



International Actuarial Association  
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# IAA Risk Book

## Appropriate Applications of Stress and Scenario Testing

Insurance Regulation  
Committee

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# **IAA Risk Book**

## **Appropriate Applications of Stress and Scenario Testing**

**This Risk Book chapter has been developed and approved  
by the Insurance Regulation Committee of the IAA**

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## Version

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## Introducing the IAA Risk Book

The actuarial profession has contributed significantly to the development of risk management tools and processes, in insurance, pensions and related industries. Actuarial skills are also increasingly being applied in new and developing areas of knowledge.

Actuarial practice continues to improve the understanding, measurement and communication of risk and risk events and their implications through the development of tools and increasingly processes to manage the future uncertainty of risks in a sustainable and transparent way. These tools and processes trace, manage and mitigate the acceptance and transmission of the uncertain outcomes of risks.

The Risk Book is intended to provide high-quality reference materials to support a better understanding of the risks and inherently uncertain future outcomes that need to be managed when delivering financial services products – whether they involve insurance, investments or retirement incomes, or more broadly. The Risk Book is written to be accessible to a wide range of readers, many of whom may not be actuaries or experts in the areas discussed but may be decision-makers in those areas. Consequently, the Risk Book should provide insight into the ideas and concepts behind actuarial topics and concepts. It is therefore focused on being descriptive rather than being formal and mathematically precise.

All the Risk Book chapters are publicly available on the IAA website and are periodically updated. See [www.actuaries.org](http://www.actuaries.org) and follow the path to 'Knowledge / Publications / IAA Risk Book'. A discussion of their structure and relationships is provided in the Chapter: *Introduction – Using the Risk Book*.

The Risk Book is intended to be a dynamic and evolving resource, updated over time, reflecting new areas where actuarial expertise can add value, experience and advances, and topics of current interest and importance. It is electronically distributed to support ongoing updates. Risk Book chapters will be reviewed periodically at least every 5 years and more frequently if significant changes or developments occur.

The development and maintenance of the Risk Book is managed by the Risk Book Editorial Board of the IAA Insurance Regulation Committee.

Many people, mostly actuaries, have contributed to the Risk Book. Contributors are listed on the website.

To submit comments or questions about this Risk Book chapter, or to report any problems with the website, please email [riskbookcomments@actuaries.org](mailto:riskbookcomments@actuaries.org). To express interest in becoming involved with the Risk Book please go to the website and provide the requested information.

## 1 Executive Summary

This chapter builds on prior work carried out by the IAA<sup>1</sup> and the CRO Forum<sup>2</sup>, amongst others, with a focus on the appropriate application of the stress testing process. Depending on the business model, desired purpose and need, this stress testing is relevant to concepts from the risk book chapters on capital, operational risk, recovery and resolution, and risk and uncertainty. Stress testing and scenario analysis is a valuable methodology for bridging the diverse facts of risk and uncertainty where some solutions lead to quantifiable assessments of risk via capital requirements and other solutions lead to better solutions via controls and processes that are accessible to and understandable to non-technical stakeholders. Its key sections include:

1. Definitions – The terms “Stress Test (ST)” and “Scenario Analysis (SA)” have often been distinguished as a single change or stress versus multiple sets of assumptions created for a SA. However, it has become a more common practice to simply use the term “Stress Test” whether for single or multiple factor exercises. The only distinction (which is necessary in cases where it really matters) might be the likelihood of the respective scenarios (unlikely but possible for a ST, while SA may include likely, or expected, cases).
2. Purposes and process – The key to conducting a meaningful ST is a clear view of its purpose and the involved parties, such as: Who raises which questions? Who will get which results? What could be the consequences of its results? For example, the application of STs to liquidity risks, insurance risks and long-term or systemic risks may result in (among others) one or more of the following: disclosure of results to a supervisor(s) or the public, increased (or modified) capital requirements, required changes to policy provisions or laws, business decisions such as limiting the volume of business or reducing concentration in certain asset classes, etc.
3. Governance – To avoid misleading conclusions, clear governance rules should be in place: Who sets the rules and procedures? Who conducts the ST? Who delivers the data? Who validates the data and results? Who delivers and explains the results to decision makers? This chapter will provide clear examples of good governance requirements.
4. Transparency on Possible Limitations – To obtain the desired benefits of ST/SAs, the receiver of the result must understand the limitations of the exercise, especially when the results are used for decision-making rather than seeking a second opinion. Examples of important considerations here include:
  - a. The “likelihood” of the analyzed stress or scenario. While the objective is to test outside of usually expected reasonable stresses, it will be increasingly difficult to attach a definite (or reasonably reliable) probability to a given scenario “further down in the tail”. This does not mean results need to be dismissed, but their limitations must be understood, including the sensitivity of the result to certain key assumptions like correlations/diversification.
  - b. All parties involved should have a clear understanding of the data and valuation environment, as results might deviate considerably in different valuation systems (such as International Financial Reporting Standards (IFRS), US Generally Accepted Accounting Principles (GAAP), other local GAAPs and valuation rules (e.g., economic versus nominal).

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<sup>1</sup> Stress Testing and Scenario Analysis – IAA 2013 (IAA 2013)

<sup>2</sup> Scenario Analysis – CRO Forum, December 2013 (CRO-Forum 2013)

- c. If entire markets are conducting similar or identical STs and certain consequences (e.g., additional capital requirements) depend on the outcomes, this may contribute to its systemic risk. That is, certain market conditions may result in the same kind of ST-driven reactions throughout the larger market.
5. Examples – Lastly, we have included a set of examples of past successful applications and benefits of the stress testing process.

## 2 Definitions: Which Kind of Stress Tests are Covered?

While STs are common in many industries, our focus here is on the insurance industry within the context of financial markets. The following are major types of tests:

1. Reverse – reverse-engineered tests to identify the events that could lead to a given outcome, e.g., a failure or a certain consumption of the available capital. A typical question might be: “what has to occur so that 50% of the capital is exhausted”.
2. Deterministic – tests to assess risk in specific ways based on its specific exposures (these may be done through STs or SA).
3. Stochastic based – These tests may be a set of randomly generated scenarios where the focus is on mitigating some set % level of tail events, a specific scenario may be chosen from a set of stochastically generated scenarios, or different sets of scenarios can be generated to assess the significance of the parameters which generate the set of stochastic scenarios. The latter may be used in field testing the impact of possible regulatory capital requirements.
4. Combination – tests where multiple events that were tested in other scenarios happen simultaneously or sequentially with or without the possibility of management decisions.

For the purposes of this chapter, the formal definition of stress testing is largely the IAA definition<sup>3</sup>: “A ST is the projection of a target variable of a company or an economy under a specific set of unlikely but possible conditions that may be the result of several risk factors over several time periods with consequences that can extend over months or years”. Compared with the IAA definition we do not just consider “adverse” events (example: a cure for cancer might be modeled with “favorable” impacts for mortality portfolios but “adverse” impact for longevity portfolios) and have broadened the target variable beyond financial conditions (e.g., market share).

## 3 Purpose of ST/SA and Process

### 3.1 Who Defines the ST/SA and Uses the Results?

ST/SA exercises support specific interests of one or more of the following parties: market participants such as boards and management, regulators and supervisors, rating agencies, macroeconomic bodies or governments. The following list is not exhaustive but gives a broad overview of application areas for ST/SAs:

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<sup>3</sup> Stress Testing and Scenario Analysis, IAA 2013, p. 4

- a. business purposes (as listed in the CRO-Forum's priority list<sup>4</sup>) – internal risk reporting, reporting to regulators, risk appetite setting, risk monitoring, internal capital models, model calibration and validation, target capital setting, external reports to analysts/investors, reports to rating agencies, mergers and acquisitions, new product pricing, liquidity testing, and strategic planning purposes for the Board and management;
- b. regulatory oversight of individual companies – capital adequacy, extent of exposure to long-term guarantees, recovery and resolution planning, and tax asset recovery assessments;
- c. rating agency purposes – capital model impacts, the sustainability of profit targets, and impact of and exposure to operational risk events;
- d. macroeconomic exercises (e.g., OECD, FSB, G20, ISAPs, OFR, US Federal Reserve Board, OSFI, EIOPA, PRA) – capital standards, financial system stability, systemic risk assessment, and worldwide macroeconomic impacts; and
- e. application to insurance for differing time horizons:
  - i. Liquidity – micro specific focus on liquidity stress testing within insurance for those companies whose activities expose them to possible liquidity risks. This includes companies with activities in derivatives, secured funding transactions and guaranteed interest contracts with termination clauses. It can also include companies with cash surrender risks, and ratings/triggers tied to credit default swap spreads or subsidiary capital support agreements.
  - ii. Capital (1-to 3- or 5-year horizon) – Typical Total Balance Sheet focus as applied under Solvency II.
  - iii. Long-term/tail/non-quantifiable – these are risks with unknown probability or a time horizon beyond that of the market.
  - iv. While capital requirements are a fundamental quantitative safeguard, stress testing is also needed to inform and establish qualitative safeguards.

## **3.2 Elements of the ST/SA: Input, Output and Interpretation of Results**

### **3.2.1 Input environment**

The keys to derive effective, unbiased results include an organizational structure and process that meets appropriate governance requirements (see Section 4). Factors to be taken into account include (but are not limited to):

- a. input data and their quality (Who is generating which data? How have they been validated? Which point in time or time span do they represent? When will they be updated?);
- b. accounting environment (e.g., IFRS, U.S. GAAP, local GAAP, regulatory, economic);
- c. benchmark objectives (Who is determining which target variables? Who decides on acceptable metrics?);
- d. macro-economic environment (e.g., “risk-free” rates) and political actions (e.g., central bank actions);

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<sup>4</sup> Scenario Analysis, CRO-Forum 2013, p. 5

- e. competitive situation (Are market participants likely to move in the same direction? How is this situation expected to change?);
- f. expected policyholder behavior (e.g., lapse rates);
- g. risk tolerances (e.g., through limit and threshold systems); and
- h. applicable risk mitigation tools (e.g., participating bonuses/dividends, reinsurance); and the impact of public discussion.

### **3.2.2 Assessment and valuation**

The assessment and valuation procedures may be predefined by others, such as regulators or rating agencies, or may be determined internally. A typical example of a predefined assessment/valuation process is the standard model under Solvency II. The main input in this example comes from volume data (e.g., premiums, liabilities by line of business, asset volumes by asset class) generated under a specific valuation environment based on accounting data. The stress is conducted by applying certain factors to these volume figures, regardless of whether this represents a targeted 1-in-200-year situation for the specific undertaking or not. Usefulness is enhanced when all companies have to apply the same factors. The disadvantage is that it may not be close to the targeted risk likelihood (e.g., occurrence probability 0.5%) for the specific company.

The opposite is true for internal models. While the basic input is structurally the same (e.g., volume data) that data will now be used to generate random distributions and parameters to apply to actuarial “tail valuations” (e.g., VaR, CVaR) in order to find out what happens under the 0.5% probability conditions.

- a. The most material aspect of this valuation procedure – apart from defining the risk metrics and the degree of stress to be tested – is the level of aggregation of different risks while considering the complications of correlation and diversification. While in normal times there might be significant offsets through diversification between different risk classes, for example, catastrophe risk and credit risk, huge catastrophes (e.g., in the tail to the 1,000-year event) may send a number of market participants into insolvency due to credit risk side effects on a company’s investment portfolio. The interaction between different risks in a stress scenario is a key consideration for any valuation and/or assessment procedure.
- b. Output environment – the most common ST/SA output is a quantitative value that can be compared to the respective figure in an unstressed situation (e.g., capital, profit). A typical finding for a 1-in-200-year natural catastrophe can be that it costs a certain percentage of the available capital. In turn, this can be used to establish limit and threshold systems by defining that a 1-in-200-year natural catastrophe should not cost more than x% of the available capital.
- c. Quantitative data can be expressed in absolute (e.g., currency) or in relative terms (e.g., loss ratio, combined ratio or market share). Also, time may act as a quantitative factor (e.g., survival ratio in case of asbestos/environmental liabilities).
- d. Qualitative findings of STs can include quantitative consequences (e.g., a rating downgrade because of missing required capital targets, or questions from the regulator). They can also impact a qualitative target (e.g., customer satisfaction, reputation) and can lead to changed situations that require special actions (e.g., recovery and resolution or mitigating correlated cat and credit risks by investing in assets not exposed to the covered exposure). The “match” with

the input environment is important for any output environment. Deviations should be transparent to the receiver of the result in order to avoid misleading conclusions (see Section 4).

### **3.2.3 Interpretation of Results**

#### **3.2.3.1 Quantitative conclusions**

If a quantitative result (e.g., available capital) is outside the acceptable range there can be three types of conclusions:

- i. broaden the acceptable range to make the ST/SA result “fit” (this is only possible if this is not in conflict with external requirements, e.g., set by regulators or a target set by rating agency for a particular rating);
- ii. adjust the starting value of the target variable (e.g., capital) to an amount that leaves the ST/SA result within the acceptable range; and
- iii. adjust input variables for the ST/SA (e.g., exposures, premiums, assets) to amounts that leave the ST/SA result within the acceptable range (“de-risking”).

In principle these three options are available for any kind of quantitative result, be it for capital requirements, profit and loss impact or asset allocation. The first option usually leads to the respective adjustment of the limit and threshold system, the second to outside injections into the process (e.g., capital infusion) and the third to business actions (e.g., reinsurance, new business limitations, sale of portfolios, or change in asset allocation).

#### **3.2.3.2 Qualitative conclusions**

Examples of qualitative conclusions include:

- i. process adjustments (e.g., Information Technology improvements);
- ii. organizational changes (e.g., enforcement of independence between the first and second line of defense);
- iii. improvement of legal procedures (e.g., seeking a second opinion/third party assistance);
- iv. improvement of communication procedures (e.g., by establishing committee structures with minutes to be distributed to all effected parties);
- v. modifying direct coverages or the use of reinsurance; and
- vi. limits on acceptable levels of concentration risks

Like quantitative conclusions, qualitative conclusions may be initiated internally or imposed by third parties (e.g., regulators, rating agencies).

## **4 Governance of Stress Tests**

Whether a simple ST (analyzing the impact of a single risk factor) or a complex SA (analyzing the impact of a variety of risk factors simultaneously) is conducted, a set of basic governance principles to be

followed is needed to achieve the intended objectives. The following considerations are based on the previously referenced CRO-Forum publication.<sup>5</sup>

Prior to conducting the ST, a clear description of the question to be answered should be agreed to. It can be costly and lead to inappropriate or misleading findings to begin a ST/SA process without a clear view of the objectives, especially when the likelihood of certain adverse but rare scenarios are examined. Internal objectives may be to better understand and manage the possible risks and returns. External objectives are often dominated by micro regulatory requirements for solvency testing and macro interests in the stability of financial systems.

After the objectives are described, the following principles describe how ST/SA governance and processes apply to the cycle of design, analysis, reporting and actions. While principles for sound model governance also apply to models supporting ST/SAs, the following ST/SA principles were highlighted by the CRO Forum:

**Principle 1:** *A ST/SA framework should be embedded in the risk management system of the company, be it for internal purposes or regulatory or other external requirements.*

**Principle 2:** *A clear responsibility for every ST/SA should be established and the necessary resources necessary to carry it out be made available.*

**Principle 3:** *Senior management should be involved in the overall ST/SA process and should develop an understanding beyond the simple acceptance of the final results. This requires transparency on such aspects as assumptions, parameters and model limitations.*

**Principle 4:** *Data, expert judgements (and their rationale) and indicators used in scenarios (by management, regulators or other affected party) should be relevant, transparent and representative.*

**Principle 5:** *Recurring ST/SA processes should be reviewed regularly and checked to find whether they are effective and fit for their intended purpose.*

**Principle 6:** *There should be a feedback loops as the outcomes of a ST/SA are used in various ways, so the underlying assumptions and parameters need to be validated and the severity checked for appropriateness.at least annually.*

**Principle 7:** *STs/SAs for adverse situations should be based on exceptional, but plausible conditions and events. The assessment might cover a range of scenarios with different severities.*

**Principle 8:** *The time horizon of the ST/SA, as well as the relevance and credibility of the data used, and how recent it is, should be transparent. For all input data it is mandatory to describe exactly which point in time or time span it represents.*

**Principle 9:** *The analysis of results should be consistent with the initial objectives.*

**Principle 10:** *The practicality and effectiveness of recommended risk mitigation actions resulting from ST/SAs should be challenged through a control cycle process.*

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<sup>5</sup> Scenario Analysis, CRO Forum 2013, pp. 9ff

## 5 Limitations of Stress Tests

### 5.1 Limitations Overview

For quantitative based outcomes, one of the most important elements of an ST/SA is the occurrence probability (or return period) of the scenario used. Usually ST/SAs are conducted based on rare but possible events or conditions, leaving a substantial degree of uncertainty<sup>6</sup> about probabilities. This is not problematic if only an isolated view of the respective ST/SA is conducted, without taking into account occurrence probabilities. However, when the results are to be combined with results from other exercises - e.g., when determining capital requirements, transparency about the assumed probabilities estimated in all of the exercises is essential. If this leads to assumptions concerning the occurrence probability of an ST scenario, it must be made clear who produced these estimates, on what basis, and how they were validated.

In principle, the following processes are possible:

- A scenario is defined as precisely as possible by a governmental body (e.g., regulator), a rating agency or other external institutions (e.g., OECD, G20), and companies have to follow these settings regardless of their own view about the occurrence probabilities. Although this may provide a certain degree of comparability across markets, it may also result in a lack a realistic risk assessment (e.g., a five deaths per thousand excess mortality in case of worldwide pandemics) or relevance to an individual market participant.
- A probability (or return period) will be given by an external source or by management and those conducting the test(s) create the respective ST/SA (e.g., 100-year natural catastrophe, 200-year pandemic) and calculate the consequences.
- A given outcome (e.g., a drop of the capital position by 50 percent) has to be developed based on an assumption and assessment of a probability distribution for the target variable. The probability of reaching or exceeding the given outcome has to be calculated and possible scenarios leading to this situation have to be described.
- A certain set of scenarios for “tail events” (e.g., Lloyds’ “realistic disaster scenarios” or RDS) will be defined and those who apply the RDS determine the impact from each of these scenarios, as well as their specific view of its occurrence probability (e.g., re-occurrence of an event like 9/11).

Stress scenarios are usually developed based on deterministic assumptions regarding selected parameters of the “real world”. These may include financial parameters and scientific parameters (e.g., an earthquake of a predefined Richter magnitude at a certain well-specified location).

In regards to using results or defining quantitative requirements based on the results of a ST/SA, it should be pointed out that if a deterministic point in a continuous universe is selected, the weight of this single point is simply zero! Only if parameters are allowed to vary within an interval will a positive weight be achieved. In other words, it is impossible to quantify desired required capital by selecting even a set of distinct deterministic scenarios regardless how large the set might be.

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<sup>6</sup> See Risk Book Chapter 17: Risk and Uncertainty

This rule should always be taken into account when drawing conclusions for “real world” decisions from ST/SAs. In other words, it is useful to know what happens to a target variable in the case of a certain deterministic scenario. It is also interesting to know which scenario might lead to a certain outcome of the target variable (e.g., in a reverse ST). But this knowledge has a weight of “zero” in the universe of all possible scenarios if it is based on a single point.

On the other hand, the use of deterministic single scenarios can be an invaluable tool for educating, in clear and understandable ways, non-technical stakeholders (whether internal or external to a company) on the implications of a specific risk exposure and/or outcome and the controls or processes that might be used to address it.

## **5.2 Getting Meaningful Results From ST/SAs?**

The usual approach is to imply the presence of “intervals”, even if deterministic descriptions are used. When speaking of a “100-year event”, for example, it is usually assumed that all (similar) events that occur even less frequently than once in 100 years are implicitly included. Implicitly, that means a 1,000-year event also qualifies for the 100-year case. In terms of probabilistic natural catastrophe simulation models this leads to “non-exceedance curves” for tail events beyond a certain threshold. (See Chapter 5 – Catastrophe Models)

The same applies to the “value at risk” definition under Solvency II. It is required that an insurance undertaking should have enough capital to survive a 200-year event in a given year. All this means is that the interval of all scenarios that wipe out the company’s capital should not have a probability of more than 0.005.

STs/SAs can identify certain configurations within this interval that might lead to the loss of the entire capital of a company, but it is impossible to describe all scenarios with this outcome. This suggests that it might be dangerous to establish capital requirements solely on the basis of a small number of selected (deterministic) scenarios. Thus, it may be preferable to use a comprehensive (probabilistic) analysis that also implicitly covers scenarios that cannot be described based on past experience or be based on the creativity of experts about potential events (including grey and black swan events).

The following questions highlight considerations to provide more meaningful and reliable ST/SA results:

- i. Scenario Description - Will different people apply/test a scenario in a similar manner?
- ii. Data - Do outcomes include all relevant aspects of the scenarios, such as fire following losses in case of major earthquakes. Is the data reliable and unbiased?
- iii. Valuation Systems - Are input/output figures subject to certain valuation systems like U.S. GAAP, IFRS, local GAAP, economic valuation?
- iv. Result Presentation - Are decision makers informed about the choices mentioned above?
- v. Embedding and Integration - How do ST/SA assumptions and results compare to other exercises? How can they be combined/integrated?
- vi. Communication - How can reputational risks be avoided or limited where certain thresholds are violated? For example, is there a transparent communication strategy following a regulatory ST/SA exercise that provides realistic options via capital and/or operational changes?

- vii. Unknown Probabilities – Does the extreme potential for loss make it less important to think about the exact probability and to rather focus on the mitigation/control/response capacity of the company or jurisdiction?
- viii. Stochastic Scenarios & Real-World Constraints – Does the scenario generation process incorporate real world restrictions to avoid implausible/impossible results? For example, any comprehensive probabilistic analysis for earthquake losses would still need to be constrained by certain physical properties (such as the amount of stress that can be built up in a given fault line).

A potential unwanted side effect of regulator imposed STs/SAs could be an increase in systemic risk. If all market participants are subject to the same STs/SAs, regardless of how material this ST/SA might be for the individual undertaking, in stressed times a large number of undertakings may carry out “de-risking actions” (e.g., selling assets that contribute to adverse ST/SA results) simultaneously. This may contribute to sharpening the actual stressed situation rather than mitigating it.

### **5.3 Selection of scenarios and examples (by risk category or historical usage)**

There are two main sources for defining STs or stress scenarios: historic events and hypothetical (expert) assumptions. In both cases it is necessary to make the description operational. Simply using the phrase “subprime crisis 2007/2008” as the description for a historic scenario can lead to significant differences between undertakings when setting the detailed parameters. A more precise description might be “subprime crisis 2007/2008 as specified in the economic scenario generator of vendor company XYZ”.

The respective detailed assumptions (e.g., stock market, interest rate and spread development over a specified period) are then set by the economic scenario generator. But even for expert settings clear language that is understood in the same way by all involved parties is needed. For example, the specification of a natural catastrophe by a “return period” for a “200-year windstorm” can range from a worldwide view (combining all events including Caribbean hurricanes, Asian typhoons and European winter storms) to continental views (U.S. hurricanes), regional views (Florida hurricanes) and local views (Miami hurricanes). Also, company-specific views are quite common (e.g., a 200-year windstorm event from all (re)insurance treaties of company ABC gross of reinsurance). In addition, it might be helpful to look at respective “non-exceedance curves” from vendor models. The scenario can then be described as a “200-year U.S. hurricane as modeled by vendor company PQR in their 2018 model, version X”. Alternatively, the parameters describing the selected stress can be specified as precisely as possible.

## **6 Examples**

### **6.1 Examples of Typical Stress Targets**

These include:

- quantitative STs – market risk STs (stocks, bonds, interest), insurance risk STs (catastrophes, reserve changes due to mortality or longevity), and credit risk STs (counterparty defaults);

- qualitative STs – operational risk STs (fire; terror attacks; legal actions; accidents to senior management (including kidnap or ransom); strategic risk STs (market changes, customer behavior); and reputational risk STs (media coverage);
- reverse STs – predefining the output situation and developing back to respective scenarios, e.g., a natural catastrophe that would wipe out the expected profits; and
- implications of A, B, and C for groups versus legal entities.

## 6.2 Historical Examples

These include:

- historical events used to define possible events – San Francisco Earthquake, in 1906; Spanish Flu epidemic, in 1918; financial crisis, in 1920/21; Great Kanto Earthquake, in 1923; Labor Day Hurricane, in 1935; 9/11-type terror attack, in 2001; Hurricane Katrina, in 2005; financial crisis, in 2007; low interest rate environment in Japan, from the 1990s to the 2010s.
- “typical” setups with broader usage like Lloyds’ RDS, or the Willis Towers Watson (formerly Tillinghast/Towers Watson) biannual studies of “Extreme events” including alien invasion and the typical setup for a pandemic scenario (e.g., 1/1,000 worldwide excess mortality caused by the pandemic): and
- use of stress testing – 2006 Swiss FSAP, Fed 2009 tests, EIOPA tests, evolution of internal practices.

## 6.3 Examples of practical use

Some more detailed examples of how these principles can or have been applied using the concepts discussed in this chapter include:

- *Swiss Solvency Test (SST)*

The Swiss regulator FINMA requires insurance companies to conduct specified STs as well develop their own company specific scenarios.<sup>7</sup> Some of the prescribed scenarios are:

i. Financial Distress Scenario

Material changes of financial market parameters that may also impact existing and new business: stock, real estate and hedge fund values drop by 30%, interest rates rise by 300bp, new business declines by 75% and actual lapse rate increases by 25%.

ii. Market Risk Scenario

STs based on historic market events: 2008 financial crisis (the period from December 29, 2007, to December 31, 2008), 2000/2001 stock crash (October 1, 2000, to Oct. 1, 2001), or 1998 Long-Term Capital Management (LTCM) crisis (August 1, 1998, to Sept 30, 1998).

iii. Pandemic Scenario

A comprehensive scenario impacting the entire (Swiss) population, not only considering insurance losses but also leading to depreciation of assets. Details are taken from the

<sup>7</sup> FINMA (eidgenössische Finanzmarktaufsicht): *Wegleitung betreffend Szenarien und Stresstests im SST*, 30.10.2015; see [www.finma.ch](http://www.finma.ch)

*Influenza Pandemieplan Schweiz.* Factors included are impact of loss payments, assets, overall business activities and intra-group guarantees/defaults.

iv. Industrial Accident Scenario

A major accident/explosion in a chemical plant with the massive emission of toxic gases is assumed. To be analyzed are the additional death and morbidity cases, property losses, liability losses in different classes, pollution and business interruption.

- *Swiss Financial Sector Assessment Program (FSAP)*

The success of the Swiss FSAP in late 2006 is an example of a regulator (the International Monetary Fund) seeing a black swan event happening in a two-year event horizon and examining how bad it could be. The group who scoped out just what might happen were “doubly lucky”

- i. to have forecast the main features correctly of what became the “Great Recession” and
- ii. to have a national regulator who decided to “de-risk” just in case the black swan scenario came to pass.

The result was serendipitous—but an extreme case of stress testing involving a scenario far outside the scenarios that would have been caught by the normal Swiss Solvency Testing.

- *New Brunswick Pension Reform*

Just as relevant is the stress testing mandated in 2012 as part of the New Brunswick Shared Risk Pension reform. To begin with, the situation was that almost every pension plan in the province was woefully underfunded. The New Brunswick pension reform required pension plans that wanted pension funding relief to implement stress testing based on the maturity of the pension fund with a funding horizon of 15 years. On the fifth anniversary of the legislation, all pension plans in the province were close to being (or actually were) adequately funded.

The driving concept was that “mature pension plans” (those that pay out more in benefits than they take in with contributions) need a much-less-volatile investment policy than immature pension plans (which benefit from the dollar cost averaging phenomenon). The New Brunswick example is one of pension stress testing. But it is also an example of using stress testing as a device, not to look at black swan events, but to look at normal economic events when faced with very mature pension funds in a jurisdiction that is itself very mature (i.e., the population is declining).

- *Potential ORSA Stress Tests under Solvency II<sup>8</sup>*

The following examples may be conducted by insurance companies within their Own Risk and Solvency Assessments. As there is no binding requirement by regulators, they have to be selected carefully by the individual company in order to address their individual risk situation and any potential impact on the Solvency Capital Requirement.

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<sup>8</sup> “Grundsätzliche Überlegungen zu Stresstests und deren Herleitung im Kontext des ORSA”, Ergebnisbericht des Ausschusses Enterprise Risk Management, Köln, February 26, 2018, [https://aktuar.de/unsere-themen/fachgrundsaeetze-oeffentlich/2018-02-26\\_Ergebnisbericht\\_Stresstests\\_ORSA.pdf](https://aktuar.de/unsere-themen/fachgrundsaeetze-oeffentlich/2018-02-26_Ergebnisbericht_Stresstests_ORSA.pdf)



i. Capital Market Stress Tests

Interest rates rise or decline (modification of the “risk free” interest curves), adverse interest developments over a longer time horizon (“Japan” scenario), spread widening (with or without volatility adjustment), stock crash, (EU) state default, historic events (subprime 2007).

ii. Insurance Risk Stress Tests

Changes in mortality, longevity, and morbidity rates, pandemic with high extra mortality, major natural catastrophe, change in customer behavior (e.g., increased lapse rate), unexpected expense increase, necessary rate increases not exercisable, shortage in reinsurance capacities, and adverse development of new business or business mix.

iii. Reverse Stress Tests

Definition of a target solvency ratio (e.g., 100%) and development of scenarios that would end up below the target ratio (e.g., natural catastrophes with respective “high” return periods).

iv. Further Stress Tests

A change of regulatory requirements (e.g., ultimate forward rate), legal environment (e.g., disposal of private health insurance), tax environment, and business model (e.g., new lines).



IAA Risk Book

Chapter: Appropriate Applications of Stress and Scenario Testing

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