

### **Guidelines to Banks on Stress Testing**

The overall objectives, governance, design and implementation of stress testing programmes as well as issues relating to stress testing of individual risks and products are presented below:

#### **1. Introduction and Background**

##### **1.1. General**

**1.1.1** Stress testing is commonly described as the evaluation of a bank's financial position under a severe but plausible scenario to assist in decision making within the bank. It enables a bank in forward looking assessment of risks, which overcomes the limitations of statistical risk measures or models based mainly on historical data and assumptions. It also facilitates internal and external communication and helps senior management understand the condition of the bank in the stressed time. Moreover, stress testing outputs are used by a bank in decision making process in terms of potential actions like risk mitigation techniques, contingency plans, capital and liquidity management in stressed conditions, etc. It was, therefore, included as an important element of risk management framework and capital planning in the Basel Committee on Banking Supervision (BCBS) document titled 'An International Convergence of Capital Measurement and Capital Standards: A Revised Framework' known as Basel II'.

**1.1.2** The 2007-08 global financial crisis has brought into sharp focus the imperativeness of a rigorous and stringent stress testing programme for banks. The magnitude of the financial crisis has led many banks and supervisory authorities to question whether stress testing practices were sufficient prior to the crisis and whether they were adequate to cope with rapidly changing circumstances. A number of initiatives including G20's November 2008 action plan have strongly advocated raising the level and sophistication of stress testing programmes to make them realistic and meaningful.

**1.1.3** Stress testing should form an integral part of the internal capital adequacy assessment process (ICAAP), which requires banks to undertake rigorous, forward-looking stress testing that identifies severe events or changes in market conditions that could adversely impact the bank. The ICAAP should demonstrate that stress testing reports provide the senior management with a thorough understanding of the material risks to which the bank may be exposed. Stress testing should also be a central tool in identifying, measuring and controlling funding liquidity risks, in particular for assessing the bank's liquidity profile and the adequacy of liquidity buffers in case of both bank-specific and market-wide stress events.

**1.1.4** These guidelines, applicable both at solo as well as group level, would be considered by the Reserve Bank to review the suitability of stress testing programmes and resultant actions including the requirement of additional capital and liquidity buffers as part of Supervisory Review and Evaluation Process (SREP) under the Basel II framework. Banks may perform the stress tests in terms of these guidelines at least at half yearly intervals.

## **1.2 Objective**

**1.2.1** The development and implementation of a stress-testing programme would require 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.

**1.2.2** Stress testing which is based on forward looking approach should provide a complementary and independent risk perspective to other risk management tools such as value-at-risk (VaR) and economic capital. Stress tests should complement risk management approaches that are based on complex, quantitative models using backward looking data and estimated statistical relationships. It should be used to assess the robustness of models to possible changes in the economic and financial environment. In particular, appropriate stress tests should challenge the projected risk characteristics of new products where limited historical data are available. Banks should

also simulate stress scenarios in which the model-embedded statistical relationships break down as has been observed during the financial market crisis.

**1.2.3** Stress tests should play an important role in the communication of risk within the bank and external communication with supervisors to provide support for internal and regulatory capital adequacy assessments.

## **2. Governance**

### **2.1 Board and Senior Management Involvement**

**2.1.1** The ultimate responsibility for overall stress testing programme in a bank rests with the board of directors of the bank and with the Chief Executive Officer in the case of the foreign banks with branch presence in India. Senior management may be accountable for the programme's implementation, management and oversight. It is emphasised that the involvement of the Board and Senior management is critical for the success and effectiveness of stress testing programme.

**2.1.2** On practical considerations, some aspects of stress testing, such as design of methodologies, identification of risk factors, implementation, potential actions, etc., may be delegated. However, the board should actively participate in setting stress testing objectives, defining scenarios, discussing the results of stress tests in the context of bank's risk profile, assessing potential actions and decision making. The board/committees of board must therefore engage in the discussion of modelling assumptions and are expected to question assumptions underlying the stress tests from a common/business sense perspective e.g. whether assumptions about correlations in a stressed environment are reasonable. The Board should also take responsibility for identifying and agreeing credible management intervention and mitigating actions.

### **2.2 Integration of Stress Testing in Risk Governance and Risk Management Processes of a Bank**

**2.2.1** To promote risk identification and control, stress testing should be included in risk management activities of a bank at various levels of aggregation or complexity. This includes the use of stress testing for the risk management of individual or groups of

borrowers and transactions, for portfolio risk management, as well as for risk management of business lines or business strategy. In particular, it should be used to address existing or potential firm-wide risk exposures and concentrations.

**2.2.2** Stress tests should be used to support a range of decisions. Board and senior management should be made aware of the limitations of underlying assumptions of stress tests, the methodologies used and an evaluation of the impact of stress tests. It is thus important that senior management participates in the review and identification of potential stress scenarios and contributes to risk mitigating strategies. Stress tests should be used as an input for setting the risk appetite of the firm or setting exposure limits and to support the evaluation of strategic choices when undertaking and discussing longer term business planning. Importantly, stress tests should feed into the capital and liquidity planning process.

### **2.3 Internal Policies & Procedures and Documentation**

**2.3.1** The stress testing programme should be governed by internal policies and procedures that are appropriately documented.

**2.3.2** The following aspects should be detailed in policies and procedures governing the stress testing programme:

- (i) the type and specification of stress testing and scenarios and the main purpose / objective of each component of the programme;
- (ii) frequency of stress testing exercises which is likely to vary depending on type and purpose;
- (iii) the methodological details of each component, including the definition of relevant scenarios and the role of expert judgement; and
- (iv) the range of remedial actions envisaged, based on the purpose, type and result of the stress testing, including an assessment of the feasibility of corrective actions in stress situations.

**2.3.3** A bank should document the underlying assumptions and fundamental elements for each stress testing exercise. These include the reasoning and judgments underlying the chosen scenarios and the sensitivity of stress testing results to the range and severity of the scenarios. An evaluation of such fundamental assumptions should be performed regularly or in light of changes in the risk characteristics of the bank or its external conditions and documented.

## **2.4 An Appropriate and Flexible Infrastructure**

**2.4.1** Commensurate with the principle of proportionality, a bank should have suitably flexible infrastructure like IT system, qualified professionals, as well as data of appropriate quality and granularity. Banks should have adequate MIS in place to support the stress testing framework. Banks must ensure that they devote sufficient resources to developing and maintaining such infrastructures to enable the bank on a timely basis to modify methodologies to apply new scenarios as needed. The infrastructure should also be sufficiently flexible to allow for targeted or ad-hoc stress tests at the business line or firm-wide level to assess specific risks in times of stress.

## **3. Design**

**3.1.1** The identification of relevant stress events, the application of sound modelling approaches and the appropriate use of stress testing results require the collaboration of different senior experts within a bank. The unit with responsibility for implementing the stress testing programme should organise appropriate dialogue among these experts, challenge their opinions, check them for consistency (e.g. with other relevant stress tests) and decide on the design and the implementation of the stress tests, ensuring an adequate balance between usefulness, accuracy, comprehensiveness and tractability.

**3.1.2** There are broadly two categories of stress tests used in banks viz. **sensitivity tests** and **scenario tests**.

**3.1.3** Sensitivity analysis estimates the impact on a bank's financial position due to predefined movements in a single risk factor like interest rate, foreign exchange rate or equity prices, shift in probabilities of defaults (PDs), etc. In the sensitivity analysis,

generally, the source of the shock on risk factors is not identified and usually, the underlying relationship between different risk factors or correlation is not considered or ignored. For example, the impact of adverse movement in interest rate or foreign exchange rate on profitability is considered separately but the fact that movement in interest rate and foreign exchange rate is inter-related is ignored to keep stress test simple. These tests can be run relatively quickly and form an approximation of the impact on the bank of a move in a risk driver.

**3.1.4** Banks should identify relevant risk drivers in particular: macro-economic risk drivers (e.g. interest rates, foreign exchange rates), credit risk drivers (e.g. impact of monsoon or a shift in PDs), financial risk drivers (e.g. increased volatility in financial markets), operational risk drivers (e.g. natural disaster, terrorist attack, collapse of communication systems across the entire region / country, etc.), and external events other than operational risk events (e.g. sudden drying up of external funding, sovereign downgrade, market events, events affecting regional areas or industry, global events, etc).

**3.1.5** Banks should then stress the identified risk drivers using different degrees of severity. For example, a sensitivity test might explore the impact of varying declines in equity prices such as by 40%, 50%, 60% or a range of increases in interest rates such as by 100, 200, 300 basis points. The severity of single risk factor is likely to be influenced by long-term historical experience but banks are advised to supplement this with hypothetical assumptions of wide range of possibilities to test their vulnerability to specific risk factors.

**3.1.6** Banks can conduct sensitivity analyses at the level of individual exposures, portfolios or business units, as well as firm-wide, against specific risk areas as sensitivity analysis is likely to lend itself to risk-specific stress testing. It is likely to be influenced by purpose of stress testing.

**3.1.7** Single factor analysis can be supplemented by simple multi-factor sensitivity analyses, where a combined occurrence of some risk drivers is assumed, without

necessarily having a scenario in mind. While banks classified under Group C\* may use multi-factor sensitivity analysis as an option, banks classified under Group B and Group A should invariably use multi-factor sensitivity analysis as part of their stress testing.

**3.1.8** In utilising this technique, a bank must be mindful of the correlations between the various risk factors and ensure that these are taken into consideration when developing the underlying assumptions used in the stress scenarios.

**3.1.9** An effective stress testing programme should comprise scenarios along a spectrum of events and severity levels. It helps deepen management's understanding of vulnerabilities and the effect of non-linear loss profiles.

## **3.2 Review of Stress Testing**

**3.2.1** As the environment in which banks are operating is quite dynamic, the stress testing framework should be reviewed periodically, both qualitatively and quantitatively, to determine its efficacy and to consider the need for modifying any of the elements. The framework should be subjected to at least annual reviews which should cover, among others, the following aspects:

- (i) the effectiveness of the programme in meeting its intended purposes;
- (ii) integration of the stress testing in the risk management processes;
- (iii) realistic levels of stress applied;
- (iv) systems implementation;
- (v) management oversight;
- (vi) data quality and MIS;
- (vii) documentation;
- (viii) business and/or managerial assumptions used; and
- (ix) any other assumptions used.

**3.2.2** The quantitative processes should include benchmarking with other stress tests within and outside the bank.

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\* For grouping banks into A, B and C, please see Annex 3.

**3.2.3** Since the stress test development and maintenance processes often imply judgmental and expert decisions (e.g. assumptions to be tested, calibration of the stress, etc.), the independent control functions such as risk management and internal audit should also play a key role in the process.

**3.2.4** An important corollary of review and assessment of stress testing programmes involves updation of the processes to keep them relevant and meaningful and suitable to the requirements of the bank.

## **4. Coverage**

### **4.1 Use of a Suite of Techniques & Methodologies**

**4.1.1** Banks in general should use multiple perspectives and a range of techniques and methodologies in order to achieve comprehensive coverage in their stress testing programme.

**4.1.2** The suite may include quantitative and qualitative techniques to support and complement the use of models and to extend stress testing to areas where effective risk management requires greater use of judgments. For example, it may contain a narrative scenario which should include various trigger events, such as monetary policy, financial sector developments, commodity prices, political events, global events, monsoon and natural disasters.

**4.1.3** Stress tests should range from simple sensitivity analysis to more complex stress tests like scenario analysis with system-wide interactions and feedback effects. Some stress tests should be run at regular intervals while the stress testing programme should also allow for the possibility of ad hoc stress testing. Stress testing should include various time horizons depending on the risk characteristics of the analysed exposures and purposes.

**4.1.4** Banks are expected to employ a combination of stress testing techniques that are most appropriate to the size and complexity of their business activities, as also the objectives in mind.



## **4.2 Forward Looking Scenario**

**4.2.1** The stress testing programme should cover forward-looking scenarios to incorporate different possibilities of multi-level stress tests, changes in portfolio composition, new information and emerging risk possibilities. These are generally not covered by relying on historical risk management or replicating previous stress episodes. However, historical scenarios (where a range of risk drivers are moved simultaneously) may provide useful information on the way risk drivers behave collectively in a crisis and they may therefore be useful to assess the assumptions of an internal capital model, and in particular correlation estimates.

**4.2.2** The compilation of forward-looking scenarios requires combining the knowledge and judgment of experts across the organisation. Further, as the statistical relationships used to derive the probability tend to break down in stressed conditions, giving appropriate weight to expert judgment in defining relevant scenarios with a forward looking perspective thus becomes critical.

**4.2.3** Forward looking scenarios of varying severity and for various purposes can be designed by calibrating historically observed macro-economic and financial variables, internal risk parameters, losses, etc. The formulation of realistic and imaginative scenarios requires at minimum the following two steps indicated in paragraphs 4.2.4 and 4.2.5 below:

**4.2.4** Banks should take into account both the systematic and institution-specific changes in the present and near future scenarios to be forward-looking. For this purpose, the following aspects are relevant:

- (i) All the material risk factors e.g. credit risk, market risk, operational risk, interest rate risk, liquidity risk, etc. that a bank may be exposed to should be stressed. In this regard, the results obtained from single factor analyses may be used to identify scenarios that include a set of highly plausible risk factors. No material risk factor should be left unstressed or unconsidered.
- (ii) Identified risk drivers should behave in ways which are consistent with the other risk drivers in a stress.

- (iii) All bank-specific vulnerabilities should be identified and analysed. These should take the regional and sectoral characteristics of a bank into account as well as consider specific product or business line exposures and funding policies.
- (iv) Banks should take into account developments in technology such as newly developed and sophisticated financial products and their interaction with the valuation of more traditional products.
- (v) The chosen scenario should be applied to all positions e.g. on- and off-balance sheet exposure of a bank.

**4.2.5** Banks should identify and develop appropriate and meaningful mechanisms to convert scenarios into relevant internal risk parameters and potential losses. It should also be tested regularly to check their reliability. For this purpose, the following aspects are relevant:

- (i) Banks should make realistic explicit estimates/assumptions about the correlation between underlying macro-economic and financial variables such as interest rates, exchange rate, global oil prices, GDP, monsoon, equity, consumer and asset prices, capital flows, etc.
- (ii) The transformation of external variables or institution-specific events into internal losses or increased risk measures on consistent basis is a challenging task. Banks should be aware of the possible dynamic interactions among risk drivers, the effects on earnings and on- and off-balance sheet position.
- (iii) The links between underlying economic factors and internal risk parameters are likely to be based primarily on institutional experience and analysis, which may be supplemented by external research. Benchmarks, such as those based on external research, may be quantitative or qualitative.
- (iv) Considering the complexity involved in modelling hypothetical and macro-economic based scenarios, banks should be aware of the model risk involved. A regular and conservative expert review of the model's assumptions and mechanics are important as well as a conservative modelling approach to account for model risk.

- (v) Where a wide variety of models, supporting formulas and varying assumptions are used, banks should consider ways to streamline their stress testing programmes to improve transparency and simplicity.

### **4.3 System-wide Interactions and Feedback Effects**

**4.3.1** The strong links between the real economy and financial economy as well as the process of globalisation have amplified the need to look at system-wide interactions and feedback effects. The stress test should explicitly identify interdependences, e.g. among regions, among sectors and among markets. The overall scenario should take into account system-wide dynamics – such as leverage building up across the system, closure of certain markets, risk concentrations in a whole asset class such as mortgages, and adverse feedback dynamics, for example through interactions among valuations, losses, margining requirements and insurance relations.

**4.3.2** The above analysis can be very difficult to model quantitatively. Thus, banks may make qualitative assessments of the second order effects of stress. Such assumptions should be documented and reviewed by senior management.

### **4.4 Levels of Severity in Scenarios**

**4.4.1** Stress testing should be based on exceptional but plausible events. However, their stress testing programme should cover a range of scenarios with different severities including scenarios calibrated against the most adverse movements in individual risk drivers experienced over a long historical period. Where appropriate, a bank might consider a scenario with a severe economic downturn and/or a system-wide shock to liquidity.

**4.4.2** In developing severe downturn scenarios banks should also consider plausibility. For example, as an economy enters recession banks should not necessarily always assume a further specific level of stress. There may be times when the stressed scenario is close to the base case scenario, but supplemented with specific shocks (e.g. interest rates, exchange rates), which should be reflected in the scenarios.

**4.4.3** Some of the scenarios that can be constructed from historical disturbances or events of significance may be the 1973 world oil crisis, 1973-74 stock market crisis, the secondary banking crisis of 1973-75 in UK, the default of Latin American countries on their debt in the early 1980s, the Japanese property bubble of the 1980s, the 1987 Market Crash, the Scandinavian banking crisis of 1990s, the 1991 external payments crisis in India, the securities scam of 1991-92 in India, the ERM crises of 1992 and 1993, the fall in bond markets in 1994, the 1994 economic crisis in Mexico, the 1997 Asian Crisis, the 1998 Russian Crisis, 26/11 2001 U.S. Crisis, the sub-prime mortgage crisis of 2007-2008 turning into severe recession, debt crisis of Greece in 2010, etc. Scenarios may also contain some risk factors or variables which were specially observed during financial crisis of 2007-08:

- (i) Scenarios to include significant strategic or reputational risk in particular for significant business lines;
- (ii) Scenarios to include, where relevant, an episode of financial market turbulence or a shock to market liquidity;
- (iii) Scenarios under which capital might not be freely transferable within banking groups in periods of severe downturn or extended market disruption;
- (iv) Scenarios under which a crisis impairs the ability of even very healthy banks to raise funds at reasonable cost;
- (v) Scenarios under which model-embedded statistical relationships break down;
- (vi) Scenarios under which risk characteristics of new products projected on the basis of limited historical data are challenged;
- (vii) Scenarios to include simultaneous pressures in funding and asset markets, and the impact of a reduction in market liquidity on exposure valuation, etc.

**4.4.4** Some of the scenarios can be designed from the specific observed/imaginative risk parameters or events like:

- domestic economic downturn, economic downturn of major economies to which the bank is directly exposed or to which the domestic economy is related;

- decline in the prospects of sectors to which the banks are having significant exposures, increase in level of NPAs and provisioning levels, rating downgrades, failure of major counterparties;
- timing difference in interest rate changes (repricing risk), unfavourable differential changes in key interest rates (basis risk), parallel / non parallel yield curve shifts (yield curve risk), changes in the values of standalone and embedded options (option risk), adverse changes in exchange rates of major currencies, decline in market liquidity for financial instruments, stock market declines, tightening of market liquidity;
- significant operational risk events viz. bank-specific or market-wide cyber attacks, increasing fraud risk in an economic downturn like increase in credit card frauds, internet banking frauds and litigation, rogue trader scenarios, damage to tangible assets due to a natural disaster say tsunami.

## **4.5 Reverse Stress Testing**

**4.5.1** Reverse stress testing is a technique that involves assuming worst stressed outcome and tracing the extreme event/shocks that bring the maximum impact. Reverse stress testing starts from an outcome of business failure and identifies circumstances where this might occur. It is seen as one of the risk management tools usefully complementing the “usual” stress testing, which examines outcomes of predetermined scenarios. Reverse stress testing is not expected to result in capital planning instead it is primarily designed as a risk management tool in identifying scenarios and underlying dynamism of risk drivers in those scenarios, that could cause an institution’s business model to fail.

**4.5.2** It is a useful tool in risk management as it helps understand potential vulnerabilities and fault lines in the business, including ‘tail risks’. It will also be useful in assessing assumptions made about the business model, business strategy and the capital plan. The results of reverse stress test may be used for monitoring and contingency planning.

**4.5.3** Reverse stress testing should be carried out regularly by large and complex banks i.e., Group A banks, to investigate the risk factors that wipe out their capital resources and also make their business unviable. As a starting point reverse stress testing is likely to be carried out in a more qualitative manner than other types of stress testing. As experience is developed this should then be mapped into more sophisticated qualitative and quantitative approaches developed for other stress testing.

## **4.6 Complex and Bespoke Products**

**4.6.1** Banks mistakenly assess the risk of some products by relying on external credit ratings or historically observed credit spreads related to (seemingly) similar products like corporate bonds with the same external rating. Such approaches cannot capture relevant risk characteristics of complex, structured products under severely stressed conditions.

**4.6.2** Stress tests for securitised assets should consider the underlying asset pools, their exposure to systematic market factors, relevant contractual arrangements and embedded triggers, and the impact of leverage, particularly as it relates to the subordination level of the specific tranches in the issue structure.

## **4.7 Pipeline and Warehousing Risk**

**4.7.1** The stress testing programme should cover pipeline and warehousing risks associated with securitization activities. A bank should include such exposures in its stress tests regardless of their probability of being securitised.

## **4.8 Reputational and Other Off-Balance Sheet Risks**

**4.8.1** To mitigate reputational spill-over effects and maintain market confidence, a bank should develop methodologies to measure the effect of reputational risk on other risk types, with a particular focus on credit, liquidity and market risks. For instance, a bank should include non-contractual off-balance sheet exposures in its stress tests to determine the effect on its credit, liquidity and market risk profiles.

**4.8.2** Banks should carefully assess the risks associated with commitments to off-balance sheet vehicles e.g. structured credit securities and the possibility that assets

will need to be taken on balance sheet for reputational reasons. Therefore, in its stress testing programme, a bank should include scenarios assessing the size and soundness of such vehicles relative to its own financial, liquidity and regulatory capital positions. This analysis should include structural, solvency, liquidity and other risk issues, including the effects of covenants and triggers.

#### **4.9 Risks from Leveraged Counterparties**

**4.9.1** A bank may have large gross exposures to leveraged counterparties including financial guarantors, investment banks and derivatives counterparties that may be particularly exposed to specific asset types and market movements. In case of severe market shocks, these exposures may increase abruptly and potential cross-correlation of the creditworthiness of such counterparties with the risks of assets being hedged may emerge (i.e. wrong-way risk). The bank should enhance its stress testing approaches related to these counterparties in order to capture adequately such correlated tail risks.

#### **4.10 Management Intervention Action**

**4.10.1** The performance of risk mitigating techniques like hedging, netting and the use of collateral should be challenged and assessed systematically under stressed conditions when markets may not be fully functioning and multiple institutions could simultaneously be pursuing similar risk mitigating strategies.