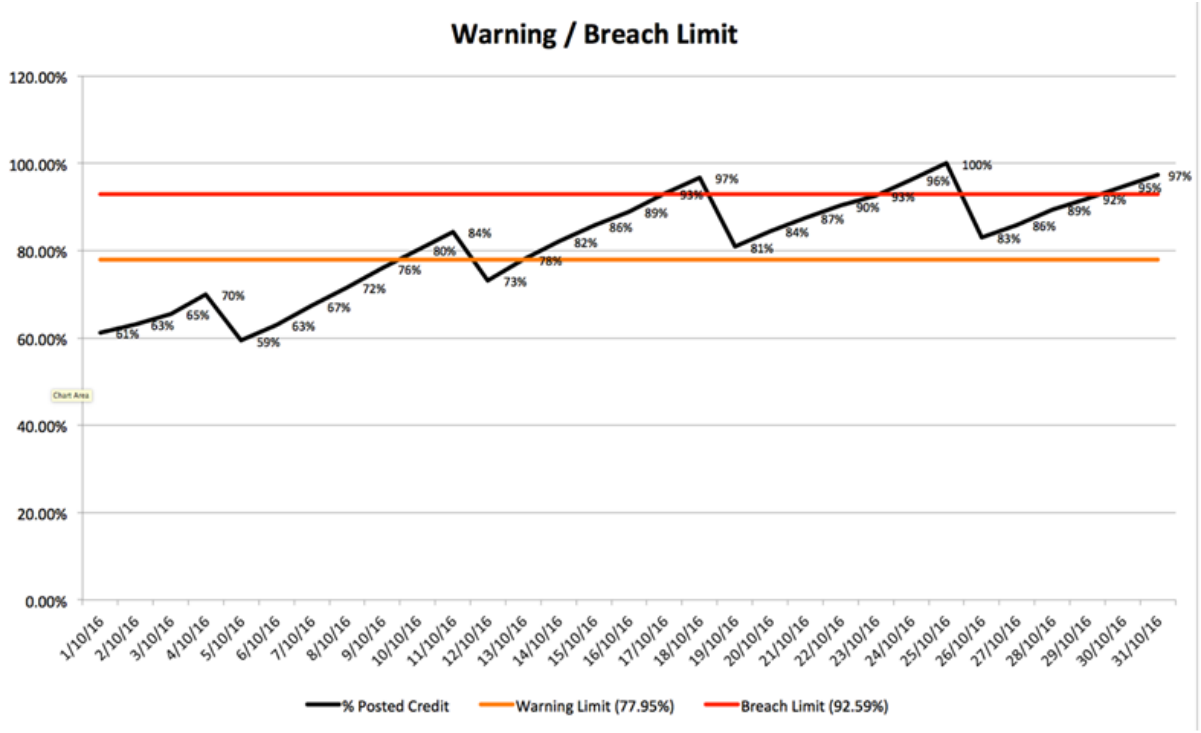

Figure 16: Warning and Breach Limit Approaching Date of Maximum Posted Credit Cover

Ideally the limits would be helpful without being onerous, resulting in warning notices being issued with high frequency so that Participants ignore them. But as shown in Figure 15, there are a number of days at the start of the sample period where a warning notice would be generated, only to be resolved the next day by payment of an account. Lower values, which would be indicative of Participants having earlier than 10 days warning, would increase the number of notices generated, therefore it is a trade-off between the usefulness of early notice versus the frequency of notices.

7.4 Recommendations

A value of 77.95% is recommended for the level of the Warning Limit from go-live of the I-SEM based on ten days' warning of the potential for being deemed in default, however a range of other values are outlined in the report and Participant feedback on the value which would be of most use to them would be welcomed.

8. Level of the Breach Limit

8.1 Background

The Breach Limit is a new parameter to be applied for I-SEM. It is a value used in the monitoring of credit cover, where the ratio of a Participant's Required Credit Cover to their Posted Credit Cover is checked against this value. If the ratio is greater than the value of this parameter, then the unit is deemed to be in breach of its credit cover requirements, and a Credit Cover Increase Notice will be issued by the Market Operator to the Participant.

8.2 Considerations

The current design of the SEM provides for a Credit Cover Increase Notice to be issued where a Participant's Required Credit Cover exceeds its Posted Credit Cover. At this point, a Participant is obliged to put in place additional collateral within two working days. This approach can be replicated for the I-SEM by setting the Breach Limit to 100%; however, this limit has been made a parameter to allow for an alternative approach if deemed desirable given the interaction between the different sub-markets.

In this manner, a value of Breach Limit that is less than 100% may be proposed in a way which takes into account the two working day requirement to post additional collateral. This may be of benefit to Participants as it may serve to impose restrictions on a Participant's ex-ante trading before their total collateral levels are surpassed. This approach is not set out in any design at this point but it may be included in the rules at a later point should there be a view that an approach similar to the GB market (with level 1 and level 2 Credit Default) could be applied.

It would also reduce the possibility of bad debt events in cases where a Participant is in default. If the Credit Cover Increase Notice is issued prior to the Participant's ratio of Required Credit Cover to Posted Credit Cover breaching 100%, their exposures would have less chance of growing to exceed their Posted Credit Cover over the two days allowed to respond to such a notice than if the notice was only issued at 100%. Therefore with a Breach Limit of less than 100% it is more likely that there would be sufficient collateral to cover the exposure of a Participant which has defaulted.

8.2.1 Gap Analysis

The following table outlines any gaps which have arisen and need to be considered in potential changes to the methodology to accurately incorporate any new context.

Current Approach	New Context	Change Required and Impact
Issue a Credit Cover Increase Notice when	Issue a Credit Cover Increase Notice when	Uses a distinct Breach Limit as opposed to a fixed comparison between the values. Provides for setting the value at less than 100%,

Current Approach	New Context	Change Required and Impact
Required Credit Cover > Posted Credit Cover.	Required Credit Cover/Posted Credit Cover > Breach Limit.	thereby requiring action while a Participant still has collateral in excess of its requirement. This provides an additional buffer for Participant risk given the additional sub-markets that apply in I-SEM.
Credit Cover Increase Notice requires update to collateral requirement with MO.	Breach Notice will require update to collateral with market operator and could also lead to impacts from trading with NEMOS, as in the BETTA market.	The interactions with the ex-ante markets give this value extra impact for I-SEM and can lead to restrictions on a Participant's ability to trade with NEMOs, as in the BETTA market. This has an additional impact on a Participant's ability to trade as well as impacting on liquidity in the ex-ante markets. The restriction is intended to prevent any Participant from creating unsecured delivery risk in the balancing market. This makes the sensitivity of the Breach Limit quite important: too close to 100% and the risk of unsecured debt increases, too far from 100% and the risk of restricting liquidity in the ex-ante markets is compounded.

8.3 Results and Analysis

Both the Warning and Breach Limits are designed to respectively provide notice to Participants that they are within range of limits, or very close to limits and might breach their posted credit cover.

Using the same data as outlined in Figure 15 and the same approach to determining the Warning Limit, by allowing 2 days' notice before the ratio of Required Credit Cover to Posted Credit Cover reaches 100%, the level of Breach Limit implied is 92.59%. This is the line shown in red in Figure 15. With this setting, a total of 7 breach notices would have been issued to the "steady supplier" unit used for this analysis throughout the sample year. The value for this limit which would nominally give two days' notice was chosen based on the maximum number of days allowed for a Participant to respond to a Credit Cover Increase Notice, which would be issued upon the ratio of Required Credit Cover to Posted Credit Cover exceeding the Breach Limit. After being issued this notice, Participants have two days to ensure that their ratio of Required Credit Cover to Posted Credit Cover is less than this limit, because if they fail to do this in time they will be deemed in default.

8.4 Recommendation

A value of 92.59% is recommended for the level of the Breach Limit from go-live of the I-SEM based on the two days' requirement to respond to a Credit Cover Increase Notice. This value reduces the likelihood of bad debt events occurring when a Participant defaults, as issuing a Credit Cover Increase Notice when the ratio of Required Credit Cover to Posted Credit Cover is less than 100% would make it more

likely that there would be sufficient collateral to cover the exposure of a Participant which has defaulted.

9. Conclusions

The recommended values for the Credit Cover Parameters are proposed in the table below, taking into account operational experience since the start of the SEM in November 2007, changes in context through the introduction of the I-SEM arrangements, and the criteria for the signals from the new parameters introduced in the I-SEM arrangements including values proposed in previous market design decisions.

Parameter	2017 Approved Value (or Equivalent)	I-SEM Go-Live Proposed Value
Fixed Credit Requirement (FCR_{py}) for Suppliers	Based on rate of 8.77€/MWh of average daily demand subject to a minimum value of €1,000 and a maximum of €15,000	Based on rate of 8.77€/MWh of average daily demand subject to a minimum value of €1,000 and a maximum of €15,000
Fixed Credit Requirement for Generator Units	€5,000	€5,000
Fixed Credit Requirement (FCR_{py}) for Netting Generator Units	€1,000	N/A
Fixed Credit Requirement (FCR_{py}) for Capacity Market Units	N/A	€0
Number of days in the Undefined Exposure Period for each Undefined Exposure Period, g, $UEPBD_g$	16	16
Number of days in the Historical Assessment Period, DINHAP	100 (for Billing Periods) or 90 (for Capacity Periods)	30
Analysis Percentile Parameter, AnPP	1.96	2.33
Credit Cover Adjustment Trigger	30%	10%
Level of the Warning Limit	75%	77.92%
Level of the Breach Limit	100%	92.59%

Appendix A Approaches for Results and Analysis

A.1 Approach for the Number of Days in the Historical Assessment Period

A.1.1 Input Data

- Total daily metered demand for a “steady supplier”;
- Total daily energy settlement amounts for a “steady supplier”;
- Daily average SMP.

A.1.2 Process Steps

For the first year of operation of the I-SEM arrangements, the following “Initial Methodology” will be used (based on the current methodology for the determination of the Historical Assessment Period for Billing Periods):

1. Extract the data for the daily total metered demand of a “steady supplier”.
2. Calculate the absolute values and normalised values of this metered demand:
    a. The normalised values are calculated by dividing the absolute value of metered demand in that period by the average of the absolute values of metered demand for all periods in the study.
3. Extract the data for the daily energy settlement amounts of the same “steady supplier”.
4. Calculate the absolute values of these settlement amounts.
5. Calculate, for each day, the Sample Undefined Exposure, which is the sum of the absolute energy settlement amounts calculated as part of step 4 which have been realised over the most recent days in the past, equal to the number of days in the Sample Undefined Exposure Period (which is equal to the number of days in the Undefined Exposure Period), starting from and inclusive of the day for which the calculation is being carried out.
6. Calculate, for each day, the average Sample Undefined Exposure in the Historical Assessment Period for the Undefined Exposure Period, which is the average of the Sample Undefined Exposures calculated as part of step 5 for the most recent days in the past, starting from and inclusive of the day which is three days prior to the day for which the calculation is being carried out and working backwards, with the number of Sample Undefined Exposures used in the average equal to the number of Sample Undefined Exposure Periods within the Historical Assessment Period. This needs to be calculated for each option of the number of days in the Historical Assessment Period being compared:
    a. For example, if the options for the number of days in the Historical Assessment Period to be compared are 20 days, 30 days, 45 days etc., and the number of days in the Sample Undefined Exposure Period

is 16, this calculation is done by taking the average over the Sample Undefined Exposures equal to the amount of 16 day (contiguous) samples can be found within the 20 days (i.e. 5 Sample Undefined Exposures), 30 days (i.e. 15 Sample Undefined Exposures), 45 days (i.e. 30 Sample Undefined Exposure), etc.

7. Calculate, for each day, the estimated Undefined Exposure for the Undefined Exposure Period, which is the average Sample Undefined Potential Exposure for that day calculated as part of step 6, plus the standard deviation of the Sample Undefined Exposures calculated as part of step 5 over the same period considered in the calculation of step 6, multiplied by the Analysis Percentile Parameter represented as the number of standard deviations from the mean. This needs to be calculated for each option of the number of days in the Historical Assessment Period being compared, and for each option of the Analysis Percentile Parameter being compared.
8. Calculate, for each day, the realised Undefined Exposure by summing the absolute settlement amounts for the most recent days in the future, equal to the number of days in the Undefined Exposure Period, starting from two days prior to the day for which the calculation is being carried out, including the day for which the calculation is being carried out, and continuing until the number of days in the Undefined Exposure Period has been reached in the future.
9. Calculate, for each day, for each option of the number of days in the Historical Assessment Period, and for each option of the Analysis Percentile Parameter, the Undefined Exposure Variance. This is calculated by subtracting the estimated Undefined Exposure for that option calculated as part of step 7 from the realised Undefined Exposure calculated as part of step 8, and dividing by the realised Undefined Exposure, representing this value as a percentage.
10. Extract the data for the Daily Average Price for each day considered in the study.
11. Adjust the normalised values of metered demand calculated as part of step 2 to a level which can be viewed on the chart created as part of step 12:
    a. This could be done by multiplying the data by a multiple of 10 until the data is most visibly clear on the graph.
12. Create a chart with days of the year on the X axis, and with the following data elements:
    a. The Undefined Exposure Variance (percentage) calculated as part of step 9 for the option of the Analysis Percentile Parameter and the number of days in the Historical Assessment Period which reflect the currently implemented parameters. Use the primary Y axis for this data;
    b. The Daily Average Price extracted as part of step 10. Use the secondary Y axis for this data;
    c. The adjusted normalised values of metered demand calculated as part of step 11. Use the secondary Y axis for this data.

13. Use the chart created as part of step 12 to analyse the relationship between prices, metered demand, and Undefined Exposure Variance, including commentary and any particular things to note for conclusions or further analysis.
14. Create charts with days of the year on the X axis, and with the following data elements:
    a. The Undefined Exposure Variance as a percentage calculated as part of step 9, or as a series for the estimated Undefined Exposure and a series for the realised Undefined Exposure as calculated in steps 7 and 8, for the option of the Analysis Percentile Parameter which reflects the currently implemented parameter, or currently proposed parameter. Use the primary Y axis for this data.
15. Use the charts created as part of step 14 to analyse the most appropriate value for the number of days in the Historical Assessment Period to be used, considering the high level objectives of the Credit Cover methodology and trade-offs for different trends displayed by the results for each value.

A.1.3 Outputs

- The Undefined Exposure Variance, as a percentage and as the estimated Undefined Exposure versus the realised Undefined Exposure, per day per option considered for the number of days in the Historical Assessment Period (in data and chart form).

A.2 Approach for the Analysis Percentile Parameter

A.2.1 Input Data

- Outputs of the analysis for the days in the Historical Assessment Period parameter.

A.2.2 Process Steps

The majority of the process for this parameter is carried out as part of the process for determining the Historical Assessment Period. The following are the additional steps required for the analysis of the Analysis Percentile Parameter:

1. Create charts with days of the year on the X axis, and with the following data elements:
    a. The Undefined Exposure Variance as a percentage, or as a series for the estimated Undefined Exposure and a series for the realised Undefined Exposure, for each option of the number of the Analysis Percentile Parameter being considered, for the option of the number of days in the Historical Assessment Period which reflects the currently implemented parameter (or the currently proposed parameter). Use the primary Y axis for this data;

2. Use the charts created as part of step 1 to analyse the most appropriate value for the Analysis Percentile Parameter to be used, considering the high level objectives of the Credit Cover methodology and trade-offs for different trends displayed by the results for each value.

A.2.3 Outputs

- The Undefined Exposure Variance per day per option considered for the Analysis Percentile Parameter (in data and chart form).

A.3 Approach for the Credit Cover Adjustment Trigger

A.3.1 Input Data

- Outputs of the analysis for the days in the Historical Assessment Period parameter.

A.3.2 Process Steps

Process steps for methodology of analysing Undefined Exposure Variance which would have occurred if the realised Undefined Exposure changed by the different Credit Cover Adjustment Trigger values:

1. Choose a subset of data from the results of the parameter of the number of days in the Historical Assessment Period which would remove seasonal effects (for example a summer period from June to July).
2. Using that subset of data, calculate, for each value of the Credit Cover Adjustment Trigger being analysed, what the metered demand would have been, and therefore what the realised Undefined Exposure would have been, if it had been increased by the amount of the Credit Cover Adjustment Trigger.
3. Calculate, for each value of the Credit Cover Adjustment Trigger being analysed, the adjusted estimated Undefined Exposure which would result from using the adjusted realised Undefined Exposure calculated for that level of Credit Cover Adjustment Trigger as part of step 2, for the values of the Analysis Percentile Parameter and number of days in the Historical Assessment Period which reflects the currently implemented parameters (or the currently proposed parameters).
4. Calculate, for each value of the Credit Cover Adjustment Trigger being analysed, the Undefined Exposure Variance between the estimated Undefined Exposure as part of step 3 and the realised Undefined Exposure as part of step 2.
5. Create a chart, for each option of the Credit Cover Adjustment Trigger being analysed, with days of the subset of data considered for this study on the X axis, and with the following data elements:

- The Undefined Exposure Variance as a percentage calculated as part of step 3, or as a series for the adjusted estimated Undefined Exposure and a series for the adjusted realised Undefined Exposure, for the option of the Analysis Percentile Parameter and the number of days in the Historical Assessment Period which reflect the currently implemented parameters (or the currently proposed parameters). Use the primary Y axis for this data;
- The adjusted values of metered demand calculated as part of step 11. Use the secondary Y axis for this data.

6. Create a chart with days of the year on the X axis (for the paste 3-4 years), and with the following data elements:
   - The Undefined Exposure Variance (percentage), with a series for each option of the Credit Cover Adjustment Trigger being considered, calculated as part of step 4 for the option of the Analysis Percentile Parameter and the number of days in the Historical Assessment Period which reflect the currently implemented parameters. Use the primary Y axis for this data. Use the primary Y axis for this data.
7. Use the data used, and charts created, as part of steps 5 and 6 to determine the following outputs which need to be used to analyse market risk, including commentary and any particular things to note for conclusions or further analysis, for each option of the value for the Credit Cover Adjustment Trigger being considered:
   - The maximum level of over-collateralisation in € (the maximum positive difference between the estimated Undefined Exposure and the realised Undefined Exposure);
   - The maximum level of over-collateralisation in terms of Undefined Exposure Variance percentage (the maximum positive value for the Undefined Exposure Variance);
   - The maximum level of under-collateralisation in € (the largest negative difference between the estimated Undefined Exposure and the realised Undefined Exposure);
   - The maximum level of under-collateralisation in terms of Undefined Exposure Variance percentage (the largest negative value for the Undefined Exposure Variance);
   - The number of days in the study period where the Undefined Exposure Variance is negative.
8. Use the data used, outputs determined, and charts created, as part of steps 5 to 7, to analyse the most appropriate value for the Credit Cover Adjustment Trigger to be used, considering the high level objectives of the Credit Cover methodology and trade-offs for different trends displayed by the results for each value:
   - Analysis can include comparing the change in the maximum level of under-collateralisation relative to the level of realised Undefined

Exposure between the different options for Credit Cover Adjustment Trigger being considered – if there is no major difference between two options in other metrics, and this metric is a relatively low amount, then there is a case for choosing the higher of the two options with the logic that for the lower of the options there is little market risk benefit versus the potential disbenefit of increasing the number of cases where Adjusted Participant notices need to be sent.

A.3.3 Outputs

- The maximum level of over-collateralisation in € and % for a "steady supplier" over the study period;
- The maximum level of under-collateralisation in € and % for a "steady supplier" over the study period;
- The number of days in the study period where the Undefined Exposure Variance is negative for a "steady supplier";
- The Undefined Exposure Variance per day in the study period per option considered for the Credit Cover Adjustment Trigger (in data and chart form).

A.4 Approach for the Level of the Warning Limit

A.4.1 Input Data

- Total daily metered demand for a "steady supplier";
- Daily Average SMP;
- Value of Posted Credit Cover.

A.4.2 Key Assumptions and Sensitivities

- The process to determine the most appropriate value of Warning Limit will be the same as that used for setting the Breach Limit.
- The value of any early warning for Participants needs to consider the number of days required to react to any Warning Limit breach.
- No special data is required for this calculation and a proposed value can be determined from the same data as used in the determination of other Credit Cover Parameters.
- An assumption of a Posted Credit Cover value can be made to assist in the determination of the proposal.

A.4.3 Process Steps

1. Taking account of the data provided for the "steady supplier", calculate a value of settlement as the daily metered demand * daily average SMP.
2. Determine the days of the week to identify each Friday as a billing date.
3. Determine the days of the week to identify each Wednesday as a payment date.

4. Calculate the value of known exposure as the “Invoiced Not Paid”. This is done by summing the settlement amounts for each billing week (Sunday to Saturday) on each subsequent Friday.
5. Calculate the value of known exposure as the “Settled Not Invoiced”. This is done by summing the settlement amounts for each billing week (Sunday to Saturday) that has not been included in the calculations for step 4 above.
6. Assume each Invoice is settled on its payment date by removing the invoice amount from the “Invoiced Not Paid” segment.
7. Calculate the value of estimated Undefined Exposure according to the methodology for the number of days in the Historical Assessment Period.
8. From these three values, calculate a daily value of Required Credit Cover as the sum of the amounts calculated under steps 4, 5, 6 and 7.
9. Use this calculated value to determine an estimate of Posted Credit Cover that will cover the maximum exposure calculated.
10. Determine a value for the ratio of Posted Credit Cover to Required Credit Cover (as Required Credit Cover/Posted Credit Cover) for each day. For the date used in step 9 this ratio should be 100% and for all others it should be a value less than 100%.

The calculations above should now have a value of Posted Credit Cover that is equal to the maximum value of Required Credit Cover. This should enable us to observe how long it takes a Participants exposure to rise to the 100% from a lower level.

Taking account of other factors such as number of days required to meet a credit cover increase notice, possible number of banking days required to amend a Letter of Credit, minimum size of credit cover increase, etc., estimate the appropriate setting for the Warning Limit.

The Warning Limit should:

- Provide Participants with additional days beyond the 2 working days provided for under the Code to response to the Credit Cover Increase Notice;
- Should not be set so low that it will lead Participants to ignore it;
- Should not lead to Participant’s seeking to update posted credit cover for small amounts (e.g. less than €1,000);
- Should take account of the speed at which an average Participant’s required credit cover increases in normal conditions.

A.4.4 Outputs

- The number of days in advance of the ratio of Posted Credit Cover to Required Credit Cover exceeding 100%.
- The corresponding ratio to this number of days which can be used as a Warning Limit.

A.5 Approach for the Level of the Breach Limit

A.5.1 Input Data

- Total daily metered demand for a “steady supplier”;
- Daily Average SMP;
- Value of Posted Credit Cover.

A.5.2 Key Assumptions and Sensitivities

- The process to determine the most appropriate value of Breach Limit will be the same as that used for setting the Warning Limit.
- The value of any Breach Limit for Participants needs to consider the number of days provided to allow Participants respond to a Credit Cover Increase Notice.
- No special data is required for this calculation and a proposed value can be determined from the same data as used in the determination of other Credit Cover Parameters.
- An assumption of a Posted Credit Cover value can be made to assist in the determination of the proposal.

A.5.3 Process Steps

1. Taking account of the data provided for the “steady supplier”, calculate a value of settlement as the daily metered demand * daily average SMP.
2. Determine the days of the week to identify each Friday as a billing date.
3. Determine the days of the week to identify each Wednesday as a payment date.
4. Calculate the value of known exposure as the “Invoiced Not Paid”. This is done by summing the settlement amounts for each billing week (Sunday to Saturday) on each subsequent Friday.
5. Calculate the value of known exposure as the “Settled Not Invoiced”. This is done by summing the settlement amounts for each billing week (Sunday to Saturday) that has not been included in the calculations for step 4 above.
6. Assume each Invoice is settled on its payment date by removing the invoice amount from the “Invoiced Not Paid” segment.
7. Calculate the value of estimated Undefined Exposure according to the methodology for the number of days in the Historical Assessment Period.
8. From these three values, calculate a daily value of Required Credit Cover as the sum of the amounts calculated under steps 4, 5, 6 and 7.
9. Use this calculated value to determine an estimate of Posted Credit Cover that will cover the maximum exposure calculated.
10. Determine a value for the ratio of Posted Credit Cover to Required Credit Cover (as Required Credit Cover/Posted Credit Cover) for each day. For the date used in step 9 this ratio should be 100% and for all others it should be a value less than 100%.

The calculations above should now have a value of Posted Credit Cover that is equal to the maximum value of Required Credit Cover. This should enable us to observe how long it takes a Participants exposure to rise to the 100% from a lower level.

Taking account of other factors such as number of days required to meet a credit cover increase notice, possible number of banking days required to amend a Letter of Credit, minimum size of credit cover increase, etc, estimate the appropriate setting for the Breach Limit.

The Breach Limit should:

- Provide Participants with 2 working days as provided for under the Code to respond to the Credit Cover Increase Notice;
- Should not lead to Participant's seeking to update posted credit cover for small amounts (e.g., less than €1,000);
- Should take account of the speed at which an average Participant's required credit cover increases in normal conditions.

A.5.4 Outputs

- The corresponding ratio to this number of days which can be used as a Breach Limit if the process is considered to provide two working days for a Participant to respond to the Breach Notice.