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ECC Derivative Market Margining

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1. Introduction

This document provides the documentation of ECC's margining system for the derivative market. The current values of used calculation parameters, if not set in this document, can be found in the risk parameter file[1]. The documentation of the Spot Margin Model can be found on the ECC´s website[2]. Information on margin reports can be found: https://www.ecc.de/en/risk-management/reports-and-files/

1.1 Overview of Margin Types

The following table gives an overview of the different margin types:

Exposure Type	Margin Type	Description
Current Exposure	**Variation Margin**	Mark-to-market value (change) of all open positions in futures and future style options using the latest market prices received from the markets. Will be called on each ECC business day.
	Intraday Variation Margin	Will be called during an ECC business day in case of increased intraday Mark-to-market value changes of all open positions
	Premium Margin	No daily Variation Margin is calculated for premium style options. Therefore, Premium Margin has to be deposited for corresponding net short positions. For net long positions, credits from Premium Margin are used to offset other margin requirements
Potential Future Exposure	**SPAN® Initial Margin**	SPAN® Initial Margin covers the risk in open positions in futures and options
	Delivery Margin	Delivery Margin covers the risk in positions in physically settled futures during the delivery period as well as the risk of positions in storable commodities two business days before expiry of the contract
	Margin Cap (MCAP)	MCAP covers the difference between the (regulatory) allowed 80% margin reduction and the actual margin reduction if the latter is higher
	Concentration Risk Margin	Concentration Risk Margin covers the risk from illiquid markets with a liquidation period greater than two days
	Stresstest Supplementary Margin	Stresstest Supplementary Margins will be called if the stress test result exceeds the financial resources in the default fund.
	Other Margins	Other Margins are calculated based on the SPAN® Initial Margin to cover cases where the margin needs to be deposited longer than the expiry date (e.g. due to missing final settlement prices)

[1] https://www.ecc.de/fileadmin/ECC/Downloads/Risk_Management/Margining/ECC_Risk_Parameters.pdf

[2] https://www.ecc.de/ecc-en/risk-management/margining

For derivatives markets, ECC employs a statistical approach using SPAN® [3] that calculates potential changes in the value of a trading member's portfolio over a time horizon that is needed to liquidate the portfolio. The parameters are calibrated to cover ECC's exposure with a confidence level of 99%.

Margin parameters for derivatives are adjusted on each ECC business day thus allowing ECC to quickly adopt its risk management to new market conditions. Stress testing according to EMIR Article 42, where the default of one or more clearing members under extreme but plausible market scenarios is simulated, is performed daily. Its results are used to determine the default fund ECC maintains to cover counterparty risk in extreme market conditions.

ECC performs daily back testing for single and spread margin parameters as well as portfolio margins[4]. Daily historical stress testing is used to assess the adequacy of margins. ECC performs an annual validation of methods, models, and model assumptions.

[3] 'SPAN®' is a registered trademark of Chicago Mercantile Exchange Inc. Chicago Mercantile Exchange Inc. assumes no liability in connection with the use of SPAN® by any person or entity

[4] See Back Testing Procedure.

1.2 Regulatory Requirements

Regulatory Item	ECC Methodology
ESMA[5] Article 24 requires that for the calculation of initial margins the CCP shall at least respect the following confidence intervals: (a) For OTC derivatives, 99.5%; (b) For financial instruments other than OTC derivatives, 99%	For derivative markets, ECC uses 99% confidence interval for derivatives other than OTC.
ESMA Article 25 requires that a CCP shall ensure that initial margins cover at least with the confidence interval defined the exposures resulting from historical volatility calculated based on data covering at least the latest 12 months. A CCP shall ensure that the data used for calculating historical volatility capture a full range of market conditions, including periods of stress.	A one-year look-back period is used (255 business days).
ESMA Article 26 requires that the liquidation period shall be at least two business days for financial instruments other than OTC derivatives.	Liquidation period is two business days for most instruments, only for freight products a liquidation period of three days is considered
According to ESMA Article 28, a CCP shall ensure that its policy for selecting and revising the confidence interval, the liquidation period and the look back period deliver forward looking, stable and prudent margin requirements that limit procyclicality to the extent that the soundness and financial security of the CCP is not negatively affected. This shall include avoiding when possible disruptive or big step changes in margin requirements and establishing transparent and predictable procedures for adjusting margin requirements in response to changing market conditions. In doing so, the CCP shall employ at least one of the following options: (a) Applying a margin buffer at least equal to 25 % of the calculated margins which it allows to be temporarily exhausted in periods when calculated margin requirements are rising significantly (b) Assigning at least 25 % weight to stressed observations in the look back period calculated in accordance with ESMA Article 26 (c) Ensuring that its margin requirements are not lower than those that would be calculated using volatility estimated over a 10-year historical look back period.	ECC uses a margin buffer of 25% to account for procyclicality.

[5] Commission Delegated Regulation (EU) No 153/2013 (Regulatory technical standards), p. 41ff, Official Journal of the European Union, L 52, 23 February 2013

1.3 Model Limitations and Restrictions

According to EMIR Article 26 inherent model limitations and restrictions shall be considered and documented:

Limitation/Restriction	Impact	Mitigation
Availability of Price Data	Incomplete or stale data might lead to incorrect initial margin calculations	Monitoring for stale prices; conservative corrections for short time series (see 2.3)
Consideration of Portfolio Effects for Derivatives	Portfolio effects are only considered for pairs of opposing positions (long/short); diversification effects for positions on same side (long/long; short/short) are not considered in SPAN	As margining becomes more conservative (i.e. margin efficiency is reduced) this improves the resilience of ECCs financial resources however ECC benchmarks its margin requirements against other systems/CCPs

2. Calculation of Margin Parameters

2.1 Calculation of Single Margin Parameters

Single margin parameters are values which quantify risk of futures positions and are used to determine the SPAN® Initial Margin for derivatives. The next sections describe the calculation of the single margin parameters and the modifying anti-procyclicality buffer. Another modifier of the single margin parameter is the expiry month factor which is only applied in physically settled contracts during delivery.

2.1.1 Margin Parameter

Single margin parameters are the result of a filtered historical simulation over the past 255 days with non-zero returns. The single margin parameter $M_X(t)$ (without buffer) is given by a multiple of a contract's returns' standard deviation[6]

$$M_X(t) = R_X(t) \cdot \sigma_X(t) \cdot p_X(t) \cdot \sqrt{l_X}.$$

p_X is the contract's current settlement price.

The standard deviation of futures daily returns $\sigma_X(t)$ is computed as an exponentially weighted moving average (EWMA)[7] of the last 255 daily relative non-zero returns from the observed daily settlement prices. For options, all relative changes of the implied volatility are used. ECC uses the concept of constant maturities, i.e., the returns and margin parameters are calculated for time buckets with a fixed time to expiry. The use of an exponentially weighted average allows for quicker reaction of the margin parameters to changes in market volatility than the equally weighted estimator for the empirical standard deviation.

R_X is calculated as a quantile of the volatility normalized returns: $R_X = (|q(X_\tau/\sigma_X(\tau-1))_\alpha| + |q(X_\tau/\sigma_X(\tau-1))_{1-\alpha}|)/2$, where $\alpha = 0.99$ and $q(X_\tau)_\alpha$ is the empirical α-quantile of X using data from the past 255 days with non-zero returns. There is both a lower and an upper cut-off, $R_{\max}$ and $R_{\min}$, for the calculated values of R_X. For time series with less than 100 values, R_X is set $R_X = R_{\max}$.

The factor $\sqrt{l_X}$ is used for scaling to a liquidation period of l_X days. For most contracts the liquidation period is two days, only for freight contracts a liquidation period of three days is being considered.

[6] Always valid for day t.

[7] Under the assumption that the mean return is zero, the implemented formula is

$$\sigma_X(\tau) = \sqrt{\sum_{k=\max\{\tau-255,1\}}^{\tau} (X_k^2\, \lambda^{\tau-k}) \;/ \sum_{k=\max\{\tau-255,1\}}^{\tau} \lambda^{\tau-k}}\,.$$

ECC uses $\lambda = 0.99$. Zeros and missing values are not taken into account.

2.1.2 Procyclicality and Period of Stress Buffer

ESMA allows three different methods to prevent procyclical margining.

1. Applying a 25% weight for stress volatility,
2. Using all available data,
3. Applying a 25% buffer, which can be temporarily exhausted.

ECC has decided to adopt the buffer-method in the following way:
ECC first calculates the minimal and maximal volatility $\sigma_{\min}$ and $\sigma_{\max}$ of a contract's return time series using all available data up to the day for which margin is calculated. $\sigma_{\min}$ and $\sigma_{\max}$ refer to the minimal and maximal values in the total time series of the EWMA-volatilities.
ECC then calculates a stressed volatility by adding a weighted stress part into the calculation

$$\sigma_X^S = \frac{255 - w}{255}\sigma_X + \frac{w}{255}\sigma_{\max},$$

where the weight is currently set[8] $w = 5$.
Below a threshold of $\sigma_{\text{crit}} = \sigma_{\min} + a \cdot (\sigma_{\max} - \sigma_{\min})$, the margin parameter is increased by 25%. The value of a is currently set to 0.2. Above the threshold σ_{crit}, the buffer of 25% is linearly reduced to zero:

$$b_X = \begin{cases} 0.25 & \sigma_X \leq \sigma_{\text{crit}} \\ 0.25 \cdot \left(1 - \dfrac{\sigma_X - \sigma_{\text{crit}}}{\sigma_{\max} - \sigma_{\text{crit}}}\right) & \text{else} \end{cases}.$$

ECC now calculates the final single margin parameter by taking the maximum of the requirements of the stressed volatility and the buffer method:

$$\mathcal{M}_X = R_X \cdot \sigma_X \cdot \sqrt{2} \cdot \left(1 + \max\left\{b_X; \frac{w}{255}\frac{\sigma_{\max} - \sigma_X}{\sigma_X}\right\}\right) \cdot p_X$$

with p_X being the contract's current settlement price.

2.1.3 Additional weighting factors for contracts in delivery

For contracts in delivery, the single margin parameter is adjusted by an additional weighting factor to cover the intra-month risk profile or additional risk components more adequatly.

<u>Expiry Month Factor (EMF)</u>

During the delivery period of physically settled futures, ECC faces an increased price risk and / or delivery risk. Price risk results from the fact that there is no variation margin payment during the delivery. Delivery risk results only in areas where ECC’s nomination has no priority and therefore ECC could be imbalanced in the default of a trading participant. To cover these risks, the single margin parameter is adjusted by the expiry month factor (EMF). The EMF is set as follows:

[8] This equals a stress period of one week which has been observed after the Fukushima Earthquake

- For delivery areas where ECC's nomination has priority or with single sided nomination the EMF is set for natural gas and power futures separately. The current values can be found in the risk parameter file on the website.
- For delivery areas where ECC's nomination has no priority, the EMF considers the maximum number of calendar days between last successful settlement and suspension by a TSO following default to deliver (this takes into account local holidays and weekends).

The EMF will be updated on a monthly basis and is subject to annual validation. It can be found in the risk parameter file on the website.

During the delivery period of physically settled monthly products, the contract size of such contracts will be reduced by multiplying the EMF value on day t with the factor

$$\max\left(x,\ (Expiry\ Date\ - \max(t,\ First\ Delivery\ Date))/\ (Expiry\ Date\ -\ First\ Delivery\ Date)\right)$$

The floor x is considered to ensure that margin requirements towards the end of the month are still sufficient taking into account the time needed to close out open positions. The floor is subject to annual validation and can be found in the risk parameter file on the website.

The application of the EMF and the reduction of the contract size during the delivery period are already incorporated in the single margin parameter published on the website.

Weighting factor for freight contracts in delivery

To cover the intramonth risk profile of freight futures in delivery in a risk-adequate manner an additional factor is used to modify the SMP. The objective of the factor is to incorporate the fact that such contracts are already partially settled throughout the month in delivery. The factor has the effect that – in line with decreasing exposure to market risk – margins are reduced throughout the front month.

The caculation of the weights is done by determining the volatility structure for each trading day in delivery from the overall volatility structure observed for the corresponding product distinguishing between short-term and long-term volatility. The weight for a trading day itself is then given by the obtained daily volatility for that day dived by the average over all obtained daily volatilities. A floor ensures that margin requirement towards the end of the month are prevented from falling to zero. Considering the 3-day holding period for freight margining, this floor is set to the weight three delivery days prior to expiry of the contract.

The weighting factor for each trading day and each freight contract in delivery can be found in the risk parameter file on the website. They are already incorporated in the single margin parameter published on the website.

The weights will be updated on a monthly basis and the methodology used is subject to annual validation.

2.2 Calculation of Spread-Margin Parameters

Spread-Margin parameters are calculated in the form of credit C_P for selected bivariate portfolios with spread positions, i.e. one asset being held long and the other being held short. These portfolios are not assigned a gross margin, i.e., the sum of the margin requirements for the individual contracts, but a net portfolio margin. ECC's approach to calculate the net margin for such portfolios is similar to the approach for single margins. The margin is seen as the 99%-quantile of a volatility-normalized historical simulation[9] of the absolute portfolio returns in € over the past 255 days with non-zero returns of both contracts.

The portfolio is constructed for day[10] t. Its absolute returns (with respect to the current price level and denoted in €) are a time series indexed by τ:

$$P_\tau(t) = a(t)X_\tau\, p_X(t) - b(t)Y_\tau\, p_Y(t),$$

where X_τ, Y_τ are the returns on day τ, $a(t)$, $b(t)$ are the position sizes and $p_X(t)$, $p_Y(t)$ are the prices on day t. The times τ are defined such that both time series (X_τ, Y_τ) are non-zero for each τ[11], as shown in the following table:

Target-2 days	1	2	3	4	5	6	7	8
p_X (€)	30	26.4	26.4	26.93	28.28	28.28	31.11	32.67
X	0.1	-0.12	0	0.02	0.05	0	0.1	0.05
p_Y (€)	25	25	22.75	23.89	26.28	29.17	26.25	22.31
Y	0.11	0	-0.09	0.05	0.1	0.11	-0.1	-0.15
τ	1			2	3		4	5

The time series comprises the past 255 τ-values before t. In the following $a(t)$ and $b(t)$ are set to equal the margin parameters of Y and X, respectively.
Standard deviations and correlations are computed using exponentially weighted averages, i.e., EWMA. The gross margin for the portfolio is the sum of the individual assets' margin requirements

$$\widetilde{M}_P(t) = a(t)M_X(t) + b(t)M_Y(t),$$

where the margins M_X and M_Y are calculated as shown in chapter 2.1.1, i.e. as the product of the EWMA standard deviation and a dynamically adjusted risk multiplier. The risk multiplier also has to be computed for the portfolio itself, yielding the net margin $M_P(t) = R_P(t) \cdot \sigma_P(t)$. Here, the portfolio's

[9] Also known as "filtered historical simulation".

[10] Under the assumption that both contracts are quoted on t. If this is not the case, the most recent credit is taken.

[11] Given the individual time series X_t and Y_t, only values are taken into account where both time series are simultaneously non-zero. This can lead to time series being different from those used for the calculation of the single margin parameters of X and Y.

standard deviation can be expressed by the assets' correlation coefficient ρ obtained by statistical averaging[12] over τ

$$\sigma_P(t) = \sqrt{(a(t)\,\sigma_X(t)\,p_X(t))^2 + (b\,(t)\sigma_Y(t)\,p_Y(t))^2 - 2\rho(t)\big(a(t)\cdot b(t)\big)\big(\sigma_X(t)p_X(t)\cdot\sigma_Y(t)p_Y(t)\big)}.$$

When calculating the net margin, a conservative correction is applied to the correlation coefficient, such that $\sigma_P(t) \to \sigma_P^{\mathrm{corr}}(t)$ and thus $M_P(t) = R_P(t)\cdot\sigma_P^{\mathrm{corr}}(t)$. Details are explained in the next section. Like for the single margin parameters, the risk multiplier is given as

$$R_P(t) = (|q(P_\tau(t)/\sigma_P(\tau-1))_\alpha| + |q(P_\tau(t)/\sigma_P(\tau-1))_{1-\alpha}|)/2,$$

where again $\alpha = 0.99$, and $q(X_\tau)_\alpha$ denotes the empirical α-quantile of X_τ, i.e., with respect to the time-index τ. However, the conservative correction of the correlation coefficient is not applied when the risk multiplier is calculated.
Finally, the credit is given by the ratio of gross to net margin – both without margin buffer –

$$C_P = 1 - \frac{M_P}{\widetilde{M}_P}.$$

SPAN® calculates the gross margin $\widetilde{\mathcal{M}}_P$ based on the single margin parameters $\mathcal{M}_X$, $\mathcal{M}_Y$, which already include the margin buffer b_X, b_Y, and subtracts $C_P\cdot\widetilde{\mathcal{M}}_P$ leaving the net margin requirement also including the required margin buffer:

$$\mathcal{M}_P = \widetilde{\mathcal{M}}_P(1 - C_P).$$

2.3 Conservative corrections applied to the correlation coefficient

To account for statistical uncertainty in the estimation of volatility for short time series in particular, ECC has implemented a bootstrapping method to apply conservative corrections to the correlation coefficients that are used to calculate the net portfolio standard deviation and hence the margin credit. Drawing from a sample of 100,000 time series with defined correlation, the 10% quantile of the observed EWMA-correlations are determined. These values are stored with respect to length of the time series and underlying correlation coefficient.

In the determination of the net margin, the standard deviation is obtained using the corrected correlation coefficient, thereby increasing σ_P, yielding a larger net margin and accordingly a smaller margin credit. Given the length N of the time series and the sample correlation coefficient ρ to be corrected, two time series, x_t and y_t, of length N with independent Gaussian random numbers (zero mean and unit standard deviation) are constructed. From these a third time series is constructed as

$$z_t = \rho\, x_t + \sqrt{1-\rho^2}\, y_t,$$

such that the time series x_t and z_t are correlated with Pearson-coefficient ρ.

[12] The statistical averaging is again exponentially weighted.

In the next step the sample correlation r of x_t and z_t is computed using exponentially weighted moving averages (EWMA). Repeating this for 100,000 samples of x_t and z_t produces a distribution of sample correlations. ECC measures the 10% quantile, $q_{0.1}$, of this distribution.

Sample correlations between the pre-recorded values are linearly interpolated, i.e., given a sample correlation ρ and both the next lower and the next higher value for which data is stored in the look-up table $\rho^< \leq \rho < \rho^>$, and $r^<$, $r^>$ being the corrected values $q_{0.1}$ for $\rho^<$ and $\rho^>$, respectively, the corrected value for ρ is

$$r = r^< + \frac{r^> - r^<}{\rho^> - \rho^<} (\rho - \rho^<).$$

3. Initial Margin Requirements

3.1 SPAN® Calculation

ECC uses the standard SPAN®[13] methodology to account for portfolio effects on derivatives markets. The methodology allows ECC to optimally align margin requirements with risk, thereby realizing efficient margining. ECC updates SPAN® risk parameters daily, which are available on ECC's homepage for download. ECC recognizes the diversification effect in large portfolios by granting margin credits of up to 99% for opposing positions in highly correlated products.

3.1.1 Combined Commodity

Products (futures and options) with the same underlying, load profile, delivery period and maturity form a combined commodity, e.g. all power futures of the same delivery area and delivery period with the same maturity including all option series of the same maturity form a combined commodity[14].

3.1.2 Scan Risk

SPAN® uses a configurable range of price and volatility movements to calculate the worst-case loss of a combined commodity. SPAN® comes with 16 pre-defined scenarios of combinations of price and volatility movements over an assumed liquidation period; at ECC these are used without further customization. The scenarios are so-called scan points, each of which is characterized by a price change (multiple of price scan range), volatility change (multiple of volatility scan range) and the weight attached to the scan point. In the case of futures, the worst-case loss is determined by the price scan range only. To comply with standard methods, ECC bases this price scan range on the single margin parameter defined before.

$$Price\ Scan\ Range = \mathcal{M}_X \cdot ContractVolume$$

For simplicity, the term price scan range is also referred to as scan range. For options, ECC sets the price scan range to the price scan range of the underlying, uses a look-ahead period according to the assumed liquidation period (i.e. the time to maturity is decreased by the liquidation period) and an adequate volatility scan range. In SPAN® options are priced using the Black76-model[15]. The value of

[13] SPAN® being short for The Standard Portfolio Analysis of Risk system is a methodology that calculates margin requirements by analyzing the "what-ifs" of different market scenarios. Developed and implemented in 1988 by Chicago Mercantile Exchange (CME), SPAN® was the first system ever to calculate margin requirements exclusively on the basis of overall portfolio risk at both clearing and customer level. In the years since its inception, SPAN® has become the industry standard for portfolio risk assessment.

[14] Due to technical constraints at the Clearing Members' vendors, a combined commodity across two exchanges is not possible; the same effect is achieved by setting the inter-commodity spreads to 1.

[15] Black, Fischer. The pricing of commodity contracts, Journal of Financial Economics **3** 167-179 (1976)

the volatility scan range, the appropriateness of the 16 scenarios and the inclusion of interest-rate-risk are determined by Risk Controlling and are subject to at least annual validation.
These scenarios are applied to all products of each portfolio. The scenario with the greatest loss is called active scenario and is considered for the calculation of the SPAN® Initial Margin. The scan risk is calculated by multiplying the active scenario loss by the net position. The scan risk of a combined commodity is calculated by summing over the respective scan risks of the constituent product families.

3.1.3 Volatility Scan Range

The volatility scan range is the expected change of the implied volatility of an option over the assumed liquidation period. It is expressed as a number in percentage points of the current implied volatility of an option.

For environmental options, the volatility scan range parameter is determined from analyzing the non-zero daily changes in implied volatilities across all tradable options over a one-year lookback period. Hereby, the daily changes are multiplied with the factor $\sqrt{2}$ in order to scale the daily changes to a liquidation period of 2 days. The volatility scan range parameter is then calculated as the empirical 99 percent quantile and a buffer is added to prevent procyclicality. The buffer is determined similar to the method described in chapter 2.1.2 on the average daily implied volatilities across all strikes and maturities.

For all other options, the volatility scan range is determined from analyzing the daily changes in implied volatility across all existing liquid options[16] with the same underlying (across all maturities and strikes). The maximum day-to-day change (rounded up to the next 10%) is then used as the volatility scan range parameter for all options of the same commodity.

3.1.4 Short-Option Minimum (SOM)

For short options that are deep out of the money, the theoretical risk calculated can be near to zero. In market situations where the underlying price changes significantly, these options may move into-the-money and may generate large losses for holders of short positions in these options. Therefore, a minimum margin requirement for net short positions in options is implemented, called short option minimum. If the short option minimum of a combined commodity exceeds the scan risk after spreading, it constitutes the SPAN® Initial Margin of the combined commodity. The short-option minimum is subject to annual validation.

3.1.5 Spreads

A spread contains offsetting positions in correlated instruments. Due to ECC's product portfolio, ECC uses not only correlation to form regular spreads but also arbitrage-free prices to form so-called perfect spreads. Both kinds of spreads allow ECC to reduce margin requirements without compromising risk coverage.

[16] Liquid Options are all options that have been traded at least once.

Physically settled contracts in delivery as well as short-term contracts (day and weekend futures) are not included in spreading.

3.1.5.1 Perfect Spreads

Opposing positions with the same underlying and completely overlapping delivery periods, which differ only in delivery profile or delivery period, are called perfect spreads. Such positions are nearly risk free – i.e. the daily variation margin of all positions in a perfect spread is zero – because the settlement prices are arbitrage free. To account for differences from rounding effects the margin credit is set to 99%. Thus, the intercommodity credit for each position in a perfect spread is

$$Intercommodity\ Credit = Scan\ Risk\ \cdot 0.99$$

Perfect spreads can contain different combined commodities. Perfect spreads are obtained by decomposing all products in subproducts, such as years in seasons/quarters/months, seasons in quarters and months, quarters in months, base in peak and offpeak. The decomposition is implemented using a Chomsky-type-2 algorithm.

3.1.5.2 Regular Spreads

Regular spreads exploit the correlation between time series to reduce the margin requirement. The granted margin reduction is calculated in SPAN® using the credit as introduced in section 2.2. Credits less than 0.01% are deleted, and the maximum applied margin credit is 99%.
If a portfolio consists of two opposing positions X and Y, the intercommodity credit for each of both positions is given by

$$Intercommodity\ Credit = \min(Scan\ Risk_X, Scan\ Risk_Y)\ \cdot C_P,$$

where C_P is the margin credit[17] as determined according to the procedure detailed in section 2.2. Extraction of regular spreads from portfolio data using the margin credits given in the span-file is done by the SPAN®-software.

3.1.6 SPAN® Initial Margin

To summarize, the SPAN® initial margin is calculated per combined commodity in the following steps:

1. Calculation of the overall scan risk for each combined commodity.
2. The scan risk is then reduced by the inter-commodity credits to reflect the reduced risk in portfolios with opposing positions. This process is called spreading. Perfect spreads are applied first. Then ordinary spreads are applied to the portfolio in descending order of inter-commodity credit. If necessary, the short option minimum is applied afterwards.
3. The resulting amount per portfolio is called SPAN® initial margin.

[17] The applied margin credits for contracts with open interest can be found in the Intercommodity Spread File available on ECC website (https://www.ecc.de/en/risk-management/reports-and-files).

3.2 Delivery Margin

Delivery Margin (DM) is called for net short positions in storable commodities two business days before expiry of the contract.
Each holder of an open short position in storable commodities such as emission rights or guarantees of origin is obliged to pre-deliver the respective commodities to ECC's storable commodities account before the settlement day of the position. In case of a shortage of holdings ECC will demand securities in the form of a Delivery Margin.

The Delivery Margin for storable commodities is given by:

$$\mathrm{DM}_{Storable\ Commodities} = \text{Last Spot Price} \cdot (1 + \mathrm{HC}_{Storable\ Commodities}) \cdot \text{Volume} \cdot |\text{Net Short Position}|$$

where $\mathrm{HC}_{\text{Storable Commodities}}$ is the haircut for storable commodities which is applied to account for potential fluctuations in market value and whose current value can be found in the risk parameter file published on the ECC website.
ECC calculates the Delivery Margin two business days before expiry of the contract and adjusts the Delivery Margin on a daily basis until expiry of the contract. ECC will mark-to-market the exposure from the net short balances intraday and add a haircut for potential fluctuations in market value. The current value of this haircut can be found in the risk parameter file on the website. The Delivery Margin for storable commodities is reported under the Margin Class DMEM.

3.3 Concentration Risk Margin

SPAN® Initial Margin IM_{SPAN} considers a liquidation period of at least two days according to ESMA Article 26. However, the real liquidation period in narrow markets could exceed this regulatory minimum requirement. If the effective liquidation period l of an existing position is greater than two days an additional concentration risk margin is required

$$Concentration\ Risk\ Margin := IM_{SPAN} \cdot \max\left(\sqrt{\frac{l}{2}} - 1; 0\right).$$

3.3.1 Concentration risk margin on account level

Let $OI_A^{CC_i}$ be the net open interest size ("net quantity times contract value") of a specific commodity[18] CC_i within an account (A). The liquidation period for this specific position is given as

$$l_A^{CC_i} = \frac{OI_A^{CC_i}}{MC^{CC_i}}$$

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18 Here products (futures and options) with the same underlying (same market) form a commodity, e.g. all German power contracts form the commodity "German Power".

with the assumed daily market capacity MC^{CC_i}.[19]

Let $\widetilde{OI}_A^{CC_i}$ be the euro amount of the net open interest $OI_A^{CC_i}$. The liquidation period on account level l_A is the weighted liquidation period over all positions $CC_i, i = 1, \dots, n$

$$l_A = \frac{\sum_{i=1}^{n} l_A^{CC_i} \cdot \widetilde{OI}_A^{CC_i}}{\sum_{i=1}^{n} \widetilde{OI}_A^{CC_i}}.$$

The concentration risk margin on account level is defined as

$$CONR_A = \max\left(\sqrt{\frac{l_A}{2}} - 1; 0\right) \cdot IM_{SPAN,A}$$

with the SPAN® Initial Margin $IM_{SPAN,A}$ of the account.

3.3.2 Concentration risk margin on clearing member level

The aggregation of positional volumes of accounts can create concentration on Clearing Member level (cluster effect through small but similar positions of accounts of a CM). To consider this risk analogous calculations are needed on CM level based on the net position of the CM. The final margin requirement on CM level considers the collected concentration risk margin of all accounts and a fraction of the initial margin buffer ("$IM_{Buffer} = \sum_{A\ of\ CM} IM_{SPAN,A} - NetMargin_{CM}$")

$$CONR_{CM} = \max\left\{\max\left(\sqrt{\frac{l_{CM}}{2}} - 1; 0\right) \cdot \sum_{A\ of\ CM} IM_{SPAN,A} - \sum_{A\ of\ CM} CONR_A - \alpha \cdot IM_{Buffer}; 0\right\}.$$

$\alpha \in [0,1]$ is initially set to 50%.

3.3.3 Caps and floors

To consider the time needed to identify a default and design the close out strategy the calculation of the liquidation period $l_A^{CC_i}/l_{CM}^{CC_i}$ takes an additional add-on of 0.3 days into account.

On account level, the final liquidation period l_A is capped at 3 days as ECC's default management procedure ends after 3 days. On Clearing Member level, the concentration risk margin is capped at 50% of the total SPAN® initial margin requirement $\left(\sum_{A\ of\ CM} IM_{SPAN,A}\right)$.

ECC validates the adequacy and, if necessary, adjusts the caps and floors on a regular basis.

[19] The used market capacities are provided at ECC's website (https://www.ecc.de/fileadmin/ECC/Downloads/Risk_Management/Margining/Market_Capacity.xlsx).

3.4 Other Margin Classes

3.4.1 Additional Margin for expiring before the final settlement / delivery

For every product where the final settlement price is not available on expiry date or where the expiry date is before the final delivery date, it is necessary to perform a margin correction. In such a situation, the products don't appear in the position file anymore which is the base for the SPAN initial margin procedure. So instead of the Margin Class "SPAN", the corresponding SPAN initial margin for those futures is booked as additional margin in the CC750 reports. The margin will be released on the next payment day after the final settlement price was calculated.

The calculation is done per account and margin class. The following margin classes exist in this context:

- Additional Margin Power (AMPO)
- Additional Margin Coal (AMCO)
- Additional Margin Iron Ore (AMIO)
- Additional Margin Balance of the Month (AMBO)

3.4.2 Additional Margin for expiring before emissions delivery

In order to cover the time period between contract expiry and delivery of emisson contracts, an additional margin from the buy-side of expiring emissions contracts is required. This Additional Margin Emissions (AMEM) is equal to the SPAN margin of the contract and will be released with the payment of the delivery day.

3.4.3 Additional Margin for open payment obligations

Since open payment obligations for certain currencies such as JPY are settled on d+2, it is necessary to collateralize these payments by a dedicated EoD margin equal to the debit amount of these payments in order to mitigate the default risk until the cash settlement.

The AMOP margin requirement is calculated during the EoD process on day d. AMOP is equal to the Variation Margin debit amount in JPY with the settlement date on d+2 in order to secure the pending payment obligation by the Clearing Member. The AMOP will be booked on Margin Account level (i.e. down to NCM and Account level) and will be included in the total margin requirement, which has to be covered by 8:00 am CE(S)T on d+1 at the latest. On d+1 end-of-day, AMOP for day d will be released.

In general, AMOP margin corresponds to the aggregated debit value of VMAR payments in a foreign currency with the settlement date ≥ d+2. AMOP takes into account bank holidays in a foreign currency (not EUR) and can be extended up to 4 days. For example, if there are 2 consecutive bank holidays in Japan, the settlement day for the payments in JPY from the trading day d is moved from d+2 to d+4. Therefore, AMOP Margin will include aggregated debit amounts of VMAR payments from day d, day d+1 and d+2.

3.4.4 Japanese Power Pre-Opening Limits Margin

The Pre-Opening Limit is a pre-funded trading limit which applies at the level of the Clearing Member and can be set by Clearing Members in the EEX Japan Power Portal for trading in Japanese Power futures. Without having a collateralized limit in place no entries for trade registration can be entered into the EEX Japan Power Portal during the European nighttime. Pre-Opening Limits are processed by ECC as an additional margin requirement (margin class JPPL = pre-opening limit). The JPPL margin is booked to the CM's PP margin account and covers aggregate overnight trading activity in Japanese Power futures of all its NCMs.

In the EEX Japan Power Portal the sum of all positions (long and short positions are not netted but aggregated) multiplied by the scanning range for the respective contract(s) has to stay within the Pre-Opening Limit for entries for trade registration to be accepted in the EEX Japan Power Portal.

$$\sum_{NCM \in CM} \sum_{contract \in NCM} |Quantity_{Contract}\ in\ Japan\ Power\ Future|_{NCM} \cdot ScanningRange_{contract} \leq JPPL_{CM}$$

4. Mark-to-Market Margin Requirements

4.1 Variation Margin

Variation Margin (VM) reflects changes in market value of future and future style positions and is called daily on ECC business days. Since the Initial Margin covers potential losses within the future liquidation period, recent day-to-day moves in market value have to be reset (mark-to-market). The payments associated with marking-to-market are called Variation Margin, where adverse market movements cause payment requirements, and advantageous market movements are accounted for as margin credit. Accumulated, Variation Margin represents profit and loss, such that on maturity date, accumulated Variation Margin represents the total loss of an unprofitable position held until maturity and the total profit of a profitable position.

Variation Margin called on day t consists of two components: One component for the existing position, and one component for new transactions since the last Variation Margin settlement.

For a future or a future style option X with settlement prices $p_X(t)$, $p_X(t-1)$ for day t and the previous business day $t-1$ respectively and index i over all transactions of X, where $\mathrm{TransactionQuantity}_i$ is positive for buys and negative for sells, $\mathrm{position}_X(t-1)$ being the net position at the end of day $t-1$, and $p_X^{\mathrm{transaction}_i}$ being the price as concluded in the transaction i, the Variation Margin is determined as follows:

$$\mathrm{VM}_X(t) = \mathrm{VM}_{X,\mathrm{existing\ position}}(t) + \mathrm{VM}_{X,\mathrm{new\ transactions}}(t)$$

$$\mathrm{VM}_{X,\mathrm{existing\ position}}(t) = \mathrm{position}_X(t-1) \cdot \mathrm{ContractVolume}_X \cdot \left(p_X(t) - p_X(t-1)\right)$$

$$\mathrm{VM}_{X,\mathrm{new\ transactions}}(t) = \sum_i \mathrm{TransactionQuantity}_i \cdot \mathrm{ContractVolume}_X \cdot \left(p_X(t) - p_X^{\mathrm{transaction}_i}\right)$$

Note that “transaction” not only includes trades but also exercises of options on futures. The total Variation Margin is then the sum over all futures and future style options X:

$$\mathrm{VM}(t) = \sum_X \mathrm{VM}_X(t)$$

4.2 Intraday Variation Margin

An Intraday Variation Margin is calculated for futures and future style options from 8 am to 6 pm, every 10 minutes on each ECC business day. As the settlement price $p_X(t)$ of the current day is not yet available at that time, the process uses two sources as input:

- Exchange prices
- Non-exchange prices (i.e. OTC)

In the case an exchange price is available, ECC uses this price as a reference. Otherwise, ECC takes the median of the last 5 non-exchange prices as a reference. If the number of available non-exchange prices is less than 5, ECC does not calculate any median but considers the non-exchange price signal as not available. Based on the difference between the above reference price and last settlement price ECC checks whether an intraday margin call is required.

4.3 Premium Margin and Additional Collateral

Premium style options are not subject to variation margin. Instead, a premium margin is defined as the product of net position, contract size, and current option settlement price. For short options, the premium margin is called daily; for long options, the premium is credited to the member's account but not paid out.
EMIR Article 46 (2) allows the acceptance of the underlying of a derivative or the financial instrument that gives rise to a risk to be used as collateral (additional collateral). Currently, ECC accepts EUA as collateral, which is applied similar to premium margin, i.e., an additional collateral amount reduces the margin requirement. Different models are offered which have to be selected by the Clearing Member:

#	Formula per selected Model incl. Risk Management Limits[20]
1	:= Min (Available Collateral Value ; 0)
2	:= Min (Available Collateral Value ; x % * Req_{BASE} ; y € ; Req_{IMSM})
3	:= Min (Available Collateral Value ; x % * Req_{BASE} ; y € ; Req_{IMSM} + Req_{SPAN})
4	:= Min (Available Collateral Value ; x % * Req_{BASE} ; y € ; Req_{IMSM} + Req_{SPAN} + Req_{PREM})
5	:= Min (Available Collateral Value ; x % * Req_{BASE} ; y € ; Req_{IMSM} + $Req_{SPANcapped}$)
6	:= Min (Available Collateral Value ; x % * Req_{BASE} ; y € ; $Req_{SPANcapped}$)

Where:

$$\mathrm{Req_{BASE}} := \mathrm{Req_{IMSM}} + \mathrm{Req_{SPAN}}$$

$$\mathrm{Req_{SPANcapped}} := Min(Min(\mathrm{Pieces_{Available}}; \text{Net Short Future Position}) * (\text{Value} * (1 - \text{Haircut})); \mathrm{Req_{SPAN}}$$

Concentration limits on ECC level according to the current concentration risk policy apply to limit the maximum share of EUA that can be used as collateral.

[20] For information on the Initial Margin Spot Market (IMSM) refer to the document *ECC Spot Market Margining* on https://www.ecc.de/ecc-en/risk-management/margining