Unofficial Translation prepared by The Foreign Banks' Association

This translation is for the convenience of those unfamiliar with the Thai language.
Please refer to the Thai text for the official version

Market Risk

Audit Manual

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Section 1 Definition of Market Risk [1]

1.1 Definition of Market Risk

Market risk refers to risk arisen from movements of interest rate, foreign exchange rates and prices of instruments in the money and capital markets which negatively affect the earning and capital of the financial institution. Market risks can be classified into 3 types which are interest rate risk, foreign exchange risk, and price risk.

1.2 Types of Market Risks

1.2.1 Interest Rate Risk

It is a risk that earnings or capital may be negatively affected from changes in interest rates of assets, debts, and off-balance sheet items, all of which are rate sensitive items. It can also affect net interest income, market value of the trading account, incomes and other expenses associated to interest rates[2] such as loan fees, deposit service fees, and provision expenses, etc. Sources of interest rate risks are as follows:

Repricing Risk is a risk occurred from timing mismatch in fixing new interest rates (for floating interest rate contracts), and contract terms (for fixed interest rate contracts) of assets, debts and off-balance sheet items, such as when the financial institution lends long-term loans with fixed interest rates funded by short-term deposits. Where market interest rate is inclined to increase, the financial institution will be at risk of receiving lower future incomes if the deposit rate increases in the short term while the lending rate is fixed till the end of the contract which is long term.

Basis Risk occurs from the changing in market interest rates causing the interest rates received and paid of assets, debts and off-balance sheet items, each linked to a different interest rate or being a different type of financial tools, to change differently. For example, when the short

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[1] This Market Risk Audit Manual has been used since 2001. It focuses on the assessment of market risk on a whole without separating the trading book and the banking book. When the Financial Institutions Policy Group issues a clear policy on capital charge for market risk, this manual will be duly amended. Nevertheless, the Bank of Thailand has herewith inserted information on Trading Book and Banking Book in Appendix (f.).

[2] Income from other services excluding interest e.g. loan servicing such as debt collection and asset securitization. These may be significantly tied to the movement of market interest rate in which the return depends on the size of lending. When interest rate decreases, this unit may receive less fees as more debtors repay their debts prior to due date.

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term interest rate increases by 50 bps, deposit interest rate linked to 3-month LIBOR rate may increase by 50 bps while lending rate may increase by only 25 bps.

Yield Curve Risk occurs from the changing of shape and gradient of the yield curve from previous prediction, which has a negative impact on earning or economic value, e.g. value of the hedge from holding an asset which is 10-year government bond (long) by selling 5-year government bond (short). If the long term interest rate changes more than the rise of short term interest rate, the yield curve will be steeper. This will cause a decline in economic value as the value of asset, the 10-year bond, will decrease more than the value of debt from the 5- year bond.

Option Risk occurs from the changing of market interest rates causing the volume or the cash flow period to be received from a financial tool with an underlying option to change which in turn produces negatively impact on the earnings or capital of the financial institution. For example, a financial institution buys a callable debenture issued at the time that the market interest rate was equal to 10 percent, with coupon rate of 10 percent and a term of 30 years. If the market interest rate decreases to 8 percent, the issuer may redeem the debenture before the maturity date. This causes a change in the cash inflow projected by the financial institution which has a negatively impact on the financial institution as they have to re-invest at a lower market interest rate. Alternatively, bank's customers with overdraft accounts may withdraw from the accounts without prior notice.

Loans and deposits also have option risk in the case that the debtor is able to repay the loan before maturity, either partially or entirely at any time without having to pay any fees to the financial institution, known as prepayment risk, or in the event the customer may withdraw their deposits before due date. Both events affect the financial institution's cash flow estimate and may have negatively effect if reinvested is at a lower market interest rate or if funded at a higher interest rate. Option risk is, therefore, crucial and must be considered in evaluating the interest rate risk.

1.2.2 Foreign Exchange Risk

It is a risk that earning or capital may be negatively affected from the fluctuation of exchange rate, due to a transaction in a foreign currency or from holding an asset or debt in a foreign currency. The assessment of foreign exchange risk can be classified into 2 categories, transaction risk and translation risk.

1.2.3 Price Risk

It is a risk that earning or capital may be negatively affected from the changes in the price of debt or equity instruments. This causes the value of the investment in the trading portfolio and profit of the financial institution to diminish.

Section 2 Recommended Market Risk Management Practical Guidelines

Risk Management Factors

In managing market risks, financial Institutions need to have four fundamental management factors as follows:

1. Appropriateness of the roles for the board of directors and senior management[3] as well as suitability of the organizational structure
2. Sufficiency of policy and practical guidelines for risk management
3. Appropriateness of the specification, measurement, monitoring and reporting.
4. Effective internal control and audit independence

The financial Institutions need to adjust these 4 components to suit their characteristics, complexity of their transactions and their existing risk levels. Therefore the suitability of the method of risk management may vary for each financial institution. For example, for a small financial institution, where the senior management level is involved with the daily operation, it can use basic risk management. However for a large financial institution, where the business involves various complex transactions, it will need a more formal and comprehensive risk management to assist the senior management in obtaining adequate information in order to monitor and manage its operations.

Complex risk management process needs sufficient internal control and audit, as well as adequate supervision mechanism. This is to ensure that the senior management receives reliable information to monitor compliance with the set policy and risk level. Moreover, there must be segregation of duties in measuring, monitoring and controlling risk to be independent from decision makers and those who transact [the business] such that duties may be performed with the best interest of the financial institution.

In managing risks, the financial institutions should consider the overall picture of risks or consolidated[4] risk management and should bear in mind that the accounting practice which permits offsetting risk positions of the affiliated companies within the group will decrease the

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[3] Definition of senior management in accordance with the Notification No.: ThorPorTor. SorNorSor. (31) Wor. 2770/2002 Re: Structure of Good Governance Committees of Commercial Banks dated 3rd December 2002.
[4] Definition in accordance with the Notification No.: ThorPorTor. SorNorSor. (31) V. 2770/2002 Structure of Good Governance Committees of Commercial Banks, 3rd December 2002.

consolidated risk for the group. However, the said method may cause assessed risk to be lower than actual risk if there is any legal limitation or constraint in actual practice which obstructs the adjustment of risk level.

Good Risk Management Process

Good market risk management process must have an efficient and concise method covering the specification, measurement, monitoring, reporting and controlling of risk in a timely manner. Each financial institution may have a different process varied by its complexity and sizes. Risk management principles and process should be documented to allow an effective control and communication over the entire organization.

An effective risk management process should have the following characteristics:

2.1 Appropriateness of the Roles for the Board of Directors of the Financial Institution and Senior Management and Suitability of the Organizational Structure

The board of directors and senior management of the financial institution should have an effective way of controlling risks and should understand the characteristics and existing levels of risks that befit the business strategies and mechanisms for risk management. Effective risk management must have reporting to the board of directors and capable managers and effective staff.

2.1.1 Roles of the Board of Directors of the Financial Institution

The board of directors of the financial institution should consist of people with diverse experiences, possessing a basic understanding of the business and market risk management, being independent and participating in meetings - regularly contributing opinions or useful suggestions. In addition, it should have the following duties.

- To establish strategies and risk tolerance levels
- To appoint senior management with authority to be responsible for risk management
- To monitor performance and overall market risk of the financial institution to ensure that it is manageable and have a sufficient supporting capital
- To ensure that the financial institution develops basic guidelines in specifying, measuring, monitoring and reporting market risks.

- To arrange to have suitable and sufficient educated staff with capability in market risk management

2.1.2 Roles of Senior Management

Senior management must arrange to have market risk management both short-term and long-term comprising of these activities:

- Improving and developing procedures and various operating processes in conformity with the objectives and an appropriate risk tolerance as approved by the board of directors of the financial institution by setting operating standards and communicating with the staff to ensure proper understanding.
- Overseeing that operation follows the prescribed line of authority and responsibilities enabling timely measurement, monitoring and reporting of market risk as well as ensuring that staff responsible for analysis and market risk management is knowledgeable, capable and experienced in line with the characteristics and scope of transactions of the financial institution. There also must be an adequate number of staff and they should have the ability to perform work of one another.
- Overseeing that information technology and other systems are utilized to facilitate market risk management.
- Establishing a system for internal control and an effective verification process of market risk management.
- Stipulating adequate segregation of duties in risk management process to circumvent any conflict of interest, including establishing various security measures.
- Stipulating adequate and appropriate risk tolerance ceiling.

Standards for the assessment of position, performance, and report of market risk must be set. Management reports should give overall information of risks and a sufficient amount of details, enough to evaluate changes or effects to financial institution and enable decision making.

2.1.3 Organizational Structure of Market Risk Management

The organizational structure should allow verification, check and balance system, possess line of supervision and specify responsibilities in line with the development strategies and the procedures for measuring, monitoring and reporting of market risk. The senior management should ensure that these jobs are included in market risk management system.

The financial institution should have sufficient numbers of relevant committees. There should be units that are responsible for verification of compliance with laws and internal control including teams that control and monitor market risks.

The policy should clearly state the responsibilities of the management staff and risk control team. These staff should be independent from both front and back offices.

2.2 Sufficiency of Policy and Practical Guidelines of Risk Management

The financial institution should clearly state the policy and practical guidelines in managing market risks by containing the following importance characteristics:

- Standards of assessment of status and performance as well as market risk report must be set. Report to the management should present overall information of risks and a sufficient amount of details, enough to evaluate changes or effects on the financial institution and enable decision making process.
- It should be clear and documented with approval from the board of directors of the financial institution. Moreover, it should be re-evaluated by board of risk management or other related committees at least once a year.
- Consolidated risk of the financial institution and its affiliated companies should be considered.
- Responsibilities for risk management must be stipulated.
- Types of financial tools offered, policies on risk deterrence and maintenance of position must be prescribed.
- Estimated factors are to be specified. Risk tolerance of the financial institution should be stipulated which may be in accordance with the type of financial tools, type of portfolios, and type of transactions. In the event of an action which is exceptional or deviated from the policy, risk ceiling or approval authority, procedures and approval process should be clearly stated in written document.
- For any new service or work plan, risks must be specified. Establishment of procedures, checking process and adequate control must be made prior the commencing the service or new transaction.
- The initiation of risk deterrence strategies or important risk management methods shall require approval from the board of directors of the financial institution or other related committees. This is to ensure that the financial institution understand the risk factors of

those services or transactions and to offer them in conjunction with the current process of risk management.

- Business Continuity Plan (BCP) and systems to handle emergency situations which may affect operations and capital must be established.

The financial institution should communicate their policies and practical guideline to related divisions to allow correct understanding and practice.

2.3 Appropriateness of Risk Specification, Measurement, Monitor, Report and Control

2.3.1 Risk Specification

The financial institution should be able to specify the market risks currently facing and which may occurs in the future by understanding which types of market risks are important and must able to identify the sources of the said risks. This is especially applied to risk from interest rate which may develop from various sources. Risk specification should be undertaken on a continuous basis in order to follow the changing situation. Moreover, various factors, either quantitative or qualitative, which trigger market risks, should be specified.

2.3.2 Risk Measurement

Measuring market risk is one of an importance step in risk management process. Risk measuring system should fit the type and complexity of transactions. This is to enable assessment of the effect on income, economical value and capital of the financial institution. The method should also identify risks which may increase in the future.

The appropriate risk measurement system in this case shall detail the measurement system for interest rate risk since it is significant to Thai financial institutions and its measurement systems are complex and varied.

2.3.2.1 Good risk measurement system should contain the following characteristics:

- Ability to measure all important market risks of the assets, liabilities and off-balance sheet items as well as covering all risks from both trading and non-trading items.

- Sources of all type of interest rate risks, exchange rate risk, and pricing risk should be included.

- Possessing underlying financial theory and being a generally accepted measuring tool. There are many ways to measure market risks, each have its benefits and restrictions depending on the factors of the market risks. Different financial institution may use different methods to measure different risks from different sources. Examples of tools or models employed to measure market risks are Repricing Gap Report, Net Income Simulation, Economic Valuation Model and Stress Test. (See Appendix for details of the various models).

- Information employed must be current, accurate, reliable and timely. It is an important factor in the risk measuring process, regardless of whether it is the information of the position in the balance sheet or off-balance sheet and information on cash flow or various return rates from financial tools or related agreements. If there is any adjustment in the information such as adjustment in estimated cash inflow from loan prepayment, redemption of a debt instrument before maturity that may affect the valuation of the instrument, such shall be clearly documented specifying the detail and the rationale of the adjustment for verification.

- Assumptions and factors used in assessing negative effects on the system should be derived from reliable sources. Risk manager and management of the financial institution must fully understand the said assumptions, in particular the technique of simulation, as it employs many assumptions and is complex. Otherwise, the "tool" shall produce data which appears to be correct but in fact may be incorrect which may lead to a wrong decision. The assumptions should get tested and evaluate at least once a year as well as must be documented as evidence.

2.3.2.2 Appropriate risk measuring system for financial institution

Any risk measuring system regardless of type or complexity, must consists of information gathering, input of information into the system, establishment of assumptions on possible future interest rate, assumption on customer's behavior including computer system and an appropriate risk calculation method. Therefore, the method of measuring interest rate risk should have the following 3 crucial steps which are 1) Information gathering 2) Simulation and assumption of the situation 3) Calculations of risk level.

1) Compilation of Information

The compilation of information to reflect the current financial status (or for Economic Valuation Model will need composite information of the current balance sheet), the gathering of information in the simulation model sometimes called current position inputs; such collected information must be reliable in order to benefit the risk measurement. The financial institution should then possess a Management Information System (MIS) in order to retrieve information that is appropriate, adequate and well-timed. It should have vital resources for the risk measurement system. Problems that can occur from the information for interest rate risk are: incomplete information on operations, on portfolio and branches; lack of status information on off-balance sheet items, caps and floors of lending and deposits or insufficient amount of collected information, etc.

The financial institution must have information of the offered financial tools or all significant types of portfolios. The collected information should consist of the followings:

- Outstanding balance of the account and interest rate as specified in the agreement of the financial tool or portfolio.
- Conditions for principal repayment, date of fixing a new interest rate and the term of the agreement of the financial tool or portfolio.
- For variable interest rate, there must be information on the rate used as reference for the new rate (e.g. prime, LIBOR) including contractual interest rate ceiling or floors.
- The financial institution may have to gather additional information for other types of financial tools in order to observe the complete picture of interest rate risk. For example, for interest rate risk, the additional information required is seasonal factor of some types of credits which may affect prepayment. The financial institution may need to have information on the originating date, interest rate of the financial tool, geographic or local conditions of lending or deposit site. Such information may help to evaluate the speed of repayment or withdrawal before maturity. As the interest rate risk of financial institution expands from risk of on-balance sheet items to off-balance sheet items and fee generating items that are sensitive to interest rate, therefore the system of interest rate risk measurement for financial institution must include such items.

The financial institution must have a system to tap or extract information from the database, which keeps information on terms, interest rates, and conditions for repayment of various items, in order to obtain necessary data for the risk measurement. The financial institution must be able to access any relate information of various related database including information on commercial credits, household credits, information on securities investment, deposit system and general ledger system which are necessary to verify the accuracy of the balance that was extracted from these database. (Normally general ledger system is unable to furnish adequate information on the terns and interest rates of the portfolio of the financial institution.)

2) Simulation and Assumption

This step is to estimate the future value of interest rate and to measure risks under the predicted changes of interest rate. In this step the financial institution must formulate assumptions on the future situation. Such assumptions must be reasonable.

Risks from interest rate for most financial institutions usually depend on the sensitivity of the financial tools to the change of interest rate, the magnitude and direction of the change. Therefore simulation and assumption must take into accounts the two said factors. Nevertheless, problems may occur during this step, such as:

- Inability to measure the potential risk exposure in order to understand the vulnerabilities or stress point in the event when there is a substantial changes in interest rate.
- Inability to adjust or change the assumptions of the financial tools with underlying derivatives to correspond with the interest rate in each simulation.
- Assumptions that are based solely on the behaviors and operating history of the customers without consideration of the ability to compete of the financial institution in the market including the customers' status that may change in the future.
- Failure to periodically evaluate the justification and the accuracy of the new assumptions.

Assumptions on the Interest Rate

The financial institution must consider the rate of changes for the interest rate. The managements must be confident that risk measurements during interest rate movement are

logical and that it selects a simulation model that renders a meaningful estimation. There must be an evaluation of the effect of changes of interest rate for changes that are sudden as well as gradual including stress test scenarios under drastic interest rate changes. This will enable the management to understand the underlying risks in the financial tools and transactions.

In order to set simulation of interest rate, all appropriate related factors must be considered such as current term structure of interest rate, historical volatility and implied volatility. Specific risk characteristics of the financial institution must also be considered, as well as unwind unfavorable risk position and losses from repositioning.

Financial institutions with significant option risks should set a simulation that includes these risks in order to estimate how the risk level of the financial institution would change. Moreover, since the value of derivative changes with volatility and change of the interest rate, the assumptions must be developed to assess the risk from fluctuation changes.

<u>Interest Rate Simulation Methodology</u>

Each financial institution may have different simulation methodologies. Nevertheless, the important point that the financial institution must specify is the current term structure of interest rate and the relationship between yield curve and the various referenced rates such as spread between LIBOR and the rate of certificate of deposit, etc. Moreover, the administered rates of the financial institution such as rate for premium customers, some types of deposit rates must be evaluated as they may change due to the influence of market rate; however, such administered rates usually move slower than the market rate.

Financial institutions generally conduct interest rate simulation by using these two methodologies:

Deterministic Approach

It is a method to pre-determine the magnitude and period of interest rate fluctuation. Then it is evaluated by presetting the standard base case scenario. Further, the worst possible case of interest rate movement is considered. There should also be periodical stress testing. The number of simulations used may ranged from 3 (flat, up, down) to 40 or more simulations. Sometimes it may include "rate shocks" simulation (assuming that the interest rate suddenly changes to another level).   This approach measures the comparative risks of the

difference of net incomes in each scenario with the standard scenario. In general it is expressed as a risk matrix by separating into base case scenario, high risk scenario and low risk scenario.

Stochastic Approach

It is a method that uses randomly generated scenarios which will calculate the result of each random variable (there are thousands of random variables) and distribute the dispersion of the results. Then it will determine the likelihood and confidence level, such as 95%, to calculate net incomes for the next 12 months that will not be less than a fixed amount (such is the lowest net incomes under the 95% confidence level).

Assumptions on Customer's Behaviors

The financial institution must exercise its judgment and set assumptions based on the actual maturity or from re-pricing behavior which may be different from the term in the contract of the financial tool e.g. debtor may prepay, withdraw the deposit or close account at any time. The financial institution has to determine the probability that the customer will exercise the option. These probabilities will vary in each interest rate simulation, geographical regions, competition, pricing, as well as business strategy of each customer base.

The assumptions on customer's behavior is crucial especially for financial tools that do not stipulate new repricing date such as current accounts, saving accounts and credit card loans, etc. The management must estimate the dates that these balances will be repriced, withdrawn or closed at any time. The management must consider various factors such as the current market rates, spreads between the rates of the financial institution and market rate, competition situation, location, and demography of the customer base.

The assumptions must be reasonable and be consistent in each simulation. For example, the assumption on the prepayment of housing credit should fluctuate with the interest rate assumption and reflect the incentives for prepayment under various interest rate scenarios. It is to avoid selecting of any assumptions by basing on sentiment and unable to prove its suitability based on experience and past operations. Sources of information that are generally used to set assumptions are:

- Analysis of the trends of previous portfolios and movements of each account.
- Repayment simulation that the financial institution develops or purchases.
- Various estimated values from the simulation of the seller.

- Information related to business strategies and pricing of commercial unit.

Important assumptions should be verified in order to assess its validation at least once a year since the market situation, competition environment, and change of strategy could render the existing assumptions inappropriate. For example, the market competitiveness changes lowering cost for customer's refinancing thus, triggering faster repayment rate.

The review of important assumptions should include the evaluation of the effect of the assumptions to the risk assessment of the financial institution. The assessment may be conducted under "if it happens according to the assumptions, what will be the effect?" or as sensitivity analysis. This is to assist the management to consider which critical assumptions must be closely monitored. Such analysis is also considered as a type of stress test which will ensure the management that the financial institution will be stable in unexpected events.

The management should arrange for documented analysis of factors using critical assumptions. This will help in the review of the assumptions and in the understanding of the sources of the assumptions. The amount and details of the document should correspond with significance of the risk as well as the complexity of the analysis.

3) Calculation of Risk Level

Calculation of risk level uses information of the current position of the financial institution in conjunction with the assumptions of future interest rate, customer's behavior and transactions of the financial institution to calculate either the period to maturity of the expected term, cash flow or estimation of incomes, or all 3 items. Nevertheless, some financial institutions using risk measuring simulation may encounter some problems such as simulation may not entirely cover all sources of crucial interest rate risks; the management does not understand the method and assumptions of the simulation model in particular purchased simulation; or there is few personnel who can understand the simulation well and the financial institution cannot find a replacement in the event that the particular staff who understands the simulation is absent or resigns.

Calculation of Earning-at-Risk

The financial institutions should have a system to measure interest rate risk on earnings. This earning-at-risk calculation which is a widely used simulation emphasizes on:

1) Net interest income by considering the risk to earnings on accrual accounts. This simulation is similar to the budget or forecasting model which is calculated from the product of the projected average rate and the projected average balances derived from the current position, the assumption of future interest rate, terms, and the calculation of new interest rate on the current position as well as the assumption on new businesses.

2) Gains or losses from mark-to-market of trading book items. The calculation is normally done by the separate values from interest rate risk simulation model. This involves estimating the future cash flow of every items and converting them to present values. The risk is the present values that change in accordance with the interest rate scenarios.

3) Fees incomes that are sensitive to interest rate such as fees from mortgage securitization and credit card fees.

Calculation of Risk to Capital Funds

The financial institutions that maintain positions consisting of large number of medium terms and long terms should evaluate the effect of changes in interest rate on incomes and economical value of equity (EVE), which is a long term effect. The appropriate method in calculating long term risk depends on the terms and the complexity of the on and off-balance sheet items of the financial institutions. Gap Report, EVE model or simulation model may be used.

To select a system to evaluate the effect on its capital funds, the financial institution must consider the structure of its balance sheet and the existing option risk. The financial institutions with the following characteristics should use economic value of equity simulation to measure the risks.

- Possessing long-term assets with fixed interest rates in excess of 25% of the total assets
- Holding deposits at call in large portion compared to total sources of funds
- Having a high ratio of credits and investments with embedded options (such as caps, floors, or assets that can be recalled before maturity, etc.)
- Using risk hedging derivatives

Financial institutions can calculate the fluctuation of long-term interest rate in several ways. Nonetheless, to measure the risk on business value, the Duration-Based Model or Market Valuation Model is generally used. These simulations are compilations of present values of future cash flows for each interest rate scenarios.

2.3.3 Risk Monitoring and Reporting

Market risks occur from risk factors that are constantly changing or are dynamic. Therefore, measuring only market risks of current business may not be sufficient. There also should be an evaluation of risks in the future. In monitoring market risks, financial institutions should evaluate their strategies periodically to see whether it is still appropriate with the risk profile or not. The boards of directors and the senior management of the financial institutions should receive reports to ensure that the existing market risks are still appropriate to a level that it can accept.

In evaluating its strategies, financial institutions must consider risks from future growth of the business. Therefore establishing assumptions about future business is essential. For example, in analyzing risk to income, assumptions may be set on types and proportion of the transactions and businesses undertaken, estimated changes of the interest rate and terms by using market strategy plan, budget, and trend analysis of the past to help determining the assumptions. Some financial institutions may include assumption on future business in analyzing risk on commercial value. For example, to calculate EVE, the risk on EVE at present has to be calculated prior to calculating the sensitivity of future EVE from estimation of balance sheet.

The assumptions on new product lines can help in managing risks in the future. To include the assumptions on the business line in the consideration, the management should be confident that such assumptions are likely to occur and should avoid any assumption that is too optimistic. For example, to increase income under rising interest rate situation, the management must increase credits with floating rate float and reduce credits with fixed interest rates. Such action must take into account the credit strategy, customer base and the needs of the customers.

Normally large financial institutions will monitor market risk regularly and adjusting its strategies in order to adjust the risk by deciding on buying or selling specific financial tools, adjusting terms, prices or using derivatives. Moreover, interest rate risk simulation may be tested or evaluated on strategies prior to actually being implemented. Alternatively, mini simulation may be used especially to analyze financial tools or specific strategies such as trading

deal or derivatives by inputting the results into the simulation model which analyzes consolidated risks.

Financial institutions should have suitable reporting systems. The appointed committees or the senior management should receive, at the minimum, monthly risk reporting. In the event that there is material change in risk level or trend, the reporting should be more frequent. Such reporting should provide information to the committees and the senior management that will enable them to determine the followings.

1) Able to measure the level and trend of risk in general.
2) Able to gauge the sensitivity of the interest rate, exchange rate, or price under significant assumptions.
3) Balancing between risks on returns and the selection of strategy.
4) Reviewing the practice according to the set risk limits including the ones that differ from the set policy.
5) Able to assess whether the level of capital funds is sufficient to bear the existing risk level.
6) Report to the committee and senior management should be clear, precise and timely. Information provided should be relevant to the decision making process and cover supervision activities. It should also include auditing report, appraisal report of financial tools used in risk management by an independent person and report of test on simulation models.

2.3.4 Risk Control

2.3.4.1 Organizational Structure for Risk Control

The financial institution should have an organizational structure that promotes internal control and risk management including suitable line of control and segregation of duties. These are important responsibilities for the management. The staff that is responsible for evaluating the risk controlling and monitoring should be independent from the work that they have to evaluate. The structure of the controlling unit has to be completely separate from the operations unit, front office and being independent from each other in various functions such as:

- Segregation of duties
- Supervisory system

- Reporting system
- Internal control system
- Performance related remuneration system

Examples of departments needed to be independent from others are risk management committee, audit committee, internal audit department or other departments which are responsible for controlling and monitoring the roles of risk management committee.

An audit committee has the following functions:

1) Supervising policies, rules, instructions to rectify any important problem. The internal audit unit must directly report to the audit committee without going through the senior management of the finance department to ensure independence.

2) Following up any urgent problem according to its priority in order to reduce any possible risk.

3) Find the cause and effect of the damage occurred in order to an approach for rectification and to monitor the implementation.

A risk management committee has the following functions:

The risk management committee is established to manage risks of the entire organization by delegating work to teams or staff to continuously supervise and monitor the risks in each area. It should be independent from the units subject to the control and monitor. The main duty of the risk management committee is to issue risk management policy in each area covering all activities or products of the financial institution, to prescribe an appropriate risk tolerance level and the frequency for verifying the suitability of the tolerance level and for reporting.

The committee must set timeframe, frequency of the evaluation and monitor of risks to suit the risk characteristics of the transactions. The financial institution should set type of reports and its frequency including special report in the case of urgency. Such should be submitted to the board of directors in writing. Information used in the review for risk control and monitor should cover information that can specify possible risks. The need of information varies from one financial institution to another depending on its size, complexity and scope of business.

2.3.4.2 <u>Major Components of Risk Control</u>

      a.   Risk Limits

The boards of directors of financial institutions should determine the highest risk tolerance level and notify the management. The management must then use this information to set an appropriate risk limit for the various interest rate scenarios. The management must focus on the cases which exceed the prescribed risk limits.

The prescribed risk limits should be in line with the risk measurement method and depends on the level of capital funds, performance and risk tolerance of the financial institution. Risk limits should match the size, the complexity of the business and the adequacy of capital funds. It should also point out the effects from the changes of interest rate, exchange rate or market price of future incomes and the financial institution's economical value.

Financial institutions may control risks by using several types of risk limits in combinations, regardless of whether they are primary limits which determine earning level or economical value affected by the risks, for example, setting the net earning limit and economical value that change in each simulation of various interest rates or secondary limits that set the limit of the number of transactions by their terms, coupon rates[5], types of financial tools or different financial markets.

<u>Determining Earnings at Risk Limit</u>

This is the limit used to control risk position of the financial institution regarding the expected earnings at a fixed interest rate for each situation. This limit is usually expressed as a change of earnings (as a monetary amount or as a percentage) during an interval and at a particular interest rate situation. Financial institutions usually set the limits relative to one of the following items - net interest income, net income before deducting reserve, and net income or profit per share.

The appropriateness in selecting the said item depends on the sources of normal earning of the financial institution. If the fluctuation of the earnings of the financial institution occurs in the net interest income, the appropriate item should be net interest income. To set a

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[5] Coupon rate could be used to set limit of the amount of business in the situation where you need to control the density of the portfolio, as it can affect the calculation of the bond price.

limit with reference to the net interest income, the management should consider and understand how the fluctuation of the interest margin affects the bottom line. For example, for financial institutions with high general expense, even a small change of margin can significantly affect the net income. At the same time, financial institutions with earnings and expenses that largely do not come from interest but are sensitive to the interest rate changes should choose items that are bottom-line earnings such as net income or profit per share.

Economic Value Limit

The limit should reflect the size and the complexity of the referenced position. Financial institutions that have simple financial tools, low risk and few repricing mismatches of the financial tools of both medium term and long term may choose to use simple risk limits. But in the case of financial institutions that are complex and have a large number of repricing mismatches of financial tools in both medium term and long term or have numerous complex options, they should set risk limits that will assist the damage control of both the economical value and capital funds.

Gap Limits between Assets and Liabilities

Gap limit between assets and liabilities is used to lessen the risks of earnings and capital funds causing by interest rate changes. This limit will control the imbalance of the repricing within the time band.

This limit usually determines the ratio of interest sensitive assets to the interest sensitive liabilities in each time band. A ratio value which exceeds one indicates that the financial institution is net sensitive on the asset side. If other factors remain constant, the earnings of the financial institution will decrease if the interest rate decreases. However, if that ratio is less than one, the financial institution is net sensitive on the liability side. Its earnings will decrease when the interest rate increases. The gap limits between other assets and other liabilities that the financial institutions use to control risk position are gap to asset ratios, gap to equity ratios, and dollar limits on the net gap.

Even though the ratios between assets and liabilities are useful method in setting risk limit of repricing, it may not be effective to render a picture of interest rate risk to the management or the board of directors of the financial institution. Since the gap limits between assets and liabilities do not show the level of net interest income that is affected by risks. Hence, if

the financial institution only uses the said method, its management and board of directors should receive further explanations on earning level and capital funds that are affected from risks ensued from the imbalance of the gaps between assets and liabilities.

   b.   Other Controlling Systems

          The financial institutions should sufficiently have other controlling systems to ensure that the process of risk management is complete. They should support practices that are efficient and effective. In addition, they should have reliable financial and regulatory reports as well as compliance with the laws, regulations and policies.

          The supervision by the boards of directors and senior management of the financial institutions is the heart of internal control system. In addition to establishing a clear line of management, job description and risk limits, the boards of directors and management should ascertain that they have allotted resources to perform the duties of monitoring, examining and controlling sufficiently. Persons or divisions, whose jobs are to monitor and control risks, are to be segregated from the front office which produces risks. This could be a unit of the audit department, compliance department, or risk management department. If the unit responsible for monitoring and controlling is a part of the treasury unit, which is responsible for implementing investment strategy and risk mitigation, the financial institutions then should have a good internal controlling system.

          The boards of directors of the financial institutions may delegate to Asset-Liability Management Committee (ALCO) the responsibility of establishing the policies, rules and procedures related to market risk as well as the duty to manage the structure of assets, liabilities, market risks and liquidity primarily by managing the interest rate risks, organizing a risk measurement system that reflects the actual risks and arranging reporting systems sufficient to be informed of the levels and sources of risks of the financial institutions.

          For an efficient risk management, the ALCO should consist of representatives from each division that encounters interest rate risks. For some financial institutions, ALCO will have representatives from marketing department to allow marketing strategies to be in line with the business structure set by ALCO. The committee should consist of senior executives and determine authority and responsibility in supervising strategies and risk management plan for each of the related divisions on a regular basis in order to measure the risk of conducting business in the future.

In general the ALCO will delegate to the treasury unit the responsibility of supervising the day to day operations. For a small financial institution this could be delegated to staff in investment unit. Nevertheless, prior to the delegation of responsibilities, it shall be under the responsibility of the treasury unit. The ALCO should set a clear procedure and risk limits to control the operations of the treasury unit first. The treasury unit will have the responsibility to invest and manage the structure of assets and liabilities of the financial institution in accordance to ALCO policy. The treasury unit or any other unit responsible for monitoring risk position should report the position to ALCO within a stipulated time frame.

A good internal control system for market risks should have the following characteristics.

- Having an environment that fosters good internal control such as having executives that are knowledgeable of, understand good internal control, and have set up an appropriate organizational structure.
- Having adequate procedures to specify and measure risks.
- Having established policies, procedures, and methods for supervision.
- Having adequate information technology system.
- Undertaking to comply with the stipulated policies and continuously conducting evaluations.

An important component of the internal control system is the regular assessment and verification which includes assessing whether the staff has complied with the established policies, procedures and measures set to accomplish the desired objectives. The assessment and verification should emphasize the changes that may affect the effectiveness of the supervision such as the changing market condition, personnel, technology, operating structure in accordance with interest risk limits and any transaction exceeding the limits should be adequately monitored.

The management should ascertain that the verification, when undergoing any adjustment in the internal control, has a mechanism to ensure that the adjustment is completed within an appropriate period. The verification of the market risk measurement system should include the assessment of assumptions, variables, and the methods adopted. It should be conducted to induce understanding and testing. Documents related to present assessment

process including the evaluation of the correctness of the system should be prepared. Suggestions should be given on various errors. Testing of the compatibility of the sub-systems with main system should be included as well as reporting is to be duly made to the management or various committees.

Establishing of frequency and scope of evaluation of the risk measurement methods and simulation models partly depends on the risk position, activities, changes of interest rate, exchange rate, market rate, and the complexity of the innovation related to the measurement and management of such particular risk.

The financial institution should verify the measurement, monitoring and controlling of risks on a regular basis. It is to be conducted by an independent assessor, such as the internal or external auditor, to ensure that the risk management system of the financial institution is adequate and contain every factors of market risk, on or off balance sheet.

Section 3 Audit Guidelines

3.1 Audit Objectives

1. To assess market risk profile of the financial institution to determine the negative effects on earnings and capital funds from movements of interest rates, foreign currency exchange rates and prices of the financial and capital markets.
2. To assess the adequacy of capital funds to support market risk of the financial institution.
3. To assess the quality of risk management system.
4. To evaluate the management of the financial institution whether it has specified and assessed its existing market risks.
5. To assess whether the officers and staff of the financial institution comply in accordance with the stipulated guidelines for market risk management.
6. To assess the scope and adequacy of internal audit, internal assessment, and internal control.
7. To establish appropriate measures for the financial institution to rectify any errors upon discovering that the existing market risk management has problems or upon having insufficient capital funds to support risks.

3.2 Scope of Audit

3.2.1. Guidelines for Assessing Risk Level

3.2.1.1 The verification and analysis of balance sheet of the financial institution in order to identity the sources of market risks should consider:

- Structure of the maturity terms and the setting of the new interest rate of loans, securities investments and liabilities
- Volume of products with embedded options taking into account the interest rates of such products and the market interest rates
- Indices used to establish the floating interest rates of various products (e.g. prime, LIBOR, etc.) and the level or proportion of the products that are referenced with such indices

- Asset and liability structure and off balance sheet items that are in foreign currencies
- The balance sheet structure, it consistent with the growth assumption set by the financial institution?
- Components of investment portfolio
- Volume and complexity in the employment of various derivative instruments
- Other off balance sheet items such as L/C and Loan Commitment, etc.
- Volume of mismatches of assets and liabilities
- Trends of ratio of asset and liability components on the balance sheet
- Items and volume with risk hedging
- Level of capital charge for market risks

3.2.1.2 Assessment of Interest Rate Risks by Evaluating the Vulnerability to Changes in Interest Rate.

Changes of interest rate in the market may adversely impact the financial institution in 2 ways, on its earnings and its economical value. Therefore in assessing interest rate risk, both must be considered.

Earning Perspective

- Changes in interest rate affecting reported earnings on accrual basis
- The volatility of earnings is crucial in analyzing interest rate risk because the sudden decline of earnings or losses affects the stability of the financial institution causing insufficient capital funds and triggering confidence to falter.
- Net interest income is the difference between interest income and interest expense which is the key item affected by the changes in interest rate as it is directly related to market interest rate and is significant to the overall earnings of the financial institution. Nonetheless, when the financial institution expands its financial activities which generate fee incomes and non-interest incomes such that the net income is composed of incomes and expenses from interest and non-interest sources. Non-interest items can be increased from many activities as well as sources of non-interest incomes such as transaction processing fees are getting closer related to interest rate. The management

and auditors must have a wider perspective related to various items that are affected by changes in interest rate.

Economical Value Perspective

Changes in market interest rate can affect the economical values of assets, liabilities, and off balance sheet items. Therefore the shareholders, management and auditors must take into account the relationships of those changes of the said economical values to the movement of interest rate. The economical value perspective will show the vulnerability of the net shareholders' equity to the changes in interest rate. Economical values of various financial tools can be assessed from the present value of expected net cash flow by discounting the actual rate of return of the market.

Therefore the economical value of the financial institution can be assessed from the present value of the expected net cash flow which is an estimation of cash inflow of assets deducted by the expected cash outflow of the liabilities plus expected net cash flow of off balance sheet items.

The economical value perspective is extremely important because it takes into account the probability that the interest rate movement will affect the present value of cash flow. Hence, it is a broader perspective and includes the effects that may occur in the future rather than the earning perspective, which is a near-term earning perspective only. If only the earning perspective is considered, it is unable to render correct information regarding the effects of interest rate movement on the overall status of the financial institution in long term. In particular, it will not be sufficient in estimating the effects from financial instruments with fixed interest rate in long term or financial instruments with embedded options as the financial instruments that have not been marked to market shall produce profit or loss from the past changes in interest rate that is embedded within such instruments. Therefore to determine the tolerance level for interest rate risk, the financial institution has to consider both the movement of interest rate in the past that produces embedded losses and the effects on future performance. For example, extending credit during the low interest rate period and subsequently the interest rate increases causes the cost of fund to increase. In this case the financial institution is deemed to have an embedded loss.

To assess interest rate risk, the following factors should be considered:

- The changes of directions of interest rate will affect maturity mismatches or the repricing of assets and liabilities.

- The changes of market interest rate cause interest rates received an paid of assets, liabilities, and off balance sheet items that are referenced to different interest rates or different types of financial tools to change differently including changes in the basis risk relationship.

- The impact of changes in the yield curve on both shift and shape on the position on and off balance sheet such as it may be steeper, moderately sloped or horizontal, etc.

- Characteristics, volume and complexity of the transactions with embedded options.

- Interest rate volatility.

- The liquidity of products affected by interest rate. It should be considered that if the said products are adversely affected such that loss is incurred, how quickly is the financial institution able to sell the said products to stop the loss.

- The impact from changes of interest rate to fee incomes.

- The volatility of net interest income. The cause of volatility must be investigated whether it arises from the change of interest rate or not. In addition, the expected future circumstances both internal and external must be considered as well.

- The effects of changes in interest rate to assets and liabilities sensitive to interest rate, both on and off balance sheet separated by main currencies and all other currencies combined, to net interest income and capital funds. This can be assessed by sensitivity analysis of gap in period of 1 year regardless of whether it is obtained from repricing gap report and/or simulation model by considering the embedded option and basis risk.

- The effects from sensitivity and volatility of interest rate to assets and liabilities, which are sensitive to interest rate both on and off balance sheet separated by main currencies and all other currencies combined, and which affect the net income and capital funds. This can be assessed from value at risk (VaR).

- The effects of interest rate to economical value calculated from the difference of net present value between assets and liabilities, on and off balance sheet

adjusted by duration value which may be estimated from the economical value of equity model (EVE Model).

- The objectives and volume of derivative transactions with interest rate risk to be considered in conjunction with the knowledge and understanding of the stated tools.

- Results from stress test of interest rate.

Remarks: Tools - 1) Re-pricing Gap Report, 2) Simulation model, 3) EVE model/ Duration/ Convexity and 4) VaR may be studied in details in appendices.

3.2.1.3 Assessment of Exchange Rate Risk by considering the followings:

- Foreign currency positions
  - Net open position in each currency including on-shore and off-shore[6] items. It should also be considered whether it is a currency that is at risk to incur losses when unwind or hedge position or not. For example, foreign currencies which lack liquidity in the market, etc.
  - Aggregate positions both on-shore and off-shore.

- The volatility of profit/loss from the exchange both realized and unrealized by determining the causes of the volatility whether it arises from exchange rate or not, as well as the expected future circumstances both internally and externally.

- The effects of changes of exchange rates to earnings and capital funds by conducting sensitivity analysis and the effects that take into account the changes and volatility of exchange rates which may be assessed from VaR simulation model.

- The adjustments of capital funds arisen from the changes of exchange rates will affect the proportion of capital funds that is in foreign currencies[7].

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[6] On-shore transaction means a transaction undertaken with domestic counter-party. Off-shore transaction means a transaction undertaken with counter-party abroad.
[7] Capital funds in foreign currencies occur in the case when there is an issue of foreign currency subordinated debenture which is able to be included in the calculation of second tier capital funds.

- Risks from foreign currency translation should take into account:
    - The volume and stability of aggregate portfolios of transactions in foreign currencies,
    - Receiving and payment items which positions are in foreign currencies.
    - The correlation of assets and liabilities which positions are in foreign currencies.
    - Types of products held in foreign currencies such as credits, bonds and derivatives, etc.

- The efficiency of the hedging of currency translation risk can be considered from:
    - The correlation between structure and terms of the assets and liabilities that are in foreign currencies, both in Baht and other currencies or cross currency that excludes Baht currency
    - The effects to economical value from closing out exchange rate risk
    - The hedging of projected income
    - The uses of derivatives for hedging risk

- Result from stress test on exchange rate.
- The effects from changing business strategies related to foreign currencies.
- The volatility of market condition or other external factors such as economic situation, legal changes, changes in technology, competition, and etc.

3.2.1.4 Assessment of Pricing Risk should consider the following factors:

- The volume of investments for trading purpose and for sale purpose in debt and equity instruments and derivative instruments both on and off balance sheet with the objective of gaining a profit.
- The sensitivity of the price to market risk factors such as exchange rate, interest rate, and instrument rate.
- The characteristic of the relationship between price and market risk factors that is linear and non linear.
- Risk level expected from the changes in correlation values, which may be the correlation within the same type of risks (such as interest rate, exchange rate,

stock price, including options that is related to the said types of risks) and/or the correlation between the types of risks.

- Risk of investments in securities for trading purpose and for sale purpose including off balance sheet derivatives that is in the trading book (such as future, interest rate swap, interest rate option, etc.) and that affect the earnings and capital funds. For debt instruments is to be assessed from market value adjusted by modified duration or assessed by using VaR model.

- The volume of profit/loss from investments in securities for trading purpose and for sale purpose, both realized and unrealized, compared to profit before deducting provision.

- The density of debt or equity instruments with pricing risk including off balance sheet derivatives in the trading book and the density of option strike price.

- Market liquidity of debt and equity instruments in the investments for trading and for sale purposes and derivatives. Such can be gauged from the large disparity between purchase and selling prices, lack of purchase and selling prices, or having a low trading volume in the market.

- The stability of income from trading.
  - Proportion of income from trading with customers relative to income form proprietary trading.
  - The volatility of profit/loss from investments in securities for trading and for sale purposes, both realized and unrealized. The cause of volatility whether it occurs from price changes as well as the expected situation in the future both internal and external should be considered.

- Result from stress test of pricing risk.

3.2.2   Guidelines for Assessing the Quality of Risk Management

3.2.2.1 Supervision by the Board of Directors and Senior Management

The board of directors and senior management responsible for the market risk management must have an understanding of the characteristics of the transactions and risk level facing the financial institution.

(1) The board of directors must approve and review the business strategies related to market risks as well as the supervisory policy on market risk management with the objective of

generating income, liquidity and value to the financial institution at the acceptable risk level. The factors requiring consideration are:

- The board of directors of the financial institution must assume a crucial role in monitoring the market risk management.
- It approves policies and delegate duties and responsibilities to senior management enabling them to effectively specify, assess, monitor and control market risks.
- It has assessed the market risks which impact the asset values and the overall financial institution.
- The policies and strategies for risk management are effectively communicated. The related personnel has accurate understanding [of the said policies and strategies].

(2) The senior management is responsible for implementing the approved policies by the board of the financial institution for the management of market risks of both short and long term. The goals, objectives and policies to limit risks provided by the board must be applied by considering:

- The policies and procedures for market risk management should be documented with sufficient details as follows:
    - Specification of duties and responsibilities, line of command and decision making;
    - Clarity in the authorization for transacting [business], the approval of risk prevention and the strategy on positions taking;
    - Precise stipulation of the frequency and assessment methodology and monitoring of market risks, including planning for regular assessment and monitoring;
    - Stipulation of market risk ceiling quantitatively which reflects the level of market risk tolerance of the financial institution.
- The risk assessment system must be effective, of standard and able to affirm the existing volume of market risks of the financial institution.
- There should be procedures for reporting and monitoring risks which the senior management can employ to assess the vulnerability of the financial institution to the market changes.
- The internal control and verification procedures must be effective.

- The senior management should regularly review the policies and procedures of risk management to ensure their suitability to the business undertaking of the financial institution.

- The human resources must have potential, knowledge, understanding and experience by examining the education, training and length of time performing responsible duty.

Remark: Human resources herein include executives and employees in the risk taking, risk control, risk management or other sections related to market risks.

(3) Assessing the appropriateness of the risk management organizational structure

- Structure of the market risk management of the parent company and affiliated companies;

- Establishment of responsible unit for the management and monitoring of market risks;

- Performance results of the market risk management of the parent and affiliated companies and the market risk management of the organization on a consolidation basis.

3.2.2.2 Risk Assessment System

Market risk assessment is one of the crucial steps in the risk management procedures. Hence, the auditor must under the characteristics of each type of tools employed for the assessment in order to evaluate the procedures, assessment methodology, the adequacy of the data base, the capability of the personnel, the sufficiency and suitability of the tools utilized by the financial institution in assessing risks in relation to the size and complexity of its transactions.

(1) Evaluation of the appropriateness and adequacy of the risk assessment system of the financial institution shall examine:

- The capability of the risk assessment system in specifying and assessing important market risks. If it unable to assess all market risks that occur, the financial institution must be able to declare the percentage that the said methodology is able to assess e.g. where the financial institution locates only a portion of the securities prices, it should be able to specify the volume (in monetary term) of collected data is of what proportion to the entire value of the portfolio with market risks.

- The compatibility of the size, characteristics, complexity of the transactions and the policies of treasury management with the market risk management.
- The capability in assessing risk volume with effectiveness.
- The capability in assessing the impact on income and economic value from the changes of interest rate.
- The capacity in specifying and assessing risk positions in medium and long terms.
- The capacity in assessing risks which change with the characteristics of the business, transactions and products to derive a result which would be beneficial to the financial institution.

(2) Evaluation of the reports from the risk assessment system shall examine:

- The ability to issue reports in the format that is easy to understand enabling the board of directors of the financial institution and the senior management to utilize the data to facilitate a timely decision making process.
- Reporting to provide useful information and constraints of the employed methodology as well as the risk assessment system.

(3) Evaluation of the reliability of the tools and effectiveness of the risk assessment methodology shall examine:

- The board of directors of the financial institution or the senior management grants approval to adopt the risk simulation model.
- The assessment of pricing and revaluation of the input data which the financial institution may use mark-to-market from a reliable source or mark-to-model where there is no market price, such shall examine:
    - The independence of the unit which performs the valuation.
    - The reliability and consistency of the employment of pricing sources.
    - The consistency of the applied prices and the price derivation method.
    - The accuracy of the price derivation.
- The input data is checked and reconciled to confirm the accuracy and comprehensiveness as follows:
    - The applied internal data is correctly corresponded with the data on the ledger account in accordance to the maturity of the agreement and others.

- The external data employed is reconciled with other sources to ensured accuracy and reliability.
- There is a well-defined responsible unit for examining the data that is independent from the users and developer of the simulation model.

- The assessment of the suitability of the interest rate changing simulations at various levels that are used as data for the market risk assessment by considering:
    - There is a well-defined responsible unit for examining the data that is independent from the users and developer of the simulation model.
    - The period covered is suitable in terms of past interest rate movement.
    - A simulation of drastic movement of interest rate in a one year period is conducted.
    - The ability to estimate the holding period or period for strategic risk mitigation, ability to estimate transactions, the ability of the financial institution in market penetration and the capability of the management.
    - The ability to specify risks arisen from positions related to options.

- The assessment of the principal assumptions adopted for the simulation model must examine:
    - The review of the suitability of the assumptions is conducted periodically and the assumptions should be compared with the actual data, in particular the assumption using economic conditions.
    - A verification of the principal assumptions is conducted at least once a year and is documented as well as reported to the board of directors and senior management.
    - The assumptions are appropriate with the transactions, business strategies, past experience and competitiveness of the financial institution.
    - If a simulation model is employed to create assumptions, the financial institution should conduct assessments on the said model in the same manners as conducted on the risk assessment simulation. In addition, the auditor of the financial institution must evaluate the procedures of the said assessment as well.

- In the case that the financial institution adopts purchased simulation model, it shall determine:
    - If a simulation model is employed to create assumptions, an assessment must be conducted similar to that conducted on the risk assessment simulation.

- The model is upgraded to support the volume and complexity of the changing transactions as necessary.

- The related personnel understand the process, the application method of the simulation model and is adequately trained to ensure that the staff is able to apply and interpret the meaning of the result derived from the model.

- There is a detailed manual for the simulation model.

- There is a continuous after-sale service.

- In the case that the financial institution develops its risk assessment tools, it shall consider:

  - A manual is prepared which provides important details such as operating methods, calculation techniques and sources of the data, etc. It should be prepared from the development, the operating and testing of the simulation model to be used for study by staff to enable them to substitute one another in their work.

  - The developed simulation models or tools are constantly updated.

  - The unit which develops the simulation or tools has tested and verify the accuracy of the data used in various assumptions, of the calculation, the analysis and the derived outcomes.

- The assessment tools and market risk simulation models, classified in accordance with the types of tools generally employed by financial institutions are as follows:

a. Report of the Difference between Assets and Liabilities (Gap Report)

The Gap Report mentioned here is a tool to assess risk from interest rate (Repricing Gap Report) which occurs from the assets, liabilities and off-balance sheet items with different residual terms (for items with fixed interest rates) and the remaining terms which shall be calculated at the new interest rates (for items with floating interest rates). Such will affect the net interest income and capital funds. The said assessment tool shall consider:

1. Items in Repricing Gap Report cover assets, liabilities and off-balance sheet items, both on the banking book and trading book, which are sensitive to interest rate.

2. Information used must be complete, correct, up-to-date and reliable. The data base should be comprehensive, containing complete and up-to-date positions of assets, liabilities and off-balance sheet items. There must be a review of the accuracy of the data.

3.   Rules and assumptions for specification of time band of the assets, liabilities and off-balance sheet items shall be suitable, accurately computed and appropriately distributing these items within each time band by considering from the days to recalculation of the new interest rate. Too narrow a time band may not be beneficial to the risk management. However, too broad time band could cause the cash flow of assets, liabilities and off-balance sheet items which are within their maturities to be within the same time band as those that will be calculated at the new interest rates. As such it reduces the accuracy in the assessment of interest risk of the Repricing Gap Report.

4.   Is the Repricing Gap Report separated by the major currencies such as Baht, USD or JPY, etc.? Separation by currencies clearly distinguishes the items in Baht and foreign currencies and facilitates evaluation of the effects. In addition, the assumptions for assessing the effects from the changing of interest rates in each currency could be stipulated individually depending on the past data of interest rate of each of the currency and their magnitude of changes.

5.   In setting appropriate assumptions, the factors composing the assumptions are assessed whether they reflect the actual position of the financial institution or not. For example, for the estimation of the past volume, seasonal factor or consumers' behavior in the distribution of assets, liabilities and off-balance sheet items, estimates are made on the maturities of these items which are not due or terms till the fixing of the new interest rate such as savings, overdrafts and items with embedded options, prepayment of loans or early withdraw of deposits, etc. Furthermore, documents are prepared for these assumptions and the review of the assumptions is reported to the management or not. The management hence needs to fully understand the assumptions used.

6.   Does the result from the Repricing Gap Report have any benefit? How it is utilized? To who is it reported?

7.   The limitations associated in using Repricing Gap Report. In assessing the capability of the said tool, the management and the tool user must recognize its limitations as follows:

- It is simple to prepare but is a crude assessment. Wide time bands may cause the accuracy to reduce which the financial institution may repair by using weighted average of the repricing maturity in each time band or narrow down the time bands.

- It is a tool with static assumptions i.e. it is assumed that for the next 12 months from the audit date the various information used in the Repricing Gap Report remain unchanged while in the real life situation, assets, liabilities and off-balance sheet items are constantly changing (dynamic).

- In stipulating that the market interest rate changes by 1%, it is assumed that the short-term and the long-term interest rate change at the same rate (parallel shift in yield curve). However, the actual situation, the interest rate for each time band may changes unequally. Hence, this tool is unable to assess Yield Curve Risk.

- In stipulating the interest rate of assets, liabilities and off-balance sheet items changes at 1% across the board causes the exclusion of Basis Risk from the Repricing Gap Report unless the Index of each of these items is established that if the referenced rate changes by 1%, how would each of these items change.

- It does not cover Option Risk if the financial institution does not set assumptions for items with embedded options.

b. Earning Simulation Model

This is a tool to assess interest rate risk which affects the net interest income and capital funds by Simulation which creates various business plans under a variety of interest rate scenarios. It is able to assess the interest rate risk more accurately than the Repricing Gap Report since it is able to produce more accurate cash flows from different periods as each item is calculated separately and it is a dynamic assessment. Furthermore, it enables better interest rate management. In assessing the said tool, the followings should be considered:

1. Earning Simulation is utilized to assess which items of the assets, liabilities and off-balance sheet items are affected by the interest rate and to assess the risks both short and long term. If all these items are not covered, how will the financial institution assess and monitor the remainders?

2. The entirety, accuracy, timeliness and reliability of the input used in the preparation and evaluation of the data base of the financial institution that utilizes these data to build a simulation model since these data are significant and have direct effects on the output.

3. The sufficiency and the reasonableness of the assumptions used. Assumptions of any simulation model are fairly complex and sorted into groups. Each group may

consist of interest rate management plan, technique to mitigate risks and various interest rates. Factors worth considering are:

- Whether the rationale and data in making the assumptions and the preparation of documents in adjunct to the assumptions are clear or not?
- The knowledge, the capability and the know-how of the staff preparing the assumption e.g. computer skills, ability to analyze risks and know-how in the business, etc. since the simulation model involves making a vast number of assumptions.
- Is there a regular reporting of the review of the assumptions to the management? The management must understand the assumptions and have the assumptions adjusted to the changed situation.

4. Upon changing of the environment, is the scenario adjusted to accommodate the said changes? Since the various simulations must observe the business conduct of such a financial institution, it is extremely necessary that it make modifications when the business environment changes.

5. The developer, the user and the tester of the simulation model must be knowledgeable and have an understanding of the methods and the meaning of the output to ensure that such a model is not just a black box i.e. such staff should be adept in computation, computer operation as well as is averse in business and risk analysis.

6. Is the computer system of the financial institution able to support the running of a simulation since it requires the computer system to create numerous scenarios?

7. How is the output used e.g. for only risk assessment or for planning and establishing the risk management guideline and for managing interest rates. How is it useful to the financial institution? To who is the output reported? The output should be reported to the management and the management should be able to interpret the implication of the output. The reports generated from the simulation model may be numerous and in many formats.

8. Is the back testing conducted to test the simulation model or not? What is the result? Is it conducted on a regular basis or not?

9. The financial institution must be aware of the limitations of the simulation model such as:

- It may express inaccurate risk position due to being linked with several assumptions. In such a case, it may render indication or assessment with much difficulty. How does each variable affect on the changing of the value of the target item?

- Most income simulation models are used to assess risks within a period not exceeding 2 years. Longer period will yield inaccurate results. Hence, the financial institution should in conjunction uses the economic value simulation model in order to cover assessment for the long-term.

- It requires a rather long period of time to analyze the data.

- The outcomes are numerous and diverse.

- It requires constant medications to reflect the changing situations.

- Problem solving is conducted on a trail and error basis.

- It requires personnel with knowledge and expertise in computer, data analysis or risks in addition to business proficiency.

c. Economic Valuation Model or Duration Model and Convexity

These are tools for assessing interest rate risks that affect Economic Value of Equity (EVE) by assessing the changing of present values of assets, liabilities and off-balance sheet items under various interest rate scenarios. In assessing the said tool, the followings should be considered:

1. Sensitivity of the economic values affected by the interest rate should be assessed by weighting the assets, liabilities and off-balance sheet items within each time band with the modified duration, which is the percentage of the changes of the position when the interest rate changes by 1%. This type of methods is an assessment of the effects in the long term which arise from the changing of interest rate to all assets and liabilities. Hence, it is suitable to a financial institution with a larger number of mismatch positions in medium and long term and a large proportion of fixed interest rates.

2. Which assets, liabilities and off-balance sheet items are covered by the economic value simulation model?

3. Suitability of the various interest rates used as discount rates to derive the present value of the cash flow of each asset, liability and off-balance sheet item in order to assess the consistency of the interest rates used with the characteristics and types of each of the asset,

liability and off-balance sheet item as well as review of the reliability of the interest rates used and the sources of the interest rate data.

4.   Duration is a tool for assessing the relationships between interest rate and values of assets, liabilities and off-balance sheet items that are linear. Where the relationship is non-linear, the Duration is unable to assess with any accuracy. The tool required is called Convexity which shall be explained as the next topic.

5.   The financial institution is aware of the limitations on using Duration as a tool for assessing the sensitivity of the economic value. Limitations are Duration are, for example,:

- It is relevant for assessing value changes when interest changes slightly and equally in every time band (parallel shift in yield curve) but unable to be used for assessing value changes when interest in each time band changes differently. The accuracy will diminish if interest changes extensively.
- Duration of different financial tools will change at various rates as time passes. Therefore, in the portfolio that is hedged for duration, the effectiveness of hedging shall diminish when time passes.
- There is an assumption that the expected cash flow is constant. Hence, the said assessment may not be accurate for financial tools with embedded options, which tend to be increasingly sensitive to interest when the interest rates increase; such is a non-linear relationship.

6.   Utilization of outcomes by taking into account of who are these outcome reported, how are they utilized, does the management acknowledge and understand the meanings of the outcomes or not.

7.   Personnel that develops, uses and tests the simulation models have know-how, understanding in applying the simulation models and outcomes or not. Qualifications of the said personnel should include proficiency in computation, computer and capable in analyzing business data as well as risks.

8.   Is back testing conducted to check the simulation models or not? What is the result? Is it conducted on a regular basis or not?

Convexity

It is a tool to assess the changes of the value of an instrument that has a non-linear relationship between the interest rate and the value of assets and liabilities in addition to the interest rate greatly fluctuates creating a chance of a big shift in yield curve. The assessment of the said tool should consider:

1.   Products using Convexity for risk assessment, directive and procedure for using the said tool for risk assessment.

2.   The know-how, understanding and experience of personnel in the application of the tool, procedures of risk assessment and the derived outcomes. Qualifications of the said personnel should include proficiency in computation, computer and capable in analyzing business data, in analyzing risks and understanding of the products.

3.   How is the outcome report utilized? To whom is it reported? Does the management acknowledge and understand the meaning of the outcome or not? Has it been used to complement the planning and determining the direction of interest rate risk management or not? How?

4.   The financial institution being aware of the limitation in using Convexity such as the assumption is that the changes of interest rates are equal in every time band (parallel shift in yield curve), what means does it have to remedy the limitation?

d.   Value at Risk Simulation (VaR)

It is a tool to assess the interest rate risk, exchange risk, pricing risk by taking into account the changing of the market factors (e.g. interest rate, exchange rate, stock price, etc.) and the volatility of the said changes. Furthermore, the VaR simulation is also use to control and manage portfolios. In assessing a VaR simulation model, [the followings] should be considered;

1. Is the method of VaR calculation corresponds to the type, size and complexity of the transaction of the financial institution or not? For example, for the case that the financial institution has many non-linear transactions, the variance-covariance method which is unable to assess risk of non-linear transactions may not be suitable. The adequacy and reasonableness of the assumptions of each method [must also be considered}. There are 3 basic VaR calculation methods which are variance-covariance (Parametric VaR), historical simulation

and Monte Carlo simulation. Each method has different strengths and weaknesses. The auditor must determine if the method selected by the financial institution is appropriate or not?

2.   Which product or type of risks does the financial institution use the VaR simulation to assess and which market risk factors? Risk factor means factor whose change causes the valuation of the position of the financial institution to change with it such as interest rate, exchange rate, bond price, stock price and volatility. How are such factors assessed?

3.   What are the constraints of the VaR simulation? Is the financial institution aware of [them]? Has it been reported to the management or not? Since this simulation model is unable to assess all products and every risk which may be caused by the constraint of the tool or of the financial institution itself, how will the financial institution remedy and improve the said constraints e.g. constraints on data, assessment and calculation method or capability of the personnel, etc.?

4.   At what values are the parameters set and what are the rationales behind setting the value of each parameter? Such parameters are:

- *Confidence Level*   The confidence level in VaR calculation is the level of confidence on the outcome derived. The financial institution may use confidence level of 95%, 97.5% or 99%. Each confidence level will yield different VaR. The financial institution may specify different confidence level for each risk depending on its discretion such as specifying a confidence level of 99% for exchange risk and 95% for pricing risk, etc.
- *Holding Period*   Position holding period is the period which the financial institution expects to close its various asset and liability positions e.g. 1 day, 10 days or 1 month, etc. In the trading book case, it may be able to quickly close the losses e.g. 1 day or 10 days. However, banking book may require months.

5.   Is the data employed correct, complete, up to date and reliable or not? Such important data are position, market data, historical data, volatility, correlation and calculation. Historical data should be collected for no less than 250 days for the case where the data are weighted equally (unweighted) or it may be less than 250 days for the weighted data i.e. more weight is given on current data since it is deemed that further back data has less effect on the present. The amount of weight given depends on the decay factor selected by the financial institution e.g. 0.94, 0.97 or 0.99, etc. The rationale for selecting such [factor] should be given.

Moreover, it should determine the sufficiency of the collected data and whether the source of the data is reliable or not. For instance, market data should come from a reliable source such as Reuter, Bloomberg or Telerate, etc. Additionally, how frequent is the data updated?

6. How does the financial institution determine the correlations? Is it a correlation within the same type of risks (e.g. interest rate, exchange rate and stock price including options related to the said type of risks) and/or a correlation between the types?

7. How does the financial institution derive the volatility value? Is it a historical volatility derived from using Moving Average method, ARCH method or GARCH method or is it implied volatility?

8. As the Running Time for processing VaR requires considerable amount of time, is the data available in time to be of benefits? Is the computer system able to accommodate such processing or not?

9. Has the VaR simulation model been approved by the senior management or the relevant committee and the approval been documented and reviewed by an independent unit or not?

10. How is the outcome report utilized and how the management it in planning and setting the management directions? For example, to whom is risk control by establishing VaR limit reported? How well does the reporting format assist the management to understand the outcome? Does the management understand and is it able to interpret the outcome as well as able to recognize the various constraints of the simulation model?

11. Did the financial institution conduct any test on the simulation model prior to the implementation (validation) and has it there been constant revalidation? How frequent is the revalidation? It should be at least once a year or upon significant changes. There is a unit responsible for revalidation of the simulation model which is independent from the unit that develops and uses the model.

12. Does the financial institution conduct any back test to check the precision and accuracy of the calculation of the VaR simulation model?

Back testing is the number of exception occurrences (actual loss exceeds the derived VaR) when the resulted values of VaR are compared to the actual profit/loss. In assessing the back test, [the followings] should be considered:

- Confidence level used in conducting Back Test should correspond to the specification and confidence level used in assessing VaR for comparison of the results. The confidence level will be the indicator of the number of times the financial institution is willing to allow errors to occur. For example, the confidence level of 95% indicates that 5 out of 100 errors are allowed. Therefore, in the assessment of 250 days of VaR, the [number of days that] actual losses are permitted to exceed the VaR is no more than 12.5 days in 1 year (250 business days).
- Holding Period that the financial institution may select is 1 day, 10 days or 1 month. However, 1 day is normally selected for trading book by BIS standard.
- Historical period used in the consideration of outcome from Back Test should not be less than 250 business days (1 year).
- The comparison of VaR and Actual P/L or Hypothetical P/L

e. <u>Stress Testing of Financial Institution</u>

Stress test is method for assessing risks arisen during stress events. Since the aforementioned tools for assessing various risks are used for risk assessment under normal circumstances only and in the case there statistical assessment which specifies a confidence level e.g. 99%, the use of stress test may account for the loss events within the remaining 1%. The risks arisen during the said stress events may have a small probability but if occur may cause great losses. Stress tests may be classified into 3 types as follows:

1) Historical simulation is a simulation of the past changes including the worst case scenario of the occurrence.

2) Random simulation is a set adjustment of the yield curve causing the price scenario to be created randomly to determine the deviation from the norm. For example, a scenario is created that the yield curve shift up or down within 100 bsp., to make the yield curve steeper in the interval of + or – 50 bsp., or the shift of convexity[8], etc.

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[8] The shift of convexity occurs where the instrument has an underlying call option such as mortgage backed securities and callable bond. These instruments grant the right of early redemption to the issuer when the market interest rate is on the down side. As such, it causes the relationship between interest and pricing to

3)   Improbable events are changing scenarios which cause greater deviation than 3 standard deviations. In the testing, there is a fixing of the price, foreign exchange rate and various interest rates to change within the interval of -6 and +6 standard deviations.

In assessing the stress testing of the financial institution, the following should be examined:

1)   Does the financial institution conduct a stress test or not? If so, verification of rules, procedures for setting various scenarios should determine:

- How the scenarios correspond to the size, complexity and the existing risks of the financial institution by including stress event e.g. various drastic events in the past which are linear and non-linear, the quantitative and qualitative changes i.e. the shift of yield curve, the liquidity problem, the significant changes of correlations between the various markets?
- Can the financial institution explain the process and method for creating various scenarios?
- Which factors are considered upon changing of situations? Does the financial institution verify the scenarios regularly or not? Are adjustments made upon changing of situations?
- Are the various assumptions for creating the scenario appropriate or not? Are the sources of the data used to create the assumptions reliable?

2)   To whom are the outcomes of the stress tests reported to? What is the frequency, regularity of the reporting? Does the management understand the outcomes? Are they used in the planning and establishment of the approach for risk management? How? Examples are the establishment of the alert trigger, the business continuity plan (BCP) or the capital charge to buffer against the said risks, etc.

Remark: Details of the market risk assessment tools may be further studies from the Appendix.

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have negative convexity or concavity instigating high volatility on the returns to the instrument holders. It should therefore be set as a possible scenario for the simulation.

3.2.2.3 Risk Monitoring and Reporting

(1) Assessment of the effectiveness of the market risk monitoring system and examine if the data reporting enables the board of directors of the financial institution and senior management to assess the level and inclination of the overall market risk by considering:

- The sensitivity of the principal assumptions adopted.
- The balance between the risks incurred and the result of the performance.
- The operations of the financial institution are within the risk level stipulated by the board of directors.
- The verification of market risk policies and sufficiency of the risk assessment system as well as the development of strategies to correspond with the existing risks.
- The method used by the financial institution to compile data corresponded with the characteristics and existing market risk constraints.
- The audit conducted by the financial institution on the effectiveness of the information technology for providing past data, trends and customers' information to be used in assessing behavior assumptions of the customers such as prepayment of loans, early withdrawal of deposits, etc.

(2) Risk reports containing up-to-date and correct data are submitted to the board of directors of the financial institution as appropriate such as monthly, quarterly and in case of market volatility, the frequency may be increased. Additionally, the said reports provide comparisons between the actual risk volume of the financial institution and the stipulated policies of risk limits.

(3) The rules, procedures and monitoring process with regards to risk prevention are stipulated as follows:

- There are daily management and operating procedures regarding risk prevention.
- There are instructions for the approval procedures for the undertaking of new products, various markets and maturity extension of any financial tool.
- Authorities and line of commands of executives involved in the decision makings related to risks are stipulated, such as the override or approval of transaction exceeding the risk ceiling, etc.

- There is supervision by senior management.
- Strategies and transactions are adjusted in keeping with the market conditions.

(4) The movement of the budget in the budget report during the past 12 months is reviewed with an emphasis on earnings.

(5) The conducts of the management comply with the internal policies of the financial institution regarding the review, modification of assumptions related to pricing revaluation and risk assessment simulation models to determine whether the factors used in the setting of the assumptions and the policies are rational or not.

3.2.2.4 Risk Control and Limits

(1) The adequacy assessment of the policies regarding market risk management, operating procedures and internal control for the purpose of limiting risks to the tolerable level shall consider the followings:

- The congruity of the risk management policies, the directions and business strategies as well as restricting risks within a tolerable level.
- The appropriateness of the guidelines adopted to set the risk limits or position limits including the periodic reviewing of the said limits.
- The rationale of the rules and guidelines of approval process of the policy exceptions.
- The procedures to comply with the set risk limits and the appropriateness of the procedures for approving the exceptions.
- The quality of the accuracy control procedures, the integrity and reliability of the information.
- The appropriateness of the adjustment of risk limits in response to the changing of the market environment.
- The independence of the officers responsible for the monitoring - controlling of risks from the risk takers.
- The assessment of the response of the risk control system to the arisen errors of the internal control.

(2) The types of risk limits adopted are audit to ensure that they are suitable to the business strategies, policies, risk tolerance and capital funds.

(3) The setting of the types of risk limits for long-term positions such as position limit of each portfolio, limit of the size of gap in medium and long terms, the vulnerability limit of the economic values of the financial institution, etc., is audited.

(4) The undertaking of transactions is audited to determine if it is within the set limits as well as the reporting to the management and the approval of the exceptions related to risk limits.

(5) Does the establishment of the risk limits of the financial institution comply with the position, quality of risk management, the proficiency of the management and the capital fund or not; has it been approved by the senior management or not; are the risk limits set at too high a level or not?

(6) The verification of the structure of the risk limits related to the treasury management activities shall consider:

- The congruity between the risk limits and the strategies as well as returns.
- The appropriateness of the risk limits to the qualifications of the treasury management staff and their experience in earning profits or incurring losses.
- The risk control is sufficient during the normal and volatile market conditions.
- The risk limits reflects the liquidity differences in normal and volatile market conditions such as during the volatile situation, the financial institution may set risk limits at lower levels than it may during the normal situation.
- The suitability of the assignment of responsibilities of the dealing desks.
- Is the assessment of the risk limits reviewed continuously, in particular upon changing of strategies, personnel and market environment?

Section 4 Appendices: Market Risk Management Tools, Simulation Models, Etc.

Market risk tools and simulation models herein shall provide details of the tools and models that are generally employed by financial institutions, which in most case they are for managing risks arisen from interest rate. Examples are gap report, earnings simulation model, economic valuation model or duration model /convexity, value at risk model, and Monte Carlo simulation.

a. Gap Report

Gap report is often used in assessing and managing the position of interest rate risk arisen from mismatch of maturity and re-pricing period. In general, the basic gap report is unable to specify all interest rate risks. However, the financial institution can modify the basic gap report to be able to specify risks from the basis risk yield, curve risk and option risk.

The gap report separates assets, liabilities, and all off-balance sheet items of the financial institution into different groups according to residual periods before the next re-pricing or the maturity dates of those tools. The balance of each time period will be combined (assets and off-balance sheet items that are in long position have positive values and liabilities and off-balance sheet times that are in short position have negative values). The remainder is the net gap position of each time period. The size of the said gap in each period and the duration which the gap remains, are factors to assess the risks.

Financial institutions can use the gap report to specify and assess the imbalance of repricing both in short and long term. They can use this information to estimate earnings and economical risk under the stipulated constraints. The gap report is useful in specifying risks from repricing of the budget structure prior to making decision to invest in new business or to reinvest of the matured funds in any time band. Nevertheless, the financial institution may have a gap report that is positive, negative, or zero. By having positive gap report, when the assets have to be repriced or more reach maturity than liabilities, or so called being "asset sensitive" in that time band. Such financial institutions having more assets than liabilities will get benefits from an increase of interest rate as the assets will be repriced (interest rate) faster than liabilities.

Table 1

Sample Gap Report Schedule

	< 1 Mo.	1 - 3 Mos.	3 - 6 Mos.	6 - 12 Mos.	1 - 2 Yrs.	2 - 3 Yrs.	> 3 Yrs.	Total
Loans	100	10	20	45	5	20	30	230
Investments		5	5	10	20	20	50	110
Other Assets	5						15	20
Total Assets	105	15	25	55	25	40	95	360
Nonmaturity Deposits	-65				-30		-50	-145
CDs and Other Liabilities	-35	-35	-45	-30	-10	-10	-20	-185
Total Liabilities	-100	-35	-45	-30	-40	-10	-70	-330
Equity								-30
Net Periodic Gap	5	-20	-20	25	-15	30	25	0
Cumulative Gap	5	-15	-35	-10	-25	5	30	0

Financial institutions possessing a negative gap are called "Liability Sensitive" meaning that they have liabilities to be repriced during such period more than assets. The financial institutions having assets equal to their liabilities are called "Neutral Gap". In any case, this group of financial institution is without any risk when interest rate changes in any situation because even though they have low repricing risks, but they are still subject to the risk from interest rates changing at different rates (basis risk). Moreover, changes in the relationship of various interest rates cannot be assessed from the basic gap report in this example.

From the example in Table 1, it can be seen that the financial institution is "Asset Sensitive" in the time bands of less than 1 month, 6-12 months, and more than 2 years. If the interest rate in the said time band increases, it will receive higher net interest income. Vice-versa, when the interest rate decreases, its net interest income will also decrease.

Normally financial institutions will use information in gap report to assess how the imbalance of the repricing of the financial institution affects the vulnerability of net interest income when interest rate changes. Moreover, the repricing information can also be used to assess the vulnerability of net economical value to changes of interest rates.

1. **Creating Gap Report**   In creating gap report, the following factors should be included:

    1.1 <u>Various Items in the Gap Report</u>

    (1) Assets, debt and off-balance sheet items that are rate sensitive, must be all included in the gap report.

    (2) Financial institutions should consider all of the assets and liabilities, including those that are not sensitive to interest rate as well. Since the assets with such characteristics may change in their conditions and become assets that require repricing, While the liabilities without interests such as current deposits should also be included in the report, even though there is no apparent payment of the interest since upon their maturities, the financial institution may incur interest rate risks (such as when the financial institution may need to find sources of funds to replace the current deposits through using new sources that may contain interests such as certificates of deposit).

    (3) If the financial institutions largely book transactions in currencies other than Baht, they should have a gap report for each currency, as the interest rates in different countries may move in opposite directions and have different volatilities. Nonetheless, if a financial institution has a policy to not take any position or disparity in repricing of foreign currency items (zero gaps); it may not need to prepare any gap report for foreign currencies.

    1.2 <u>Time Band</u>

    The financial institutions must decide how many time bands they should have in the report. The narrower a time band, the more accurate the risk assessment. When assessing earning risk, the report should, at least, divide the time into monthly bands for the first year and into quarterly bands in the second year. If the reports are for long-term assessment of risk position and risk to economical values, the time band should be extended to the last period of maturities of the assets and liabilities.

    The time bands that are further away such as after 10 years may be set to be wider such as 5 years because the vulnerability to interest rate does not change significantly for maturities which exceed 10 years. In other words, the use of a wide gap after 10 years will not cause any error in the estimation of risk positions from rates during such periods.

1.3 Report of Off-Balance Sheet Items

The gap report should include all off-budget positions which values change with the interest rates such as forward interest rate contracts, forward exchange rate contracts, options, etc.

Off-balance sheet tools usually are reported by separating them into 2 components that can offset one another upon interest rate change. In other words, one component is the notional amount of the contract that will be reported as a positive value. Another is the offset component which will be reported as a negative value. If the off-balance sheet position increases in its value when the interest rate decreases (e.g. holding a forward contract, holding a floating interest rate swap contract, purchasing a call option and selling a put option, etc.), the first component will be a negative value and the second will be positive. Vice-versa, of the position increases in its value when the interest rate increases (e.g. selling a forward contract, holding a fixed interest rate swap contract, selling a call option and purchasing a put option, etc.), the first component will be positive and the second will be negative. As such, they will reflect the effects of the off-balance sheet tools on the due date of the assets on the balance sheet.

For example, the financial institution has an interest rate swap contract of 5 years, with a value of USD 100 millions, receiving a fixed interest rate and paying an interest referenced to the 3-month LIBOR rate, the financial institution will report a positive position of USD 100 millions in the 5-year time band and negative USD 100 millions in the 3-month time band. Such treatment will reflect the fact that the financial institution long a fixed income (since holding an asset with a fixed rate) and short payment at a floating rate (since having a floating rate liability).

Holding a forward purchase contract will increase the age of the asset for financial institution, while the selling of a forward contract will decrease the age of the asset. Therefore, by having a forward contract of 10 years that will mature in 5 months, it will be reported as a negative value in the 5-month time band and a positive value in the 10- year time band.

Derivatives such as caps and floors will have problems in gap report because most of the reports will assume static interest rate so there will be no records of caps and floors until the interest rate reaches the strike rate. Assuming the financial institution holds an interest rate cap with the term of 10 years, before the interest rate reaches the strike rate; the gap report will state a floating rate liability position and will not state the cap option, which converts debt to at

a fixed interest rate for 10 years. If the interest rate reaches the strike rate stated at cap but when the interest rate is equal to the strike rate, the position will turn to a fixed rate liability of 10 years.

1.4 Report of Positions Related to Instruments with Embedded Options

Many types of products with options that the investors (or the buyers) of such products is able to exercise the rights to effect the conversion of the asset in accordance with the stipulated conditions which may affect the value of the asset to fluctuate with the volatility of the interest rate. Therefore, the financial institution should include these products into the report as well.

The cash flow of the products with options will depend on the direction of the movement of the interest rate. Therefore, the different movements of the interest rate should also be kept in mind because the exercise date will change with the said movement and will affect the cash flow. A gap report only will give an incomplete picture of the option products, as the report consists of only one repricing date.

There are 3 widely used methods of consolidating risk positions of option instruments in the gap report as follows:

Method 1 Setting the cap to be fully affected from the residual period of the particular product or without regards to the cap during such period by selecting one method. An example of the cap in floating interest loan, the financial institution extends credit of USD 100 thousand with a 10-years term, floating interest rate and repricing every 6 months but capping at 12% throughout the term of the contract (interest rate of the loan will not be higher than 12%). Using method 1, if the market interest rate is lower than 12%, this method will consider the loan as having a floating interest rate of 6 months but if the market interest rate is equivalent to or exceeds 12%, the loan will convert to a fixed interest rate which will be due for repricing in 10 years.

This method has some limitations which are: 1) it does not accurately reflect the risk position of net interest income to the changes of future interest rate. For example, if the loan is an asset subject to reprice every 6 months and the source of funds is 6-month certificates of deposit. The gap report between assets and liabilities will not express the interest rate risk but if the interest rate exceeds 12%, the loan cannot be repriced but the source of fund from certificates of deposit continues to increase, causing a decrease in the spread; 2) it does not suggest how to protect the risk position against the risks. Regardless of whether to deem the asset as being 6-

month floating rate or the 10-year fixed rate, the protection of the asset against the risks are both inappropriate.

Method 2 A better methods as the financial institution should have 2 sets of gap reports. The first set is for high interest rate situation. The other is for low interest rate situation. In the case of high interest rate, the cap will be included as fixed interest rate loan. In the case of low interest rate, the report will express it as a floating interest rate loan.

The financial institution should use a similar method to assess risks from the prepayment option for property loans with fixed interest rates. In the events of high interest rate, the weighted age of these property loans with fixed interest rates will increase in report, reflecting slower repayment. In the events of low interest rate, the weighted age will be shorter, reflecting faster prepayment. The comparison of these two gap reports will indicate the numbers of risks from option instruments that the financial institution is facing.

Although the second method can assess that the embedded options may change the reprice disparity under various interest rates, it also has a limitation that it gives specific values to the options when consolidated or when they are in the money. In reality, the options possess values throughout their terms and their values depend on other factors such as residual time, difference from the strike price and the volatility of interest rate, etc.

Method 3 Consolidation of options in a report will allow the options to have different values according to the underlying instruments. It is accomplished by combining the options of delta-equivalent in the report. The derived values of delta-equivalent of the weights between 0 to 100% will reflect the possibility that the options will be in the money.

In the above example of the loan having a cap of 12% throughout its term, the financial institution can separate the cap from loan and treat the cap and loan as 2 separate tools. The financial institution will report the loan as having 6-month floating rate and report the cap as an off-balance sheet with value equivalent to delta value. This value will be equal to delta of cap times the notational amount of the cap (in this example, it is USD 100 thousand).

The cap in this example will have the delta value between 50% and 100% when the interest rate exceeds 12%. A high delta value indicates the possibility of the cap option will be exercised during the term of the loan. If the market interest rate is 8%, the delta will decrease significantly, reflecting decreasing possibility that the cap option will be exercised during the term.

The limitation of this delta method is the delta of option will change in relations to the time and the interest rate with non-linear characteristic. Therefore, the value of delta-equivalent of options is applicable only when the changes in interest rate are small, where the value of delta-equivalent changes constantly.

2. **Assessment of Interest Rate Risks by Using Gap Report**

2.1 Assessment of Net Interest Income at Risk

After the financial institution categorizes the assets, liabilities, and off-balance items into groups according to their time bands and sets the procedures for options, the financial institution must assess the net interest income at risk. The formula for converting the gap between assets and liabilities to net interest income upon risk events for the assessment of risk positions during different time bands are:

Change in Net Interest Income =
(Periodic Gap * Change in Interest Rate * Period that Periodic Gap is in Effect)

From the example of the gap report shown in Table 1, if the interest rate increases instantly 2% (200 basis points), the calculation of changes in net interest income will be as shown. During the 1-3 month time band, the financial institution will have more liabilities than assets by the amount of USD 20 millions (Liability Sensitive) which means that there are more liabilities needed to be repriced or matured more than assets. Therefore, for the residual period of 10 months from the 12-month period, the financial institution will be liability sensitive to the amount of USD 20 millions that must be repriced at 200 basis points higher as shown in Table 2. The increase of interest rate will cause the financial institution's earnings during 10-month period to decrease by approximately USD 333,000. The accumulated difference for every time band in the period of 12 months will have an impact on the earnings which is a decrease in the net interest income by approximately USD 362,500.

Table 2

Sample Net Interest Income Sensitivity Calculation

Time Band	Size of Gap (In Millions of Dollars)	Basis Point Change	Part of Year Gap Is in Effect*	Impact on Annualized NII (In Thousands of Dollars)
< 1 Month	$ 5	200	11.5/12	$95.8
1 - 3 Months	-$20	200	10/12	-$333.3
3 - 6 Months	-$20	200	7.5/12	-$250.0
6 - 12 Months	$25	200	3/12	$125.0
Total				-$362.5

* Assumes all repricings occur at midpoint of time band

The above method of estimating the effects to net interest income is a rough method of estimation with the following assumptions.

- The repricing and maturities in each time band occur concurrently such as at the beginning, middle or the ending.
- All matured assets and liabilities are reinvested at the overnight interest rate.
- No new transaction.
- The overnight interest rate changes instantly as a fixed rate.
- All types of interest rates change uniformly. The sensitivity of the outcome to this assumption can be tested by using a simulation model.

2.2 Assessment of Risks to Economical Value

Gap report may use to assess risk position of the economical value of the financial institution to changes in interest rate by multiplying the net balance of each time band with the sensitivity of the price to changes in interest rate to estimate the changes of the present values of financial tools with similar cash flows and maturity dates. For example, the financial institution records government securities with a term of 2 years, value of USD 10 millions in the time band of 2-3 years of the report. It will multiply the balance of that value with the estimated present value of the said securities. When the interest rate changes by 200 basis points, the present value of the instrument having a coupon of 7.5% will be decreased by 3.6%. Hence, the

market value of the instrument of USD 100 millions with 2-year term will decrease by approximately USD 360,000 (USD 10 millions multiplies by negative 3.6%).

This price sensitivity can be applied with other financial tools and for other time bands. The risk position for the net economical value of the financial institution will be equal to the sum of the weighted balances.

3. **Limitations of Gap Report**

3.1 Basis Risk

Gap report will focus on the level of net repricing by assuming that in each time period, the changes of the interest rates of assets and liabilities will completely offset each other. However in practice, assets and liabilities will be valuated from different return curves or indices and do not always move together in terms of volume and directions.

The financial institution should adjust gap report in order to rectify above problems of basis risk[9] by having the following guidelines.

(1) For the ease of interpretation of the meaning of the risk from unequal changes in interest rates, the financial institution may group the tools with similar basis together and report the interest rates as well as the average rates of returns of each group such as in the 30-60 day time band, the unevenness from the repricing for accounts referenced to the return rates of the certificates of deposit will be reported in one group, separated from the accounts that reference to the rate of returns of government bonds. This method will roughly estimate the value of risk from uneven changes of interest rates on the balance sheet.

(2) Some financial institution will prepare a beta-adjusted gap report to assess risk from uneven changes of interest rates. In such report the balance which is repriced for each account will be multiplied by a correlation between the pricing behavior of such item and the referenced interest rate. For example, the report is able to compare the pricing behavior of every item with the official reference rate. If the analysis indicates that the setting of deposit rate will change by 50 basis points for every change of the official rate by 100 basis points. 50% of the

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[9] The values of assets and liabilities used for the calculation in each time band in the gap report are not tied to the same interest rate causing the movement of the values of the assets and liabilities to be disproportionate i.e. it does not have a relationship of 1 to 1 or have basis risk.

said balance will be expressed as a short-term rate-sensitive and the rest of the balance will be deemed as having longer maturity.

Nonetheless, beta-adjusted gap report does not always portray the complete picture of risk arisen from uneven changes of interest rates because the correlation between the setting of price and market interest rate when the interest increases and decreases differently and yet different in each time band. The financial institution must estimate the correlation value or beta in each situation.

From the aforementioned limitations of the gap report, the analyst must understand the limitation in using the said report to assess the risk positions of earnings upon interest rate changes.

3.2 Yield Curve Risk

In assessing accumulated risks from repricing in many time bands, the majority of the users of the report will compile the gaps of every time band to find the accumulated position of all the gaps of assets and liabilities. This method will assume that the interest rate in every time band will change in a correlated manner and change at the same rate. This assumption can be adjusted by weighting each time band with a different rate such as for the gap between assets and liabilities in a shorter period will weigh more than that of a longer period because the short-term interest will fluctuate more and change in a larger number than long-term interest.

The configuration of the gaps between assets and liabilities will be the indicator of the risk position of the financial institution to the changes in the shape of yield curve. If the financial institution has a negative gap in both short and long term but positive in medium term, it will have a flat risk in relations to the yield curve when the short-term interest rate increases and a stable long term rate. The gap of net interest will decrease because interest of the liabilities in short term will increase. Nevertheless, because long term interest rate is stable, the market price of the long term liabilities will be stable. Hence, the financial institution will not benefit from decrease of the future value of long-term obligation.

3.3 Option Risks

Assessing option risks by using gap report is difficult because the underlying options will cause imbalance and non-linearity in the risk characteristics of the financial institution.

Even though there are various techniques that attempt to remedy this point such as employing many sets of reports or reporting the value of the option compared to the delta value. Such techniques are still unable to fully assess the risks. The financial institution possessing a high risk of this type must use gap report with an income simulation model or an option price simulation model.

3.4 Gap in a Time Band

Even though the gap report will reference to balance separated into time bands but the said report does not disclose the imbalance in those time bands. Some financial institutions attempt to rectify this weak point by reporting the weighted matured values in each time band or reducing the width of the time bands.

3.5 New business

Most gap reports of most financial institutions will examine only the present financial position of the financial institution. Hence, these reports are static because they only assess risks arisen from the current balance sheet structure without including assumptions on new businesses. Some financial institutions may prepare dynamic reports which create from income simulation model and express the future gap for the financial institution after incorporating the assumptions about new businesses in the risk assessment.

Other than the using gap report, most financial institutions also like to assess risk by using tools like models to simulate general situations, i.e. statistic tools used to estimate variables which values are not definite. The estimation then must involve the probability and the assigning of accepted confidence level. Risk is also one of the variables that we do not know its definite value such as market risk which means changing of different market risk factors e.g. interest rates, exchange rates, prices of debt instruments and equity instruments, including prices of commodities traded in the financial market that affect earnings or capital funds of financial institutions.

Therefore, the simulation model used in assessing market risk is a statistical tool in estimating the highest possible value of losses that may occur under a certain level of confidence. Models for assessing the amount of other types of risks are simulation models of credit risk that mainly have similar line of thoughts and methods of preparation. The financial institutions can use the estimated risks assessed from this model in the risk management to keep them below the acceptable levels.

B. <u>Earnings Simulation Model</u>

Earning simulation model is a tool to assess interest rate risk that occurs from business situation in both present and future. The model can simulate risk position of the financial institution under various assumptions so it can be used to separate the sources of risks or to assess some types of estimated risks. Normally the financial institutions will prepare models for many scenarios under various assumptions and situations that are different in each scenario.
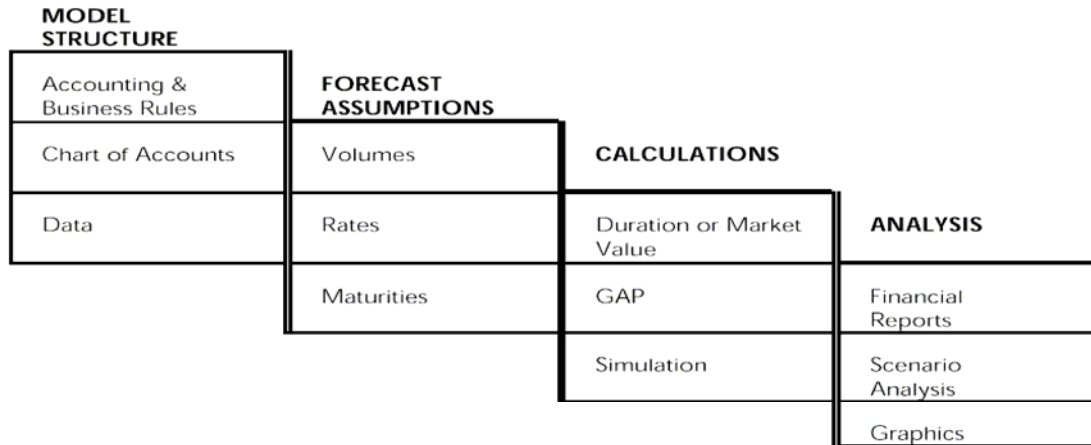
In general, earning simulation model will be more dynamic than the analysis of the gap and market price simulation model because these two types will present pictures of risks at a certain time. However, earning simulation model will assess risk positions through out the duration by considering changes in the balance sheet, prices, time, relationships between maturity periods and assumptions about possible new businesses.

Financial institutions usually use the earning simulation model to analyze its options in decision making or to test the effects of the decision on risks of the financial institutions before actual implementation. Above all, it can also be used to plan budgets and profits.

1. Creating Net Earnings Simulation Model

Most simulation models will link with computer programs that calculate in series under difference scenarios and assumptions. The data used comprises of the current data of the financial institution, the assumptions of the management about future changes in interest rate, consumer's behavior and new businesses. The model will estimate cash flows, earnings, and future expenses. The assumptions adopted to set the expanding rate of credits, funding plans and others related to replacing different assets and liabilities (the main component of the simulation model is shown in the table below).

Earnings Simulation Model
Basic Structure

MODEL STRUCTURE

Accounting & Business Rules	**FORECAST ASSUMPTIONS**		
Chart of Accounts	Volumes	**CALCULATIONS**	
Data	Rates	Duration or Market Value	**ANALYSIS**
	Maturities	GAP	Financial Reports
		Simulation	Scenario Analysis
			Graphics

In general, information from the accounting ledgers and accounting entries will provide information about the current position of the financial institution of each portfolio in the accounting chart of the simulation model. This information hence is similar to the one used in the gap report which is composed of information related to the current balances, interest rates, repricing of products and the terms till maturities. The information regarding new businesses and re-investment plans are employed to create assumptions by the management. Such assumptions may come from the past trends, business plans or economic simulation model by assuming market interest rates and the composition of the businesses. To forecast the interest rate will be a of conjecture in the directions of the interest rate, the characteristics of the future rate of return curve in the future and the relationship between the indices employed to set the prices of the products.

Possible risk positions are estimated by calculating how the changes in interest rate will affect the values, earnings, and the expensed of the financial institution.

The outcomes of the earnings simulation model consists of 1) future balance sheets and income statements under various interest and business composition scenarios, 2) Analyses of various scenarios that affect the values of target items and 3) Visual presentations of the analyses used to communicate the outcomes to the management and the board.

2. **Assessing Risks by Using Earning Simulation Model**

The volatility of interest rate will impact the derived outcomes, in particular the net interest income or net income. Most earnings simulation models can assess the effects to market values of the capital funds, if there is any change in market interest rate and business strategies.

The table below shows the report of income generated by an earnings simulation model. This report expresses the fluctuation of net interest income under various interest scenarios by assuming that the interest rate has a flat rate of changes. The same types of reports usually are generated to indicate how the net interest income will alter according to business composition and strategies.

Net Interest Income Sensitivity
(In millions of dollars)

	NII Flat	Change in NII	
		Up 200 BP	Down 200 BP
Qtr 1	100	-5	5
Qtr 2	90	-5	5
Qtr 3	95	-10	15
Qtr 4	110	-10	15
Total	395	-30	40

The financial institution may institute risk limits to limit the interest income losses in various situations in the stated periods such as in the above table, it may restrict the annual net interest income losses from interest rate change of 2% (200 basis points) at 10% of the net interest income.

3. **Attributes and Limitations of Earnings Simulation Model**

3.1 Attributes of the Earnings Simulation Models

Utilization of the earnings simulation models allows flexibility in the gap report analysis because the various assumptions as well as variables used for the calculation may be modified. For example, the gap report assumes that the interest rate changes only once, while the earnings simulation models can incorporate dynamic changes and such changes need not be flat. Moreover, the gap report tends to assume that the all current assets and liabilities are reinvested

at the overnight rate upon maturity while the earnings simulation models are able to employ the business forecast that is closer to the reality as they are able to carry many types of simulated scenarios. Thus they allow more flexibility than the sensitivity analysis of the interest rate changes.

The crucial attribute of the earnings simulation models is that it can show risks in a clear and meaningful format to the management and the board of directors. The outcomes of the earning simulation models express risks and returns at various interest rates in the form of net interest income, net income and present values (economic value of the capital fund) which are the basic financial information understood by the management of the financial institutions.

The earnings simulation models may differ according to the complexity and accuracy. The modern development in technology reduces the construction cost of the simulation models and enables faster computation.

- The earnings simulation model can support the gradual repayment of the principal such as instalment payments.
- The cap and floor of the adjustable rate loans or property loans which allow prepayment under various interest rate scenarios (with embedded options) can be accommodated.
- Swaps and forward contracts are supported.
- The relationship between interest rate and rate of return curve may be varied.
- The internal conformity of the assumptions is tested.
- The market risks and economic risks to interest income are analyzed.

3.2 Limitations of the Earnings Simulation Models

Although the earnings simulation models may be more useful than other methodologies, they however may indicate inaccurate risk positions since they are based on the management's assumptions on future businesses of the financial institution. Such is the chief limitation.

There are numerous assumptions in an earnings simulation model which makes it more difficult to estimate how much a variable affect the values of the target items. Hence, many financial institutions supplement the model by separating risks on the balance sheet by using the gap report or the assessment of risk on economic value of the capital fund.

In assessing earnings upon risk occurrence, the financial institutions often limit the risk assessing period to 2 years because the interest rates and estimated business assumptions after 2 years have high uncertainty. Hence, the financial institutions employing an earnings simulation model for 1-2 year periods are unable to capture all the long-term risks. Such financial institutions should supplement the derived outcomes from the model with the gap report or the simulation model on the economic value of the capital fund which assesses the long-term risk positions of repricing.

C. Economic Valuation Model or Duration Model and Convexity

Similar to the earnings simulation model, the economic valuation model is a tool to assess risks from interest rates arisen from the present and future business situations that are dynamic and able to simulate the risk positions of the financial institutions under various assumptions.

The economic valuation model can show the sensitivity of the economic value (shareholders' equity) to the changes of the market interest rate by utilizing the concept of present values of assets and liabilities.

1. Creating Economic Valuation Model

The net economic value of a portfolio is derived from:

	Present Value of the Net Cash Flow from Assets
Subtract	Present Value of the Net Cash Flow from Liabilities
Add	Present Value of the Net Received Cash Flow from Options or Off-Balance Sheet Contracts Held

This method utilizes the information of the portfolios during a time band to estimate its base value and the value of the portfolios at 6 various interest rates (-300, -200, -100, +100, +200, +300 basis points). The information employed is all the assets, liabilities and off-balance sheet items in conjunction with the rate of returns in each time band (Term Structure) at the end of period.

The derivation of the economic value may be accomplished by many methods. However, most apply discounted cash flow analysis. This method estimates the cash inflow and receiving time of each type of the financial tools, and then multiplies the said cash flow by an appropriate discount factor.

The basic formula to derive the present value is:

$$PV = CF_1 \left[\frac{1}{(1+Z)} \right] + CF_2 \left[\frac{1}{(1+Z)^2} \right] + \ldots + CF_t \left[\frac{1}{(1+Z)^t} \right]$$

The accuracy of the method depends on the precision in estimating the cash flow and discount factor used in the analysis. The discount factor should be the rate of return that the investor desires in holding such financial tool, which is equivalent to the risk free interest rate and risk premium that compensate the risk of such tool to the investor including the credit risk and liquidity risk.

This discount rate will increase or decrease according to the general interest rates. If the interest rate increases, the investor will want a higher rate of return which causes the rate to increase and the present value of the cash flow and asset price to decrease.

Moreover, the size and timing of the cash flow will change according to the changes in interest rate. For example, if the interest rate decreases causing the more prepayment of loans or in the case of cap and floor, the value will change when the interest rate is equal to the strike rate.

There are two techniques in deriving the present value based on cash flow. These are the static discounted cash flow method normally utilized with financial tools without any embedded options such as consumer loans, corporate loans, fixed deposits, current deposits, interest rate swaps, etc. and option-based pricing approach used with tools with embedded options such as property securitized loans. Since this type of instruments allows the borrowers to prepay before due, it causes high uncertainty in the cash flow.

Therefore, the option-based pricing using the concept of the Monte Carlo simulation will be able to better estimate the sensitivity of the property securitized assets than the static discounted cash flow because it takes into account the changes of interest rate in conjunction with the prepayment simulation in order to estimate the cash flow from the securitized

loans or, in other words, the optioned based pricing is several executions of the static discounted cash flow in various interest rate directions.

2. Assessing Risks by Using Economic Valuation Model

This method of risk assessment may be classified into 6 scenarios, which are interest rate decreases by 300, 200 and 100 basis points and increases by 100, 200 and 300 basis points and the base case is shown in the example below:

```
DOCKET:0000                      OFFICE OF THRIFT SUPERVISION              DATE:08/18/1999
XYZ FEDERAL SAVINGS, A FSB          RISK MANAGEMENT DIVISION               TIME:9:17
WASHINGTON, DC                                                            EDIT:06/28/1999
CYCLE: MAR 1999                 INTEREST RATE RISK EXPOSURE REPORT         PAGE: 01
                                      (Balances in $000)
```

*** INTEREST RATE SENSITIVITY OF NET PORTFOLIO VALUE (NPV) ***

Change in Rates	Net Portfolio Value			NPV as % of PV of Assets	
	$ Amount	$ Change	% Change	NPV Ratio	Change
+300 bp	34,152	-140,087	-80%	1.32%	-500 bp
+200 bp	89,110	-85,129	-49%	3.36%	-296 bp
+100 bp	135,149	-39,090	-22%	4.99%	-133 bp
0 bp	174,239			6.32%	
-100 bp	201,330	27,090	+16%	7.20%	+88 bp
-200 bp	213,431	39,192	+22%	7.56%	+124 bp
-300 bp	222,071	47,832	+27%	7.80%	+147 bp

**Denotes rate shock used to compute interest rate risk capital component

The value of the portfolio at the interest rate level as at the reported date is equivalent to USD 174,239,000. On the various levels of the interest rate changes, the impact on the total value of the portfolio differs. When the interest rate increases, the value of the portfolio will diminish and will increase when the interest decreases.

For example, the ratio used to assess the impact of the interest rate changes to the value of the portfolio based on net present value (NPV) may be derived from 2 cases:

Pre-shock NPV ratio is the NPV of the fixed interest rate base shown as the ratio of the shareholder's equity to the total assets (leverage ratio) of the present value.

$$\text{Pre-Shock NPV Ratio} = \frac{NPV_{Base}}{PVA_{Base}} = \frac{174,239}{2,735,760} = 6.32\%$$

PVA (Present Value of Assets) is the value at present of the total assets at the present level of interest rate.

Post-shock NPV ratio indicates the strength of the capital fund and the sensitivity to the interest rate change. For example, if the interest rate increases by 200 bps, how will the ratio of the shareholders' equity (in the net present value format) to the present value of total assets changes? If this ratio diminishes significantly, the financial institution may consider reducing the positions sensitive to the interest rate or build up a more secured capital funds.

$$\text{Post-Shock NPV Ratio} = \frac{NPV_{After\ Adverse\ Shock}}{PVA_{After\ Adverse\ Shock}}$$

$$= \frac{NPV_{+200} \quad (\text{or } NPV_{-200})}{PVA_{+200} \quad (\text{or } PVA_{-200})} \quad \text{whichever is lower}$$

$$= \frac{89,110}{2,650,131} = 3.36\% \text{ or } \frac{213,431}{2,823,480} = 7.56\%$$

The sensitivity measure can be assessed from the differences of pre-shock and post0shock NPV ratios by expressing the net present value ratio (as basis points) to the changes in interest rate.

In general, financial institutions having sensitive positions (such as duration of the assets, etc.) that is great imbalance between the assets and liabilities will likewise have high ratios. Nonetheless, this ratio does not always reflect interest rate risk because such depends on the strength of the particular financial institution's capital funds and other factors.

	Percentage
Pre-shock NPV Ratio	6.32
Post-shock NPV Ratio	3.36
Sensitivity Measure	2.96

In assessing the sensitivity of the position of economic risk to the interest rate changes, the simulation model calculates the conversion of cash flow by various interest rates in the same fashion. The levels and durations of the cash flows of products with options will often change with the rate used to assess such as the rate of prepayment will increase when the interest rate decreases.

The outcome of the risk assessment by using economic valuation model is that the ratio of the present value of the portfolio to the net present value of the total assets under the scenario of changes interest rate on various levels. When the economic value changes in the case where the position indicates sensitivity of the economic value to the interest rate, the more the economic value changes the riskier is the position of the financial institution.

Calculation of Duration

Most sensitivity simulation models will calculate the duration value in the sensitivity assessment of the assets and liabilities held by the financial institution. It is derived by using weighted average cash flows to be received from the products in the future (weighted average time to maturity). The weight assigned is the age of the cash flow in each period which is equivalent to the proportion of the present value of the amount of cash flow discounted by the rate of return to the price of the product, the so-called "Macaulay Duration".

However, if the value of the products changed due to the interest rate change is required, it is necessary to calculate the "modified duration" derived from dividing the Macualay duration with (1+ Present rate of interest). The modified duration will mean that if the interest rate changes by 1%, the value of the product will change equally to the modified duration.

The table below demonstrates the calculation of the Macaulay duration and modified duration of an instrument with 2-year term, value of USD 100,000, paying interest semi-annually and has a coupon of 7.5% purchased when the face value yields a rate of return of 7.5% which this instrument has a modified duration of 1.82%. Hence, if the interest rate increases by 1% (100 basis points), the value of the instrument is expected to decreased by 1.82% (182 basis points).

Sample Duration Calculation

Period (t)	Cash Flow	PV of $1 at 3.75 percent*	PV of CF	t x PV of CF
1	$3,750	0.96386	$3,614	$3,614
2	$3,750	0.92902	$3,484	$6,968
3	$3,750	0.89544	$3,358	$10,074
4	$103,750	0.86307	$89,544	$358,176
Total			$100,000	$378,832

Macaulay Duration: $378,832/$100,000 = 3.79 semiannual periods or 1.89 years

Modified Duration: 1.89/(1+(7.50%/2) = 1.89/(1+0.0375) = 1.82

* A 3.75% coupon and discount rate is used, because the semiannual payment of interest.

        The calculation on the Table does not adjust the cash flow with the interest rate changes. Hence, the modified duration calculation is not serviceable. In some instruments, the cash flow of the option will change upon interest rate change such as debt instruments with early redemption options, instruments backed by properties. To rectify this problem, many financial institutions employ effective duration derived from using simulation techniques to calculate the changes in the prices upon interest rate change by 100 basis points.

Interest Rate Scenario (basis points)	Estimated Present Value (000s)	Percentage Change
+ 100	$174,869	- 4.41
No change	182,941	0.0
- 100	189,819	3.75

        An example is, from the above Table, the debenture with a 30-year term. Upon calculating the present value of the instrument when the interest rate changes either up or down by 100 basis points, it appears that when it increases by 100 basis points, the present value of the instrument diminishes by 4.4 %. Vice-versa, if the interest rate decreases by an equal amount, the value of the instrument will increase 3.75%. This is the same method shown in the EVE model. When both rates of changes are averaged, the effective duration of 4.08% is achieved or it may be derived from the formula:

$$\text{Effective Duration} = \left[\frac{PV_{-100} - PV_{+100}}{2xPV_{Base\ case}} \right] x\ 100$$

$$\text{Effective Duration} = \left[\frac{189,819 - 174,869}{2x182,941} \right] x\ 100\ = 4.08$$

Characteristics of Duration

In general, duration has the following characteristics:

1)   The higher the duration value, the more sensitive is the value of such instrument to the changes in market interest rate.

2)   Of the two products with the same residual terms, the one with higher coupon rate will have lower duration and its price will be less sensitive due to the majority of cash flow of the said product will receive faster interest causing a reduced average cash receiving period.

3)   The duration of the fixed return that has one time cash flow (such as zero coupon bonds) will be equal to the residual term of such instrument. Therefore, the zero coupon bond with a residual term of 5 years will have a duration of 5 years. If there is a coupon payment before maturity, the duration will be reduced reflecting cash receipt before the due date e.g. a 5-year coupon bond paying a coupon rate of 100% has a duration of 4.2 year when the market interest is equivalent to 10%.

4)   The fixed return instrument will have high duration if the market interest rate is low.

5)   Duration may be positive or negative. The fixed return instrument will have a positive duration and it market value will diminish upon interest rate increase. However, the mortgage servicing rights and interest-only mortgage-baked securities will have negative durations because the increased interest rate will reduce the pace of the prepayment of mortgage-back loans and will enhance the market value of such instrument.

6)   Duration can be added together when weighted by the number of contracts. For example, if the portfolio has investments in 2 instruments with the same market values. One has duration of 6 and the other of 2. Hence, the duration of this investment portfolio is 4. Consequently the duration is able to assess the position of economic value risk of one contract or of the portfolio which consists of several contracts at the market price. Duration of the portfolio is calculated by weighting all the cash flows of the portfolio with the residual terms.

Nevertheless, since duration of each tool is easily obtained, the financial institutions often calculate the duration of the portfolio by weighting the duration of each contract and sum up all the values. Many financial institution use the duration to assess and limit risks in the portfolio with fixed return contracts. Such assessment will yield a more accurate result than limiting the number of instruments with residual terms held by financial institutions during some of the periods. Duration will also assist the portfolio manage in consolidating the risks of various contracts together by linking with the price sensitivity and help to prevent risks in the portfolio.

Duration is Able to Assess the Economic Value of Equity

Some financial institutions use duration to assess or prevent risks related to the sensitivity of the economic value of the portfolio equity to the interest rate changes. Duration of equity may be derived from duration of all assets, liabilities and off-balance sheet items.

To understand how duration of capital is used to assess risks, the economic value of the portfolio equity may be deemed as the position of the debt instruments held. Assets are deemed as holding bonds with positive durations and liabilities are deemed as selling bonds with negative durations. Duration indicates that the net economic value of the bonds (or portfolio equity) will increase or decrease upon interest rate changes.

In normal circumstances, financial institutions holding long-term assets while their sources of funds are from short-term debts will have positive equity duration. The economic value of the portfolio equity of the financial institutions will decrease upon interest rate increase. Financial institutions holding short-term assets which sources of funds are from long-term debts will have negative equity duration. The economic value of the financial institutions will increase upon interest rate increase. The higher the equity duration (regardless of positive or negative) the more sensitive is the economic value to the changes of interest rate.

3. Attributes and Limitations

3.1 Attributes of the Economic Valuation Model or Duration Model

Duration is a useful tool for establishing risk limits on net economic value of the financial institution or on some portfolio such as investment portfolio which better reflects risks in particular the sensitivity of the market price to the changes of interest rate. Some financial institutions try to limit risk positions by establishing simple position limits which tie to the residual

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terms of the bonds. Such limits are unable to assess the risk from the movement of interest rates as good as the limits that tie to Duration.

3.2 Limitation of Duration

Duration as a tool to assess the sensitivity of the economic value has some limitations. The Macaulay Duration, Modified Duration and Effective Duration can accurately assess the changes of values when the interest varies moderately and equally in every time-band. However, they are unable to assess the value changes when the interest in each period changes unevenly. The error which increases in proportion with the change of the interest rate is called convexity.

Duration of the different tools will change at different rates when duration drifts. In other words, the effectiveness of hedging of the portfolio hedged for duration shall diminish as time passes.

The Macaulay Duration, Modified Duration and Effective Duration assume that the expected cash flow from an instrument is constant. Hence, the duration assessment is unsuitable for tools with embedded options which tend to be more vulnerable to interest as the rate increases.

4. Convexity

The financial institution can adjust the limitation of the aforementioned Duration by finding the Convexity value to supplement the Duration value for the assessment of the response of product value to the interest rate at the present level as the Convexity can be utilized for the assessment of the value changes of an instrument in the non-linear fashion because the relationship between the price and return is not linear. The calculation formula is as follows:

Convexity of the instrument with constant return and without embedded option may be assessed by the following formula:

$$Convexity = \frac{\sum_{t=1}^{n} t(t+1)PVCF_t}{(1+Y)^2 PVTCF_t}$$

Given:

$PVCF_t$	=	Present value of the cash flow during t
t	=	Duration of cash inflow
n	=	Number of periods of cash inflow
Y	=	Yield to Maturity
PVTCF	=	Present value of the aggregate cash flow

The size of the price change which is the result of the relationship between price and interest rate is non linear, can be calculated as follows:

Estimated Value Change (Percentage) =

(0.5) * Convexity Value * (Rate of Change of Interest)^2 * 100

Example:

The table below calculates the Convexity of a debt instrument with coupon rate of 1% carried from the calculation of Modified Duration which expresses the changes of price of the debt instrument under the heading of duration calculation.

The above calculation of the change of bond price that is the result from the change of interest rate by 1% can be calculated from adding the Modified Duration and Convexity values. For debt instruments without embedded options, the Convexity shall always have a positive effect with the price while the Duration will have a negative effect due to the converse relationship between the price and interest rate. Hence, the value of the change of a debt instrument with coupon rate of 7.5% shall reduced by 1.84% (Duration - 1.82% + 0.02% Convexity). Conversely, if the interest rate decreases by 1%, the price of the debt instrument shall increase 1.84% (Duration of 1.82% + 0.02% Convexity).

D. Value at Risk Simulation Model

The Value at Risk Simulation is an acceptable tool for assessing market risks in addition to other tools e.g. Duration and Convexity, etc. The computed VaR means the maximum loss that the financial institution shall sustain under at a specific level of confidence during a specific period upon the changes of interest rate, the rate of exchange, price of debt and equity instruments as well as price of financial products.

1. Important Variables

From the above definition, it can be seen that the calculation of VaR must stipulate two significant values, which are:

(1) The Confidence Level indicated the probability of the maximum loss calculated by a simulation. Most financial institutions use the 95% or 99% Confidence Level which BIS prescribes 90%.

(2) The Holding Period meaning the period which the financial institution required to liquidate/close out position depended on the structure of its portfolio. If it consists of government bonds which have liquid/deep market, it shall be able to close out the position easily and quickly, for example, in 1 day. However, in the event of an economic crisis such as Russian Crisis, even the Russian government bonds are difficult to sell in the international market, etc. The Holding Period in this case can then be longer.

Therefore, the VaR = 300 million Baht calculated from the 99% confidence level and the Holding Period of 1 day means that for the minimum 248 of 250 days (99%) that the Trading Port of the financial institution shall sustain a maximum loss of no greater than 300 million Baht.

2. Risk Assessment

VaR may be calculated in 3 main methods as follows:

(1) Parametric or Variance-Covariance is a method for calculating VaR from equation, volatility and correlation of various factors of market risk under the assumption that the

relative change of these factors has a Normal Distribution. An example for the calculation of this method is shown in the next section.

(2) Historical Simulation is a method for calculating VaR by valuating the present position of the financial institution using daily market price at no less than 250 days or 1 previous year. Then the maximum possible damage under the specific confidence level is calculated.

(3) Monte Carlo Simulation is method for calculating VaR by simulating various scenarios with regards to the Portfolio value and the distribution of the relative change of the various factors of market risk.

Each method has advantages and disadvantages shown in the table below. The financial institution should select a method appropriate to the type of financial tools held in its Portfolio such as Variance-Covariance method may not be suitable for a financial institution holding options since [the method] is unable to deal with the non-linear market risk.

Table of Advantage and Disadvantage of Methods for the Calculation of VaR

Method	Advantage	Disadvantage
Variance-Covariance	Simple to use	Inappropriate for Non-linear products e.g. Option. Calculated from historical data under the assumption that the relative change of market risk factors has a normal distribution.
Historical Simulation	Fairly accurate[10] for nearly all types of financial products	Calculation using historical data may not be accurate for high confidence level.
Monte Carlo Simulation	Most accurate for nearly all types of financial products **Able to stipulate various assumptions**	Time consuming. Utilize large computer capacity.

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[10] Accurate measurement by using Back Test, detail is in the section G Back Testing of the Appendix.

Table of Relationships between VaR Calculating Methods and Types of Products

	Type of Product	Suitable Method
Linear Products	Debt instrument (Debenture), equity instrument (Share), financial instrument related to foreign currency e.g. Spot, Forward, Swap and products traded in the financial market	Variance-Covariance
Non-linear Products	Option type of products	Historical Simulation, Monte Carlo Simulation

3.   Calculation of VaR by Variance-Covariance Method

This section shall explain the calculation of VaR by Variance-Covariance as well as showing an example of foreign exchange risk as it is the most simple. The calculation of VaR by Historical Simulation and Monte Carla Simulation shall not be included in the manual.

The Variance-Covariance method of VaR calculation may be obtained from 3 main components, which are:

Portfolio position separated into various market risk factors such as long position in USD equal to USD 100 (foreign exchange risk) or investing in 2,000 shares of the Siam Cement Company (risk from share price), etc.

The estimation of the sensitivity of the value of the position to the changes of market risk factors such as the change of the value foreign exchange position when the exchange rate of Baht to USD moves (1%) or the value of the securities investment when the price of such share changes (1%), etc.

The estimation of the volume of the changes of market risk factor per day calculated from the standard deviation (S.D.) and Z-score which will correlate with the specified confidence level under the normal distribution assumption of the relative change of the market risk factors. For example, the exchange rate of Baht to USD has the probability to change in one day equal to 1% with 99 % level of confidence, etc.

Therefore, calculation of VaR is summarized in the diagram below.

VaR	=	Marked to Market Position	X	Product of the standard deviation of the market risk factor per day and the Z-score which depends to the specified confidence level

Formula for the Calculation of VaR (In the case that the financial institution has market risks in only 2 factors)

VaR i = (Market Value of Portfolio i) x (S.D. Value) x (Z-Score Value)

Provided:

VaRi   =   VaR of Portfolio at i (where i depends on the number of market risk factors that the financial institution has)

S.D. Value   =   Standard Deviation of the risk factor per day calculated from the following formula:

$$S.D._x = \sqrt{\frac{\sum (x, - \bar{x})^2}{(n-1)}}$$

Provided:

x =   Change of risk factor per day e.g. change of exchange rate of Baht to USD per day, change of share price per day

$\bar{x}$ =   Average of the changes of risk factor per day e.g. during the past 250 business days, share price of Company A increases on the average of 5 Baht per day

n   =   Number of all past data used in the calculation e.g. in the case using daily information of all business days in 1 year, it shall equal to 250 business days

The Z-score is a value the correlates the specified confidence level with normal distribution such as if specify the confidence level at 95% and 99%, the Z-score is equivalent to 1.645 and 2.346, respectively.

The VaR including for the case that there are more than 1 risk factor, shall be equivalent to the sum of VaR from each portfolio which related to each of the risk factor, adjusted by correlation or covariance matrix called Diversification Benefits.

When the Portfolio has 2 risk factors, the Total VaR can be derived from the formula below:

$$\text{Total VaR} = \sqrt{[\text{VaR1}^2 + \text{VaR2}^2 + (2 \times r \times \text{VaR1} \times \text{VaR2})]}$$

Provided:

VaR1   =   VaR of the portfolio arisen from risk factor 1

VaR2   =   VaR of the portfolio arisen from risk factor 2

r   =   Correlation between the two said risk factors

Provided the correlation between factor x and factor y: Correlation ($r_{x,y}$) can be derived from the following formula:

Correlation ($r_{x,y}$)   =   Covariance / (S.D. $_x$) (S.D. $_y$)

Covariance $_{x,y}$ = $\dfrac{\sum (x, -\bar{x})(y_i - \bar{y})}{(n\text{-}1)}$

Provided that the correlation of value between -1 and 1. If the value is positive (negative), it indicates that both factors relate in the same direction (opposite directions). The higher the value without regard to the [positive or negative] signs, the stronger is the relationship.

<u>Example:</u>   Spot FX case

At the end of December 2002, Bank A has a net FX position of long USD 20,000 and long JPY 100,000. The rates of exchange at the end of December 2002 are THB 35: JPY 100 and THB 38: USD 1. It is assumed that the bank has no position in the interest rate risk, prices of debt and equity instrument risks at all.

VaR for exchange rate risk of Bank A may be derived as follows:

Specifications (according to the estimating guidelines of the BIS) of the Holding Period = 1 day and Confidence Level = 99%.

Marked to market of each position are as follows:

JPY 100,000 x THB 35/ JPY 100 = THB 35,000
USD 20,000 x THB 38/ USD 1 = THB 760,000

Standard Deviation (SD) of the change of JPY value (SD_y) and USD value (SD_x) and correlation between JPY and USD compared to THB ($r_{x,y}$) can be calculated with the aforementioned formula. Normally the standard deviation may be derived by using any calculator with financial functions or basis computer program such as Excel. The calculation therefore shall not be shown here. Additionally, it is assumed that SD_x = 0.01 and SD_y = 0.02, respectively.

Calculation of VaR of each portfolio using the following formulas:

VaR i   = (Value of portfolio) x (S.D.$_i$) x (Z-score)
VaR (JPY)   = 35,000 x 0.02 x 2.33 = THB 1,631
VaR (USD)   = 760,000 x 0.01 x 2.33 = THB 17,708

Provided the Z-score at Confidence Level of 99% which can be looked up in the one-tailed normal distribution table in any basic statistic text book is equal to 2.33.

The calculation of overall VaR of the entire portfolio takes into account the diversification benefits of the portfolio from the correlation (r) between JPY and USD as following, assuming r value as derived above is equal to 0.4.

$$\text{Total VaR} \quad = \sqrt{[\text{VaR1}^2 + \text{VaR2}^2 + (2 \times r \times \text{VaR1} \times \text{VaR2})]}$$

$$= \sqrt{[1,631^2 + 17,708^2 + (2 \times 0.4 \times 1,631 \times 17,708)]}$$

$$= \quad \text{THB } 18,421$$

Hence, the probability of Bank A having maximum loss per day not exceeding 18, 241 Baht at least 248 days of 250 total business days (at the confidence level of 99%)

4. Limitations of VaR Simulation

Despite the VaR simulation modal is being used at several financial institutions for the calculation of market risk, it has the following limitations:

- It often makes calculation under the assumption that the holding period is the same in each of the product groups which they may not.
- The Variance – Covariance method does not address the non-normal distribution cases.
- If the financial institution does not assess real time risks, it shall not account for the intraday trading.
- VaR is normally used to express the risks of portfolio level or the overall level of the financial institution, however, risk management of the trader lever usually does not consider the risk of the transactions in VaR format.

E. Technique of Monte Carlo Simulation

Assessment of occurrences by random selection or Stochastic Element such as the change of interest rates under a large number circumstances including, for instance, finding value of the Portfolio or finding VaR as previously mentioned.

The various simulations mentioned in this manual with the exception of the Monte Carlo simulation model, assessing the values of the portfolio of the financial institution under

prescribed interest scenarios is an approach with limitations or the so called "Deterministic Model". Hence, if the interest rate fails to change according to the assumptions of the model, the risk of the financial institution actually incurred may be different from what the simulation model has projected.

Therefore, given the above limitations, the Monte Carlo Simulation is preferred since its technique can create countless interest rate scenarios randomly allowing probable distribution. The value of the portfolio of the financial institution is then assessed at various interest rates rendering parameters for the result to be more probable.

In addition, the Monte Carlo Simulation can handle the financial tools with risks from many variables. For example, FX swap of USD/THB with market value changes with the FX rate and interest rate of both countries. Since these exchange and interest rates is correlated, the adaptation of the Monte Carlo Simulation must take into account the Correlation between Risk Factor via the Cholesky Decomposition to allow accurate result. The details for building a Monte Carlo Simulation with one risk factor is shown herewith.

1. Monte Carlo Simulation with One Variable Risk Factor

Creating a Monte Carlo Simulation is rather complex; it has 5 basic steps as follows:

(1) Create a Probability Distribution for interest rate to be generated randomly using present forward Yield Curve as the core in the calculation of Probability Distribution.

(2) Use the variables or other characteristics for the calculation to ensure that the average interest rate to be generated is consistent with the present interest rate structure and to ensure that the probability distribution of the interest corresponds with the market volatility. These characteristics are crucial in ensuring that the simulation does not provide an opportunity to Arbitrage.

(3) Calculate the cash flow consistent with the interest rate randomly generated. In other word, the financial institution shall specify the relationship between the interest rate and the cash flow in its portfolio. For example, the financial institution may create an equation for prepayment related to various interest rates. Upon adjusting the interest rate and the prepayment, such cash flow is called Option-adjusted.

(4) The option-adjusted cash flow for various interests shall be used to derive the present value by using risk-free interest rate such as yield of government bond. All results shall then be added together. The sum shall be divided by the number of all interest rate types and the result is the expected present value for the distribution. If the cash flow is adjusted correctly and the interest reflects market expectation accurately regarding the distribution of the expected interests in the future, this expected present value shall then express the base market price. If the assumptions of the simulation are correct, the cash flow is adjusted according to all risks, the market of the instruments under consideration is according to the theory, and then this base price shall be fairly close to the market price. If the net present value does not match the market price, a spread is generally added to the risk-free interest rate. Such is called Option Adjusted Spread.

(5) After deriving the base case scenario under Clause (4), adjust the present Forward Yield Curve with interest rates for various cases that the financial institution uses in the risk analysis. For example, if it assesses the risk in the case that interest rate increases 2% (200 basis points) equally along the return rate curve; the distribution of interest rates generated in Clause (1) shall move 200 basis points and the average shall increase by 200 basis points for every interval of the term. By conducting steps 2-4 repeatedly excepting when the market price indicates the possible price if interest rate changes in accordance with the assumption for such cases, the projected value derived shall then be included in the report.

2. Attributes and Limitations of the Monte Carlo Simulation

2.1 Attributes of the Monte Carlo Simulation

The Monte Carlo Simulation is an effective tool for risk analysis because it is able to adjust projected risk in accordance with Optionality and Convexity accurately and plainly. The stock market uses Monte Carlo technique in establishing prices of interest rate derivatives and housing mortgage derivatives by using the Option-Adjusted Spread analysis. Moreover, the financial institution is able to use Monte Carlo technique in creating an understanding and for assessing present market price including economic value in a risk occurrence. This technique is then a good tool for financial institutions for the assessment and management of interest rate risk.

2.2 Limitations of the Monte Carlo Simulation

The Monte Carlo Simulation has similar limitations as those of other interest rate risk assessment systems, which is the accuracy and effectiveness depend on the input and assumptions used for the deriving the results. The two important assumptions of the Monte Carlo

analysis are the steps in generating various types of interest rates and the relationships of the various interest rates with cash flow. Furthermore, creating the Monte Carlo Simulation is rather complex and requires a great deal of calculation. Therefore, the financial institution must have staff with expertise in theoretical statistics and finance in creating and adapting this simulation.

Simulation in general has errors for several reasons such as the user may specify incorrect assumptions regarding the deposit behaviour, change of interest rate spread, unsuitable selection of simulation with regard to the variables or a simulation may yield satisfactory result for one set of input may give unsatisfactory result upon changing of assumptions. Some users use a simulation wrongly while it may have been a good simulation. For example, inadequate number of interest scenarios may be generated for the want of speed, or when the designer prepares insufficient supporting documents can also to the probability that the simulation will have errors, etc.

F. Principal Transactions of Financial Institutions (Trading Book and Banking Book)

Generally the transactions of a financial institution may be categorized into two main types. These are transactions in the Trading Book and transactions in the Banking Book. The two types of transactions have different objectives and characteristics as follows:

Transactions in the Trading Book

These are transactions with the intention of generating short-term profits such as within one day, two days or three days. This type of transactions has the trading characteristic whereby the financial institution generates profits from the price changes e.g. the changes of exchange rates, the changes of securities prices, the changes of bond prices and the changes of commodity prices, etc. The products in the trading book are highly liquid i.e. able to be bought and sold rapidly in the market and the buying and selling prices are not significantly different. Hence, the products range from straightforward e.g. trading of foreign currencies, bonds, to complex ones e.g. various derivatives. Nevertheless, trading foreign currencies for customers is not deemed as transaction in the trading book since there is an underlying asset and the translation risk is likewise not included in the trading book.

Liquidity Risks are:

- Funding-liquidity risk arisen from the inability of the financial institution to find funding such that the cash inflow and outflow are mismatch.
- Market-liquidity risk arisen from the inability of the financial institution to quickly liquidate the loss position at a reasonable price.

Credit Risk is:

- Counterparty credit risk arisen from the inability of the counterparty to fulfil the stipulated conditions of the agreement resulting in losses to the financial institution.

Operational risk arises from the error in the operations, fraud or failure of various operating systems which causes damage to the financial institution including:

- Clearing/settlement risk arisen from the faulty delivery system or payment.
- Legal risk arisen from non-compliance with the laws or regulations of the government resulting losses in the trading book e.g. incomplete documents or counterparty is a bankrupt entity, etc.

Managing Market Risks in the Trading Book

Since the trading book has the objective of gaining profits in the short-term, the financial institution must recognize profit and loss from all positions in the trading book by marking to market or marking to model where there is no market price or price in accordance to the related accounting standard.

Financial institutions can measure the market risk from transaction in the trading book by using the valuated position to calculate the risk value. Such is the tool often used by financial institutions to assess and manage market risk i.e. Value at Risk (VaR). Upon knowing the size of risk, the financial institution is then able to manage the risk for the trading book portfolio. [It may be achieved] by reducing the amount of risk by hedging or controlling the amount of risk by stipulating various limits. In stipulating limits, it may do so by limiting the transaction volume by stipulating Position Limits such as Gross Position Limit, Net Position Limit, Currency Limit, Intra-day Limit and Overnight Limit. Alternatively, it may stipulate risk limits such as VaR Limit, PVO1

Limit and Stop Loss Limit. It may stipulate such limits in various levels such as branch level, portfolio level, desk level or dealer level.

The tools used by financial institutions to measure the said risk may be applicable in the normal situation. However, as the market risk may severe affect financial institutions in a crisis, the financial institutions must then conduct stress test to determine possible damage under such circumstance. In the case that the contingent plan for the trading book fails due to the crisis of the market which makes situation control and implementation of the plan difficult to accomplish, the financial institutions may prevent the risk before the event of a crisis by establishing limits such as limiting positions or limiting loss by setting a trigger upon which the management must promptly take actions.

Transactions in the Banking Book

Transaction undertaken by the financial institution for the banking book means any position or financial instrument held by bank in the normal course of business, not for trading purpose, or financial instrument that the financial institution intended to hold until maturity. The transactions in the banking book, for example, are lending, deposits, bonds in the for-sale portfolio (without intending to make a profit) and bonds or equity instruments held until maturity, etc.

Risks from Transactions in the Banking Book

Risks developed from transactions in the banking book may not produce a negative effect immediately as it may occur in the trading portfolio. However, they may have long effects. Related risks are as follows:

Market Risk mainly comprises of interest rate risk since the interest rate change is the crucial factor to cause values of assets and liabilities in the banking book to change as time passes, in particular the medium term to long term transactions.

Liquidity Risk results from the inability of the financial institution to find funding such that the cash inflow and outflow are mismatch.

Credit Risk arises from the inability of the counterparty to fulfil the stipulated conditions of the agreement resulting in losses to the financial institution.

Operational risk develops from the error in the operations, fraud or failure of various operating systems which causes damage to the financial institution including:

- Legal risk arisen from non-compliance with the laws or regulations of the government or upon legal changes or changes of the regulations of the government which negatively affects the banking portfolio.

Managing Market Risks in the Banking Book

In transacting for the banking book, the financial institution shall recognize profit and loss on the accrual basis. It is able to measure the market risk of the transaction in banking book by using various tools or simulation models to assess and manage such risk. Most financial institutions use Gap Report, Duration Convexity, Earning Simulation Model, Economic Valuation Model (EVE Model). The financial institution can reduce risk by hedging such as using interest rate swap (IRS) to mitigate risk in lending, etc. or control the amount of risk by establishing various limits. Such maybe established in the form of limiting volume of transactions by setting the duration of the assets and liabilities such as setting the volume of lending with 5 year term or setting risk limits such as Gap Limit, Earning at Risk Limit, Duration Limit and Stop Loss Limit. The said limits are usually on the portfolio level.

The said tools used by the financial institution measure risks under the normal situation as mentioned earlier. The market risk can affect a financial institution severely in a crisis situation. It therefore must conduct stress test simulations to determine any extensive damage that may occur in the said situation and it should prepare a contingent plan to sustain any severe losses in the banking book to enable it to control the situation and implement its plan. Moreover, the financial institution may use additional preventive methods before the crisis such as establishing position limits or limiting loss by setting a trigger to activate management action upon reaching the set level.

Limitations of the Supervision of Trading Book and Banking Book

Currently the BOT has not established any regulation regarding separating trading book and banking book. The manual then emphasizes the market risk assessment on the whole book. Nevertheless when the BOT policy regarding determining capital funds to cushion market risk currently being developed, is enforced, the financial institution must prepare Trading Book Policy in which it shall clearly specify which transactions are to be in trading book and which to be in the banking book. In the said division, the auditor must determine if there is conformity in the

nature of the business of the financial institution or not and if the financial institution has complied with the policy on the grouping of the assets or not.

G. Back Testing

Back testing is an accuracy test of a risk simulation model by comparing daily VaR (projected maximum loss in 1 day at a specified confidence level) with the realized profit/loss from trading transactions. The number of days, which actual loss is incurred at a higher value than VaR which is projected by a simulation called exceptions, are counted and compared the proportion (in percentage) of exceptions whether it is higher or lower then the set confidence level. Such shall use previous data of the past 250 business days.

In conducting back testing, the VaR used for comparison shall be calculated from holding period of 1 day which differs from the BIS Framework that sets at 10 business days to reduce the effect of the actual position change during the holding period on the actual profit and loss, however, not reflected in the VaR since it is a projection calculated from a simulation of the position at the end of the business day.

Nonetheless, the daily profit/loss still has some limitations since the consolidated profit/loss incurred from intraday trading, fee income and other income not included in the VaR calculation. More complex methods rectify this drawback by attributing income by source such as fees, spreads between buying and selling prices, market movements and Intraday trading, etc. and comparing the VaR with the profit/loss incurred from such movement of market price only.

Therefore, the profit/loss for back testing should be derived from the valuation of the position at the end of the previous day using the market price of the day which is called hypothetical profit/loss. Then it shall be compared with the VaR.