Basel Committee
on Banking Supervision

# Minimum capital requirements for market risk

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## Contents

# Errata

The following table lists the corrections made in this version of the standard relative to the version originally published on 14 January 2019.

| Paragraph | Correction made | Reason for correction |
|---|---|---|
| RBC25.9 Footnote 2 | *"... fair valued **though** the P&L account."* corrected to *"... fair valued **through** the P&L account."* (emphasis added) | Spelling error |
| MAR21.5(2)(f) | Formula corrected from: $CVR_k^- = -\sum_i \{V_i(x_k^{RW(Curvature)^-}) - V(x_k) - RW_k^{Curvature} \times s_{ik}\}$ to: $CVR_k^- = -\sum_i \{V_i(x_k^{RW(Curvature)^-}) - V(x_k) + RW_k^{Curvature} \times s_{ik}\}$ | Formula misspecification; no change to the addition operation that precedes the term $RW_k^{Curvature} \times s_{ik}$ was intended relative to the January 2016 version of the standard or relative to the March 2018 consultative document that proposed revisions to the standard |

# Minimum capital requirements for market risk

## Introduction

This document sets outs the amended minimum capital requirements for market risk that will serve as the Pillar 1 minimum capital requirement as of 1 January 2022, replacing the current minimum capital requirements for market risk as set out in Basel II[1] and its subsequent amendments.

This standard supersedes the January 2016 publication *Minimum capital requirements for market risk*,[2] for which the Basel Committee proposed targeted revisions via a March 2018 consultative document.[3] Descriptions of the changes that have been incorporated into the standard relative to the January 2016 publication are set out in the publication *Explanatory note on the minimum capital requirements for market risk*.[4]

The market risk standard set out in this document has been prepared in a new modular format. This reflects the style of a "consolidated framework" currently being prepared by the Basel Committee, which intends to improve the accessibility of the Basel standards.[5] The Committee expects to publish all standards in this format on its website in the coming months. An alternate version of the standard that includes previously published frequently asked questions is also available on the Basel Committee website.[6]

At a high level, the chapters of the standard are organised as follows:

| Chapter acronym | Chapter name |
|---|---|
| RBC25 | Boundary between the banking book and the trading book |
| MAR10 to MAR12 | Definitions and application |
| MAR10 | Market risk terminology |
| MAR11 | Definitions and application of market risk |
| MAR12 | Definition of a trading desk |
| MAR20 to MAR 23 | Standardised approach |
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| MAR21 | Standardised approach: sensitivities-based method |
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| MAR30 | Internal models approach: general provisions |
| MAR31 | Internal models approach: model requirements |
| MAR32 | Internal models approach: backtesting and P&L attribution test requirements |

1 Basel Committee on Banking Supervision, *International Convergence of Capital Measurement and Capital Standards: A Revised Framework: Comprehensive Version*, June 2006, www.bis.org/publ/bcbs128.pdf.

2 Basel Committee on Banking Supervision, *Minimum capital requirements for market risk*, January 2016, www.bis.org/bcbs/publ/d352.pdf.

3 Basel Committee on Banking Supervision, *Consultative Document – Revisions to the minimum capital requirements for market risk*, March 2018, www.bis.org/bcbs/publ/d436.pdf.

4 Basel Committee on Banking Supervision, *Explanatory note on the minimum capital requirements for market risk*, January 2019, www.bis.org/bcbs/publ/d457_note.pdf.

5 For the purpose of this publication, cross-references to other paragraphs or chapters are indicated within square brackets (eg [MAR21.1]). These will be replaced with hyperlinks once the consolidated framework is made available on the BCBS website.

6 Basel Committee on Banking Supervision, *Minimum capital requirements for market risk*, January 2019 (version includes frequently asked questions), www.bis.org/bcbs/publ/d457_faq.pdf.

| Chapter acronym | Chapter name |
|---|---|
| MAR33 | Internal models approach: capital requirements calculation |
| MAR40 | Simplified standardised approach |
| MAR90 | Transitional arrangements |
| MAR99 | Guidance on use of the internal models approach |

# RBC25 Boundary between the banking book and the trading book

*This chapter sets out the instruments to be included in the trading book (which are subject to market risk capital requirements) and those to be included in the banking book (which are subject to credit risk capital requirements).*

## Scope of the trading book

25.1 A trading book consists of all instruments that meet the specifications for trading book instruments set out in [RBC25.2] through [RBC25.13]. All other instruments must be included in the banking book.

25.2 Instruments comprise financial instruments, foreign exchange (FX), and commodities. A financial instrument is any contract that gives rise to both a financial asset of one entity and a financial liability or equity instrument of another entity. Financial instruments include primary financial instruments (or cash instruments) and derivative financial instruments. A financial asset is any asset that is cash, the right to receive cash or another financial asset or a commodity, or an equity instrument. A financial liability is the contractual obligation to deliver cash or another financial asset or a commodity. Commodities also include non-tangible (ie non-physical) goods such as electric power.

25.3 Banks may only include a financial instrument, instruments on FX or commodity in the trading book when there is no legal impediment against selling or fully hedging it.

25.4 Banks must fair value daily any trading book instrument and recognise any valuation change in the profit and loss (P&L) account.

## Standards for assigning instruments to the regulatory books

25.5 Any instrument a bank holds for one or more of the following purposes must, when it is first recognised on its books, be designated as a trading book instrument, unless specifically otherwise provided for in [RBC25.3] or [RBC25.8]:

(1) short-term resale;

(2) profiting from short-term price movements;

(3) locking in arbitrage profits; or

(4) hedging risks that arise from instruments meeting (1), (2) or (3) above.

25.6 Any of the following instruments is seen as being held for at least one of the purposes listed in [RBC25.5] and must therefore be included in the trading book, unless specifically otherwise provided for in [RBC25.3] or [RBC25.8]:

(1) instruments in the correlation trading portfolio;

(2) instruments that would give rise to a net short credit or equity position in the banking book;[1] or

(3) instruments resulting from underwriting commitments, where underwriting commitments refer only to securities underwriting, and relate only to securities that are expected to be actually purchased by the bank on the settlement date.

*Footnote*

[1] *A bank will have a net short risk position for equity risk or credit risk in the banking book if the present value of the banking book increases when an equity price decreases or when a credit spread on an issuer or group of issuers of debt increases.*

25.7 Any instrument which is not held for any of the purposes listed in [RBC25.5] at inception, nor seen as being held for these purposes according to [RBC25.6], must be assigned to the banking book.

25.8 The following instruments must be assigned to the banking book:

(1) unlisted equities;

(2) instruments designated for securitisation warehousing;

(3) real estate holdings, where in the context of assigning instrument to the trading book, real estate holdings relate only to direct holdings of real estate as well as derivatives on direct holdings;

(4) retail and small or medium-sized enterprise (SME) credit;

(5) equity investments in a fund, unless the bank meets at least one of the following conditions:

(a) the bank is able to look through the fund to its individual components and there is sufficient and frequent information, verified by an independent third party, provided to the bank regarding the fund's composition; or

(b) the bank obtains daily price quotes for the fund and it has access to the information contained in the fund's mandate or in the national regulations governing such investment funds;

(6) hedge funds;

(7) derivative instruments and funds that have the above instrument types as underlying assets; or

(8) instruments held for the purpose of hedging a particular risk of a position in the types of instrument above.

25.9 There is a general presumption that any of the following instruments are being held for at least one of the purposes listed in [RBC25.5] and therefore are trading book instruments, unless specifically otherwise provided for in [RBC25.3] or [RBC25.8]:

(1) instruments held as accounting trading assets or liabilities;[2]

(2) instruments resulting from market-making activities;

(3) equity investments in a fund excluding those assigned to the banking book in accordance with [RBC25.8](5);

(4) listed equities;[3]

(5) trading-related repo-style transaction;[4] or

(6) options including embedded derivatives[5] from instruments that the institution issued out of its own banking book and that relate to credit or equity risk.

*Footnotes*

[2] *Under IFRS (IAS 39) and US GAAP, these instruments would be designated as held for trading. Under IFRS 9, these instruments would be held within a trading business model. These instruments would be fair valued through the P&L account.*

[3] *Subject to supervisory review, certain listed equities may be excluded from the market risk framework. Examples of equities that may be excluded include, but are not limited to, equity positions arising from deferred compensation plans, convertible debt securities, loan products with interest paid in the form of "equity kickers", equities taken as a debt previously contracted, bank-owned life insurance products, and legislated programmes. The set of listed equities that the bank wishes to exclude from the market risk framework should be made available to, and discussed with, the national supervisor and should be managed by a desk that is separate from desks for proprietary or short-term buy/sell instruments.*

[4] *Repo-style transactions that are (i) entered for liquidity management and (ii) valued at accrual for accounting purposes are not part of the presumptive list of [RBC25.9].*

[5] An embedded derivative is a component of a hybrid contract that includes a non-derivative host such as liabilities issued out of the bank's own banking book that contain embedded derivatives. The embedded derivative associated with the issued instrument (ie host) should be bifurcated and separately recognised on the bank's balance sheet for accounting purposes.

25.10 Banks are allowed to deviate from the presumptive list specified in [RBC25.9] according to the process set out below.[6]

(1) If a bank believes that it needs to deviate from the presumptive list established in [RBC25.9] for an instrument, it must submit a request to its supervisor and receive explicit approval. In its request, the bank must provide evidence that the instrument is not held for any of the purposes in [RBC25.5].

(2) In cases where this approval is not given by the supervisor, the instrument must be designated as a trading book instrument. Banks must document any deviations from the presumptive list in detail on an on-going basis.

*Footnote*

[6] *The presumptions for the designation of an instrument to the trading book or banking book set out in this text will be used where a designation of an instrument to the trading book or banking book is not otherwise specified in this text.*

## Supervisory powers

25.11 Notwithstanding the process established in [RBC25.10] for instruments on the presumptive list, the supervisor may require the bank to provide evidence that an instrument in the trading book is held for at least one of the purposes of [RBC25.5]. If the supervisor is of the view that a bank has not provided enough evidence or if the supervisor believes the instrument customarily would belong in the banking book, it may require the bank to assign the instrument to the banking book, except if it is an instrument listed under [RBC25.6].

25.12 The supervisor may require the bank to provide evidence that an instrument in the banking book is not held for any of the purposes of [RBC25.5]. If the supervisor is of the view that a bank has not provided enough evidence, or if the supervisor believes such instruments would customarily belong in the trading book, it may require the bank to assign the instrument to the trading book, except if it is an instrument listed under [RBC25.8].

## Documentation of instrument designation

25.13 A bank must have clearly defined policies, procedures and documented practices for determining which instruments to include in or to exclude from the trading book for the purposes of calculating their regulatory capital, ensuring compliance with the criteria set forth in this section, and taking into account the bank's risk management capabilities and practices. A bank's internal control functions must conduct an ongoing evaluation of instruments both in and out of the trading book to assess whether its instruments are being properly designated initially as trading or non-trading instruments in the context of the bank's trading activities. Compliance with the policies and procedures must be fully documented and subject to periodic (at least yearly) internal audit and the results must be available for supervisory review.

## Restrictions on moving instruments between the regulatory books

25.14 Apart from moves required by [RBC25.5] through [RBC25.10], there is a strict limit on the ability of banks to move instruments between the trading book and the banking book by their own discretion after initial designation, which is subject to the process in [RBC25.15] and [RBC25.16]. Switching instruments for regulatory arbitrage is strictly prohibited. In practice, switching should be rare and will be allowed by supervisors only in extraordinary circumstances. Examples are a major publicly announced event, such as a bank restructuring that results in the permanent closure of trading desks, requiring termination of the business activity applicable to the instrument or portfolio or a change in accounting standards that allows an item to be fair-valued through P&L. Market events, changes in the liquidity of a financial instrument, or a change of trading intent alone are not valid reasons for reassigning an instrument to a different book. When switching positions, banks must ensure that the standards described in [RBC25.5] to [RBC25.10] are always strictly observed.

25.15 Without exception, a capital benefit as a result of switching will not be allowed in any case or circumstance. This means that the bank must determine its total capital requirement (across the banking book and trading book) before and immediately after the switch. If this capital requirement is reduced as a result of this switch, the difference as measured at the time of the switch will be imposed on the bank as a disclosed Pillar 1 capital surcharge. This surcharge will be allowed to run off as the positions mature or expire, in a manner agreed with the supervisor. To maintain operational simplicity, it is not envisaged that this additional capital requirement would be recalculated on an ongoing basis, although the positions would continue to also be subject to the ongoing capital requirements of the book into which they have been switched.

25.16 Any reassignment between books must be approved by senior management and the supervisor as follows. Any reallocation of securities between the trading book and banking book, including outright sales at arm's length, should be considered a reassignment of securities and is governed by requirements of this paragraph.

(1) Any reassignment must be approved by senior management thoroughly documented; determined by internal review to be in compliance with the bank's policies; subject to prior approval by the supervisor based on supporting documentation provided by the bank; and publicly disclosed.

(2) Unless required by changes in the characteristics of a position, any such reassignment is irrevocable.

(3) If an instrument is reclassified to be an accounting trading asset or liability there is a presumption that this instrument is in the trading book, as described in [RBC25.9].

Accordingly, in this case an automatic switch without approval of the supervisor is acceptable.

25.17 A bank must adopt relevant policies that must be updated at least yearly. Updates should be based on an analysis of all extraordinary events identified during the previous year. Updated policies with changes highlighted must be sent to the appropriate supervisor. Policies must include the following:

(1) The reassignment restriction requirements in [RBC25.14] through [RBC25.16], especially the restriction that re-designation between the trading book and banking book may only be allowed in extraordinary circumstances, and a description of the circumstances or criteria where such a switch may be considered.

(2) The process for obtaining senior management and supervisory approval for such a transfer.

(3) How a bank identifies an extraordinary event.

(4) A requirement that re-assignments into or out of the trading book be publicly disclosed at the earliest reporting date.

## Treatment of internal risk transfers

25.18 An internal risk transfer is an internal written record of a transfer of risk within the banking book, between the banking and the trading book or within the trading book (between different desks).

25.19 There will be no regulatory capital recognition for internal risk transfers from the trading book to the banking book. Thus, if a bank engages in an internal risk transfer from the trading book to the banking book (eg for economic reasons) this internal risk transfer would not be taken into account when the regulatory capital requirements are determined.

25.20 For internal risk transfers from the banking book to the trading book, [RBC25.21] to [RBC25.27] apply.

### *Internal risk transfer of credit and equity risk from banking book to trading book*

25.21 When a bank hedges a banking book credit risk exposure or equity risk exposure using a hedging instrument purchased through its trading book (ie using an internal risk transfer),

(1) The credit exposure in the banking book is deemed to be hedged for capital requirement purposes if and only if:

(a) the trading book enters into an external hedge with an eligible third-party protection provider that exactly matches the internal risk transfer; and

(b) the external hedge meets the requirements of paragraphs 191 to 194 of the Basel II standard vis-à-vis the banking book exposure.[7]

(2) The equity exposure in the banking book is deemed to be hedged for capital requirement purposes if and only if:

(a) the trading book enters into an external hedge from an eligible third-party protection provider that exactly matches the internal risk transfer; and

(b) the external hedge is recognised as a hedge of a banking book equity exposure.

(3) External hedges for the purposes of [RBC25.21](1) can be made up of multiple transactions with multiple counterparties as long as the aggregate external hedge

exactly matches the internal risk transfer, and the internal risk transfer exactly matches the aggregate external hedge.

*Footnote*

*[7] With respect to paragraph 192 of the Basel II standard, the cap of 60% on a credit derivative without a restructuring obligation only applies with regard to recognition of credit risk mitigation of the banking book instrument for regulatory capital purposes and not with regard to the amount of the internal risk transfer.*

25.22 Where the requirements in [RBC25.21] are fulfilled, the banking book exposure is deemed to be hedged by the banking book leg of the internal risk transfer for capital purposes in the banking book. Moreover both the trading book leg of the internal risk transfer and the external hedge must be included in the market risk capital requirements.

25.23 Where the requirements in [RBC25.21] are not fulfilled, the banking book exposure is not deemed to be hedged by the banking book leg of the internal risk transfer for capital purposes in the banking book. Moreover, the third-party external hedge must be fully included in the market risk capital requirements and the trading book leg of the internal risk transfer must be fully excluded from the market risk capital requirements.

25.24 A banking book short credit position or a banking book short equity position created by an internal risk transfer[8] and not capitalised under banking book rules must be capitalised under the market risk rules together with the trading book exposure.

*Footnote*

*[8] Banking book instruments that are over-hedged by their respective documented internal risk transfer create a short (risk) position in the banking book.*

### *Internal risk transfer of general interest rate risk from banking book to trading book*

25.25 When a bank hedges a banking book interest rate risk exposure using an internal risk transfer with its trading book, the trading book leg of the internal risk transfer is treated as a trading book instrument under the market risk framework if and only if:

(1) the internal risk transfer is documented with respect to the banking book interest rate risk being hedged and the sources of such risk;

(2) the internal risk transfer is conducted with a dedicated internal risk transfer trading desk which has been specifically approved by the supervisor for this purpose; and

(3) the internal risk transfer must be subject to trading book capital requirements under the market risk framework on a stand-alone basis for the dedicated internal risk transfer desk, separate from any other GIRR or other market risks generated by activities in the trading book.

25.26 Where the requirements in [RBC25.25] are fulfilled, the banking book leg of the internal risk transfer must be included in the banking book's measure of interest rate risk exposures for regulatory capital purposes.

25.27 The supervisor-approved internal risk transfer desk may include instruments purchased from the market (ie external parties to the bank). Such transactions may be executed directly between the internal risk transfer desk and the market. Alternatively, the internal risk transfer desk may obtain the external hedge from the market via a separate non-internal risk transfer trading desk acting as an agent, if and only if the GIRR internal risk transfer entered into with the non-internal risk transfer trading desk exactly matches the external hedge from the market. In this latter case the respective legs of the GIRR internal risk transfer are included in the internal risk transfer desk and the non-internal risk transfer desk.

*Internal risk transfers within the scope of application of the market risk capital requirement*

25.28 Internal risk transfers between trading desks within the scope of application of the market risk capital requirements (including FX risk and commodities risk in the banking book) will generally receive regulatory capital recognition. Internal risk transfers between the internal risk transfer desk and other trading desks will only receive regulatory capital recognition if the constraints in [RBC25.25] to [RBC25.27] are fulfilled.

25.29 The trading book leg of internal risk transfers must fulfil the same requirements under [RBC25] as instruments in the trading book transacted with external counterparties.

*Eligible hedges for the CVA capital requirement*

25.30 Eligible external hedges that are included in the credit valuation adjustment (CVA) capital requirement must be removed from the bank's market risk capital requirement calculation.

25.31 Banks may enter into internal risk transfers between the CVA portfolio and the trading book. Such an internal risk transfer consists of a CVA portfolio side and a non-CVA portfolio side. Where the CVA portfolio side of an internal risk transfer is recognised in the CVA risk capital requirement, the CVA portfolio side should be excluded from the market risk capital requirement, while the non-CVA portfolio side should be included in the market risk capital requirement.

25.32 In any case, such internal CVA risk transfers can only receive regulatory capital recognition if the internal risk transfer is documented with respect to the CVA risk being hedged and the sources of such risk.

25.33 Internal CVA risk transfers that are subject to curvature, default risk or residual risk add-on as set out in [MAR20] through [MAR23] may be recognised in the CVA portfolio capital requirement and market risk capital requirement only if the trading book additionally enters into an external hedge with an eligible third-party protection provider that exactly matches the internal risk transfer.

25.34 Independent from the treatment in the CVA risk capital requirement and the market risk capital requirement, internal risk transfers between the CVA portfolio and the trading book can be used to hedge the counterparty credit risk exposure of a derivative instrument in the trading or banking book as long as the requirements of [RBC25.21] are met.

# MAR10 Market risk terminology

*This chapter provides a high-level description of terminologies used in the market risk and credit valuation adjustment risk frameworks.*

## General terminology

10.1 Market risk: the risk of losses in on- and off-balance sheet risk positions arising from movements in market prices.

10.2 Notional value: the notional value of a derivative instrument is equal to the number of units underlying the instrument multiplied by the current market value of each unit of the underlying.

10.3 Trading desk: a group of traders or trading accounts in a business line within a bank that follows defined trading strategies with the goal of generating revenues or maintaining market presence from assuming and managing risk.

10.4 Pricing model: a model that is used to determine the value of an instrument (mark-to-market or mark-to-model) as a function of pricing parameters or to determine the change in the value of an instrument as a function of risk factors. A pricing model may be the combination of several calculations; eg a first valuation technique to compute a price, followed by valuation adjustments for risks that are not incorporated in the first step.

## Terminology for financial instruments

10.5 Financial instrument: any contract that gives rise to both a financial asset of one entity and a financial liability or equity instrument of another entity. Financial instruments include primary financial instruments (or cash instruments) and derivative financial instruments.

10.6 Instrument: the term used to describe financial instruments, instruments on foreign exchange (FX) and commodities.

10.7 Embedded derivative: a component of a financial instrument that includes a non-derivative host contract. For example, the conversion option in a convertible bond is an embedded derivative.

10.8 Look-through approach: an approach in which a bank determines the relevant capital requirements for a position that has underlyings (such as an index instrument, multi-underlying option, or an equity investment in a fund) as if the underlying positions were held directly by the bank.

## Terminology for market risk capital requirement calculations

10.9 Risk factor: a principal determinant of the change in value of an instrument (eg an exchange rate or interest rate).

10.10 Risk position: the portion of the current value of an instrument that may be subject to losses due to movements in a risk factor. For example, a bond denominated in a currency different to a bank's reporting currency has risk positions in general interest rate risk, credit spread risk (non-securitisation) and FX risk, where the risk positions are the potential losses to the current value of the instrument that could occur due to a change in the relevant underlying risk factors (interest rates, credit spreads, or exchange rates).

10.11 Risk bucket: a defined group of risk factors with similar characteristics.

10.12 Risk class: a defined list of risks that are used as the basis for calculating market risk capital requirements: general interest rate risk, credit spread risk (non-securitisation), credit spread risk (securitisation: non-correlation trading portfolio), credit spread risk (securitisation: correlation trading portfolio), FX risk, equity risk and commodity risk.

## Terminology for risk metrics

10.13 Sensitivity: a bank's estimate of the change in value of an instrument due to a small change in one of its underlying risk factors. Delta and vega risks are sensitivities.

10.14 Delta risk: the linear estimate of the change in value of a financial instrument due to a movement in the value of a risk factor. The risk factor could be the price of an equity or commodity, or a change in an interest rate, credit spread or FX rate.

10.15 Vega risk: the potential loss resulting from the change in value of a derivative due to a change in the implied volatility of its underlying.

10.16 Curvature risk: the additional potential loss beyond delta risk due to a change in a risk factor for financial instruments with optionality. In the standardised approach in the market risk framework, it is based on two stress scenarios involving an upward shock and a downward shock to each regulatory risk factor.

10.17 Value at risk (VaR): a measure of the worst expected loss on a portfolio of instruments resulting from market movements over a given time horizon and a pre-defined confidence level.

10.18 Expected shortfall (ES): a measure of the average of all potential losses exceeding the VaR at a given confidence level.

10.19 Jump-to-default (JTD): the risk of a sudden default. JTD exposure refers to the loss that could be incurred from a JTD event.

10.20 Liquidity horizon: the time assumed to be required to exit or hedge a risk position without materially affecting market prices in stressed market conditions.

## Terminology for hedging and diversification

10.21 Basis risk: the risk that prices of financial instruments in a hedging strategy are imperfectly correlated, reducing the effectiveness of the hedging strategy.

10.22 Diversification: the reduction in risk at a portfolio level due to holding risk positions in different instruments that are not perfectly correlated with one another.

10.23 Hedge: the process of counterbalancing risks from exposures to long and short risk positions in correlated instruments.

10.24 Offset: the process of netting exposures to long and short risk positions in the same risk factor.

10.25 Standalone: being capitalised on a stand-alone basis means that risk positions are booked in a discrete, non-diversifiable trading book portfolio so that the risk associated with those risk positions cannot diversify, hedge or offset risk arising from other risk positions, nor be diversified, hedged or offset by them.

## Terminology for risk factor eligibility and modellability

10.26 Real prices: a term used for assessing whether risk factors pass the risk factor eligibility test. A price will be considered real if it is (i) a price from an actual transaction conducted by the bank, (ii) a price from an actual transaction between other arm's length parties (eg at an exchange), or

(iii) a price taken from a firm quote (ie a price at which the bank could transact with an arm's length party).

10.27 Modellable risk factor: risk factors that are deemed modellable, based on the number of representative real price observations and additional qualitative principles related to the data used for the calibration of the ES model. Risk factors that do not meet the requirements for the risk factor eligibility test are deemed as non-modellable risk factors (NMRF).

## Terminology for internal model validation

10.28 Backtesting: the process of comparing daily actual and hypothetical profits and losses with model-generated VaR measures to assess the conservatism of risk measurement systems.

10.29 Profit and loss (P&L) attribution (PLA): a method for assessing the robustness of banks' risk management models by comparing the risk-theoretical P&L predicted by trading desk risk management models with the hypothetical P&L.

10.30 Trading desk risk management model: the trading desk risk management model (pertaining to in-scope desks) includes all risk factors that are included in the bank's ES model with supervisory parameters and any risk factors deemed not modellable, which are therefore not included in the ES model for calculating the respective regulatory capital requirement, but are included in NMRFs.

10.31 Actual P&L (APL): the actual P&L derived from the daily P&L process. It includes intraday trading as well as time effects and new and modified deals, but excludes fees and commissions as well as valuation adjustments for which separate regulatory capital approaches have been otherwise specified as part of the rules or which are deducted from Common Equity Tier 1. Any other valuation adjustments that are market risk-related must be included in the APL. As is the case for the hypothetical P&L, the APL should include FX and commodity risks from positions held in the banking book.

10.32 Hypothetical P&L (HPL): the daily P&L produced by revaluing the positions held at the end of the previous day using the market data at the end of the current day. Commissions, fees, intraday trading and new/modified deals, valuation adjustments for which separate regulatory capital approaches have been otherwise specified as part of the rules and valuation adjustments which are deducted from CET1 are excluded from the HPL. Valuation adjustments updated daily should usually be included in the HPL. Time effects should be treated in a consistent manner in the HPL and risk-theoretical P&L.

10.33 Risk-theoretical P&L (RTPL): the daily desk-level P&L that is predicted by the valuation engines in the trading desk risk management model using all risk factors used in the trading desk risk management model (ie including the NMRFs).

## Terminology for credit valuation adjustment risk

10.34 Credit valuation adjustment (CVA): an adjustment to the valuation of a derivative transaction to account for the credit risk of contracting parties.

10.35 CVA risk: the risk of changes to CVA arising from changes in credit spreads of the contracting parties, compounded by changes to the value or variability in the value of the underlying of the derivative transaction.

# MAR11 Definitions and application of market risk

*This chapter defines the methods available for calculating and the scope of application of market risk capital requirements.*

## Definition and scope of application

11.1 Market risk is defined as the risk of losses arising from movements in market prices. The risks subject to market risk capital requirements include but are not limited to:

(1) default risk, interest rate risk, credit spread risk, equity risk, foreign exchange (FX) risk and commodities risk for trading book instruments; and

(2) FX risk and commodities risk for banking book instruments.

11.2 All transactions, including forward sales and purchases, shall be included in the calculation of capital requirements as of the date on which they were entered into. Although regular reporting will in principle take place only at intervals (quarterly in most countries), banks are expected to manage their market risk in such a way that the capital requirements are being met on a continuous basis, including at the close of each business day. Supervisory authorities have at their disposal a number of effective measures to ensure that banks do not window-dress by showing significantly lower market risk positions on reporting dates. Banks will also be expected to maintain strict risk management systems to ensure that intraday exposures are not excessive. If a bank fails to meet the capital requirements at any time, the national authority shall ensure that the bank takes immediate measures to rectify the situation.

11.3 A matched currency risk position will protect a bank against loss from movements in exchange rates, but will not necessarily protect its capital adequacy ratio. If a bank has its capital denominated in its domestic currency and has a portfolio of foreign currency assets and liabilities that is completely matched, its capital/asset ratio will fall if the domestic currency depreciates. By running a short risk position in the domestic currency, the bank can protect its capital adequacy ratio, although the risk position would lead to a loss if the domestic currency were to appreciate. Supervisory authorities are free to allow banks to protect their capital adequacy ratio in this way and exclude certain currency risk positions from the calculation of net open currency risk positions, subject to meeting each of the following conditions:

(1) The risk position is taken or maintained for the purpose of hedging partially or totally against the potential that changes in exchange rates could have an adverse effect on its capital ratio.

(2) The risk position is of a structural (ie non-dealing) nature such as positions stemming from:

(a) investments in affiliated but not consolidated entities denominated in foreign currencies; or

(b) investments in consolidated subsidiaries or branches denominated in foreign currencies.

(3) The exclusion is limited to the amount of the risk position that neutralises the sensitivity of the capital ratio to movements in exchange rates.

(4) The exclusion from the calculation is made for at least six months.

(5) The establishment of a structural FX position and any changes in its position must follow the bank's risk management policy for structural FX positions. This policy must be pre-approved by the national supervisor.

(6) Any exclusion of the risk position needs to be applied consistently, with the exclusionary treatment of the hedge remaining in place for the life of the assets or other items.

(7) The bank is subject to a requirement by the national supervisor to document and have available for supervisory review the positions and amounts to be excluded from market risk capital requirements.

11.4 No FX risk capital requirement need apply to positions related to items that are deducted from a bank's capital when calculating its capital base.

11.5 Holdings of capital instruments that are deducted from a bank's capital or risk weighted at 1250% are not allowed to be included in the market risk framework. This includes:

(1) holdings of the bank's own eligible regulatory capital instruments; and

(2) holdings of other banks', securities firms' and other financial entities' eligible regulatory capital instruments, as well as intangible assets, where the national supervisor requires that such assets are deducted from capital.

(3) Where a bank demonstrates that it is an active market-maker, then a national supervisor may establish a dealer exception for holdings of other banks', securities firms', and other financial entities' capital instruments in the trading book. In order to qualify for the dealer exception, the bank must have adequate systems and controls surrounding the trading of financial institutions' eligible regulatory capital instruments.

11.6 In the same way as for credit risk and operational risk, the capital requirements for market risk apply on a worldwide consolidated basis.

(1) Supervisory authorities may permit banking and financial entities in a group which is running a global consolidated trading book and whose capital is being assessed on a global basis to include just the net short and net long risk positions no matter where they are booked.[1]

(2) Supervisory authorities may grant this treatment only when the standardised approach in [MAR20] to [MAR23] permits a full offset of the risk position (ie risk positions of the opposite sign do not attract a capital requirement).

(3) Nonetheless, there will be circumstances in which supervisory authorities demand that the individual risk positions be taken into the measurement system without any offsetting or netting against risk positions in the remainder of the group. This may be needed, for example, where there are obstacles to the quick repatriation of profits from a foreign subsidiary or where there are legal and procedural difficulties in carrying out the timely management of risks on a consolidated basis.

(4) Moreover, all supervisory authorities will retain the right to continue to monitor the market risks of individual entities on a non-consolidated basis to ensure that significant imbalances within a group do not escape supervision. Supervisory authorities will be especially vigilant in ensuring that banks do not conceal risk positions on reporting dates in such a way as to escape measurement.

*Footnote*

*[1] The positions of less than wholly owned subsidiaries would be subject to the generally accepted accounting principles in the country where the parent company is supervised.*

## Methods of measuring market risk

11.7 In determining its market risk for regulatory capital requirements, a bank may choose between two broad methodologies: the standardised approach and internal models approach (IMA) for market risk, described in [MAR20] to [MAR23] and [MAR30] to [MAR33], respectively, subject to the approval of the national authorities. Supervisors may allow banks that maintain smaller or simpler trading books to use the simplified alternative to the standardised approach as set out in [MAR40].

(1) To determine the appropriateness of the simplified alternative for use by a bank for the purpose of its market risk capital requirements, supervisors may wish to consider the following indicative criteria:

(a) The bank should not be a global systemically important bank (G-SIB).

(b) The bank should not use the IMA for any of its trading desks.

(c) The bank should not hold any correlation trading positions.

(2) The use of the simplified alternative is subject to supervisory approval and oversight. Supervisors can mandate that banks with relatively complex or sizeable risks in particular risk classes apply the full standardised approach instead of the simplified alternative, even if those banks meet the indicative eligibility criteria referred to above.

11.8 All banks, except for those that are allowed to use the simplified alternative as set out in [MAR11.7], must calculate the capital requirements using the standardised approach. Banks that are approved by the supervisor to use the IMA for market risk capital requirements must also calculate and report the capital requirement values calculated as set out below.

(1) A bank that uses the IMA for any of its trading desks must also calculate the capital requirement under the standardised approach for all instruments across all trading desks, regardless of whether those trading desks are eligible for the IMA.

(2) In addition, a bank that uses the IMA for any of its trading desks must calculate the standardised approach capital requirement for each trading desk that is eligible for the IMA as if that trading desk were a standalone regulatory portfolio (ie with no offsetting across trading desks). This will:

(a) serve as an indication of the fallback capital requirement for those desks that fail the eligibility criteria for inclusion in the bank's internal model as outlined in [MAR30], [MAR32] and [MAR33];

(b) generate information on the capital outcomes of the internal models relative to a consistent benchmark and facilitate comparison in implementation between banks and/or across jurisdictions;

(c) monitor over time the relative calibration of standardised and modelled approaches, facilitating adjustments as needed; and

(d) provide macroprudential insight in an ex ante consistent format.

11.9 All banks must calculate the market risk capital requirement using the standardised approach for the following:

(1) securitisation exposures; and

(2) equity investments in funds that cannot be looked through but are assigned to the trading book in accordance to the conditions set out in [RBC25.8](5)(b).

# MAR12 Definition of a trading desk

*This chapter defines a trading desk, which is the level at which model approval is granted.*

12.1 For the purposes of market risk capital calculations, a trading desk is a group of traders or trading accounts that implements a well-defined business strategy operating within a clear risk management structure.

12.2 Trading desks are defined by the bank but subject to the regulatory approval of the supervisor for capital purposes.

(1) A bank should be allowed to propose the trading desk structure per their organisational structure, consistent with the requirements set out in [MAR12.4].

(2) A bank must prepare a policy document for each trading desk it defines, documenting how the bank satisfies the key elements in [MAR12.4].

(3) Supervisors will treat the definition of the trading desk as part of the initial model approval for the trading desk, as well as ongoing approval:

(a) Supervisors may determine, based on the size of the bank's overall trading operations, whether the proposed trading desk definitions are sufficiently granular.

(b) Supervisors should check that the bank's proposed definition of trading desk meets the criteria listed in key elements set out in [MAR12.4].

12.3 Within this supervisory approved trading desk structure, banks may further define operational subdesks without the need for supervisory approval. These subdesks would be for internal operational purposes only and would not be used in the market risk capital framework.

12.4 The key attributes of a trading desk are as follows:

(1) A trading desk for the purposes of the regulatory capital charge is an unambiguously defined group of traders or trading accounts.

(a) A trading account is an indisputable and unambiguous unit of observation in accounting for trading activity.

(b) The trading desk must have one head trader and can have up to two head traders provided their roles, responsibilities and authorities are either clearly separated or one has ultimate oversight over the other.

(i) The head trader must have direct oversight of the group of traders or trading accounts.

(ii) Each trader or each trading account in the trading desk must have a clearly defined specialty (or specialities).

(c) Each trading account must only be assigned to a single trading desk. The desk must have a clearly defined risk scope consistent with its pre-established objectives. The scope should include specification of the desk's overall risk class and permitted risk factors.

(d) There is a presumption that traders (as well as head traders) are allocated to one trading desk. A bank can deviate from this presumption and may assign an individual trader to work across several trading desks provided it can be justified to the supervisor on the basis of sound management, business and/or resource allocation reasons. Such assignments must not be made for the only purpose of avoiding other trading desk requirements (eg to optimise the likelihood of success in the backtesting and profit and loss attribution tests).

(e) The trading desk must have a clear reporting line to bank senior management, and should have a clear and formal compensation policy clearly linked to the pre-established objectives of the trading desk.

(2) A trading desk must have a well-defined and documented business strategy, including an annual budget and regular management information reports (including revenue, costs and risk-weighted assets).

(a) There must be a clear description of the economics of the business strategy for the trading desk, its primary activities and trading/hedging strategies.

(i) Economics: what is the economics behind the strategy (eg trading on the shape of the yield curve)? How much of the activities are customer driven? Does it entail trade origination and structuring, or execution services, or both?

(ii) Primary activities: what is the list of permissible instruments and, out of this list, which are the instruments most frequently traded?

(iii) Trading/hedging strategies: how would these instruments be hedged, what are the expected slippages and mismatches of hedges, and what is the expected holding period for positions?

(b) The management team at the trading desk (starting from the head trader) must have a clear annual plan for the budgeting and staffing of the trading desk.

(c) A trading desk's documented business strategy must include regular Management Information reports, covering revenue, costs and risk-weighted assets for the trading desk.

(3) A trading desk must have a clear risk management structure.

(a) Risk management responsibilities: the bank must identify key groups and personnel responsible for overseeing the risk-taking activities at the trading desk.

(b) A trading desk must clearly define trading limits based on the business strategy of the trading desk and these limits must be reviewed at least annually by senior management at the bank. In setting limits, the trading desk must have:

(i) well defined trading limits or directional exposures at the trading desk level that are based on the appropriate market risk metric (eg sensitivity of credit spread risk and/or jump-to-default for a credit trading desk), or just overall notional limits; and

(ii) well-defined trader mandates.

(c) A trading desk must produce, at least weekly, appropriate risk management reports. This would include, at a minimum:

(i) profit and loss reports, which would be periodically reviewed, validated and modified (if necessary) by Product Control; and

(ii) internal and regulatory risk measure reports, including trading desk value-at-risk (VaR) / expected shortfall (ES), trading desk VaR/ES sensitivities to risk factors, backtesting and p-value.

12.5 The bank must prepare, evaluate, and have available for supervisors the following for all trading desks:

(1) inventory ageing reports;

(2) daily limit reports including exposures, limit breaches, and follow-up action;

(3) reports on intraday limits and respective utilisation and breaches for banks with active intraday trading; and

(4) reports on the assessment of market liquidity.

12.6 Any foreign exchange or commodity positions held in the banking book must be included in the market risk capital requirement as set out in [MAR11.1]. For regulatory capital calculation purposes, these positions will be treated as if they were held on notional trading desks within the trading book.

# MAR20 Standardised approach: general provisions and structure

*This chapter sets out the general provisions and the structure of the standardised approach for calculating risk-weighted assets for market risk.*

## General provisions

20.1 The risk-weighted assets for market risk under the standardised approach are determined by multiplying the capital requirements calculated as set out in [MAR20] to [MAR23] by 12.5.

20.2 The standardised approach must be calculated and reported to the relevant supervisor on a monthly basis. Subject to supervisory approval, the standardised approach for market risks arising from non-banking subsidiaries of a bank may be calculated and reported to the relevant supervisor on a quarterly basis.

20.3 A bank must also determine its regulatory capital requirements for market risk according to the standardised approach for market risk at the demand of its supervisor.

## Structure of the standardised approach

20.4 The standardised approach capital requirement is the simple sum of three components: the capital requirement under the sensitivities-based method, the default risk capital (DRC) requirement and the residual risk add-on (RRAO).

(1) The capital requirement under the sensitivities-based method must be calculated by aggregating three risk measures – delta, vega and curvature, as set out in [MAR21]:

(a) *Delta*: a risk measure based on sensitivities of an instrument to regulatory delta risk factors.

(b) *Vega*: a risk measure based on sensitivities to regulatory vega risk factors.

(c) *Curvature*: a risk measure which captures the incremental risk not captured by the delta risk measure for price changes in an option. Curvature risk is based on two stress scenarios involving an upward shock and a downward shock to each regulatory risk factor.

(d) The above three risk measures specify risk weights to be applied to the regulatory risk factor sensitivities. To calculate the overall capital requirement, the risk-weighted sensitivities are aggregated using specified correlation parameters to recognise diversification benefits between risk factors. In order to address the risk that correlations may increase or decrease in periods of financial stress, a bank must calculate three sensitivities-based method capital requirement values, based on three different scenarios on the specified values for the correlation parameters as set out in [MAR21.6] and [MAR21.7]].

(2) The DRC requirement captures the jump-to-default risk for instruments subject to credit risk as set out in [MAR22.2]. It is calibrated based on the credit risk treatment in the banking book in order to reduce the potential discrepancy in capital requirements for similar risk exposures across the bank. Some hedging recognition is allowed for similar types of exposures (corporates, sovereigns, and local governments/municipalities).

(3) Additionally, the Committee acknowledges that not all market risks can be captured in the standardised approach, as this might necessitate an unduly complex regime. An RRAO is thus introduced to ensure sufficient coverage of market risks for instruments specified in [MAR23.2]. The calculation method for the RRAO is set out in [MAR23.8].

## Definition of correlation trading portfolio

20.5 For the purpose of calculating the credit spread risk capital requirement under the sensitivities based method and the DRC requirement, the correlation trading portfolio is defined as the set of instruments that meet the requirements of (1) or (2) below.

(1) The instrument is a securitisation position that meets the following requirements:

(a) The instrument is not a re-securitisation position, nor a derivative of securitisation exposures that does not provide a pro rata share in the proceeds of a securitisation tranche, where the definition of securitisation positon is identical to that used in the credit risk framework.

(b) All reference entities are single-name products, including single-name credit derivatives, for which a liquid two-way market exists,[1] including traded indices on these reference entities.

(c) The instrument does not reference an underlying that is treated as a retail exposure, a residential mortgage exposure, or a commercial mortgage exposure under the standardised approach to credit risk.

(d) The instrument does not reference a claim on a special purpose entity.

(2) The instrument is a non-securitisation hedge to a position described above.

<u>*Footnote*</u>

*[1] A two-way market is deemed to exist where there are independent bona fide offers to buy and sell so that a price reasonably related to the last sales price or current bona fide competitive bid-ask quotes can be determined within one day and the transaction settled at such price within a relatively short time frame in conformity with trade custom.*

# MAR21 Standardised approach: sensitivities-based method

*This chapter sets out the calculation of the sensitivities-based method under the standardised approach for market risk.*

## Main concepts of the sensitivities-based method

21.1 The sensitivities of financial instruments to a prescribed list of risk factors are used to calculate the delta, vega and curvature risk capital requirements. These sensitivities are risk-weighted and then aggregated, first within risk buckets (risk factors with common characteristics) and then across buckets within the same risk class as set out in [MAR21.8] to [MAR21.14]. The following terminology is used in the sensitivities-based method:

(1) Risk class: seven risk classes are defined (in [MAR21.39] to [MAR21.89]).

(a) General interest rate risk (GIRR)

(b) Credit spread risk (CSR): non-securitisations

(c) CSR: securitisations (non-correlation trading portfolio, or non-CTP)

(d) CSR: securitisations (correlation trading portfolio, or CTP)

(e) Equity risk

(f) Commodity risk

(g) Foreign exchange (FX) risk

(2) Risk factor: variables (eg an equity price or a tenor of an interest rate curve) that affect the value of an instrument as defined in [MAR21.8] to [MAR21.14]

(3) Bucket: a set of risk factors that are grouped together by common characteristics (eg all tenors of interest rate curves for the same currency), as defined in [MAR21.39] to [MAR21.89].

(4) Risk position: the portion of the risk of an instrument that relates to a risk factor. Methodologies to calculate risk positions for delta, vega and curvature risks are set out in [MAR21.3] to [MAR21.5] and [MAR21.15] to [MAR21.26].

(a) For delta and vega risks, the risk position is a sensitivity to a risk factor.

(b) For curvature risk, the risk position is based on losses from two stress scenarios.

(5) Risk capital requirement: the amount of capital that a bank should hold as a consequence of the risks it takes; it is computed as an aggregation of risk positions first at the bucket level, and then across buckets within a risk class defined for the sensitivities-based method as set out in [MAR21.3] to [MAR21.7].

## Instruments subject to each component of the sensitivities-based method

21.2 In applying the sensitivities-based method, all instruments held in trading desks as set out in [MAR12] and subject to the sensitivities-based method (ie excluding instruments where the value at any point in time is purely driven by an exotic underlying as set out in [MAR23.3]), are subject to delta risk capital requirements. Additionally, the instruments specified in (1) to (4) are subject to vega and curvature risk capital requirements:

(1) Any instrument with optionality[1].

(2) Any instrument with an embedded prepayment option[2] – this is considered an instrument with optionality according to above (1). The embedded option is subject to vega and curvature risk with respect to interest rate risk and CSR (non-securitisation and securitisation) risk classes. When the prepayment option is a behavioural option the instrument may also be subject to the residual risk add-on (RRAO) as per [MAR23]. The pricing model of the bank must reflect such behavioural patterns where relevant. For securitisation tranches, instruments in the securitised portfolio may have embedded prepayment options as well. In this case the securitisation tranche may be subject to the RRAO.

(3) Instruments whose cash flows cannot be written as a linear function of underlying notional. For example, the cash flows generated by a plain-vanilla option cannot be written as a linear function (as they are the maximum of the spot and the strike). Therefore, all options are subject to vega risk and curvature risk. Instruments whose cash flows can be written as a linear function of underlying notional are instruments without optionality (eg cash flows generated by a coupon bearing bond can be written as a linear function) and are not subject to vega risk nor curvature risk capital requirements.

(4) Curvature risks may be calculated for all instruments subject to delta risk, not limited to those subject to vega risk as specified in (1) to (3) above. For example, where a bank manages the non-linear risk of instruments with optionality and other instruments holistically, the bank may choose to include instruments without optionality in the calculation of curvature risk. This treatment is allowed subject to all of the following restrictions:

(a) Use of this approach shall be applied consistently through time.

(b) Curvature risk must be calculated for all instruments subject to the sensitivities-based method.

<u>*Footnotes*</u>

*[1] For example, each instrument that is an option or that includes an option (eg an embedded option such as convertibility or rate dependent prepayment and that is subject to the capital requirements for market risk). A non-exhaustive list of example instruments with optionality includes: calls, puts, caps, floors, swaptions, barrier options and exotic options.*

*[2] An instrument with a prepayment option is a debt instrument which grants the debtor the right to repay part of or the entire principal amount before the contractual maturity without having to compensate for any foregone interest. The debtor can exercise this option with a financial gain to obtain funding over the remaining maturity of the instrument at a lower rate in other ways in the market.*

## Process to calculate the capital requirement under the sensitivities-based method

21.3 As set out in [MAR21.1], the capital requirement under the sensitivities-based method is calculated by aggregating delta, vega and curvature capital requirements. The relevant paragraphs that describe this process are as follows:

(1) The risk factors for delta, vega and curvature risks for each risk class are defined in [MAR21.8] to [MAR21.14].

(2) The methods to risk weight sensitivities to risk factors and aggregate them to calculate delta and vega risk positions for each risk class are set out in [MAR21.4] and [MAR21.15]

to [MAR21.95], which include the definition of delta and vega sensitivities, definition of buckets, risk weights to apply to risk factors, and correlation parameters.

(3) The methods to calculate curvature risk are set out in [MAR21.5] and [MAR21.96] to [MAR21.101], which include the definition of buckets, risk weights and correlation parameters.

(4) The risk class level capital requirement calculated above must be aggregated to obtain the capital requirement at the entire portfolio level as set out in [MAR21.6] and [MAR21.7].

### *Calculation of the delta and vega risk capital requirement for each risk class*

21.4 For each risk class, a bank must determine its instruments' sensitivity to a set of prescribed risk factors, risk weight those sensitivities, and aggregate the resulting risk-weighted sensitivities separately for delta and vega risk using the following step-by-step approach:

(1) For each risk factor (as defined in [MAR21.8] to [MAR21.14]), a sensitivity is determined as set out in [MAR21.15] to [MAR21.38].

(2) Sensitivities to the same risk factor must be netted to give a net sensitivity $s_k$ across all instruments in the portfolio to each risk factor *k*. In calculating the net sensitivity, all sensitivities to the same given risk factor (eg all sensitivities to the one-year tenor point of the three-month Euribor swap curve) from instruments of opposite direction should offset, irrespective of the instrument from which they derive. For instance, if a bank's portfolio is made of two interest rate swaps on three-month Euribor with the same fixed rate and same notional but of opposite direction, the GIRR on that portfolio would be zero.

(3) The weighted sensitivity $WS_k$ is the product of the net sensitivity $s_k$ and the corresponding risk weight $RW_k$ as defined in [MAR21.39] to [MAR21.95].

$$WS_k = RW_k s_k$$

(4) Within bucket aggregation: the risk position for delta (respectively vega) bucket *b*, $K_b$, must be determined by aggregating the weighted sensitivities to risk factors within the same bucket using the prescribed correlation $\rho_{kl}$ set out in the following formula, where the quantity within the square root function is floored at zero:

$$K_b = \sqrt{\max\left(0, \sum_k WS_k^2 + \sum_k \sum_{k \neq l} \rho_{kl} WS_k WS_l\right)}$$

(5) Across bucket aggregation: The delta (respectively vega) risk capital requirement is calculated by aggregating the risk positions across the delta (respectively vega) buckets within each risk class, using the corresponding prescribed correlations $\gamma_{bc}$ as set out in the following formula, where:

(a) $S_b = \sum_k WS_k$ for all risk factors in bucket *b*, and $S_c = \sum_k WS_k$ in bucket *c*.

(b) If these values for $S_b$ and $S_c$ described in above [MAR21.4](5)(a) produce a negative number for the overall sum of $\sum_b K_b^2 + \sum_b \sum_{c \neq b} \gamma_{bc} S_b S_c$, the bank is to calculate the delta (respectively vega) risk capital requirement using an alternative specification whereby:

(i) $S_b = \max[\min(\sum_k WS_k, K_b), -K_b]$ for all risk factors in bucket *b;* and

(ii) $S_c = \max[\min(\sum_k WS_k, K_c), -K_c]$ for all risk factors in bucket *c*.

$$Delta\ (respectively\ vega) = \sqrt{\sum_b K_b^2 + \sum_b \sum_{c \neq b} \gamma_{bc} S_b S_c}$$

### *Calculation of the curvature risk capital requirement for each risk class*

21.5 For each risk class, to calculate curvature risk capital requirements a bank must apply an upward shock and a downward shock to each prescribed risk factor and calculate the incremental loss for instruments sensitive to that risk factor above that already captured by the delta risk capital requirement using the following step-by-step approach:

(1) For each instrument sensitive to curvature risk factor *k*, an upward shock and a downward shock must be applied to *k*. The size of shock (ie risk weight) is set out in [MAR21.98] and [MAR21.99].

(a) For example for GIRR, all tenors of all the risk free interest rate curves within a given currency (eg three-month Euribor, six-month Euribor, one year Euribor, etc for the euro) must be shifted upward applying the risk weight as set out in [MAR21.99]. The resulting potential loss for each instrument, after the deduction of the delta risk positions, is the outcome of the upward scenario. The same approach must be followed on a downward scenario.

(b) If the price of an instrument depends on several risk factors, the curvature risk must be determined separately for each risk factor.

(2) The net curvature risk capital requirement, determined by the values $CVR_k^+$ and $CVR_k^-$ for a bank's portfolio for risk factor *k* described in above [MAR21.5](1) is calculated by the formula below. It calculates the aggregate incremental loss beyond the delta capital requirement for the prescribed shocks, where

(a) $i$ is an instrument subject to curvature risks associated with risk factor *k*;

(b) $x_k$ is the current level of risk factor *k*;

(c) $V_i(x_k)$ is the price of instrument $i$ at the current level of risk factor *k*;

(d) $V_i\left(x_k^{(RW^{(curvature)}+)}\right)$ and $V_i\left(x_k^{(RW^{(curvature)}-)}\right)$ denote the price of instrument $i$ after $x_k$ is shifted (ie "shocked") upward and downward respectively;

(e) $RW_k^{(curvature)}$ is the risk weight for curvature risk factor k for instrument *i;* and

(f) $s_{ik}$ is the delta sensitivity of instrument $i$ with respect to the delta risk factor that corresponds to curvature risk factor *k,* where:

(i) for the FX and equity risk classes, $s_{ik}$ is the delta sensitivity of instrument *i; and*

(iii) for the GIRR, CSR and commodity risk classes, $s_{ik}$ is the sum of delta sensitivities to all tenors of the relevant curve of instrument $i$ with respect to curvature risk factor *k*.

$$CVR_k^+ = -\sum_i \left\{V_i(x_k^{RW(Curvature)^+}) - V(x_k) - RW_k^{Curvature} \times s_{ik}\right\}$$

$$CVR_k^- = -\sum_i \left\{V_i(x_k^{RW(Curvature)^-}) - V(x_k) + RW_k^{Curvature} \times s_{ik}\right\}$$

(3) Within bucket aggregation: the curvature risk exposure must be aggregated within each bucket using the corresponding prescribed correlation $\rho_{kl}$ as set out in the following formula, where:

(a) The bucket level capital requirement ($K_b$) is determined as the greater of the capital requirement under the upward scenario ( $K_b^+$ ) and the capital requirement under the downward scenario ($K_b^-$). Notably, the selection of upward and downward scenarios is not necessarily the same across the high, medium and low correlations scenarios specified in [MAR21.6].

(i) Where $K_b = K_b^+$, this shall be termed "selecting the upward scenario".

(ii) Where $K_b = K_b^-$ , this shall be termed "selecting the downward scenario".

(iii) In the specific case where $K_b^+ = K_b^-$, if $\sum_k CVR_k^+ > \sum_k CVR_k^-$ , it is deemed that the upward scenario is selected; otherwise the downward scenario is selected.

(b) $\psi(CVR_k, CVR_l)$ takes the value 0 if $CVR_k$ and $CVR_l$ both have negative signs and the value 1 otherwise.

$$K_b = \max(K_b^+, K_b^-),$$

$$where \begin{cases} K_b^+ = \sqrt{\max\left(0, \sum_k max(CVR_k^+, 0)^2 + \sum_{l \neq k} \sum_k \rho_{kl} CVR_k^+ CVR_l^+ \psi(CVR_k^+, CVR_l^+)\right)} \\ K_b^- = \sqrt{\max\left(0, \sum_k max(CVR_k^-, 0)^2 + \sum_{l \neq k} \sum_k \rho_{kl} CVR_k^- CVR_l^- \psi(CVR_k^-, CVR_l^-)\right)} \end{cases}$$

(4) Across bucket aggregation: curvature risk positions must then be aggregated across buckets within each risk class, using the corresponding prescribed correlations $\gamma_{bc}$, where:

(a) $S_b = \sum_k CVR_k^+$ for all risk factors in bucket *b*, when the upward scenario has been selected for bucket *b* in above (3)(a). $S_b = \sum_k CVR_k^-$ otherwise; and

(b) $\psi(S_b,\ S_c)$ takes the value 0 if $S_b$ and $S_c$ both have negative signs and 1 otherwise.

$$Curvature\ risk\ = \sqrt{\max\left(0, \sum_b K_b^2 + \sum_{c \neq b} \sum_b \gamma_{bc} S_b S_c \psi(S_b, S_c)\right)}$$

### *Calculation of aggregate sensitivities-based method capital requirement*

21.6 In order to address the risk that correlations increase or decrease in periods of financial stress, the aggregation of bucket level capital requirements and risk class level capital requirements per each risk class for delta, vega, and curvature risks as specified in [MAR21.4] to [MAR21.5] must be repeated, corresponding to three different scenarios on the specified values for the correlation parameter $\rho_{kl}$ (correlation between risk factors within a bucket) and $\gamma_{bc}$ (correlation across buckets within a risk class).

(1) Under the "medium correlations" scenario, the correlation parameters $\rho_{kl}$ and $\gamma_{bc}$ as specified in [MAR21.39] to [MAR21.101] apply.

(2) Under the "high correlations" scenario, the correlation parameters $\rho_{kl}$ and $\gamma_{bc}$ that are specified in [MAR21.39] to [MAR21.101] are uniformly multiplied by 1.25, with $\rho_{kl}$ and $\gamma_{bc}$ subject to a cap at 100%.

(3) Under the "low correlations" scenario, the correlation parameters $\rho_{kl}$ and $\gamma_{bc}$ that are specified in MAR21.39 to MAR21.101] are replaced by $\rho_{kl}^{low} = \max(2 \times \rho_{kl} - 100\%; 75\% \times \rho_{kl})$ and $\gamma_{bc}^{low} = \max(2 \times \gamma_{bc} - 100\%; 75\% \times \gamma_{bc})$.

21.7 The total capital requirement under the sensitivities-based method is aggregated as follows:

(1) For each of three correlation scenarios, the bank must simply sum up the separately calculated delta, vega and curvature capital requirements for all risk classes to determine the overall capital requirement for that scenario.

(2) The sensitivities-based method capital requirement is the largest capital requirement from the three scenarios.

(a) For the calculation of capital requirements for all instruments in all trading desks using the standardised approach as set out in [MAR11.8](1) and [MAR20.2] and [MAR33.40], the capital requirement is calculated for all instruments in all trading desks.

(b) For the calculation of capital requirements for each trading desk using the standardised approach as if that desk were a standalone regulatory portfolio as set out in [MAR11.8](2), the capital requirements under each correlation scenario are calculated and compared at each trading desk level, and the maximum for each trading desk is taken as the capital requirement.

## Sensitivities-based method: risk factor and sensitivity definitions

### *Risk factor definitions for delta, vega and curvature risks*

21.8 GIRR factors

(1) Delta GIRR: the GIRR delta risk factors are defined along two dimensions: (i) a risk-free yield curve for each currency in which interest rate-sensitive instruments are denominated and (ii) the following tenors: 0.25 years, 0.5 years, 1 year, 2 years, 3 years, 5 years, 10 years, 15 years, 20 years and 30 years, to which delta risk factors are assigned.[3]

(a) The risk-free yield curve per currency should be constructed using money market instruments held in the trading book that have the lowest credit risk, such as overnight index swaps (OIS). Alternatively, the risk-free yield curve should be based on one or more market-implied swap curves used by the bank to mark positions to market. For example, interbank offered rate (BOR) swap curves.

(b) When data on market-implied swap curves described in above (1)(a) are insufficient, the risk-free yield curve may be derived from the most appropriate sovereign bond curve for a given currency. In such cases the sensitivities related to sovereign bonds are not exempt from the CSR capital requirement: when a bank cannot perform the decomposition *y=r+cs*, any sensitivity to *y* is allocated both to the GIRR and to CSR classes as appropriate with the risk factor and sensitivity definitions in the standardised approach. Applying swap curves to bond-derived sensitivities for GIRR will not change the requirement for basis risk to be captured between bond and credit default swap (CDS) curves in the CSR class.

(c) For the purpose of constructing the risk-free yield curve per currency, an OIS curve (such as Eonia or a new benchmark rate) and a BOR swap curve (such as three-month Euribor or other benchmark rates) must be considered two different curves. Two BOR curves at different maturities (eg three-month Euribor and six-month Euribor) must be considered two different curves. An onshore and an offshore currency curve (eg onshore Indian rupee and offshore Indian rupee) must be considered two different curves.

(2) The GIRR delta risk factors also include a flat curve of market-implied inflation rates for each currency with term structure not recognised as a risk factor.

(a) The sensitivity to the inflation rate from the exposure to implied coupons in an inflation instrument gives rise to a specific capital requirement. All inflation risks for a currency must be aggregated to one number via simple sum.

(b) This risk factor is only relevant for an instrument when a cash flow is functionally dependent on a measure of inflation (eg the notional amount or an interest payment depending on a consumer price index). GIRR risk factors other than for inflation risk will apply to such an instrument notwithstanding.

(c) Inflation rate risk is considered in addition to the sensitivity to interest rates from the same instrument, which must be allocated, according to the GIRR framework, in the term structure of the relevant risk-free yield curve in the same currency.

(3) The GIRR delta risk factors also include one of two possible cross-currency basis risk factors[4] for each currency (ie each GIRR bucket) with the term structure not recognised as a risk factor (ie both cross-currency basis curves are flat).

(a) The two cross-currency basis risk factors are basis of each currency over USD or basis of each currency over EUR. For instance, an AUD-denominated bank trading a JPY/USD cross-currency basis swap would have a sensitivity to the JPY/USD basis but not to the JPY/EUR basis.

(b) Cross-currency bases that do not relate to either basis over USD or basis over EUR must be computed either on "basis over USD" or "basis over EUR" but not both. GIRR risk factors other than for cross-currency basis risk will apply to such an instrument notwithstanding.

(c) Cross-currency basis risk is considered in addition to the sensitivity to interest rates from the same instrument, which must be allocated, according to the GIRR framework, in the term structure of the relevant risk-free yield curve in the same currency.

(4) Vega GIRR*:* within each currency, the GIRR vega risk factors are the implied volatilities of options that reference GIRR-sensitive underlyings; as defined along two dimensions:[5]

(a) The maturity of the option: the implied volatility of the option as mapped to one or several of the following maturity tenors: 0.5 years, 1 year, 3 years, 5 years and 10 years.

(b) The residual maturity of the underlying of the option at the expiry date of the option: the implied volatility of the option as mapped to two (or one) of the following residual maturity tenors: 0.5 years, 1 year, 3 years, 5 years and 10 years.

(5) Curvature GIRR*:*

(a) The GIRR curvature risk factors are defined along only one dimension: the constructed risk-free yield curve per currency with no term structure decomposition. For example, the euro, Eonia, three-month Euribor and six-month Euribor curves must be shifted at the same time in order to compute the euro-relevant risk-free yield curve curvature risk capital requirement. For the calculation of sensitivities, all tenors (as defined for delta GIRR) are to be shifted in parallel.

(b) There is no curvature risk capital requirement for inflation and cross-currency basis risks.

(6) The treatment described in above (1)(b) for delta GIRR also applies to vega GIRR and curvature GIRR risk factors.

*Footnotes*

*[3] The assignment of risk factors to the specified tenors should be performed by linear interpolation or a method that is most consistent with the pricing functions used by the independent risk control function of a bank to report market risks or P&L to senior management.*

*[4] Cross-currency basis are basis added to a yield curve in order to evaluate a swap for which the two legs are paid in two different currencies. They are in particular used by market participants to price cross-currency interest rate swaps paying a fixed or a floating leg in one currency, receiving a fixed or a floating leg in a second currency, and including an exchange of the notional in the two currencies at the start date and at the end date of the swap.*

*[5] For example, an option with a forward starting cap, lasting 12 months, consists of four consecutive caplets on USD three-month Libor. There are four (independent) options, with option expiry dates in 12, 15, 18 and 21 months. These options are all on underlying USD three-month Libor; the underlying always matures three months after the option expiry date (its residual maturity being three months). Therefore, the implied volatilities for a regular forward starting cap, which would start in one year and last for 12 months should be defined along the following two dimensions: (i) the maturity of the option's individual components (caplets) – 12, 15, 18 and 21 months; and (ii) the residual maturity of the underlying of the option – three months.*

21.9 CSR non-securitisation risk factors

(1) Delta CSR non-securitisation: the CSR non-securitisation delta risk factors are defined along two dimensions:

(a) the relevant issuer credit spread curves (bond and CDS); and

(b) the following tenors: 0.5 years, 1 year, 3 years, 5 years and 10 years.

(2) Vega CSR non-securitisation: the vega risk factors are the implied volatilities of options that reference the relevant credit issuer names as underlyings (bond and CDS); further defined along one dimension - the maturity of the option. This is defined as the implied volatility of the option as mapped to one or several of the following maturity tenors: 0.5 years, 1 year, 3 years, 5 years and 10 years.

(3) Curvature CSR non-securitisation: the CSR non-securitisation curvature risk factors are defined along one dimension: the relevant issuer credit spread curves (bond and CDS). For instance, the bond-inferred spread curve of an issuer and the CDS-inferred spread curve of that same issuer should be considered a single spread curve. For the calculation of sensitivities, all tenors (as defined for CSR) are to be shifted in parallel.

21.10 CSR securitisation: non-CTP risk factors

(1) For securitisation instruments that do not meet the definition of CTP as set out in [MAR20.5] (ie, non-CTP), the sensitivities of delta risk factors (ie CS01) must be calculated with respect to the spread of the tranche rather than the spread of the underlying of the instruments.

(2) Delta CSR securitisation (non-CTP): the CSR securitisation delta risk factors are defined along two dimensions:

(a) Tranche credit spread curves; and

(b) The following tenors: 0.5 years, 1 year, 3 years, 5 years and 10 years to which delta risk factors are assigned.

(3) Vega CSR securitisation (non-CTP): Vega risk factors are the implied volatilities of options that reference non-CTP credit spreads as underlyings (bond and CDS); further defined along one dimension - the maturity of the option. This is defined as the implied volatility of the option as mapped to one or several of the following maturity tenors: 0.5 years, 1 year, 3 years, 5 years and 10 years.

(4) Curvature CSR securitisation (non-CTP): the CSR securitisation curvature risk factors are defined along one dimension, the relevant tranche credit spread curves (bond and CDS). For instance, the bond-inferred spread curve of a given Spanish residential mortgage-backed security (RMBS) tranche and the CDS-inferred spread curve of that given Spanish RMBS tranche would be considered a single spread curve. For the calculation of sensitivities, all the tenors are to be shifted in parallel.

21.11 CSR securitisation: CTP risk factors

(1) For securitisation instruments that meet the definition of a CTP as set out in [MAR20.5], the sensitivities of delta risk factors (ie CS01) must be computed with respect to the names underlying the securitisation or nth-to-default instrument.

(2) Delta CSR securitisation (CTP): the CSR correlation trading delta risk factors are defined along two dimensions:

(a) the relevant underlying credit spread curves (bond and CDS); and

(b) the following tenors: 0.5 years, 1 year, 3 years, 5 years and 10 years, to which delta risk factors are assigned.

(3) Vega CSR securitisation (CTP): the vega risk factors are the implied volatilities of options that reference CTP credit spreads as underlyings (bond and CDS), as defined along one dimension, the maturity of the option. This is defined as the implied volatility of the option as mapped to one or several of the following maturity tenors: 0.5 years, 1 year, 3 years, 5 years and 10 years.

(4) Curvature CSR securitisation (CTP): the CSR correlation trading curvature risk factors are defined along one dimension, the relevant underlying credit spread curves (bond and CDS). For instance, the bond-inferred spread curve of a given name within an iTraxx series and the CDS-inferred spread curve of that given underlying would be considered

a single spread curve. For the calculation of sensitivities, all the tenors are to be shifted in parallel.

21.12 Equity risk factors

(1) Delta equity: the equity delta risk factors are:

(a) all the equity spot prices; and

(b) all the equity repurchase agreement rates (equity repo rates).

(2) Vega equity:

(a) The equity vega risk factors are the implied volatilities of options that reference the equity spot prices as underlyings as defined along one dimension, the maturity of the option. This is defined as the implied volatility of the option as mapped to one or several of the following maturity tenors: 0.5 years, 1 year, 3 years, 5 years and 10 years.

(b) There is no vega risk capital requirement for equity repo rates.

(3) Curvature equity:

(a) The equity curvature risk factors are all the equity spot prices.

(a) There is no curvature risk capital requirement for equity repo rates.

21.13 Commodity risk factors

(1) Delta commodity: the commodity delta risk factors are all the commodity spot prices. However for some commodities such as electricity (which is defined to fall within bucket 3 (energy – electricity and carbon trading) in [MAR21.82] the relevant risk factor can either be the spot or the forward price, as transactions relating to commodities such as electricity are more frequent on the forward price than transactions on the spot price. Commodity delta risk factors are defined along two dimensions:

(a) legal terms with respect to the delivery location[6] of the commodity; and

(b) time to maturity of the traded instrument at the following tenors: 0 years, 0.25 years, 0.5 years, 1 year, 2 years, 3 years, 5 years, 10 years, 15 years, 20 years and 30 years.

(2) Vega commodity: the commodity vega risk factors are the implied volatilities of options that reference commodity spot prices as underlyings. No differentiation between commodity spot prices by the maturity of the underlying or delivery location is required. The commodity vega risk factors are further defined along one dimension, the maturity of the option. This is defined as the implied volatility of the option as mapped to one or several of the following maturity tenors: 0.5 years, 1 year, 3 years, 5 years and 10 years.

(3) Curvature commodity: the commodity curvature risk factors are defined along only one dimension, the constructed curve (ie no term structure decomposition) per commodity spot prices. For the calculation of sensitivities, all tenors (as defined for delta commodity) are to be shifted in parallel.

<u>*Footnote*</u>

*[6] For example, a contract that can be delivered in five ports can be considered having the same delivery location as another contract if and only if it can be delivered in the same five ports. However, it cannot be considered having the same delivery location as another contract that can be delivered in only four (or less) of those five ports.*

21.14 FX risk factors

(1) Delta FX: the FX delta risk factors are defined below.

(a) The FX delta risk factors are all the exchange rates between the currency in which an instrument is denominated and the reporting currency. For transactions that reference an exchange rate between a pair of non-reporting currencies, the FX delta risk factors are all the exchange rates between:

(i) the reporting currency; and

(ii) both the currency in which an instrument is denominated and any other currencies referenced by the instrument.[7]

(b) Subject to supervisory approval, FX risk may alternatively be calculated relative to a base currency instead of the reporting currency. In such case the bank must account for not only:

(i) the FX risk against the base currency; but also

(ii) the FX risk between the reporting currency and the base currency (ie translation risk).

(c) The resulting FX risk calculated relative to the base currency as set out in (b) is converted to the capital requirements in the reporting currency using the spot reporting/base exchange rate reflecting the FX risk between the base currency and the reporting currency.

(d) The FX base currency approach may be allowed under the following conditions:

(i) To use this alternative, a bank may only consider a single currency as its base currency; and

(ii) The bank shall demonstrate to the relevant supervisor that calculating FX risk relative to their proposed base currency provides an appropriate risk representation for their portfolio (for example, by demonstrating that it does not inappropriately reduce capital requirements relative to those that would be calculated without the base currency approach) and that the translation risk between the base currency and the reporting currency is taken into account.

(2) Vega FX: the FX vega risk factors are the implied volatilities of options that reference exchange rates between currency pairs; as defined along one dimension, the maturity of the option. This is defined as the implied volatility of the option as mapped to one or several of the following maturity tenors: 0.5 years, 1 year, 3 years, 5 years and 10 years.

(3) Curvature FX: the FX curvature risk factors are defined below.

(a) The FX curvature risk factors are all the exchange rates between the currency in which an instrument is denominated and the reporting currency. For transactions that reference an exchange rate between a pair of non-reporting currencies, the FX risk factors are all the exchange rates between:

(i) the reporting currency; and

(ii) both the currency in which an instrument is denominated and any other currencies referenced by the instrument.

(b) Where supervisory approval for the base currency approach has been granted for delta risks, FX curvature risks shall also be calculated relative to a base currency instead of the reporting currency, and then converted to the capital requirements in the reporting currency using the spot reporting/base exchange rate.

(4) No distinction is required between onshore and offshore variants of a currency for all FX delta, vega and curvature risk factors.

*Footnote*

[7] *For example, for an FX forward referencing USD/JPY, the relevant risk factors for a CAD-reporting bank to consider are the exchange rates USD/CAD and JPY/CAD. If that CAD-reporting bank calculates FX risk relative to a USD base currency, it would consider separate deltas for the exchange rate JPY/USD risk and CAD/USD FX translation risk and then translate the resulting capital requirement to CAD at the USD/CAD spot exchange rate.*

### *Sensitivities-based method: definition of sensitivities*

21.15 Sensitivities for each risk class must be expressed in the reporting currency of the bank.

21.16 For each risk factor defined in [MAR21.8] to [MAR21.14], sensitivities are calculated as the change in the market value of the instrument as a result of applying a specified shift to each risk factor, assuming all the other relevant risk factors are held at the current level as defined in [MAR21.17] to [MAR21.38].

### *Requirements on instrument price or pricing models for sensitivity calculation*

21.17 In calculating the risk capital requirement under the sensitivities-based method in [MAR21], the bank must determine each delta and vega sensitivity and curvature scenario based on instrument prices or pricing models that an independent risk control unit within a bank uses to report market risks or actual profits and losses to senior management.

21.18 A key assumption of the standardised approach for market risk is that a bank's pricing models used in actual profit and loss reporting provide an appropriate basis for the determination of regulatory capital requirements for all market risks. To ensure such adequacy, banks must at a minimum establish a framework for prudent valuation practices that include the requirements of paragraph 718(c) to 718(cxii) of Basel II.

### *Sensitivity definitions for delta risk*

21.19 Delta GIRR: the sensitivity is defined as the PV01. PV01 is measured by changing the interest rate $r$ at tenor $t$ ($r_t$) of the risk-free yield curve in a given currency by 1 basis point (ie 0.0001 in absolute terms) and dividing the resulting change in the market value of the instrument ($V_i$) by 0.0001 (ie 0.01%) as follows, where:

(1) $r_t$ is the risk-free yield curve at tenor $t$;

(2) $cs_t$ is the credit spread curve at tenor $t$; and

(3) $V_i$ is the market value of the instrument $i$ as a function of the risk-free interest rate curve and credit spread curve:

$$s_{k,r_t} = \frac{V_i(r_t + 0.0001, cs_t) - V_i(r_t, cs_t)}{0.0001}$$

21.20 Delta CSR non-securitisation, securitisation (non-CTP) and securitisation (CTP): the sensitivity is defined as CS01. The CS01 (sensitivity) of an instrument $i$ is measured by changing a credit spread *cs* at tenor *t* ($cs_t$) by 1 basis point (ie 0.0001 in absolute terms) and dividing the resulting change in the market value of the instrument ($V_i$) by 0.0001 (ie 0.01%) as follows:

$$s_{k,cs_t} = \frac{V_i(r_t, cs_t + 0.0001) - V_i(r_t, cs_t)}{0.0001}$$

21.21 Delta equity spot: the sensitivity is measured by changing the equity spot price by 1 percentage point (ie 0.01 in relative terms) and dividing the resulting change in the market value of the instrument ($V_i$) by 0.01 (ie 1%) as follows, where:

(1) *k* is a given equity;

(2) $EQ_k$ is the market value of equity *k*; and

(3) $V_i$ is the market value of instrument *i* as a function of the price of equity *k*.

$$s_k = \frac{V_i(1.01\ EQ_k) - V_i(EQ_k)}{0.01}$$

21.22 Delta equity repo rates: the sensitivity is measured by applying a parallel shift to the equity repo rate term structure by 1 basis point (ie 0.0001 in absolute terms) and dividing the resulting change in the market value of the instrument $V_i$ by 0.0001 (ie 0.01%) as follows, where:

(1) *k* is a given equity;

(2) $RTS_k$ is the repo term structure of equity *k*; and

(3) $V_i$ is the market value of instrument *i* as a function of the repo term structure of equity *k*.

$$s_k = \frac{V_i(RTS_k + 0.0001) - V_i(RTS_k)}{0.0001}$$

21.23 Delta commodity: the sensitivity is measured by changing the commodity spot price by 1 percentage point (ie 0.01 in relative terms) and dividing the resulting change in the market value of the instrument $V_i$ by 0.01 (ie 1%) as follows, where:

(1) *k* is a given commodity;

(2) $CTY_k$ is the market value of commodity k; and

(3) $V_i$ is the market value of instrument i as a function of the spot price of commodity *k*:

$$s_k = \frac{V_i(1.01\ CTY_k) - V_i(CTY_k)}{0.01}$$

21.24 Delta FX: the sensitivity is measured by changing the exchange rate by 1 percentage point (ie 0.01 in relative terms) and dividing the resulting change in the market value of the instrument $V_i$ by 0.01 (ie 1%), where:

(1) *k* is a given currency;

(2) $FX_k$ is the exchange rate between a given currency and a bank's reporting currency or base currency, where the FX spot rate is the current market price of one unit of another currency expressed in the units of the bank's reporting currency or base currency; and

(3) $V_i$ is the market value of instrument *i* as a function of the exchange rate *k*:

$$s_k = \frac{V_i(1.01\ FX_k) - V_i(FX_k)}{0.01}$$

### *Sensitivity definitions for vega risk*

21.25 The option-level vega risk sensitivity to a given risk factor[8] is measured by multiplying vega by the implied volatility of the option as follows, where:

(1) vega, $\frac{\partial V_i}{\partial \sigma_i}$, is defined as the change in the market value of the option $V_i$ as a result of a small amount of change to the implied volatility $\sigma_i$; and

(2) the instrument's vega and implied volatility used in the calculation of vega sensitivities must be sourced from pricing models used by the independent risk control unit of the bank.

$$s_k = vega \times implied\ volatility$$

*Footnote*

*[8] As specified in the vega risk factor definitions in [MAR21.8] to [MAR21.14], the implied volatility of the option must be mapped to one or more maturity tenors.*

21.26 The following sets out how to derive vega risk sensitivities in specific cases:

(1) Options that do not have a maturity, are assigned to the longest prescribed maturity tenor, and these options are also assigned to the RRAO.

(2) Options that do not have a strike or barrier and options that have multiple strikes or barriers, are mapped to strikes and maturity used internally to price the option, and these options are also assigned to the RRAO.

(3) CTP securitisation tranches that do not have an implied volatility, are not subject to vega risk capital requirement. Such instruments may not, however, be exempt from delta and curvature risk capital requirements.

### *Requirements on sensitivity computations*

21.27 When computing a first-order sensitivity for instruments subject to optionality, banks should assume that the implied volatility either:

(1) remains constant, consistent with a "sticky strike" approach; or

(2) follows a "sticky delta" approach, such that implied volatility does not vary with respect to a given level of delta.

21.28 For the calculation of vega sensitivities, the distribution assumptions (ie log-normal assumptions or normal assumptions) for pricing models are applied as follows:

(1) For the computation of a vega GIRR or CSR sensitivity, banks may use either the log-normal or normal assumptions.

(2) For the computation of a vega equity, commodity or FX sensitivity, banks must use the log-normal assumption.[9]

*Footnote*

*[9] Since vega ($\frac{\partial V}{\partial \sigma_i}$) of an instrument is multiplied by its implied volatility ($\sigma_i$), the vega risk sensitivity for that instrument will be the same under the log-normal assumption and the normal assumption. As a consequence, banks may use a log-normal or normal assumption for GIRR and CSR (in recognition of the trade-offs between constrained specification and computational burden for a standardised approach). For the other risk classes, banks must only use a log-normal assumption (in recognition that this is aligned with common practices across jurisdictions).*

21.29 If, for internal risk management, a bank computes vega sensitivities using different definitions than the definitions set out in this standard, the bank may transform the sensitivities computed for internal risk management purposes to deduce the sensitivities to be used for the calculation of the vega risk measure.

21.30 All vega sensitivities must be computed ignoring the impact of credit valuation adjustments (CVA).

*Treatment of index instruments and multi-underlying options*

21.31 In the delta and curvature risk context: for index instruments and multi-underlying options, a look-through approach should be used. However, a bank may opt not to apply the look-through approach for instruments referencing any listed and widely recognised and accepted equity or credit index, where:

(1) it is possible to look-through the index (ie the constituents and their respective weightings are known);

(2) the index contains at least 20 constituents;

(3) no single constituent contained within the index represents more than 25% of the total index;

(4) the largest 10% of constituents represents less than 60% of the total index; and

(5) the total market capitalisation of all the constituents of the index is no less than USD 40 billion.

21.32 For a given instrument, irrespective of whether a look-through approach is adopted or not, the sensitivity inputs used for the delta and curvature risk calculation must be consistent.

21.33 Where a bank opts not to apply the look-through approach in accordance with [MAR21.31], a single sensitivity shall be calculated to each widely recognised and accepted index that an instrument references. The sensitivity to the index should be assigned to the relevant delta risk bucket defined in [MAR21.53] and [MAR21.72] as follows:

(1) Where more than 75% of constituents in that index (taking into account the weightings of that index) would be mapped to a specific sector bucket (ie bucket 1 to bucket 11 for equity risk, or bucket 1 to bucket 16 for CSR), the sensitivity to the index shall be mapped to that single specific sector bucket and treated like any other single-name sensitivity in that bucket.

(2) In all other cases, the sensitivity may be mapped to an "index" bucket (ie bucket 12 or bucket 13 for equity risk; or bucket 17 or bucket 18 for CSR).

21.34 A look-through approach must always be used for indices that do not meet the criteria set out in [MAR21.31](2) to [MAR21.31](5), and for any multi-underlying instruments that reference a bespoke set of equities or credit positions.

(1) Where a look-through approach is adopted, for index instruments and multi-underlying options other than the CTP, the sensitivities to constituent risk factors from those instruments or options are allowed to net with sensitivities to single-name instruments without restriction.

(2) Index CTP instruments cannot be broken down into its constituents (ie the index CTP should be considered a risk factor as a whole) and the above-mentioned netting at the issuer level does not apply either.

(3) Where a look-through approach is adopted, it shall be applied consistently through time,[10] and shall be used for all identical instruments that reference the same index.

*Footnote*

*[10] In other words, a bank can initially not apply a look-through approach, and later decide to apply it. However once applied (for a certain type of instrument referencing a particular index), the bank will require supervisory approval to revert to a "no look-through" approach.*

### *Treatment of equity investments in funds*

21.35 For equity investments in funds that can be looked through as set out in [RBC25.8](5)(a), banks must apply a look-through approach and treat the underlying positions of the fund as if the positions were held directly by the bank (taking into account the bank's share of the equity of the fund, and any leverage in the fund structure), except for the funds that meet the following conditions:

(1) For funds that hold an index instrument that meets the criteria set out under [MAR21.31], banks must still apply a look-through and treat the underlying positions of the fund as if the positions were held directly by the bank, but the bank may then choose to apply the "no look-through" approach for the index holdings of the fund as set out in [MAR21.33].

(2) For funds that track an index benchmark, a bank may opt not to apply the look-through approach and opt to measure the risk assuming the fund is a position in the tracked index only where:

(a) the fund has an absolute value of a tracking difference (ignoring fees and commissions) of less than 1%; and

(b) the tracking difference is checked at least annually and is defined as the annualised return difference between the fund and its tracked benchmark over the last 12 months of available data (or a shorter period in the absence of a full 12 months of data).

21.36 For equity investments in funds that cannot be looked through (ie do not meet the criterion set out in [RBC25.8](5)(a)), but that the bank has access to daily price quotes and knowledge of the mandate of the fund (ie meet both the criteria set out in [RBC25.8](5)(b)), banks may calculate capital requirements for the fund in one of three ways:

(1) If the fund tracks an index benchmark and meets the requirement set out in [MAR21.35](2)(a) and (b), the bank may assume that the fund is a position in the tracked index, and may assign the sensitivity to the fund to relevant sector specific buckets or index buckets as set out in [MAR21.33].

(2) Subject to supervisory approval, the bank may consider the fund as a hypothetical portfolio in which the fund invests to the maximum extent allowed under the fund's mandate in those assets attracting the highest capital requirements under the sensitivities-based method, and then progressively in those other assets implying lower capital requirements. If more than one risk weight can be applied to a given exposure under the sensitivities-based method, the maximum risk weight applicable must be used.

(a) This hypothetical portfolio must be subject to market risk capital requirements on a stand-alone basis for all positions in that fund, separate from any other positions subject to market risk capital requirements.

(b) The counterparty credit and CVA risks of the derivatives of this hypothetical portfolio must be calculated using the simplified methodology set out in accordance with paragraph 80(vii)(c) of the banking book equity investment in funds treatment.

(3) A bank may treat their equity investment in the fund as an unrated equity exposure to be allocated to the "other sector" bucket (bucket 11). In applying this treatment, banks must also consider whether, given the mandate of the fund, the default risk capital (DRC) requirement risk weight prescribed to the fund is sufficiently prudent (as set out in [MAR22.8]), and whether the RRAO should apply (as set out in [MAR23.6]).

21.37 As per the requirement in [RBC25.8](5), net long equity investments in a given fund in which the bank cannot look through or does not meet the requirements of [RBC25.8](5) for the fund must be assigned to the banking book. Net short positions in funds, where the bank cannot look through or does not meet the requirements of [RBC25.8](5), must be excluded from any trading book capital requirements under the market risk framework, with the net position instead subjected to a 100% capital requirement.

### *Treatment of vega risk for multi-underlying instruments*

21.38 In the vega risk context:

(1) Multi-underlying options (including index options) are usually priced based on the implied volatility of the option, rather than the implied volatility of its underlying constituents and a look-through approach may not need to be applied, regardless of the approach applied to the delta and curvature risk calculation as set out in [MAR21.31] through [MAR20.35].[11]

(2) For indices, the vega risk with respect to the implied volatility of the multi-underlying options will be calculated using a sector specific bucket or an index bucket defined in [MAR21.53] and [MAR21.72] as follows:

(a) Where more than 75% of constituents in that index (taking into account the weightings of that index) would be mapped to a single specific sector bucket (ie bucket 1 to bucket 11 for equity risk; or bucket 1 to bucket 16 for CSR), the sensitivity to the index shall be mapped to that single specific sector bucket and treated like any other single-name sensitivity in that bucket.

(b) In all other cases, the sensitivity may be mapped to an "index" bucket (ie bucket 12 or bucket 13 for equity risk or bucket 17 or bucket 18 for CSR).

<u>*Footnote*</u>

*[11] As specified in the vega risk factor definitions in [MAR21.8] to [MAR21.14], the implied volatility of an option must be mapped to one or more maturity tenors.*

## Sensitivities-based method: definition of delta risk buckets, risk weights and correlations

21.39 [MAR21.41] to [MAR21.89] set out buckets, risk weights and correlation parameters for each risk class to calculate delta risk capital requirement as set out in [MAR21.4].

21.40 The prescribed risk weights and correlations in [MAR21.41] to [MAR21.89] have been calibrated to the liquidity adjusted time horizon related to each risk class.

*Delta GIRR buckets, risk weights and correlations*

21.41 Each currency is a separate delta GIRR bucket, so all risk factors in risk-free yield curves for the same currency in which interest rate-sensitive instruments are denominated are grouped into the same bucket.

21.42 For calculating weighted sensitivities, the risk weights for each tenor in risk-free yield curves are set in Table 1 as follows:

Delta GIRR buckets and risk weights — Table 1

| Tenor | 0.25 year | 0.5 year | 1 year | 2 year | 3 year |
|---|---|---|---|---|---|
| Risk weight | 1.7% | 1.7% | 1.6% | 1.3% | 1.2% |
| | | | | | |
| Tenor | 5 year | 10 year | 15 year | 20 year | 30 year |
| Risk weight (percentage points) | 1.1% | 1.1% | 1.1% | 1.1% | 1.1% |

21.43 The risk weight for the inflation risk factor and the cross-currency basis risk factors, respectively, is set at 1.6%.

21.44 For specified currencies by the Basel Committee,[12] the above risk weights may, at the discretion of the bank, be divided by the square root of 2.

<u>Footnote</u>

*[12] Specified currencies by the Basel Committee are: EUR, USD, GBP, AUD, JPY, SEK, CAD as well as the domestic reporting currency of a bank.*

21.45 For aggregating GIRR risk positions within a bucket, the correlation parameter $\rho_{kl}$ between weighted sensitivities $WS_k$ and $WS_l$ within the same bucket (ie same currency), same assigned tenor, but different curves is set at 99.90%. In aggregating delta risk positions for cross-currency basis risk for onshore and offshore curves, which must be considered two different curves as set out in [MAR21.8], a bank may choose to aggregate all cross-currency basis risk for a currency (ie "Curr/USD" or "Curr/EUR") for both onshore and offshore curves by a simple sum of weighted sensitivities.

21.46 The delta risk correlation $\rho_{kl}$ between weighted sensitivities $WS_k$ and $WS_l$ within the same bucket with different tenor and same curve is set in the following Table 2:[13]

Delta GIRR correlations ($\rho_{kl}$) within the same bucket, with different tenor and same curve — Table 2

| | 0.25 year | 0.5 year | 1 year | 2 year | 3 year | 5 year | 10 year | 15 year | 20 year | 30 year |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.25 year | 100.0% | 97.0% | 91.4% | 81.1% | 71.9% | 56.6% | 40.0% | 40.0% | 40.0% | 40.0% |
| 0.5 year | 97.0% | 100.0% | 97.0% | 91.4% | 86.1% | 76.3% | 56.6% | 41.9% | 40.0% | 40.0% |
| 1 year | 91.4% | 97.0% | 100.0% | 97.0% | 94.2% | 88.7% | 76.3% | 65.7% | 56.6% | 41.9% |
| 2 year | 81.1% | 91.4% | 97.0% | 100.0% | 98.5% | 95.6% | 88.7% | 82.3% | 76.3% | 65.7% |
| 3 year | 71.9% | 86.1% | 94.2% | 98.5% | 100.0% | 98.0% | 93.2% | 88.7% | 84.4% | 76.3% |
| 5 year | 56.6% | 76.3% | 88.7% | 95.6% | 98.0% | 100.0% | 97.0% | 94.2% | 91.4% | 86.1% |
| 10 year | 40.0% | 56.6% | 76.3% | 88.7% | 93.2% | 97.0% | 100.0% | 98.5% | 97.0% | 94.2% |
| 15 year | 40.0% | 41.9% | 65.7% | 82.3% | 88.7% | 94.2% | 98.5% | 100.0% | 99.0% | 97.0% |
| 20 year | 40.0% | 40.0% | 56.6% | 76.3% | 84.4% | 91.4% | 97.0% | 99.0% | 100.0% | 98.5% |
| 30 year | 40.0% | 40.0% | 41.9% | 65.7% | 76.3% | 86.1% | 94.2% | 97.0% | 98.5% | 100.0% |

*Footnote*

*[13]* *The delta GIRR correlation parameters ($\rho_{kl}$) set out in Table 2 is determined by* $max\left[e^{\left(-\theta\cdot\frac{|T_k-T_l|}{min\{T_k;T_l\}}\right)};40\%\right]$*, where* $T_k$ *(respectively* $T_l$*) is the tenor that relates to* $WS_k$ *(respectively* $WS_l$*); and* $\theta$ *is set at* $3\%$*. For example, the correlation between a sensitivity to the one-year tenor of the Eonia swap curve and the a sensitivity to the five-year tenor of the Eonia swap curve in the same currency is* $max\left[e^{\left(-3\%\cdot\frac{|1-5|}{min\{1;5\}}\right)};40\%\right]=88.69\%$.

21.47 Between two weighted sensitivities $WS_k$ and $WS_l$ within the same bucket with different tenor and different curves, the correlation $\rho_{kl}$ is equal to the correlation parameter specified in [MAR21.46] multiplied by 99.90%.[14]

*Footnote*

*[14]* *For example, the correlation between a sensitivity to the one-year tenor of the Eonia swap curve and a sensitivity to the five-year tenor of the three-month Euribor swap curve in the same currency is* $(88.69\%)\cdot(0.999)=88.60\%$.

21.48 The delta risk correlation $\rho_{kl}$ between a weighted sensitivity $WS_k$ to the inflation curve and a weighted sensitivity $WS_l$ to a given tenor of the relevant yield curve is 40%.

21.49 The delta risk correlation $\rho_{kl}$ between a weighted sensitivity $WS_k$ to a cross-currency basis curve and a weighted sensitivity $WS_l$ to each of the following curves is 0%:

(1) a given tenor of the relevant yield curve;

(2) the inflation curve; or

(3) another cross-currency basis curve (if relevant).

21.50 For aggregating GIRR risk positions across different buckets (ie different currencies), the parameter $\gamma_{bc}$ is set at 50%.

### *Delta CSR non-securitisations buckets, risk weights and correlations*

21.51 For delta CSR non-securitisations, buckets are set along two dimensions – credit quality and sector – as set out in Table 3. The CSR non-securitisation sensitivities or risk exposures should first be assigned to a bucket defined before calculating weighted sensitivities by applying a risk weight.

| Buckets for delta CSR non-securitisations | | Table 3 |
|---|---|---|
| Bucket number | Credit quality | Sector |
| 1 | Investment grade (IG) | Sovereigns including central banks, multilateral development banks |
| 2 | | Local government, government-backed non-financials, education, public administration |
| 3 | | Financials including government-backed financials |
| 4 | | Basic materials, energy, industrials, agriculture, manufacturing, mining and quarrying |
| 5 | | Consumer goods and services, transportation and storage, administrative and support service activities |
| 6 | | Technology, telecommunications |
| 7 | | Health care, utilities, professional and technical activities |
| 8 | | Covered bonds[15] |
| 9 | High yield (HY) & non-rated (NR) | Sovereigns including central banks, multilateral development banks |
| 10 | | Local government, government-backed non-financials, education, public administration |
| 11 | | Financials including government-backed financials |
| 12 | | Basic materials, energy, industrials, agriculture, manufacturing, mining and quarrying |
| 13 | | Consumer goods and services, transportation and storage, administrative and support service activities |
| 14 | | Technology, telecommunications |
| 15 | | Health care, utilities, professional and technical activities |
| 16 | Other sector[16] | |
| 17 | IG indices | |
| 18 | HY indices | |

<u>*Footnotes*</u>

*[15] Covered bonds must meet the definition provided in paragraphs 68, 70 and 71 in the following publication: Basel Committee on Banking Supervision. Supervisory framework for measuring and controlling large exposures. April 2014, www.bis.org/publ/bcbs283.pdf.*

*[16] Credit quality is not a differentiating consideration for this bucket.*

21.52 To assign a risk exposure to a sector, banks must rely on a classification that is commonly used in the market for grouping issuers by industry sector.

(1) The bank must assign each issuer to one and only one of the sector buckets in the table under [MAR21.51].

(2) Risk positions from any issuer that a bank cannot assign to a sector in this fashion must be assigned to the other sector (ie bucket 16).

21.53 For calculating weighted sensitivities, the risk weights for buckets 1 to 18 are set out in Table 4. Risk weights are the same for all tenors (ie 0.5 years, 1 year, 3 years, 5 years, 10 years) within each bucket:

| Risk weights for buckets for delta CSR non-securitisations | Table 4 |
|---|---|
| Bucket number | Risk weight |
| 1 | 0.5% |
| 2 | 1.0% |
| 3 | 5.0% |
| 4 | 3.0% |
| 5 | 3.0% |
| 6 | 2.0% |
| 7 | 1.5% |
| 8 | 2.5%[17] |
| 9 | 2.0% |
| 10 | 4.0% |
| 11 | 12.0% |
| 12 | 7.0% |
| 13 | 8.5% |
| 14 | 5.5% |
| 15 | 5.0% |
| 16 | 12.0% |
| 17 | 1.5% |
| 18 | 5.0% |

_Footnote_

*[17] For covered bonds that are rated AA- or higher, the applicable risk weight may at the discretion of the bank be 1.5%.*

21.54 For buckets 1 to 15, for aggregating delta CSR non-securitisations risk positions within a bucket, the correlation parameter $\rho_{kl}$ between two weighted sensitivities $WS_k$ and $WS_l$ within the same bucket, is set as follows, where:

(1) $\rho_{kl}^{(name)}$ is equal to 1 where the two names of sensitivities *k* and *l* are identical, and 35% otherwise;

(2) $\rho_{kl}^{(tenor)}$ is equal to 1 if the two tenors of the sensitivities *k* and *l* are identical, and to 65% otherwise; and

(3) $\rho_{kl}^{(basis)}$ is equal to 1 if the two sensitivities are related to same curves, and 99.90% otherwise.

$$\rho_{kl} = \rho_{kl}^{(name)} \cdot \rho_{kl}^{(tenor)} \cdot \rho_{kl}^{(basis)}$$ [18]

_Footnote_

*[18] For example, a sensitivity to the five-year Apple bond curve and a sensitivity to the 10-year Google CDS curve would be* $35\% \cdot 65\% \cdot 99.90\% = 22.73\%$.

21.55 For buckets 17 and 18, for aggregating delta CSR non-securitisations risk positions within a bucket, the correlation parameter $\rho_{kl}$ between two weighted sensitivities $WS_k$ and $WS_l$ within the same bucket is set as follows, where:

(1) $\rho_{kl}^{(name)}$ is equal to 1 where the two names of sensitivities *k* and *l* are identical, and 80% otherwise;

(2) $\rho_{kl}^{(tenor)}$ is equal to 1 if the two tenors of the sensitivities *k* and *l* are identical, and to 65% otherwise; and

(3) $\rho_{kl}^{(basis)}$ is equal to 1 if the two sensitivities are related to same curves, and 99.90% otherwise.

$$\rho_{kl} = \rho_{kl}^{(name)} \cdot \rho_{kl}^{(tenor)} \cdot \rho_{kl}^{(basis)}$$

21.56 The correlations above do not apply to the other sector bucket (ie bucket 16).

(1) The aggregation of delta CSR non-securitisation risk positions within the other sector bucket (ie bucket 16) would be equal to the simple sum of the absolute values of the net weighted sensitivities allocated to this bucket. The same method applies to the aggregation of vega risk positions.

$$K_{b(other\ bucket)} = \sum_k |WS_k|$$

(2) The aggregation of curvature CSR non-securitisation risk positions within the other sector bucket (ie bucket 16) would be calculated by the formula below.

$$K_{b(other\ bucket)} = \max\left(\sum_k max(CVR_k^+, 0), \sum_k max(CVR_k^-, 0)\right)$$

21.57 For aggregating delta CSR non-securitisation risk positions across buckets 1 to 16, the correlation parameter $\gamma_{bc}$ is set as follows, where:

(1) $\gamma_{bc}^{(rating)}$ is equal to 50% where the two buckets *b* and *c* are both in buckets 1 to 15 and have a different rating category (either IG or HY/NR). $\gamma_{bc}^{(rating)}$ is equal to 1 otherwise; and

(2) $\gamma_{bc}^{(sector)}$ is equal to 1 if the two buckets belong to the same sector, and to the specified numbers in Table 5 otherwise.

$$\gamma_{bc} = \gamma_{bc}^{(rating)} \cdot \gamma_{bc}^{(sector)}$$

Values of $\gamma_{bc}^{(sector)}$ where the buckets do not belong to the same sector — Table 5

| Bucket | 1 / 9 | 2 / 10 | 3 / 11 | 4 / 12 | 5 / 13 | 6 / 14 | 7 / 15 | 8 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 / 9 | | 75% | 10% | 20% | 25% | 20% | 15% | 10% | 0% | 45% | 45% |
| 2 / 10 | | | 5% | 15% | 20% | 15% | 10% | 10% | 0% | 45% | 45% |
| 3 / 11 | | | | 5% | 15% | 20% | 5% | 20% | 0% | 45% | 45% |
| 4 / 12 | | | | | 20% | 25% | 5% | 5% | 0% | 45% | 45% |
| 5 / 13 | | | | | | 25% | 5% | 15% | 0% | 45% | 45% |
| 6 / 14 | | | | | | | 5% | 20% | 0% | 45% | 45% |
| 7 / 15 | | | | | | | | 5% | 0% | 45% | 45% |
| 8 | | | | | | | | | 0% | 45% | 45% |
| 16 | | | | | | | | | | 0% | 0% |
| 17 | | | | | | | | | | | 75% |
| 18 | | | | | | | | | | | |

*Delta CSR securitisation (CTP) buckets, risk weights and correlations*

21.58 Sensitivities to CSR arising from the CTP and its hedges are treated as a separate risk class as set out in MAR21.1]. The buckets, risk weights and correlations for the CSR securitisations (CTP) apply as follows:

(1) The same bucket structure and correlation structure apply to the CSR securitisations (CTP) as those for the CSR non-securitisation framework as set out in [MAR21.51] to [MAR21.57] with an exception of index buckets (ie buckets 17 and 18).

(2) The risk weights and correlation parameters of the delta CSR non-securitisations are modified to reflect longer liquidity horizons and larger basis risk as specified in [MAR21.59] to [MAR21.61].

21.59 For calculating weighted sensitivities, the risk weights for buckets 1 to 16 are set out in Table 6. Risk weights are the same for all tenors (ie 0.5 years, 1 year, 3 years, 5 years, 10 years) within each bucket:

Risk weights for sensitivities to CSR arising from the CTP — Table 6

| Bucket number | Risk weight |
|---|---|
| 1 | 4.0% |
| 2 | 4.0% |
| 3 | 8.0% |
| 4 | 5.0% |
| 5 | 4.0% |
| 6 | 3.0% |
| 7 | 2.0% |
| 8 | 6.0% |
| 9 | 13.0% |
| 10 | 13.0% |
| 11 | 16.0% |
| 12 | 10.0% |
| 13 | 12.0% |
| 14 | 12.0% |
| 15 | 12.0% |
| 16 | 13.0% |

21.60 For aggregating delta CSR securitisations (CTP) risk positions within a bucket, the delta risk correlation $\rho_{kl}$ is derived the same way as in [MAR21.54] and [MAR21.55], except that the correlation parameter applying when the sensitivities are not related to same curves, $\rho_{kl}^{(basis)}$, is modified.

(1) $\rho_{kl}^{(basis)}$ is now equal to 1 if the two sensitivities are related to same curves, and 99.00% otherwise.

(2) The identical correlation parameters for $\rho_{kl}^{(name)}$ and $\rho_{kl}^{(tenor)}$ to CSR non-securitisation as set out in [MAR21.54] and [MAR21.55] apply.

21.61 For aggregating delta CSR securitisations (CTP) risk positions across buckets, the correlation parameters for $\gamma_{bc}$ are identical to CSR non-securitisation as set out in [MAR21.57].

*Delta CSR securitisation (non-CTP) buckets, risk weights and correlations*

21.62 For delta CSR securitisations not in the CTP, buckets are set along two dimensions – credit quality and sector – as set out in Table 7. The delta CSR securitisation (non-CTP) sensitivities or risk exposures must first be assigned to a bucket before calculating weighted sensitivities by applying a risk weight.

Buckets for delta CSR securitisations (non-CTP) Table 7

| Bucket number | Credit quality | Sector |
|---|---|---|
| 1 | Senior investment grade (IG) | RMBS – Prime |
| 2 | | RMBS – Mid-prime |
| 3 | | RMBS – Sub-prime |
| 4 | | CMBS |
| 5 | | Asset-backed securities (ABS) – Student loans |
| 6 | | ABS – Credit cards |
| 7 | | ABS – Auto |
| 8 | | Collateralised loan obligation (CLO) non-CTP |
| 9 | Non-senior IG | RMBS – Prime |
| 10 | | RMBS – Mid-prime |
| 11 | | RMBS – Sub-prime |
| 12 | | Commercial mortgage-backed securities (CMBS) |
| 13 | | ABS – Student loans |
| 14 | | ABS – Credit cards |
| 15 | | ABS – Auto |
| 16 | | CLO non-CTP |
| 17 | High yield & non-rated | RMBS – Prime |
| 18 | | RMBS – Mid-prime |
| 19 | | RMBS – Sub-prime |
| 20 | | CMBS |
| 21 | | ABS – Student loans |
| 22 | | ABS – Credit cards |
| 23 | | ABS – Auto |
| 24 | | CLO non-CTP |
| 25 | Other sector[19] | |

<u>*Footnote*</u>

*[19] Credit quality is not a differentiating consideration for this bucket.*

21.63 To assign a risk exposure to a sector, banks must rely on a classification that is commonly used in the market for grouping tranches by type.

(1) The bank must assign each tranche to one of the sector buckets in above Table 7.

(2) Risk positions from any tranche that a bank cannot assign to a sector in this fashion must be assigned to the other sector (ie bucket 25).

21.64 For calculating weighted sensitivities, the risk weights for buckets 1 to 8 (senior IG) are set out in Table 8:

| Risk weights for buckets 1 to 8 for delta CSR securitisations (non-CTP) | Table 8 |
|---|---|
| Bucket number | Risk weight (in percentage points) |
| 1 | 0.9% |
| 2 | 1.5% |
| 3 | 2.0% |
| 4 | 2.0% |
| 5 | 0.8% |
| 6 | 1.2% |
| 7 | 1.2% |
| 8 | 1.4% |

21.65 The risk weights for buckets 9 to 16 (non-senior investment grade) are then equal to the corresponding risk weights for buckets 1 to 8 scaled up by a multiplication by 1.25. For instance, the risk weight for bucket 9 is equal to $1.25 \times 0.9\% = 1.125\%$.

21.66 The risk weights for buckets 17 to 24 (high yield and non-rated) are then equal to the corresponding risk weights for buckets 1 to 8 scaled up by a multiplication by 1.75. For instance, the risk weight for bucket 17 is equal to $1.75 \times 0.9\% = 1.575\%$.

21.67 The risk weight for bucket 25 is set at 3.5%.

21.68 For aggregating delta CSR securitisations (non-CTP) risk positions within a bucket, the correlation parameter $\rho_{kl}$ between two sensitivities $WS_k$ and $WS_l$ within the same bucket, is set as follows, where:

(1) $\rho_{kl}^{(tranche)}$ is equal to 1 where the two names of sensitivities *k* and *l* are within the same bucket and related to the same securitisation tranche (more than 80% overlap in notional terms), and 40% otherwise;

(2) $\rho_{kl}^{(tenor)}$ is equal to 1 if the two tenors of the sensitivities *k* and *l* are identical, and to 80% otherwise; and

(3) $\rho_{kl}^{(basis)}$ is equal to 1 if the two sensitivities are related to same curves, and 99.90% otherwise.

$$\rho_{kl} = \rho_{kl}^{(tranche)} \cdot \rho_{kl}^{(tenor)} \cdot \rho_{kl}^{(basis)}$$

21.69 The correlations above do not apply to the other sector bucket (ie bucket 25).

(1) The aggregation of delta CSR securitisations (non-CTP) risk positions within the other sector bucket would be equal to the simple sum of the absolute values of the net weighted sensitivities allocated to this bucket. The same method applies to the aggregation of vega risk positions.

$$K_{b(other\ bucket)} = \sum_k |WS_k|$$

(2) The aggregation of curvature CSR risk positions within the other sector bucket (ie bucket 16) would be calculated by the formula below.

$$K_{b(other\ bucket)} = \max\left(\sum_k max(CVR_k^+, 0), \sum_k max(CVR_k^-, 0)\right)$$

21.70 For aggregating delta CSR securitisations (non-CTP) risk positions across buckets 1 to 24, the correlation parameter $\gamma_{bc}$ is set as 0%.

21.71 For aggregating delta CSR securitisations (non-CTP) risk positions between the other sector bucket (ie bucket 25) and buckets 1 to 24, the correlation parameter $\gamma_{bc}$ is set at 1. Bucket level capital requirements will be simply summed up to the overall risk class level capital requirements, with no diversification or hedging effects recognised with any bucket.

*Equity risk buckets, risk weights and correlations*

21.72 For delta equity risk, buckets are set along three dimensions – market capitalisation, economy and sector – as set out in Table 9. The equity risk sensitivities or exposures must first be assigned to a bucket before calculating weighted sensitivities by applying a risk weight.

Buckets for delta sensitivities to equity risk — Table 9

<table>
<tr><th>Bucket number</th><th>Market cap</th><th>Economy</th><th>Sector</th></tr>
<tr><td>1</td><td rowspan="8">Large</td><td rowspan="4">Emerging market economy</td><td>Consumer goods and services, transportation and storage, administrative and support service activities, healthcare, utilities</td></tr>
<tr><td>2</td><td>Telecommunications, industrials</td></tr>
<tr><td>3</td><td>Basic materials, energy, agriculture, manufacturing, mining and quarrying</td></tr>
<tr><td>4</td><td>Financials including government-backed financials, real estate activities, technology</td></tr>
<tr><td>5</td><td rowspan="4">Advanced economy</td><td>Consumer goods and services, transportation and storage, administrative and support service activities, healthcare, utilities</td></tr>
<tr><td>6</td><td>Telecommunications, industrials</td></tr>
<tr><td>7</td><td>Basic materials, energy, agriculture, manufacturing, mining and quarrying</td></tr>
<tr><td>8</td><td>Financials including government-backed financials, real estate activities, technology</td></tr>
<tr><td>9</td><td rowspan="2">Small</td><td>Emerging market economy</td><td>All sectors described under bucket numbers 1, 2, 3 and 4</td></tr>
<tr><td>10</td><td>Advanced economy</td><td>All sectors described under bucket numbers 5, 6, 7 and 8</td></tr>
<tr><td>11</td><td colspan="3">Other sector[20]</td></tr>
<tr><td>12</td><td colspan="3">Large market cap, advanced economy equity indices (non-sector specific)</td></tr>
<tr><td>13</td><td colspan="3">Other equity indices (non-sector specific)</td></tr>
</table>

<u>Footnote</u>

*[20] Market capitalisation or economy (ie advanced or emerging market) is not a differentiating consideration for this bucket.*

21.73 Market capitalisation (market cap) is defined as the sum of the market capitalisations based on the market value of the total outstanding shares issued by the same listed legal entity or a group of legal entities across all stock markets globally, where the total outstanding shares issued by the group of legal entities refer to cases where the listed entity is a parent company of a group of legal entities. Under no circumstances should the sum of the market capitalisations of multiple related listed entities be used to determine whether a listed entity is "large market cap" or "small market cap".

21.74 Large market cap is defined as a market capitalisation equal to or greater than USD 2 billion and small market cap is defined as a market capitalisation of less than USD 2 billion.

21.75 The advanced economies are Canada, the United States, Mexico, the euro area, the non-euro area western European countries (the United Kingdom, Norway, Sweden, Denmark and Switzerland), Japan, Oceania (Australia and New Zealand), Singapore and Hong Kong SAR.

21.76 To assign a risk exposure to a sector, banks must rely on a classification that is commonly used in the market for grouping issuers by industry sector.

(1) The bank must assign each issuer to one of the sector buckets in the table under [MAR21.72] and it must assign all issuers from the same industry to the same sector.

(2) Risk positions from any issuer that a bank cannot assign to a sector in this fashion must be assigned to the other sector (ie bucket 11).

(3) For multinational multi-sector equity issuers, the allocation to a particular bucket must be done according to the most material region and sector in which the issuer operates.

21.77 For calculating weighted sensitivities, the risk weights for the sensitivities to each of equity spot price and equity repo rates for buckets 1 to 13 are set out in Table 10:

Risk weights for buckets 1 to 13 for sensitivities to equity risk — Table 10

| Bucket number | Risk weight for equity spot price | Risk weight for equity repo rate |
|---|---|---|
| 1 | 55% | 0.55% |
| 2 | 60% | 0.60% |
| 3 | 45% | 0.45% |
| 4 | 55% | 0.55% |
| 5 | 30% | 0.30% |
| 6 | 35% | 0.35% |
| 7 | 40% | 0.40% |
| 8 | 50% | 0.50% |
| 9 | 70% | 0.70% |
| 10 | 50% | 0.50% |
| 11 | 70% | 0.70% |
| 12 | 15% | 0.15% |
| 13 | 25% | 0.25% |

21.78 For aggregating delta equity risk positions within a bucket, the correlation parameter $\rho_{kl}$ between two sensitivities $WS_k$ and $WS_l$ within the same bucket is set at as follows

(1) The correlation parameter $\rho_{kl}$is set at 99.90%, where:

(a) one is a sensitivity to an equity spot price and the other a sensitivity to an equity repo rates; and

(b) both are related to the same equity issuer name.

(2) The correlation parameter $\rho_{kl}$ is set out in (a) to (d) below, where both sensitivities are to equity spot price, and where:

(a) 15% between two sensitivities within the same bucket that fall under large market cap, emerging market economy (bucket number 1, 2, 3 or 4).

(b) 25% between two sensitivities within the same bucket that fall under large market cap, advanced economy (bucket number 5, 6, 7 or 8).

(c) 7.5% between two sensitivities within the same bucket that fall under small market cap, emerging market economy (bucket number 9).

(d) 12.5% between two sensitivities within the same bucket that fall under small market cap, advanced economy (bucket number 10).

(e) 80% between two sensitivities within the same bucket that fall under either index bucket (bucket number 12 or 13)

(3) The same correlation parameter $\rho_{kl}$ as set out in above (2)(a) to (d) apply, where both sensitivities are to equity repo rates.

(4) The correlation parameter $\rho_{kl}$ is set as each parameter specified in above (2)(a) to (d) multiplied by 99.90%, where:

(a) One is a sensitivity to an equity spot price and the other a sensitivity to an equity repo rate; and

(b) Each sensitivity is related to a different equity issuer name.

21.79 The correlations set out above do not apply to the other sector bucket (ie bucket 11).

(1) The aggregation of equity risk positions within the other sector bucket capital requirement would be equal to the simple sum of the absolute values of the net weighted sensitivities allocated to this bucket. The same method applies to the aggregation of vega risk positions.

$$K_{b(other\ bucket)} = \sum_k |WS_k|$$

(2) The aggregation of curvature equity risk positions within the other sector bucket (ie bucket 11) would be calculated by the formula:

$$K_{b(other\ bucket)} = \max\left(\sum_k max(CVR_k^+, 0), \sum_k max(CVR_k^-, 0)\right)$$

21.80 For aggregating delta equity risk positions across buckets 1 to 13, the correlation parameter $\gamma_{bc}$ is set at:

(1) 15% if bucket *b* and bucket *c* fall within bucket numbers 1 to 10;

(2) 0% if either of bucket *b* and bucket *c* is bucket 11;

(3) 75% if bucket *b* and bucket *c* are bucket numbers 12 and 13 (i.e. one is bucket 12, one is bucket 13); and

(4) 45% otherwise.

### *Commodity risk buckets, risk weights and correlations*

21.81 For delta commodity risk, 11 buckets that group commodities by common characteristics are set out in Table 11.

21.82 For calculating weighted sensitivities, the risk weights for each bucket are set out in Table 11:

## Delta commodity buckets and risk weights

Table 11

| Bucket number | Commodity bucket | Examples of commodities allocated to each commodity bucket (non-exhaustive) | Risk weight |
|---|---|---|---|
| 1 | Energy - solid combustibles | Coal, charcoal, wood pellets, uranium | 30% |
| 2 | Energy - liquid combustibles | Light-sweet crude oil; heavy crude oil; West Texas Intermediate (WTI) crude; Brent crude; etc (ie various types of crude oil)<br>Bioethanol; biodiesel; etc (ie various biofuels)<br>Propane; ethane; gasoline; methanol; butane; etc (ie various petrochemicals)<br>Jet fuel; kerosene; gasoil; fuel oil; naphtha; heating oil; diesel etc (ie various refined fuels) | 35% |
| 3 | Energy - electricity and carbon trading | Spot electricity; day-ahead electricity; peak electricity; off-peak electricity (ie various electricity types)<br>Certified emissions reductions; in-delivery month EU allowance; Regional Greenhouse Gas Initiative CO2 allowance; renewable energy certificates; etc (ie various carbon trading emissions) | 60% |
| 4 | Freight | Capesize; Panamax; Handysize; Supramax (ie various types of dry-bulk route)<br>Suezmax; Aframax; very large crude carriers (ie various liquid-bulk/gas shipping route) | 80% |
| 5 | Metals – non-precious | Aluminium; copper; lead; nickel; tin; zinc (ie various base metals)<br>Steel billet; steel wire; steel coil; steel scrap; steel rebar; iron ore; tungsten; vanadium; titanium; tantalum (ie steel raw materials)<br>Cobalt; manganese; molybdenum (ie various minor metals) | 40% |
| 6 | Gaseous combustibles | Natural gas; liquefied natural gas | 45% |
| 7 | Precious metals (including gold) | Gold; silver; platinum; palladium | 20% |
| 8 | Grains and oilseed | Corn; wheat; soybean seed; soybean oil; soybean meal; oats; palm oil; canola; barley; rapeseed seed; rapeseed oil; rapeseed meal; red bean; sorghum; coconut oil; olive oil; peanut oil; sunflower oil; rice | 35% |
| 9 | Livestock and dairy | Live cattle; feeder cattle; hog; poultry; lamb; fish; shrimp; milk; whey; eggs; butter; cheese | 25% |
| 10 | Softs and other agriculturals | Cocoa; arabica coffee; robusta coffee; tea; citrus juice; orange juice; potatoes; sugar; cotton; wool; lumber; pulp; rubber | 35% |
| 11 | Other commodity | Potash; fertilizer; phosphate rocks (ie various industrial materials)<br>Rare earths; terephthalic acid; flat glass | 50% |

21.83 For the purpose of aggregating commodity risk positions within a bucket using a correlation parameter, the correlation parameter $\rho_{kl}$ between two sensitivities $WS_k$ and $WS_l$ within the same bucket, is set as follows, where:

(1) $\rho_{kl}^{(cty)}$ is equal to 1 where the two commodities of sensitivities k and l are identical, and to the intra-bucket correlations in Table 12 otherwise, where, any two commodities are

considered distinct commodities if in the market two contracts are considered distinct when the only difference between each other is the underlying commodity to be delivered. For example, WTI and Brent in bucket 2 (ie energy – liquid combustibles) would typically be treated as distinct commodities;

(2) $\rho_{kl}^{(tenor)}$ is equal to 1 if the two tenors of the sensitivities k and l are identical, and to 99.00% otherwise; and

(3) $\rho_{kl}^{(basis)}$ is equal to 1 if the two sensitivities are identical in the delivery location of a commodity, and 99.90% otherwise.

$$\rho_{kl} = \rho_{kl}^{(cty)} \cdot \rho_{kl}^{(tenor)} \cdot \rho_{kl}^{(basis)}$$ [21]

## Values of $\rho_{kl}^{(cty)}$ for intra-bucket correlations

Table 12

| Bucket number | Commodity bucket | Correlation ($\rho_{kl}^{(cty)}$) |
|---|---|---|
| 1 | Energy – Solid combustibles | 55% |
| 2 | Energy – Liquid combustibles | 95% |
| 3 | Energy – Electricity and carbon trading | 40% |
| 4 | Freight | 80% |
| 5 | Metals – non-precious | 60% |
| 6 | Gaseous combustibles | 65% |
| 7 | Precious metals (including gold) | 55% |
| 8 | Grains and oilseed | 45% |
| 9 | Livestock and dairy | 15% |
| 10 | Softs and other agriculturals | 40% |
| 11 | Other commodity | 15% |

*Footnote*

*[21] For example, the correlation between the sensitivity to Brent, one-year tenor, for delivery in Le Havre and the sensitivity to WTI, five-year tenor, for delivery in Oklahoma is* $95\% \cdot 99.00\% \cdot 99.90\% = 93.96\%$.

21.84 For determining whether the commodity correlation parameter ($\rho_{kl}^{(cty)}$) as set out in Table 12 in [MAR21.83](1)(a) should apply, this paragraph provides non-exhaustive examples of further definitions of distinct commodities as follows:

(1) For bucket 3 (energy – electricity and carbon trading):

(a) Each time interval (i) at which the electricity can be delivered and (ii) that is specified in a contract that is made on a financial market is considered a distinct electricity commodity (eg peak and off-peak).

(b) Electricity produced in a specific region (eg Electricity NE, Electricity SE or Electricity North) is considered a distinct electricity commodity.

(2) For bucket 4 (freight):

(a) Each combination of freight type and route is considered a distinct commodity.

(b) Each week at which a good has to be delivered is considered a distinct commodity.

21.85 For aggregating delta commodity risk positions across buckets, the correlation parameter $\gamma_{bc}$ is set as follows:

(1) 20% if bucket *b* and bucket *c* fall within bucket numbers 1 to 10; and

(2) 0% if either bucket *b* or bucket *c* is bucket number 11.

### *Foreign exchange risk buckets, risk weights and correlations*

21.86 An FX risk bucket is set for each exchange rate between the currency in which an instrument is denominated and the reporting currency.

21.87 A unique relative risk weight equal to 15% applies to all the FX sensitivities.

21.88 For the specified currency pairs by the Basel Committee,[22] and for currency pairs forming first-order crosses across these specified currency pairs,[23] the above risk weight may at the discretion of the bank be divided by the square root of 2.

*Footnotes*

*[22] Specified currency pairs by the Basel Committee are: USD/EUR, USD/JPY, USD/GBP, USD/AUD, USD/CAD, USD/CHF, USD/MXN, USD/CNY, USD/NZD, USD/RUB, USD/HKD, USD/SGD, USD/TRY, USD/KRW, USD/SEK, USD/ZAR, USD/INR, USD/NOK, USD/BRL.*

*[23] For example, EUR/AUD is not among the selected currency pairs specified by the Basel Committee, but is a first-order cross of USD/EUR and USD/AUD.*

21.89 For aggregating delta FX risk positions across buckets, the correlation parameter $\gamma_{bc}$ is uniformly set to 60%.

## Sensitivities-based method: definition of vega risk buckets, risk weights and correlations

21.90 [MAR21.91] to [MAR21.95] set out buckets, risk weights and correlation parameters to calculate vega risk capital requirement as set out in [MAR21.4].

21.91 The same bucket definitions for each risk class are used for vega risk as for delta risk.

21.92 For calculating weighted sensitivities for vega risk, the risk of market illiquidity is incorporated into the determination of vega risk, by assigning different liquidity horizons for each risk class as set out in Table 13. The risk weight for each risk class[24] is also set out in Table 13.

Regulatory liquidity horizon, $LH_{risk\ class}$ and risk weights per risk class — Table 13

| Risk class | $LH_{risk\ class}$ | Risk weights |
|---|---|---|
| GIRR | 60 | 100% |
| CSR non-securitisations | 120 | 100% |
| CSR securitisations (CTP) | 120 | 100% |
| CSR securitisations (non-CTP) | 120 | 100% |
| Equity (large cap and indices) | 20 | 77.78% |
| Equity (small cap and other sector) | 60 | 100% |
| Commodity | 120 | 100% |
| FX | 40 | 100% |

*Footnote*

*[24] The risk weight for a given vega risk factor k ($RW_k$) is determined by $RW_k = min\left[RW_\sigma \cdot \frac{\sqrt{LH_{risk\ class}}}{\sqrt{10}}; 100\%\right]$, where $RW_\sigma$ is set at 55%; and $LH_{risk\ class}$ is specified per risk class in Table 13.*

21.93 For aggregating vega GIRR risk positions within a bucket, the correlation parameter $\rho_{kl}$ is set as follows, where:

(1) $\rho_{kl}^{(option\ maturity)}$ is equal to $e^{-\alpha \cdot \frac{|T_k - T_l|}{min\{T_k; T_l\}}}$, where:

(a) $\alpha$ is set at 1%;

(b) $T_k$ (respectively $T_l$) is the maturity of the option from which the vega sensitivity $VR_k$ ($VR_l$) is derived, expressed as a number of years; and

(2) $\rho_{kl}^{(underlying\ maturity)}$ is equal to $e^{-\alpha \cdot \frac{|T_k^U - T_l^U|}{min\{T_k^U; T_l^U\}}}$, where:

(a) $\alpha$ is set at 1%; and

(b) $T_k^U$ (respectively $T_l^U$) is the maturity of the underlying of the option from which the sensitivity $VR_k$ ($VR_l$) is derived, expressed as a number of years after the maturity of the option.

$$\rho_{kl} = min\left[\rho_{kl}^{(option\ maturity)} \cdot \rho_{kl}^{(underlying\ maturity)}; 1\right]$$

21.94 For aggregating vega risk positions within a bucket of the other risk classes (ie non-GIRR), the correlation parameter $\rho_{kl}$ is set as follows, where:

(1) $\rho_{kl}^{(DELTA)}$ is equal to the correlation that applies between the delta risk factors that correspond to vega risk factors *k* and *l*. For instance, if *k* is the vega risk factor from equity option X and *l* is the vega risk factor from equity option Y then $\rho_{kl}^{(DELTA)}$ is the delta correlation applicable between X and Y; and

(2) $\rho_{kl}^{(option\ maturity)}$ is defined as in [MAR21.93]:

$$\rho_{kl} = min\left[\rho_{kl}^{(DELTA)} \cdot \rho_{kl}^{(option\ maturity)}; 1\right]$$

21.95 For aggregating vega risk positions across different buckets within a risk class (GIRR and non-GIRR), the same correlation parameters for $\gamma_{bc}$, as specified for delta correlations for each risk class in [MAR21.39] to [MAR21.89] are to be used for the aggregation of vega risk (eg $\gamma_{bc}$ = 50% is to be used for the aggregation of vega risk sensitivities across different GIRR buckets).

## Sensitivities-based method: definition of curvature risk buckets, risk weights and correlations

21.96 [MAR21.97] to [MAR21.101] set out buckets, risk weights and correlation parameters to calculate curvature risk capital requirement as set out in [MAR21.5].

21.97 The delta buckets are replicated for the calculation of curvature risk capital requirement, unless specified otherwise in the preceding paragraphs within [MAR21.8] to [MAR21.89].

21.98 For calculating the net curvature risk capital requirement $CVR_k$ for risk factor *k* for FX and equity risk classes, the curvature risk weight, which is the size of a shock to the given risk factor, is a relative shift equal to the respective delta risk weight. For FX curvature, for options that do not reference a bank's reporting currency (or base currency as set out in [MAR21.14](b)) as an underlying, net curvature risk charges ($CVR_k^+$ and $CVR_k^-$) may be divided by a scalar of 1.5. Alternatively, and subject to supervisory approval, a bank may apply the scalar of 1.5 consistently to all FX instruments provided curvature sensitivities are calculated for all currencies, including sensitivities determined by shocking the reporting currency (or base currency where used) relative to all other currencies.

21.99 For calculating the net curvature risk capital requirement $CVR_k$ for curvature risk factor *k* for GIRR, CSR and commodity risk classes, the curvature risk weight is the parallel shift of all the tenors for each curve based on the highest prescribed delta risk weight for each risk class. For example, in the case of GIRR the risk weight assigned to 0.25-year tenor (ie the most punitive tenor risk weight) is applied to all the tenors simultaneously for each risk-free yield curve (consistent with a "translation", or "parallel shift" risk calculation).

21.100 For aggregating curvature risk positions within a bucket, the curvature risk correlations $\rho_{kl}$ are determined by squaring the corresponding delta correlation parameters $\rho_{kl}$ except for CSR non-securitisations and CSR securitisations (CTP). In applying the high and low correlations scenario set out in [MAR21.6], the curvature risk capital requirements are calculated by applying the curvature correlation parameters $\rho_{kl}$ determined in this paragraph.

(1) For CSR non-securitisations and CSR securitisations (CTP), consistent with [MAR21.9] which defines a bucket along one dimension (ie the relevant credit spread curve), the correlation parameter $\rho_{kl}$ as defined in [MAR21.54] and [MAR21.55] is not applicable to the curvature risk capital requirement calculation. Thus, the correlation parameter is determined by whether the two names of weighted sensitivities are the same. In the formula in [MAR21.54] and [MAR21.55], the correlation parameters $\rho_{kl}^{(basis)}$ and $\rho_{kl}^{(tenor)}$ need not apply and only correlation parameter $\rho_{kl}^{(name)}$ applies between two weighted sensitivities within the same bucket. This correlation parameter should be squared.

21.101 For aggregating curvature risk positions across buckets, the curvature risk correlations $\gamma_{bc}$ are determined by squaring the corresponding delta correlation parameters $\gamma_{bc}$. For instance, when aggregating $CVR_{EUR}$ and $CVR_{USD}$ for the GIRR, the correlation should be $50\%^2 = 25\%$. In applying the high and low correlations scenario set out in [MAR21.6], the curvature risk capital requirements are calculated by applying the curvature correlation parameters $\gamma_{bc}$, (ie the square of the corresponding delta correlation parameter).

# MAR22 Standardised approach: default risk capital requirement

*This chapter sets out the calculation of the default risk capital requirement under the standardised approach for market risk.*

## Main concepts of default risk capital requirements

22.1 The default risk capital (DRC) requirement is intended to capture jump-to-default (JTD) risk that may not be captured by credit spread shocks under the sensitivities-based method. DRC requirements provide some limited hedging recognition. In this chapter offsetting refers to the netting of exposures to the same obligor (where a short exposure may be subtracted in full from a long exposure) and hedging refers to the application of a partial hedge benefit from the short exposures (where the risk of long and short exposures in distinct obligors do not fully offset due to basis or correlation risks).

## Instruments subject to the default risk capital requirement

22.2 The DRC requirement must be calculated for instruments subject to default risk:

(1) Non-securitisation portfolios

(2) Securitisation portfolio (non-correlation trading portfolio, or non-CTP)

(3) Securitisation (correlation trading portfolio, or CTP)

## Overview of DRC requirement calculation

22.3 The following step-by-step approach must be followed for each risk class subject to default risk. The specific definition of gross JTD risk, net JTD risk, bucket, risk weight and the method for aggregation of DRC requirement across buckets are separately set out per each risk class in subsections in [MAR22.9] to [MAR22.26].

(1) The gross JTD risk of each exposure is computed separately.

(2) With respect to the same obligator, the JTD amounts of long and short exposures are offset (where permissible) to produce net long and/or net short exposure amounts per distinct obligor.

(3) Net JTD risk positions are then allocated to buckets.

(4) Within a bucket, a hedge benefit ratio is calculated using net long and short JTD risk positions. This acts as a discount factor that reduces the amount of net short positions to be netted against net long positions within a bucket. A prescribed risk weight is applied to the net positions which are then aggregated.

(5) Bucket level DRC requirements are aggregated as a simple sum across buckets to give the overall DRC requirement.

22.4 No diversification benefit is recognised between the DRC requirements for:

(1) non-securitisations;

(2) securitisations (non-CTP); and

(3) securitisations (CTP).

22.5 For traded non-securitisation credit and equity derivatives, JTD risk positions by individual constituent issuer legal entity should be determined by applying a look-through approach.

22.6 For the CTP, the capital requirement calculation includes the default risk for non-securitisation hedges. These hedges must be removed from the calculation of default risk non-securitisation.

22.7 Claims on sovereigns, public sector entities and multilateral development banks may, at national discretion, be subject to a zero default risk weight in line with paragraphs 7 through 15 in the Basel III credit risk framework. National authorities may apply a non-zero risk weight to securities issued by certain foreign governments, including to securities denominated in a currency other than that of the issuing government.

22.8 For claims on an equity investment in a fund that is subject to the treatment specified in [MAR21.36](3) (ie treated as an unrated "other sector" equity), the equity investment in the fund shall be treated as an unrated equity instrument. Where the mandate of that fund allows the fund to invest in primarily high-yield or distressed names, banks shall apply the maximum risk weight per Table 2 in [MAR 22.24] that is achievable under the fund's mandate (by calculating the effective average risk weight of the fund when assuming that the fund invests first in defaulted instruments to the maximum possible extent allowed under its mandate, and then in CCC-rated names to the maximum possible extent, and then B-rated, and then BB-rated). Neither offsetting nor diversification between these generated exposures and other exposures is allowed.

## Default risk capital requirement for non-securitisations

### *Gross jump-to-default risk positions (gross JTD)*

22.9 The gross JTD risk position is computed exposure by exposure. For instance, if a bank has a long position on a bond issued by Apple, and another short position on a bond issued by Apple, it must compute two separate JTD exposures.

22.10 For the purpose of DRC requirements, the determination of the long/short direction of positions must be on the basis of long or short with respect to whether the credit exposure results in a loss or gain in the case of a default.

(1) Specifically, a long exposure is defined as a credit exposure that results in a loss in the case of a default.

(2) For derivative contracts, the long/short direction is also determined by whether the contract will result in a loss in the case of a default (ie long or short position is not determined by whether the option or credit default swap (CDS), is bought or sold). Thus, for the purpose of DRC requirements, a sold put option on a bond is a long credit exposure, since a default results in a loss to the seller of the option.

22.11 The gross JTD is a function of the loss given default (LGD), notional amount (or face value) and the cumulative profit and loss (P&L) already realised on the position, where:

(1) *notional* is the bond-equivalent notional amount (or face value) of the position; and

(2) P&L is the cumulative mark-to-market loss (or gain) already taken on the exposure. P&L is equal to the market value minus the notional amount, where the market value is the current market value of the position.

$$JTD\ (long) = max\ (LGD \times notional + P\&L,\ 0)$$

$$JTD\ (short) = min\ (LGD \times notional + P\&L,\ 0)$$

22.12 For calculating the gross JTD, LGD is set as follows:

(1) Equity instruments and non-senior debt instruments are assigned an LGD of 100%.

(2) Senior debt instruments are assigned an LGD of 75%.

(3) Covered bonds, as defined within [MAR21.51], are assigned an LGD of 25%.

(4) When the price of the instrument is not linked to the recovery rate of the defaulter (eg a foreign exchange-credit hybrid option where the cash flows are swap of cash flows, long EUR coupons and short USD coupons with a knockout feature that ends cash flows on an event of default of a particular obligor), there should be no multiplication of the notional by the LGD.

22.13 In calculating the JTD as set out in [MAR22.11], the notional amount of an instrument that gives rise to a long (short) exposure is recorded as a positive (negative) value, while the P&L loss (gain) is recorded as a negative (positive) value. If the contractual or legal terms of the derivative allow for the unwinding of the instrument with no exposure to default risk, then the JTD is equal to zero.

22.14 The notional amount is used to determine the loss of principal at default, and the mark-to-market loss is used to determine the net loss so as to not double-count the mark-to-market loss already recorded in the market value of the position.

(1) For all instruments, the notional amount is the notional amount of the instrument relative to which the loss of principal is determined. Examples are as follows:

(a) For a bond, the notional amount is the face value.

(b) For credit derivatives, the notional amount of a CDS contract or a put option on a bond is the notional amount of the derivative contract.

(c) In the case of a call option on a bond, the notional amount to be used in the JTD calculation is zero (since, in the event of default, the call option will not be exercised). In this case, a JTD would extinguish the call option's value and this loss would be captured through the mark-to-market P&L term in the JTD calculation.

(2) Table 1 illustrates examples of the notional amounts and market values for a long credit position with a mark-to-market loss to be used in the JTD calculation, where:

(a) the bond-equivalent market value is an intermediate step in determining the P&L for derivative instruments;

(b) the mark-to-market value of CDS or an option takes an absolute value; and

(c) the strike amount of the bond option is expressed in terms of the bond price (not the yield).

| Examples of components for a long credit position in the JTD calculation | | | Table 1 |
|---|---|---|---|
| Instrument | Notional | Bond-equivalent market value | P&L |
| Bond | Face value of bond | Market value of bond | Market value – face value |
| CDS | Notional of CDS | Notional of CDS – \| mark-to-market (MtM) value of CDS \| | – \| MtM value of CDS \| |
| Sold put option on a bond | Notional of option | Strike amount – \| MtM value of option \| | (Strike – \| MtM value of option \| ) – Notional |
| Bought call option on a bond | 0 | MtM value of option | MtM value of option |

P&L = bond-equivalent market value – notional.

With this representation of the P&L for a sold put option, a lower strike results in a lower JTD loss.

22.15 To account for defaults within the one-year capital horizon, the JTD for all exposures of maturity less than one year and their hedges are scaled by a fraction of a year. No scaling is applied to the JTD for exposures of one year or greater.[1] For example, the JTD for a position with a six month maturity would be weighted by one-half, while the JTD for a position with a one year maturity would have no scaling applied to the JTD.

*Footnote*

*[1] Note that this paragraph refers to the scaling of gross JTD (ie not net JTD).*

22.16 Cash equity positions (ie stocks) are assigned to a maturity of either more than one year or three months, at banks' discretion.

22.17 For derivative exposures, the maturity of the derivative contract is considered in determining the offsetting criterion, not the maturity of the underlying instrument.

22.18 The maturity weighting applied to the JTD for any sort of product with a maturity of less than three months (such as short term lending) is floored at a weighting factor of one-fourth or, equivalently, three months (that means that the positions having shorter-than-three months remaining maturity would be regarded as having a remaining maturity of three months for the purpose of the DRC requirement).

### *Net jump-to-default risk positions (net JTD)*

22.19 Exposures to the same obligator may be offset as follows:

(1) The gross JTD risk positions of long and short exposures to the same obligor may be offset where the short exposure has the same or lower seniority relative to the long exposure. For example, a short exposure in an equity may offset a long exposure in a bond, but a short exposure in a bond cannot offset a long exposure in the equity.

(2) For the purposes of determining whether a guaranteed bond is an exposure to the underlying obligor or an exposure to the guarantor, the credit risk mitigation requirements set out in paragraphs 189 and 190 of the Basel II framework apply.

(3) Exposures of different maturities that meet this offsetting criterion may be offset as follows.

(a) Exposures with maturities longer than the capital horizon (one year) may be fully offset.

(b) An exposure to an obligor comprising a mix of long and short exposures with a maturity less than the capital horizon (equal to one year) must be weighted by the ratio of the exposure's maturity relative to the capital horizon. For example, with the one-year capital horizon, a three-month short exposure would be weighted so that its benefit against long exposures of longer-than-one-year maturity would be reduced to one quarter of the exposure size.[2]

*Footnote*

[2] *Basel Committee on Banking Supervision, Revisions to the securitisation framework, December 2014, 2016 and 2018*. www.bis.org/bcbs/publ/d303.htm; www.bis.org/bcbs/publ/d374.pdf; *www.bis.org/bcbs/publ/d442.pdf*.

22.20 In the case of long and short offsetting exposures where both have a maturity under one year, the scaling can be applied to both the long and short exposures.

22.21 Finally, the offsetting may result in net long JTD risk positions and net short JTD risk positions. The net long and net short JTD risk positions are aggregated separately as described below.

### *Calculation of default risk capital requirement for non-securitisation*

22.22 For the default risk of non-securitisations, three buckets are defined as:

(1) corporates;

(2) sovereigns; and

(3) local governments and municipalities.

22.23 In order to recognise hedging relationship between net long and net short positions within a bucket, a hedge benefit ratio is computed as follows.

(1) A simple sum of the net long JTD risk positions (not risk-weighted) must be calculated, where the summation is across the credit quality categories (ie rating bands). The aggregated amount is used in the numerator and denominator of the expression of the hedge benefit ratio (HBR) below.

(2) A simple sum of the net (not risk-weighted) short JTD risk positions must be calculated, where the summation is across the credit quality categories (ie rating bands). The aggregated amount is used in the denominator of the expression of the *HBR* below.

(3) The HBR is the ratio of net long JTD risk positions to the sum of net long JTD and absolute value of net short JTD risk positions:

$$HBR = \frac{\sum net\,JTD_{long}}{\sum net\,JTD_{long} + \sum |net\,JTD_{short}|}$$

22.24 For calculating the weighted net JTD, default risk weights are set depending on the credit quality categories (ie rating bands) for all three buckets (ie irrespective of the type of counterparty), as set out in Table 2:

| Default risk weights for non-securitisations by credit quality category | Table 2 |
|---|---|
| Credit quality category | Default risk weight |
| AAA | 0.5% |
| AA | 2% |
| A | 3% |
| BBB | 6% |
| BB | 15% |
| B | 30% |
| CCC | 50% |
| Unrated | 15% |
| Defaulted | 100% |

22.25 The capital requirement for each bucket is to be calculated as the combination of the sum of the risk-weighted long net JTD, the HBR, and the sum of the risk-weighted short net JTD, where the summation for each long net JTD and short net JTD is across the credit quality categories (ie rating bands). In the following formula, DRC stands for DRC requirement; and $i$ refers to an instrument belonging to bucket $b$.

$$DRC_b = max\left[\left(\sum_{i \in Long} RW_i \cdot net\ JTD_i\right) - HBR \cdot \left(\sum_{i \in Short} RW_i \cdot |net\ JTD_i|\right); 0\right]$$

22.26 No hedging is recognised between different buckets - the total DRC requirement for non-securitisations must be calculated as a simple sum of the bucket level capital requirements.

## Default risk capital requirement for securitisations (non-CTP)

### *Gross jump-to-default risk positions (gross JTD)*

22.27 For the computation of gross JTD on securitisations, the same approach must be followed as for default risk (non-securitisations), except that an LGD ratio is not applied to the exposure. Because the LGD is already included in the default risk weights for securitisations to be applied to the securitisation exposure (see below), to avoid double counting of LGD the JTD for securitisations is simply the market value of the securitisation exposure (ie the JTD for tranche positions is their market value).

22.28 For the purposes of offsetting and hedging recognition for securitisations (non-CTP), positions in underlying names or a non-tranched index position may be decomposed proportionately into the equivalent replicating tranches that span the entire tranche structure. When underlying names are treated in this way, they must be removed from the non-securitisation default risk treatment.

### *Net jump-to-default risk positions (net JTD)*

22.29 For default risk of securitisations (non-CTP), offsetting is limited to a specific securitisation exposure (ie tranches with the same underlying asset pool). This means that:

(1) no offsetting is permitted between securitisation exposures with different underlying securitised portfolio (ie underlying asset pools), even if the attachment and detachment points are the same; and

(2) no offsetting is permitted between securitisation exposures arising from different tranches with the same securitised portfolio.

22.30 Securitisation exposures that are otherwise identical except for maturity may be offset. The same offsetting rules for non-securitisations including scaling down positions of less than one year as set out in [MAR22.15] through [MAR22.18] apply to JTD risk positions for securitisations (non-CTP). Offsetting within a specific securitisation exposure is allowed as follows.

(1) Securitisation exposures that can be perfectly replicated through decomposition may be offset. Specifically, if a collection of long securitisation exposures can be replicated by a collection of short securitisation exposures, then the securitisation exposures may be offset.

(2) Furthermore, when a long securitisation exposure can be replicated by a collection of short securitisation exposures with different securitised portfolios, then the securitisation exposure with the "mixed" securitisation portfolio may be offset by the combination of replicating securitisation exposures.

(3) After the decomposition, the offsetting rules would apply as in any other case. As in the case of default risk (non-securitisations), long and short securitisation exposures should be determined from the perspective of long or short the underlying credit, eg the bank making losses on a long securitisation exposure in the event of a default in the securitised portfolio.

*Calculation of default risk capital requirement for securitisations (non-CTP)*

22.31 For default risk of securitisations (non-CTP), the buckets are defined as follows:

(1) Corporates (excluding small and medium enterprises) – this bucket takes into account all regions.

(2) Other buckets – these are defined along two dimensions:

(a) Asset classes: the 11 asset classes are defined as asset-backed commercial paper; auto Loans/Leases; residential mortgage-backed securities (MBS); credit cards; commercial MBS; collateralised loan obligations; collateralised debt obligation (CDO)-squared; small and medium enterprises; student loans, other retail; and other wholesale.

(b) Regions: the four regions are defined as Asia, Europe, North America and all other.

22.32 To assign a securitisation exposure to a bucket, banks must rely on a classification that is commonly used in the market for grouping securitisation exposures by type and region of underlying.

(1) The bank must assign each securitisation exposure to one and only one of the buckets above and it must assign all securitisations with the same type and region of underlying to the same bucket.

(2) Any securitisation exposure that a bank cannot assign to a type or region of underlying in this fashion must be assigned to the "other bucket".

22.33 The capital requirement for default risk of securitisations (non-CTP) is determined using a similar approach to that for non-securitisations. The DRC requirement within a bucket is calculated as follows:

(1) The hedge benefit discount *HBR*, as defined in [MAR22.23], is applied to net short securitisation exposures in that bucket.

(2) The capital requirement is calculated as in [MAR22.25].

22.34 For calculating the weighted net JTD, the risk weights of securitisation exposures are defined by the tranche instead of the credit quality. The risk weight for securitisations (non-CTP) is applied as follows:

(1) The default risk weights for securitisation exposures are based on the corresponding risk weights for banking book instruments, which is defined in a separate Basel Committee publication - Revisions to the Securitisations framework of 2014, 2016 and 2018 (securitisation transactions that are assessed as simple, transparent and comparable-compliant for capital purposes are subject to alternative capital treatment requirements outlined in [the same documents]) with the following modification: the maturity component in the banking book securitisation framework is set to zero (ie a one-year maturity is assumed) to avoid double-counting of risks in the maturity adjustment (of the banking book approach) since migration risk in the trading book will be captured in the credit spread capital requirement.

(2) Following the corresponding treatment in the banking book, the hierarchy of approaches in determining the risk weights should be applied at the underlying pool level.

(3) The capital requirement under the standardised approach for an individual cash securitisation position can be capped at the fair value of the transaction.

22.35 No hedging is recognised between different buckets. Therefore, the total capital requirement for default risk securitisations must be calculated as a simple sum of the bucket-level capital requirements.

## Default risk capital requirement for securitisations (CTP)

### *Gross jump-to-default risk positions (gross JTD)*

22.36 For the computation of gross JTD on securitisations (CTP), the same approach must be followed as for default risk-securitisations (non-CTP) as described in [MAR22.27].

22.37 The gross JTD for non-securitisations (CTP) (ie single-name and index hedges) positions is defined as their market value.

22.38 Nth-to-default products should be treated as tranched products with attachment and detachment points defined below, where "Total names" is the total number of names in the underlying basket or pool:

(1) Attachment point = (N – 1) / Total names

(2) Detachment point = N / Total names

### *Net jump-to-default risk positions (net JTD)*

22.39 Exposures that are otherwise identical except for maturity may be offset. The same concept of long and short positions from a perspective of loss or gain in the event of a default as set out in [MAR22.10] and offsetting rules for non-securitisations including scaling down positions of less than one year as set out in [MAR22.15] to [MAR22.18] apply to JTD risk positions for securitisations (non-CTP).

(1) For index products, for the exact same index family (eg CDX.NA.IG), series (eg series 18) and tranche (eg 0–3%), securitisation exposures should be offset (netted) across maturities (subject to the offsetting allowance as described above).

(2) Long and short exposures that are perfect replications through decomposition may be offset as follows. When the offsetting involves decomposing single name equivalent exposures, decomposition using a valuation model would be allowed in certain cases as follows. Such decomposition is the sensitivity of the security's value to the default of the underlying single name obligor. Decomposition with a valuation model is defined as follows: a single name equivalent constituent of a securitisation (eg tranched position) is the difference between the unconditional value of the securitisation and the conditional value of the securitisation assuming that the single name defaults, with zero recovery, where the value is determined by a valuation model. In such cases, the decomposition into single-name equivalent exposures must account for the effect of marginal defaults of the single names in the securitisation, where in particular the sum of the decomposed single name amounts must be consistent with the undecomposed value of the securitisation. Further, such decomposition is restricted to vanilla securitisations (eg vanilla CDOs, index tranches or bespokes); while the decomposition of exotic securitisations (eg CDO squared) is prohibited.

(3) Moreover, for long and short positions in index tranches, and indices (non-tranched), if the exposures are to the exact same series of the index, then offsetting is allowed by replication and decomposition. For instance, a long securitisation exposure in a 10–15% tranche vs combined short securitisation exposures in 10–12% and 12–15% tranches on the same index/series can be offset against each other. Similarly, long securitisation exposures in the various tranches that, when combined perfectly, replicate a position in the index series (non-tranched) can be offset against a short securitisation exposure in the index series if all the positions are to the exact same index and series (eg CDX.NA.IG series 18). Long and short positions in indices and single-name constituents in the index may also be offset by decomposition. For instance, single-name long securitisation exposures that perfectly replicate an index may be offset against a short securitisation exposure in the index. When a perfect replication is not possible, then offsetting is not allowed except as indicated in the next sentence. Where the long and short securitisation exposures are otherwise equivalent except for a residual component, the net amount must show the residual exposure. For instance, a long securitisation exposure in an index of 125 names, and short securitisation exposures of the appropriate replicating amounts in 124 of the names, would result in a net long securitisation exposure in the missing 125th name of the index.

(4) Different tranches of the same index or series may not be offset (netted), different series of the same index may not be offset, and different index families may not be offset.

*Calculation of default risk capital requirement for securitisations (CTP)*

22.40 For default risk of securitisations (CTP), each index is defined as a bucket of its own. A non-exhaustive list of indices include: CDX North America IG, iTraxx Europe IG, CDX HY, iTraxx XO, LCDX (loan index), iTraxx LevX (loan index), Asia Corp, Latin America Corp, Other Regions Corp, Major Sovereign (G7 and Western Europe) and Other Sovereign.

22.41 Bespoke securitisation exposures should be allocated to the index bucket of the index they are a bespoke tranche of. For instance, the bespoke tranche 5% - 8% of a given index should be allocated to the bucket of that index.

22.42 The default risk weights for securitisations applied to tranches are based on the corresponding risk weights for the banking book instruments, which is defined in a separate Basel Committee publication - Revisions to the Securitisations framework of 2014, 2016 and 2018, with the following modification: the maturity component in the banking book securitisation framework is set to zero, ie a one-year maturity is assumed to avoid double-counting of risks in the maturity adjustment (of the banking book approach) since migration risk in the trading book will be captured in the credit spread capital requirement.

22.43 For the non-tranched products, the same risk weights for non-securitisations as set out in [MAR22.24] apply. For the tranched products, banks must derive the risk weight using the banking book treatment as set out in [MAR22.42].

22.44 Within a bucket (ie for each index) at an index level, the capital requirement for default risk of securitisations (CTP) is determined in a similar approach to that for non-securitisations.

(1) The hedge benefit ratio (*HBR)*, as defined in [MAR22.23], is modified and applied to net short positions in that bucket as in the formula below, where the subscript *ctp* for the term $HBR_{ctp}$ indicates that the HBR is determined using the combined long and short positions across all indices in the CTP (ie not only the long and short positions of the bucket by itself). The summation of risk-weighted amounts in the formula spans all exposures relating to the index (ie index tranche, bespoke, non-tranche index or single name).

(2) A deviation from the approach for non-securitisations is that no floor at zero applies at the bucket level, and consequently, the DRC requirement at the index level ($DRC_b$) can be negative.

$$DRC_b = \left(\sum\nolimits_{i \in Long} RW_i \cdot net\ JTD_i\right) - HBR_{ctp} \cdot \left(\sum\nolimits_{i \in Short} RW_i \cdot |net\ JTD_i|\right)$$

22.45 The total DRC requirement for securitisations (CTP) is calculated by aggregating bucket level capital amounts as follows. For instance, if the DRC requirement for the index CDX North America IG is +100 and the DRC requirement for the index Major Sovereign (G7 and Western Europe) is -100, the total DRC requirement for the CTP is $100 - 0.5 \times 100 = 50$.[3]

$$DRC_{CTP} = max[\sum_b (max[DRC_b, 0] + 0.5 \times min[DRC_b, 0]), 0]$$

<u>*Footnote*</u>

*[3] The procedure for the $DRC_b$ and $DRC_{CTP}$ terms accounts for the basis risk in cross index hedges, as the hedge benefit from cross-index short positions is discounted twice, first by the hedge benefit ratio HBR in $DRC_b$, and again by the term 0.5 in the $DRC_{CTP}$ equation.*

# MAR23 Standardised approach: residual risk add-on

*This chapter sets out the calculation of residual risk add-on under the standardised approach for market risk.*

## Introduction

23.1 The residual risk add-on (RRAO) is to be calculated for all instruments bearing residual risk separately in addition to other components of the capital requirement under the standardised approach.

## Instruments subject to the residual risk add-on

23.2 Instruments with an exotic underlying and instruments bearing other residual risks are subject to the RRAO.

23.3 Instruments with an exotic underlying are trading book instruments with an underlying exposure that is not within the scope of delta, vega or curvature risk treatment in any risk class under the sensitivities-based method or default risk capital (DRC) requirements in the standardised approach.[1]

<u>*Footnote*</u>

*[1] Examples of exotic underlying exposures include: longevity risk, weather, natural disasters, future realised volatility (as an underlying exposure for a swap).*

23.4 Instruments bearing other residual risks are those that meet criteria (1) and (2) below:

(1) Instruments subject to vega or curvature risk capital requirements in the trading book and with pay-offs that cannot be written or perfectly replicated as a finite linear combination of vanilla options with a single underlying equity price, commodity price, exchange rate, bond price, credit default swap price or interest rate swap; or

(2) Instruments which fall under the definition of the correlation trading portfolio (CTP) in [MAR20.5], except for those instruments that are recognised in the market risk framework as eligible hedges of risks within the CTP.

23.5 A non-exhaustive list of other residual risks types and instruments that may fall within the criteria set out in [MAR23.4] include:

(1) Gap risk: risk of a significant change in vega parameters in options due to small movements in the underlying, which results in hedge slippage. Relevant instruments subject to gap risk include all path dependent options, such as barrier options, and Asian options as well as all digital options.

(2) Correlation risk: risk of a change in a correlation parameter necessary for determining the value of an instrument with multiple underlyings. Relevant instruments subject to correlation risk include all basket options, best-of-options, spread options, basis options, Bermudan options and quanto options.

(3) Behavioural risk: risk of a change in exercise/prepayment outcomes such as those that arise in fixed rate mortgage products where retail clients may make decisions motivated by factors other than pure financial gain (such as demographical features and/or and other social factors). A callable bond may only be seen as possibly having behavioural risk if the right to call lies with a retail client.

23.6 When an instrument is subject to one or more of the following risk types, this by itself will not cause the instrument to be subject to the RRAO:

(1) Risk from a cheapest-to-deliver option;

(2) Smile risk: the risk of a change in an implied volatility parameter necessary for determining the value of an instrument with optionality relative to the implied volatility of other instruments optionality with the same underlying and maturity, but different moneyness;

(3) Correlation risk arising from multi-underlying European or American plain vanilla options, and from any options that can be written as a linear combination of such options. This exemption applies in particular to the relevant index options;

(4) Dividend risk arising from a derivative instrument whose underlying does not consist solely of dividend payments; and

(5) Index instruments and multi-underlying options of which treatment for delta, vega or curvature risk are set out in [MAR21.31] and [MAR21.32]. These are subject to the RRAO if they fall within the definitions set out in this chapter. For funds that are subject to the treatment specified in [MAR21.36](3) (ie treated as an unrated "other sector" equity), banks shall assume the fund is exposed to exotic underlying exposures, and to other residual risks, to the maximum possible extent allowed under the fund's mandate.

23.7 In cases where a transaction exactly matches with a third-party transaction (ie a back-to-back transaction), the instruments used in both transactions must be excluded from the RRAO capital requirement. Any instrument that is listed and/or eligible for central clearing must be excluded from the RRAO.

## Calculation of the residual risk add-on

23.8 The residual risk add-on must be calculated in addition to any other capital requirements within the standardised approach. The residual risk add-on is to be calculated as follows.

(1) The scope of instruments that are subject to the RRAO must not have an impact in terms of increasing or decreasing the scope of risk factors subject to the delta, vega, curvature or DRC treatments in the standardised approach.

(2) The RRAO is the simple sum of gross notional amounts of the instruments bearing residual risks, multiplied by a risk weight.

(a) The risk weight for instruments with an exotic underlying specified in [MAR23.3] is 1.0%.

(b) The risk weight for instruments bearing other residual risks specified in [MAR23.4] is 0.1%.[2]

*__Footnote__*

*[2] Where the bank cannot satisfy the supervisor that the RRAO provides a sufficiently prudent capital charge, the supervisor will address any potentially under-capitalised risks by imposing a conservative additional capital charge under Pillar 2.*

# MAR30 Internal models approach: general provisions

*This chapter sets out the general criteria for banks' use of the internal models approach.*

## General criteria

30.1 The use of internal models for the purposes of determining market risk capital requirements is conditional upon the explicit approval of the bank's supervisory authority.

30.2 The supervisory authority will only approve a bank's use of internal models to determine market risk capital requirements if, at a minimum:

(1) the supervisory authority is satisfied that the bank's risk management system is conceptually sound and is implemented with integrity;

(2) the bank has, in the supervisory authority's view, a sufficient number of staff skilled in the use of sophisticated models not only in the trading area but also in the risk control, audit and, if necessary, back office areas;

(3) the bank's trading desk risk management model has, in the supervisory authority's judgement, a proven track record of reasonable accuracy in measuring risk;

(4) the bank regularly conducts stress tests along the lines set out in [MAR30.19] to [MAR30.23]; and

(5) the positions included in the bank's internal trading desk risk management models for determining minimum market risk capital requirements are held in trading desks that have been approved for the use of those models and that have passed the required tests described in [MAR30.17].

30.3 Supervisory authorities may insist on a period of initial monitoring and live testing of a bank's internal trading desk risk management model before it is used for the purposes of determining the bank's market risk capital requirements.

30.4 The scope of trading portfolios that are eligible to use internal models to determine market risk capital requirements is determined based on a three-prong approach as follows:

(1) The bank must satisfy its supervisory authority that both the bank's organisational infrastructure (including the definition and structure of trading desks) and its bank-wide internal risk management model meet qualitative evaluation criteria, as set out in [MAR30.5] to [MAR30.16].

(2) The bank must nominate individual trading desks, as defined in [MAR12.1] to [MAR12.6], for which the bank seeks model approval in order to use the internal models approach (IMA).

(a) The bank must nominate trading desks that it intends to be in-scope for model approval and trading desks that are out-of-scope for the use of the IMA. The bank must specify in writing the basis for these nominations.

(b) The bank must not nominate trading desks to be out-of-scope for model approval due to capital requirements for a particular trading desk determined using the standardised approach being lower than those determined using the IMA.

(c) The bank must use the standardised approach to determine the market risk capital requirements for trading desks that are out-of-scope for model approval. The positions in these out-of-scope trading desks are to be combined with all other positions that are subject to the standardised approach in order to determine the bank's standardised approach capital requirements.

(d) Trading desks that the bank does not nominate for model approval at the time of model approval will be ineligible to use the IMA for a period of at least one year from the date of the latest internal model approval.

(3) The bank must receive supervisory approval to use the IMA on individual trading desks. Following the identification of eligible trading desks, this step determines which trading desks will be in-scope to use the IMA and which risk factors within in-scope trading desks are eligible to be included in the bank's internal expected shortfall (ES) models to determine market risk capital requirements as set out in [MAR33].

(a) Each trading desk must satisfy profit and loss (P&L) attribution (PLA) tests on an ongoing basis to be eligible to use the IMA to determine market risk capital requirements. In order to conduct the PLA test, the bank must identify the set of risk factors to be used to determine its market risk capital requirements.

(b) Each trading desk also must satisfy backtesting requirements on an ongoing basis to be eligible to use the IMA to determine market risk capital requirements as set out in [MAR32.4] to [MAR32.19].

(c) Banks must conduct PLA tests and backtesting on a quarterly basis to update the eligibility and trading desk classification in PLA for trading desks in-scope to use the IMA.

(d) The market risk capital requirements for risk factors that satisfy the risk factor eligibility test as set out in [MAR31.12] to [MAR31.24] must be determined using ES models as specified in [MAR33.1] to [MAR33.15].

(e) The market risk capital requirements for risk factors that do not satisfy the risk factor eligibility test must be determined using stressed expected shortfall (SES) models as specified in [MAR33.16] to [MAR33.17]

## Qualitative standards

30.5 In order to use the IMA to determine market risk capital requirements, the bank must have market risk management systems that are conceptually sound and implemented with integrity. Accordingly, the bank must meet the qualitative criteria set out below on an ongoing basis. Supervisors will assess that the bank has met the criteria before the bank is permitted to use the IMA.

30.6 The bank must have an independent risk control unit that is responsible for the design and implementation of the bank's market risk management system. The risk control unit should produce and analyse daily reports on the output of the trading desk's risk management model, including an evaluation of the relationship between measures of risk exposure and trading limits. This risk control unit must be independent of business trading units and should report directly to senior management of the bank.

30.7 The bank's risk control unit must conduct regular backtesting and PLA assessments at the trading desk level. The bank must also conduct regular backtesting of its bank-wide internal models used for determining market risk capital requirements.

30.8 A distinct unit of the bank that is separate from the unit that designs and implements the internal models must conduct the initial and ongoing validation of all internal models used to determine market risk capital requirements. The model validation unit must validate all internal models used for purposes of the IMA on at least an annual basis.

30.9 The board of directors and senior management of the bank must be actively involved in the risk control process and must devote appropriate resources to risk control as an essential aspect of the business. In this regard, the daily reports prepared by the independent risk control unit must be reviewed by a level of management with sufficient seniority and authority to enforce both reductions of positions taken by individual traders and reductions in the bank's overall risk exposure.

30.10 Internal models used to determine market risk capital requirements are likely to differ from those used by a bank in its day-to-day internal risk management functions. Nevertheless, the core design elements of both the market risk capital requirement model and the internal risk management model should be the same.

(1) Valuation models that are a feature of both models should be similar. These valuation models must be an integral part of the internal identification, measurement, management and internal reporting of price risks within the bank's trading desks.

(2) Internal risk management models should, at a minimum, be used to assess the risk of the positions that are subject to market risk capital requirements, although they may assess a broader set of positions.

(3) The construction of a trading desk risk management model must be based on the methodologies used in the bank's internal risk management model with regard to risk factor identification, parameter estimation and proxy concepts and deviate only if this is appropriate due to regulatory requirements. A bank's market risk capital requirement model and its internal risk management model should address an identical set of risk factors.

30.11 A routine and rigorous programme of stress testing is required. The results of stress testing must be:

(1) reviewed at least monthly by senior management;

(2) used in the bank's internal assessment of capital adequacy; and

(3) reflected in the policies and limits set by the bank's management and its board of directors.

30.12 Where stress tests reveal particular vulnerability to a given set of circumstances, the bank must take prompt action to mitigate those risks appropriately (eg by hedging against that outcome, reducing the size of the bank's exposures or increasing capital).

30.13 The bank must maintain a protocol for compliance with a documented set of internal manuals, policies, controls and procedures concerning the operation of the internal market risk management model. The bank's risk management model must be well documented. Such documentation may include a comprehensive risk management manual that describes the basic principles of the risk management model and that provides a detailed explanation of the empirical techniques used to measure market risk.

30.14 The bank must receive approval from its supervisory authority prior to implementing any significant changes to its internal models used to determine market risk capital requirements.

30.15 The bank's internal models for determining market risk capital requirements must address the full set of positions that are in the scope of application of the model. All models' measurements of risk must be based on a sound theoretical basis, calculated correctly, and reported accurately.

30.16 The bank's internal audit and validation functions or external auditor must conduct an independent review of the market risk measurement system on at least an annual basis. The scope of the independent review must include both the activities of the business trading units and the activities of the independent risk control unit. The independent review must be sufficiently detailed to determine which trading desks are impacted by any failings. At a minimum, the scope of the independent review must include the following:

(1) the organisation of the risk control unit;

(2) the adequacy of the documentation of the risk management model and process;

(3) the accuracy and appropriateness of market risk management models (including any significant changes);

(4) the verification of the consistency, timeliness and reliability of data sources used to run internal models, including the independence of such data sources;

(5) the approval process for risk pricing models and valuation systems used by the bank's front- and back-office personnel;

(6) the scope of market risks reflected in the trading desk risk management models;

(7) the integrity of the management information system;

(8) the accuracy and completeness of position data;

(9) the accuracy and appropriateness of volatility and correlation assumptions;

(10) the accuracy of valuation and risk transformation calculations;

(11) the verification of trading desk risk management model accuracy through frequent backtesting and PLA assessments; and

(12) the general alignment between the model to determine market risk capital requirements and the model the bank uses in its day-to-day internal management functions.

## Model validation standards

30.17 Banks must maintain a process to ensure that their internal models have been adequately validated by suitably qualified parties independent of the model development process to ensure that each model is conceptually sound and adequately reflects all material risks. Model validation must be conducted both when the model is initially developed and when any significant changes are made to the model. The bank must revalidate its models periodically, particularly when there have been significant structural changes in the market or changes to the composition of the bank's portfolio that might lead to the models no longer being adequate. Model validation must include PLA and backtesting, and must, at a minimum, also include the following:

(1) Tests to demonstrate that any assumptions made within internal models are appropriate and do not underestimate risk. This may include reviewing the appropriateness of assumptions of normal distributions and any pricing models.

(2) Further to the regulatory backtesting programmes, model validation must assess the hypothetical P&L (HPL) calculation methodology.

(3) The bank must use hypothetical portfolios to ensure that internal models are able to account for particular structural features that may arise. For example, where the data

history for a particular instrument does not meet the quantitative standards in [MAR33.1] to [MAR33.12] and the bank maps these positions to proxies, the bank must ensure that the proxies produce conservative results under relevant market scenarios, with sufficient consideration given to ensuring:

(a) that material basis risks are adequately reflected (including mismatches between long and short positions by maturity or by issuer); and

(b) that the models reflect concentration risk that may arise in an undiversified portfolio.

## External validation

30.18 The model validation conducted by external auditors and/or supervisory authorities of a bank's internal model to determine market risk capital requirements should, at a minimum, include the following steps:

(1) Verification that the internal validation processes described in [MAR30.17] are operating in a satisfactory manner;

(2) Confirmation that the formulae used in the calculation process, as well as for the pricing of options and other complex instruments, are validated by a qualified unit, which in all cases should be independent from the bank's trading area;

(3) Confirmation that the structure of internal models is adequate with respect to the bank's activities and geographical coverage;

(4) Review of the results of both the bank's backtesting of its internal models (ie comparison of value-at-risk with actual P&L and HPL) and its PLA process to ensure that the models provide a reliable measure of potential losses over time. On request, a bank should make available to its supervisory authority and/or to its external auditors the results as well as the underlying inputs to ES calculations and details of the PLA exercise; and

(5) Confirmation that data flows and processes associated with the risk measurement system are transparent and accessible. On request and in accordance with procedures, the bank should provide its supervisory authority and its external auditors access to the models' specifications and parameters.

## Stress testing

30.19 Banks that use the IMA for determining market risk capital requirements must have in place a rigorous and comprehensive stress testing programme both at the trading desk level and at the bank-wide level.

30.20 Banks' stress scenarios must cover a range of factors that (i) can create extraordinary losses or gains in trading portfolios, or (ii) make the control of risk in those portfolios very difficult. These factors include low-probability events in all major types of risk, including the various components of market, credit and operational risks. A bank must design stress scenarios to assess the impact of such factors on positions that feature both linear and non-linear price characteristics (ie options and instruments that have option-like characteristics).

30.21 Banks' stress tests should be of a quantitative and qualitative nature, incorporating both market risk and liquidity risk aspects of market disturbances.

(1) Quantitative elements should identify plausible stress scenarios to which banks could be exposed.

(2) Qualitatively, a bank's stress testing programme should evaluate the capacity of the bank's capital to absorb potential significant losses and identify steps the bank can take to reduce its risk and conserve capital.

30.22 Banks should routinely communicate results of stress testing to senior management and should periodically communicate those results to the bank's board of directors.

30.23 Banks should combine the use of supervisory stress scenarios with stress tests developed by the bank itself to reflect its specific risk characteristics. Stress scenarios may include the following:

(1) Supervisory scenarios requiring no simulations by the bank. A bank should have information on the largest losses experienced during the reporting period and may be required to make this available for supervisory review. Supervisors may compare this loss information to the level of capital requirements that would result from a bank's internal measurement system. For example, the bank may be required to provide supervisory authorities with an assessment of how many days of peak day losses would have been covered by a given ES estimate.

(2) Scenarios requiring a simulation by the bank. Banks should subject their portfolios to a series of simulated stress scenarios and provide supervisory authorities with the results. These scenarios could include testing the current portfolio against past periods of significant disturbance (eg the 1987 equity crash, the Exchange Rate Mechanism crises of 1992 and 1993, the increase in interest rates in the first quarter of 1994, the 1998 Russian financial crisis, the 2000 bursting of the technology stock bubble, the 2007–08 subprime mortgage crisis, or the 2011–12 Euro zone crisis) incorporating both the significant price movements and the sharp reduction in liquidity associated with these events. A second type of scenario would evaluate the sensitivity of the bank's market risk exposure to changes in the assumptions about volatilities and correlations. Applying this test would require an evaluation of the historical range of variation for volatilities and correlations and evaluation of the bank's current positions against the extreme values of the historical range. Due consideration should be given to the sharp variation that at times has occurred in a matter of days in periods of significant market disturbance. For example, the above-mentioned situations involved correlations within risk factors approaching the extreme values of 1 or –1 for several days at the height of the disturbance.

(3) Bank-developed stress scenarios. In addition to the scenarios prescribed by supervisory authorities under [MAR30.23](1), a bank should also develop its own stress tests that it identifies as most adverse based on the characteristics of its portfolio (eg problems in a key region of the world combined with a sharp move in oil prices). A bank should provide supervisory authorities with a description of the methodology used to identify and carry out the scenarios as well as with a description of the results derived from these scenarios.

# MAR31 Internal models approach: model requirements

*This chapter sets out specification and model eligibility for risk factors per the internal models approach.*

## Specification of market risk factors

31.1 An important part of a bank's trading desk internal risk management model is the specification of an appropriate set of market risk factors. Risk factors are the market rates and prices that affect the value of the bank's trading positions. The risk factors contained in a trading desk risk management model must be sufficient to represent the risks inherent in the bank's portfolio of on- and off-balance sheet trading positions. Although banks will have some discretion in specifying the risk factors for their internal models, the following requirements must be fulfilled.

31.2 A bank's market risk capital requirement models should include all risk factors that are used for pricing. In the event a risk factor is incorporated in a pricing model but not in the trading desk risk management model, the bank must support this omission to the satisfaction of its supervisory authority.

31.3 A bank's market risk capital requirement model must include all risk factors that are specified in the standardised approach for the corresponding risk class, as set out in [MAR20] to [MAR22]. In the event a standardised approach risk factor is not included in the market risk capital requirement model, the bank must support this omission to the satisfaction of its supervisory authority.

(1) For securitised products, banks are prohibited from using internal models to determine market risk capital requirements. Banks must use the standardised approach to determine the market risk capital requirements for securitised products as set out in [MAR11.9]. Accordingly, a bank's market risk capital requirement model should not specify risk factors for securitisations as defined in [MAR21.10] to [MAR21.11].

31.4 A bank's market risk capital requirement model and any stress scenarios calculated for non-modellable risk factors must address non-linearities for options and other relevant products (eg mortgage-backed securities), as well as correlation risk and relevant basis risks (eg basis risks between credit default swaps and bonds).

31.5 A bank may use proxies for which there is an appropriate track record for their representation of a position (eg an equity index used as a proxy for a position in an individual stock). In the event a bank uses proxies, the bank must support their use to the satisfaction of the bank's supervisory authority.

31.6 For general interest rate risk, a bank must use a set of risk factors that corresponds to the interest rates associated with each currency in which the bank has interest rate sensitive on- or off-balance sheet trading positions.

(1) The trading desk risk management model must model the yield curve using one of a number of generally accepted approaches (eg estimating forward rates of zero coupon yields).

(2) The yield curve must be divided into maturity segments in order to capture variation in the volatility of rates along the yield curve.

(3) For material exposures to interest rate movements in the major currencies and markets, banks must model the yield curve using a minimum of six risk factors.

(4) The number of risk factors used ultimately should be driven by the nature of the bank's trading strategies. A bank with a portfolio of various types of securities across many points of the yield curve and that engages in complex arbitrage strategies would require the use of a greater number of risk factors than a bank with less complex portfolios.

31.7 The trading desk risk management model must incorporate separate risk factors to capture credit spread risk (eg between bonds and swaps). A variety of approaches may be used to reflect the credit spread risk arising from less-than-perfectly correlated movements between government and other fixed income instruments, such as specifying a completely separate yield curve for non-government fixed income instruments (eg swaps or municipal securities) or estimating the spread over government rates at various points along the yield curve.

31.8 For exchange rate risk, the trading desk risk management model must incorporate risk factors that correspond to the individual foreign currencies in which the bank's positions are denominated. Because the output of a bank's risk measurement system will be expressed in the bank's reporting currency, any net position denominated in a foreign currency will introduce foreign exchange risk. A bank must utilise risk factors that correspond to the exchange rate between the bank's reporting currency and each foreign currency in which the bank has a significant exposure.

31.9 For equity risk, a bank must utilise risk factors that correspond to each of the equity markets in which the bank holds significant positions.

(1) At a minimum, a bank must utilise risk factors that reflect market-wide movements in equity prices (eg a market index). Positions in individual securities or in sector indices may be expressed in beta-equivalents relative to a market-wide index.

(2) A bank may utilise risk factors that correspond to various sectors of the overall equity market (eg industry sectors or cyclical and non-cyclical sectors). Positions in individual securities within each sector may be expressed in beta-equivalents relative to a sector index.

(3) A bank may also utilise risk factors that correspond to the volatility of individual equities.

(4) The sophistication and nature of the modelling technique for a given market should correspond to the bank's exposure to the overall market as well as the bank's concentration in individual equities in that market.

31.10 For commodity risk, bank must utilise risk factors that correspond to each of the commodity markets in which the bank holds significant positions.

(1) For banks with relatively limited positions in commodity-based instruments, the bank may utilise a straightforward specification of risk factors. Such a specification could entail utilising one risk factor for each commodity price to which the bank is exposed (including different risk factors for different geographies where relevant).

(2) For a bank with active trading in commodities, the bank's model must account for variation in the convenience yield[1] between derivatives positions such as forwards and swaps and cash positions in the commodity.

<u>*Footnote*</u>

*[1] The convenience yield reflects the benefits from direct ownership of the physical commodity (eg the ability to profit from temporary market shortages). The convenience yield is affected both by market conditions and by factors such as physical storage costs.*

31.11 For the risks associated with equity investments in funds:

(1) For funds that meet the criterion set out in [RBC25.8](5)(a) (ie funds with look-through possibility), banks must consider the risks of the fund, and of any associated hedges, as if the fund's positions were held directly by the bank (taking into account the bank's share of the equity of the fund, and any leverage in the fund structure). The bank must assign these positions to the trading desk to which the fund is assigned.

(2) For funds that do not meet the criterion set out in [RBC25.8](5)(a), but meet both the criteria set out in [RBC25.8](5)(b) (ie daily prices and knowledge of the mandate of the fund), banks must use the standardised approach to calculate capital requirements for the fund.

## Model eligibility of risk factors

31.12 A bank must determine which risk factors within its trading desks that have received approval to use the internal models approach as set out in [MAR32] are eligible to be included in the bank's internal expected shortfall (ES) model for regulatory capital requirements as set out in [MAR33]. For a risk factor to be classified as modellable by a bank, a necessary condition is that it passes the risk factor eligibility test (RFET). This test requires identification of a sufficient number of real prices that are representative of the risk factor. Collateral reconciliations or valuations cannot be considered real prices to meet the RFET. A price will be considered real if it meets at least one of the following criteria:

(1) It is a price at which the institution has conducted a transaction;

(2) It is a verifiable price for an actual transaction between other arms-length parties;

(3) It is a price obtained from a committed quote made by (i) the bank itself or (ii) another party. The committed quote must be collected and verified through a third-party vendor, a trading platform or an exchange; or

(4) It is a price that is obtained from a third-party vendor, where:

(a) the transaction or committed quote has been processed through the vendor;

(b) the vendor agrees to provide evidence of the transaction or committed quote to supervisors upon request; or

(c) the price meets any of the three criteria immediately listed in [MAR31.12](1) to [MAR31.12](3).

31.13 To pass the RFET, a risk factor that a bank uses in an internal model must meet either of the following criteria on a quarterly basis. Any real price that is observed for a transaction should be counted as an observation for all of the risk factors for which it is representative.

(1) The bank must identify for the risk factor at least 24 real price observations per year (measured over the period used to calibrate the current ES model, with no more than one real price observation per day to be included in this count).[2][3] Moreover, over the previous 12 months there must be no 90-day period in which fewer than four real price observations are identified for the risk factor (with no more than one real price observation per day to be included in this count). The above criteria must be monitored on a monthly basis; or

(2) The bank must identify for the risk factor at least 100 "real" price observations over the previous 12 months (with no more than one "real" price observation per day to be included in this count).

*Footnotes*

[2] *When a bank uses data for real price observations from an external source, and those observations are provided with a time lag (eg data provided for a particular day is only made available a number of weeks later), the period used for the RFET may differ from the period used to calibrate the current ES model. The difference in periods used for the RFET and calibration of the ES model should not be greater than one month, ie the banks could use, for each risk factor, a one-year time period finishing up to one month before the RFET assessment instead of the period used to calibrate the current ES model.*

[3] *In particular, a bank may add modellable risk factors, and replace non-modellable risk factors by a basis between these additional modellable risk factors and these non-modellable risk factors. This basis will then be considered a non-modellable risk factor. A combination between modellable and non-modellable risk factors will be a non-modellable risk factor.*

31.14 In order for a risk factor to pass the RFET, a bank may also count real price observations based on information collected from a third-party vendor provided all of the following criteria are met:

(1) The vendor communicates to the bank the number of corresponding real prices observed and the dates at which they have been observed.

(2) The vendor provides, individually, a minimum necessary set of identifier information to enable banks to map real prices observed to risk factors.

(3) The vendor is subject to an audit regarding the validity of its pricing information. The results and reports of this audit must be made available on request to the relevant supervisory authority and to banks as a precondition for the bank to be allowed to use real price observations collected by the third-party vendor. If the audit of a third-party vendor is not satisfactory to a supervisory authority, the supervisory authority may decide to prevent the bank from using data from this vendor.[4]

*Footnote*

[4] *In this case, the bank may be permitted to use real price observations from this vendor for other risk factors.*

31.15 A real price is representative for a risk factor of a bank where the bank is able to extract the value of the risk factor from the value of the real price. The bank must have policies and procedures that describe its mapping of real price observations to risk factors. The bank must provide sufficient information to its supervisory authorities in order to determine if the methodologies the bank uses are appropriate.

## *Bucketing approach for the RFET*

31.16 Where a risk factor is a point on a curve or a surface (and other higher dimensional objects such as cubes), in order to count real price observations for the RFET, banks may choose from the following bucketing approaches:

(1) The *own bucketing approach*. Under this approach, the bank must define the buckets it will use and meet the following requirements:

(a) Each bucket must include only one risk factor, and all risk factors must correspond to the risk factors that are part of the risk-theoretical profit and loss (RTPL) of the bank for the purpose of the profit and loss (P&L) attribution (PLA) test.[5]

(b) The buckets must be non-overlapping.

(2) The *regulatory bucketing approach*. Under this approach, the bank must use the following set of standard buckets as set out in Table 1.

(a) For interest rate, foreign exchange and commodity risk factors with one maturity dimension (excluding implied volatilities) (t, where t is measured in years), the buckets in row (A) below must be used.

(b) For interest rate, foreign exchange and commodity risk factors with several maturity dimensions (excluding implied volatilities) (t, where t is measured in years), the buckets in row (B) below must be used.

(c) Credit spread and equity risk factors with one or several maturity dimensions (excluding implied volatilities) (t, where t is measured in years), the buckets in row (C) below must be used.

(d) For any risk factors with one or several strike dimensions (delta, $\delta$; ie the probability that an option is "in the money" at maturity), the buckets in row (D) below must be used.[6]

(e) For expiry and strike dimensions of implied volatility risk factors (excluding those of interest rate swaptions), only the buckets in rows (C) and (D) below must be used.

(f) For maturity, expiry and strike dimensions of implied volatility risk factors from interest rate swaptions, only the buckets in row (B), (C) and (D) below must be used.

Standard buckets for the regulatory bucketing approach Table 1

| Row | Bucket | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| (A) | $0 \le t < 0.75$ | $0.75 \le t < 1.5$ | $1.5 \le t < 4$ | $4 \le t < 7$ | $7 \le t < 12$ | $12 \le t < 18$ | $18 \le t < 25$ | $25 \le t < 35$ | $35 \le t < \infty$ |
| (B) | $0 \le t < 0.75$ | $0.75 \le t < 4$ | $4 \le t < 10$ | $10 \le t < 18$ | $18 \le t < 30$ | $30 \le t < \infty$ | | | |
| (C) | $0 \le t < 1.5$ | $1.5 \le t < 3.5$ | $3.5 \le t < 7.5$ | $7.5 \le t < 15$ | $15 \le t < \infty$ | | | | |
| (D) | $0 \le \delta < 0.05$ | $0.05 \le \delta < 0.3$ | $0.3 \le \delta < 0.7$ | $0.7 \le \delta < 0.95$ | $0.95 \le \delta < 1.00$ | | | | |

<u>*Footnotes*</u>

*[5] The requirement to use the same buckets or segmentation of risk factors for the PLA test and the RFET recognises that there is a trade-off in determining buckets for an ES model. The use of more granular buckets may facilitate a trading desk's success in meeting the requirements of the PLA test, but additional granularity may challenge a bank's ability to source a sufficient number of real observed prices per bucket to satisfy the RFET. Banks should consider this trade-off when designing their ES models.*

*[6] For options markets where alternative definitions of moneyness are standard, banks shall convert the regulatory delta buckets to the market-standard convention using their own approved pricing models.*

31.17 Banks may count all real price observations allocated to a bucket to assess whether it passes the RFET for any risk factors that belong to the bucket. A real price observation must be allocated to a bucket for which it is representative of any risk factors that belong to the bucket.

31.18 As debt instruments mature, real price observations for those products that have been identified within the prior 12 months are usually still counted in the maturity bucket to which they were initially allocated per [MAR31.17]. When banks no longer need to model a credit spread risk factor belonging to a given maturity bucket, banks are allowed to re-allocate the real price observations of this bucket to the adjacent (shorter) maturity bucket.[7] A real price observation may only be counted in a single maturity bucket for the purposes of the RFET.

*Footnote*

*[7] For example, if a bond with an original maturity of four years, had a real price observation on its issuance date eight months ago, banks can opt to allocate the real price observation to the bucket associated with a maturity between 1.5 and 3.5 years instead of to the bucket associated with a maturity between 3.5 and 7.5 years to which it would normally be allocated.*

31.19 Where a bank uses a parametric function to represent a curve/surface and defines the function's parameters as the risk factors in its risk measurement system, the RFET must be passed at the level of the market data used to calibrate the function's parameters and not be passed directly at the level of these risk factor parameters (due to the fact that real price observations may not exist that are directly representative of these risk factors).

31.20 A bank may use systematic credit or equity risk factors within its models that are designed to capture market-wide movements for a given economy, region or sector, but not the idiosyncratic risk of a specific issuer (the idiosyncratic risk of a specific issuer would be a non-modellable risk factor (NMRF) unless there are sufficient real price observations of that issuer). Real price observations of market indices or instruments of individual issuers may be considered representative for a systematic risk factor as long as they share the same attributes as the systematic risk factor.

31.21 In addition to the approach set out in [MAR31.20], where systematic risk factors of credit or equity risk factors include a maturity dimension (eg a credit spread curve), one of the bucketing approaches set out above must be used for this maturity dimension to count "real" price observations for the RFET.

31.22 Once a risk factor has passed the RFET, the bank should choose the most appropriate data to calibrate its model. The data used for calibration of the model does not need to be the same data used to pass the RFET.

31.23 Once a risk factor has passed the RFET, the bank must demonstrate that the data used to calibrate its ES model are appropriate based on the principles contained in [MAR31.25] to [MAR31.26]. Where a bank has not met these principles to the satisfaction of its supervisory authority for a particular risk factor, the supervisory authority may choose to deem the data unsuitable for use to calibrate the model and, in such case, the risk factor must be excluded from the ES model and subject to capital requirements as an NMRF.

31.24 There may, on very rare occasions, be a valid reason why a significant number of modellable risk factors across different banks may become non-modellable due to a widespread reduction in trading activities (for instance, during periods of significant cross-border financial market stress affecting several banks or when financial markets are subjected to a major regime shift). One possible supervisory response in this instance could be to consider as modellable a risk factor that no longer passes the RFET. However, such a response should not facilitate a decrease in capital requirements. Supervisory authorities should only pursue such a response under the most extraordinary, systemic circumstances.

*Principles for the modellability of risk factors that pass the RFET*

31.25 Banks use many different types of models to determine the risks resulting from trading positions. The data requirements for each model may be different. For any given model, banks may use different sources or types of data for the model's risk factors. Banks must not rely solely on the number of observations of real prices to determine whether a risk factor is modellable. The accuracy of the source of the risk factor real price observation must also be considered.

31.26 In addition to the requirements specified in [MAR31.12] to [MAR31.23], banks must apply the principles below to determine whether a risk factor that passed the RFET can be modelled using the ES model or should be subject to capital requirements as an NMRF. Banks are required to demonstrate to their supervisory authorities that these principles are being followed. Supervisory authorities may determine risk factors to be non-modellable in the event these principles are not applied.

(1) *Principle one*. The data used may include combinations of modellable risk factors. Banks often price instruments as a combination of risk factors. Generally, risk factors derived solely from a combination of modellable risk factors are modellable. For example, risk factors derived through multifactor beta models for which inputs and calibrations are based solely on modellable risk factors, can be classified as modellable and can be included within the ES model. A risk factor derived from a combination of modellable risk factors that are mapped to distinct buckets of a given curve/surface is modellable only if this risk factor also passes the RFET.

(a) Interpolation based on combinations of modellable risk factors should be consistent with mappings used for PLA testing (to determine the RTPL) and should not be based on alternative, and potentially broader, bucketing approaches. Likewise, banks may compress risk factors into a smaller dimension of orthogonal risk factors (eg principal components) and/or derive parameters from observations of modellable risk factors, such as in models of stochastic implied volatility, without the parameters being directly observable in the market.

(b) Subject to the approval of the supervisor, banks may extrapolate up to a reasonable distance from the closest modellable risk factor. The extrapolation should not rely solely on the closest modellable risk factor but on more than one modellable risk factor. In the event that a bank uses extrapolation, the extrapolation must be considered in the determination of the RTPL.

(2) *Principle two*. The data used must allow the model to pick up both idiosyncratic and general market risk. General market risk is the tendency of an instrument's value to change with the change in the value of the broader market, as represented by an appropriate index or indices. Idiosyncratic risk is the risk associated with a particular issuance, including default provisions, maturity and seniority. The data must allow both components of market risk to be captured in any market risk model used to determine capital requirements. If the data used in the model do not reflect either idiosyncratic or general market risk, the bank must apply an NMRF charge for those aspects that are not adequately captured in its model.

(3) *Principle three*. The data used must allow the model to reflect volatility and correlation of the risk positions. Banks must ensure that they do not understate the volatility of an asset (eg by using inappropriate averaging of data or proxies). Further, banks must ensure that they accurately reflect the correlation of asset prices, rates across yield curves and/or volatilities within volatility surfaces. Different data sources can provide dramatically different volatility and correlation estimates for asset prices. The bank

should choose data sources so as to ensure that (i) the data are representative of real price observations; (ii) price volatility is not understated by the choice of data; and (iii) correlations are reasonable approximations of correlations among real price observations. Furthermore, any transformations must not understate the volatility arising from risk factors and must accurately reflect the correlations arising from risk factors used in the bank's ES model.

(4) *Principle four*. The data used must be reflective of prices observed and/or quoted in the market. Where data used are not derived from real price observations, the bank must demonstrate that the data used are reasonably representative of real price observations. To that end, the bank must periodically reconcile price data used in a risk model with front office and back office prices. Just as the back office serves to check the validity of the front office price, risk model prices should be included in the comparison. The comparison of front or back office prices with risk prices should consist of comparisons of risk prices with real price observations, but front office and back office prices can be used where real price observations are not widely available. Banks must document their approaches to deriving risk factors from market prices.

(5) *Principle five*. The data used must be updated at a sufficient frequency. A market risk model may require large amounts of data, and it can be challenging to update such large data sets frequently. Banks should strive to update their model data as often as possible to account for frequent turnover of positions in the trading portfolio and changing market conditions. Banks should update data at a minimum on a monthly basis, but preferably daily. Additionally, banks should have a workflow process for updating the sources of data. Furthermore, where the bank uses regressions to estimate risk factor parameters, these must be re-estimated on a regular basis, generally no less frequently than every two weeks. Calibration of pricing models to current market prices must also be sufficiently frequent, ideally no less frequent than the calibration of front office pricing models. Where appropriate, banks should have clear policies for backfilling and/or gap-filling missing data.

(6) *Principle six*. The data used to determine stressed expected shortfall ($ES_{R,S}$) must be reflective of market prices observed and/or quoted in the period of stress. The data for the $ES_{R,S}$ model should be sourced directly from the historical period whenever possible. There are cases where the characteristics of current instruments in the market differ from those in the stress period. Nevertheless, banks must empirically justify any instances where the market prices used for the stress period are different from the market prices actually observed during that period. Further, in cases where instruments that are currently traded did not exist during a period of significant financial stress, banks must demonstrate that the prices used match changes in prices or spreads of similar instruments during the stress period.

(a) In cases where banks do not sufficiently justify the use of current market data for products whose characteristics have changed since the stress period, the bank must omit the risk factor for the stressed period and meet the requirement of [MAR33.5](2)(b) that the reduced set of risk factors explain 75% of the fully specified ES model. Moreover, if name-specific risk factors are used to calculate the ES in the actual period and these names were not available in the stressed period, there is a presumption that the idiosyncratic part of these risk factors are not in the reduced set of risk factors. Exposures for risk factors that are included in the current set but not in the reduced set need to be mapped to the most suitable risk factor of the reduced set for the purposes of calculating ES measures in the stressed period.

(7) *Principle seven*. The use of proxies must be limited, and proxies must have sufficiently similar characteristics to the transactions they represent. Proxies must be appropriate for the region, quality and type of instrument they are intended to represent. Supervisors will assess whether methods for combining risk factors are conceptually and empirically sound.

(a) For example, the use of indices in a multifactor model must capture the correlated risk of the assets represented by the indices, and the remaining idiosyncratic risk must be demonstrably uncorrelated across different issuers. A multifactor model must have significant explanatory power for the price movements of assets and must provide an assessment of the uncertainty in the final outcome due to the use of a proxy. The coefficients (betas) of a multifactor model must be empirically based and must not be determined based on judgment. Instances where coefficients are set by judgment generally should be considered as NMRFs.

(b) If risk factors are represented by proxy data in the current period ES model, the proxy data representation of the risk factor – not the risk factor itself – must be used in the RTPL unless the bank has identified the basis between the proxy and the actual risk factor and properly capitalised the basis either by including the basis in the ES model (if the risk factor is a modellable) or capturing the basis as a NMRF. If the capital requirement for the basis is properly determined, then the bank can choose to include in the RTPL either:

(i) the proxy risk factor and the basis; or

(ii) the actual risk factor itself.

# MAR32 Internal models approach: backtesting and P&L attribution test requirements

*This chapter sets out the profit and loss attribution test and backtesting requirements for banks that use the internal models approach.*

32.1 As set out in [MAR30.4], a bank that intends to use the internal models approach (IMA) to determine market risk capital requirements for a trading desk must conduct and successfully pass backtesting at the bank-wide level and both the backtesting and profit and loss (P&L) attribution (PLA) test at the trading desk level as identified in [MAR30.4](2).

32.2 For a bank to remain eligible to use the IMA to determine market risk capital requirements, a minimum of 10% of the bank's aggregated market risk capital requirement must be based on positions held in trading desks that qualify for use of the bank's internal models for market risk capital requirements by satisfying the backtesting and PLA test as set out in this chapter. This 10% criterion must be assessed by the bank on a quarterly basis when calculating the aggregate capital requirement for market risk according to [MAR33.43].

32.3 The implementation of the backtesting programme and the PLA test must begin on the date that the internal models capital requirement becomes effective.

(1) For supervisory approval of a model, the bank must provide a one-year backtesting and PLA test report to confirm the quality of the model.

(2) The bank's supervisory authority may require backtesting and PLA test results prior to that date.

(3) The bank's supervisory authority will determine any necessary supervisory response to backtesting results based on the number of exceptions over the course of 12 months (ie 250 trading days) generated by the bank's model.

(a) Based on the assessment on the significance of exceptions, the supervisory authority may initiate a dialogue with the bank to determine if there is a problem with a bank's model.

(b) In the most serious cases, the supervisory authority will impose an additional increase in a bank's capital requirement or disallow use of the model.

## Backtesting requirements

32.4 Backtesting requirements compare the value-at-risk (VaR) measure calibrated to a one-day holding period against each of the actual P&L (APL) and hypothetical P&L (HPL) over the prior 12 months. Specific requirements to be applied at the bank-wide level and trading desk level are set out below.

32.5 Backtesting of the bank-wide risk model must be based on a VaR measure calibrated at a 99th percentile confidence level.

(1) An exception or an outlier occurs when either the actual loss or the hypothetical loss of the bank-wide trading book registered in a day of the backtesting period exceeds the corresponding daily VaR measure given by the model. As per [MAR99.8], exceptions for actual losses are counted separately from exceptions for hypothetical losses; the overall number of exceptions is the greater of these two amounts.

(2) In the event either the P&L or the daily VaR measure is not available or impossible to compute, it will count as an outlier.

32.6 In the event an outlier can be shown by the bank to relate to a non-modellable risk factor, and the capital requirement for that non-modellable risk factor exceeds the actual or hypothetical loss for that day, it may be disregarded for the purpose of the overall backtesting process if the supervisory authority is notified accordingly and does not object to this treatment. In these cases, a bank must document the history of the movement of the value of the relevant non-modellable risk factor and have supporting evidence that the non-modellable risk factor has caused the relevant loss.

32.7 The scope of the portfolio subject to bank-wide backtesting should be updated quarterly based on the results of the latest trading desk-level backtesting, risk factor eligibility test and PLA tests.

32.8 The framework for the supervisory interpretation of backtesting results for the bank-wide capital model encompasses a range of possible responses, depending on the strength of the signal generated from the backtesting. These responses are classified into three backtesting zones, distinguished by colours into a hierarchy of responses.

(1) *Green zone*. This corresponds to results that do not themselves suggest a problem with the quality or accuracy of a bank's model.

(2) *Amber zone*. This encompasses results that do raise questions in this regard, for which such a conclusion is not definitive.

(3) *Red zone*. This indicates a result that almost certainly indicates a problem with a bank's risk model.

32.9 These zones are defined according to the number of exceptions generated in the backtesting programme considering statistical errors as explained in [MAR99.9] to [MAR99.21]. Table 1 sets out boundaries for these zones and the presumptive supervisory response for each backtesting outcome, based on a sample of 250 observations.

Backtesting zones — Table 1

| Backtesting zone | Number of exceptions | Backtesting dependent multiplier (to be added to any qualitative add-on per [MAR33.44]) |
|---|---|---|
| Green | 0 | 1.50 |
| | 1 | 1.50 |
| | 2 | 1.50 |
| | 3 | 1.50 |
| | 4 | 1.50 |
| Amber | 5 | 1.70 |
| | 6 | 1.76 |
| | 7 | 1.83 |
| | 8 | 1.88 |
| | 9 | 1.92 |
| Red | 10 or more | 2.00 |

32.10 The backtesting green zone generally would not initiate a supervisory increase in capital requirements for backtesting (ie no backtesting add-on would apply).

32.11 Outcomes in the backtesting amber zone could result from either accurate or inaccurate models. However, they are generally deemed more likely for inaccurate models than for accurate models. Within the backtesting amber zone, the supervisory authority will impose a higher capital requirement in the form of a backtesting add-on. The number of exceptions should generally inform the size of any backtesting add-on, as set out in Table 1 of [MAR32.9].

32.12 A bank must also document all of the exceptions generated from its ongoing backtesting programme, including an explanation for each exception.

32.13 A bank may also implement backtesting for confidence intervals other than the 99th percentile, or may perform other statistical tests not set out in this standard.

32.14 Besides a higher capital requirement for any outcomes that place the bank in the backtesting amber zone, in the case of severe problems with the basic integrity of the model, the supervisory authority may consider whether to disallow the bank's use of the model for market risk capital requirement purposes altogether.

32.15 If a bank's model falls into the backtesting red zone, the supervisor will automatically increase the multiplication factor applicable to the bank's model or may disallow use of the model.

### *Backtesting at the trading desk level*

32.16 The performance of a trading desk's risk management model will be tested through daily backtesting.

32.17 The backtesting assessment is considered to be complementary to the PLA assessment when determining the eligibility of a trading desk for the IMA.

32.18 At the trading desk level, backtesting must compare each desk's one-day VaR measure (calibrated to the most recent 12 months' data, equally weighted) at both the 97.5th percentile and the 99th percentile, using at least one year of current observations of the desk's one-day P&L.

(1) An exception or an outlier occurs when either the actual or hypothetical loss of the trading desk registered in a day of the backtesting period exceeds the corresponding daily VaR measure determined by the bank's model. Exceptions for actual losses are counted separately from exceptions for hypothetical losses; the overall number of exceptions is the greater of these two amounts.

(2) In the event either the P&L or the risk measure is not available or impossible to compute, it will count as an outlier.

32.19 If any given trading desk experiences either more than 12 exceptions at the 99th percentile or 30 exceptions at the 97.5th percentile in the most recent 12-month period, the capital requirement for all of the positions in the trading desk must be determined using the standardised approach.[1]

*Footnote*

*[1] Desks with exposure to issuer default risk must pass a two-stage approval process. First, the market risk model must pass backtesting and PLA. Conditional on approval of the market risk model, the desk may then apply for approval to model default risk. Desks that fail either test must be capitalised under the standardised approach.*

## PLA test requirements

32.20 The PLA test compares daily risk-theoretical P&L (RTPL) with the daily HPL for each trading desk. It intends to:

(1) measure the materiality of simplifications in a banks' internal models used for determining market risk capital requirements driven by missing risk factors and differences in the way positions are valued compared with their front office systems; and

(2) prevent banks from using their internal models for the purposes of capital requirements when such simplifications are considered material.

32.21 The PLA test must be performed on a standalone basis for each trading desk in scope for use of the IMA.

*Definition of profits and losses used for the PLA test and backtesting*

32.22 The RTPL is the daily trading desk-level P&L that is produced by the valuation engine of the trading desk's risk management model.

(1) The trading desk's risk management model must include all risk factors that are included in the bank's expected shortfall (ES) model with supervisory parameters and any risk factors deemed not modellable by the supervisory authority, and which are therefore not included in the ES model for calculating the respective regulatory capital requirement, but are included in non-modellable risk factors.

(2) The RTPL must not take into account any risk factors that the bank does not include in its trading desk's risk management model.

32.23 Movements in all risk factors contained in the trading desk's risk management model should be included, even if the forecasting component of the internal model uses data that incorporate~~s~~ additional residual risk. For example, a bank using a multifactor beta-based index model to capture event risk might include alternative data in the calibration of the residual component to reflect potential events not observed in the name-specific historical time series. The fact that the name is a risk factor in the model, albeit modelled in a multifactor model environment, means that, for the purposes of the PLA test, the bank would include the actual return of the name in the RTPL (and in the HPL) and receive recognition for the risk factor coverage of the model.

32.24 The PLA test compares a trading desk's RTPL with its HPL. The HPL used for the PLA test should be identical to the HPL used for backtesting purposes. This comparison is performed to determine whether the risk factors included and the valuation engines used in the trading desk's risk management model capture the material drivers of the bank's P&L by determining if there is a significant degree of association between the two P&L measures observed over a suitable time period. The RTPL can differ from the HPL for a number of reasons. However, a trading desk risk management model should provide a reasonably accurate assessment of the risks of a trading desk to be deemed eligible for the internal models-based approach.

32.25 The HPL must be calculated by revaluing the positions held at the end of the previous day using the market data of the present day (ie using static positions). As HPL measures changes in portfolio value that would occur when end-of-day positions remain unchanged, it must not take into account intraday trading nor new or modified deals, in contrast to the APL. Both APL and HPL include foreign denominated positions and commodities included in the banking book.

32.26 Fees and commissions must be excluded from both APL and HPL as well as valuation adjustments for which separate regulatory capital approaches have been otherwise specified as part of the rules (eg credit valuation adjustment and its associated eligible hedges) and valuation adjustments that are deducted from Common Equity Tier 1 (eg the impact on the debt valuation adjustment component of the fair value of financial instruments must be excluded from these P&Ls).

32.27 Any other market risk-related valuation adjustments, irrespective of the frequency by which they are updated, must be included in the APL while only valuation adjustments updated daily must be included in the HPL, unless the bank has received specific agreement to exclude them from its supervisory authority. Smoothing of valuation adjustments that are not calculated daily is not allowed. P&L due to the passage of time should be included in the APL and should be treated consistently in both HPL and RTPL.[2]

*Footnote*

*[2] Time effects can include various elements such as: the sensitivity to time, or theta effect (ie using mathematical terminology, the first-order derivative of the price relative to the time) and carry or costs of funding.*

32.28 Valuation adjustments that the bank is unable to calculate at the trading desk level (eg because they are assessed in terms of the bank's overall positions/risks or because of other constraints around the assessment process) are not required to be included in the HPL and APL for backtesting at the trading desk level, but should be included for bank-wide backtesting. To the satisfaction of its supervisory authority, the bank must provide support for valuation adjustments that are not computed at a trading desk level.

32.29 Both APL and HPL must be computed based on the same pricing models (eg same pricing functions, pricing configurations, model parametrisation, market data and systems) as the ones used to produce the reported daily P&L.

### *PLA test data input alignment*

32.30 For the sole purpose of the PLA assessment, banks are allowed to align RTPL input data for its risk factors with the data used in HPL if these alignments are documented, justified to the supervisory authority and the requirements set out below are fulfilled:

(1) Banks must demonstrate that HPL input data can be appropriately used for RTPL purposes, and that no risk factor differences or valuation engine differences are omitted when transforming HPL input data into a format which can be applied to the risk factors used in RTPL calculation.

(2) Any adjustment of RTPL input data must be properly documented, validated and justified to the supervisory authority.

(3) Banks must have procedures in place to identify changes with regard to the adjustments of RTPL input data. Banks must notify the supervisory authority of any such changes.

(4) Banks must provide assessments on the effect these input data alignments would have on the RTPL and the PLA test. To do so, banks must compare RTPL based on HPL-aligned market data with the RTPL based on market data without alignment. This comparison must be performed when designing or changing the input data alignment process and upon the request of the bank's supervisory authority.

32.31 Adjustments to RTPL input data will be allowed when the input data for a given risk factor that is included in both the RTPL and the HPL differs due to different providers of market data sources or time fixing of market data sources, or transformations of market data into input data suitable for the risk factors of the underlying pricing models. These adjustments can be done either:

(1) by direct replacement of the RTPL input data (eg par rate tenor x, provider a) with the HPL input data (eg par rate tenor x, provider b); or

(2) by using the HPL input data (eg par rate tenor x, provider b) as a basis to calculate the risk factor data needed in the RTPL/ES model (eg zero rate tenor x).

32.32 If the HPL uses market data in a different manner to RTPL to calculate risk parameters that are essential to the valuation engine, these differences must be reflected in the PLA test and as a result in the calculation of HPL and RTPL. In this regard, HPL and RTPL are allowed to use the same market data only as a basis, but must use their respective methods (which can differ) to calculate the respective valuation engine parameters. This would be the case, for example, where market data are transformed as part of the valuation process used to calculate RTPL. In that instance, banks may align market data between RTPL and HPL pre-transformation but not post-transformation.

32.33 Banks are not permitted to align HPL input data for risk factors with input data used in RTPL. Adjustments to RTPL or HPL to address residual operational noise are not permitted. Residual operational noise arises from computing HPL and RTPL in two different systems at two different points in time. It may originate from transitioning large portions of data across systems, and potential data aggregations may result in minor reconciliation gaps below tolerance levels for intervention; or from small differences in static/reference data and configuration.

*PLA test metrics*

32.34 The PLA requirements are based on two test metrics:

(1) the Spearman correlation metric to assess the correlation between RTPL and HPL; and

(2) the Kolmogorov-Smirnov (KS) test metric to assess similarity of the distributions of RTPL and HPL.

32.35 To calculate each test metric for a trading desk, the bank must use the time series of the most recent 250 trading days of observations of RTPL and HPL.

*Process for determining the Spearman correlation metric*

32.36 For a time series of HPL, banks must produce a corresponding time series of ranks based on the size of the P&L ($R_{HPL}$). That is, the lowest value in the HPL time series receives a rank of 1, the next lowest value receives a rank of 2 and so on.

32.37 Similarly, for a time series of RTPL, banks must produce a corresponding time series of ranks based on size ($R_{RTPL}$).

32.38 Banks must calculate the Spearman correlation coefficient of the two time series of rank values of $R_{RTPL}\ and\ R_{HPL}$ based on size using the following formula, where $\sigma_{R_{HPL}}$ and $\sigma_{R_{RTPL}}$ are the standard deviations of $R_{RTPL}\ and\ R_{HPL}$.

$$r_S = \frac{cov(R_{HPL}, R_{RTPL})}{\sigma_{R_{HPL}} \times \sigma_{R_{RTPL}}}$$

*Process for determining Kolmogorov-Smirnov test metrics*

32.39 The bank must calculate the empirical cumulative distribution function of RTPL. For any value of RTPL, the empirical cumulative distribution is the product of 0.004 and the number of RTPL observations that are less than or equal to the specified RTPL.

32.40 The bank must calculate the empirical cumulative distribution function of HPL. For any value of HPL, the empirical cumulative distribution is the product of 0.004 and number of HPL observations that are less than or equal to the specified HPL.

32.41 The KS test metric is the largest absolute difference observed between these two empirical cumulative distribution functions at any P&L value.

*PLA test metrics evaluation*

32.42 Based on the outcome of the metrics, a trading desk is allocated to a PLA test red zone, an amber zone or a green zone as set out in Table 2.

(1) A trading desk is in the PLA test green zone if both

(a) the correlation metric is above 0.80; and

(b) the KS distributional test metric is below 0.09 (p-value = 0.264).

(2) A trading desk is in the PLA test red zone if the correlation metric is less than 0.7 or if the KS distributional test metric is above 0.12 (p-value = 0.055).

(3) A trading desk is in the PLA amber zone if it is allocated neither to the green zone nor to the red zone.

PLA test thresholds

Table 2

| Zone | Spearman correlation | KS test |
|---|---|---|
| Amber zone thresholds | 0.80 | 0.09 (p-value = 0.264) |
| Red zone thresholds | 0.70 | 0.12 (p-value = 0.055) |

32.43 If a trading desk is in the PLA test red zone, it is ineligible to use the IMA to determine market risk capital requirements and must be use the standardised approach.

(1) Risk exposures held by these ineligible trading desks must be included with the out-of-scope trading desks for purposes of determining capital requirement per the standardised approach.

(2) A trading desk deemed ineligible to use the IMA must remain out-of-scope to use the IMA until:

(a) the trading desk produces outcomes in the PLA test green zone; and

(b) the trading desk has satisfied the backtesting exceptions requirements over the past 12 months.

32.44 If a trading desk is in the PLA test amber zone, it is not considered an out-of-scope trading desk for use of the IMA.

(1) If a trading desk is in the PLA test amber zone, it cannot return to the PLA test green zone until:

(a) the trading desk produces outcomes in the PLA test green zone; and

(b) the trading desk has satisfied its backtesting exceptions requirements over the prior 12 months.

(2) Trading desks in the PLA test amber zone are subject to a capital surcharge as specified in [MAR33.43]

## Treatment for exceptional situations

32.45 There may, on very rare occasions, be a valid reason why a series of accurate trading desk level-models across different banks will produce many backtesting exceptions or inadequately track the P&L produced by the front office pricing model (for instance, during periods of significant cross-border financial market stress affecting several banks or when financial markets are subjected to a major regime shift). One possible supervisory response in this instance would be to permit the relevant trading desks to continue to use the IMA but require each trading desk's model to take account of the regime shift or significant market stress as quickly as practicable while maintaining the integrity of its procedures for updating the model. Supervisory authorities should only pursue such a response under the most extraordinary, systemic circumstances.

# MAR33 Internal models approach: capital requirements calculation

*This chapter sets out the process by which capital requirements are calculated per the internal models approach.*

## Calculation of expected shortfall

33.1 Banks will have flexibility in devising the precise nature of their expected shortfall (ES) models, but the following minimum standards will apply for the purpose of calculating market risk capital requirements. Individual banks or their supervisory authorities will have discretion to apply stricter standards.

33.2 ES must be computed on a daily basis for the bank-wide internal models to determine market risk capital requirements. ES must also be computed on a daily basis for each trading desk that uses the internal models approach (IMA).

33.3 In calculating ES, a bank must use a 97.5th percentile, one-tailed confidence level.

33.4 In calculating ES, the liquidity horizons described in [MAR33.12] must be reflected by scaling an ES calculated on a base horizon. The ES for a liquidity horizon must be calculated from an ES at a base liquidity horizon of 10 days with scaling applied to this base horizon result as expressed below, where:

(1) $ES$ is the regulatory liquidity-adjusted ES;

(2) $T$ is the length of the base horizon, ie 10 days;

(3) $ES_T(P)$ is the ES at horizon $T$ of a portfolio with positions $P = (p_i)$ with respect to shocks to all risk factors that the positions $P$ are exposed to;

(4) $ES_T(P, j)$ is the ES at horizon $T$ of a portfolio with positions $P = (p_i)$ with respect to shocks for each position $p_i$ in the subset of risk factors $Q(p_i, j)$, with all other risk factors held constant;

(5) the $ES$ at horizon $T$, $ES_T(P)$ must be calculated for changes in the risk factors, and $ES_T(P, j)$ must be calculated for changes in the relevant subset $Q(p_i, j)$ of risk factors, over the time interval $T$ without scaling from a shorter horizon;

(6) $Q(p_i, j)_j$ is the subset of risk factors for which liquidity horizons, as specified in [MAR33.12], for the desk where $p_i$ is booked are at least as long as $LH_j$ according to the table below. For example, $Q(p_i, 4)$ is the set of risk factors with a 60-day horizon and a 120-day liquidity horizon. Note that $Q(p_i, j)$ is a subset of $Q(p_i, j–1)$;

(7) the time series of changes in risk factors over the base time interval $T$ may be determined by overlapping observations; and

(8) $LH_j$ is the liquidity horizon $j$, with lengths in the following table:

| Liquidity horizons, j | Table 1 |
|---|---|
| *j* | $LH_j$ |
| 1 | 10 |
| 2 | 20 |
| 3 | 40 |
| 4 | 60 |
| 5 | 120 |

$$ES = \sqrt{\left(ES(P)\right)^2 + \sum_{j\geq 2}\left(ES_T(P,j)\sqrt{\frac{\left(LH_j - LH_{j-1}\right)}{T}}\right)^2}$$

33.5 The ES measure must be calibrated to a period of stress.

(1) Specifically, the ES measure must replicate an ES outcome that would be generated on the bank's current portfolio if the relevant risk factors were experiencing a period of stress. This is a joint assessment across all relevant risk factors, which will capture stressed correlation measures.

(2) This calibration is to be based on an indirect approach using a reduced set of risk factors. Banks must specify a reduced set of risk factors that are relevant for their portfolio and for which there is a sufficiently long history of observations.

(a) This reduced set of risk factors is subject to supervisory approval and must meet the data quality requirements for a modellable risk factor as outlined in [MAR31.12] to [MAR31.24].

(b) The identified reduced set of risk factors must be able to explain a minimum of 75% of the variation of the full ES model (ie the ES of the reduced set of risk factors should be at least equal to 75% of the fully specified ES model on average measured over the preceding 12-week period).

33.6 The ES for market risk capital purposes is therefore expressed as follows, where:

(1) The ES for the portfolio using the above reduced set of risk factors ($ES_{R,S}$), is calculated based on the most severe 12-month period of stress available over the observation horizon.

(2) $ES_{R,S}$ is then scaled up by the ratio of (i) the current ES using the full set of risk factors to (ii) the current ES measure using the reduced set of factors. For the purpose of this calculation, this ratio is floored at 1.

(a) $ES_{F,C}$ is the ES measure based on the current (most recent) 12-month observation period with the full set of risk factors; and

(b) $ES_{R,C}$ is the ES measure based on the current period with a reduced set of risk factors.

$$ES = ES_{R,S} \times \frac{ES_{F,C}}{ES_{R,C}}$$

33.7 For measures based on stressed observations ($ES_{R,S}$), banks must identify the 12-month period of stress over the observation horizon in which the portfolio experiences the largest loss. The observation horizon for determining the most stressful 12 months must, at a minimum, span back to and include 2007. Observations within this period must be equally weighted. Banks must update their 12-month stressed periods at least quarterly, or whenever there are material changes in the risk factors in the portfolio. Whenever a bank updates its 12-month stressed periods it must also update the reduced set of risk factors (as the basis for the calculations of $E_{R,C}$ and $E_{R,S}$) accordingly.

33.8 For measures based on current observations ($ES_{F,C}$), banks must update their data sets no less frequently than once every three months and must also reassess data sets whenever market prices are subject to material changes.

(1) This updating process must be flexible enough to allow for more frequent updates.

(2) The supervisory authority may also require a bank to calculate its ES using a shorter observation period if, in the supervisor's judgement; this is justified by a significant upsurge in price volatility. In this case, however, the period should be no shorter than six months.

33.9 No particular type of ES model is prescribed. Provided that each model used captures all the material risks run by the bank, as confirmed through profit and loss (P&L) attribution (PLA) tests and backtesting, and conforms to each of the requirements set out above and below, supervisors may permit banks to use models based on either historical simulation, Monte Carlo simulation, or other appropriate analytical methods.

33.10 Banks will have discretion to recognise empirical correlations within broad regulatory risk factor classes (interest rate risk, equity risk, foreign exchange risk, commodity risk and credit risk, including related options volatilities in each risk factor category). Empirical correlations across broad risk factor categories will be constrained by the supervisory aggregation scheme, as described in [MAR33.14] to [MAR33.15], and must be calculated and used in a manner consistent with the applicable liquidity horizons, clearly documented and able to be explained to supervisors on request.

33.11 Banks' models must accurately capture the risks associated with options within each of the broad risk categories. The following criteria apply to the measurement of options risk:

(1) Banks' models must capture the non-linear price characteristics of options positions.

(2) Banks' risk measurement systems must have a set of risk factors that captures the volatilities of the rates and prices underlying option positions, ie vega risk. Banks with relatively large and/or complex options portfolios must have detailed specifications of the relevant volatilities. Banks must model the volatility surface across both strike price and vertex (ie tenor).

33.12 As set out in [MAR33.4], a scaled ES must be calculated based on the liquidity horizon $n$ defined below. $n$ is calculated per the following conditions:

(1) Banks must map each risk factor on to one of the risk factor categories shown below using consistent and clearly documented procedures.

(2) The mapping of risk factors must be:

(a) set out in writing;

(b) validated by the bank's risk management;

(c) made available to supervisors; and

(d) subject to internal audit.

(3) $n$ is determined for each broad category of risk factor as set out in Table 2. However, on a desk-by-desk basis, $n$ can be increased relative to the values in the table below (ie the liquidity horizon specified below can be treated as a floor). Where $n$ is increased, the increased horizon must be 20, 40, 60 or 120 days and the rationale must be documented and be subject to supervisory approval. Furthermore, liquidity horizons should be capped at the maturity of the related instrument.

Liquidity horizon n by risk factor — Table 2

| Risk factor category | *n* | Risk factor category | *n* |
|---|---|---|---|
| Interest rate: specified currencies - EUR, USD, GBP, AUD, JPY, SEK, CAD and domestic currency of a bank | 10 | Equity price (small cap): volatility | 60 |
| Interest rate: unspecified currencies | 20 | Equity: other types | 60 |
| Interest rate: volatility | 60 | Foreign exchange (FX) rate: specified currency pairs[1] | 10 |
| Interest rate: other types | 60 | FX rate: currency pairs | 20 |
| Credit spread: sovereign (investment grade, or IG) | 20 | FX: volatility | 40 |
| Credit spread: sovereign (high yield, or HY) | 40 | FX: other types | 40 |
| Credit spread: corporate (IG) | 40 | Energy and carbon emissions trading price | 20 |
| Credit spread: corporate (HY) | 60 | Precious metals and non-ferrous metals price | 20 |
| Credit spread: volatility | 120 | Other commodities price | 60 |
| Credit spread: other types | 120 | Energy and carbon emissions trading price: volatility | 60 |
| | | Precious metals and non-ferrous metals price: volatility | 60 |
| Equity price (large cap) | 10 | Other commodities price: volatility | 120 |
| Equity price (small cap) | 20 | Commodity: other types | 120 |
| Equity price (large cap): volatility | 20 | | |

Footnotes

[1] *USD/EUR, USD/JPY, USD/GBP, USD/AUD, USD/CAD, USD/CHF, USD/MXN, USD/CNY, USD/NZD, USD/RUB, USD/HKD, USD/SGD, USD/TRY, USD/KRW, USD/SEK, USD/ZAR, USD/INR, USD/NOK, USD/BRL, EUR/JPY, EUR/GBP, EUR/CHF and JPY/AUD. Currency pairs forming first-order crosses across these specified currency pairs are also subject to the same liquidity horizon.*

## Calculation of capital requirement for modellable risk factors

33.13 For those trading desks that are permitted to use the IMA, all risk factors that are deemed to be modellable must be included in the bank's internal, bank-wide ES model. The bank must calculate its internally modelled capital requirement at the bank-wide level using this model, with no supervisory constraints on cross-risk class correlations (*IMCC(C)*).

33.14 The bank must calculate a series of partial ES capital requirements (ie all other risk factors must be held constant) for the range of broad regulatory risk classes (interest rate risk, equity risk, foreign exchange risk, commodity risk and credit spread risk). These partial, non-diversifiable (constrained) ES values (*IMCC*($C_i$)) will then be summed to provide an aggregated risk class ES capital requirement.

33.15 The aggregate capital requirement for modellable risk factors (*IMCC*) is based on the weighted average of the constrained and unconstrained ES capital requirements, where:

(1) The stress period used in the risk class level $ES_{R,S,i}$ should be the same as that used to calculate the portfolio-wide $ES_{R,S}$.

(2) *Rho* ($\rho$) is the relative weight assigned to the firm's internal model. The value of ρ is 0.5.

(3) *B* stands for broad regulatory risk classes as set out in [MAR33.14].

$$IMCC = \rho\big(IMCC(C)\big) + (1-\rho)\left(\sum_{i=1}^{B} IMCC(C_i)\right)$$

where $IMCC(C) = ES_{R,S}\frac{ES_{F,C}}{ES_{R,C}}$ and $IMCC(C_i) = ES_{R,S,i}\frac{ES_{F,C,i}}{ES_{R,C,i}}$

## Calculation of capital requirement for non-modellable risk factors

33.16 Capital requirements for each non-modellable risk factor (NMRF) are to be determined using a stress scenario that is calibrated to be at least as prudent as the ES calibration used for modelled risks (ie a loss calibrated to a 97.5% confidence threshold over a period of stress). In determining that period of stress, a bank must determine a common 12-month period of stress across all NMRFs in the same risk class. Subject to supervisory approval, a bank may be permitted to calculate stress scenario capital requirements at the bucket level (using the same buckets that the bank uses to disprove modellability, per [MAR31.16]) for risk factors that belong to curves, surfaces or cubes (ie a single stress scenario capital requirement for all the NMRFs that belong to the same bucket).

(1) For each NMRF, the liquidity horizon of the stress scenario must be the greater of the liquidity horizon assigned to the risk factor in [MAR33.12] and 20 days. The bank's supervisory authority may require a higher liquidity horizon.

(2) For NMRFs arising from idiosyncratic credit spread risk, banks may apply a common 12-month stress period. Likewise, for NMRFs arising from idiosyncratic equity risk arising from spot, futures and forward prices, equity repo rates, dividends and volatilities, banks may apply a common 12-month stress scenario. Additionally, a zero correlation assumption may be used when aggregating gains and losses provided the bank conducts analysis to demonstrate to its supervisor that this is appropriate.[2] Correlation or diversification effects between other non-idiosyncratic NMRFs are recognised through the formula set out in [MAR33.17].

(3) In the event that a bank cannot provide a stress scenario which is acceptable for the supervisor, the bank will have to use the maximum possible loss as the stress scenario.

<u>*Footnote*</u>

*[2] The tests are generally done on the residuals of panel regressions where the dependent variable is the change in issuer spread while the independent variables can be either a change in a market factor or a dummy variable for sector and/or region. The assumption is that the data on the names used to estimate the model suitably proxies the names in the portfolio and the idiosyncratic residual component captures the multifactor-name basis. If the model is missing systematic explanatory factors or the data suffers from measurement error, then the residuals would exhibit heteroscedasticity (which can be tested via White, Breuche Pagan tests etc) and/or serial correlation (which can be tested*

*with Durbin Watson, Lagrange multiplier (LM) tests etc) and/or cross-sectional correlation (clustering).*

33.17 The aggregate regulatory capital measure for *I* (non-modellable idiosyncratic credit spread risk factors that have been demonstrated to be appropriate to aggregate with zero correlation), *J* (non-modellable idiosyncratic equity risk factors that have been demonstrated to be appropriate to aggregate with zero correlation) and the remaining *K* (risk factors in model-eligible trading desks that are non-modellable *(SES)*) is calculated as follows, where:

(1) $ISES_{NM,i}$ is the stress scenario capital requirement for idiosyncratic credit spread non-modellable risk *i* from the *I* risk factors aggregated with zero correlation;

(2) $ISES_{NM,j}$ is the stress scenario capital requirement for idiosyncratic equity non-modellable risk *j* from the J risk factors aggregated with zero correlation;

(3) $SES_{NM,k}$ is the stress scenario capital requirement for non-modellable risk *k from K risk factors; and*

(4) Rho ($\rho$) is equal to 0.6.

$$SES = \sqrt{\sum_{i=1}^{I} ISES_{NM,i}^2} + \sqrt{\sum_{j=1}^{J} ISES_{NM,j}^2} + \sqrt{\left(\rho * \sum_{k=1}^{K} SES_{NM,k}\right)^2 + (1-\rho^2) * \sum_{k=1}^{K} SES_{NM,k}^2}$$

## Calculation of default risk capital requirement

33.18 Banks must have a separate internal model to measure the default risk of trading book positions. The general criteria in [MAR30.1] to [MAR30.4] and the qualitative standards in [MAR30.5] to [MAR30.16] also apply to the default risk model.

33.19 Default risk is the risk of direct loss due to an obligor's default as well as the potential for indirect losses that may arise from a default event.

33.20 Default risk must be measured using a value-at-risk (VaR) model.

(1) Banks must use a default simulation model with two types of systematic risk factors.

(2) Default correlations must be based on credit spreads or on listed equity prices. Correlations must be based on data covering a period of 10 years that includes a period of stress as defined in [MAR33.5] and based on a one-year liquidity horizon.

(3) Banks must have clear policies and procedures that describe the correlation calibration process, documenting in particular in which cases credit spreads or equity prices are used.

(4) Banks have the discretion to apply a minimum liquidity horizon of 60 days to the determination of default risk capital (DRC) requirement for equity sub-portfolios.

(5) The VaR calculation must be conducted weekly and be based on a one-year time horizon at a one-tail, 99.9 percentile confidence level.

33.21 All positions subject to market risk capital requirements that have default risk as defined in [MAR33.19], with the exception of those positions subject to the standardised approach, are subject to the DRC requirement model.

(1) Sovereign exposures (including those denominated in the sovereign's domestic currency), equity positions and defaulted debt positions must be included in the model.

(2) For equity positions, the default of an issuer must be modelled as resulting in the equity price dropping to zero.

33.22 The DRC requirement model capital requirement is the greater of:

(1) the average of the DRC requirement model measures over the previous 12 weeks; or

(2) the most recent DRC requirement model measure.

33.23 A bank must assume constant positions over the one-year horizon, or 60 days in the context of designated equity sub-portfolios.

33.24 Default risk must be measured for each obligor.

(1) Probabilities of default (PDs) implied from market prices are not acceptable unless they are corrected to obtain an objective probability of default.[3]

(2) PDs are subject to a floor of 0.03%.

_Footnote_

*[3] Market-implied PDs are not acceptable.*

33.25 A bank's model may reflect netting of long and short exposures to the same obligor. If such exposures span different instruments with exposure to the same obligor, the effect of the netting must account for different losses in the different instruments (eg differences in seniority).

33.26 The basis risk between long and short exposures of different obligors must be modelled explicitly. The potential for offsetting default risk among long and short exposures across different obligors must be included through the modelling of defaults. The pre-netting of positions before input into the model other than as described in [MAR33.25] is not allowed.

33.27 The DRC requirement model must recognise the impact of correlations between defaults among obligors, including the effect on correlations of periods of stress as described below.

(1) These correlations must be based on objective data and not chosen in an opportunistic way where a higher correlation is used for portfolios with a mix of long and short positions and a low correlation used for portfolios with long only exposures.

(2) A bank must validate that its modelling approach for these correlations is appropriate for its portfolio, including the choice and weights of its systematic risk factors. A bank must document its modelling approach and the period of time used to calibrate the model.

(3) These correlations must be measured over a liquidity horizon of one year.

(4) These correlations must be calibrated over a period of at least 10 years.

(5) Banks must reflect all significant basis risks in recognising these correlations, including, for example, maturity mismatches, internal or external ratings, vintage etc.

33.28 The bank's model must capture any material mismatch between a position and its hedge. With respect to default risk within the one-year capital horizon, the model must account for the risk in the timing of defaults to capture the relative risk from the maturity mismatch of long and short positions of less than one-year maturity.

33.29 The bank's model must reflect the effect of issuer and market concentrations, as well as concentrations that can arise within and across product classes during stressed conditions.

33.30 As part of this DRC requirement model, the bank must calculate, for each and every position subjected to the model, an incremental loss amount relative to the current valuation that the bank would incur in the event that the obligor of the position defaults.

33.31 Loss estimates must reflect the economic cycle; for example, the model must incorporate the dependence of the recovery on the systemic risk factors.

33.32 The bank's model must reflect the non-linear impact of options and other positions with material non-linear behaviour with respect to default. In the case of equity derivatives positions with multiple underlyings, simplified modelling approaches (for example modelling approaches that rely solely on individual jump-to-default sensitivities to estimate losses when multiple underlyings default) may be applied (subject to supervisory approval).

33.33 Default risk must be assessed from the perspective of the incremental loss from default in excess of the mark-to-market losses already taken into account in the current valuation.

33.34 Owing to the high confidence standard and long capital horizon of the DRC requirement, robust direct validation of the DRC model through standard backtesting methods at the 99.9%/one-year soundness standard will not be possible.

(1) Accordingly, validation of a DRC model necessarily must rely more heavily on indirect methods including but not limited to stress tests, sensitivity analyses and scenario analyses, to assess its qualitative and quantitative reasonableness, particularly with regard to the model's treatment of concentrations.

(2) Given the nature of the DRC soundness standard, such tests must not be limited to the range of events experienced historically.

(3) The validation of a DRC model represents an ongoing process in which supervisors and firms jointly determine the exact set of validation procedures to be employed.

33.35 Banks should strive to develop relevant internal modelling benchmarks to assess the overall accuracy of their DRC models.

33.36 Due to the unique relationship between credit spread and default risk, banks must seek approval for each trading desk with exposure to these risks, both for credit spread risk and default risk. Trading desks which do not receive approval will be deemed ineligible for internal modelling standards and be subject to the standardised capital framework.

33.37 Where a bank has approved PD estimates as part of the internal ratings-based (IRB) approach, this data must be used. Where such estimates do not exist, or the bank's supervisor determines that they are not sufficiently robust, PDs must be computed using a methodology consistent with the IRB methodology and satisfy the following conditions.

(1) Risk-neutral PDs should not be used as estimates of observed (historical) PDs.

(2) PDs must be measured based on historical default data including both formal default events and price declines equivalent to default losses. Where possible, this data should be based on publicly traded securities over a complete economic cycle. The minimum historical observation period for calibration purposes is five years.

(3) PDs must be estimated based on historical data of default frequency over a one-year period. The PD may also be calculated on a theoretical basis (eg geometric scaling) provided that the bank is able to demonstrate that such theoretical derivations are in line with historical default experience.

(4) PDs provided by external sources may also be used by banks, provided they can be shown to be relevant for the bank's portfolio.

33.38 Where a bank has approved loss-given-default (LGD)[4] estimates as part of the IRB approach, this data must be used. Where such estimates do not exist, or the supervisor determines that they are not sufficiently robust, LGDs must be computed using a methodology consistent with the IRB methodology and satisfy the following conditions.

(1) LGDs must be determined from a market perspective, based on a position's current market value less the position's expected market value subsequent to default. The LGD should reflect the type and seniority of the position and cannot be less than zero.

(2) LGDs must be based on an amount of historical data that is sufficient to derive robust, accurate estimates.

(3) LGDs provided by external sources may also be used by institutions, provided they can be shown to be relevant for the bank's portfolio.

<u>*Footnote*</u>

*[4] LGD should be interpreted in this context as 1 – recovery rate.*

33.39 Banks must establish a hierarchy ranking their preferred sources for PDs and LGDs, in order to avoid the cherry-picking of parameters.

## Calculation of capital requirement for model-ineligible trading desks

33.40 The regulatory capital requirement associated with trading desks that are either out-of-scope for model approval or that have been deemed ineligible to use an internal model (*Cu*) is to be calculated by aggregating all such risks and applying the standardised approach.

## Aggregation of capital requirement

33.41 The aggregate (non-DRC) capital requirement for those trading desks approved and eligible for the IMA (ie trading desks that pass the backtesting requirements and that have been assigned to the PLA test green zone or amber zone ($C_A$) in [MAR32.43] to [MAR32.45]) is equal to the maximum of the most recent observation and a weighted average of the previous 60 days scaled by a multiplier and is calculated as follows where *SES* is the aggregate regulatory capital measure for the risk factors in model-eligible trading desks that are non-modellable.

$$C_A = max\{IMCC_{t-1} + SES_{t-1};\ m_c \cdot IMCC_{avg} + SES_{avg}\}$$

33.42 The multiplication factor $m_c$ is fixed at 1.5 unless it is set at a higher level by the supervisory authority to reflect the addition of a qualitative add on and/or a backtesting add-on per the following considerations.

(1) Banks must add to this factor a "plus" directly related to the ex-post performance of the model, thereby introducing a built-in positive incentive to maintain the predictive quality of the model.

(2) For the backtesting add-on, the plus will range from 0 to 0.5 based on the outcome of the backtesting of the bank's *daily VaR at the 99$^{th}$ percentile* based on current observations on the full set of risk factors *($VaR_{FC}$)*.

(3) If the backtesting results are satisfactory and the bank meets all of the qualitative standards set out in [MAR30.5] to [MAR30.16], the plus factor could be zero. [MAR32] presents in detail the approach to be applied for backtesting and the plus factor.

(4) The backtesting add-on factor is determined based on the maximum of the exceptions generated by the backtesting results against actual P&L (APL) and hypothetical P&L (HPL) as described [MAR32].

33.43 The aggregate capital requirement for market risk ($ACR_{total}$) is equal to the aggregate capital requirement for approved and eligible trading desks ($IMA_{G,A}$ = $C_A$ + DRC) plus the standardised approach capital requirement for trading desks that are either out-of-scope for model approval or that have been deemed ineligible to use the internal models approach ($C_u$). If at least one eligible trading desk is in the PLA test amber zone, a capital surcharge is added. The impact of the capital surcharge is limited by the formula:

$$ACR_{total} = min\{IMA_{G,A} + Capital\ surcharge + C_U\ ;\ SA_{all\ desk}\} + max\{0;\ IMA_{G,A} - SA_{G,A}\ \}$$

33.44 For the purposes of calculating the capital requirement, the risk factor eligibility test, the PLA test and the trading desk-level backtesting are applied on a quarterly basis to update the modellability of risk factors and desk classification to the PLA test green zone, amber zone, or red zone. In addition, the stressed period and the reduced set of risk factors ($E_{R,C}$ and $E_{R,S}$) must be updated on a quarterly basis. The reference dates to perform the tests and to update the stress period and selection of the reduced set of risk factors should be consistent. Banks must reflect updates to the stressed period and to the reduced set of risk factors as well as the test results in calculating capital requirements in a timely manner. The averages of the previous 60 days (IMCC, SES) and or respectively 12 weeks (DRC) have only to be calculated at the end of the quarter for the purpose of calculating the capital requirement.

33.45 The capital surcharge is calculated as the difference between the aggregated standardised capital charges ($\mathrm{SA_{G,A}}$) and the aggregated internal models-based capital charges ($\mathrm{IMA_{G,A}} = \mathrm{C_A} + \mathrm{DRC}$) multiplied by a factor *k*. To determine the aggregated capital charges, positions in all of the trading desks in the PLA green zone or amber zone are taken into account. The capital surcharge is floored at zero. In the formula below:

(1) $k = 0.5 \times \frac{\sum_{i \in A} SA_i}{\sum_{i \in G,A} SA_i}$;

(2) $SA_i$ denotes the standardised capital requirement for all the positions of trading desk "i";

(3) $i \in A$ denotes the indices of all the approved trading desks in the amber zone; and

(4) $i \in G, A$ denotes the indices of all the approved trading desks in the green zone or amber zone.

$$Capital\ surcharge = \ k \cdot max\{0, SA_{G,A} - IMA_{G,A}\}$$

33.46 The risk-weighted assets for market risk under the IMA are determined by multiplying the capital requirements calculated as set out in this chapter by 12.5.

# MAR40 Simplified standardised approach

*This chapter sets out a simplified standardised approach for calculating risk-weighted assets for market risk.*

## Risk-weighted assets and capital requirements

40.1 The risk-weighted assets for market risk under the simplified standardised approach are determined by multiplying the capital requirements calculated as set out in this chapter by 12.5.

(1) [MAR40.3] to [MAR40.73] deal with interest rate, equity, foreign exchange (FX) and commodities risk.

(2) [MAR40.74] to [MAR40.86] set out a number of possible methods for measuring the price risk in options of all kinds.

(3) The capital requirement under the simplified standardised approach will be the measures of risk obtained from [MAR40.2] to [MAR40.86], summed arithmetically.

40.2 The capital requirement arising from the simplified standardised approach is the simple sum of the recalibrated capital requirements arising from each of the four risk classes – namely interest rate risk, equity risk, FX risk and commodity risk as detailed in the formula below, where:

(1) $CR_{IRR}$ = capital requirement under [MAR40.3] to [MAR40.40] (interest rate risk), plus additional requirements for option risks from debt instruments (non-delta risks) under [MAR40.74] to [MAR40.86] (treatment of options);

(2) $CR_{EQ}$ = capital requirement under [MAR40.41] to [MAR40.52] (equity risk), plus additional requirements for option risks from equity instruments (non-delta risks) under [MAR40.74] to [MAR40.86] (treatment of options);

(3) $CR_{FX}$ = capital requirement under [MAR40.53] to [MAR40.62] (FX risk), plus additional requirements for option risks from foreign exchange instruments (non-delta risks) under [MAR40.74] to [MAR40.86] (treatment of options);

(4) $CR_{COMM}$ = capital requirement under [MAR40.63] to [MAR40.73] (commodities risk), plus additional requirements for option risks from commodities instruments (non-delta risks) under [MAR40.74] to [MAR40.86] (treatment of options);

(5) $SF_{IRR}$ = Scaling factor of 1.30;

(6) $SF_{EQ}$ = Scaling factor of 3.50;

(7) $SF_{COMM}$ = Scaling factor of 1.90; and

(8) $SF_{FX}$ = Scaling factor of 1.20.

$$Capital\ requirement = CR_{IRR} * SF_{IRR} + CR_{EQ} * SF_{EQ} + CR_{FX} * SF_{FX} + CR_{COMM} * SF_{Comm}$$

## Interest rate risk

40.3 This section sets out the simplified standard approach for measuring the risk of holding or taking positions in debt securities and other interest rate related instruments in the trading book. The instruments covered include all fixed-rate and floating-rate debt securities and instruments that behave like them, including non-convertible preference shares.[1] Convertible bonds, ie debt issues or preference shares that are convertible, at a stated price, into common shares of the issuer, will be treated as debt securities if they trade like debt securities and as equities if they trade like equities. The basis for dealing with derivative products is considered in [MAR40.31] to [MAR40.40].

Footnote

[1] *Traded mortgage securities and mortgage derivative products possess unique characteristics because of the risk of prepayment. Accordingly, for the time being, no common treatment will apply to these securities, which will be dealt with at national discretion. A security that is the subject of a repurchase or securities lending agreement will be treated as if it were still owned by the lender of the security, ie it will be treated in the same manner as other securities positions.*

*40.4* The minimum capital requirement is expressed in terms of two separately calculated amounts, one applying to the "specific risk" of each security, whether it is a short or a long position, and the other to the interest rate risk in the portfolio (termed "general market risk") where long and short positions in different securities or instruments can be offset.

## *Specific risk*

40.5 The capital requirement for specific risk is designed to protect against an adverse movement in the price of an individual security owing to factors related to the individual issuer. In measuring the risk, offsetting will be restricted to matched positions in the identical issue (including positions in derivatives). Even if the issuer is the same, no offsetting will be permitted between different issues since differences in coupon rates, liquidity, call features, etc mean that prices may diverge in the short run.

40.6 The specific risk capital requirements for "government" and "other" categories will be as follows:

### Specific risk capital requirements for issuer risk

Government and "other" categories — Table 1

| Categories | External credit assessment | Specific risk capital requirement |
|---|---|---|
| Government | AAA to AA– | 0% |
| | A+ to BBB– | 0.25% (residual term to final maturity 6 months or less)<br>1.00% (residual term to final maturity greater than 6 and up to and including 24 months)<br>1.60% (residual term to final maturity exceeding 24 months) |
| | BB+ to B– | 8.00% |
| | Below B– | 12.00% |
| | Unrated | 8.00% |
| Qualifying | | 0.25% (residual term to final maturity 6 months or less)<br>1.00% (residual term to final maturity greater than 6 and up to and including 24 months)<br>1.60% (residual term to final maturity exceeding 24 months) |
| Other | BB+ to BB– | 8.00% |
| | Below BB– | 12.00% |
| | Unrated | 8.00% |

40.7 The government category will include all forms of government[2] paper including bonds, treasury bills and other short-term instruments, but national authorities reserve the right to apply a specific risk capital requirement to securities issued by certain foreign governments, especially to securities denominated in a currency other than that of the issuing government.

*Footnote*

[2] *Including, at national discretion, local and regional governments subject to a zero credit risk weight in the credit risk framework.*

40.8 When the government paper is denominated in the domestic currency and funded by the bank in the same currency, at national discretion a lower specific risk capital requirement may be applied.

40.9 The qualifying category includes securities issued by public sector entities and multilateral development banks, plus other securities that are:

(1) rated investment grade (IG)[3] by at least two credit rating agencies specified by the national authority; or

(2) rated IG by one rating agency and not less than IG by any other rating agency specified by the national authority (subject to supervisory oversight); or

(3) subject to supervisory approval, unrated, but deemed to be of comparable investment quality by the reporting bank, *and* the issuer has securities listed on a recognised stock exchange.

*Footnote*

[3] *For example, IG include rated Baa or higher by Moody's and BBB or higher by Standard and Poor's.*

40.10 Each supervisory authority will be responsible for monitoring the application of these qualifying criteria, particularly in relation to the last criterion where the initial classification is essentially left to the reporting banks. National authorities will also have discretion to include within the qualifying category debt securities issued by banks in countries which have implemented this framework, subject to the express understanding that supervisory authorities in such countries undertake prompt remedial action if a bank fails to meet the capital standards set forth in this framework. Similarly, national authorities will have discretion to include within the qualifying category debt securities issued by securities firms that are subject to equivalent rules.

40.11 Furthermore, the qualifying category shall include securities issued by institutions that are deemed to be equivalent to IG quality and subject to supervisory and regulatory arrangements comparable to those under this framework.

40.12 Unrated securities may be included in the qualifying category when they are subject to supervisory approval, unrated, but deemed to be of comparable investment quality by the reporting bank, and the issuer has securities listed on a recognised stock exchange. This will remain unchanged for banks using the simplified standardised approach. For banks using the internal ratings-based (IRB) approach for a portfolio, unrated securities can be included in the qualifying category if both of the following conditions are met:

(1) the securities are rated equivalent[4] to IG under the reporting bank's internal rating system, which the national supervisor has confirmed complies with the requirements for an IRB approach; and

(2) the issuer has securities listed on a recognised stock exchange.

*Footnote*

[4] *Equivalent means the debt security has a one-year probability of default (PD) equal to or less than the one year PD implied by the long-run average one-year PD of a security rated IG or better by a qualifying rating agency.*

40.13 However, since this may in certain cases considerably underestimate the specific risk for debt instruments which have a high yield to redemption relative to government debt securities, each national supervisor will have the discretion:

(1) to apply a higher specific risk charge to such instruments; and/or

(2) to disallow offsetting for the purposes of defining the extent of general market risk between such instruments and any other debt instruments.

40.14 The specific risk capital requirement of securitisation positions as defined in a separate Basel Committee publication - Revisions to the securitisation framework, December 2014, 2016 and 2018 that are held in the trading book is to be calculated according to the revised method for such positions in the banking book as set out in revisions to the securitisation framework. A bank shall calculate the specific risk capital requirement applicable to each net securitisation position by dividing the risk weight calculated as if it were held in the banking book by 12.5.

40.15 Banks may limit the capital requirement for an individual position in a credit derivative or securitisation instrument to the maximum possible loss. For a short risk position this limit could be calculated as a change in value due to the underlying names immediately becoming default risk-free. For a long risk position, the maximum possible loss could be calculated as the change in value in the event that all the underlying names were to default with zero recoveries. The maximum possible loss must be calculated for each individual position.

40.16 Full allowance will be recognised for positions hedged by credit derivatives when the values of two legs (ie long and short) always move in the opposite direction and broadly to the same extent. This would be the case in the following situations, in which cases no specific risk capital requirement applies to both sides of the position:

(1) the two legs consist of completely identical instruments; or

(2) a long cash position (or credit derivative) is hedged by a total rate of return swap (or vice versa) and there is an exact match between the reference obligation and the underlying exposure (ie the cash position).[5]

_Footnote_

*[5] The maturity of the swap itself may be different from that of the underlying exposure.*

40.17 An 80% offset will be recognised when the value of two legs (ie long and short) always moves in the opposite direction but not broadly to the same extent. This would be the case when a long cash position (or credit derivative) is hedged by a credit default swap (CDS) or a credit-linked note (or vice versa) and there is an exact match in terms of the reference obligation, the maturity of both the reference obligation and the credit derivative, and the currency of the underlying exposure. In addition, key features of the credit derivative contract (eg credit event definitions, settlement mechanisms) should not cause the price movement of the credit derivative to materially deviate from the price movements of the cash position. To the extent that the transaction transfers risk (ie taking account of restrictive payout provisions such as fixed payouts and materiality thresholds), an 80% specific risk offset will be applied to the side of the transaction with the higher capital requirement, while the specific risk requirement on the other side will be zero.

40.18 Partial allowance will be recognised when the value of the two legs (ie long and short) usually moves in the opposite direction. This would be the case in the following situations:

(1) The position is captured in [MAR40.16](2), but there is an asset mismatch between the reference obligation and the underlying exposure. Nonetheless, the position meets the requirements in [CRE22.86].

(2) The position is captured in [MAR40.16](1) or [MAR40.17] but there is a currency or maturity mismatch[6] between the credit protection and the underlying asset.

(3) The position is captured in [MAR40.17] but there is an asset mismatch between the cash position (or credit derivative) and the credit derivative hedge. However, the underlying asset is included in the (deliverable) obligations in the credit derivative documentation.

<u>*Footnote*</u>

*[6] Currency mismatches should feed into the normal reporting of FX risk.*

40.19 In each of these cases in [MAR40.16] to [MAR40.18], the following rule applies. Rather than adding the specific risk capital requirements for each side of the transaction (ie the credit protection and the underlying asset) only the higher of the two capital requirements will apply.

40.20 In cases not captured in [MAR40.16] to [MAR40.18], a specific risk capital requirement will be assessed against both sides of the position.

40.21 An nth-to-default credit derivative is a contract where the payoff is based on the nth asset to default in a basket of underlying reference instruments. Once the nth default occurs the transaction terminates and is settled.

(1) The capital requirement for specific risk for a first-to-default credit derivative is the lesser of:

(a) the sum of the specific risk capital requirements for the individual reference credit instruments in the basket; and

(b) the maximum possible credit event payment under the contract.

(2) Where a bank has a risk position in one of the reference credit instruments underlying a first-to-default credit derivative and this credit derivative hedges the bank's risk position, the bank is allowed to reduce, with respect to the hedged amount, both the capital requirement for specific risk for the reference credit instrument and that part of the capital requirement for specific risk for the credit derivative that relates to this particular reference credit instrument. Where a bank has multiple risk positions in reference credit instruments underlying a first-to-default credit derivative, this offset is allowed only for that underlying reference credit instrument having the lowest specific risk capital requirement.

(3) The capital requirement for specific risk for an nth-to-default credit derivative with n greater than one is the lesser of:

(a) the sum of the specific risk capital requirements for the individual reference credit instruments in the basket but disregarding the (n-1) obligations with the lowest specific risk capital requirements; and

(b) the maximum possible credit event payment under the contract. For nth-to-default credit derivatives with n greater than 1, no offset of the capital requirement for specific risk with any underlying reference credit instrument is allowed.

(4) If a first or other nth-to-default credit derivative is externally rated, then the protection seller must calculate the specific risk capital requirement using the rating of the derivative and apply the respective securitisation risk weights as specified in [MAR40.14], as applicable.

(5) The capital requirement against each net nth-to-default credit derivative position applies irrespective of whether the bank has a long or short position, ie obtains or provides protection.

40.22 A bank must determine the specific risk capital requirement for the correlation trading portfolio (CTP) as follows:

(1) The bank computes:

(a) the total specific risk capital requirements that would apply just to the net long positions from the net long correlation trading exposures combined; and

(b) the total specific risk capital requirements that would apply just to the net short positions from the net short correlation trading exposures combined.

(2) The larger of these total amounts is then the specific risk capital requirement for the CTP.

*General market risk*

40.23 The capital requirements for general market risk are designed to capture the risk of loss arising from changes in market interest rates. A choice between two principal methods of measuring the risk is permitted – a maturity method and a duration method. In each method, the capital requirement is the sum of four components:

(1) the net short or long position in the whole trading book;

(2) a small proportion of the matched positions in each time band (the "vertical disallowance");

(3) a larger proportion of the matched positions across different time bands (the "horizontal disallowance"); and

(4) a net charge for positions in options, where appropriate (see [MAR40.84] and [MAR40.85]).

40.24 Separate maturity ladders should be used for each currency and capital requirements should be calculated for each currency separately and then summed with no offsetting between positions of the opposite sign. In the case of those currencies in which business is insignificant, separate maturity ladders for each currency are not required. Rather, the bank may construct a single maturity ladder and slot, within each appropriate time band, the net long or short position for each currency. However, these individual net positions are to be summed within each time band, irrespective of whether they are long or short positions, to produce a gross position figure.

40.25 In the maturity method (see [MAR40.29] for the duration method), long or short positions in debt securities and other sources of interest rate exposures including derivative instruments, are slotted into a maturity ladder comprising 13 time bands (or 15 time bands in the case of low coupon instruments). Fixed rate instruments should be allocated according to the residual term to maturity and floating-rate instruments according to the residual term to the next repricing date. Opposite positions of the same amount in the same issues (but not different issues by the same issuer), whether actual or notional, can be omitted from the interest rate maturity framework, as well as closely matched swaps, forwards, futures and forward rate agreements (FRAs) which meet the conditions set out in [MAR40.35] and [MAR40.36] below.

40.26 The first step in the calculation is to weight the positions in each time band by a factor designed to reflect the price sensitivity of those positions to assumed changes in interest rates. The weights for each time band are set out in Table 4. Zero-coupon bonds and deep-discount bonds (defined as bonds with a coupon of less than 3%) should be slotted according to the time bands set out in the second column of Table 4.

Maturity method: time bands and weights

Table 4

| Coupon 3% or more | Coupon less than 3% | Risk weight | Assumed changes in yield |
|---|---|---|---|
| 1 month or less | 1 month or less | 0.00% | 1.00 |
| 1 to 3 months | 1 to 3 months | 0.20% | 1.00 |
| 3 to 6 months | 3 to 6 months | 0.40% | 1.00 |
| 6 to 12 months | 6 to 12 months | 0.70% | 1.00 |
| 1 to 2 years | 1.0 to 1.9 years | 1.25% | 0.90 |
| 2 to 3 years | 1.9 to 2.8 years | 1.75% | 0.80 |
| 3 to 4 years | 2.8 to 3.6 years | 2.25% | 0.75 |
| 4 to 5 years | 3.6 to 4.3 years | 2.75% | 0.75 |
| 5 to 7 years | 4.3 to 5.7 years | 3.25% | 0.70 |
| 7 to 10 years | 5.7 to 7.3 years | 3.75% | 0.65 |
| 10 to 15 years | 7.3 to 9.3 years | 4.50% | 0.60 |
| 15 to 20 years | 9.3 to 10.6 years | 5.25% | 0.60 |
| Over 20 years | 10.6 to 12 years | 6.00% | 0.60 |
| | 12 to 20 years | 8.00% | 0.60 |
| | Over 20 years | 12.50% | 0.60 |

40.27 The next step in the calculation is to offset the weighted longs and shorts in each time band, resulting in a single short or long position for each band. Since, however, each band would include different instruments and different maturities, a 10% capital requirement to reflect basis risk and gap risk will be levied on the smaller of the offsetting positions, be it long or short. Thus, if the sum of the weighted longs in a time band is USD 100 million and the sum of the weighted shorts USD 90 million, the so-called vertical disallowance for that time band would be 10% of USD 90 million (ie USD 9 million).

40.28 The result of the above calculations is to produce two sets of weighted positions, the net long or short positions in each time band (USD 10 million long in the example above) and the vertical disallowances, which have no sign.

(1) In addition, however, banks will be allowed to conduct two rounds of horizontal offsetting:

(a) first between the net positions in each of three zones, where zone 1 is set as zero to one year, zone 2 is set as one year to four years, and zone 3 is set as four years and over (however, for coupons less than 3%, zone 2 is set as one year to 3.6 years and zone 3 is set as 3.6 years and over); and

(b) subsequently between the net positions in the three different zones.

(2) The offsetting will be subject to a scale of disallowances expressed as a fraction of the matched positions, as set out in Table 5. The weighted long and short positions in each of three zones may be offset, subject to the matched portion attracting a disallowance factor that is part of the capital requirement. The residual net position in each zone may be carried over and offset against opposite positions in other zones, subject to a second set of disallowance factors.

## Horizontal disallowances

Table 5

| Zones[7] | Time band[7] | Within the zone | Between adjacent zones | Between zones 1 and 3 |
|---|---|---|---|---|
| Zone 1 | 0-1 month<br>1-3 months<br>3-6 months<br>6-12 months | 40% | 40% | 100% |
| Zone 2 | 1-2 years<br>2-3 years<br>3-4 years<br>4-5 years | 30% | 40% | |
| Zone 3 | 5-7 years<br>7-10 years<br>10-15 years<br>15-20 years<br>Over 20 years | 30% | | |

*Footnote*

*[7] The zones for coupons less than 3% are 0 to 1 year, 1 to 3.6 years, and 3.6 years and over.*

40.29 Under the alternative duration method, banks with the necessary capability may, with their supervisors' consent, use a more accurate method of measuring all of their general market risk by calculating the price sensitivity of each position separately. Banks must elect and use the method on a continuous basis (unless a change in method is approved by the national authority) and will be subject to supervisory monitoring of the systems used. The mechanics of this method are as follows:

(1) First calculate the price sensitivity of each instrument in terms of a change in interest rates of between 0.6 and 1.0 percentage points depending on the maturity of the instrument (see Table 6);

(2) Slot the resulting sensitivity measures into a duration-based ladder with the 15 time bands set out in Table 6;

(3) Subject long and short positions in each time band to a 5% vertical disallowance designed to capture basis risk; and

(4) Carry forward the net positions in each time band for horizontal offsetting subject to the disallowances set out in Table 5 above.

Duration method: time bands and assumed changes in yield — Table 6

| | Assumed change in yield | | Assumed change in yield |
|---|---|---|---|
| Zone 1: | | Zone 3: | |
| 1 month or less | 1.00 | 3.6 to 4.3 years | 0.75 |
| 1 to 3 months | 1.00 | 4.3 to 5.7 years | 0.70 |
| 3 to 6 months | 1.00 | 5.7 to 7.3 years | 0.65 |
| 6 to 12 months | 1.00 | 7.3 to 9.3 years | 0.60 |
| Zone 2: | | 9.3 to 10.6 years | 0.60 |
| 1.0 to 1.9 years | 0.90 | 10.6 to 12 years | 0.60 |
| 1.9 to 2.8 years | 0.80 | 12 to 20 years | 0.60 |
| 2.8 to 3.6 years | 0.75 | Over 20 years | 0.60 |

40.30 In the case of residual currencies (see [MAR40.24] above) the gross positions in each time band will be subject to either the risk weightings set out in [MAR40.26], if positions are reported using the maturity method, or the assumed change in yield set out in [MAR40.29], if positions are reported using the duration method, with no further offsets.

*Interest rate derivatives*

40.31 The measurement system should include all interest-rate derivatives and off-balance sheet instruments in the trading book which react to changes in interest rates (eg FRAs, other forward contracts, bond futures, interest rate and cross-currency swaps and forward foreign exchange positions). Options can be treated in a variety of ways as described in [MAR40.74] to [MAR40.86]. A summary of the rules for dealing with interest rate derivatives is set out in [MAR40.40].

40.32 The derivatives should be converted into positions in the relevant underlying and become subject to specific and general market risk charges as described above. In order to calculate the standard formula described above, the amounts reported should be the market value of the principal amount of the underlying or of the notional underlying resulting from the prudent valuation guidance set out in paragraphs 690 to 701 in Basel II.[8]

<u>Footnote</u>

*[8] For instruments where the apparent notional amount differs from the effective notional amount, banks must use the effective notional amount.*

40.33 Futures and forward contracts (including FRAs) are treated as a combination of a long and a short position in a notional government security. The maturity of a future or an FRA will be the period until delivery or exercise of the contract, plus – where applicable – the life of the underlying instrument. For example, a long position in a June three-month interest rate future (taken in April) is to be reported as a long position in a government security with a five-month maturity and a short position in a government security with a two-month maturity. Where a range of deliverable instruments may be delivered to fulfil the contract, the bank has flexibility to elect which deliverable security goes into the maturity or duration ladder but should take account of any conversion factor defined by the exchange. In the case of a future on a corporate bond index, positions will be included at the market value of the notional underlying portfolio of securities.

40.34 Swaps will be treated as two notional positions in government securities with relevant maturities. For example, an interest rate swap under which a bank is receiving floating rate interest and paying fixed will be treated as a long position in a floating rate instrument of maturity equivalent to the period until the next interest fixing and a short position in a fixed-rate instrument of maturity equivalent to the residual life of the swap. For swaps that pay or receive a fixed or floating interest rate against some other reference price, eg a stock index, the interest rate component should be slotted into the appropriate repricing maturity category, with the equity component being included in the equity framework. The separate legs of cross-currency swaps are to be reported in the relevant maturity ladders for the currencies concerned.

40.35 Banks may exclude from the interest rate maturity framework altogether (for both specific and general market risk) long and short positions (both actual and notional) in identical instruments with exactly the same issuer, coupon, currency and maturity. A matched position in a future or forward and its corresponding underlying may also be fully offset[10] and thus excluded from the calculation. When the future or the forward comprises a range of deliverable instruments offsetting of positions in the future or forward contract and its underlying is only permissible in cases where there is a readily identifiable underlying security that is most profitable for the trader with a short position to deliver. The price of this security, sometimes called the "cheapest-to-deliver", and the price of the future or forward contract should, in such cases, move in close alignment. No offsetting will be allowed between positions in different currencies; the separate legs of cross-currency swaps or forward FX deals are to be treated as notional positions in the relevant instruments and included in the appropriate calculation for each currency.

<u>*Footnote*</u>

*[9] The leg representing the time to expiry of the future should, however, be reported.*

40.36 In addition, opposite positions in the same category of instruments[10] can in certain circumstances be regarded as matched and allowed to offset fully. To qualify for this treatment, the positions must relate to the same underlying instruments, be of the same nominal value and be denominated in the same currency.[11] In addition:

(1) for futures: offsetting positions in the notional or underlying instruments to which the futures contract relates must be for identical products and mature within seven days of each other;

(2) for swaps and FRAs: the reference rate (for floating rate positions) must be identical and the coupon closely matched (ie within 15 basis points); and

(3) for swaps, FRAs and forwards: the next interest fixing date or, for fixed coupon positions or forwards, the residual maturity must correspond within the following limits:

  (a) less than one month hence: same day;

  (b) between one month and one year hence: within seven days; and

  (c) over one year hence: within 30 days.

<u>*Footnotes*</u>

*[10] This includes the delta-equivalent value of options. The delta equivalent of the legs arising out of the treatment of caps and floors as set out in [MAR40.78] can also be offset against each other under the rules laid down in this paragraph.*

*[11] The separate legs of different swaps may also be matched subject to the same conditions.*

40.37 Banks with large swap books may use alternative formulae for these swaps to calculate the positions to be included in the maturity or duration ladder. One method would be to first convert the payments required by the swap into their present values. For that purpose, each payment should be discounted using zero coupon yields, and a single net figure for the present value of the cash flows entered into the appropriate time band using procedures that apply to zero- (or low-) coupon bonds; these figures should be slotted into the general market risk framework as set out above. An alternative method would be to calculate the sensitivity of the net present value implied by the change in yield used in the maturity or duration method and allocate these sensitivities into the time bands set out in [MAR40.26] or [MAR40.29]. Other methods which produce similar results could also be used. Such alternative treatments will, however, only be allowed if:

(1) the supervisory authority is fully satisfied with the accuracy of the systems being used;

(2) the positions calculated fully reflect the sensitivity of the cash flows to interest rate changes and are entered into the appropriate time bands; and

(3) the positions are denominated in the same currency.

40.38 Interest rate and currency swaps, FRAs, forward FX contracts and interest rate futures will not be subject to a specific risk charge. This exemption also applies to futures on an interest rate index (eg London Interbank Offer Rate, or LIBOR). However, in the case of futures contracts where the underlying is a debt security, or an index representing a basket of debt securities, a specific risk charge will apply according to the credit risk of the issuer as set out in [MAR40.5] to [MAR40.21].

40.39 General market risk applies to positions in all derivative products in the same manner as for cash positions, subject only to an exemption for fully or very closely matched positions in identical instruments as defined in [paragraphs 718(xiii) and 718(xiv) / [MAR40.35] and [MAR40.36]. The various categories of instruments should be slotted into the maturity ladder and treated according to the rules identified earlier.

40.40 Table 7 presents a summary of the regulatory treatment for interest rate derivatives, for market risk purposes.

Summary of treatment of interest rate derivatives — Table 7

| Instrument | Specific risk charge[12] | General market risk charge |
|---|---|---|
| Exchanged-traded future | | |
| Government debt security | Yes[13] | Yes, as two positions |
| Corporate debt security | Yes | Yes, as two positions |
| Index on interest rates (eg LIBOR) | No | Yes, as two positions |
| Over-the-counter (OTC) forward | | |
| Government debt security | Yes[13] | Yes, as two positions |
| Corporate debt security | Yes | Yes, as two positions |
| Index on interest rates | No | Yes, as two positions |
| FRAs, swaps | No | Yes, as two positions |
| Forward FX | No | Yes, as one position in each currency |
| Options | | Either |
| Government debt security | Yes[13] | (a) carve out together with the associated hedging positions: simplified approach; scenario analysis; internal models |
| Corporate debt security | Yes | (b) general market risk charge according to the delta-plus method (gamma and vega should receive separate capital requirements) |
| Index on interest rates | No | |
| FRAs, swaps | No | |

*Footnotes*

[12] *This is the specific risk charge relating to the issuer of the instrument. Under the credit risk rules, a separate capital requirement for the counterparty credit risk applies.*

[13] *The specific risk capital requirement only applies to government debt securities that are rated below AA– (see [MAR40.6] and [MAR40.7]).*

## Equity risk

40.41 This section sets out a minimum capital standard to cover the risk of holding or taking positions in equities in the trading book. It applies to long and short positions in all instruments that exhibit market behaviour similar to equities, but not to non-convertible preference shares (which are covered by the interest rate risk requirements described in [MAR40.3] to [MAR40.40]). Long and short positions in the same issue may be reported on a net basis. The instruments covered include common stocks (whether voting or non-voting), convertible securities that behave like equities, and commitments to buy or sell equity securities. The treatment of derivative products, stock indices and index arbitrage is described in [MAR40.44] to [MAR40.52] below.

### *Specific and general market risks*

40.42 As with debt securities, the minimum capital standard for equities is expressed in terms of two separately calculated capital requirements for the specific risk of holding a long or short position in an individual equity and for the general market risk of holding a long or short position in the market as a whole. Specific risk is defined as the bank's gross equity positions (ie the sum of all long equity positions and of all short equity positions) and general market risk as the difference between the sum of the longs and the sum of the shorts (ie the overall net position in an equity market).The long or short position in the market must be calculated on a market-by-market basis, ie a separate calculation has to be carried out for each national market in which the bank holds equities.

40.43 The capital requirement for specific risk and for general market risk will each be 8%.

### *Equity derivatives*

40.44 Except for options, which are dealt with in [MAR40.74] to [MAR40.86], equity derivatives and off-balance sheet positions that are affected by changes in equity prices should be included in the measurement system.[14] This includes futures and swaps on both individual equities and on stock indices. The derivatives are to be converted into positions in the relevant underlying. The treatment of equity derivatives is summarised in [MAR40.52] below.

*Footnote*

[14] *Where equities are part of a forward contract, a future or an option (quantity of equities to be received or to be delivered), any interest rate or foreign currency exposure from the other leg of the contract should be reported as set out in [MAR40.3] to [MAR40.40] and [MAR40.53] to [MAR40.62].*

40.45 In order to calculate the standard formula for specific and general market risk, positions in derivatives should be converted into notional equity positions:

(1) Futures and forward contracts relating to individual equities should in principle be reported at current market prices.

(2) Futures relating to stock indices should be reported as the marked-to-market value of the notional underlying equity portfolio.

(3) Equity swaps are to be treated as two notional positions.[15]

(4) Equity options and stock index options should be either carved out together with the associated underlyings or be incorporated in the measure of general market risk described in this section according to the delta-plus method.

<u>*Footnote*</u>

*[15] For example, an equity swap in which a bank is receiving an amount based on the change in value of one particular equity or stock index and paying a different index will be treated as a long position in the former and a short position in the latter. Where one of the legs involves receiving/paying a fixed or floating interest rate, that exposure should be slotted into the appropriate repricing time band for interest rate related instruments as set out in [MAR40.3] to [MAR40.40]. The stock index should be covered by the equity treatment.*

40.46 Matched positions in each identical equity or stock index in each market may be fully offset, resulting in a single net short or long position to which the specific and general market risk charges will apply. For example, a future in a given equity may be offset against an opposite cash position in the same equity.[16]

<u>*Footnote*</u>

*[16] The interest rate risk arising out of the future, however, should be reported as set out in [MAR40.3] to [MAR40.40].*

40.47 Besides general market risk, a further capital requirement of 2% will apply to the net long or short position in an index contract comprising a diversified portfolio of equities. This capital requirement is intended to cover factors such as execution risk. National supervisory authorities will take care to ensure that this 2% risk weight applies only to well-diversified indices and not, for example, to sectoral indices.

40.48 In the case of the futures-related arbitrage strategies described below, the additional 2% capital requirement described above (set out in [MAR40.47]) may be applied to only one index with the opposite position exempt from a capital requirement. The strategies are:

(1) when the bank takes an opposite position in exactly the same index at different dates or in different market centres; and

(2) when the bank has an opposite position in contracts at the same date in different but similar indices, subject to supervisory oversight that the two indices contain sufficient common components to justify offsetting.

40.49 Where a bank engages in a deliberate arbitrage strategy, in which a futures contract on a broadly based index matches a basket of stocks, it will be allowed to carve out both positions from the simplified standardised approach on condition that:

(1) the trade has been deliberately entered into and separately controlled; and

(2) the composition of the basket of stocks represents at least 90% of the index when broken down into its notional components.

40.50 In such a case as set out in [MAR40.49] the minimum capital requirement will be 4% (ie 2% of the gross value of the positions on each side) to reflect divergence and execution risks. This applies even if all of the stocks comprising the index are held in identical proportions. Any excess value of the stocks comprising the basket over the value of the futures contract or excess value of the futures contract over the value of the basket is to be treated as an open long or short position.

40.51 If a bank takes a position in depository receipts against an opposite position in the underlying equity or identical equities in different markets, it may offset the position (ie bear no capital requirement) but only on condition that any costs on conversion are fully taken into account.[17]

<u>Footnote</u>

*[17] Any FX risk arising out of these positions has to be reported as set out in [MAR40.53] to [MAR40.67].*

40.52 Table 8 summarises the regulatory treatment of equity derivatives for market risk purposes.

Summary of treatment of equity derivatives — Table 8

| Instrument | Specific risk [18] | General market risk |
|---|---|---|
| Exchanged-traded or OTC future | | |
| Individual equity | Yes | Yes, as underlying |
| Index | 2% | Yes, as underlying |
| Options | | Either |
| Individual equity | Yes | (a) carve out together with the associated hedging positions: simplified approach; scenario analysis; internal models |
| Index | 2% | (b) general market risk charge according to the delta-plus method (gamma and vega should receive separate capital requirements) |

<u>Footnote</u>

*[18] This is the specific risk charge relating to the issuer of the instrument. Under the credit risk rules], a separate capital requirement for the counterparty credit risk applies.*

## Foreign exchange risk

40.53 This section sets out the simplified standardised approach for measuring the risk of holding or taking positions in foreign currencies, including gold.[19]

<u>Footnote</u>

*[19] Gold is to be dealt with as an FX position rather than a commodity because its volatility is more in line with foreign currencies and banks manage it in a similar manner to foreign currencies.*

40.54 Two processes are needed to calculate the capital requirement for FX risk.

(1) The first is to measure the exposure in a single currency position as set out in [MAR40.55] to [MAR40.58].

(2) The second is to measure the risks inherent in a bank's mix of long and short positions in different currencies as set out in [MAR40.59] to [MAR40.62].

### *Measuring the exposure in a single currency*

40.55 The bank's net open position in each currency should be calculated by summing:

(1) the net spot position (ie all asset items less all liability items, including accrued interest, denominated in the currency in question);

(2) the net forward position (ie all amounts to be received less all amounts to be paid under forward FX transactions, including currency futures and the principal on currency swaps not included in the spot position);

(3) guarantees (and similar instruments) that are certain to be called and are likely to be irrecoverable;

(4) net future income/expenses not yet accrued but already fully hedged (at the discretion of the reporting bank);

(5) any other item representing a profit or loss in foreign currencies (depending on particular accounting conventions in different countries); and

(6) the net delta-based equivalent of the total book of foreign currency options.[20]

<u>*Footnote*</u>

*[20] Subject to a separately calculated capital requirement for gamma and vega as described in [MAR40.77] to [MAR40.80]; alternatively, options and their associated underlyings are subject to one of the other methods described in [MAR40.74] to [MAR40.86].*

40.56 Positions in composite currencies need to be separately reported but, for measuring banks' open positions, may be either treated as a currency in their own right or split into their component parts on a consistent basis. Positions in gold should be measured in the same manner as described in [MAR40.68].[21]

<u>*Footnote*</u>

*[21] Where gold is part of a forward contract (quantity of gold to be received or to be delivered), any interest rate or foreign currency exposure from the other leg of the contract should be reported as set out in [MAR40.3] to [MAR40.40] and MAR40.55] above.*

40.57 Interest, other income and expenses should be treated as follows. Interest accrued (ie earned but not yet received) should be included as a position. Accrued expenses should also be included. Unearned but expected future interest and anticipated expenses may be excluded unless the amounts are certain and banks have taken the opportunity to hedge them. If banks include future income/expenses they should do so on a consistent basis, and not be permitted to select only those expected future flows which reduce their position.

40.58 Forward currency and gold positions should be measured as follows: Forward currency and gold positions will normally be valued at current spot market exchange rates. Using forward exchange rates would be inappropriate since it would result in the measured positions reflecting current interest rate differentials to some extent. However, banks that base their normal management accounting on net present values are expected to use the net present values of each position, discounted using current interest rates and valued at current spot rates, for measuring their forward currency and gold positions.

### *Measuring the foreign exchange risk in a portfolio of foreign currency positions and gold*

40.59 For measuring the FX risk in a portfolio of foreign currency positions and gold as set out in [MAR40.54](2), a bank that is not approved to use internal models by its supervisory authority must use a shorthand method which treats all currencies equally.

40.60 Under the shorthand method, the nominal amount (or net present value) of the net position in each foreign currency and in gold is converted at spot rates into the reporting currency.[22] The overall net open position is measured by aggregating:

(1) the sum of the net short positions or the sum of the net long positions, whichever is the greater;[23] plus

(2) the net position (short or long) in gold, regardless of sign.

Footnotes

*[22] Where the bank is assessing its FX risk on a consolidated basis, it may be technically impractical in the case of some marginal operations to include the currency positions of a foreign branch or subsidiary of the bank. In such cases, the internal limit in each currency may be used as a proxy for the positions. Provided there is adequate ex post monitoring of actual positions against such limits, the limits should be added, without regard to sign, to the net open position in each currency.*

*[23] An alternative calculation, which produces an identical result, is to include the reporting currency as a residual and to take the sum of all the short (or long) positions.*

40.61 The capital requirement will be 8% of the overall net open position (see example in Table 9). In particular, the capital requirement would be 8% of the higher of either the net long currency positions or the net short currency positions (ie 300) and of the net position in gold (35) = 335 x 8% = 26.8.

Example of the shorthand measure of FX risk — Table 9

| | JPY | EUR | GBP | CAD | USD | Gold |
|---|---|---|---|---|---|---|
| Net position per currency | +50 | +100 | +150 | -20 | -180 | -35 |
| Net open position | +300 | | | -200 | | 35 |

40.62 A bank of which business in foreign currency is insignificant and which does not take FX positions for its own account may, at the discretion of its national authority, be exempted from capital requirements on these positions provided that:

(1) its foreign currency business, defined as the greater of the sum of its gross long positions and the sum of its gross short positions in all foreign currencies, does not exceed 100% of eligible capital as defined in paragraphs 49 of Basel III definition of capital; and

(2) its overall net open position as defined in [MAR40.60] above does not exceed 2% of its eligible capital as defined in paragraphs 49 of Basel III definition of capital.

## Commodities risk

40.63 This section sets out the simplified standardised approach for measuring the risk of holding or taking positions in commodities, including precious metals, but excluding gold (which is treated as a foreign currency according to the methodology set out in [MAR40.53] to [MAR40.62] above). A commodity is defined as a physical product which is or can be traded on a secondary market, eg agricultural products, minerals (including oil) and precious metals.

40.64 The price risk in commodities is often more complex and volatile than that associated with currencies and interest rates. Commodity markets may also be less liquid than those for interest rates and currencies and, as a result, changes in supply and demand can have a more dramatic effect on price and volatility.[24] These market characteristics can make price transparency and the effective hedging of commodities risk more difficult.

*Footnote*

*[24] Banks need also to guard against the risk that arises when the short position falls due before the long position. Owing to a shortage of liquidity in some markets, it might be difficult to close the short position and the bank might be squeezed by the market.*

40.65 The risks associated with commodities include the following risks:

(1) For spot or physical trading, the directional risk arising from a change in the spot price is the most important risk.

(2) However, banks using portfolio strategies involving forward and derivative contracts are exposed to a variety of additional risks, which may well be larger than the risk of a change in spot prices. These include:

(a) basis risk (the risk that the relationship between the prices of similar commodities alters through time);

(b) interest rate risk (the risk of a change in the cost of carry for forward positions and options); and

(c) forward gap risk (the risk that the forward price may change for reasons other than a change in interest rates).

(3) In addition, banks may face counterparty credit risk on over-the-counter derivatives, but this is captured by one of the methods set out in Annex 4 of Basel II.

(4) The funding of commodities positions may well open a bank to interest rate or FX exposure and if that is so the relevant positions should be included in the measures of interest rate and FX risk described in [MAR40.3] to [MAR40.40] and [MAR40.53] to [MAR40.62], respectively.[25]

*Footnote*

*[25] Where a commodity is part of a forward contract (quantity of commodities to be received or to be delivered), any interest rate or foreign currency exposure from the other leg of the contract should be reported as set out in [MAR40.3] to MAR40.40] and [MAR40.53] to [MAR40.62]. Positions which are purely stock financing (ie a physical stock has been sold forward and the cost of funding has been locked in until the date of the forward sale) may be omitted from the commodities risk calculation although they will be subject to interest rate and counterparty risk requirements.*

40.66 There are two alternatives for measuring commodities position risk under the simplified standardised approach that are described in [MAR40.68] to [MAR40.73] below. Commodities risk can also be measured, using either (i) the maturity ladder approach, which is a measurement system that captures forward gap and interest rate risk separately by basing the methodology on seven time bands as set out in [MAR40.68] to [MAR40.71] below or (ii) the simplified approach, which is a very simple framework as set out in [MAR40.72] and [MAR40.73] below. Both the maturity ladder approach and the simplified approach are appropriate only for banks that, in relative terms, conduct only a limited amount of commodities business.

40.67 For the maturity ladder approach and the simplified approach, long and short positions in each commodity may be reported on a net basis for the purposes of calculating open positions. However, positions in different commodities will, as a general rule, not be offsettable in this fashion. Nevertheless, national authorities will have discretion to permit netting between different subcategories[26] of the same commodity in cases where the subcategories are deliverable against each other. They can also be considered as offsettable if they are close substitutes against each other and a minimum correlation of 0.9 between the price movements can be clearly established over a minimum period of one year. However, a bank wishing to base its calculation of capital requirements for commodities on correlations would have to satisfy the relevant supervisory authority of the accuracy of the method that has been chosen and obtain its prior approval.

*Footnote*

*[26] Commodities can be grouped into clans, families, subgroups and individual commodities. For example, a clan might be Energy Commodities, within which Hydro-Carbons are a family with Crude Oil being a subgroup and West Texas Intermediate, Arabian Light and Brent being individual commodities.*

### *Maturity ladder approach*

40.68 In calculating the capital requirements under the maturity ladder approach, banks will first have to express each commodity position (spot plus forward) in terms of the standard unit of measurement (barrels, kilos, grams etc). The net position in each commodity will then be converted at current spot rates into the national currency.

40.69 Secondly, in order to capture forward gap and interest rate risk within a time band (which, together, are sometimes referred to as curvature/spread risk), matched long and short positions in each time band will carry a capital requirement. The methodology is similar to that used for interest rate related instruments as set out in [MAR40.3] to [MAR40.40]. Positions in the separate commodities (expressed in terms of the standard unit of measurement) will first be entered into a maturity ladder while physical stocks should be allocated to the first time band. A separate maturity ladder will be used for each commodity as defined in [MAR40.67] above.[27] For each time band as set out in Table 10, the sum of short and long positions that are matched will be multiplied first by the spot price for the commodity, and then by the spread rate of 1.5%.

Time bands and spread rates — Table 10

| Time band | Spread rate |
|---|---|
| 0-1 month | 1.5% |
| 1-3 months | 1.5% |
| 3-6 months | 1.5% |
| 6-12 months | 1.5% |
| 1-2 years | 1.5% |
| 2-3 years | 1.5% |
| over 3 years | 1.5% |

*Footnote*

*[27] For markets that have daily delivery dates, any contracts maturing within 10 days of one another may be offset.*

40.70 The residual net positions from nearer time bands may then be carried forward to offset exposures in time bands that are further out. However, recognising that such hedging of positions among different time bands is imprecise, a surcharge equal to 0.6% of the net position carried forward will be added in respect of each time band that the net position is carried forward. The capital requirement for each matched amount created by carrying net positions forward will be calculated as in [MAR40.69] above. At the end of this process, a bank will have either only long or only short positions, to which a capital requirement of 15% will apply.

40.71 All commodity derivatives and off-balance sheet positions that are affected by changes in commodity prices should be included in this measurement framework. This includes commodity futures, commodity swaps, and options where the "delta-plus" method[28] is used (see [MAR40.77] to [MAR40.80] below). In order to calculate the risk, commodity derivatives should be converted into notional commodities positions and assigned to maturities as follows:

(1) Futures and forward contracts relating to individual commodities should be incorporated as notional amounts of the standard unit of measurement (barrels, kilos, grams etc) and should be assigned a maturity with reference to expiry date.

(2) Commodity swaps where one leg is a fixed price and the other the current market price should be incorporated as a series of positions equal to the notional amount of the contract, with one position corresponding with each payment on the swap and slotted into the maturity ladder accordingly. The positions would be long positions if the bank is paying fixed and receiving floating, and short positions if the bank is receiving fixed and paying floating.[29]

(3) Commodity swaps where the legs are in different commodities are to be incorporated in the relevant maturity ladder. No offsetting will be allowed in this regard except where the commodities belong to the same subcategory as defined in [MAR40.67] above.

*Footnotes*

*[28] For banks using other approaches to measure options risk, all options and the associated underlyings should be excluded from both the maturity ladder approach and the simplified approach.*

*[29] If one of the legs involves receiving/paying a fixed or floating interest rate, that exposure should be slotted into the appropriate repricing maturity band in the maturity ladder covering interest rate related instruments.*

### *Simplified approach*

40.72 In calculating the capital requirement for directional risk under the simplified approach, the same procedure will be adopted as in the maturity ladder approach described above (see [MAR40.68] and [MAR40.71]. Once again, all commodity derivatives and off-balance sheet positions that are affected by changes in commodity prices should be included. The capital requirement will equal 15% of the net position, long or short, in each commodity.

40.73 In order to protect the bank against basis risk, interest rate risk and forward gap risk under the simplified approach, the capital requirement for each commodity as described in [MAR40.68] and [MAR40.71] above will be subject to an additional capital requirement equivalent to 3% of the bank's gross positions, long plus short, in that particular commodity. In valuing the gross positions in commodity derivatives for this purpose, banks should use the current spot price.

## Treatment of options

40.74 In recognition of the wide diversity of banks' activities in options and the difficulties of measuring price risk for options, two alternative approaches will be permissible at the discretion of the national authority under the simplified standardised approach.

(1) Those banks which solely use purchased options[30] can use the simplified approach described in [MAR40.76] below];

(2) Those banks which also write options are expected to use the delta-plus method or scenario approach which are the intermediate approaches as set out in [MAR40.77] to

[MAR40.86]. The more significant its trading activity is, the more the bank will be expected to use a sophisticated approach, and a bank with highly significant trading activity is expected to use the standardised approach or the internal models approach as set out in [MAR20] to [MAR23] or [MAR30] to [MAR33].

Footnote

[30] *Unless all their written option positions are hedged by perfectly matched long positions in exactly the same options, in which case no capital requirement for market risk is required.*

40.75 In the simplified approach for options, the positions for the options and the associated underlying, cash or forward, are not subject to the standardised methodology but rather are carved-out and subject to separately calculated capital requirements that incorporate both general market risk and specific risk. The risk numbers thus generated are then added to the capital requirements for the relevant category, ie interest rate related instruments, equities, FX and commodities as described in [MAR40.3] to [MAR40.73]. The delta-plus method uses the sensitivity parameters or Greek letters associated with options to measure their market risk and capital requirements. Under this method, the delta-equivalent position of each option becomes part of the simplified standardised approach set out in [MAR40.3] to [MAR40.73] with the delta-equivalent amount subject to the applicable general market risk charges. Separate capital requirements are then applied to the gamma and vega risks of the option positions. The scenario approach uses simulation techniques to calculate changes in the value of an options portfolio for changes in the level and volatility of its associated underlyings. Under this approach, the general market risk charge is determined by the scenario grid (ie the specified combination of underlying and volatility changes) that produces the largest loss. For the delta-plus method and the scenario approach, the specific risk capital requirements are determined separately by multiplying the delta-equivalent of each option by the specific risk weights set out in [MAR40.3] to [MAR40.52].

### *Simplified approach*

40.76 Banks that handle a limited range of purchased options can use the simplified approach set out in Table 11 for particular trades. As an example of how the calculation would work, if a holder of 100 shares currently valued at USD 10 each holds an equivalent put option with a strike price of USD 11, the capital requirement would be: USD 1,000 x 16% (ie 8% specific plus 8% general market risk) = USD 160, less the amount the option is in the money (USD 11 - USD 10) x 100 = USD 100, ie the capital requirement would be USD 60. A similar methodology applies for options whose underlying is a foreign currency, an interest rate related instrument or a commodity.

Simplified approach: capital requirements — Table 11

| Position | Treatment |
|---|---|
| Long cash and long put<br>or<br>short cash and long call | The capital requirement will be the market value of the underlying security[31] multiplied by the sum of specific and general market risk charges[32] for the underlying less the amount the option is in the money (if any) bounded at zero[33] |
| Long call<br>or<br>long put | The capital requirement will be the lesser of: (i) the market value of the underlying security multiplied by the sum of specific and general market risk charges[32] for the underlying and (ii) the market value of the option[34] |

Footnotes

[31] *In some cases such as FX, it may be unclear which side is the underlying security; this should be taken to be the asset that would be received if the option were exercised. In*

*addition, the nominal value should be used for items where the market value of the underlying instrument could be zero, eg caps and floors, swaptions etc.*

[32] *Some options (eg where the underlying is an interest rate, a currency or a commodity) bear no specific risk but specific risk will be present in the case of options on certain interest rate related instruments (eg options on a corporate debt security or corporate bond index; see [MAR40.3] to [MAR40.40] for the relevant capital requirements) and for options on equities and stock indices (see [MAR40.41] to [MAR40.52]). The charge under this measure for currency options will be 8% and for options on commodities 15%.*

[33] *For options with a residual maturity of more than six months, the strike price should be compared with the forward, not current, price. A bank unable to do this must take the in the money amount to be zero.*

[34] *Where the position does not fall within the trading book (ie options on certain FX or commodities positions not belonging to the trading book), it may be acceptable to use the book value instead.*

### *Delta-plus method*

40.77 Banks that write options will be allowed to include delta-weighted options positions within the simplified standardised approach set out in [MAR40.3] to [MAR40.73]. Such options should be reported as a position equal to the market value of the underlying multiplied by the delta. However, since delta does not sufficiently cover the risks associated with options positions, banks will also be required to measure gamma (which measures the rate of change of delta) and vega (which measures the sensitivity of the value of an option with respect to a change in volatility) sensitivities in order to calculate the total capital requirement. These sensitivities will be calculated according to an approved exchange model or to the bank's proprietary options pricing model subject to oversight by the national authority.[35]

Footnote

[35] *National authorities may wish to require banks doing business in certain classes of exotic options (eg barriers, digitals) or in options at the money that are close to expiry to use either the scenario approach or the internal models alternative, both of which can accommodate more detailed revaluation approaches.*

40.78 Delta-weighted positions with debt securities or interest rates as the underlying will be slotted into the interest rate time bands, as set out in [MAR40.3] to [MAR40.40], under the following procedure. A two-legged approach should be used as for other derivatives, requiring one entry at the time the underlying contract takes effect and a second at the time the underlying contract matures. For instance, a bought call option on a June three-month interest-rate future will in April be considered, on the basis of its delta-equivalent value, to be a long position with a five-month maturity and a short position with a two-month maturity.[36] The written option will be similarly slotted as a long position with a two-month maturity and a short position with a five-month maturity. Floating rate instruments with caps or floors will be treated as a combination of floating rate securities and a series of European-style options. For example, the holder of a three-year floating rate bond indexed to six month LIBOR with a cap of 15% will treat it as:

(1) a debt security that reprices in six months; and

(2) a series of five written call options on an FRA with a reference rate of 15%, each with a negative sign at the time the underlying FRA takes effect and a positive sign at the time the underlying FRA matures.[37]

*Footnotes*

[36] *A two-month call option on a bond future where delivery of the bond takes place in September would be considered in April as being long the bond and short a five-month deposit, both positions being delta-weighted.*

[37] *The rules applying to closely matched positions set out in [MAR40.36] will also apply in this respect.*

40.79 The capital requirement for options with equities as the underlying will also be based on the delta-weighted positions that will be incorporated in the measure of equity risk described in [MAR40.41] to [MAR40.52]. For purposes of this calculation each national market is to be treated as a separate underlying. The capital requirement for options on FX and gold positions will be based on the method for FX rate risk as set out in [MAR40.53] to [MAR40.62]. For delta risk, the net delta-based equivalent of the foreign currency and gold options will be incorporated into the measurement of the exposure for the respective currency (or gold) position. The capital requirement for *options on commodities* will be based on the simplified or the maturity ladder approach for commodities risk as set out in [MAR40.63] to [MAR40.73]. The delta-weighted positions will be incorporated in one of the measures described in that section.

40.80 In addition to the above capital requirements arising from delta risk, there are further capital requirements for gamma and vega risk. Banks using the delta-plus method will be required to calculate the gamma and vega for each option position (including hedge positions) separately. The capital requirements should be calculated in the following way:

(1) For each individual option a gamma impact should be calculated according to a Taylor series expansion as follows, where VU is the variation of the underlying of the option.

$$Gamma\ impact = \frac{1}{2} \times Gamma \times VU^2$$

(2) VU is calculated as follows:

(a) For interest rate options if the underlying is a bond, the market value of the underlying should be multiplied by the risk weights set out in [MAR40.26]. An equivalent calculation should be carried out where the underlying is an interest rate, again based on the assumed changes in the corresponding yield in [MAR40.26].

(b) For options on equities and equity indices: the market value of the underlying should be multiplied by 8%.[38]

(c) For FX and gold options: the market value of the underlying should be multiplied by 8%.

(d) For options on commodities: the market value of the underlying should be multiplied by 15%.

(3) For the purpose of this calculation the following positions should be treated as the same underlying:

(a) for interest rates,[39] each time band as set out in [paragraph 718(iv) / [MAR40.26];[40]

(b) for equities and stock indices, each national market;

(c) for foreign currencies and gold, each currency pair and gold; and

(d) for commodities, each individual commodity as defined in [MAR40.67].

(4) Each option on the same underlying will have a gamma impact that is either positive or negative. These individual gamma impacts will be summed, resulting in a net gamma impact for each underlying that is either positive or negative. Only those net gamma impacts that are negative will be included in the capital requirement calculation.

(5) The total gamma risk capital requirement will be the sum of the absolute value of the net negative gamma impacts as calculated above.

(6) For volatility risk, banks will be required to calculate the capital requirements by multiplying the sum of the vega risks for all options on the same underlying, as defined above, by a proportional shift in volatility of ± 25%.

(7) The total capital requirement for vega risk will be the sum of the absolute value of the individual capital requirements that have been calculated for vega risk.

<u>Footnotes</u>

*[38] The basic rules set out here for interest rate and equity options do not attempt to capture specific risk when calculating gamma capital requirements. However, national authorities may wish to require specific banks to do so.*

*[39] Positions have to be slotted into separate maturity ladders by currency.*

*[40] Banks using the duration method should use the time bands as set out in [MAR40.29].*

### *Scenario approach*

40.81 More sophisticated banks may opt to base the market risk capital requirement for options portfolios and associated hedging positions on scenario matrix analysis. This will be accomplished by specifying a fixed range of changes in the option portfolio's risk factors and calculating changes in the value of the option portfolio at various points along this grid. For the purpose of calculating the capital requirement, the bank will revalue the option portfolio using matrices for simultaneous changes in the option's underlying rate or price and in the volatility of that rate or price. A different matrix will be set up for each individual underlying as defined in [MAR40.80] above. As an alternative, at the discretion of each national authority, banks that are significant traders in options will for interest rate options be permitted to base the calculation on a minimum of six sets of time bands. When using this method, not more than three of the time bands as defined in [MAR40.26] and [MAR40.29] should be combined into any one set.

40.82 The options and related hedging positions will be evaluated over a specified range above and below the current value of the underlying. The range for interest rates is consistent with the assumed changes in yield in [MAR40.26]. Those banks using the alternative method for interest rate options set out in [MAR40.81] above should use, for each set of time bands, the highest of the assumed changes in yield applicable to the group to which the time bands belong.[41] The other ranges are ± 8% for equities,[42] ± 8% for FX and gold, and ± 15% for commodities. For all risk categories, at least seven observations (including the current observation) should be used to divide the range into equally spaced intervals.

<u>Footnotes</u>

*[41] If, for example, the time bands 3 to 4 years, 4 to 5 years and 5 to 7 years are combined the highest assumed change in yield of these three bands would be 0.75.*

*[42] The basic rules set out here for interest rate and equity options do not attempt to capture specific risk when calculating gamma capital requirements. However, national authorities may wish to require specific banks to do so.*

40.83 The second dimension of the matrix entails a change in the volatility of the underlying rate or price. A single change in the volatility of the underlying rate or price equal to a shift in volatility of + 25% and - 25% is expected to be sufficient in most cases. As circumstances warrant, however, the supervisory authority may choose to require that a different change in volatility be used and/or that intermediate points on the grid be calculated.

40.84 After calculating the matrix, each cell contains the net profit or loss of the option and the underlying hedge instrument. The capital requirement for each underlying will then be calculated as the largest loss contained in the matrix.

40.85 The application of the scenario analysis by any specific bank will be subject to supervisory consent, particularly as regards the precise way that the analysis is constructed. Banks' use of scenario analysis as part of the simplified standardised approach will also be subject to validation by the national authority, and to those of the qualitative standards for internal models as set out in [MAR30].

40.86 Besides the options risks mentioned above, the Committee is conscious of the other risks also associated with options, eg rho (rate of change of the value of the option with respect to the interest rate) and theta (rate of change of the value of the option with respect to time). While not proposing a measurement system for those risks at present, it expects banks undertaking significant options business at the very least to monitor such risks closely. Additionally, banks will be permitted to incorporate rho into their capital calculations for interest rate risk, if they wish to do so.

# MAR90 Transitional arrangements

*This chapter sets out the process by which capital requirements are calculated per the internal models approach.*

90.1 Banks are required to conduct the profit and loss (P&L) attribution (PLA) test beginning 1 January 2022 as set out in [MAR32.3]. The outcomes of the PLA test will be used for Pillar 2 purposes beginning 1 January 2022. The Pillar 1 capital requirement consequences of assignment to the PLA test amber zone or PLA test red zone, as set out in [MAR32.43], [MAR32.44] and [MAR33.43], will apply beginning 1 January 2023.

# MAR99 Guidance on use of the internal models approach

*This chapter sets out application guidance for backtesting requirements and principles for risk factor modellability under the internal models approach.*

## Trading desk-level backtesting

99.1 An additional consideration in specifying the appropriate risk measures and trading outcomes for profit and loss (P&L) attribution test and backtesting arises because the internally modelled risk measurement is generally based on the sensitivity of a static portfolio to instantaneous price shocks. That is, end-of-day trading positions are input into the risk measurement model, which assesses the possible change in the value of this static portfolio due to price and rate movements over the assumed holding period.

99.2 While this is straightforward in theory, in practice it complicates the issue of backtesting. For instance, it is often argued that neither expected shortfall nor value-at-risk measures can be compared against actual trading outcomes, since the actual outcomes will reflect changes in portfolio composition during the holding period. According to this view, the inclusion of fee income together with trading gains and losses resulting from changes in the composition of the portfolio should not be included in the definition of the trading outcome because they do not relate to the risk inherent in the static portfolio that was assumed in constructing the value-at-risk measure.

99.3 This argument is persuasive with regard to the use of risk measures based on price shocks calibrated to longer holding periods. That is, comparing the liquidity-adjusted time horizon 99th percentile risk measures from the internal models capital requirement with actual liquidity-adjusted time horizon trading outcomes would probably not be a meaningful exercise. In particular, in any given multi-day period, significant changes in portfolio composition relative to the initial positions are common at major trading institutions. For this reason, the backtesting framework described here involves the use of risk measures calibrated to a one-day holding period. Other than the restrictions mentioned in this paper, the test would be based on how banks model risk internally.

99.4 Given the use of one-day risk measures, it is appropriate to employ one-day trading outcomes as the benchmark to use in the backtesting programme. The same concerns about "contamination" of the trading outcomes discussed above continue to be relevant, however, even for one-day trading outcomes. That is, there is a concern that the overall one-day trading outcome is not a suitable point of comparison, because it reflects the effects of intraday trading, possibly including fee income that is booked in connection with the sale of new products.

99.5 On the one hand, intraday trading will tend to increase the volatility of trading outcomes and may result in cases where the overall trading outcome exceeds the risk measure. This event clearly does not imply a problem with the methods used to calculate the risk measure; rather, it is simply outside the scope of what the measure is intended to capture. On the other hand, including fee income may similarly distort the backtest, but in the other direction, since fee income often has annuity-like characteristics. Since this fee income is not typically included in the calculation of the risk measure, problems with the risk measurement model could be masked by including fee income in the definition of the trading outcome used for backtesting purposes.

99.6 To the extent that backtesting programmes are viewed purely as a statistical test of the integrity of the calculation of the risk measures, it is appropriate to employ a definition of daily trading outcome that allows for an uncontaminated test. To meet this standard, banks must have the capability to perform the tests based on the hypothetical changes in portfolio value that would occur were end-of-day positions to remain unchanged.

99.7 Backtesting using actual daily P&Ls is also a useful exercise since it can uncover cases where the risk measures are not accurately capturing trading volatility in spite of being calculated with integrity.

99.8 For these reasons, the Committee requires banks to develop the capability to perform these tests using both hypothetical and actual trading outcomes. In combination, the two approaches are likely to provide a strong understanding of the relation between calculated risk measures and trading outcomes. The total number of backtesting exceptions for the purpose of the thresholds in [MAR32.9] must be calculated as the maximum of the exceptions generated under hypothetical or actual trading outcomes.

## Bank-wide backtesting

### *Statistical considerations in defining the backtesting zones*

99.9 To place the definitions of three zones of the bank-wide backtesting in proper perspective, however, it is useful to examine the probabilities of obtaining various numbers of exceptions under different assumptions about the accuracy of a bank's risk measurement model.

99.10 Three zones have been delineated and their boundaries chosen in order to balance two types of statistical error:

(1) the possibility that an accurate risk model would be classified as inaccurate on the basis of its backtesting result, and

(2) the possibility that an inaccurate model would not be classified that way based on its backtesting result.

99.11 Table 1 reports the probabilities of obtaining a particular number of exceptions from a sample of 250 independent observations under several assumptions about the actual percentage of outcomes that the model captures (ie these are binomial probabilities). For example, the left-hand portion of Table 1 sets out probabilities associated with an accurate model (that is, a true coverage level of 99%). Under these assumptions, the column labelled "exact" reports that exactly five exceptions can be expected in 6.7% of the samples.

Probabilities of exceptions from 250 independent observations Table 1

| | Model is accurate | | Model is inaccurate: possible alternative levels of coverage | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coverage = 99% | | Coverage = 98% | | Coverage = 97% | | Coverage = 96% | | Coverage = 95% | |
| | Exact | Type 1 | Exact | Type 2 | Exact | Type 2 | Exact | Type 2 | Exact | Type 2 |
| 0 | 8.1% | 100.0% | 0.6% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 1 | 20.5% | 91.9% | 3.3% | 0.6% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 2 | 25.7% | 71.4% | 8.3% | 3.9% | 1.5% | 0.4% | 0.2% | 0.0% | 0.0% | 0.0% |
| 3 | 21.5% | 45.7% | 14.0% | 12.2% | 3.8% | 1.9% | 0.7% | 0.2% | 0.1% | 0.0% |
| 4 | 13.4% | 24.2% | 17.7% | 26.2% | 7.2% | 5.7% | 1.8% | 0.9% | 0.3% | 0.1% |
| 5 | 6.7% | 10.8% | 17.7% | 43.9% | 10.9% | 12.8% | 3.6% | 2.7% | 0.9% | 0.5% |
| 6 | 2.7% | 4.1% | 14.8% | 61.6% | 13.8% | 23.7% | 6.2% | 6.3% | 1.8% | 1.3% |
| 7 | 1.0% | 1.4% | 10.5% | 76.4% | 14.9% | 37.5% | 9.0% | 12.5% | 3.4% | 3.1% |
| 8 | 0.3% | 0.4% | 6.5% | 86.9% | 14.0% | 52.4% | 11.3% | 21.5% | 5.4% | 6.5% |
| 9 | 0.1% | 0.1% | 3.6% | 93.4% | 11.6% | 66.3% | 12.7% | 32.8% | 7.6% | 11.9% |
| 10 | 0.0% | 0.0% | 1.8% | 97.0% | 8.6% | 77.9% | 12.8% | 45.5% | 9.6% | 19.5% |
| 11 | 0.0% | 0.0% | 0.8% | 98.7% | 5.8% | 86.6% | 11.6% | 58.3% | 11.1% | 29.1% |
| 12 | 0.0% | 0.0% | 0.3% | 99.5% | 3.6% | 92.4% | 9.6% | 69.9% | 11.6% | 40.2% |
| 13 | 0.0% | 0.0% | 0.1% | 99.8% | 2.0% | 96.0% | 7.3% | 79.5% | 11.2% | 51.8% |
| 14 | 0.0% | 0.0% | 0.0% | 99.9% | 1.1% | 98.0% | 5.2% | 86.9% | 10.0% | 62.9% |
| 15 | 0.0% | 0.0% | 0.0% | 100.0% | 0.5% | 99.1% | 3.4% | 92.1% | 8.2% | 72.9% |

**Notes to Table 1:** The table reports both exact probabilities of obtaining a certain number of exceptions from a sample of 250 independent observations under several assumptions about the true level of coverage, as well as type 1 or type 2 error probabilities derived from these exact probabilities.

The left-hand portion of the table pertains to the case where the model is accurate and its true level of coverage is 99%. Thus, the probability of any given observation being an exception is 1% (100% – 99% = 1%). The column labelled "exact" reports the probability of obtaining exactly the number of exceptions shown under this assumption in a sample of 250 independent observations. The column labelled "type 1" reports the probability that using a given number of exceptions as the cut-off for rejecting a model will imply erroneous rejection of an accurate model using a sample of 250 independent observations. For example, if the cut-off level is set at five or more exceptions, the type 1 column reports the probability of falsely rejecting an accurate model with 250 independent observations is 10.8%.

The right-hand portion of the table pertains to models that are inaccurate. In particular, the table concentrates of four specific inaccurate models, namely models whose true levels of coverage are 98%, 97%, 96% and 95% respectively. For each inaccurate model, the exact column reports the probability of obtaining exactly the number of exceptions shown under this assumption in a sample of 250 independent observations. The type 2 columns report the probability that using a given number of exceptions as the cut-off for rejecting a model will imply erroneous acceptance of an inaccurate model with the assumed level of coverage using a sample of 250 independent observations. For example, if the cut-off level is set at five or more exceptions, the type 2 column for an assumed coverage level of 97% reports the probability of falsely accepting a model with only 97% coverage with 250 independent observations is 12.8%.

99.12 The right-hand portion of the table reports probabilities associated with several possible inaccurate models, namely models whose true levels of coverage are 98%, 97%, 96%, and 95%, respectively. Thus, the column labelled “exact” under an assumed coverage level of 97% shows that five exceptions would then be expected in 10.9% of the samples.

99.13 Table 1 also reports several important error probabilities. For the assumption that the model covers 99% of outcomes (the desired level of coverage), the table reports the probability that selecting a given number of exceptions as a threshold for rejecting the accuracy of the model will result in an erroneous rejection of an accurate model (type 1 error). For example, if the threshold is set as low as one exception, then accurate models will be rejected fully 91.9% of the time, because they will escape rejection only in the 8.1% of cases where they generate zero exceptions. As the threshold number of exceptions is increased, the probability of making this type of error declines.

99.14 Under the assumptions that the model's true level of coverage is not 99%, the table reports the probability that selecting a given number of exceptions as a threshold for rejecting the accuracy of the model will result in an erroneous acceptance of a model with the assumed (inaccurate) level of coverage (type 2 error). For example, if the model's actual level of coverage is 97%, and the threshold for rejection is set at seven or more exceptions, the table indicates that this model would be erroneously accepted 37.5% of the time.

99.15 The results in Table 1 also demonstrate some of the statistical limitations of backtesting. In particular, there is no threshold number of exceptions that yields both a low probability of erroneously rejecting an accurate model and a low probability of erroneously accepting all of the relevant inaccurate models. It is for this reason that the Committee has rejected an approach that contains only a single threshold.

99.16 Given these limitations, the Committee has classified outcomes for the backtesting of the bank-wide model into three categories. In the first category, the test results are consistent with an accurate model, and the possibility of erroneously accepting an inaccurate model is low (ie backtesting "green zone"). At the other extreme, the test results are extremely unlikely to have resulted from an accurate model, and the probability of erroneously rejecting an accurate model on this basis is remote (ie backtesting "red zone"). In between these two cases, however, is a zone where the backtesting results could be consistent with either accurate or inaccurate models, and the supervisor should encourage a bank to present additional information about its model before taking action (ie backtesting "amber zone").

99.17 Table 2 sets out the Committee's agreed boundaries for these zones and the presumptive supervisory response for each backtesting outcome, based on a sample of 250 observations. For other sample sizes, the boundaries should be deduced by calculating the binomial probabilities associated with true coverage of 99%, as in Table 1. The backtesting amber zone begins at the point such that the probability of obtaining that number or fewer exceptions equals or exceeds 95%. Table 2 reports these cumulative probabilities for each number of exceptions. For 250 observations, it can be seen that five or fewer exceptions will be obtained 95.88% of the time when the true level of coverage is 99%. Thus, the backtesting amber zone begins at five exceptions. Similarly, the beginning of the backtesting red zone is defined as the point such that the probability of obtaining that number or fewer exceptions equals or exceeds 99.99%. Table 2 shows that for a sample of 250 observations and a true coverage level of 99%, this occurs with 10 exceptions.

Backtesting zone boundaries

Table 2

| Backtesting zone | Number of exceptions | Backtesting-dependent multiplier (to be added to any qualitative add-on per [MAR 33.44]) | Cumulative probability |
|---|---|---|---|
| Green | 0 | 1.50 | 8.11% |
| | 1 | 1.50 | 28.58% |
| | 2 | 1.50 | 54.32% |
| | 3 | 1.50 | 75.81% |
| | 4 | 1.50 | 89.22% |
| Amber | 5 | 1.70 | 95.88% |
| | 6 | 1.76 | 98.63% |
| | 7 | 1.83 | 99.60% |
| | 8 | 1.88 | 99.89% |
| | 9 | 1.92 | 99.97% |
| Red | 10 or more | 2.00 | 99.99% |

**Notes to Table 2:** The table defines the backtesting green, amber and red zones that supervisors will use to assess backtesting results in conjunction with the internal models approach to market risk capital requirements. The boundaries shown in the table are based on a sample of 250 observations. For other sample sizes, the amber zone begins at the point where the cumulative probability equals or exceeds 95%, and the red zone begins at the point where the cumulative probability equals or exceeds 99.99%.

The cumulative probability is simply the probability of obtaining a given number or fewer exceptions in a sample of 250 observations when the true coverage level is 99%. For example, the cumulative probability shown for four exceptions is the probability of obtaining between zero and four exceptions.

Note that these cumulative probabilities and the type 1 error probabilities reported in Table 1 do not sum to one because the cumulative probability for a given number of exceptions includes the possibility of obtaining exactly that number of exceptions, as does the type 1 error probability. Thus, the sum of these two probabilities exceeds one by the amount of the probability of obtaining exactly that number of exceptions.

99.18 The backtesting green zone needs little explanation. Since a model that truly provides 99% coverage would be quite likely to produce as many as four exceptions in a sample of 250 outcomes, there is little reason for concern raised by backtesting results that fall in this range. This is reinforced by the results in Table 1, which indicate that accepting outcomes in this range leads to only a small chance of erroneously accepting an inaccurate model.

99.19 The range from five to nine exceptions constitutes the backtesting amber zone. Outcomes in this range are plausible for both accurate and inaccurate models, although Table 1 suggests that they are generally more likely for inaccurate models than for accurate models. Moreover, the results in Table 1 indicate that the presumption that the model is inaccurate should grow as the number of exceptions increases in the range from five to nine.

99.20 Table 2 sets out the Committee's agreed guidelines for increases in the multiplication factor applicable to the internal models capital requirement, resulting from backtesting results in the backtesting amber zone.

99.21 These particular values reflect the general idea that the increase in the multiplication factor should be sufficient to return the model to a 99th percentile standard. For example, five exceptions in a sample of 250 imply only 98% coverage. Thus, the increase in the multiplication factor should be sufficient to transform a model with 98% coverage into one with 99% coverage. Needless to say, precise calculations of this sort require additional statistical assumptions that are not likely to hold in all cases. For example, if the distribution of trading outcomes is assumed to be normal, then the ratio of the 99th percentile to the 98th percentile is approximately 1.14, and the increase needed in the multiplication factor is therefore approximately 1.13 for a multiplier of 1. If the actual distribution is not normal, but instead has "fat tails", then larger increases may be required to reach the 99th percentile standard. The concern about fat tails was also an important factor in the choice of the specific increments set out in Table 2.

## Examples of the application of the principles for risk factor modellability

99.22 Although supervisors may use discretion regarding the types of evidence required of banks to provide risk factor modellability, the following are examples of the types of evidence that banks may be required to provide.

(1) *Regression diagnostics for multi-factor beta models*. In addition to showing that indices or other regressors are appropriate for the region, asset class and credit quality (if applicable) of an instrument, banks must be prepared to demonstrate that the coefficients used in multi-factor models are adequate to capture both general market risk and idiosyncratic risk. If the bank assumes that the residuals from the multi-factor model are uncorrelated with each other, the bank should be prepared to demonstrate that the modellable residuals are uncorrelated. Further, the factors in the multi-factor model must be appropriate for the region and asset class of the instrument and must explain the general market risk of the instrument. This must be demonstrated through goodness-of-fit statistics (eg an adjusted-$R^2$ coefficient) and other diagnostics on the coefficients. Most importantly, where the estimated coefficients are not used (ie the parameters are judgment-based), the bank must describe how the coefficients are chosen and why they cannot be estimated, and demonstrate that the choice does not underestimate risk. In general, risk factors are not considered modellable in cases where parameters are set by judgment.

(2) *Recovery of price from risk factors*. The bank must periodically demonstrate and document that the risk factors used in its risk model can be fed into front office pricing models and recover the actual prices of the assets. If the recovered prices substantially deviate from the actual prices, this can indicate a problem with prices used to derive the risk factors and call into question the validity of data inputs for risk purposes. In such cases, supervisors may determine that the risk factor is non-modellable.

(3) *Risk pricing is periodically reconciled with front office and back office prices*. While banks are free to use price data from external sources, these external prices should periodically be reconciled with internal prices (from both front office and back office) to ensure they do not deviate substantially, and that they are not consistently biased in any fashion. Results of these reconciliations should be made available to supervisors, including statistics on the differences of the risk price from front office and back office prices. It is standard practice for banks to conduct reconciliation of front office and back office prices; the risk prices must be included as part of the reconciliation of the front office and whenever there is a potential for discrepancy. If the discrepancy is large, supervisors may determine that the risk factor is non-modellable.

(4) *Risk factor backtesting*. Banks must periodically demonstrate the appropriateness of their modelling methodology by comparing the risk factor returns forecast produced by the risk management model with actual returns produced by front office prices. Alternatively, a bank could backtest hypothetical portfolios that are substantively dependent on key risk factors (or combinations thereof). This risk factor backtesting is intended to confirm that risk factors accurately reflect the volatility and correlations of the instruments in the risk model. Hypothetical backtesting can be effective in identifying whether risk factors in question adequately reflect volatility and correlations when the portfolio of instruments is chosen to highlight specific products.

(5) *Risk factors generated from parameterised models*. For options, implied volatility surfaces are often built using a parameterised model based on single-name underlyings and/or option index RPOs and/or market quotes. Liquid options at moneyness, tenor and option expiry points may be used to calibrate level, volatility, drift and correlation parameters for a single-name or benchmark volatility surface. Once these parameters are set, they are derived risk factors in their own right that must be updated and recalibrated periodically as new data arrive and trades occur. In the event that these risk factors are used to proxy for other single-name option surface points, there must be an additional-basis non-modellable risk factor overlay for any potential deviations.