

**USE OF INTERNAL MODELS
TO CALCULATE CAPITAL REQUIREMENTS**

1. The authority shall, subject to the conditions laid down in this Annex, allow institutions to calculate their capital requirements for position risk, foreign-exchange risk and/or commodities risk using their own internal risk-management models instead of or in combination with the methods described in Annexes I, III and V. Explicit recognition by the authority of the use of models for supervisory capital purposes shall be required in each case.
2. Recognition shall only be given if the authority is satisfied that the institution's risk-management system is conceptually sound and implemented with integrity and that, in particular, the following qualitative standards are met:
 - (a) the internal risk-measurement model is closely integrated into the daily risk-management process of the institution and serves as the basis for reporting risk exposures to senior management of the institution;
 - (b) the institution has a risk control unit that is independent from business trading units and reports directly to senior management. The unit must be responsible for designing and implementing the institution's risk-management system. It shall produce and analyse daily reports on the output of the risk-measurement model and on the appropriate measures to be taken in terms of trading limits. The unit shall also conduct the initial and on-going validation of the internal model;
 - (c) the institution's board of directors and senior management are actively involved in the risk-control process and the daily reports produced by the risk-control unit are reviewed by a level of management with sufficient authority to enforce both reductions of positions taken by individual traders as well as in the institution's overall risk exposure;
 - (d) the institution has sufficient numbers of staff skilled in the use of sophisticated models in the trading, risk-control, audit and back-office areas;
 - (e) the institution has established procedures for monitoring and ensuring compliance with a documented set of internal policies and controls concerning the overall operation of the risk-measurement system;
 - (f) the institution's models have a proven track record of reasonable accuracy in measuring risks;
 - (g) the institution frequently conducts a rigorous programme of stress testing and the results of these tests are reviewed by senior management and

reflected in the policies and limits it sets. This process shall particularly address illiquidity of markets in stressed market conditions, concentration risk, one way markets, event and jump-to-default risks, non-linearity of products, deep out-of-the-money positions, positions subject to the gapping of prices and other risks that may not be captured appropriately in the VaR model. The shocks applied shall reflect the nature of the portfolios and the time it could take to hedge out or manage risks under severe market conditions;

- (h) the institution must conduct, as part of its regular internal auditing process, an independent review of its risk-measurement system.

The review referred to in point (h) above shall include both the activities of the business trading units and of the independent risk-control unit. At least once a year, the institution must conduct a review of its overall risk-management process.

The review shall consider the following:

- (a) the adequacy of the documentation of the risk-management system and process and the organisation of the risk-control unit;
 - (b) the integration of market risk measures into daily risk management and the integrity of the management information system;
 - (c) the process the institution employs for approving risk-pricing models and valuation systems that are used by front and back-office personnel;
 - (d) the scope of market risks captured by the risk-measurement model and the validation of any significant changes in the risk-measurement process;
 - (e) the accuracy and completeness of position data, the accuracy and appropriateness of volatility and correlation assumptions, and the accuracy of valuation and risk sensitivity calculations;
 - (f) the verification process the institution employs to evaluate the consistency, timeliness and reliability of data sources used to run internal models, including the independence of such data sources;
 - (g) the verification process the institution uses to evaluate back-testing that is conducted to assess the model's accuracy.
3. Institutions shall have processes in place to ensure that their internal models have been adequately validated by suitably qualified parties independent of the development process to ensure that they are conceptually sound and adequately capture all material risks. This validation shall be conducted when the model is

initially developed and when any significant changes are made to the model. The validation shall also be conducted on a periodic basis but especially where there have been any significant structural changes in the market or changes to the composition of the portfolio which might lead to the model no longer being adequate. As techniques and best practices evolve, institutions shall avail themselves of these advances. Model validation shall not be limited to backtesting, but shall, at a minimum, also include the following:

- (a) tests to demonstrate that any assumptions made within the internal model are appropriate and do not underestimate or overestimate the risk;
 - (b) in addition to the regulatory backtesting programmes, institutions shall carry out their own model validation tests in relation to the risks and structures of their portfolios;
 - (c) the use of hypothetical portfolios to ensure that the model is able to account for particular structural features that may arise, for example material basis risks and concentration risk.
4. The institution shall monitor the accuracy and performance of its model by conducting a back-testing programme. The back-testing has to provide for each business day a comparison of the one-day value-at-risk measure generated by the institution's model for the portfolio's end-of-day positions to the one-day change of the portfolio's value by the end of the subsequent business day.

The authority shall examine the institution's capability to perform back-testing on both actual and hypothetical changes in the portfolio's value. Back-testing on hypothetical changes in the portfolio's value is based on a comparison between the portfolio's end-of-day value and, assuming unchanged positions, its value at the end of the subsequent day. The authority shall require the institution to take appropriate measures to improve their back-testing programme if deemed deficient. As a minimum, the authority shall require institutions to perform backtesting on hypothetical (using changes in portfolio value that would occur were end-of-day positions to remain unchanged) outcomes.

5. For the purpose of calculating capital requirements for specific risk associated with traded debt and equity positions, the authority shall recognise the use of an institution's internal model if, in addition to compliance with the conditions in the remainder of this Annex, the internal model meets the following conditions:
- (a) it explains the historical price variation in the portfolio;
 - (b) it captures concentration in terms of magnitude and changes of composition of the portfolio;
 - (c) it is robust to an adverse environment;

- (d) it is validated through back-testing aimed at assessing whether specific risk is being accurately captured. If the authority allows such back-testing to be performed on the basis of relevant sub-portfolios, these must be chosen in a consistent manner;
- (e) it captures name-related basis risk, namely institutions shall demonstrate that the internal model is sensitive to material idiosyncratic differences between similar but not identical positions;
- (f) it captures event risk.

The institution's internal model shall conservatively assess the risk arising from less liquid positions and positions with limited price transparency under realistic market scenarios. In addition, the internal model shall meet minimum data standards. Proxies shall be appropriately conservative and may be used only where available data is insufficient or is not reflective of the true volatility of a position or portfolio.

An institution may choose to exclude from the calculation of its specific risk capital requirement using an internal model those positions in securitisations or n-th-to-default credit derivatives for which it meets a capital requirement for position risks in accordance with Annex III with the exception of those positions that are subject to the approach set out in point 48.

As techniques and best practices evolve, institutions shall avail themselves of those new techniques and practices.

An institution shall not be required to capture default and migration risks for traded debt instruments in its internal model where it is capturing those risks through the requirements set out in points 5a to 5k below.

- 5a. Institutions subject to point 5 for traded debt instruments shall have an approach in place to capture, in the calculation of their capital requirements, the default and migration risks of its trading book positions that are incremental to the risks captured by the value-at-risk measure as specified in point 5. An institution shall demonstrate that its approach meets soundness standards comparable to the approach set out in the Internal Ratings Based Approach, under the assumption of a constant level of risk, and adjusted where appropriate to reflect the impact of liquidity, concentrations, hedging and optionality.

Scope

- 5b. The approach to capture the incremental default and migration risks shall cover all positions subject to a capital charge for specific interest rate risk but shall not cover securitisation positions and n-th-to-default credit derivatives. Subject to

supervisory approval, the institution may choose to consistently include all listed equity positions and derivatives positions based on listed equities for which such inclusion is consistent with how the institution internally measures and manages risk. The approach shall reflect the impact of correlations between default and migration events. The impact of diversification between, on the one hand, default and migration events and, on the other hand, other market risk factors shall not be reflected.

Parameters

- 5c. The approach to capture the incremental risks shall measure losses due to default and internal or external ratings migration at the 99.9% confidence interval over a capital horizon of 1 year.

Correlation assumptions shall be supported by analysis of objective data in a conceptually sound framework. The approach to capture the incremental risks shall appropriately reflect issuer concentrations. Concentrations that can arise within and across product classes under stressed conditions shall also be reflected. The approach shall be based on the assumption of a constant level of risk over the one-year capital horizon, implying that given individual trading book positions or sets of positions that have experienced default or migration over their liquidity horizon are re-balanced at the end of their liquidity horizon to attain the initial level of risk. Alternatively, an institution may choose to consistently use a one-year constant position assumption.

- 5d. The liquidity horizons shall be set according to the time required to sell the position or to hedge all material relevant price risks in a stressed market, having particular regard to the size of the position. Liquidity horizons shall reflect actual practice and experience during periods of both systematic and idiosyncratic stresses. The liquidity horizon shall be measured under conservative assumptions and shall be sufficiently long that the act of selling or hedging, in itself, would not materially affect the price at which the selling or hedging would be executed.

The determination of the appropriate liquidity horizon for a position or set of positions is subject to a floor of 3 months.

The determination of the appropriate liquidity horizon for a position or set of positions shall take into account an institution's internal policies relating to valuation adjustments and the management of stale positions. When an institution determines liquidity horizons for sets of positions rather than for individual positions, the criteria for defining sets of positions shall be defined in a way that meaningfully reflects differences in liquidity. The liquidity horizons shall be greater for positions that are concentrated, reflecting the longer period needed to liquidate such positions. The liquidity horizon for a securitisation warehouse shall reflect the time to build, sell and securitise the assets, or to hedge the material risk factors, under stressed market conditions.

- 5e. Hedges may be incorporated into an institution's approach to capture the incremental default and migration risks. Positions may be netted when long and short positions refer to the same financial instrument. Hedging or diversification effects associated with long and short positions involving different instruments or different securities of the same obligor, as well as long and short positions in different issuers, may only be recognised by explicitly modelling gross long and short positions in the different instruments. Institutions shall reflect the impact of material risks that could occur during the interval between the hedge's maturity and the liquidity horizon as well as the potential for significant basis risks in hedging strategies by product, seniority in the capital structure, internal or external rating, maturity, vintage and other differences in the instruments. An institution shall reflect a hedge only to the extent that it can be maintained even as the obligor approaches a credit or other event.

For trading book positions that are hedged via dynamic hedging strategies, a rebalancing of the hedge within the liquidity horizon of the hedged position may be recognised provided that the institution:

- (i) chooses a model rebalancing of the hedge consistently over the relevant set of trading book positions;
 - (ii) demonstrates that the inclusion of rebalancing results in a better risk measurement; and
 - (iii) demonstrates that the markets for the instruments serving as hedges are liquid enough to allow for such rebalancing even during periods of stress. Any residual risks resulting from dynamic hedging strategies must be reflected in the capital charge.
- 5f. The approach to capture the incremental default and migration risks shall reflect the nonlinear impact of options, structured credit derivatives and other positions with material nonlinear behaviour with respect to price changes. The institution shall also have due regard to the amount of model risk inherent in the valuation and estimation of price risks associated with such products.
- 5g. The approach to capture the incremental default and migration risks shall be based on data that are objective and up-to-date.

Validation

- 5h. As part of the independent review of their risk measurement system and the validation of their internal models as required in this Annex, institutions shall, with a view to the approach to capture incremental default and migration risks, in particular:

- (i) validate that its modelling approach for correlations and price changes is appropriate for its portfolio, including the choice and weights of its systematic risk factors;
- (ii) perform a variety of stress tests, including sensitivity analysis and scenario analysis, to assess the qualitative and quantitative reasonableness of the approach, particularly with regard to the treatment of concentrations. Such tests shall not be limited to the range of events experienced historically;
- (iii) apply appropriate quantitative validation including relevant internal modelling benchmarks.

The approach to capture the incremental risks shall be consistent with the institution's internal risk management methodologies for identifying, measuring, and managing trading risks.

Documentation

- 5i. An institution shall document its approach to capturing incremental default and migration risks so that its correlation and other modelling assumptions are transparent to the authority.

Internal Approaches based on Different Parameters

- 5j. If the institution uses an approach to capturing incremental default and migration risks that does not comply with all requirements of this point but that is consistent with the institution's internal methodologies for identifying, measuring and managing risks, it shall be able to demonstrate that its approach results in a capital requirement that is at least as high as if it was based on an approach in full compliance with the requirements of this point. The authority shall review compliance with the previous sentence at least annually. Institutions shall comply with the provisions laid down in [EBA's Guidelines on the Incremental Default and Migration Risk Charge \(IRC\)](#).

Frequency of Calculation

- 5k. An institution shall perform the calculations required under its chosen approach to capture the incremental risk at least weekly.
- 5l. The authority shall recognise the use of an internal approach for calculating an additional capital charge instead of a capital charge for the correlation trading portfolio in accordance with point 17a of Annex III provided that all conditions in this point are fulfilled.

Such an internal approach shall adequately capture all price risks at the 99.9% confidence interval over a capital horizon of 1 year under the assumption of a

constant level of risk, and adjusted where appropriate to reflect the impact of liquidity, concentrations, hedging and optionality. The institution may incorporate any positions in the approach referred to in this point that are jointly managed with positions of the correlation trading portfolio and may then exclude those positions from the approach required under point 5a.

The amount of the capital charge for all price risks shall not be less than 8% of the capital charge that would be calculated in accordance with point 17a of Annex III for all positions incorporated in the charge for all price risks.

In particular, the following risks shall be adequately captured:

- (a) the cumulative risk arising from multiple defaults, including the ordering of defaults, in tranching products;
- (b) credit spread risk, including the gamma and cross-gamma effects;
- (c) volatility of implied correlations, including the cross effect between spreads and correlations;
- (d) basis risk, including both:
 - (i) the basis between the spread of an index and those of its constituent single names, and
 - (ii) the basis between the implied correlation of an index and that of bespoke portfolios;
- (e) recovery rate volatility, as it relates to the propensity for recovery rates to affect tranche prices; and
- (f) to the extent the comprehensive risk measure incorporates benefits from dynamic hedging, the risk of hedge slippage and the potential costs of rebalancing such hedges.

For the purposes of this point, an institution shall have sufficient market data to ensure that it fully captures the salient risks of those exposures in its internal approach in accordance with the standards set out in this point, demonstrates through back testing or other appropriate means that its risk measures can appropriately explain the historical price variation of those products, and is able to separate the positions for which it holds approval in order to incorporate them in the capital charge in accordance with this point from those positions for which it does not hold such approval.

With regard to portfolios subject to this point, the institution shall regularly apply a set of specific, predetermined stress scenarios. Such stress scenarios shall

examine the effects of stress to default rates, recovery rates, credit spreads, and correlations on the profit and loss of the correlation trading desk. The institution shall apply such stress scenarios at least weekly and report at least quarterly to the authority the results, including comparisons with the institution's capital charge in accordance with this point. Any instances where the stress tests indicate a material shortfall of this capital charge shall be reported to the authority in a timely manner. Based on those stress testing results, the authority shall consider a supplemental capital charge against the correlation trading portfolio as set out in Banking Act 1994 Article 16A(2)(1).

An institution shall calculate the capital charge to capture all price risks at least on a weekly basis.

6. Institutions using internal models which are not recognised in accordance with point 5 above shall be subject to a separate capital charge for specific risk as calculated in accordance with Annex III.
7. For the purpose of points 10b (a) and (b), the results of the institution's own calculation shall be scaled up by the multiplication factors (m_c) and (m_s). Those factors shall be at least 3.
8. For the purposes of points 10b (a) and (b), the multiplication factors (m_c) and (m_s) shall be increased by a plus-factor of between 0 and 1 in accordance with Table 1 below, depending on the number of overshootings for the most recent 250 business days as evidenced by the institution's back-testing of the value-at-risk measure as set out in point 10. The authority shall require the institutions to calculate overshootings consistently on the basis of back-testing on hypothetical and actual changes in the portfolio's value. An overshooting is a one-day change in the portfolio's value that exceeds the related one-day value-at-risk measure generated by the institution's model. For the purpose of determining the plus-factor, the number of overshootings shall be assessed at least quarterly and shall be equal to the higher of the number of overshootings under hypothetical and actual changes in the value of the portfolio.

Table 1

Number of overshootings	Plus-factor
Fewer than 5	0.00
5	0.40
6	0.50
7	0.65

8	0.75
9	0.85
10 or more	1.00

The authority may, in individual cases and owing to an exceptional situation, waive the requirement to increase the multiplication factor by the plus-factor according to Table 1 above, if the institution has demonstrated to the satisfaction of the authority that such an increase is unjustified and that the model is basically sound.

If numerous overshootings indicate that the model is not sufficiently accurate, the authority shall revoke the model's recognition or impose appropriate measures to ensure that the model is improved promptly.

In order to allow the authority to monitor the appropriateness of the plus-factor on an ongoing basis, institutions shall notify promptly, and in any case no later than within five working days, the authority of overshootings that result from their back-testing programme and that would according to the above table imply an increase of a plus-factor.

9. Point 9 deleted as per EU Directive 2010/76/EU.
10. The calculation of value-at-risk shall be subject to the following minimum standards:
 - (a) at least daily calculation of value-at-risk;
 - (b) a 99th percentile, one-tailed confidence interval;
 - (c) a 10-day equivalent holding period (institutions may use value-at-risk numbers calculated according to shorter holding periods scaled up to 10 days by, for example, the square root of time. An institution using that approach shall periodically justify the reasonableness of its approach to the satisfaction of the authority;
 - (d) an effective historical observation period of at least one year except where a shorter observation period is justified by a significant upsurge in price volatility;
 - (e) monthly data set updates.
- 10a. In addition, each institution shall calculate a "stressed value-at-risk" based on the 10-day, 99th percentile, one-tailed confidence interval value-at-risk measure of the current portfolio, with value-at-risk model inputs calibrated to historical data from

- a continuous 12-month period of significant financial stress relevant to the institution's portfolio. The choice of such historical data shall be subject to approval by the authority and to annual review by the institution. Institutions shall calculate the stressed value-at-risk at least weekly and shall comply with the provisions laid down in [EBA's Guidelines on Stressed Value at Risk](#).
- 10b. Each institution shall meet, on a daily basis, a capital requirement expressed as the sum of points (a) and (b) and an institution that uses its internal model to calculate the capital requirement for specific position risk shall meet a capital requirement expressed as the sum of points (c) and (d) as follows:
- (a) the higher of:
 - (i) its previous day's value-at-risk number calculated in accordance with point 10 (VaR_{t-1}); and
 - (ii) an average of the daily value-at-risk measures in accordance with point 10 on each of the preceding sixty business days (VaR_{avg}), multiplied by the multiplication factor (m_c);
 - (b) the higher of:
 - (i) its latest available stressed-value-at-risk number in accordance with point 10a ($sVaR_{t-1}$); and
 - (ii) an average of the stressed value-at-risk numbers calculated in the manner and frequency specified in point 10a during the preceding sixty business days ($sVaR_{avg}$) multiplied by the multiplication factor (m_s);
 - (c) a capital charge calculated in accordance with Annex III for the position risks of securitisation positions and nth to default credit derivatives in the trading book with the exception of those incorporated in the capital charge in accordance with point 5l;
 - (d) the higher of the institution's most recent and the institution's 12 weeks average measure of incremental default and migration risk in accordance with point 5a and, where applicable, the higher of the institution's most recent and its 12-week-average measure of all price risks in accordance with point 5l.
- 10c. Institutions shall also carry out reverse stress tests.
11. The authority shall require that the model captures accurately all the material price risks of options or option-like positions and that any other risks not captured by the model are covered adequately by own funds.

12. The risk-measurement model shall capture a sufficient number of risk factors, depending on the level of activity of the institution in the respective markets. Where a risk factor is incorporated into the institution's pricing model but not into the risk-measurement model, the institution shall be able to justify such an omission to the satisfaction of the authority. In addition, the risk-measurement model shall capture nonlinearities for options and other products as well as correlation risk and basis risk. Where proxies for risk factors are used, they shall show a good track record for the actual position held. In addition, the following shall apply for individual risk types:

Interest Rate Risk

The risk-measurement system shall incorporate a set of risk factors corresponding to the interest rates in each currency in which the institution has interest rate sensitive on- or off-balance sheet positions. The institution shall model the yield curves using one of the generally accepted approaches. For material exposures to interest-rate risk in the major currencies and markets, the yield curve shall be divided into a minimum of six maturity segments, to capture the variations of volatility of rates along the yield curve. The risk-measurement system must also capture the risk of less than perfectly correlated movements between different yield curves.

Foreign Exchange Risk

The risk-measurement system shall incorporate risk factors corresponding to gold and to the individual foreign currencies in which the institution's positions are denominated.

For CIUs the actual foreign exchange positions of the CIU shall be taken into account. Institutions may rely on third party reporting of the foreign exchange position in the CIU, where the correctness of this report is adequately ensured. If an institution is not aware of the foreign exchange positions in a CIU, this position should be carved out and treated in accordance with Annex I Section 1.1.0.

Equity Risk

The risk-measurement system shall use a separate risk factor at least for each of the equity markets in which the institution holds significant positions.

Commodity Risk

The risk-measurement system shall use a separate risk factor at least for each commodity in which the institution holds significant positions. The risk-measurement system must also capture the risk of less than perfectly correlated movements between similar, but not identical, commodities and the exposure to

changes in forward prices arising from maturity mismatches. It shall also take account of market characteristics, notably delivery dates and the scope provided to traders to close out positions.

13. The authority may allow institutions to use empirical correlations within risk categories and across risk categories if they are satisfied that the institution's system for measuring correlations is sound and implemented with integrity.