# ECC Derivative Market Margining

Version 1.12

**Contact**
European Commodity Clearing AG
CCP Risk Methodology

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# 1. Glossary

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|---|---|
| Clearing Member | A Clearing Member is a guarantor and payment agent and steps between the transactions of ECC and Non-Clearing Member (Trading Participant) to be contractual counter party for both on the Derivatives Market. |
| Combined Commodity | A concept of the SPAN Initial Margin model component. It represents a set of (future and option) contracts with the same underlying. |
| Trading Participant | A counterparty to a trade cleared via ECC. |
| Margin Account | Initial Margin is calculated for each client’s proprietary positions and agency positions individually. The resulting initial margin is booked in separate margin accounts. |
| Margin Parameter | A margin parameter represents the key input to the SPAN Initial Margin model component. The model distinguishes Single Margin Parameters, Spread-Margin Parameters, Volatility Scan Range Parameters and Short Option Minimum Parameter. |
| (Anti-)Procyclicality Buffer | A component for margin parameter calculation. It aims at remediating procyclical effects of the initial margin calculation. |
| Risk Multiplier | A component for margin parameter calculation. It measures the quantile of normalised return distributions. |
| Short Option Minimum Parameter | A floor to the initial margin for option contracts. It is the key output from the Short Option Minimum model component. |
| Single Margin Parameter, SMP | A risk measure estimating the quantile of a return distribution. It is the key output from the Single Margin Parameter model component. |
| Spread-Margin Parameter | A scaling factor to measure hedge relations. It is the key output from the Spread-Margin Parameter model component. |
| Tier | Tiers are sub-categories of Combined Commodities. ECC uses tiering for contracts within a Combined Commodity with a similar risk profile. In general, a Tier is represented by a set of consecutive contract expiries. |
| Volatility Scan Range Parameter, VSR | The modelled maximum change in implied volatility of each option's underlying price. It is the key output from the Volatility Scan Range Parameter model component. |

# 2. Introduction

This document provides the documentation of ECC's margining model 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]. Information on margin reports can be found under https://www.ecc.de/en/risk-management/reports-and-files/

The Spot Margin Model is not in scope of this document. A separate documentation can be found on the ECC website.

## 2.1 Overview of Margin Components

The following table gives an overview of the different margin components relevant in the context of derivative margining:

| Exposure Type | Margin Component | 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 |
| | **Concentration Risk Margin** | Concentration Risk Margin covers the risk from illiquid markets with a liquidation period greater than two days |
| | **Additional Margins** | Other Margins are calculated to cover product, system or settlement specifics not covered by SPAN® Initial Margin (e.g. to cover cases where the margin needs to be deposited longer than the expiry date) |

All margin components are calculated per Margin Account and aggregated on a gross basis to each Clearing Member. Based on the aggregated margin, collateral is called from Clearing members.

For derivatives markets, ECC employs a statistical approach using SPAN® [2] 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%.

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[1] The ECC Risk Parameter file is available in the download section on the ECC website https://www.ecc.de/en/risk-management/margining.

[2] '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

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 on portfolio level and regular analysis for margin parameters. ECC performs an annual validation of methods, models, and model assumptions.

## 2.2 Regulatory Requirements

| Regulatory Item | ECC Methodology |
|---|---|
| **ESMA[3] Article 24 requires that for the calculation of initial margins the CCP shall at least respect the following confidence intervals:**<br>(a) **For OTC derivatives, 99.5%;**<br>(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.**<br>**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 used |
| **ESMA Article 27 requires that in case portfolio margining covers multiple instruments, the amount of margin reduction shall be no greater than 80% of the difference between the sum of the margins for each product calculated on an individual basis and the margin calculated based on the combined estimation of the exposure for the combined portfolio.** | ECC applies a cap of 80% to the margin credit parameters for contracts with different underlying commodities directly within the initial margin calculation[4]. |
| **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** | ECC uses a margin buffer of 25% to account for procyclicality. |

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

[4] For the definition of "product" the specification in the ESMA opinion esma70-708036281-18_opinion_on_portfolio_margining.pdf (europa.eu) is used

**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.**

# 3. Overview of Model Methodology

In this section, we give an overview of the model components. Moreover, we sketch the key elements of the methodology of the model components. Details on the methodologies are elaborated in the forthcoming sections.

**Input Data**

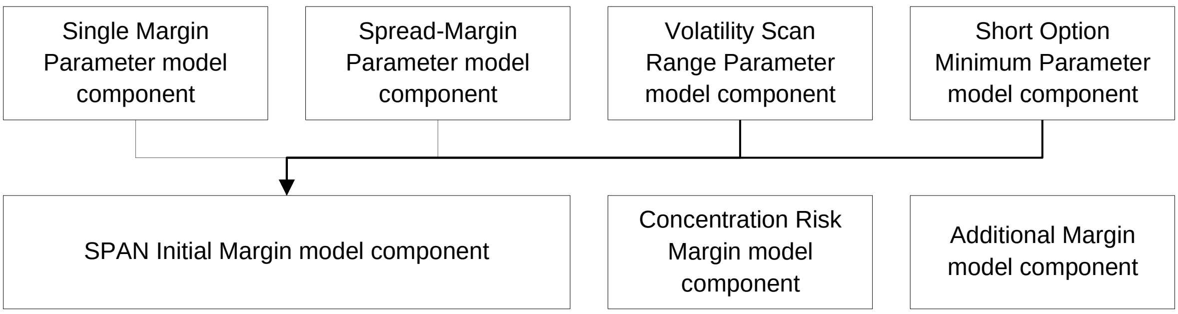
The margining model for the derivative market uses the following market data inputs:

- Daily settlement prices for all contracts in scope of the model as determined by the relevant markets according to their settlement price procedures,
- Implied Volatilities for all option contracts in scope of the model
- FX spot rates for all contracts denominated in non-EUR currency,
- Risk-free interest rates for all premium-style option contracts (in their respective currency).
- Net Open Interests and Market capacities for Concentration Margin

Model parameters are specified in ECC's Risk Parameter File.[5]

**Initial Margin Methodology**

The initial margin model components and their dependencies are illustrated in the following graph:




Details on the model components are elaborated below.

Formally, initial margin $IM$ is decomposed into the following sum

$$IM = IM^{\text{SPAN}}[M_X, C_P, VSR_U, SOM_U] + IM^{\text{Conc}} + \sum_k IM_k^{\text{Add}}.$$

Here,

- $IM^{\text{SPAN}}$ represents the initial margin component calculated by the SPAN Initial Margin model component,

[5] See ‚ECC Risk Parameters' at https://www.ecc.de/en/downloads.

- $IM^{\text{Conc}}$ represents the concentration risk margin calculated by the Concentration Risk Margin model component,
- $IM_k^{\text{Add}}$ represent additional initial margin components applicable to certain products covering product or settlement specific features.

**SPAN Initial Margin Methodology**

The SPAN initial margin component $IM^{\text{SPAN}}$ is the most significant margin component in ECC's initial margin model.

Key model inputs to the SPAN Initial Margin model component are Single Margin Parameters $M_X$, Inter-commodity Spread-Margin Parameters $C_P$, Volatility Scan Range Parameters $VSR_U$, and Short Option Minimum Parameters $SOM_U$.

Single Margin Parameters $M_X$ represent quantiles of price returns for a given future contract. The parameters are calculated by the Single Margin Parameter model component. The methodology for this model component is summarized in section 4.1.2.1

Inter-commodity Spread-Margin Parameters $C_P$ are used to model hedging relations between Tiers of different Combined Commodities. The parameters represent multipliers in the range $[0,1]$ where $0$ represents no hedge relation and $1$ represents a perfect hedge relation. The parameters are calculated by the Spread-Margin Parameter model component. The methodology for this model component is summarized in section 4.1.2.2.

Volatility Scan Range Parameters $VSR_U$ represent ranges within which the implied volatility of an option contract might reasonably be expected to move during the liquidation period. The parameters are calculated by the Volatility Scan Range Parameter model component. The methodology for this model component is summarized in section 4.1.2.3.

Short Option Minimum Parameters $SOM_U$ represent floors of the initial margin output for certain option contracts. The parameters are calculated by the Short Option Minimum Parameter model component. The methodology for this model component is summarized in section 4.1.2.4

The calculation methodology for the SPAN initial margin $IM^{\text{SPAN}}$ is based on the calculation of pre-defined scenario valuations. The initial margin component is calculated by the SPAN Initial Margin model component. The methodology for the model component is specified in section 4.1.

**Further Initial Margin Methodologies**

Concentration risk margin $IM^{\text{Conc}}$ covers the risk of large position in less liquid markets which would result in a liquidation period greater than two days. Concentration risk margin is calculated by the Concentration Risk Margin model component. The methodology for this model component is specified in section 4.2.

Additional initial margin components $IM_k^{\mathrm{Add}}$ cover the following aspects

- technical margin calculation gap for contracts with expiry before final settlement,
- technical margin calculation gap for emission contracts with expiry before emissions delivery,
- open payment obligations from margin calls in foreign currency,
- Japanese Power Pre-Opening limits, and
- Delivery Margin for risk from short positions in storable commodities prior to contract expiry date.

Additional initial margin components are calculated by the Additional Margin model component. The methodology for this model component is specified in section 4.3.

**Variation Margin Methodology**

Variation margin $VM$ covers the change in risk arising from position changes and changes in market prices.

Since the Initial Margin covers potential losses within the future's 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. It is called for positions in futures and future-style options.

**Premium Margin Methodology**

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.

# 4. Initial Margin Requirements

## 4.1 SPAN® Calculation

ECC uses the standard SPAN®[6] 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.

**Overview of Calculation Methodology**

The SPAN Initial Margin is calculated per portfolio along the following steps:

1. Calculation of the overall scan risk ($IM^{\text{SCAN RISK}}$) for each Tier of a Combined Commodity.
2. Calculate margin credits for the following types of spread positions in the following order:
   a. Perfect Spreads ($CREDIT^{\text{Perfect Spread}}$) for positions with equal underlying,
   b. Intra-Commodity Spreads ($CHARGE^{\text{Intra-Commodity}}$) within each Tier of a Combined Commodity,
   c. Inter-Commodity Spreads ($CREDIT^{\text{Inter-Commodity}}$) for specified hedge relations; applied to the portfolio in descending order of the Inter-Commodity credit value.
3. If applicable to contract, apply Short Option Minimum floor ($IM^{\text{SOM}}$).

The concept of Combined Commodity and Tiering is specified in section 4.1.1. These concepts are used in the various steps of the calculation.

The SPAN Calculation requires parameters as inputs. These SPAN Margin Parameters are specified in section 4.1.2.

Scan Risk calculation (step 1 above) is specified in section 4.1.3. Margin Credit calculation (step 2 above) is specified in section 4.1.4.

Finally, Short Option Minimum floor application is specified in section 4.1.5.

[6] 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.

### 4.1.1 Contract Classifications

Contracts are specified by the following properties:

- Underlying
- Expiry (year/month, e.g. December 2023)
- Delivery period (week, month, quarter, year; if applicable)
- Contract type (future, option)
- Option details (call/put, strike; only for option contracts)

**Constant Maturities**

ECC uses the concept of Constant Maturities. A Constant Maturity represents a generic time difference (or term) between the actual expiry date and the current observation date.

For a given observation date, each contract expiry is mapped to a constant maturity. The constant maturity of a contract changes during the life time of a contract as the time to expiry reduces.

Returns and margin parameters are calculated per Constant Maturity, i.e. for time buckets with a fixed time to expiry. As a consequence, a return time series for a given Constant Maturity in general contains contracts with changing expiry dates. For example, one computes the margin parameter for the front month of a 'German power base contract with 1-month delivery period' based on the history of the current and previous front month futures.

Expiry and Constant Maturity are used synonymously. The initial margin methodologies reference the Constant Maturities of a contract.

ECC uses various classifications to group and link contracts. These classifications are

- Underlying,
- Product (with unique Product-ID),
- Combined Commodity,
- Tier, and
- Cross Margining Group

**Underlying**

An underlying of a contract represents the asset or commodity to which the contract ultimately refers.

Underlyings are, for example,

- EEX German Power Base, or
- EEX PEG Natural Gas

**Product**

A product is characterised by underlying, delivery period (if applicable) and contract type.

A product category may contain future contracts with different expiries (but same delivery period). Similarly, a product category may contain options with different expiries, strikes and call/put type (but same delivery period).

Products are, for example,

- EEX German Power Base Month Future (Product-ID: DEBM)
- EEX German Power Base Month Option, Premium Style (Product-ID O2BM)
- EEX PEG Natural Gas Month Future (G5BM)

**Combined Commodity**

At ECC a Combined Commodity is characterised by underlying and (if applicable) delivery period. This specification combines similar future contracts and option contracts.

As a consequence, a Combined Commodity can be viewed as a combination of similar Products. The identifier of the Combined Commodity is the Product-ID of the corresponding future product.[7]

Combined Commodities are, for example,

- The Combined Commodity "DEBM" encompasses "EEX German Power Base option [monthly]", "EEX German Power Base option (future style) [monthly]" and "EEX German Power Base future [monthly]".

**Tiering**

Tiers are sub-categories of Combined Commodities.

ECC uses tiering for contracts within a Combined Commodity with a similar risk profile. In general, a Tier is represented by a set of consecutive contract expiries.

ECC uses a product setup where a Tier typically includes only a single expiry. Tiers with multiple consecutive expiries are applied only to freight contracts.

For a given Tier, SPAN Initial Margin is calculated based on the net position[8] of all contracts in this Tier using the same Scanning Range.

Tiers are, for example:

[7] 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.

[8] Delta weighting is used to calculate the net position.

- The tier “DEBM122023” of the Combined Commodity “DEBM” encompasses all “EEX German Power Base option [monthly]”, “EEX German Power Base option (future style) [monthly]” and “EEX German Power Base future [monthly]” with maturity Dec 2023.
- The tier “P5TC2” of the Combined Commodity “P5TC” encompasses all EEX Baltic/Asian Panamax 5TC monthly options and futures exercising in the front quarter.

**Cross Margining Group for Spread Margin Parameters**

A Cross Margining Group represents a collection of Combined Commodities. The contracts within a Cross Margining Group are considered to be eligible for inter-commodity spread margin credits.

The different cross margining groups used for derivative margining can be found in the ECC risk parameter file available in the download section of the ECC margining website: https://www.ecc.de/ecc-en/risk-management/margining.

### 4.1.2 SPAN Margin Parameters

The SPAN Initial Margin Parameters are Single Margin Parameter (SMP), Spread Margin Parameter, Volatility Scan Range (VSR) and Short Option Minimum (SOM). These parameters are generated by model components as part of the margining model for the derivative market.

In this section, we give a summary of the parameters and their specification.

#### 4.1.2.1 Single Margin Parameter (SMP)

Single margin parameters (SMPs) are values which quantify risk of futures positions and are used to determine the SPAN® Initial Margin for derivatives. The SMPs are calculated for each business day.[9]

The single margin parameter $M$ quantifies the price change risk over the liquidation period and is a multiple of a contract's returns' standard deviation. For a given contract $X$ and day $t_n$ the single margin parameter $M_X(t_n)$ is given by:

$$M_X(t_n) = p_X(t_n) \cdot \sigma_X(t_n) \cdot \sqrt{l_X} \cdot R_X(t_n) \cdot [1 + b_X(t_n)] \cdot W_X(t_n).$$

Here,

- $p_X(t_n)$ is the contract's settlement price at $t_n$,
- $\sigma_X(t_n)$ is the volatility of relative returns of daily prices,
- $l_X$ is the contracts liquidation period in days,
- $R_X(t_n)$ is a risk multiplier derived from the confidence level of the given quantile,
- $b_X(t_n)$ is a buffer aiming at preventing procyclical margining (“Anti-Procyclicality buffer”), and

[9] Most recent parameters can be found on the internet, see https://public.eex-group.com/ecc/risk-management/reports-files/index.html

- $W_X(t_n)$ is a weight factor covering risks of specific contracts.

The settlement price $p_X(t)$ is a direct input to the methodology.

The methodology for the calculation of the volatility $\sigma_X(t)$ is specified in section 5.1.

The liquidation period $l_X$ is a direct input to the methodology.

The methodology for the calculation of the quantile risk multiplier $R_X(t)$ is specified in section 5.2.

The methodology for the calculation of the Anti-Procyclicality buffer $b_X(t)$ is specified in section 5.3.

The weight factor is $W_X(t) = 1$, except for contracts with specific risks. The methodologies for (non-trivial) additional weight factor calculations are specified in section 0.

**Aggregation of Single Margin Parameters on Tier-Level**

Within SPAN, margin calculation is specified on the level of Tiers within a Combined Commodity. Consequently, Single Margin Parameters need to be calculated on the level of Tiers.

The SMP for a Tier $T_A$ is calculated as average of the SMP's per expiry,

$$\widehat{SMP}_{T_A} = \frac{1}{|T_A|} \cdot \sum_{X \in T_A} M_X.$$

#### 4.1.2.2 Spread Margin Parameter

Spread Margin Parameters (also called margin credits) are denoted as $C_P$. Here, $P = (X, Y)$ represents a pair of two Tiers of Combined Commodities. The Tiers can correspond to the same or different Combined Commodities.

The general Spread Margin Parameters calculation formula is

$$C_P = \min\left\{1 - \frac{M_P}{\widetilde{M}_P}, Cap\right\}.$$

Here, $M_P$ represents the risk for a netted portfolio of a pair $P = (X, Y)$ and $\widetilde{M}_P$ represents the (non-netted) aggregated risk of a portfolio of $X$ and $Y$. $Cap$ is a cap on the Spread Margin Parameter applied to particular commodities.

The methodology for the calculation of the non-netted portfolio risk $\widetilde{M}_P$ is specified in section 5.5.2.

The methodology for the calculation of the netted portfolio risk $M_P$ is specified in section 5.5.3.

The commodities, for which a special cap is applied are specified in section 5.5.4.

For non-trivial Tiers with multiple expiries, an average Spread Margin Parameter on the level of Tiers is calculated as

$$C_{T_A,T_B} = \frac{1}{n_{T_A,T_B}} \sum_{X \in T_A, Y \in T_B} C_{(X,Y)}.$$

where $n_{T_A,T_B}$ represents the number of combinations of contracts between Tier $T_A$ and Tier $T_B$.

#### 4.1.2.3 Volatility Scan Range Parameter

The VSR Parameter is denoted as $VSR_U(t)$. Here, $U$ represents the corresponding underlying of an option contract and $t$ represents the current observation time.

VSR Parameters can be interpreted as quantiles of the distribution of absolute returns of implied volatilities. The core element of $VSR_U(t)$ is the quantity

$$q(\{r_{AVG}\})_\alpha \cdot \big(1 + b(t)\big).$$

Here,

- $\{r_{AVG}\}$ is a time series of absolute returns of implied volatilities,
- $b(t)$ is a "buffer" aiming at preventing procyclical margining ("Anti-Procyclicality buffer"),
- $q(\cdot)_\alpha$ is the empirical quantile function for a given confidence level $\alpha = 99\%$,

Above core Volatility Scan Range is amended by applying rounding to 1%, a floor at 10% and a fall-back value of 50% (in case of insufficient data).

The time series of volatility returns $\{r_{AVG}\}$ is determined from the daily averages of non-zero scaled absolute day-to-day changes in implied volatilities across all tradable options over a one-year lookback period. Hereby, the daily changes are multiplied with the product specific factor $\sqrt{l_X}$ in order to scale the daily changes to a liquidation period of $l_X$ days.

The volatility buffer $b(t)$ is calculated analogously as the Anti-Procyclicality Buffer for Single Margin Parameters. Here, average daily implied volatilities across all strikes and maturities are used.

#### 4.1.2.4 Short Option Minimum Parameter

The Short Option Minimum Parameter is a floor on the SPAN Initial Margin applied to short positions in out-of-the-money options. Details on the application of the SOM are specified on section 4.1.5.

The SOM Parameter is denoted by $SOM_U$. Here, $U$ represents the corresponding underlying of an option contract.

For the majority of ECC's option contracts, the SOM Parameter is set conservatively via expert judgement at 5%. Its suitability is checked as part of the annual validation as well as indirect as part of the daily portfolio back testing.

For environmental option products (OEUB), SOM Parameters are calculated based on a backtesting approach.

The backtesting approach uses a set of relevant out-of-the-money option data points (option delta less than 0.5) of a one-year look-back period. For this set, the number of outliers are counted. This gives the ratio

$$Q(SOM) = \frac{\#Outliers(SOM)}{\#Contracts\ with\ delta\ less\ than\ 0.5}.$$

An outlier is identified, if an observed move in option prices $|O_{t+1} - O_t|$ exceeds the corresponding SPAN initial margin $SPAN_t$ or Short Option Minimum Parameter $SOM_U$ times Single Margin Parameter $SMP_t$. This condition is expressed as

$$\max\{SPAN_t, SOM \cdot SMP_t\} < |O_{t+1} - O_t|.$$

The final SOM Parameter $SOM_U$ is calibrated such that ratio of outliers $Q(SOM_U)$ does not exceed 0.5%.

### 4.1.3 Scan Risk

SPAN® uses a configurable range of price and volatility movements to calculate the worst-case loss of a Tier within 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.

| Scenario | Underlying Price Scan Change | Volatility Scan Change | Scenario | Underlying Price Scan Change | Volatility Scan Change | Weight |
|---|---|---|---|---|---|---|
| 1 | UNCHANGED | UP | 9 | DOWN 67% | UP | 1 |
| 2 | UNCHANGED | DOWN | 10 | DOWN 67% | DOWN | 1 |
| 3 | UP 33% | UP | 11 | UP 100% | UP | 1 |
| 4 | UP 33% | DOWN | 12 | UP 100% | DOWN | 1 |
| 5 | DOWN 33% | UP | 13 | DOWN 100% | UP | 1 |
| 6 | DOWN 33% | DOWN | 14 | DOWN 100% | DOWN | 1 |
| 7 | UP 67% | UP | 15 | UP 300% | No | 0.33 |
| 8 | UP 67% | DOWN | 16 | DOWN 300% | No | 0.33 |

Table 1: SPAN® basis scenarios.

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 $\mathcal{M}_X$ defined as specified in section 4.1.2.1 multiplied by the contract volume. The value of the volatility scan range and the inclusion of interest-rate-risk are subject to at least annual validation. In SPAN® options are priced using the Black76-model[10].

The 16 pre-defined scenarios are applied to all Tiers of Combined Commodities 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.

### 4.1.4 Spreads

A spread contains offsetting positions in correlated instruments. Due to ECC's product portfolio different types of spreads are used. Physically settled contracts in delivery as well as short-term contracts (day and weekend futures) are not included in spreading.

#### 4.1.4.1 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 credit for each position in a perfect spread is

$$CREDIT^{\text{Perfect Spread}} = IM^{\text{SCAN RISK}} \cdot 0.99$$

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.

#### 4.1.4.2 Intra-Commodity Spreads

For opposite positions in different contracts in the same Tier of a Combined Commodity the use of the same risk arrays implicitly assumes that price changes across different expiries of a Combined

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

Commodity and Tier are perfectly correlated. This neglects possible calendar basis risks arising from term structure incongruences.

In order to correct this aspect, SPAN® proceeds as follows: The net delta for each Tier for which a position is held is considered. Long net deltas are offset with short net deltas. The highest number of possible spreads is formed. This number is then multiplied by the charge for each spread as specified by ECC.[11] The result is added to the amount calculated from the risk arrays (or "scanning risk").

$$CHARGE^{\text{Intra-Commodity}} = \#Spreads_{T_A} \cdot IC(T_A),$$

where $IC(T_A)$ is the Intra-Commodity Charge for each position for tier $T_A$ and $\#Spreads_{T_A}$ denotes the maximum number of spreads for tier $T_A$.

**Intra-Commodity Charge Calculation**

We specify the calculation of the Intra-Commodity Charge $IC(T_A)$.

The Intra-Commodity Charge $IC(T_A)$ is calculated as an average of offsetting charges $\pi(M_i, M_j)$ between two expiries $M_i$ and $M_j$ within a Tier $T_A$. That is,

$$IC(T_A) = \frac{1}{n(T_A)} \sum_{M_i, M_j \in T_A, i<j} \pi(M_i, M_j),$$

Here, $n(T_A)$ denotes the number of distinct combination of expiries within tier $T_A$.[12]

The offsetting charges $\pi(M_i, M_j)$ are calculated as

$$\pi(M_i, M_j) = 2 \cdot \widehat{SMP}_{T_A} \cdot \frac{NM(M_i, M_j)}{CM(M_i, M_j)}.$$

Inputs to above calculation are average SMP per Tier $\widehat{SMP}_{T_A}$, Net Margin Parameter $NM(M_i, M_j)$, and Cross Margin Parameter $CM(M_i, M_j)$. The inputs are calculated as follows

$$\widehat{SMP}_{T_A} = \frac{1}{|T_A|} \cdot \sum_{i \in T_A} SMP_{M_i},$$
$$CM(M_i, M_j) = SMP_{M_i} + SMP_{M_j},$$

[11] The Intra-Commodity Charge for a tier is obtained by averaging over all charges within the tier. These values are available in the ECC SPAN® file on ECC website (https://public.eex-group.com/ecc/risk-management/reports-files/index.html).

[12] If $m > 1$ denotes the number of expiries within tier $A$ then $n(t_A) = m \cdot (m+1) \cdot \frac{1}{2}$.

$$NM(M_i, M_j) = CM(M_i, M_j) - 2 \cdot \varrho \cdot \min\left(SMP_{M_i}, SMP_{M_j}\right)$$

Here, $SMP_{M_i}$ is the SMP parameter for a given expiry $M_i$ and $\varrho$ is the correlation coefficient or future price returns between the two expiries $M_i$ and $M_j$.

#### 4.1.4.3 Inter-Commodity Spreads

Inter-Commodity spreads exploit the correlation between time series to reduce the margin requirement. The granted margin reduction is calculated in SPAN® using the margin credit (Spread Margin Parameters) as specified in section 4.1.2.2. Credits less than 0.01% are deleted[13], and the maximum applied margin credit is 99%.

If a portfolio consists of two opposing positions $X$ and $Y$ in two different tiers of the same or different combined commodities, the Inter-Commodity credit for each of both positions is given by

$$CREDIT^{\text{Inter-Commodity}} = \min\left(IM_X^{\text{SCAN RISK}}, IM_Y^{\text{SCAN RISK}}\right) \cdot C_P,$$

where $C_P$ is the margin credit[14] as determined according to the procedure detailed in section 4.1.2.2. Extraction of Inter-Commodity spreads from portfolio data using the margin credits given in the span-file is done by the SPAN®-software.

### 4.1.5 Short Option Minimum

Short positions in out-of-the-money options exhibit risks which are not properly captured by the Scan Risks of the SPAN methodology.

The Scan Risks may yield a near zero risk for out-of-the-money options. However, in market situations where the underlying price changes significantly, these options may move in-the-money. Such a move may induce significant losses for holders of short positions in the options.

To mitigate this model limitation, the SPAN methodology adds a floor on the initial margin output for short option positions. This floor is specified as Short Option Minimum.

The Short Option Minimum margin $IM^{\text{SOM}}$ is calculated as the product of Short Option Minimum Parameter $SOM_U$ and Single Margin Parameter $M_X$. That is

$$IM^{\text{SOM}} = SOM_U \cdot M_X.$$

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[13] Due to this constraint negative correlation is not considered in the margining.

[14] The applied margin credits for contracts with open interest can be found in the Intercommodity Spread File available on ECC website (https://public.eex-group.com/ecc/risk-management/reports-files/index.html).

Short Option Minimum Parameter $SOM_U$ and Single Margin Parameter $M_X$ are SPAN Margin Parameters and specified in section 4.1.2.

## 4.2 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

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

### 4.2.1 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[15] $CC_i$ within an account (A). The liquidation period for this specific position is given as

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

with the assumed daily market capacity $MC^{CC_i}$.[16]
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 $CC_i, i = 1, \ldots, n$

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

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.

### 4.2.2 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 ("$IM_{Buffer} = \sum_{A\ of\ CM} IM_{SPAN,A} - NetMargin_{CM}$")

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[15] 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".

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

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

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

### 4.2.3 Caps on liquidation period and concentration risk margin

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. The current values can also be found in the risk parameter file on the website.

## 4.3 Other Margin Classes

### 4.3.1 Additional Margin for expiring before the final settlement for financially settled power contracts in delivery

For financially settled power contracts in delivery, the situation can occur that the final settlement price is not available on expiry date. In such a situation, the products don't appear in the position file anymore which is the base for the SPAN initial margin procedure. Therefore, it is necessary to perform a margin correction. Instead of the Margin Class "SPAN", the corresponding SPAN initial margin for those futures is booked as additional margin in the CC750 reports under the margin class (AMPO) (Additional Margin Power). The margin will be released on the next payment day after the final settlement price was calculated.

### 4.3.2 Additional Margin for expiring before the final settlement for physically settled gas contracts in delivery

For physically settled gas contracts in delivery, also called BOM (Balance-of-the-Month) contracts, the settlement and delivery of the last day(s) of the delivery month has not been completed on expiry date. Since the products don't appear in the position file anymore after expiry which is the base for the SPAN initial margin procedure, it is necessary to perform a margin correction. Instead of the Margin Class "SPAN", an additional margin for those futures is booked in the CC750 reports under the margin class AMBO (Additional Margin Balance-of-the-Month). The margin will be released on the last settlement day.

Since the actual open settlement amount is already known, the additional margin to be called will be calculated as the netted sum of outstanding payments (considering potential delivery risk):

$$AMBO_{new} = \max\left(0\ ,\ \sum_{c\ in\ \{EUR,GBP\}}\left(\sum_{i\ \epsilon\{1,\dots,n\}\ :\ Curr(i)=c} SP_i * RCS_i * P_i * DRF_i(P_i)\right) / \ adjxrate(c, EUR)\right)$$

where for $n$ BOM contracts in the margin account and $i = 1, \dots, n$

- $SP_i$ is the settlement price of the BOM contract $i$ that has already been fixed before the delivery month started.
- $P_i$ is the position of the BOM contract $i$ in the margin account. ($P_i > 0$ for long positions and $P_i < 0$ for short positions)
- $RCS_i$ is the remaining contract size for the BOM contract $i$ that will be settled on the last settlement day.
- $DRF_i$ is the delivery risk multiplier also used in spot margining to reserve a portion of the financial exposure to cover delivery risk.
  - $DRF_i(P_i) = 1$ for long positions
  - $DRF_i(P_i) = 1$ for short positions and underlying market without delivery risk
  - $DRF_i(P_i) < 0$ for short positions and underlying market with delivery risk. Hereby, we use the same parameter also used in the Spot Margining Model[17]
- $adjxrate(c, EUR),\ c \in \{EUR, GBP\}$ is the adjusted exchange rate transforming calculated amounts into EUR in case $c = GBP$. In case the aggregated amount is positive, the adjusted exchange rate for debits is used. For negative amounts, the adjusted exchange rate for credits is used.

The AMBO covers the already known full exposure and can be seen as a form of pre-settlement for the days to be settled on the last settlement day of the BOM contract.

### 4.3.3 Additional Margin for expiring before emissions delivery

In order to cover the time period between contract expiry and delivery of emission 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.

### 4.3.4 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.

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[17] The applied parameters are published in the ECC Risk Parameter File on the ECC website.

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 two 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 $d + 2$.

### 4.3.5 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 night-time. 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.

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

### 4.3.6 Delivery Margin for short positions in storable commodities

Delivery Margin (DM) is called for uncovered net short positions in storable commodities one business day 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:

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

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 one business day before expiry of the contract and adjusts the Delivery Margin intraday by considering the most recent spot market price and adjustments of members balance on ECC's storable commodities account.
For storable commodities like EUA or EUAA, that can be maintained via the ECC Member Area, the Delivery Margin is reported as Premium Margin under the Margin Class IMSM. For all other storable commodities, the Margin Class DMEM is used.

# 5. Appendix

In this appendix section, we document additional details on the calculation of Single Margin Parameters and Spread Margin Parameters.

## 5.1 Volatility Calculation for SMP

In this section, we specify the calculation of the volatility parameter $\sigma_X(t_n)$.

The volatility $\sigma_X(t_n)$ is derived from a time series of relative returns. Relative returns for a contract of a Combined Commodity $X$ and an observation time $t_n$ are denoted as $r_X(t_n)$. Relative returns are calculated as

$$r_X(t_n) = \frac{p_X(t_n) - p_X(t_{n-1})}{p_X(t_{n-1})}.$$

A critical aspect of the methodology is the specification of a suitable time series for volatility calculation that reflects the properties of the return distribution. The time series $\tau_X(t_n)$ is specified as the 255 most recent return observations with non-zero returns.

The property of non-zero returns in the time series aims at ensuring that stale prices do not induce an underestimation of volatility. As a consequence, the effective estimation times $\tilde{t}_k$ may reach further in the past than 255 days. The choice of 255 days ensures that the statistical error in volatility estimation is limited.

For the volatility calculation, an exponentially weighted moving average (EWMA) is applied. That is

$$\sigma_X(t_n) = \sqrt{\sum_{k=1,\ldots,255,\, \tilde{t}_k \in \tau_X(t_n)} \left( [r_X(\tilde{t}_k)]^2 \lambda^k \right) \Big/ \sum_{k=1,\ldots,255} \lambda^k}\,.$$

Here, $\lambda$ is the weighting parameter with $\lambda = 0.99$.

## 5.2 Risk Multiplier Calculation for SMP

In this section, we specify the calculation of the risk multiplier $R_X(t_n)$.

The risk multiplier is derived from empirical quantiles of the normalised return distribution. That is, we calculate

$$R_X^0(t_n) = \frac{1}{2}\left( \left| q\left( \left\{ \frac{r_X(\tilde{t}_k)}{\sigma_X(\tilde{t}_{k-1})} \right\}_{\tilde{t}_{k-1},\, \tilde{t}_k \in \tau_X(t_n)} \right)_{\alpha} \right| + \left| q\left( \left\{ \frac{r_X(\tilde{t}_k)}{\sigma_X(\tilde{t}_{k-1})} \right\}_{\tilde{t}_{k-1},\, \tilde{t}_k \in \tau_X(t_n)} \right)_{1-\alpha} \right| \right).$$

Here, $q(\cdot)_\alpha$ is the empirical $\alpha$-quantile for a given time series.

The normalised returns are formed via

$$\left\{\frac{r_X(\tilde{t}_k)}{\sigma_X(\tilde{t}_{k-1})}\right\}_{\tilde{t}_{k-1},\, \tilde{t}_k \in \tau_X(t_n)}$$

The risk multiplier calculation can be motivated as follows: Consider the special case that the sequence of volatilities $\{\sigma_X(\tilde{t}_{k-1})\}_k$ is constant and equal to the variance of $\{r_X(\tilde{t}_k)\}_k$. Then the sequene of normalised returns has variance one. This ensures that there is no double-counting with the volatility $\sigma_X(t_n)$ in the SMP formula.

The average of the upper and lower empirical quantile of the distribution yields a scaling factor which takes into account extreme moves as well as skew and kurtosis of the return distribution.

The final risk multiplier $R_X(t_n)$ is then derived applying caps and floord to the initially calculated quantity. That is

$$R_X(t_n) = \min\{\max\{R_X^0(t_n), R_{\min}\}, R_{\max}\}.$$

Furthermore, if there are less than 100 estimation times available then we also set $R_X(t_n) = R_{\max}$.

The applied caps, floors and quantile parameters are listed in ECC's Risk Parameter File available on the ECC website.

## 5.3 Anti-Procyclicality Buffer Calculation for SMP

In this section, we specify the calculation of the Anti-Procyclicality buffer $b_X(t_n)$.

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 use a combination of stressed volatility (method 1) and buffer volatility (method 3).

**Stressed Volatility Buffer Component**

ECC 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.

Then, ECC calculates a stressed volatility by adding a weighted stress part into the calculation

$$\sigma_X^S(t) = \frac{255 - w}{255}\sigma_X(t) + \frac{w}{255}\sigma_{\max}(t).$$

Here, the weight $w$ can be found in the ECC risk parameter file on the website.

We note that the stressed volatility can be re-written as

$$\sigma_X^S(t) = \sigma_X(t)\left[1 + \frac{w}{255}\frac{\sigma_{\max}(t) - \sigma_X(t)}{\sigma_X(t)}\right].$$

This yields the stressed volatility buffer component

$$b_X^0(t) = \frac{w}{255}\frac{\sigma_{\max}(t) - \sigma_X(t)}{\sigma_X(t)}.$$

**Buffer Volatility Component**

For method 3, a threshold $\sigma_{\text{crit}} = \sigma_{\min} + a \cdot (\sigma_{\max} - \sigma_{\min})$ is calculated. Below the threshold of $\sigma_{\text{crit}}$ the margin parameter is increased by 25%. The value of $a$ can be found in the ECC risk parameter file on the website. Above the threshold $\sigma_{\text{crit}}$, the buffer of 25% is linearly reduced to zero.

This yields the buffer component

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

**Final Buffer Calculation**

Finally, ECC calculates the overall buffer as the maximum of both buffer components. That is

$$b_X(t_n) = \max\{b_X^0(t_n), b_X^1(t_n)\}.$$

## 5.4 Additional Weight Factor Calculation for SMP

In this section, we specify the calculation of the additional weight factor $W_X(t_n)$.

### 5.4.1 Physically Settled Contracts in Delivery with fixed settlement price (BoMs)

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, an additional weighting factor is considered within the Single Margin Parameter calculation. Hereby, the expiry month factor (EMF) is used that is set as follows:

- 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

$$RCS(t) = \max\left(x, \frac{(ExpiryDate - \max(t, FirstDeliveryDate))}{(ExpiryDate - FirstDeliveryDate)}\right).$$

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.

### 5.4.2 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 within the SMP calculation. 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 calculation 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.

## 5.5 Spread Margin Parameter Calculation Details

Spread-Margin parameters are calculated in the form of credit $C_P$ for selected bivariate portfolios $P$ 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 $M_P$. 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[18] of the absolute portfolio returns in EUR over the past 255 days with non-zero returns of both contracts.

### 5.5.1 Synthetic Spread Portfolio Specification

The methodology for the Spread Margin Parameters calculation is based on the analysis of a synthetic portfolio consisting of a long position in a Tier of a Commodity $X$ and a short position in another Tier of a Combined Commodity $Y$.

The portfolio is constructed for day[19] $t_n$. Absolute returns of the portfolio (with respect to the current price level and denoted in EUR) are

$$r_{X,Y}(t_n) = a(t_n)[p_X(t_n) - p_X(t_{n-1})] - b(t_n)[p_Y(t_n) - p_Y(t_{n-1})].$$

Here, $p_X(t_n)$ and $p_Y(t_n)$ are the prices on day $t_n$ and $a(t_n), b(t_n)$ are the position sizes of the synthetic portfolio for the time interval (i.e. trading period) $t_{n-1}$ to $t_n$.

A key aspect in the Spread Margin Parameters calculation is the choice of the position sizes $a(t_n)$ and $b(t_n)$. Our proposition is that the synthetic portfolio should not exhibit market risk if commodities $X$ and $Y$ are perfectly correlated, but potentially exhibit different price volatilities.

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

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

Above proposition motivates the setting $a(t_n) = M_Y(t_n)$ and $b(t_n) = M_X(t_n)$. Here, $M_X$ and $M_Y$ are (reduced) Single Marging Parameters of the combined commodities $X$ and $Y$. The SMPs are multiples of the volatility of the combined commodities. This yields a corresponding risk-weighting of the synthetic portfolio.

### 5.5.2 Specification of Gross-Portfolio Risk

The gross-portfolio risk (or un-netted) portfolio risk is the sum of the risk in combined commodity $X$ and combined commodity $Y$. The gross-portfolio risk is denoted $\widetilde{M}_P$ for a pair $P = (X, Y)$.

Gross-portfolio risk of the synthetic portfolio becomes

$$\widetilde{M}_P(t_n) = a(t_n)M_X(t_n) + b(t_n)M_Y(t_n).$$

Here, $M_X$ and $M_Y$ are (reduced) Single Marging Parameters of the combined commodities $X$ and $Y$.

For the calculation of Spread Margin Parameters the Single Margin Parameters $M_X$ (and $M_Y$ respectively) are calculated as

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

Here, $p_X(t_n)$ is the price for $X$, $\sigma_X(t_n)$ is the exponentially weighted moving average volatility, $l_X$ is the contracts liquidation period in days, and $R_X(t_n)$ is the risk multiplier. The methodology for the calculation of $\sigma_X(t_n)$ and $R_X(t_n)$ follows the methodology in the Single Margin Parameter model component.

We note that the methodology for $M_X(t_n)$ and $M_Y(t_n)$ calculation for Spread Margin Parameters does not include APC Buffer components and Additional Weight Factor components.

**Choice of Reduced Single Margin Parameters**

We note that above reduced Single Margin Parameter specification does not take into account the the Anti-Procyclicality buffer and Additional Weight Factors of the Single Margin Parameter calculation methodology.

The Anti-Procyclicality buffer and Additional Weight Factors are not included in the calculation of Spread Margin Parameters because they represent additional risk charges that covers risks which are not directly addressed/modelled by the SPAN Initial Margin Model component. The Spread Margin Parameter methodology focuses on hedge relations. Such hedge relations are not linked to the additional risk charges covered by Anti-Procyclicality buffer and Additional Weight Factors.

**Effective Gross-Portfolio Risk**

We apply the portfolio position sizes $a(t_n) = M_Y(t_n)$ and $b(t_n) = M_X(t_n)$ from section 5.5.1. This yields the gross-portfolio risk

$$\begin{aligned}\widetilde{M}_P(t_n) &= M_Y(t_n)M_X(t_n) + M_X(t_n)M_Y(t_n)\\ &= 2M_X(t_n)M_Y(t_n).\end{aligned}$$

### 5.5.3 Specification of Net-Portfolio Risk

The net-portfolio risk is the risk of the portfolio of long and short position in the combined commodities $X$ and $Y$. The net-portfolio risk is denoted $M_P$ for a pair $P = (X, Y)$.

The net portfolio risk $M_P$ of the synthetic portfolio is calculated as

$$M_P(t_n) = \sigma_P^{\text{corr}}[\sigma_P, t_n] \cdot R_P(\sigma_P, t_n) \cdot \sqrt{2}.$$

Here,

- $\sigma_P = \sigma_P(t_n)$ is the volatility of *absolute* returns of portfolio prices,
- $R_P(\sigma_P, t_n)$ represents the risk multiplier for the portfolio derived from the confidence level of the given quantile,
- $\sigma_P^{\text{corr}}[\cdot, t_n]$ is a conservative correction function applied to the portfolio volatility, and
- the factor $\sqrt{2}$ accounts for the liquidation period of the netted portfolio.

**Portfolio Volatility Calculation**

The volatility $\sigma_P(t_n)$ of absolute returns is calculated as

$$\begin{aligned}\sigma_P(t_n)^2 = {} & (a(t_n)\,\sigma_X(t_n)\,p_X(t_n))^2 + (b\,(t_n)\sigma_Y(t_n)\,p_Y(t_n))^2\\ & - 2\rho(t_n)\big(a(t_n)\cdot b(t_n)\big)\big(\sigma_X(t_n)p_X(t_n)\cdot\sigma_Y(t_n)p_Y(t_n)\big)\end{aligned}$$

Here,

- $t_n$ represents the current observation time,
- portfolio positions are $a(t_n) = M_Y(t_n)$ and $b(t_n) = M_X(t_n)$ (see section 5.5.1),
- commodity prices are $p_X(t_n)$ and $p_Y(t_n)$,
- volatilities of relative commodity price returns are $\sigma_X(t_n)$ and $\sigma_Y(t_n)$, and
- the correlation coefficient between relative returns of $X$ and $Y$ is $\rho(t_n)$.

Volatilities $\sigma_X(t_n)$ and $\sigma_Y(t_n)$ as well as the correlation coefficient $\rho(t_n)$ are calculated by forming time series of relative price returns

$$r_X(t_k) = \frac{p_X(t_k) - p_X(t_{k-1})}{p_X(t_{k-1})}, \quad r_Y(t_k) = \frac{p_Y(t_k) - p_Y(t_{k-1})}{p_Y(t_{k-1})}$$

for estimation days $t_k$ prior to $t_n$.

The volatilities $\sigma_X(t_n)$ and $\sigma_Y(t_n)$ are calculated following the corresponding methodology for SMPs.

The correlation parameter $\rho(t_n)$ is calculated as the standard correlation coefficient of the time series $\{(r_X(t_k), r_Y(t_k))\}_{k=n-255,\dots,n-1}$.

**Portfolio Risk-Multiplier Calculation**

The risk multiplier for the portfolio $R_P(\sigma_P, t_n)$ is calculated following the arguments for the SMP calculation.

A critical aspect of the methodology is the specification of a suitable time series that reflects the properties of the return distribution. The time series $\tau_{X,Y}(t_n)$ is specified as the 255 most recent return observations with joint non-zero returns for commodity $X$ and commodity $Y$.

Then, the risk multiplier $R_P(\sigma_P, t_n)$ is calculated as

$$R_P(\sigma_P, t_n) = \frac{1}{2}\left(\left|q\left(\left\{\frac{r_{X,Y}(\tilde{t}_k)}{\sigma_P(\tilde{t}_{k-1})}\right\}_{\tilde{t}_{k-1},\, \tilde{t}_k \in \tau_{X,Y}(t_n)}\right)_{\alpha}\right| + \left|q\left(\left\{\frac{r_{X,Y}(\tilde{t}_k)}{\sigma_Y(\tilde{t}_{k-1})}\right\}_{\tilde{t}_{k-1},\, \tilde{t}_k \in \tau_{X,Y}(t_n)}\right)_{1-\alpha}\right|\right).$$

Here, $r_{X,Y}(\tilde{t}_k)$ is the absolute portfolio return as specified in section 5.5.1, $\sigma_P(\tilde{t}_{k-1})$ is the netted portfolio volatility, and $q(\cdot)_\alpha$ is the empirical $\alpha$-quantile for a given time series.

**Conservative corrections applied to the Spread Margin Parameter**

It remains to specify the conservative correction function $\sigma_P^{\mathrm{corr}}[\cdot, t_n]$.

The conservative correction $\sigma_P \mapsto \sigma_P^{\mathrm{corr}}$ accounts for statistical uncertainty in the estimation of volatility for short time series. It is implemented by adjusting the correlation parameter $\rho(t_n)$ in the formula for $\sigma_P(t_n)$. The adjustment decreases the correlation parameter $\rho(t_n)$. This increases the net-portfolio volatility $\sigma_P(t_n)$. As a consequence, net portfolio risk $M_P$ is increased and margin credit $C_P$ is decreased.

The basic idea is to apply statistical bootstrapping to the estimation of the correlation parameter $\rho(t_n)$. The statistical bootstrapping method is incorporated by invoking a pre-recorded look-up table for correlation adjustments[20].

[20] The look-up table is available as part of the ECC Margin Sample Calculations in the download section of the ECC website on margining (https://www.ecc.de/en/risk-management/margining).

#### 5.5.4 Portfolio Margin Cap

ECC applies a cap on margin credits at 80% for contracts that are considered to be different products according to the ESMA opinion on portfolio margining[21]. For ECC's product suite, this means the cap to margin credits is applied for contracts with the following different underlying commodities:

- Power
- Natural Gas & LNG
- Emissions
- Freight
- Dairy
- Pulp
- Potatoes.

The cap is integrated into the initial margin calculation. This prevents portfolio margin reductions exceeding 80% between different products.

21 https://www.esma.europa.eu/document/opinion-portfolio-margining-requirements-under-article-27-emir-delegated-regulation