Annex 11:

Supervisory Requirements on Internal Models Approach for Market Risk

1. Risk Factors to be Covered by Internal Models Approach

1.1 Interest Rate Risk

1.1.1 A commercial bank should include in the internal models a set of risk factors corresponding to interest rates in each currency in which the bank has interest-rate-sensitive on or off-balance sheet positions.

1.1.2 A commercial bank should model the yield curve, using one of number of generally accepted approaches in the industry. The yield curve should be divided into various maturity segments in order to capture variation in the volatility of yields along the yield curve. There will typically be one risk factor corresponding to each maturity segment.

1.1.3 For material exposures to interest rate movements in major currencies and markets, a commercial bank must model the yield curve using a minimum of six risk factors. The number of risk factors used should ultimately be driven by the nature and sophistication of the bank’s trading strategy.

1.1.4 A variety of approaches should be used to capture the material spread risk.

1.2 Equity Position Risk

1.2.1 A commercial bank should include in the internal models the risk factors corresponding to each of the equity markets in which they hold
significant positions.

1.2.2 For each equity market, at a minimum the internal model should cover one general market risk factor (such as, equity index) that is used to capture the market-wide movements in equity prices. Positions in individual securities or in sector indices may be expressed in “beta-equivalents” relative to this market-wide index.

1.2.3 The CBRC encourages a commercial bank to adopt a more detailed approach to have risk factors corresponding to various sectors of the overall equity market, such as, the industry sectors or cyclical or non-cyclical sectors. The most extensive approach would be to have risk factors corresponding to the volatility of individual equity issues.

1.2.4 The sophistication and nature of modelling technique for a given market should correspond to the bank’s exposure to the overall market as well as its concentration in individual equity issues in that market.

1.3 Exchange Rate Risk

The internal model should cover risk factors corresponding to the exchange rate between the domestic currency and each foreign currency (including gold) in which the bank has a significant exposure.

1.4 Commodities Risk

1.4.1 The internal model should incorporate risk factors corresponding to each of the commodity markets in which the bank holds significant positions.

1.4.2 A commercial bank that takes relatively limited positions in commodity-based financial instruments may adopt a straightforward
method in risk factor specification, that is, the bank may determine one risk factor for each commodity price to which the bank is exposed, or if the aggregate positions in the commodities are small, it might be acceptable to use one single risk factor for a relatively broad sub-category of commodities.

1.4.3 For more active trading, the internal model must take account of the variation in the “convenience yield” between derivative positions such as forwards and swaps and cash positions in the commodity.

1.5 Miscellaneous

1.5.1 The internal model should be able to capture option risk, basis risk, and correlation risk in relation to the above four categories of market risk.

1.5.2 In principle, all risk factors that commercial banks use in their pricing or valuation models should be included in their internal models. If otherwise, the rationale for non-inclusion should be explained.

2. Minimum Qualitative Requirement of Internal Models Approach

The internal models approach used by a commercial bank should meet the general requirements of the CBRC with respect to market risk management and the specific requirements of the Rules as well as the following qualitative requirements:

2.1 The risk measurement should be an integral part of the day-to-day
market risk management activities:

2.1.1 The risk measurement should be based on the internal model for daily market risk management, other than any specially modified model for market risk calculation.

2.1.2 The model should be fully integrated into the daily market risk management process of the bank, as a basis of risk reports to be submitted to the senior management. The modeling result should be deemed as a necessary part of market risk management.

2.1.3 The risk measurement system should be used in conjunction with trading and exposure limits. The connection between the trading limits and the model should be consistent over time and well-understood by both traders and the senior management.

2.2 The daily market risk report prepared by the independent risk control unit should 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.

2.3 A commercial bank should have an independent risk control unit that is responsible for the design and implementation of the bank’s risk management system. The unit should produce and analyze daily reports on the output of the bank’s risk measurement model, including an evaluation of the relationship between measures of risk exposure and trading limits. The unit must be independent from business trading units and reports directly to the senior management.

2.4 A commercial bank should have sufficient employees skilled in the use of sophisticated models in trading, risk control, audits and back office
operations.

2.5 A commercial bank should regularly conduct back-testing programme and stress tests pursuant to the related requirements of the Rules.

2.6 A commercial bank should have an information system that adequately supports the operation of the internal models.

2.7 A commercial bank should have its internal models well documented with sufficient details.

3 Minimum Quantitative Requirements for Internal Models Approach

3.1 A commercial bank may adopt any type of model method that captures all of the material risks, including but not limited to the variance-covariance matrices, historical simulations or Monte Carlo simulations, to calculate the market risk capital charges.

3.2 For a commercial bank adopting the internal models approach, the market risk capital charge is the sum of value-at-risk and stressed value-at-risk (sVaR), both of which should be calculated pursuant to the minimum quantitative standards in the Rules.

3.3 A commercial bank should calculate value-at-risk on a daily basis, using a 99\textsuperscript{th} percentile, one-tailed confidence interval.
3.4 In calculating value-at-risk, commercial banks should use a holding period of 10 trading days.

A commercial bank may use value-at-risk numbers calculated according to shorter holding periods scaled up to ten days (for instance, by the square root of time method), provided that they should periodically justify the reasonableness of its approach to the CBRC.

3.5 In calculating value-at-risk, the historical observation period used should meet the following requirements:

3.5.1 The observation period should be at least one year (or 250 trading days).

3.5.2 If a commercial bank uses a weighting scheme or other methods for the historical observation period, the effective observation period must be at least one year, that is, the weighted average time lag of the individual observations cannot be less than six months.

3.5.3 Historical data may also be processed by other weighting methods that do not fully comply with the requirements of Item 2 hereinabove, provided that the calculated capital charge using such other methods is not less than the calculated result pursuant to Item 2 hereinabove.

3.6 On the basis of the value-at-risk calculation, commercial banks must also calculate stressed value-at-risk for their current portfolios to capture all of the material market risk.

3.7 The stressed value-at-risk calculation should meet the following
requirements:

3.7.1 The stressed value-at-risk should be calculated at least once a week.

3.7.2 A commercial bank should select a continuous 12-month period which results in material losses as a significant financial stress scenario, and use the calibrated historical data in the period as the basis of calculation.

3.7.3 The selected continuous 12-month stress period is a continuous period that includes extreme stress events. If the extreme stress event lasts less than 12 months, the period should be extended to 12 months using suitable methods.

3.7.4 The selected continuous 12-month stress period should be relevant to the commercial bank’s own portfolios.

3.7.5 The methods that commercial banks use to determine a stress period should be approved by the CBRC. The commercial banks should file its methodology and the outcome of the selection to the CBRC, and review the stress period regularly.

3.8 A commercial bank should ensure that the data in their internal models is reliable. If no reliable data is available, alternative data or other reasonable techniques to measure value-at-risk may be used. Commercial banks should be able to demonstrate the rationale of their techniques, without materially underestimating risks.

3.9 A commercial bank must update their data sets at least once a month, reassess them whenever market prices are subject to material changes. More frequent updating is necessary to ensure the prudence of the data in the value-at-risk model. The datasets updating process must be sufficiently
flexible to meet the requirements for higher updating frequency.

4. Using Internal Models Approach to Measure Capital Charge for Specific Risk

4.1 A commercial bank may use the internal models approach to measure specific risk capital charges for interest rate risk and equity position risk.

4.2 In addition to the minimum qualitative and quantitative requirements for the internal models approach in this Annex, in using the approach to measure specific market risk capital charges, the internal model must capture all material components of price risk and be responsive to changes in market conditions and compositions of portfolios and meet the following requirements; otherwise, the standardized approach should be used to measure specific risk.

4.2.1 The internal model explains the historical price variation in the portfolio.

4.2.2 The internal model captures concentrations.

4.2.3 The internal model is robust to adverse environemnt.

4.2.4 The internal model captures name-related basis risk.

4.2.5 The internal model captures event risk.

4.2.6 The internal model can be validated through back-testing.

The internal model must conservatively assess risks arising from less liquid positions or positions with limited price transparency under realistic market scenarios.
5. Using Internal Models Approach to Measure Incremental Risk Charge

5.1 Where a commercial bank decides to use the internal models approach to measure specific risk, the bank should also use the internal models to measure incremental risk charge in the trading book. If the internal model does not capture incremental risk, the standardized approach should be used to calculate the capital charge for specific risk.

The term “incremental risk” refers to default risk or ratings migration risk that is not measured by value-at-risk models in relation to interest rate or equity products.

In using the internal models approach to calculate the incremental risk charge (IRC), the internal model should cover the incremental interest rate risk and subject to the approval of the CBRC, may include the incremental equity risk.

5.2 The incremental risk charge calculation should have a one-year holding period and a 99.9th percentile confidence interval.

5.3 The incremental risk charge is the higher of the following:

5.3.1 The average of the incremental values-at-risk in the previous 12 weeks.

5.3.2 The most recent calculated incremental value-at-risk.

A commercial bank should calculate incremental risk charge at least once a week. The model that the bank uses to measure incremental risk should meet the assumption that the risk profile remains stable in a one-year holding period, it should also be adjusted by taking account
of concentration, risk diversification strategies and option characteristics, and it should also be able to capture market-wide events that may affect more than one securities issuer.

5.4 The incremental risk model of commercial banks should take into full account the liquidity horizon of products or portfolios. The term “liquidity horizon” refers to the time required to sell the position or to hedge all material risks covered by the IRC model in a stressed market. The liquidity horizon must be measured under conservative assumptions and should be sufficiently long that the act of selling or hedging, in itself, does not materially affect market prices.

5.4.1 The liquidity horizon may be assessed by positions or on an aggregated basis. In the case that the aggregated basis is used, the aggregation criteria should be clearly defined to meaningfully reflect the differences in liquidity.

5.4.2 For non-investment grade products, less liquid secondary market products, or products that have not experienced any significant price fluctuation, the liquidity horizon should be determined with sufficient prudence.

5.4.3 The liquidity horizon should be not less than three months. The IRC model of commercial banks should take into full account the correlation between default and credit migration events, while the impact of diversification effects and other market variables should not be reflected in the computation of IRC model.

5.5 Netting can be applied only to long or short positions in the same product, and the basis risk, seniority, rating, maturity and netting error of the product must be measured reasonably.
5.6 As long as the following conditions are satisfied, a commercial bank may take into account the effect of the bank’s dynamic hedging strategies, but not deem such effect as a hedging error:

5.6.1 The bank chooses to model rebalancing of the hedge consistently over the relevant set of trading book risk positions.

5.6.2 The bank demonstrates that the inclusion of rebalancing results in a better risk measurement.

5.6.3 The bank demonstrates that the markets for the instruments serving as hedge are liquid enough to allow for this kind of rebalancing even during periods of stress.

6. Back-testing Requirements

6.1 A commercial bank should conduct back-tests by comparing daily profit and loss data with value-at-risk data generated by their internal models, determine the multiplication factor applicable to the market risk capital calculation according to the number of exceptions in the most recent one year, and report to the CBRC the back-testing results and the multiplication factor adjustments on a quarterly basis.

The CBRC oversees commercial banks’ back-testing results and multiplication factor adjustments.

6.2 In case of any of the following, commercial banks may apply to the CBRC for not adjusting the multiplication factor based on the actual number of exceptions:
6.2.1 If the commercial bank can demonstrate that its model is fundamentally stable and that the exceptional event concerned is just temporary, the CBRC may decide not to count the exceptional event concerned into the number of exceptions.

6.2.2 In the event of any substantial institutional shifts in the financial market, the fluctuation of market data and the material change to related coefficients can lead to a number of exceptional events in a short period of time. In such situation, the CBRC may require commercial banks to incorporate into their internal models the systemic factor as soon as practicable, in which process the multiplication factor may be not increased temporarily.

6.3 The back-testing for internal models should at least meet the following requirements:

6.3.1 A commercial bank should calculate the daily value-at-risk in positions on a T-1 basis, and compare the calculated result with the profit and loss data on the T day. If the loss exceeds the value-at-risk, this is referred to as an exception.

6.3.2 For the value-at-risk calculation, the holding period is one day, and the confidence interval, calculation method and historical data period and other parameters used in the calculation should be consistent with those used in calculating market risk capital charges using the internal models approach.

6.3.3 The calculation of exceptions is simple and straightforward, that is, the total number of exceptions in the back-testing result is counted over the past 250 trading days at the end of each quarter.

6.3.4 In applying to the CBRC for implementing the internal models approach, a commercial bank should have a back-testing process in
place and provide the data of back-testing results at least over a one-year period.

6.4 In using the internal models approach to measure specific market risk capital charges, a commercial bank should back-test related sub-portfolios of interest rates and equity securities.

6.5 A commercial bank should have adequate documentation and reporting framework for back-testing.

6.5.1 The bank should fully document its back-testing processes and results in writing, for reference or use by its internal management or external auditors, or the CBRC.

6.5.2 Upon an exceptional event in back-testing, it should be timely reported in writing to the bank’s senior management member responsible for market risk management.

6.5.3 Upon formal implementation of the internal models approach, the bank should submit to the CBRC a report on back-testing results over the past 250 trading days on a quarterly basis.

6.6 According to the number of exceptions over the past 250 trading days, the back-testing results can be classified into the green zone, the yellow zone and the red zone.

6.6.1 The green zone ranges from zero to four exceptions. It corresponds to back-testing results that do not themselves suggest a problem with a commercial bank’s model.

6.6.2 The yellow zone ranges from five to nine exceptions. It corresponds to back-testing results that suggest a possible problem with a
commercial bank’s model, but such a conclusion is not definitive. Thus, the model may be either accurate or inaccurate. Generally, the possibility of inaccuracy will grow as the number of exceptions increases from five to nine.

6.6.3 The red zone ranges from 10 or more exceptions. It indicates a back-testing result that almost certainly indicates a problem with a commercial bank’s internal model.

6.7 Table 1 indicates the relations between the number of back-testing exceptions, zones and capital multiplication factors in the internal model.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Back-testing exceptions over the past 250 trading days</th>
<th>Increases in multiplication factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green zone</td>
<td>Less than 5</td>
<td>0.00</td>
</tr>
<tr>
<td>Yellow zone</td>
<td>5</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>0.65</td>
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<td>8</td>
<td>0.75</td>
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<tr>
<td></td>
<td>9</td>
<td>0.85</td>
</tr>
<tr>
<td>Red zone</td>
<td>10 or more</td>
<td>1.00</td>
</tr>
</tbody>
</table>

7. Model Validation Requirements
In using the internal models approach to calculate the regulatory capital charge for market risk, a commercial bank should validate their internal models and supporting systems pursuant to the Rules to ensure that the models use correct theories, reasonable assumptions and integral dataset, and the model performance is stable, outcome is accurate and analysis is properly conducted and distributed. The detailed requirements for the validation of internal models can be found in Annex 16 of the Rules.

8. Stress Testing Requirements

8.1 In using the internal models approach to measure market risk capital charges, a commercial bank should conduct relevant stress tests pursuant to the requirements of the Rules.

The stress scenario that the bank uses in stress testing should cover a range of potential risk factors that can create extraordinary losses in or material adverse impact to the bank’s trading portfolios, or those that prove difficult to manage both in ex-ante and ex-post process. These risk factors should include low-probability events in all major types of risks, and reflect the impact of such events on positions that display both linear and non-linear price characteristics.

8.2 A commercial bank should be able to conduct stress tests on a daily basis. Also, the bank should regularly assess risk conditions in stress scenarios, with particular attention to the material risk source and key vulnerabilities disclosed by stress testing. If the stress test indicates that a given scenario has a significant adverse impact, the commercial bank should manage such impact by reducing the risk exposure or allocating more capital to it.
8.3 A commercial bank should have stress testing programs for market risks.

The stress testing program should focus on concentration risk, lack of liquidity under stressed market conditions, one-way markets, event risk, nonlinear products, and other risks that may not be properly reflected by the commercial bank’s internal model.

A commercial bank should have their stress testing programs approved by the board of directors and the senior management, and regularly assess and update such programs. The senior management should regularly review the stress testing results, then take such results into account when assessing the capital adequacy, and shed light on such results in the policies and limits set by the management and the board of directors.

8.4 Stress testing should incorporate both quantitative and qualitative standards, and take into account market and liquidity aspects of market disturbances. Quantitative standards should identify plausible stress scenarios that are probably faced by commercial banks, and qualitative standards should emphasize that the two major objectives of stress testing are to assess commercial banks’ ability to absorb potential large losses with their capital, and to identify feasible measures the bank can take to reduce risk and conserve their capital.

8.5 A commercial bank should select stress testing techniques, including sensitivity testing and scenario testing, which are the most suitable for their business scale and complexity.

8.6 A commercial bank may determine the details of a stress scenario to cover different degrees of severity, according to the position size, structural characteristics and complexity of their portfolios. Stress scenarios can be
essentially classified as follows:

8.6. **Supervisory scenarios requiring no simulations by commercial banks.** A commercial bank should have information on the five largest daily losses experienced in each quarter available for review by the CBRC. This loss information should be compared to the level of capital that results from the bank’s internal measurement system.

8.6. **Historical scenarios requiring a simulation by the bank.** A commercial bank should subject its trading portfolios to two types of historical scenarios separately. The first type covers significant price movements and the sharp reduction in liquidity associated with the events, and the second type would evaluate the sensitivity of the bank’s market risk exposure to changes in the assumptions about volatilities and correlations.

8.6. **Stress scenarios developed by the bank itself to capture the specific characteristics of its portfolio.** A commercial bank should develop its stress tests which should identify the most adverse scenarios on the characteristics of their portfolios. The bank should provide the CBRC 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.

8.7 A commercial bank should have a sound process in place to ensure comprehensive stress testing for market risks. Such process should include at least the following components: to analyze the characteristics of the bank’s portfolios and the external market environment for the bank’s operations, in order to determine major risk factors to be tested under stressful conditions; design suitable stress tests for the bank’s portfolios, including a detailed description of possible stress events and situations; document the assumptions used in stress testing and the methods used to make the assumptions; conduct regular stress tests and analyze the results to determine key vulnerabilities and potential risks; report the stress testing
results to the commercial bank’s senior management and related management personnel; determine suitable remedial actions in stressful conditions against any potential risk uncovered in stress testing; and report to the board of directors the stress testing results and the proposed remedial actions.

8.8 A commercial bank should regularly review their stress testing programs against portfolio characteristics and changes to the external market environment, to assess the effectiveness of fundamental assumptions used in stress testing. The review should at least include: the risk factors covered by the stress testing program; the integration of stress testing into daily risk management; the approval process of the stress testing, including the authorization for any material amendment thereafter; the accuracy and integrity of position data used in stress testing; the consistency, timeliness and reliability of the data sources used in stress testing; and the adequacy of the documentation of the stress testing process.

9. Reporting Requirements

Upon the approval of the use of the internal models approach to measure market risk capital charges, a commercial bank should report to the CBRC the operation of their internal models on a quarterly basis. The report should include at least: any major change to the modeling method, contents or coverage, the back-testing results for the reporting period, any major changes to the information system or management personnel, and any new business development related to market risk.