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## SUMMARY

1. The guideline reinforces the importance of stress testing as a risk management tool used to evaluate the potential effects on an institution's financial condition arising from a specific event or movement in a set of financial variables. Licensed institutions should determine their own strategies for designing and developing stress testing methods that are relevant and effective for their business environment and profile.
  
2. The role of management is crucial in making the stress test an integral part of the institution's risk management. The management is responsible for the overall framework, identifying potential stress scenarios, taking remedial measures or actions where warranted, given the institution's risk appetite and business strategy. This is especially pertinent since much of the value in stress testing is derived from internal discussion of which stress scenarios imply the greatest vulnerability.
  
3. Licensed institutions are encouraged to explore, design and develop stress tests that would be most appropriate and effective for their business environment and profile.
  - For instance, sophisticated and complex institutions should use a combination of both scenario and sensitivity analysis with greater coverage across product lines or geographical regions and consider secondary effects. Less complex institutions may, considering their risk profile, confine themselves to simple scenario tests that can be run relatively quickly and can be used by the management to form a view of the impact of a small number of variables on the financial condition of the institution.
  - However, the appropriateness of the stress tests will be assessed based on the scale and complexity of the licensed institution's business and risk profile.
  
4. Bank Negara Malaysia remains cognizant of the evolving standards. Hence, in certain areas Bank Negara Malaysia is not specifying any common

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methodologies nor prescribing any methods such as the second round effect and aggregation of risks. The main objectives are to ensure that all material risks are captured, reasons for the loss outcomes are identified and management are able to make informed decisions based on the stress test results. To facilitate the above, stress testing should be integrated into the institution's risk management framework. It is envisaged that licensed institutions will improve the sophistication of their stress test programme over time.

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## PART A: INTRODUCTION

### Overview and Objective of the Guideline

- 1.01 The primary objective of the 'Guideline on Stress Testing' (the Guideline) is to reinforce the importance of stress testing as a risk management tool.
- 1.02 The Guideline provides guidance and principles on the critical areas pertaining to stress testing as well as specific requirements that is expected of licensed institutions.

### Role of Stress Testing

- 1.03 Stress testing has become a standard risk management tool for licensed institutions to understand the nature of their risk profile and the risk drivers.
- 1.04 Stress testing involves identifying possible events or future changes in the financial and economic conditions that could have **unfavourable effects** on a licensed institution's exposure and the assessment of the licensed institution's ability to withstand such changes<sup>1</sup>, usually in relation to the capacity of its capital and earnings to absorb potentially significant losses. Steps are then identified to manage the risks and conserve capital.
- 1.05 Stress testing can be applied in identifying potential vulnerable risk areas of a licensed institution's portfolio to exceptional but plausible events. It examines an alternative future that could cause problems in the portfolio, thus enabling a licensed institution to determine how bad those problems could become and prepare for them.

<sup>1</sup> International Convergence of Capital Measurement and Capital Standards, BIS (June 2004) .

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- 1.06 In addition, by applying these exceptional but plausible events to the portfolio, stress tests can also be utilized to better understand the risk profile, evaluate business risks and thus take appropriate measures accordingly.
- 1.07 The Basel Committee on Banking Supervision also recognises the importance of stress testing. The revised framework on International Convergence of Capital Measurement and Capital Standards (June 2004) specifically provides that sound stress testing processes must be in place for use in the assessment of capital adequacy.
- 1.08 Stress testing should be both rigorous and forward looking. The stress testing methodology must be flexible so that it can be adapted quickly and efficiently to the changing environment. It should also be comprehensive so that the breadth and scale of different businesses undertaken by the licensed institutions can be captured.
- 1.09 The role of stress testing can be expanded to serve as a business decision making tool where analysis from stress test results may guide licensed institutions in the process of undertaking new business activities, entering new markets or undertaking strategic initiatives for example, mergers and acquisitions.
- 1.10 Stress tests are employed to assess the effect of tail events beyond the level of confidence assumed in statistical models. This is because in times of stress there is less predictability in the behaviour of risk factors, breakdown of correlations, sudden illiquidity in the markets, rapid price movements and the contagion impact on other markets and economies. In this sense, stress tests complement statistical models such as value-at-risk which are used to predict maximum loss in normal business conditions.
- 1.11 Stress testing can also be used in portfolios that lack historical data. These are portfolios with insufficient data for construction of statistical models or there is tendency for market gaps or difficulty in estimating non-linear relationships.

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## Licensed Institutions

1.12 The Guideline is applicable to the following licensed institutions:

- Commercial banks, finance companies and merchant banks / investment banks licensed under the Banking and Financial Institutions Act 1989 (BAFIA);
- Islamic banking institutions licensed under the Islamic Banking Act 1983; and
- Any other licensed institution specified by Bank Negara Malaysia.

which, for the purpose of these guidelines shall collectively be referred to as “licensed institutions”.

## Effective Date

1.13 The effective date of this Guideline is 19 March 2007.

## Legal Provision

1.14 This Guideline is issued pursuant to Section 126 of the Banking and Financial Institutions Act 1989 and Islamic Banking Act 1983 and supersedes the circular ‘Stress Test for Banking Institutions’ dated 9 July 1998 and subsequent updates dated 15 October 1998, 15 January 1999 and 6 July 2000.

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## PART B: APPROACH TO STRESS TEST BY LICENSED INSTITUTIONS

### Coverage and Risk Factors

- 2.01 Stress tests should be designed to take into account large movements in the risk factors. Stress tests should reflect exceptional but plausible events and take into account new concentrations of risks that may emerge, contagion effect and failure of hedging techniques. Exceptional events would be fairly rare and have a large magnitude or impact on the portfolio to be stress tested. Plausible events cannot be too extreme that no entity could withstand such a shock or have zero probability of occurring.
- 2.02 Licensed institutions should define the coverage in stress tests. This should include the full range of material risks at both business unit level and aggregated group basis <sup>2</sup>. The identification of material risk could include a comprehensive review of the institution's nature of business and composition of its own portfolio or a review of external environment in which the institution is operating that would affect its financial conditions.
- 2.03 In addition, licensed institutions also need to derive the risk drivers of these material risks as this would assist in understanding the underlying factors that affect the risks and determine the appropriate remedial measures. The number of risk factors to be stressed will depend on the complexity of the portfolio and the risks faced by the institutions. Nevertheless, licensed institutions should be able to justify their choice of factors stressed.
- 2.04 Among the risk factors<sup>3</sup> that the licensed institutions should consider when constructing the stress test would be:
- Macroeconomic factors (interest rates, foreign exchange rates, inflation, GDP growth, unemployment rate, asset prices, sentiment index);

<sup>2</sup> Business unit level refers to the portfolio within the entities that is, treasury, retail, commercial and etc. while aggregate group refers to the banking entity(ies).

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- Geographical and political factors (health of other economies, vulnerabilities to external events, contagion effects);
- Financial market conditions (liquidity);
- Concentration risks (borrowers, industries, regions);
- Borrower risk characteristics that would affect obligor risks and increase the default probabilities (for example, borrower type, demographics, industry);
- Transaction risk characteristics (product, collateral type, loan to value ratio, guarantees, seniority); and
- Other category of risks such as operational risk.

2.05 The stress tests should also reflect the specific risk characteristics of the licensed institutions including events such as mergers or strategic acquisitions.

## Frequency

2.06 The frequency of stress testing should be determined in accordance with the nature of the risks which the licensed institutions are exposed to and the types of test performed. Thus, stress tests may be run on a daily, weekly, monthly, quarterly or yearly basis, depending on the nature of the portfolio and risks as well as circumstances.

2.07 Stress tests should be produced regularly enough to take account of changing market conditions and the licensed institution's changing risk profile. Generally, the trading portfolio would be subject to more frequent stress testing. Similarly, in times of greater volatility and unstable market conditions, more stress testing would be conducted.

2.08 However under specific circumstances, *ad-hoc* stress tests may also be required to assess the impact of observed deterioration which licensed

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<sup>3</sup> The risk factors in the guideline are not intended to be exhaustive. Hence, licensed institutions are expected to identify the risk factors which are material to their institutions.

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institutions had not taken into account or to assess the impact of similar stress across the industry.

## Magnitude of Shock

- 2.09 Licensed institutions may vary the level of stress to assess its vulnerability under different scenarios. Accordingly, licensed institutions would need to determine the magnitude of shocks<sup>4</sup> to be administered.
- 2.10 Selecting the worst movement in the previous one-year period may not be optimal as the period may not include any stressful event. The time interval should include at least one business cycle<sup>5</sup> (appropriate to the portfolio).
- 2.11 The magnitude of the shock used should be greater than the conservative estimate of potential losses over the business cycle. It is more than the adverse market movement (point of worst movement) relevant to the long-term risk profile of the specific portfolio.
- 2.12 The shocks should have some reference to but not be bound by historical events nor be so large that the exercise becomes purely hypothetical. The scenarios should be forward looking and also have some relevance to the current events or circumstances.
- 2.13 Some explanation on scenarios and sensitivity analyses are given in Appendix 1 while examples of some basic stress tests are given in Appendix 2.

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<sup>4</sup> Historical data, judgement or expert opinion are among the options to determine the magnitude of shocks.

<sup>5</sup> A pattern of alternating periods of growth (recovery) and decline (recession), characterized by changing employment and industrial productivity, amongst others.

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## Second-Round Effects

2.14 It is also important to capture the second round or spillover effect that might arise from the original shock. For example, the increase in oil prices is likely to affect retail consumers as well as certain industries such as the transportation sector. The secondary effect would be manifested in lower household income, lower consumer demand for goods and services and ultimately, lower corporate earnings. The hike in oil prices will raise the cost of production and in turn increase the prices of goods and services. Higher prices lead to lower disposable household income, thus affecting retail consumers debt servicing capability. Higher prices also lead to lower demand of goods and services which would affect companies' profitability.

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## PART C: SPECIFIC REQUIREMENTS BY BANK NEGARA MALAYSIA

### Licensed Institutions Should Conduct Own Stress Tests

- 3.01 Licensed institutions are encouraged to explore, design and develop their own stress test(s) that would be most appropriate and effective for their business environment and profile, to be conducted regularly. The stress test framework should commensurate with the nature, complexity and sophistication of its business activities.
- 3.02 Bank Negara Malaysia will, as part of the regular surveillance process, evaluate the licensed institution's stress test programme for the appropriateness of stress testing methodologies and governance arrangements.

### Effective Board and Management Oversight

- 3.03 The following are the underlying principles of stress testing governance where the Board of Directors (Board) and senior management should exercise effective oversight of the stress test process and ensure that the requirements set out in this guideline are met.
- The Board or its committee should approve the policy regarding stress test which should address, *inter alia*, the process and structure to ensure that the relevant risk factors are identified and the responsibilities and authorities involved. The Board and senior management should ensure that the management of the stress test process is consistent with the licensed institution's capital strength, management expertise and risk profile.
  - The senior management should be actively involved in the process of designing the stress tests programme. In identifying potential stress scenarios, senior management should take responsibility for the choice of

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stresses to be examined as part of their responsibility for managing the entity-wide risk <sup>6</sup>.

- The results of the stress test should be communicated in a clear, concise and comprehensible format to the senior management, the Board and the Risk Management Committee to enable them to consider the implications on the licensed institution's strategy or business profile and to consider the response.
- Senior management should be responsible for outlining plans to ensure that corrective actions are taken and monitored and that the actions are appropriate and effective to address the identified risk. In addition, the relevant business line management should also be closely informed of the results.
- Management should be presented with a holistic view of the effect of stresses so that they can take an aggregated view of the implications. Where formal aggregation<sup>7</sup> is not possible, an informal assessment of the totality of entity-wide effects will still be useful.
- IT systems, resources and procedures should be adequate to allow management to identify, quantify, assess and manage efficiently the stresses that affect the group.
  - Management should ensure that the systems can handle and conduct appropriate stress tests for the business or group.
  - Management should also ensure that their staff have adequate training and qualifications to be able to identify and quantify stresses that affect the entity.
  - Appropriate documentation must be in place to ensure adequate implementation of the stress test programme.
- Formal lines of authority and the appropriate separation of duties should be established to maintain an effective check and balance within the

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<sup>6</sup> In order to enhance the appropriateness and plausibility of the stress testing programme, management is encouraged to seek expert opinion including the front-line managers, external industry experts, economists and academics.

<sup>7</sup> The aggregation of the stress testing results should facilitate management in decision-making while ensuring that all material risks are captured, understood and managed as appropriate as risks should not be evaluated in isolation.

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stress testing process. The reporting line and allocation of responsibilities and authority within the institution should be clear, precise and well defined.

- Regular and independent assessment<sup>8</sup> of stress testing policies, procedures and processes should be carried out to ensure the quality and effectiveness of the stress test programme.

### Minimum Requirements for Stress Tests Conducted by Licensed Institutions

3.04 In order to ensure that the stress tests conducted by licensed institutions are meaningful, there are certain minimum requirements that a licensed institution should adhere to.

- All material risks faced by the licensed institution must be included.
- The second round or spillover effects of events on the portfolio or business must be taken into account.
- The magnitude of the shocks should be large enough to stress the portfolio and should be larger than a regular/cyclical variation.
- Stress tests conducted should include at least a scenario that is based on an exceptional but plausible event.
- Stress tests must take into consideration the latest development from the economic, political, geographical and global perspectives.
- The stress event should exist for a period of time for example, a period of sustained high interest rates **as opposed** to a one-day shock or two-week shock<sup>9</sup>.
- The time horizon to capture or reflect the impact of the stress test should cover a period relevant to the portfolio. For example, it takes time for a

<sup>8</sup> An independent assessment can be carried out as part of the licensed institution's own internal process for example, by internal audit or those who are not involved in model development nor makes decision based on the model output.

<sup>9</sup> Stress events may take place over a matter of days or months, therefore different time period can give different changes in value of risk factors. Furthermore, not all affected markets go from peak to trough on the same day because the move from peak to trough is not always smooth and uninterrupted. Licensed institutions need to determine the length of time the portfolio will be exposed to these possible shocks.

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shock to work through to a rise in arrears (in particular the credit portfolio) and subsequent liquidation. This is apparent whereby provisions for loan losses are less in the first year of the stress test but then would increase markedly in later years.

- Licensed institutions should include its subsidiaries and associate companies if the risks are material .
- Other risks which impact the soundness of the licensed institutions.

3.05 Where licensed institutions are not ready in terms of identifying the appropriate scenarios to be applied, the licensed institutions may consider the impact of shocks to the macroeconomic factors such as the interest rate, foreign exchange rates, inflation, composite index and property prices to its portfolio.

### **Reporting to Bank Negara Malaysia**

3.06 Licensed institutions are required to report the results of the stress tests conducted to Bank Negara Malaysia on a regular basis. The details are given in Appendix 3.

3.07 From time to time, Bank Negara Malaysia may require licensed institutions to conduct stress tests based on specified scenarios and to submit the results as well.

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## Appendix 1

### Scenario and Sensitivity Analyses

There are basically two categories of stress tests: sensitivity analysis and scenario analysis.

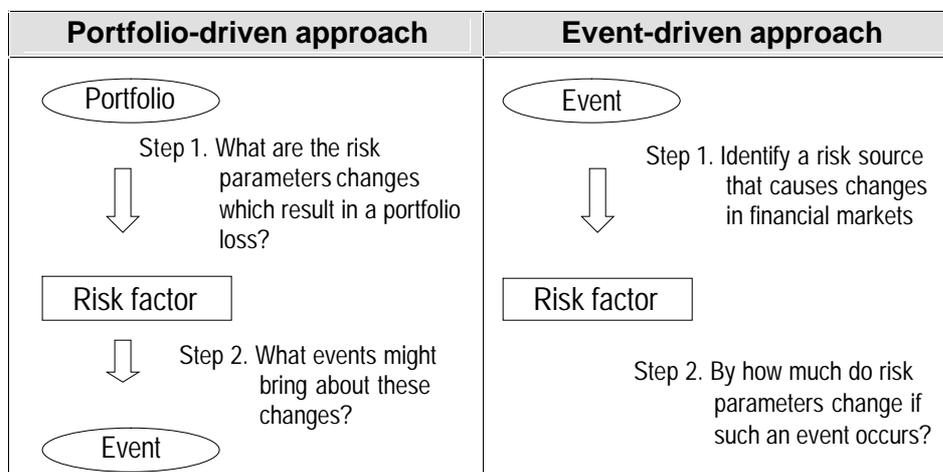
- A sensitivity analysis moves a particular risk factor or a small number of closely linked risk factors such as a parallel yield curve shift. This can be run relatively quickly and can be used to form a **first approximation** of the impact.
- A scenario analysis contains simultaneous moves in a number of risk factors (for example, equity prices, interest rates). A stress test scenario can be based on a significant market event experienced in the past (a historical scenario) such as a stock market crash or a plausible event that has not yet happened (hypothetical scenario).
- The historical scenario involves the reconstruction of historical events and involves less judgement as it reflects actual stress market condition. However, historical scenarios are backward looking, may not be the worst that can happen and it may lose relevance over time due to market and structural changes.
- Hypothetical scenario means simulating shocks to events that have not yet happened or have no historical precedent. This can be more relevant, flexible and forward looking but involves more judgement and management support.
- In scenarios, the source of the shock or stress event is well defined, as are the financial risk parameters that are affected by the shock. Sensitivity analysis while specifying the financial risk parameters, does not identify the source of the shock.
- Scenario analysis can be on a portfolio-driven approach or event-driven approach<sup>10</sup>. In the portfolio-driven approach, vulnerabilities in the portfolio are identified and plausible scenarios are then formulated under which these vulnerabilities are stressed. In event-driven scenarios, the scenario is formulated based on plausible events and how these events might affect the relevant risk

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<sup>10</sup>Stress Testing at Major Financial Institutions: Survey Results and Practices, Committee on the Global Financial System (January 2005).

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factors in the licensed institution's portfolio. The scenarios may also be tailored to incorporate recent news or developments.



- Two surveys were conducted by the Committee on the Global Financial System in May 2000 and May 2004 on the various stress testing practices. Some examples of scenarios and sensitivity analyses used by the major financial institutions are given below.

### Scenarios Analyses (By Type of Asset)

	Common Stress Test Scenarios (by type of asset)	
Category	Historical	Hypothetical
Equities	<ul style="list-style-type: none"> <li>- Black Monday 1987</li> <li>- Asian financial crisis 1997</li> <li>- Bursting of IT bubble 2000</li> <li>- Terrorist attacks 2001</li> <li>- Historical equity market decline</li> </ul>	<ul style="list-style-type: none"> <li>- Hypothetical stock market crashes</li> <li>- New Economy scenarios</li> <li>- Risk arbitrage market boom</li> <li>- Equity exotics stress</li> <li>- Geopolitical unrest</li> <li>- Terrorist attack</li> <li>- Global economic outlook</li> </ul>
Interest Rate Products	<ul style="list-style-type: none"> <li>- Historical interest rate increases and decreases</li> <li>- Bond market sell-off 1994, 2003</li> <li>- Asian financial crisis 1997</li> <li>- LTCM 1998</li> <li>- Russian devaluation 1998</li> <li>- Japan 1998 (termination of Japanese MOF Bond Purchase operation)</li> <li>- Terrorist attacks 2001</li> </ul>	<ul style="list-style-type: none"> <li>- Global tightening (focusing on increasing of short-term and long-term interest rate)</li> <li>- US tightening</li> <li>- Differential shocks to short rates</li> <li>- Spike in repo rates</li> <li>- Yield curve twist</li> <li>- US economic outlook</li> <li>- Global economic outlook</li> <li>- Increase in inflation expectations</li> <li>- China</li> <li>- Japanese monetary outlook</li> </ul>

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	<b>Common Stress Test Scenarios (by type of asset)</b>	
<b>Category</b>	<b>Historical</b>	<b>Hypothetical</b>
Commodities		<ul style="list-style-type: none"> <li>- Commodity crisis</li> <li>- Oil price scenario</li> <li>- Geopolitical unrest in the Middle East</li> </ul>
FX a) Emerging markets b) Europe c) Japan d) North America	<ul style="list-style-type: none"> <li>- Strong Yen</li> <li>- Asian financial crisis 1997</li> <li>- Russian devaluation 1998</li> <li>- European currency crisis 1992</li> </ul>	<ul style="list-style-type: none"> <li>- Country risk, Eastern Europe, Latin America</li> <li>- Weak and strong euro</li> <li>- Weak Yen</li> <li>- Weak and strong dollar</li> <li>- Collapse of currency pegs</li> </ul>
Credit	<ul style="list-style-type: none"> <li>- Russian devaluation and default 1998</li> <li>- Asian financial crisis 1997</li> <li>- Terrorist attack 2001</li> </ul>	<ul style="list-style-type: none"> <li>- Widening spread</li> <li>- Emerging market economic outlook</li> <li>- Euro area economic outlook</li> <li>- Global economic outlook</li> <li>- Natural disaster</li> <li>- China change in currency arrangement</li> <li>- US government sponsored enterprises</li> <li>- Terrorist attack</li> </ul>
Others	<ul style="list-style-type: none"> <li>- Gulf war 1990</li> <li>- Iraq war 2003</li> </ul>	<ul style="list-style-type: none"> <li>- Volatility disruption</li> <li>- Bank funding</li> <li>- Global economy</li> </ul>

### Scenarios Analyses (By Region)

	<b>Common Stress Test Scenarios (by region)</b>	
<b>Region</b>	<b>Historical</b>	<b>Hypothetical</b>
Emerging Markets	<ul style="list-style-type: none"> <li>- Mexico 1994</li> <li>- Asian financial crisis 1997</li> <li>- Russian devaluation 1998</li> </ul>	<ul style="list-style-type: none"> <li>- Asia</li> <li>- Latin America</li> <li>- Country Risk</li> <li>- Russia</li> <li>- Eastern Europe</li> <li>- Global emerging market crises</li> <li>- Emerging market economic outlook including default</li> </ul>
Europe	<ul style="list-style-type: none"> <li>- European currency crisis 1992</li> </ul>	<ul style="list-style-type: none"> <li>- European stress/weak euro</li> <li>- European divergence</li> <li>- European boom/ strong euro</li> <li>- Euro area economic outlook</li> </ul>
Japan	<ul style="list-style-type: none"> <li>- Strong Yen</li> <li>- Japan 1998</li> </ul>	<ul style="list-style-type: none"> <li>- Interest rate increase scenarios</li> <li>- Japan market-wide stress</li> <li>- Japanese economic outlook, monetary policy</li> <li>- Japanese financial system</li> </ul>
Asia (excluding	<ul style="list-style-type: none"> <li>- Asian financial crisis 1997</li> </ul>	<ul style="list-style-type: none"> <li>- China</li> </ul>

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<b>Common Stress Test Scenarios (by region)</b>		
<b>Region</b>	<b>Historical</b>	<b>Hypothetical</b>
Japan)		<ul style="list-style-type: none"> <li>- Change in currency arrangements</li> <li>- Geopolitical developments in Asia</li> <li>- Funding liquidity</li> <li>- Asian economic outlook</li> <li>- Natural disaster</li> </ul>
North America	<ul style="list-style-type: none"> <li>- Black Monday 1987</li> <li>- Bond market sell-off 1994, 2003</li> <li>- Terrorist attack 2001</li> </ul>	<ul style="list-style-type: none"> <li>- Weak and strong dollar</li> <li>- US market-wide stress</li> <li>- US economy outlook monetary policy</li> <li>- US government sponsored enterprises</li> <li>- Inflation expectations</li> </ul>
Global	<ul style="list-style-type: none"> <li>- Bond market sell-off 1994</li> <li>- LTCM and Russia 1998</li> <li>- Bursting of IT bubble 2000</li> </ul>	<ul style="list-style-type: none"> <li>- Global boom</li> <li>- Global crash</li> <li>- Global real estate collapse</li> <li>- Terrorist attack</li> <li>- Funding liquidity</li> <li>- Inflation expectations</li> <li>- Capital flight</li> </ul>

## Sensitivity Analyses

<b>Risk factors</b>	
Interest rate	<ul style="list-style-type: none"> <li>- Parallel yield curve shift</li> <li>- Change of yield curve slope</li> <li>- Shift of curve and changing slope</li> <li>- Shocks to swap spreads</li> <li>- Shocks to rates and volatilities</li> </ul>
Equities	<ul style="list-style-type: none"> <li>- Shocks to levels and volatilities</li> <li>- Shocks to levels only</li> <li>- Shocks to volatilities only</li> </ul>
Exchange rates	<ul style="list-style-type: none"> <li>- Shocks to levels only</li> <li>- Shocks to levels and volatilities</li> </ul>
Credit	<ul style="list-style-type: none"> <li>- Shocks to credit spreads</li> </ul>
Commodities	<ul style="list-style-type: none"> <li>- Shocks to levels and volatilities</li> </ul>
Emerging markets	<ul style="list-style-type: none"> <li>- Parallel yield curve shift</li> <li>- Shocks to interest rates and volatilities</li> </ul>
Others	<ul style="list-style-type: none"> <li>- Shocks to various volatilities</li> </ul>

- More recently, several countries had conducted stress tests on the banking system based on hypothetical scenarios such as global weakness and terrorism (Singapore) where the global economy weakens leading to a contraction in the manufacturing sector. The global economic weakness causes stock markets

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around the world to fall. The overall deterioration in the economy raises the unemployment rate. Residential property prices drop and the weakness in the manufacturing sector reduces the prices of industrial properties, while the prices of commercial properties suffer from the general decline in the economy. In the weak economic environment, short-term interest rates fall. No growth is seen in the real GDP for the year<sup>11</sup>.

- Other examples are scenarios with decline of 35% in equity prices, decline of 12% in house and commercial property prices, an initial 15% unanticipated depreciation in the trade-weighted exchange rate (United Kingdom<sup>12</sup>), a substantial correction of 30% decline in residential property prices, that is associated with a domestic recession, or that undermines the confidence of overseas investors (Australia<sup>13</sup>).

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<sup>11</sup> FSAP Stress Testing: Singapore's Experience, MAS Staff Paper no. 34 (August 2004). The detailed variables are found in Appendix 1 of the paper.

<sup>12</sup> Assessing The Strength of UK Banks through Macroeconomic Stress Tests, G. Hoggarth and J. Whitley, Financial Stability Review (June 2003).

<sup>13</sup> Stress Testing Housing Loan Portfolios, APRA Insight (3<sup>rd</sup> quarter/4<sup>th</sup> quarter 2003).

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## Appendix 2

### Examples of Stress Testing Methodologies

#### **STRESS TESTING for MARKET RISK**

- Stress testing should, as far as possible, be conducted on an institution-wide basis, and should take into account the effect of unusual changes in prices or volatilities, market liquidity, changes in historical correlations and assumptions in stressed market conditions, the vulnerability to historically worst case scenarios and the default of a large counter-party.

#### **Interest Rate Risk<sup>14</sup>**

- Interest rate risk is the exposure of a licensed institution's financial condition to adverse movements in interest rates arising from four main sources namely repricing risk, basis risk, yield curve risk and option risk.
- Licensed institutions can apply risk measurement techniques such gap analyses, duration analyses, income simulation or other interest rate risk model in performing stress test for the banking and trading books.
- The main step in performing the stress test is to specify the nature of the shocks to be applied. For interest rate risk, the simplest forms of shock are a parallel shift in the yield curve, a change in slope of the yield curve and a change in the spread between different interest rates with the same time horizon.
- These shocks are typically applied to the level of interest rates, but the underlying volatilities and correlations can similarly be stressed. The size of the shock can be based on historical experience or a hypothetical scenario.
- At the very basic level, licensed institutions can apply gap analysis to measure the level of interest rate risk exposure in the banking book. The gap in each time band can be multiplied by various scaling factors to calculate the sensitivity of income to changes in interest rates. For example, the average interest rate or yield on assets and liabilities in each time band can be calculated and applied to the gap as a way of scaling the change in net interest income.

<sup>14</sup> IMF Working Paper - Stress Testing of Financial Systems: An Overview of Issues, Methodologies and FSAP Experiences, Page 15 – 16

The interest rate risk include Benchmark Rate Risk in the trading book and Rate of Return Risk in the banking book for Islamic operations.

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- For licensed institutions that have adopted the Value-at-Risk (VaR) method, the time horizon (for example, the expected holding period) can be used as a stress parameter that assumes a longer holding period is required to liquidate the position in the event of an illiquid market. Moreover, licensed institutions may apply the 99<sup>th</sup> percentile of a one-tailed confidence interval in computing the VaR figures.
- The following are a set of plausible scenarios or stress event that can be included when licensed institutions conduct stress test on the **banking book**<sup>15</sup>:
  - **Parallel shifts in the yield curve** - stress the extreme movement in interest across the maturity spectrum, for example, the effects on the licensed institution's profitability of a 200 or 300 basis-point (bp) shift in the interest rates.
  - **Yield curve twists**<sup>16</sup> - identify the impact of changes in the shape of the yield curve such as when the yield curve steepens, flattens, or inverts by 25 bp.
  - **Basis changes** - assess the effect on the licensed institution's profitability due to unfavourable differential changes in key interest rates such as a three-month Malaysian Treasury Bill funded by a three-month KLIBOR interbank borrowing. Licensed institutions can stress the effect of interest rate differential (narrowing or widening) between two countries.
  - **Option and prepayment** - quantify the effect of changes in the value of both stand-alone option instruments (for example, bond options) and embedded options (bonds with call or put provisions and loans which give borrowers the right to prepay the outstanding) due to adverse interest rate movements.
- Normal risk measurement such as VaR is based on normal likelihood of adverse events, reflecting their probability. For the trading book, licensed institutions should consider not only events involving unusual price changes, but also events that may affect market liquidity, market access and contagion effect. Licensed institutions should identify the potential extreme losses of the trading instruments based on individual and aggregate basis.

<sup>15</sup> HKMA Supervisory Manual – Stress Testing, Page 17 - 18

<sup>16</sup> Derivative Policy Group (1995)

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- Licensed institutions when performing the stress test on the **trading book**<sup>17</sup> can adopt the following set of approaches:
  - **Market moves**<sup>18</sup>
    - ◆ **Decline in market value of financial instruments** - quantify the impact of adverse changes in market prices of fixed income securities, derivatives instruments or other trading portfolio. For each trading portfolio, select the size of the price shocks that are stressful enough but still possible based on evidence of a similar event in order to make it meaningful.
    - ◆ **Volatility changes and twists in the term structure of volatility** - stress the impact of changes in volatilities in the market and changes in the volatility term structure on the options and other trading portfolios. These can also be achieved by evaluating the impact of a large standard deviation move in the market, such as a 5, 6, or 7 standard deviation move in interest rates.
    - ◆ **Swap and other credit spreads** - measure the impact of changing credit spread on the trading portfolio. Licensed institutions should identify the implicit credit spread assumptions within each trading portfolios of swaps, corporate bonds, high-yield securities, and determine how these would differ by market or country.
    - ◆ **Contagion** - evaluate the portfolio impact of all positions and markets moving in the wrong direction. These require understanding of the correlation and the degree of impact between the regional and worldwide markets.

<sup>17</sup> Capital Market Risk - Integrating Stress Testing with Risk Management, Page 13 - 15

<sup>18</sup> The following approaches are also applicable for Islamic banking when conducting stress test in trading book:

- Decline in market value of financial instruments;
- Contagion; and
- Historical volatilities and correlations.

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- **Model assumptions**

- ◆ **Historical volatilities** - assess the impact on portfolio valuation and risk measures if the volatility assumptions in the model are shocked by  $\pm 10\%$ ,  $\pm 20\%$  or  $\pm 30\%$ .
- ◆ **Correlations** - stress what happens when correlations are different from history and test for extreme moves such as correlations going to 1. Test for all markets moving against the portfolio positions or correlations moving opposite from history to the extremes at 1, 0, and - 1.

- **Product complexity**

- ◆ **Derivatives** - all derivative portfolios should be stress tested along with the models used. Derivatives models assume continuous markets and the ability to dynamically hedge the portfolio. Often these assumptions are taken for granted, because this is usually the case in the most liquid derivatives markets. However, there is a crucial distinction between the conditions in major markets and conditions for derivatives in the emerging markets.
- ◆ **Structured products with embedded multiple risks** - the more complex the instrument that embodies a structured view on the market and risk types, the more difficult it is to simply view the drivers of the risks. It becomes crucial for these products to have sensitivity analysis done for extreme levels of market moves.

### **Foreign Exchange Risk<sup>19</sup>**

- Foreign exchange<sup>20</sup> risk is the risk that exchange rate changes can affect the value of a licensed institution's assets and liabilities, as well as off-balance sheet items. It can be direct that is, where the licensed institution takes or holds a position in foreign currency or indirect that is, where a foreign position taken by one of the licensed institution's borrowers or counterparties may affect their creditworthiness.

<sup>19</sup> The stress scenarios stated in the foreign exchange risk also applicable for Islamic banking

<sup>20</sup> IMF Working Paper - Stress Testing of Financial Systems: An Overview of Issues, Methodologies and FSAP Experiences, Page 17 - 22

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- The most commonly used measure of foreign exchange is the licensed institution's net open position and the net open position in each currency can be stressed against variations in the exchange rate of a particular currency.
- If the overwhelming majority of foreign exchange exposure is in one currency, licensed institutions may use either the net open position by currency or the aggregated net open position. The latter may be necessary if a breakdown by currency is not available.
- Licensed institutions are also subject to indirect foreign exchange risk, that is, foreign exchange risk incurred by the licensed institution's borrowers that can be transmitted to the licensed institutions through credit risk. In order to assess the indirect foreign exchange risk, it is necessary to stress the major borrowers of the licensed institutions and then estimate the impact on the loan portfolio.
- The basic type of shock to be used in all stress tests is a shock to the exchange rate itself. Depending on their relevance to the licensed institutions, one or more exchange rates will have to be shocked either separately (sensitivity analysis) or simultaneously (scenario analysis).
- For licensed institutions using VaR, it is not sufficient to test for shocks to exchange rates, and possibly, volatility. Since this model usually relies upon correlation assumptions, it is also necessary to stress test for breakdowns in the assumed correlations, including correlations between exchange rates as well as volatility correlation, if applicable.
- Licensed institutions should incorporate past experience of financial crisis where the domestic currency suffered sharp depreciation into the stress test in order to assess the impact of the current portfolio for example, Ringgit devalued by 25%<sup>21</sup> during Asian financial crisis.
- The following is a common scenario that licensed institutions can take into consideration when performing stress testing for foreign exchange risk:
  - **Adverse changes in exchange rates between major currencies** - this estimates the impact on the licensed institution's net open position on major currencies. In addition, licensed institutions may assess the impact of such changes on their major customers with substantial foreign exchange

<sup>21</sup> Capital Market Risk – Integrating Stress Testing with Risk Management, Page 9

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exposures. Such exposures could arise from the customers' foreign currency assets, liabilities or off-balance sheet.

### Equity Risk<sup>22</sup>

- Equity risk<sup>23</sup> is the risk that changes in equity prices or market indices that might have adverse impact on the licensed institution's financial holdings. It is divided into general risk and specific risk. General risk relates to the risk of changes in the value of equity as a result of movements in the equity market as a whole whereas specific risk refers to the risk from the individual equity issuer.
- Stress test for specific risk that is, equity risk related to the individual issuer would have to be applied to the holding of that equity concerned. Such a stress-test would primarily be relevant in cases where the licensed institution holds a highly concentrated trading portfolio of equities.
- More commonly, stress tests are conducted for general market risk, that is, the risk related to a major change in the overall stock market, usually a market crash scenario for example, during Asian financial crisis where KLCI dropped by 45%<sup>24</sup>. For this purpose, the licensed institution's equity position would be aggregated and the stress scenario applied to the aggregated position.
- In all stress tests for equity risk, the basic type of shock is a shock to the main stock market index. The prices of individual equities may be shocked as well, depending on the relevance for the licensed institutions, either separately or simultaneously.
- Licensed institutions that have adopted the VaR model should test the correlation breakdown such as absence of correlation between individual equity holding and market index (KLCI).

### Liquidity Risk<sup>25</sup>

- There are two types of liquidity risk namely asset liquidity risk and funding liquidity risk. Asset liquidity risk refers to the inability to conduct a transaction at

<sup>22</sup> Also applicable for Islamic banking

<sup>23</sup> IMF Working Paper - Stress Testing of Financial Systems: An Overview of Issues, Methodologies and FSAP Experiences, Page 31 - 34

<sup>24</sup> Capital Market Risk – Integrating Stress Testing with Risk Management, Page 9

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current market prices because of the size of the transaction. Funding liquidity risk refers to the inability to access sufficient funds to meet payment obligations in a timely manner.

- In many cases of bank failure, illiquidity occurs after the licensed institutions have become insolvent. Thus, the lack of adequate funding liquidity is considered to be a key sign that the licensed institutions are in serious financial difficulties.
- Commonly, licensed institutions face liquidity pressures from imbalances between the maturity dates on their assets and liabilities, where cash inflows from assets may not match the cash outflows to cover liabilities.
- Interest rate changes can also lead to liquidity problems where high interest rates may cause liquidity withdrawals as depositors seek higher returns elsewhere.
- Licensed institutions should include the following scenarios when performing liquidity stress test:
  - **Liquidity crisis** - assess the adequacy of its short-term liquidity to meet crisis situations such as significant deposit outflows. In assessing the impact on the licensed institution's funding and cash flow projections, licensed institutions may adopt behavioural assumptions for borrowers and depositors such as increase in depositor withdrawal rate.
  - **Credit tightening** - stress the impact of credit and counterparty lines tightening and estimate and anticipate alternative funding costs and sources in a difficult market environment due to the downgraded of licensed institution's rating. Then determine how it would affect the current business and the pricing and competitiveness of future business.
  - **Speed and time period** - estimate the speed and duration of the extreme market moves and how well the portfolio can withstand it.

Category	Common Stress Test Scenarios for Market Risk
Interest Rate	1. Banking Book <ul style="list-style-type: none"> <li>• Parallel shift in yield curve that is, 200 bp or 300 bp</li> <li>• Yield curve twist that is, 25 bp</li> </ul>

<sup>25</sup> Also applicable for Islamic banking

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Category	Common Stress Test Scenarios for Market Risk
	<ul style="list-style-type: none"> <li>• Basis changes</li> <li>• Option and prepayment</li> </ul> 2. Trading Book <ul style="list-style-type: none"> <li>• Market moves               <ul style="list-style-type: none"> <li>▪ Decline in market value of financial instruments due to adverse changes in market prices</li> <li>▪ Volatility changes in the term structure of volatility that is, 5, 6 or 7 standard deviation move</li> <li>▪ Changing credit spread of corporate bonds, high yield securities and swaps</li> <li>▪ Contagion effect due to adverse market direction</li> </ul> </li> <li>• Model assumptions               <ul style="list-style-type: none"> <li>▪ Shock volatilities that is, <math>\pm 10\%</math>, <math>\pm 20</math> or <math>\pm 30\%</math></li> <li>▪ Correlations that is, positive, negative, perfect (1) or uncorrelated (0)</li> </ul> </li> <li>• Product complexity               <ul style="list-style-type: none"> <li>▪ Derivatives instruments when market is illiquid</li> <li>▪ Structured products with embedded multiple risk that is, existence of market, credit and liquidity risks.</li> </ul> </li> </ul>
Foreign Exchange	1. Adverse changes in exchange rates <ul style="list-style-type: none"> <li>• Licensed institutions net open position on major currencies</li> <li>• Major customers with substantial foreign exchange position</li> </ul>
Equity	1. General risk related to the major change in the overall stock market that is, KLCI dropped by 45%. 2. Specific risk related to the individual issuer.

### STRESS TESTING for CREDIT RISK

- Credit risk is measured by measuring potential losses that is dependent on the obligor's ability and willingness to repay credit. There is no single indicator for credit risk since it cannot be measured directly. Hence, it is measured indirectly through the credit risk drivers **namely Exposure, Probability of Default (PD), Loss Given Default (LGD) and Maturity.**
- Credit stress test measures the impact on the licensed institution's asset quality and financial position arising from the impairment of the borrowers' creditworthiness during stress condition. Stress test by definition measures the effect of only large moves (shocks) in risk factors that would affect the obligor's business operations and income. For stress test purposes, such shocks should be 'exceptional but plausible'. **As elaborated earlier, there are two approaches to decide on the appropriate magnitude of shock; the shocks that actually occurred during historical stress episodes and shocks based on subjective judgement. When using historical episodes, the size of the**

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**shock can be based on the most adverse movement in the risk factor during the period of the stress event.**

- Similar to the measurement of credit risk under normal conditions, credit risk under stress condition could stem from both on- and off-balance sheet activities and, for banks, from both the banking and trading books.

### **Loan Book**

- In the loan book, the identification of risk drivers can be further drilled down based on its business units. Different approaches can be used to identify the risk driver and thus measure the credit losses.

### **Corporate Loans**

- Generally, licensed institutions employ a bottom-up approach in stress testing their corporate loan portfolios where corporate loans are assessed individually for the impact of the risk factors on each obligor's creditworthiness. The identified risk factor can be specific to the obligor (for example, transaction) or pool of obligors (for example, industry, sector, macroeconomics).
- The assessment of the obligor's creditworthiness during stress condition may involve the mapping of the risk factor to the financials of each obligor. The obligor's default level or repayment capacity can then be re-measured based on the adjusted accounting ratios and cash flow.
- For example, in a scenario of an upsurge in oil / diesel price coupled with a hike in interest rate, it will contribute to an increase in operating cost of a transport company. Should the demand for transport and revenue remain the same, the company's profitability will drop thus impairing the obligor's cash flow, repayment capacity and increasing its probability of default.
- Licensed institutions can also downgrade across-the-board all loans (with common risk factor) in the affected sector (for example, transport sector) by a certain level. For example, should the diesel price increase to RM2 per litre, the NPL of the obligors in the transport sector will increase by a certain percentage over the current level.
- Where established credit rating systems are in place, licensed institutions can downgrade the credit rating of each of these obligors by the desired number of credit grade notches, depending on the severity of the impact of the shift in risk

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factor to the ratings. Thus, if the risk manager suspects that there will be a deterioration in the ability or willingness of any obligor to service its debts, the obligor's credit rating should be reduced (that is, increase the PD) and the new credit loss calculated. Where models exist that qualitatively or quantitatively calculates the PD, then the factors in that model can be varied to calculate the stress loss.

- Licensed institutions can also increase the LGD by reducing the re-sale value of the collateral, say property, pledged by obligors to the bank. In stress test, licensed institutions should consider the illiquid nature of lower-quality assets or collateral. The EAD can also be stressed by increasing the EAD for certain types of exposures like lines of credit, because a higher percentage of such lines is utilised during stressful events.

### **Small and Medium Enterprise Loans <sup>26</sup>**

- Licensed institutions can choose either the bottom-up approach similar to the approach for corporate loans or the top-down portfolio approach for consumer loans. The consumer loan approach is suitable when the product is more standardized in nature and the loan quantum is small.

### **Retail / Consumer Loans**

- Consumer loans are assessed using a top-down, portfolio approach because they are usually voluminous but smaller in quantum as compared with corporate loans. Consumer loans are usually streamlined by the product type, such as mortgage loans, hire purchase loans and credit cards. This would enable the licensed institutions to identify the specific features of the product type when stress testing the portfolio.
- Taking a 'portfolio view' of credit losses can allow licensed institutions to assess the credit risk in line with the business/credit/economic cycle. Licensed institutions with scoring system for consumer loans can examine the impact of a reduction of its score across each of these loans and then recalculate its typical risk assessment in that situation. Similarly, licensed institutions with credit rating system can consider a ratings migration of the loan exposures.

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- For example, if interest rate increased by 100bp and assuming no change in the income of a borrower with a variable rate housing loan, the increase in the borrower's debt service ratio could potentially result in loan losses. Or should the unemployment rate increase, licensed institutions should reassess its customer profile as a whole or the affected sectors.
- Licensed institutions can also use the flow rate<sup>27</sup> of consumer credits through the various "aging buckets" that measure the delinquency rate structure of consumer loans. An "aging bucket" contains all accounts that are of a similar number of days past due.
- For example, the licensed institution could stress the flow rate from the bucket with accounts that are 1 – 2 months in arrears to the next bucket in which accounts are 2 – 3 months in arrears. Under stress scenario, higher flow rates are expected as more borrowers defer or default on payment. Then, based on the loan loss experience of each bucket, the licensed institution can estimate its total loan losses.

### **Investment and Trading Books**

- Unlike loans, the credit risk of the trading and investment book can be indicated by ratings assigned by rating agencies. Hence, licensed institutions with established internal rating system should map the external ratings to their own internal ratings and default probabilities. Thus if the risk manager suspects that there will be a deterioration in the ability or willingness of any obligor to service its debts, the obligor's 'mapped' credit rating should be reduced (that is, increase the PD) and the new credit loss calculated.

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<sup>26</sup> As per licensed institution own definition

<sup>27</sup> Percentage of the loan that would move to the next aging bucket on a month-to-month basis.

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## Appendix 3

### Reporting of Stress Test Results to Bank Negara Malaysia

It is expected that licensed institutions will conduct several different stress tests in terms of scenarios and frequency. However, the reporting to Bank Negara Malaysia will be required for two scenarios only that is, the **latest** stress test conducted by the licensed institutions using an **exceptional but plausible event** scenario and a **worst case** scenario, based on the minimum requirements detailed in Part 2 of the Guideline. Licensed institutions are required to submit the stress test results to the Financial Conglomerate Supervision Department and Banking Supervision Department by 30 June and 31 December each year. The submission should cover the following:

#### 1. Coverage

A description of the coverage should also be given.

(Refer to Part 2: Approach to stress test by licensed institutions)

#### 2. Conditions Prevailing and Assumptions Used Over the Stress Test Time Horizon

- i. Licensed institutions are required to describe the event as well as give details of the conditions prevailing in each scenario such as the level of GDP, interest rates, unemployment, concentration in properties etc. Licensed institutions should also include any other significant assumptions used in the stress tests.
- ii. Stress test time horizon may spread over several years<sup>28</sup>.

#### 3. Results of Latest Stress Test

- i. The results of the stress test to be reported should include, at the minimum, the impact on the profitability, capital and asset quality at each significant balance sheet date (for example, financial half-year or financial year-end) over the stress test time horizon. Both absolute amounts and key financial ratios should be reported. Other indicators and ratios may be included by the licensed institution if deemed useful.

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- ii. Licensed institutions which are adopting the advance measurement approaches under Basel requirements may incorporate the results from their internal models into the stress-test .

	Baseline <sup>29</sup>			Exceptional but plausible event Scenario			Worst Case Scenario		
	Date	Date	Date	Date	Date	Date	Date	Date	Date
1) Impact of stress test on									
- profit									
- capital									
- asset quality, etc									
2) Description of condition, assumptions									
- interest rate									
- inflation, etc									

#### 4. Assessment of Vulnerability

Other than reporting the quantitative results of the stress test, licensed institutions are also required to provide an assessment of their vulnerability, identifying the main vulnerable areas and the main risk factor(s) that affect each of these areas. A sufficient level of detail (or granularity) should be given in the assessment in order to provide a meaningful understanding of the vulnerable areas (for example, business line, geographical sectors, economic sectors or sub-sectors, market segments, borrower groups etc) and the causes of stress losses.

#### 5. Minutes of Board and Risk Management Committee Meetings

Extracts of minutes of the above meetings pertaining to the discussion on the results of the stress tests should be attached.

<sup>28</sup> As stated in paragraph 3.04

<sup>29</sup> Baseline scenario is used as a common benchmark against which to assess the effect of the shock scenario. The baseline may take into account licensed institution's business strategy, profitability target coupled with business direction as well as the expected macroeconomics and market condition for the given period.

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## Appendix 4

### Frequently Asked Questions

**Q1** The risk factors are too wide and general. Should Bank Negara Malaysia provide common risk factors and magnitude of shock to assist industry in developing the appropriate historical scenarios?

- It is not the intention of this Guideline to specify standard scenarios for comparability across industry.
- However from time to time, Bank Negara Malaysia will require stress test to be conducted based on specified risk factors and shocks for the purpose of assessing the financial system vulnerabilities.
- Given the objective and the scope of macro stress test may differ from those of specific institution, the prescribed scenarios may not be broad enough to cover all the detailed information and experiences of specific licensed institution or may be irrelevant to others.
- Hence, licensed institutions should identify their own vulnerabilities because they have the best understanding of their own business exposure and inherent vulnerabilities.

### Risk Factors

- Identifying the key vulnerabilities is a process that involves both qualitative and quantitative elements. The risk factors in the Guideline highlight the main vulnerabilities of the respective risks types and is not exhaustive. Licensed institutions are expected to identify risks which are material to them.
- This process should start with the licensed institution's own assessment of its vulnerabilities. A variety of indicators can provide important insights on the licensed institution's sources of risks. Then, licensed institutions should narrow the key vulnerabilities (risk factor) from a pool of indicators that may have material impact to its financial condition.
- Narrowing the focus permits the stress-testing exercise to be tailored more effectively because it is unrealistic to attempt to stress every possible risk factor for a portfolio.

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### **Magnitude of Shock**

- Historical data available from the publications by Bank Negara Malaysia such as Monthly/ Quarterly Statistical Bulletin, Bank Negara Malaysia Annual Report or other available website; National Bureau of Economic Research (dates and duration of business cycles) for global market data and etc may be useful to gauge the movement of some risk factors.

**Q2** What is Bank Negara Malaysia's acceptance level of the second round effect? Is there a specific approach/common methodology to link the second layer risk elements to the first layer risk factors?

- Bank Negara Malaysia acknowledges the challenge in incorporating these second round effects and understanding the complexity of the links between the scenarios. Hence, the Guideline does not specify any common methodology to conduct such an exercise.
- Licensed institutions may wish to consider the second round effect via the impact to macro economic factors. Certain macro economic factors that may not have been directly affected by the original shock may be affected by the consequences of that shock. Licensed institutions are expected to capture the second round effect based on the reasonable expectation of the impact at least for the portfolio of material risk.

**Q3** Should Bank Negara Malaysia allow licensed institutions the flexibility to determine the frequency of the stress tests depending on the approach that the licensed institutions have taken?

- The principle advocated in this Guideline is that licensed institutions have the flexibility with regards to the design and methodology adopted, so long as the management is satisfied with the robustness of the process and assumptions. In the case where the approach adopted limits the frequency of the stress test conducted, the management should re-consider the appropriateness of the approach used vis-à-vis the risk profile of the portfolio.
- It is expected that licensed institution will conduct several different stress tests in terms of scenarios, frequency and coverage. The frequency of stress

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testing should be commensurate with the nature of the risks to which the licensed institutions are exposed.

- However, for submission purposes, the results of the latest stress test already conducted (whatever the frequency) should be reported to Bank Negara Malaysia every six months. Hence, licensed institutions do not need to conduct a separate stress test for reporting to Bank Negara Malaysia.