



## Supervisory Policy Manual

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Stress-testing

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This module should be read in conjunction with the [Introduction](#) and with the [Glossary](#), which contains an explanation of abbreviations and other terms used in this Manual. If reading on-line, click on blue underlined headings to activate hyperlinks to the relevant module.

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### Purpose

To provide guidance to AIs on the key elements of an effective stress-testing programme, and describe the HKMA's supervisory approach to assessing the adequacy of their stress-testing practices

### Classification

A non-statutory guideline issued by the MA as a guidance note

### Previous guidelines superseded

IC-5 "Stress-testing" (V.1) dated 28.02.03

### Application

To all AIs

### Structure

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- 2.4 Stress-testing approaches, methodologies and techniques
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### 1. Introduction

#### 1.1 Background

1.1.1 Stress-testing involves the use of various techniques to assess a financial institution's potential vulnerability (typically in terms of its profitability, liquidity and capital adequacy) to "stressed" business conditions and thereby plays an important role in the management of risk by banks. It is also a tool commonly employed by supervisors for assessing the risks and vulnerabilities within banking systems.

1.1.2 Examples of extreme market movements and crises in the past show that it is inadequate to manage risks only on the basis of "normal" business conditions. When hit by a severe market shock, banks may incur substantial losses as a result of one or more of the following circumstances:

- assumptions of how markets behave during normal conditions no longer hold true and risk characteristics change rapidly as market events unfold, making certain historical statistical relationships (such as correlations), and thus banks' risk management models that build on these relationships, unreliable;
- new concentrations of risk emerge through unexpected linkages between different markets, risk types and positions;
- initial shocks may be dramatically amplified and spill over to other market segments, as reactions by market participants can induce feedback effects and lead to system-wide interactions;
- market prices may become highly volatile, and a squeeze in liquidity across multiple markets may occur and may last for a prolonged period of time;
- economic conditions may suddenly deteriorate in affected countries or regions;
- impairment or closure of foreign exchange swap markets may render it impossible to exchange one currency for another; or



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- difficulties in unwinding or hedging positions may be experienced as participants scramble to exit the market simultaneously, thereby drying-up market liquidity and heightening concern over counterparty credit risk.

1.1.3 The above should serve to illustrate the importance of employing stress-testing techniques to estimate an AI's likely losses under adverse conditions, and to enable the AI to be better prepared for such situations.

## 1.2 Main functions of stress-testing

1.2.1 Stress-testing is an essential risk management tool for AIs. It helps alert AIs' management to adverse unexpected outcomes related to a variety of risks to which AIs are exposed, and provides an indication of the amount of financial resources (including capital and liquidity) that might be necessary to absorb losses caused by, or to withstand, severe stressed conditions.

1.2.2 Stress-testing, in particular, serves the following purposes:

- providing a forward-looking assessment of an AI's risk exposures under stressed conditions and enabling the AI to develop appropriate risk-mitigating strategies (e.g. restructuring positions) and contingency plans across a range of stressed conditions;
- improving the AI's understanding of its own risk profile and facilitating its monitoring of changes in such profile over time;
- informing the Board<sup>1</sup> and senior management on the setting of the AI's risk appetite or tolerance and the determination of whether its risk exposures are commensurate with the stated risk appetite or tolerance;

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<sup>1</sup> In this module, the term "Board" refers to the Board of Directors of a locally incorporated AI or, in the case of an AI incorporated outside Hong Kong, its Board of Directors and/or regional or local management as appropriate.



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- supplementing the use of statistical risk measures (e.g. value-at-risk or economic capital models) which are based mainly on historical data and assumptions, and contributing to the modelling of the risks associated with new products or activities where there is a lack of sufficient historical data. Stress-testing helps quantify “tail” risk (i.e. the risk of losses under extreme market conditions) and re-assessment of modelling assumptions (e.g. those in relation to volatility and correlation);
- evaluating the AI’s existing and potential vulnerabilities on a firm-wide basis<sup>2</sup> (e.g. emerging risk concentrations) and its capacity to withstand stressed situations in terms of profitability, liquidity and capital adequacy;
- feeding into the AI’s capital and liquidity planning and strategic decision-making processes; and
- supporting internal and external communication regarding the AI’s risk appetite or tolerance, risk exposures, and risk-mitigating strategies.

### 1.3 Scope and coverage

1.3.1 This module sets out key elements of an effective stress-testing programme and explains the HKMA’s expectations with regard to AIs’ stress-testing practices. Within this context, stress-testing refers not only to the mechanics of applying specific stress tests for risk management purposes, but also to the wider environment within which the tests are developed, evaluated and used to assist in an AI’s decision-making processes.

1.3.2 This module draws principally on (i) the “Principles for sound stress testing practices and supervision” issued by the Basel Committee on Banking Supervision in May 2009; (ii) the HKMA’s relevant supervisory practices and experience; and (iii) recommendations and observations

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<sup>2</sup> For a banking group, the concept of firm-wide risk management will similarly apply on a group-wide basis, i.e. through managing the relevant risks of the parent bank and its group entities as a whole.



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made by other international organisations and industry groups to address weaknesses in banks' stress-testing practices revealed by the 2008/09 Global Financial Crisis. These weaknesses include –

- inadequate Board and senior management oversight of the stress-testing process;
- under-estimation of the potential severity and duration of stress events;
- inadequate account taken of system-wide interactions and feedback effects caused by market reactions to stressed conditions;
- insufficient identification and aggregation of risks on a firm-wide basis;
- various limitations associated with stress-testing models and methodologies (e.g. inability to change stress scenarios flexibly in response to a rapidly evolving environment, and breakdown of statistical relationships in times of stress); and
- inadequate coverage of risks arising from complex structured products, pipeline or securitization risk, counterparty credit risk, contingent risks and funding liquidity risk.

1.3.3 This module should be read in conjunction with [IC-1](#) “General Risk Management Controls”. More specific guidance on the use of stress tests, such as that for the purposes of assessing the adequacy of regulatory capital and liquidity positions, and for the management of specific risk types, is contained in other modules, including -

- [CA-G-3](#) “Use of Internal Models Approach to Calculate Market Risk”;
- [CA-G-4](#) “Validating Risk Rating Systems under the IRB Approaches”;
- [CA-G-5](#) “Supervisory Review Process”;
- [CR-G-1](#) “General Principles of Credit Risk Management”;



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- [CR-G-5](#) “Country Risk Management”;
- [CR-G-8](#) “Large Exposures and Risk Concentrations”;
- [CR-G-13](#) “Counterparty Credit Risk Management”;
- [IR-1](#) “Interest Rate Risk Management”;
- [LM-2](#) “Sound Systems and Controls for Liquidity Risk Management”;
- [RR-1](#) “Reputation Risk Management”;
- [SR-1](#) “Strategic Risk Management”;
- [TA-1](#) “Market Risk Management”;<sup>3</sup> and
- [TA-2](#) “Foreign Exchange Risk Management”.

#### 1.4 Application

1.4.1 The guidance set out in this module applies to all AIs. The HKMA will adopt a “proportionate approach” when assessing AIs’ stress-testing programmes, having regard to the nature, scale and complexity of their business activities and the risks associated with those activities. AIs with small and simple operations which undertake and pose relatively less risk will not be expected to have a stress-testing programme that is as elaborate and sophisticated as those with more complex operations which undertake and pose more risk.

1.4.2 While small and less complex AIs may not have the capacity to perform complicated firm-wide macroeconomic and scenario-based stress tests, they should still be able to utilise qualitative assessments to complement simple sensitivity and scenario analyses of the specific risk types to which they are most exposed, taking into account the interactions between these risks. Large and complex AIs should have the capacity to undertake more extensive and sophisticated stress tests as elaborated in this module.

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<sup>3</sup> This module is under development.



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- 1.4.3 Locally incorporated AIs should apply the stress-testing guidance in this module both on a legal entity basis, which provides a firm-wide view of the AI's risk exposures, and at the consolidated level, covering the AI's subsidiaries and business activities that pose material risks to it.<sup>4</sup>
- 1.4.4 For foreign AIs which operate branches in Hong Kong, the guidance applies in respect of their Hong Kong operations. Nevertheless, the HKMA will also have regard to the firm-wide stress-testing framework of these AIs in its ongoing supervision (see also para. 1.4.5 below).
- 1.4.5 Where an AI (branch or subsidiary) is part of an international banking group with stress tests being centrally managed and conducted at the regional or group level, the HKMA may consider this arrangement acceptable for the purposes of implementing the guidance in this module, so long as -
- the stress-testing approach adopted regionally or group-wide is substantially consistent with the guidance in this module;
  - the stress scenarios appropriately reflect the specific risk characteristics of the AI and its risks and vulnerabilities in the context of local markets, failing which the HKMA will expect the AI to include specific stress scenarios that are appropriate for its Hong Kong operations; and
  - the AI's local management can explain to the HKMA the stress-testing framework adopted for the Hong Kong operations and provide the HKMA with relevant stress-testing results and any other information that it may need to fully assess the stress impact on the Hong Kong operations.
- 1.4.6 AIs which seek the flexibility mentioned in para. 1.4.5 above should discuss their proposed approach with the HKMA.

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<sup>4</sup> In determining the scope of consolidation, AIs may have regard to the approach currently adopted for capital adequacy purposes.





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### 1.5 Implementation

- 1.5.1 Als are expected to take all necessary steps to bring their stress-testing programmes into line with the guidance set out in this module as soon as practicable. In particular, Als should identify gaps and implement plans for enhancing their programmes no later than six months from the issue date of the module. A longer period of time may be needed to align with the contents of this module in relation to the conduct of reverse stress tests in view of the technical challenges associated with reverse stress-testing. The HKMA would therefore expect relevant Als which are expected to conduct reverse stress-testing to bring their stress-testing programmes (insofar as they relate to such reverse stress tests) into line with this module within 12 months of its issue (see paras. 2.4.13 to 2.4.21 below).<sup>5</sup>
- 1.5.2 The HKMA will monitor Als' progress in incorporating the relevant stress-testing guidance set out in this module into their stress-testing programmes during the implementation period. Thereafter, the HKMA will incorporate a review of Als' compliance with the relevant guidance into its ongoing risk-based supervision. Hence, Als should be ready to provide their enhanced stress-testing programmes for the HKMA's review six months after the issue of this module. The HKMA may also request those Als which are expected to conduct reverse stress-testing (see para. 2.4.20) to provide updates on their progress in developing their reverse stress-testing plans (including any draft scenarios under consideration) to the HKMA nine months to one year after the issue of this module.
- 1.5.3 The HKMA recognises that stress-testing methodologies and approaches for specific risks, business lines and products are at various stages of development, with some better developed (e.g. in respect of market risk) than others (e.g. in respect of reverse stress-testing and correlation among specific risks). The HKMA will have regard to this

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<sup>5</sup> In exceptional circumstances, individual Als may seek an extension of the 6-month implementation period (12-month period in the case of reverse stress-testing) from the HKMA.



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when assessing AIs' stress-testing programmes (see para. 1.5.2).

- 1.5.4 Where necessary, the HKMA may obtain information or confirmation from any relevant home or host supervisor for the purpose of assessing an AI's stress-testing programme.

## 2. Stress-testing programme

### 2.1 General

2.1.1 A stress-testing programme represents an integrated strategy for achieving a range of objectives (such as those set out in subsection 1.2 above) by means of the origination, development, execution and application of a suitable range of stress tests.

2.1.2 AIs may differ in terms of their risk profiles, risk appetite or tolerance and ability to withstand adverse stress impacts. They are therefore expected to develop and maintain a robust and comprehensive stress-testing programme that is appropriate to the nature, scale and complexity of their business activities and the risks associated with those activities. This section describes key elements that such a programme should comprise.

### 2.2 Process, policies and procedures

2.2.1 The development and implementation of a stress-testing programme would generally entail:

- defining the main objectives of stress-testing, which should cover, among other things, assisting in risk identification and control, complementing other risk management tools, improving capital and liquidity planning, and facilitating business decision-making (see subsection 1.2 above);
- reviewing the nature of an AI's exposures as well as the external environment in which it operates with a view to drawing up a list of major risk factors that should be tested under stress scenarios (see subsection 3.2 below);



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- designing the stress tests appropriate to an AI's stress-testing objectives and exposures, including the specification of stress events and scenarios and their underlying assumptions (see subsections 2.4, 2.5 and 3.3 below);
- taking into account the professional knowledge and judgement of experts across an AI as well as the views of independent control functions (i.e. risk management and internal audit) in the key aspects of the process (particularly for conducting firm-wide stress tests);
- securing the approval of the Board (or a committee of the Board with delegated authority) of the stress-testing programme, and operating the programme through (i) regular conduct of stress tests; (ii) subsequent timely analysis of the stress-testing results to identify potential vulnerabilities and risks; (iii) determination of the appropriate remedial actions to be taken to address potential risks identified; and (iv) assessment of the viability of such actions under stressed situations;
- reporting to the Board, where appropriate, and to senior management, the stress-testing results and viable remedial actions for management decision and endorsement;
- re-assessing and updating regularly the appropriateness of stress tests, including the validity of assumptions used, in the light of changes in the risk characteristics of an AI or its external environment; and
- documenting the stress-testing programme and related procedures, including the results that it generates and the consequent decisions on risk-mitigating actions that may be taken, as set out in paras. 2.2.2 to 2.2.4 below.

2.2.2 AIs should have in place written policies and procedures governing the operation of their stress-testing programmes. These policies and procedures should be clearly defined,



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conceptually sound and consistent with an AI's risk characteristics and business activities and operations. In particular, the following aspects should be covered:

- the principal objectives of the stress-testing programme, the main purpose of each component of the programme, and the types of stress tests covered;
- the governance structure for the stress-testing programme, and the roles and responsibilities of relevant parties within the AI involved in the programme (e.g. the Board and senior management, business managers, risk managers, traders, etc.);
- the frequency of conducting stress tests, which is likely to vary depending on the type and purpose of stress-testing;
- the methodological details of each component of the stress-testing programme, including the methodologies used for defining relevant scenarios and the role of expert judgement;
- the assumptions and fundamental elements for each stress-testing exercise, including the range and severity of key scenarios;
- the procedures governing the review and reporting of the outcome of stress tests as well as the uses of the test results, including the range of remedial actions available and an assessment of the feasibility of such actions under stressed situations; and
- the independent review and update of the stress-testing programme to reflect changing circumstances and developments with respect to the AI and the market environment in which it operates.

2.2.3 Als' stress-testing policies, and any subsequent changes to those policies, should be approved by the Board (or a committee of the Board with delegated authority), and be communicated clearly to relevant staff at all levels.

2.2.4 Als should document the outcome of their stress-testing exercises and how the test results are used, including management's decision to take, or not to take, risk-



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mitigating actions to address the risks and vulnerabilities revealed. The outcome of regular evaluation of the stress-testing assumptions should also be documented.

- 2.2.5 While the stress-testing programme should be properly documented, AIs should not allow this to inhibit their flexibility to perform ad hoc stress tests that may be necessary for responding quickly to emerging risk issues.

### 2.3 Governance and infrastructure

- 2.3.1 Stress-testing should form an integral part of an AI's overall governance and risk management framework, and should be actionable in the sense that the stress-testing results should feed into the decision-making process at the appropriate management levels (such as strategic business decisions made by the Board and senior management).

- 2.3.2 This subsection describes the general roles and responsibilities of the Board and senior management in ensuring the effectiveness of an AI's stress-testing programme, and the information systems and infrastructure necessary for supporting the programme.

#### Board and senior management oversight

- 2.3.3 The Board has ultimate responsibility for an AI's stress-testing programme, whereas senior management should be accountable for the implementation, management and oversight of the programme.

- 2.3.4 The Board and senior management should both be involved in the stress-testing programme. Generally speaking, the extent of the Board's involvement in an AI's stress-testing programme will depend on the purpose and scope of the stress tests being undertaken, the nature of the risks being stress-tested, and the significance of the stress-testing results to the AI. For instance, the Board will be expected to be more actively engaged in firm-wide stress tests (and reverse stress tests where applicable), but may be less so for other types of stress tests that are of a more granular or portfolio-specific nature.



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- 2.3.5 The Board (or a committee of the Board with delegated authority) should approve the programme and oversee how it is implemented, while senior management, among other things, should participate in the design of the stress tests and in the formulation of risk-mitigating strategies. Such involvement, which helps secure “buy-in” by the Board and senior management thereby lending authority<sup>6</sup> to the programme, is essential for its effective operation.
- 2.3.6 The Board and senior management should discuss the stress-testing results in the context of the AI’s risk profile and the need for any consequent decision-making, and should ensure that suitable actions are taken to mitigate potential risks (this, however, does not preclude a conscious and well-justified management decision not to take action on the results).
- 2.3.7 To facilitate decision-making, the Board and senior management should be made aware of the limitations of the stress tests performed (e.g. key underlying assumptions, the extent of judgement used, the likelihood of a stress event occurring, etc.) and be informed of the rationale and implications for particular choices of action.
- 2.3.8 The Board and senior management should ensure that stress-testing is actively utilised by the AI for the purposes mentioned in subsection 1.2 above. It is also their responsibility to provide sufficient resources, staff with relevant skills, knowledge and experience, and robust infrastructure (see paras. 2.3.11 and 2.3.12 below) in support of the stress-testing programme.
- 2.3.9 Senior management should, in monitoring the stress-testing programme, be able to clearly articulate the AI’s risk appetite or tolerance and understand the impact of stress events on its risk profile. It is thus important that senior management participate in the review and identification of potential stress scenarios and contribute to risk-mitigating strategies.

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<sup>6</sup> The aim is to procure adequate participation and commitment at all levels of the AI and foster the sharing of perspectives and internal debate on the choices of stress scenarios, methodologies, assumptions and management response to stress-testing results.



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2.3.10 To support the Board and senior management in ensuring the effective operation of an AI's stress-testing programme, a party independent of its business units (e.g. the financial control or risk management function) should be designated with the responsibility of managing and coordinating the stress-testing programme across the organisation.

#### Infrastructure

2.3.11 There should be adequate and robust information systems and infrastructure to support an AI's stress-testing programme and accommodate different stress tests (and possible changes in those tests) on a continuing basis.

2.3.12 The infrastructure should be suitably flexible, and the information systems capable of providing data of appropriate quality and granularity on a timely basis, to allow for -

- targeted or ad hoc stress tests to be conducted at various levels (e.g. at the portfolio, business line or firm-wide level) to assess specific risks, particularly in times of stress;
- customised or new stress-testing methodologies, scenarios or data sets to be used; and
- comparable risks and exposures (e.g. to a given risk factor, product or counterparty) to be aggregated across the AI.

## 2.4 Stress-testing approaches, methodologies and techniques

#### General approach

2.4.1 AIs should adopt an integrated approach to stress-testing and conduct stress tests on a firm-wide basis and on a consolidated basis where applicable, providing a spectrum of perspectives at product-, business- and entity-specific levels. Where an AI is part of a larger banking group, its stress tests should also take into account the potential spill-



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over effects and inter-dependence among members of the group.<sup>7</sup>

- 2.4.2 Als should determine the appropriate time horizon for their stress tests. The time horizon may vary, depending on the risk characteristics of the exposures being analysed and the purposes (e.g. for strategic or tactical use) of the tests. For stress tests conducted for risk management purposes, relevant considerations include the risk management horizon of the target portfolio, the liquidity horizon of the underlying exposures, and the potential change in liquidity conditions in stressed conditions.
- 2.4.3 Als should also assess the impact of recession-type scenarios in considering the time horizon, as well as their ability to react over a medium to long term horizon. However, as the time horizon of stress tests is lengthened, Als should note the increased importance of the validity of underlying assumptions, and the greater need for incorporating feedback effects and firm-specific and market-wide reactions into such stress tests.
- 2.4.4 Stress tests should be regularly conducted at suitable intervals having regard to the nature of the risks involved and the purpose of the stress tests. Stress scenarios should be coherently developed so that risks that are inherently linked (e.g. market risk and credit risk) can be assessed together across portfolios and across time. Als may refer to other modules (see para. 1.3.3 above) for any available guidance on stress-testing for specific risks.
- 2.4.5 Als should also conduct ad hoc stress tests on specific areas whenever this is warranted under special circumstances. For example, in the light of rapidly deteriorating economic / political conditions in a country, or when stress assumptions (e.g. in relation to historical relationships of risk factors or market behaviours) breakdown and new risks or vulnerabilities emerge, an AI

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<sup>7</sup> For example, an AI may be compelled, although not legally obliged, to provide financial support to an affiliated insurance company in distress out of reputational concerns and to maintain market confidence in the group of which both institutions are members.





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will need to be able to make a quick assessment of the likely impacts on its exposures and financial strength.

### Methodologies and techniques

2.4.6 AIs should use a range of stress-testing techniques and perspectives to achieve comprehensive coverage for their stress-testing programme. These include quantitative and qualitative techniques to support and complement the use of models or other risk management approaches, and the extension of stress-testing to areas where a greater degree of expert judgement is called for. AIs should adopt those techniques that are most appropriate to, and commensurate with, the nature, scale and complexity of their business activities and the risks associated with those activities.

2.4.7 Quantitative techniques range from sensitivity tests to scenario analyses and reverse stress tests. Some of these techniques may also have important uses other than risk quantification. For example, reverse stress-testing can help senior management in assessing vulnerabilities within an AI (see also para. 2.4.17 below).

### *Sensitivity tests and scenario analyses*

2.4.8 A sensitivity test estimates the impact on the value of a portfolio of exposures of assumed movements in a single risk factor or a small number of closely related risk factors (e.g. a parallel yield curve shift). In most cases, sensitivity tests involve changing inputs or parameters without relating those changes to an underlying event or real-world outcome.<sup>8</sup> While it is helpful to draw on extreme values from historical periods of stress, sensitivity tests should also include hypothetical extreme values to ensure that a wide range of possibilities is included. Moreover, AIs should be aware of the limitation of sensitivity tests in reflecting the risks arising from transactions with non-linear,

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<sup>8</sup> For example, a sensitivity test may explore the impact of varying declines in property prices (e.g. 10%, 20%, 30%).



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kinked, or cliff-like features. If inappropriate stress parameters are adopted, test results will be unable to fully reveal the sharply changing risk sensitivities of such transactions. An adequate understanding of the risk characteristics of transactions is therefore important for the appropriate design of sensitivity tests.

- 2.4.9 A scenario analysis measures the impact on an AI of a simulation of stress scenarios that affect a number of risk factors (e.g. adverse movements in equity prices, foreign exchange rates and interest rates) together. The stress scenarios can be based on historical or hypothetical events (see subsections 2.5 and 3.3 below).
- 2.4.10 While a sensitivity test highlights the influence of specific risk factors on a portfolio of exposures (or business lines or products), a scenario analysis evaluates the potential combined and interactive effects of the change in all the risk factors encompassed in the stress test (particularly if that interaction is complex and not intuitively clear). Scenario analysis is therefore more often used for generating stress results on a firm-wide basis.
- 2.4.11 Sensitivity tests and scenario analyses can help validate whether certain quantitative approaches adopted by an AI are working as originally intended. For example, an AI may run a series of such analyses of varying severity to test whether the assumption of a linear relationship between changes in a risk factor and the resultant impacts on the capital position of the AI holds true.
- 2.4.12 In assessing the relationships between different risk factors, AIs may also use complex financial models (e.g. pricing or statistical models) or less sophisticated means (e.g. qualitative judgement based on experience or assessment by senior management and experts) that are commensurate with the nature of their portfolios and risks involved. The methods employed should take into account all relevant risk factors and stress scenarios, with results duly incorporated into the risk management process.



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### *Reverse stress-testing*

- 2.4.13 Stress tests should feature a range of severities, encompassing the most material business areas across an AI and events that are capable of generating the most damage, whether through financial damage or loss of reputation. A stress-testing programme should therefore include, through the use of reverse stress-testing, events that could threaten the viability or solvency of the AI.
- 2.4.14 Reverse stress tests start from a known stress-testing outcome (such as a breach of regulatory capital ratios, illiquidity or insolvency) and then work backwards to identify the events that could lead to such an outcome for an AI.
- 2.4.15 There is no single “correct” way for AIs to develop reverse stress scenarios, which may vary depending on AIs’ own business models and risk drivers. For illustrative purposes, an AI may consider adopting the following steps:
- defining specific trigger points that could threaten the AI’s viability or solvency. Such trigger points may involve situations in which (i) the AI’s capital or liquidity positions fall below the respective minimum regulatory standards; (ii) certain indicators are hit reflecting a loss of confidence by the AI’s major counterparties (e.g. access to wholesale funding markets denied) or by depositors (e.g. deposit run-off rates reach a significant level); or (iii) the AI is unable to repay its debt obligations. Some of the trigger points (re item (ii) above) may render the AI unviable (e.g. due to illiquidity resulting from a substantial and rapid deposit run) before it becomes insolvent;
  - “reverse-engineering” the trigger points to identify what adverse but plausible events, financial or non-financial, either individually or in combination, could have brought the AI to those trigger points notwithstanding existing management actions that can be deployed. That is, for reverse stress-testing purposes, an AI is to devise a stress scenario under which existing systems and controls (e.g. established risk limits and controls,



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collateralisation of exposures, etc) are not able to prevent the AI from reaching the trigger point(s) so as to facilitate the AI's analysis of the risks and vulnerabilities revealed by the reverse stress tests and determination of additional credible remedial actions to address them (e.g. by revising its business strategy towards a particular sector); and

- constructing the stress scenarios that would give rise to the events.

2.4.16 AIs should note that the development of reverse stress scenarios is an iterative process involving a mix of qualitative and quantitative analyses for identifying the causes, consequences and impacts under the various scenarios. During the process, AIs should take account of possible correlations between different trigger points and their associated risk factors and second-round effects.<sup>9</sup>

2.4.17 A reverse stress test allows for the consideration of scenarios that go beyond normal business settings or that lead to events with contagion risk or systemic implications. It can supplement quantitative models which are based on historical data and known experiences in the identification of "tail" risks,<sup>10</sup> and help uncover hidden vulnerabilities and interactions among risks relevant to an AI.

2.4.18 A well-designed reverse stress test should also include enough diagnostic support to allow for further investigations into the sources of potential failure, enabling proactive risk assessment and implementation of

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<sup>9</sup> As a hypothetical example, an AI with materially large and concentrated exposures to exporters to the European market might assess that the default of the AI's top five corporate customers would erode its profitability and capital to such an extent that its business would become unviable, and then (i) work backwards to identify what circumstances could possibly cause this risk to materialise; and (ii) construct a scenario that could create those circumstances (e.g. economic downturn occurring in multiple European countries, leading to loss of confidence in the Euro, plummeting demand and weakened financial positions of numerous buyers in those markets), incorporating potential correlations and second-round effects as appropriate (e.g. heightened currency risk for the AI and its corporate clients, heightened liquidity risk for the AI due to potential increased concern on the part of its counterparties, the spillover effects of any crisis in Europe to the local economy and other markets, etc.).

<sup>10</sup> As revealed from the 2008/09 Global Financial Crisis, it was common for financial institutions to underestimate the duration and severity of a crisis in their stress-testing exercises.



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appropriate strategy for risk monitoring, prevention and mitigation.<sup>11</sup>

- 2.4.19 Reverse stress tests are particularly useful for assessing the risks in certain areas such as (i) business lines where traditional risk management models indicate an exceptionally good risk/return trade-off; (ii) new products and new markets which have not experienced severe strains; and (iii) exposures where there are no liquid two-way markets.
- 2.4.20 The HKMA will expect all locally incorporated banks to include reverse stress tests into their stress-testing programmes. In assessing reverse stress tests, the HKMA will take into account the principle of proportionality (re para. 1.4.1) and recognise the limited availability of reverse stress-testing techniques and the scope for future market development in this area (re para. 1.5.3). In general, the mix of qualitative analyses and quantitative analyses may vary in relation to the nature, scale and complexity of the banks' business activities and the risks associated with those activities. Thus it will be acceptable for smaller and less complex local banks to develop reverse stress tests that focus more on qualitative analyses, while those for larger and more complex local banks should include more quantitative elements alongside the qualitative analyses.
- 2.4.21 Going forward, after gathering more experience in the application of reverse stress tests, the HKMA will consider the need for other individual AIs or groups of AIs to conduct such tests in the light of their risk profiles and their position within the banking sector in Hong Kong. This should not, however, prevent all AIs from building up their capacity to carry out reverse stress tests at the earliest opportunity for better risk management.

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<sup>11</sup> For example, if an AI has large exposures to complex structured credit products, examining what scenarios may lead to widespread losses as suffered by some financial institutions during the 2008/09 Global Financial Crisis may lead to a re-assessment of the suitability or viability of having such levels of exposure to such products, and further analysis of the robustness of its risk-hedging strategy in the context of a stressed market environment.



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### *Expert judgement*

- 2.4.22 Qualitative judgement and perspectives from relevant experts (such as risk controllers, economists, business managers and traders) within an AI can provide important input to the stress-testing programme to help supplement the mechanical analysis performed by models, assess the impact of extreme events which are difficult to model statistically (because by definition they occur very rarely), minimise the risk of “silo” effects (e.g. crucial information being compartmentalised within individual business units and not being shared with other relevant units), and analyse and respond to fast changing market conditions.
- 2.4.23 The designated unit responsible for managing and coordinating the stress-testing programme should facilitate internal dialogue and debate among the relevant experts and take into account their opinions as appropriate in the design, implementation, and use of the stress tests.

## **2.5 Design and setting of stress scenarios**

- 2.5.1 An effective stress-testing programme should comprise a range of scenarios along a spectrum of events and severity levels for all relevant risk factors of an AI, as well as the interactions among such risk factors. It should also be capable of providing a firm-wide assessment of the emerging risks to, and vulnerabilities of, an AI including vulnerability to changes in economic and financial conditions.
- 2.5.2 Stress scenarios should be forward-looking, accounting for changes in an AI (e.g. in respect of risk profile, products and activities) and in the markets in which it operates. Stress scenarios should also incorporate an element of “imagination” (e.g. thinking outside of the box) in order to better identify hidden vulnerabilities.
- 2.5.3 Stress scenarios should provide insight into the firm-wide impact of severe stress events on an AI’s financial resources (including capital and liquidity), allow for an assessment of the AI’s ability to react to such events, and produce useful results to inform decision-making at relevant levels of the AI.



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2.5.4 Stress scenarios should be subject to discussion and debate among experts and senior management within an AI, so as to combine their collective knowledge, expertise and judgement in the design of scenarios.

#### Measurement of impact

2.5.5 AIs should determine the appropriate assumptions for stress-testing various risk factors included in a particular scenario and estimate the resultant impact on their financial strength.

2.5.6 The impact of stress tests is usually evaluated against one or more measures, depending on the specific purpose of the test, and the risk exposures and particular issues being analysed. A range of measures may be needed to provide comprehensive perspectives on identified vulnerabilities and the impact of the stress scenarios. Typical measures include -

- asset values;
- accounting profit or loss;
- economic profit or loss;
- regulatory capital requirements (e.g. capital adequacy ratios or risk-weighted assets);
- regulatory liquidity requirements (e.g. minimum liquidity ratios);
- economic capital measures; and
- liquidity and funding gaps.

2.5.7 In determining the firm-wide impact of a particular type of risk or activity, AIs may aggregate the stress-testing results performed across their business lines or units, making prudent and conservative allowances for possible



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correlations among the risk factors and diversification effects between the exposures being examined.<sup>12</sup>

### Risk coverage and related considerations

2.5.8 Stress scenarios should reflect all major types of risk faced by an AI,<sup>13</sup> as well as the specific risk characteristics of the AI's exposures. All related risk factors should be identified and stressed (see subsection 3.2 below for more details). The effects of shocks across relevant risk factors should be examined at a level of granularity appropriate to the purpose of the stress test, taking into account inter-relationships among the risk factors.

2.5.9 AIs should identify and assess possible linkages across different markets and risks under stressed conditions. In particular, their stress scenarios should take into account the potentially strong interaction between asset and funding markets, and the impact of a reduction in market liquidity on the valuation of exposures, during periods of severe stress (as revealed in the 2008/09 Global Financial Crisis).

2.5.10 AIs should also consider the inter-relationships between various factors, including –

- price shocks for specific asset categories;
- the drying-up of corresponding asset liquidity;
- the possibility of significant losses damaging an AI's financial strength;
- the increase in liquidity needs as a result of the draw-down of liquidity commitments;

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<sup>12</sup> AIs should treat the aggregation of stress-testing results of individual business lines with a degree of caution and prudence, as simple aggregation may not adequately or accurately capture correlations, offsetting effects of individual exposures, and risk concentrations, resulting in double-counting of risks or under-estimation of the stress impact.

<sup>13</sup> Depending on the AI's business activities and risk profile, these risks will likely encompass the eight inherent risks covered under the HKMA's risk-based supervisory framework, viz. credit, market, liquidity, interest rate, strategic, operational, legal and reputation risks.





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- the potential obligation (whether contractual or non-contractual) to take on board affected assets of distressed off-balance sheet vehicles or conduits associated with an AI (see also para. 2.5.12 below); and
- impaired access to secured or unsecured funding markets.

2.5.11 Stress scenarios should be able to help identify, monitor and control an AI's risk concentrations.<sup>14</sup> In order to address this, stress scenarios should be firm-wide and comprehensive, covering the on- and off-balance sheet exposures and contingent and non-contingent commitments (independent of their contractual nature) at all levels of the AI, as well as potential changes in market conditions that could adversely impact the AI's risk concentrations.

2.5.12 Stress scenarios should factor in the potential effect of reputation risk on other risk types (with a focus on credit, liquidity and market risks), and be able to integrate risks arising from an AI's exposures and commitments to off-balance sheet vehicles (e.g. structured investment vehicles) and other related entities, and assess the size and soundness of such vehicles relative to the AI's own financial, liquidity and regulatory capital positions. This assessment should include structural, solvency, liquidity and other risk issues (e.g. the effects of covenants and triggers).

2.5.13 In designing stress scenarios, AIs should be mindful that for certain derivative or securitization transactions, while their net exposures to counterparties (after taking into account netting effects, continuous re-margining requirements and collateral arrangements) might be small

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<sup>14</sup> These may arise along different dimensions: (i) single-name concentrations; (ii) concentrations in regions or industries; (iii) concentrations in single risk factors; (iv) concentrations that are based on correlated risk factors that reflect subtler or more situation-specific factors, such as previously undetected correlations between market and credit risks, as well as between those risks and liquidity risk; (v) concentrations in indirect exposures via posted collateral or hedge positions; and (vi) concentrations in off-balance sheet exposures, contingent exposures, and non-contractual obligations due to reputational reasons.



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under normal circumstances, their gross exposures could be at risk. For instance, this may happen where an exchange of principal is involved and the counterparty to a transaction defaults after the AI has delivered the principal amount of the transaction.

- 2.5.14 Als' exposures may also abruptly increase, or the effectiveness of their credit risk-mitigating techniques (e.g. credit default swaps bought) may drop dramatically, in the case of severe market shocks due to specific wrong-way risk<sup>15</sup> (as evidenced in the 2008/09 Global Financial Crisis in relation to the bankruptcy of Lehman Brothers and the exposures to the monoline insurers who had sold credit protection). As a result, Als' large gross exposures to leveraged counterparties (e.g. hedge funds, financial guarantors, investment banks and derivative counterparties) that may be exposed to specific asset types or market movements should be stress-tested, taking account of the potential changes in exposures in stressed conditions.
- 2.5.15 Als should give consideration to the economic cycles to which they are most exposed, including the nature of the cycles in terms of whether they are generic or specific to particular markets, sectors or industries, the duration of the cycles, and the stages of development within the cycles. The stress scenarios should be updated on a timely basis with new economic data as appropriate in order to ensure that the scenarios remain relevant.

#### Historical versus hypothetical scenarios

- 2.5.16 In designing stress scenarios, Als should review lessons from history and tailor the events, or develop hypothetical scenarios, to reflect the risks to which they are most exposed, including those arising from the external

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<sup>15</sup> Specific wrong-way risk arises when the probability of default of counterparties is positively correlated with the level of exposure to the counterparties. See [CR-G-13](#) "Counterparty Credit Risk Management" for more information.



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environment and latest market developments. AIs should also incorporate contagion effects to related markets.

2.5.17 The 1987 Market Crash, the 1997 Asian Financial Crisis, the 1998 Russian Crisis, the 2001 terrorist attack in the U.S., the 2003 SARS outbreak, the 2008/09 Global Financial Crisis and the European Sovereign Debt Crisis<sup>16</sup> are examples of historical events that may be used for developing stress scenarios. These episodes illustrate the relationships between different risk factors and how such relationships could change and be exacerbated in a crisis.<sup>17</sup>

### Level of severity

2.5.18 In determining the level of stress to be applied to the stress scenarios, AIs should have regard to their “baseline” assessment of the normal or expected course of development. The range of scenarios should, in principle, reflect an increasing level of stress compared with the “baseline” situation.

2.5.19 Stress scenarios should be designed to evaluate an AI’s financial position under severe but plausible conditions along a spectrum of events and severity levels. In particular, these should include a severe and sustained economic downturn and, where relevant, an episode of financial market turbulence or a shock to market liquidity.

2.5.20 In identifying adverse circumstances and events, an AI should, where applicable, consider the results of its reverse stress tests (see paras. 2.4.13 to 2.4.21), which may provide complementary information about the AI’s

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<sup>16</sup> The European Sovereign Debt Crisis was still unfolding at the date of this module.

<sup>17</sup> During the Asian Financial Crisis, for instance, various Asian economies suffered from abrupt declines in their asset prices and prolonged economic downturns. Although the overall impact on Hong Kong was in some respects less severe (e.g. the HKD/USD linked exchange rate was not affected), the increase in interest rates and difficult economic conditions (with Hong Kong experiencing five consecutive quarters of negative GDP growth from January 1998 to March 1999) weakened borrowers’ repayment ability while the substantial correction in property and stock markets reduced collateral coverage on loans. The number of corporate windings-up and personal bankruptcies also rose. Collectively, these factors had an adverse impact on AIs’ asset quality, profitability and capital positions.



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vulnerabilities and also help assess the sensitivity of the AI's financial position based on different stress calibrations.

### 2.6 Use of stress-testing results and risk-mitigating strategies

- 2.6.1 The Board, senior management and relevant business managers should be adequately informed of the results of stress-testing, and their attention should be drawn to the potential risks and vulnerabilities identified, with recommendations for possible courses of remedial action. Where appropriate, the HKMA (or relevant banking supervisors in other jurisdictions) should be informed of the results and anticipated actions if they are material to the AI (i.e. in addition to normal stress-testing reporting arrangements).
- 2.6.2 AIs should be guided by a clear set of pre-agreed strategies or principles in determining whether remedial actions should be taken in response to stress-testing results. The management decision on whether and how to respond to stress-testing results should be based on careful analysis and thorough discussion of the results by the Board (or a committee of the Board with delegated authority) or senior management as appropriate, and an assessment of the potential impact of the decision (to act or not to act). In this regard, the factors for consideration may include (i) the risk appetite and tolerance of the AI; (ii) the strength of its capital, liquidity and financial positions; (iii) the robustness of its risk prevention, detection and mitigation measures; (iv) applicable supervisory requirements; (v) assumptions re market conditions in the stress scenario; and (vi) any effects upon the AI's reputation with its counterparties and investors.
- 2.6.3 AIs are expected to set appropriate management action triggers (e.g. in terms of the results of pre-defined stress scenarios) to help decide when remedial actions should be pursued.
- 2.6.4 Where an AI decides it is pertinent to address the vulnerabilities revealed by its stress-testing exercise, realistic risk-mitigating or contingency plans should be developed across a range of stressed conditions. The expected effectiveness of such actions (see para. 2.6.6



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below for examples), especially under stressed conditions when markets may not be fully functioning and multiple institutions could be simultaneously pursuing similar risk-mitigating strategies, should be challenged and assessed systematically. The implications of taking different management actions at different times should be properly assessed and understood.

2.6.5 The level of authority for determining remedial actions to be taken should be clearly designated. Once decided, the remedial actions should be properly documented and implemented.

2.6.6 The types of remedial action to be taken by AIs will vary, depending on the magnitude and likelihood of the potential stress events, and should be proportionate to the severity of the impact of the stress test, the overall risk management framework, and other limiting or risk-mitigating policies. These may generally include:

- restructuring, liquidating, unwinding or hedging a position;
- seeking collateral, buying credit protection or reducing risk exposures to specific sectors, countries, regions or portfolios;
- tightening underwriting requirements, and reviewing and adjusting exposure limits, business strategies or bank policies (including those relating to funding or capital adequacy) to constrain risk-taking;
- shrinking the balance sheet, adjusting the asset or liability structure or restricting profit distribution to conserve capital or liquidity;
- building up an additional buffer of capital or liquidity to cope with the potential impact of stressed conditions;
- amending pricing policies (e.g. on interest spread or margin income) to reflect previously unidentified risks;
- preparing for a liquidity squeeze under stressed situations by increasing credit lines and funding sources and managing the liability structure to ensure adequate funding during a crisis; or



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- implementing contingency plans.

2.6.7 If an AI decides not to take any immediate corrective action, the decision should be adequately justified. The AI should also continue to systematically monitor and manage the business through ongoing stress-testing and develop appropriate contingency plans.

## 2.7 Interpretation and communication of stress-testing results

2.7.1 Stress-testing plays an important role in the communication of risk exposure within an AI, as plausible forward-looking scenarios are more easily grasped than purely statistical models, thereby assisting in the assessment of vulnerabilities as well as the feasibility and effectiveness of potential remedial actions. Stress-testing also supports external communication with supervisors (e.g. with respect to internal assessment of the adequacy of regulatory capital or liquidity positions).

2.7.2 AIs should however be aware of the limitations when interpreting the results of stress tests. Stress-testing estimates the exposure to a specified stress event or scenario but does not give the probability of such an event or scenario occurring. Moreover, stress-testing is influenced by the judgement and experience of the experts designing the stress tests. The effectiveness of stress-testing therefore depends in particular on whether an AI has chosen the “right” scenarios for stress-testing, interpreted the results properly and taken the necessary steps to address the results.

2.7.3 Individual AIs may voluntarily disclose their stress-testing results to enable the market or their stakeholders to better understand their risk profile and risk management framework. In doing so, AIs should pay particular attention to ensure that adequate relevant supporting information (such as the major stress-testing limitations, underlying assumptions, methodologies used and an evaluation of the impact of the stress tests) is provided with a view to ensuring an informed and accurate interpretation of the stress-testing results by third parties.



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### 2.8 Independent review of stress-testing programme

2.8.1 AIs should regularly review and assess, qualitatively and quantitatively, the continued effectiveness and robustness of their stress-testing programme (including major individual components). Such reviews should be undertaken at least once a year, or more frequently if this is warranted by significant changes in the business strategies and risk characteristics of the AI or in the external environment in which it operates. Independent reviewers with relevant knowledge and expertise (such as those in an AI's risk management function or its internal or external auditors) should play a key role in the process.

2.8.2 The review should at least cover the following:

- the effectiveness of the stress-testing programme in meeting its intended purposes;
- the adequacy of management oversight;
- the adequacy of documentation for the programme;
- the integration of stress-testing into daily risk management and decision-making processes at appropriate management levels, as well as capital and liquidity planning;
- the approval process for the programme;
- the implementation of the programme as well as subsequent authorization for, and implementation of, significant changes or development work (e.g. to take account of changes in an AI's business strategies, risk characteristics or external environment);
- the scope of exposures captured by the programme, and the methodologies, scenarios and assumptions used;
- the verification of the quality of data sources used to run the stress tests (e.g. in terms of accuracy, consistency, timeliness, completeness and reliability);
- the integrity of management information and reporting systems for the stress tests; and



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- the validation of stress-testing results, such as through back-testing historical scenarios (e.g. the 2008/09 Global Financial Crisis and the 1997 Asian Financial Crisis) and their impact on an AI's portfolios, or benchmarking with other stress tests conducted within and outside the AI.

2.8.3 AIs should adequately address any issues or weaknesses revealed from the review. Any consequential changes to the stress-testing programme should be duly approved and documented.

### 3. Risk factors and stress scenarios

#### 3.1 General

3.1.1 This section outlines various risk factors and stress scenarios which AIs should take into account in their stress-testing programme. They do not however represent an exhaustive list.

3.1.2 AIs should identify their own risk factors having regard to those risk factors set out in subsection 3.2 below and other circumstances relevant to their institution. They should ensure that important risk factors or relationships between these factors are not omitted from the stress-testing analyses. The risk factors identified will form the basis for developing stress scenarios.

3.1.3 In developing their own stress scenarios, AIs should have regard to the stress scenarios set out in subsection 3.3 below and determine the relevance of these scenarios to the nature of, and risks associated with, their exposures. AIs should have the capacity to conduct integrated stress tests by using a combination of the stress scenarios most relevant to their risk profiles and activities, covering the major types of risk to which they are exposed. The outcome of such integrated stress tests will facilitate the assessment of potential vulnerabilities, taking into account possible correlation between different risks (e.g. credit risk and market risk).





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### 3.2 Identification of risk factors

3.2.1 A key step in the stress-testing process is the identification of major risk factors that should be stressed. In drawing up the list of risk factors, Als should understand the risk characteristics of their exposures and related entities, and analyse the relevant risk factors as well as the correlation (and potential for change in correlation) between these factors.

3.2.2 Highlighted below are some examples of risk factors that may be relevant to Als:

- Credit risk characterised by an increase in default probabilities (e.g. the rise in delinquencies and charge-offs); a decline in recovery rates or in the value of supporting collateral; a rating migration of counterparties, issuers or credit protection providers; and worsening of credit spreads. Als should be aware of the major drivers of repayment ability (such as economic downturns and significant market shocks) that will affect entire classes of counterparties or credits;
- Concentration risk in terms of the exposures to individual counterparties, products / instruments, industries, market sectors, countries or regions. Als should also assess the contagion effects and possible linkages (and the potential changes in such inter-relationships over time and in times of stress) between, as well as the potential vulnerabilities in, different markets, countries, regions, counterparty types and asset classes;
- Interest rate risk arising from parallel shifts or twists in the yield curve and the increase in basis risk (i.e. changes in relationships between key market rates);
- Market or price risk arising from adverse changes in the price or fair value of assets (e.g. currencies, equities, commodities or other financial instruments, and their derivative positions) and their impact on relevant portfolios and markets;



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- Liquidity risk as a result of the tightening of credit lines and market liquidity, or the triggering of obligations to provide additional collateral or margin under credit support agreements, under stressed situations and the impact on funding sources and cash-flow assumptions;
- Operational risk (including legal risk) caused by various factors such as internal or external fraud, system failure and security risks (e.g. in respect of transactional e-banking services), and litigation cases that may lead to material monetary loss or reputational impact on the AI concerned if the outcome is not in its favour;
- Strategic risk resulting from events or changes in the environment that could adversely alter the original assumptions made in the strategic plan and any potential threats to AIs' business, both financially and non-financially;
- Reputation risk in terms of the potential effect of specific events or circumstances (e.g. massive fraud or scandal, solvency concerns) on AIs' financial positions, business and reputation. Attention should also be drawn to potential exposures and obligations (whether contractual or non-contractual) to their securitization or off-balance sheet vehicles and related group entities that may have a reputational or other risk impact in times of a market crisis;<sup>18</sup>
- Product-specific risks such as prepayment risk for mortgages or securitized portfolios. Other potential risks may also arise from abnormal market movements and their impact on contingent credit exposures (e.g. derivatives) and complex products

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<sup>18</sup> The 2008/09 Global Financial Crisis revealed cases in which financial institutions, out of concerns for the reputational spillover effects and damage to market confidence, honoured commitments or took up exposures from their off-balance sheet vehicles or related group entities even though they were not legally obliged to do so.



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(e.g. structured products with embedded multiple risks);

- System-wide interactions and feedback effects that reflect the impact of likely behavioural responses of other market participants and their counterparties on the broader market in times of stress, and how that impact will feed back to AIs' own positions;
- Modelling assumptions for value-at-risk or pricing models, including assumptions for correlation, volatility and holding period, and the potential impact on AIs if such assumptions no longer hold true in crisis situations;
- Macroeconomic factors (e.g. GDP growth, change in property prices, unemployment rate and inflation or deflation rate) and their impact on other risk factors; and
- Political and economic factors pertaining to industries, regions and markets.

### 3.3 Types of stress scenarios

3.3.1 The following are examples of stress scenarios relating to credit risk and counterparty credit risk:

- Domestic economic downturn – this estimates the impact on an AI's asset quality, profitability and capital adequacy of adverse changes in selected macroeconomic variables (e.g. GDP growth, unemployment rate, interest rates, bankruptcy rates and asset prices etc.) that are relevant to the AI's exposures;
- Economic downturn in major economies affecting Hong Kong (e.g. the U.S., Mainland China and Japan) – this estimates the impact on an AI's counterparty exposures (e.g. corporate loans, holdings in securities, interbank exposures etc.) as a result of economic downturn in major economies that have significant financial / commercial / trading links with Hong Kong. As an example, the impact could be measured in terms of a drop in corporate borrowers'



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business revenues or an increase in the default risk of their trading counterparties; or mark-to-market valuation losses on the AI's holdings of securities relating to the economies concerned. The scenario could be extended to include other shocks in those economies (e.g. stock market crisis);

- Decline in the real estate market – this estimates the impact of a decline in property prices on collateral coverage, default risk and provisioning needs for loans secured by properties. In the case of a residential mortgage portfolio, AIs can assess the impact of a resultant increase in loans in negative equity and in the level of impairment allowances and regulatory reserves (based on assumptions of the probability of default and realisation value of the underlying properties for such loans);
- Decline in the value and market liquidity of financial collateral – this estimates the impact of a decline in the valuation and market liquidity of financial collateral held by AIs, which reduces the quality and quantity of the collateral, leading to lower collateral coverage and recovery rates and higher provisioning needs and capital charges;
- Increases in classified loans and provisioning levels – this assesses the resilience of an AI's loan portfolios in terms of the impact of such increases on its profitability and capital adequacy. In designing the scenario, an AI may apply different percentages of increase in classified loans and provisioning levels to its loan portfolios. Alternatively, it may conduct a loan migration test, i.e. assuming that a certain percentage of loans in each of the first four categories of the HKMA's five-grade loan classification system<sup>19</sup> is downgraded to the next category;
- Rating migration of counterparties - A similar stress test can be performed based on the internal or

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<sup>19</sup> The five loan classification categories comprise Pass, Special Mention, Substandard, Doubtful and Loss.



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external credit ratings of an AI's credit exposures, by migrating a certain percentage of the credit exposures of a specific rating grade (by one or more notches) to a lower rating grade (or to a higher rating grade in respect of short credit risk positions taken), and assessing the resultant impact on the AI's profitability and capital adequacy. The capital impact may include the effects of increases in credit losses and provisioning needs as well as the application of higher risk-weights due to rating downgrades in the calculation of regulatory capital;

- Default of major counterparties – this estimates the impact of default of an AI's major counterparties, including corporate, sovereign and bank counterparties, on its profitability as well as liquidity and capital adequacy. The test can be extended to cover aggregate exposures to major industries, market sectors, countries and regions (e.g. by assuming that a significant number of defaults occur within such aggregate exposures);
- Deterioration in the quality of consumer lending – this estimates the impact of a rising unemployment rate and an increasing number of personal bankruptcies on retail portfolios such as credit card receivables and personal loans. An appropriate scenario would be to assume a further rise in the level of charge-offs for such lending taking into account the projected increase in the unemployment rate and personal bankruptcies; and
- Decline in the value of taxi licences / gross operating income of taxi drivers – this estimates the impact on an AI's taxi loan portfolio in terms of collateral coverage, default risk and provisioning needs.

3.3.2 The following are examples of stress scenarios relating to interest rate risk:

- Repricing risk – this assesses the effects on an AI's profitability due to timing differences in interest rate changes and cash flows in respect of fixed and



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floating rate assets, liabilities and off-balance sheet instruments;

- Basis risk – this assesses the effects on an AI's profitability due to unfavourable differential changes in key market rates (e.g. HIBOR and the prime rate);
- Yield curve risk – this assesses the effects on an AI's profitability due to parallel yield curve shifts (up and down) and non-parallel yield curve shifts (i.e. steepening or flattening of the yield curve); and
- Option risk – this assesses the effects of changes in the value of both stand-alone option instruments (e.g. bond options) and embedded options (e.g. bonds with call or put provisions and loans which give borrowers the right to prepay outstandings) due to adverse interest rate movements.

Als may conduct the above stress scenarios or other scenarios that reflect their specific interest rate risk characteristics using gap analyses or simulation techniques (see [IR-1](#) "Interest Rate Risk Management" for more details on these techniques).

3.3.3 The following are examples of stress scenarios relating to other risks:

- Decline in net interest income – this estimates the impact on an AI's net interest income due to negative loan growth or squeezes in pricing caused by competition for new business or market share;
- Adverse changes in exchange rates between major currencies – this estimates the impact on an AI's net open positions in major currencies. Als should also assess the impact of such changes on their major customers with substantial foreign exchange exposures. Such exposures could arise from the customers' foreign currency assets, liabilities or income streams;
- Decline in market value of financial instruments – this estimates the impact of adverse changes in market prices (e.g. exchange rates or interest rates) and



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liquidity conditions on the market values of financial instruments (e.g. corporate bonds and derivatives). For complex and bespoke products such as securitization exposures, AIs should take into account the risk characteristics related to the underlying assets, dependence on market conditions, contractual arrangements, embedded triggers and leverage, and subordination level in the issue structure;

- Changes in market risk variables – this assesses the effects of adverse changes in market risk factors (i.e. interest rates, foreign exchange rates and equity or commodity prices) on an AI's market risk exposures. In addition, factors such as market / product illiquidity, concentration risk, effectiveness of risk-mitigating strategies and counterparty risk should be taken into account;
- Inability to access the securitization market – this covers the risk from pipeline and warehousing exposures associated with underwriting and securitization activities, which should be taken into account regardless of the probability for securitization of these exposures;
- Hidden risk concentrations – this estimates the impact from changes in market conditions which could give rise to risk concentrations. AIs may identify and assess the impact of heightened correlations or hidden inter-dependencies within and across risk types / risk factors and possible second-round effects under severe market shocks that may lead to an increase in an AI's exposures. For instance, corporate default rates may accelerate as macroeconomic conditions deteriorate progressively, pipeline and warehousing risks may emerge, or AIs may be obliged to take back exposures they have previously offloaded or to take up exposures to support their related entities;
- Widening of credit spreads – this captures the risk of increases in the credit spreads of securities or credit derivatives in a particular market (e.g. an industry



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sector or a region) due to problems in that market or across markets as witnessed in the 2008/09 Global Financial Crisis;

- Market dislocations and spillovers – this estimates the effects of market dislocations and spillovers across counterparty groups, markets or risk types as a result of the inter-connectedness and dependencies among financial institutions, counterparties, markets and economies;<sup>20</sup>
- Decline in stock prices / indices – this estimates the effect on an AI's share margin lending or holdings of stocks;
- Liquidity crisis – this analyses the adequacy of an AI's short-term liquidity to meet crisis situations (e.g. significant deposit outflows, tightening of credit lines). See [LM-2](#) "Sound Systems and Controls for Liquidity Risk Management" for more guidance; and
- Operational risk events – this assesses the effects, on an AI's capital requirement for operational risk or its ability to maintain critical operations and earning capabilities, of external events (e.g. utility outage and suspension of service by a major service provider) or internal events (e.g. business disruption or system failures, telecommunication problems and loss of key personnel).

## 4. Supervisory assessment of stress-testing practices

### 4.1 General

- 4.1.1 The HKMA considers that stress tests, if properly designed and implemented, will enhance an AI's risk management capability and decision-making process, and help the AI prepare for difficult market conditions. While stress-testing on its own cannot address all risk management issues, as

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<sup>20</sup> The 2008/09 Global Financial Crisis exemplified such risks and their impacts. During such a crisis, hedges that work efficiently under normal conditions may break down, and access to regular funding or credit sources may evaporate rapidly or may only be attained at substantially higher cost.





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part of a comprehensive risk management framework, it plays a key role in strengthening risk governance thereby fortifying the resilience of individual AIs and the Hong Kong banking system.

- 4.1.2 AIs are expected to integrate stress-testing into their risk governance and management processes and conduct stress tests on a regular basis. There is no “one-size-fits-all” stress-testing programme that is applicable to all AIs, given that the risk characteristics and risk management capabilities of individual AIs vary. There is also a diverse range of purposes for which stress-testing may be conducted, as well as a variety of techniques upon which such testing may be based. AIs should therefore develop and maintain a comprehensive stress-testing programme that reflects their specific risk profiles and is commensurate with the nature, scale and complexity of their business activities and the risks associated with those activities.

## 4.2 Assessment approach

- 4.2.1 The HKMA will regularly evaluate the appropriateness and effectiveness of AIs’ stress-testing programmes and the extent to which they reflect and are aligned with the guidance in this module during its off-site reviews or on-site examinations, having regard to the following:
- the nature, scale and complexity of an AI’s business activities and the risks associated with those activities;
  - the appropriateness of the AI’s stress tests (e.g. in terms of the coverage and the types of stress scenarios and parameters chosen) in relation to its risk appetite or tolerance, overall risk profile and business plan, and the effectiveness of the stress tests in identifying relevant vulnerabilities on a firm-wide basis;
  - the appropriateness of the assumptions used in the stress tests, taking into account existing and potentially changing conditions in respect of the AI and its operating environment;



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- the capacity of the AI's financial resources (including capital and liquidity) to absorb potential losses under stressed situations;
- the integration of stress-testing into the AI's overall governance and risk management culture, and its capital and liquidity risk management framework;
- the adequacy of resources, infrastructure and established procedures to support the stress-testing programme;
- the use of stress-testing results and how the results impact decision-making at different management levels, including strategic business decisions at the Board and senior management level;
- the adequacy, feasibility and credibility of the AI's risk-mitigating strategies and contingency planning for actions to be taken should a particular stress scenario happen, taking into account the extent to which management actions may be restrained under stressed situations;
- the level of oversight exercised by, and the involvement of, the Board and senior management in the stress-testing programme; and
- the adequacy of the AI's internal review and audit of its stress-testing programme.

4.2.2 The HKMA will expect AIs to submit for its review regularly, and whenever necessary, the results of their firm-wide stress tests, including any actions taken in response to the results generated and the supporting analyses and justifications for the actions taken. In reviewing and interpreting individual AIs' submissions, the HKMA will be mindful of the need to take into account the specific circumstances affecting the design of their stress-testing programmes.

4.2.3 In order to arrive at a comprehensive assessment of an AI's stress-testing programme, the HKMA will, where necessary, engage in discussion with the Board or senior



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management on the programme, particularly in respect of the following:

- their views on major macroeconomic and financial market vulnerabilities and relevant threats specific to the AI's operation and business model; and
- their justifications for various aspects of the stress-testing programme and the methodology employed, such as the key assumptions driving the stress-testing results, the scope and severity of the firm-wide scenarios used, and how the stress-testing results are in practice being used.

In its assessment, the HKMA will pay particular attention to situations where the impact of stress tests seems unrealistically low or where mitigating actions appear unrealistic.

4.2.4 The HKMA may also request an AI to conduct additional sensitivity analysis in respect of specific business lines, portfolios or positions which pose significant risk to the AI. Furthermore, the AI may be requested to evaluate scenarios under which its viability is compromised (e.g. reverse stress-testing scenarios), or to assess the plausibility of events that lead to significant strategic or reputation risk, particularly for significant business lines or products.

4.2.5 Where the HKMA's assessment reveals material shortcomings in an AI's stress-testing programme (or that the results generated from the programme are not adequately attended to or acted upon), it will expect the AI to provide a detailed plan of corrective actions and follow-up on its implementation.

4.2.6 The HKMA's approach to assessing AIs' compliance with stress-testing requirements for regulatory capital (i.e. under the Banking (Capital) Rules or the supervisory review process) and liquidity purposes is set out in the relevant modules of the [Supervisory Policy Manual](#) under the respective sections on [Capital Adequacy](#) and [Liquidity Risk](#)



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[Management](#). In some cases, the results of regulatory stress tests may translate into additional capital charges for the AIs concerned.<sup>21</sup>

### 4.3 Use of supervisory scenarios

- 4.3.1 Where appropriate, the HKMA may ask selected AIs to conduct additional stress tests based on common stress scenarios advised by the HKMA. Such supervisory scenarios aim to help (i) identify potential sources of risk to specific groups of AIs or macroeconomic or financial market vulnerabilities; (ii) assess the impact of such stress events on the AIs or the banking sector as a whole; and (iii) determine appropriate supervisory strategies. When conducting this type of supervisory stress test, the HKMA will work with participating AIs with a view to ensuring that their stress-testing results are comparable in terms of data quality, completeness and consistency with specific guidance. Where necessary, the HKMA will discuss the test results with individual AIs, and the management actions to be taken to address any identified supervisory concerns.
- 4.3.2 However, AIs should be mindful that any such supervisory stress tests referred to in para. 4.3.1 will be in addition to, and should not be regarded as a substitute for, the stress tests to be conducted by AIs themselves as part of their own stress-testing programme. Unlike the bespoke stress tests within an AI's stress-testing programme, a common supervisory scenario is not tailored to the specific risk characteristics of individual AIs.
- 4.3.3 The HKMA also regularly conducts its own internal supervisory stress tests, which may make use of the data and results generated from AIs' stress tests, in order to facilitate assessment of the vulnerabilities and soundness of individual AIs, specific groups of AIs, and the Hong Kong banking sector as a whole. AIs' stress-testing results and

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<sup>21</sup> For example, under section 318(3) of the Banking (Capital) Rules, the Monetary Authority may, by notice in writing given to an AI, impose a supplemental capital charge against an AI's correlation trading portfolio if the Monetary Authority is satisfied that the regulatory stress tests on the portfolio indicate a material shortfall in the related comprehensive risk charge calculated by the AI's internal models.



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the results of the HKMA's internal supervisory stress tests will inform and refine the HKMA's prudential supervisory process.

- 4.3.4 The HKMA will maintain an ongoing dialogue with the Hong Kong banking industry and relevant public authorities on stress-testing practices, particularly where macro-prudential issues and systemic vulnerabilities are concerned.

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