



AUTORITÉ
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FINANCIERS

SOUND MANAGEMENT AND MEASUREMENT OF EARTHQUAKE EXPOSURE GUIDELINE

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Introduction¹

Catastrophic losses which could be caused by earthquakes are a significant risk in Canada, and particularly in Québec and British Columbia. Like other risks which can significantly affect operations, this risk should be considered as part of the integrated risk management² of any financial institution. It should be dealt with as an intrinsic part of catastrophe risk management and taken into account in business continuity planning.³

Other than these general considerations, this guideline sets out the AMF's specific expectations regarding damage insurers which issue insurance policies covering earthquake exposure risk.

Earthquake insurance is designed primarily to cover damage directly caused by initial seismic shaking as well as damage following an earthquake (tsunami, tidal wave, fire, etc.). This insurance is generally optional and is usually sold as an endorsement or rider to the policy covering the insured's main buildings. In addition to covering damage caused directly to property, equipment and contents, it may include other types of coverage such as additional living expenses and business interruption.

Despite the above, personal property insurance policies taken out in Québec generally cover fire following an earthquake, through an endorsement or rider or in the main policy. In automobile insurance, earthquakes are covered under a policy's optional coverage.⁴ Since other products may also be exposed to earthquake risk, the AMF expects insurers to check whether any of their policies directly or indirectly offer protection against this risk and, where applicable, take it into account in assessing their overall exposure.

Based on the above, the AMF expects insurers who expose themselves to this risk measure and control it effectively through sound and prudent management of their exposure,⁵ based on their risk appetite and risk tolerance levels.⁶

The complexity associated with earthquake exposure risk management, along with the seriousness of potential losses and the difficulty of mitigating their effects, constitutes a risk which could significantly affect the insurer's financial position and, given the public visibility of such events, its reputation. The AMF therefore expects insurers who underwrite insurance policies exposing them to this risk to have sufficiently developed policies and procedures to ensure that losses are dealt with and managed efficiently in the event of an earthquake. In particular, in order to reflect the evolution of industry risk management practices, this guideline takes into consideration the use of models and data quality.

In addition to setting forth the AMF's expectations with respect to the development of sound and prudent management practices to prepare for this risk, this guideline sets out common parameters and other factors to be considered when measuring earthquake exposure and calculating the probable maximum loss (PML). This amount, used in calculating the required capital,⁷ is essential in assessing the insurer's capacity to handle and pay claims as well as its financial preparedness for such an eventuality. In this regard, insurers are expected to report certain earthquake exposure information to AMF on an annual basis.

As authorized under the *Insurers Act*,⁸ the AMF draws up this guideline for property and casualty insurers setting out its expectations with respect to the management and assessment of earthquake risk.

¹ This guideline replaces *Sound Management and Measurement of Earthquake Exposure Guideline* published in October 1998

² Autorité des marchés financiers, *Integrated Risk Management Guideline*.

³ Autorité des marchés financiers, *Business Continuity Management Guideline*.

⁴ Section B, Protections 3 and 4 of Q.P.F. No. 1, as approved by the AMF.

⁵ In this guideline, the term "exposure" is used to designate the insurance sums exposed to earthquake risk.

⁶ The notions of risk appetite and risk tolerance are more fully described in the *Integrated Risk Management Guideline*.

⁷ Autorité des marchés financiers, *Guideline on Capital Adequacy Requirements, Property and Casualty Insurance*.

⁸ *Insurers Act*, CQLR, c. A-32.1, section 463.

1. Earthquake Exposure Management

The AMF expects insurers to set up policies and procedures to ensure sound and prudent earthquake exposure management, supported by effective governance by the Board of Directors and properly implemented by senior management.

The AMF considers the Board of Directors and senior management to be ultimately responsible for decisions made and actions taken with respect to integrated risk management, and in particular, earthquake exposure risk management. They are therefore responsible for the effective governance and adequate implementation. This is especially important given the highly unforeseeable nature of losses from earthquakes and their potentially catastrophic results for an insurer.

Taking into consideration the roles and responsibilities assigned to them⁹ as well as the nature, size and complexity of the insurer's activities, senior management, overseen by the Board of Directors, should set up sound and prudent earthquake exposure risk management policies and procedures.

1.1 Policies and Procedures

The policies and procedures should document the main features of the insurer's approach to managing its earthquake risk exposure. In particular, they should include:

- the risk appetite and risk tolerance for earthquake insurance;
- data management practices;
- data aggregation and the necessary reporting for the establishment of earthquake exposure;
- understanding, selection and use of the earthquake models used, including considerations for model limitations, uncertainties and non-modelled classes of business;
- identification and estimation of relevant PML factors;
- the nature and adequacy of financial resources available in relation to the PML;
- business continuity plans to ensure adequate claim handling resources and continued effective operations;
- consideration of increases in claim and operating costs due to the emergency and short supply of resources following a catastrophe.

1.2 Role of the Board of Directors and Senior Management

In addition to ensuring that earthquake policies and procedures are set up, the Board of Directors should see that they are properly implemented. The AMF expects the Board of Directors to assess their relevance annually in connection with the insurer's overall integrated risk management.

Senior management is responsible for implementing and overseeing compliance with policies and procedures throughout the organization. As earthquake exposure risk should be managed on a continuous basis, effective management of earthquake exposure may require internal reporting more frequent than once per year. Such management should also cover the entire financial institution and take related risks into account, such as operational risks as well as insurance, reinsurance and investment risks.

⁹ Autorité des marchés financiers, *Governance Guideline*.

Moreover, the Board of Directors and senior management should see that appropriate internal control mechanisms are in place to ensure on an ongoing basis the effectiveness of, and operational compliance with, earthquake policies and procedures. Further, given the particular nature of exposure to earthquake risk (low frequency/high potential impact), these control mechanisms should ensure that the compensation plans of those involved in risk-taking are appropriately aligned.

At last, while all oversight mechanisms are expected to contribute to this effectiveness, the AMF considers that the actuarial function can play very important roles, particularly in reviewing models used to determine exposures, the adequacy of reinsurance programs to mitigate these exposures, and the pricing of earthquake insurance.

2. Earthquake Exposure Data

The AMF expects earthquake exposure data to be approximately gathered, captured and regularly validated for consistency, accuracy and completeness.

The data required to run earthquake models go beyond the data traditionally used to rate insurance policies. As a result, improving data consistency, accuracy and completeness is one area where an insurer's efforts can significantly reduce the uncertainty inherent in earthquake exposure measurement. Access to quality earthquake exposure data facilitates the management of this risk, and in particular through risk transfer, pricing and monitoring against limits as well as catastrophe modeling.

2.1 Data Integrity

An insurer's earthquake policies and procedures should reflect a strong commitment by senior management to obtain consistent, accurate and complete data to estimate the insurer's exposure to earthquake risk. Senior management needs to understand the data requirements of the model(s) used and place a high priority on the quality of data and its timely collection. Data quality needs to be considered within the context of the assumptions and requirements of the earthquake model(s) used. If necessary, new processes should be put in place to improve data quality.

Responsibilities for the accuracy of data should be clearly defined, both within the insurer and in dealing with outside parties. For example, intermediaries such as brokers and agents are often responsible for data collection. In such a case, senior management should ensure that data collection meets the insurer's quality standards.

As data quality is often impacted by a trade-off between completeness and accuracy, the insurer should implement a quality control process around data collection and entry, including the adoption of criteria to measure data completeness and accuracy. Processes may include:

- scoring data quality at the time of underwriting;
- conducting remediation of sources providing inadequate data;
- developing and implementing safeguards to prevent or reduce data entry errors;
- investing in technology to improve data quality.

2.2 Data Verification

The AMF expects insurers to have processes in place to verify that their database is accurately reflecting all the data received. While the quality of individual risk data is often the key driver of overall data quality, an aggregate analysis and assessment of the overall data quality of a portfolio/group of risks may be the most appropriate approach when the insurer has limited access to the underlying policy processing system. This will be the case in particular for assumed reinsurance portfolios. Accordingly, reinsurers should have processes in place to evaluate the quality of data submitted by their cedants. A similar situation may occur during block transfers of insurance policies from one insurer to another.

2.3 Data Limitation

Senior management also needs to understand the data limitations and the scope of possible errors in the data. While complete and explanatory data are the objective, it will be difficult or impossible to achieve this

in practice. Senior management must therefore understand the possible impact of data limitations on the results projected by the model and make prudent adjustments to the model estimates.

Data should be subject to periodic (at least annually) review by individuals, independent of those responsible for data collection and data quality. While the insurer may use reinsurance brokers for this independent review, this work should extend beyond the regular review of data prior to submission to reinsurers to include a specific report that acknowledges that their work is being done to support the insurer's compliance with this guideline. Although less frequent, external review of the insurer's data management, quality and reporting can add value by providing independent benchmarking.

These reviews should cover the completeness and accuracy of the exposure data as well as the processes applied and the steps taken to achieve the desired quality level. In thiwhichs regard, documentation of the testing and sign-off from the reviewers should be obtained. The goal of testing should be to reduce errors and erroneous entry and transcription, could include:

- aggregating data by occupancy, type of construction and geocode of insured buildings and reviewing statistics such as the percentage of data with known attributes, the amount of bulk coding and the most frequently observed values;
- comparing year-to-year earthquake exposure changes;
- using historical loss experience to identify specific portfolio coding issues and behaviour against model construction and assumptions;
- running data quality sensitivity tests as a regular part of the portfolio risk analysis process and incorporating them into decision-making.

The portfolio exposure data and model results should be updated as appropriate.

The AMF generally expects senior management to understand the data requirements of the model used and develop a plan to address all concerns identified.

3. Use of Earthquake Models

The AMF expects insurers to have a sound knowledge of the assumptions and methodologies underlying earthquake models and use a high degree of caution that reflects the significant uncertainty in such estimates.

Prudent use of catastrophe models to measure earthquake exposure risk is an important component of sound earthquake exposure risk management due to the high inherent uncertainty associated with catastrophe modeling. It is therefore critical that all users of the output of catastrophe models are aware of this uncertainty and consider using other risk management techniques, such as risk limits, risk transfer and risk avoidance.¹⁰ In this context, references to these alternatives are as important as the guidance on the use of catastrophe models.

3.1 Use of Models

Insurers are expected to utilize sound earthquake models as part of their earthquake exposure management. Considering that earthquake-related PMLs are derived from a complex set of variables and related assumptions, catastrophe models are an essential tool in providing a systematic approach to such estimates.

However, while earthquake models continue to be refined as new information and data emerge, they still present significant limitations and a high degree of inherent uncertainty. This uncertainty is demonstrated by the material differences observed when model estimates are compared with actual events and with the wide range of results from model to model.

Nevertheless, when users appropriately consider model limitations and uncertainties, they provide a valid basis for PML estimation and reinsurance arrangements. Models further enhance their value as a risk management tool when they are also used to monitor earthquake exposure accumulations and to assist in underwriting decisions.

3.2 Sound Practices for Use of Earthquake Models

Earthquake models are available through a variety of means. They may be licensed from various commercial vendors and maintained in-house or run by third parties, such as a reinsurance broker, on behalf of the insurer. Some insurers have also developed their own in-house models. In any event, in order to ensure that earthquake models are appropriately used, insurers are expected to:

- adequately document their use, including how the use of earthquake models fits within their earthquake risk management process, including PML estimates and, where applicable, how models are used to monitor exposure accumulations and make underwriting decisions;
- understand current modelling alternatives and why the model used is appropriate for their insurance portfolio;
- have adequately qualified employees to appropriately run the models on a regular basis when earthquake models are used in-house;
- have a sound understanding of the key assumptions, methodologies and limitations underlying the model used, including:

¹⁰ For example, by using concentration limits by geography.

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- how each setting impacts PML estimates. In this regard, insurers will need to justify, where applicable, why selected assumptions established and recommended in the model have been altered;
 - ability to handle related factors such as demand surges following a catastrophe, earthquake-related fires and business interruption;
 - how changes in portfolio characteristics influence PML variability;
 - modelled losses versus non-modelled losses;
 - understand inherent model uncertainty and how this is addressed in determining capital adequacy and related reinsurance arrangements;
 - ensure that the data and data granularity are appropriate for the model;
 - be able, when more than one model is used and they produce materially different results, to explain the key reasons for the differences and their efforts to carry out the necessary adjustments, if any, to the parameterization of the particular model chosen as the basis for PML.

3.3 Model Versions

While the use of an earthquake model is important, it represents only one element in an insurer's risk management framework for earthquake exposure. While models continue to be refined, they retain inherent uncertainty. To better assess this uncertainty, insurers should consider the use of more than one model.

Insurers should implement material updates to commercially available models in a timely manner. More specifically, it is expected that within one year of the release of any material change in a model, the revised model will be used, or an explanation provided otherwise. Insurers are to identify in their documentation the model and version they are using.

When using vendor software to determine its PML, it is important for an insurer to understand the model as well as its purpose, functionalities and limitations. The model documentation should provide sufficient detail to understand the mathematical basis, model methodology, parameters, limitations and specific insurer modelling refinements and changes used.

Where an earthquake model has been developed in-house, it is expected to be updated on a regular basis and periodically tested for functionality and reasonableness of results against other commercially available models.

3.4 Model Validation

Model validation provides important information on the performance of models.

An important element of this process is to ensure that the model properly captures risks based upon actual events. This analysis should demonstrate that, over a sufficient historical period, the model-based measurement of capital is consistent with actual losses.

To the extent that insufficient data exist to validate the model, an alternative solution should be found and developed to carry out a prudent and suitable validation of the model. For example, the insurer could compare major historical earthquake events with the losses produced by similar events in the model and assess any divergences. Given the limited number of earthquakes in Québec and more broadly in Canada, it may be helpful to consider the lessons learned from earthquake events in other parts of the world.

The insurer could also compare the cost of modelled tail losses with market prices for equivalent reinsurance coverage. This test is not a validation of the model per se but, rather, may serve as a starting point for further investigation. An outcome might be that the risk is treated more conservatively by the market than the model would show.

The adjustments and refinements of model parameters, including loadings for non-modelled risks and costs, should be robust and be reflected in the model validation.

As well, the model validation process should be well documented, and should clearly identify any limitations of the model or the data. As necessary, material deficiencies and major shortcomings should be indicated and should be discussed in terms of mitigation.

4. PML Estimates

The AMF expects PML to adequately reflect the ultimate total cost of losses to the insurer, including considerations for data quality, non-modelled exposures, model uncertainty and exposures to multiple regions.

While models are an essential tool for assisting insurers in the management of their earthquake exposures, they are limited in their capabilities. This creates a significant degree of uncertainty in their results. As such, while insurers are required to develop PML estimates in accordance with this principle, they are also encouraged to consider other exposure limitation techniques, such as concentration limits by geography and restrictions regarding building occupancy and construction type.

4.1 Data Quality

Senior management needs to understand the possible impact of data limitations on the results projected by a model and to make prudent adjustments to the model estimates. While upward PML adjustments may be necessary for offsetting some data shortcomings, it should be understood that a large adjustment to the PML for overcoming such a deficiency is not a substitute for appropriate quality data capture and processing at source.

4.2 Non-modelled Exposures and Risks

Many risks cannot be adequately considered, or are difficult to adequately consider, within an earthquake model. Accordingly, the AMF expects insurers to take an inventory of exposures and risks relevant to their business and identify those that are not included in the model used. These non-modelled exposures and risks may include:

- exposure growth between the date of the data and the end of the relevant period of exposure;
- business interruption;
- other insurance classes, such as automobile and marine insurance;
- claim settlement expenses;
- insufficient insurance;
- guaranteed replacement costs;
- increased risk of seismic shock after a major earthquake;
- blanket coverage and coverage extensions or clauses, such as debris removal.

These exposures and risk factors may be relatively small individually, however, their accumulation may be significant and need to be considered as part of an insurer's PML.

4.3 Model Uncertainty

Models calculate PML by converting, from a given location, estimates of ground motion to damage levels, leading to secondary uncertainty. Most vendor models now automatically recognize this uncertainty in generating results. There are other factors and sets of assumptions in the earthquake models that are in a continuous process of being updated and refined. When considering its PML as estimated by the model as

a measure of the potential financial impact of an earthquake on the insurer, senior management needs to consider factoring in a margin of safety to reflect the uncertainty of these additional assumptions.

4.4 Exposure to Multiple Regions

PMLs have historically and to date been based on the larger of the PMLs for British Columbia or Québec, the two provinces with the greatest exposure to earthquake risk, to ensure compliance with capital requirements. Although this approach is acceptable for insurers operating in only one of these provinces, which is the case for most Québec incorporated insurers, this approach ignores earthquake exposure elsewhere, which can have a material impact on the modelled tail losses. The traditional approach could therefore understate the PML for insurers.

The AMF therefore expects insurers to take account of risk which may result from exposure to more than one region. For a Canadian branch of a foreign insurance company, exposures should include risks located in Québec which have been underwritten outside Canada and which are excluded from the data indicated on the insurer's P&C-2.

5. Financial Resources and Business Continuity Plans

The AMF expects insurers to have an adequate level of financial resources¹¹ and appropriate business continuity plans to successfully operate through a major earthquake.

PML refers to the threshold dollar value of losses beyond which losses caused by a major earthquake are unlikely. Throughout this section, it includes adjustments for data quality, non-modelled exposures and risks and model uncertainty.

5.1 Financial Resources

Earthquake policies and procedures should quantify an insurer's willingness to take on earthquake insurance risk and outline to what extent the insurer's financial resources cover its gross PML.¹² Insurers should refer to the Guideline on Capital Adequacy Requirements¹³ in order to determine if they meet the regulatory test of financial preparedness for earthquakes. The following represent financial resources that could be used to support the insurer's earthquake exposures:

a) Capital and Surplus

The *Guideline on Capital Adequacy Requirements* specifies the maximum retention that can be supported within the insurer's capital.

b) Earthquake Reserves

This amount is the result of the voluntary earthquake premium reserve and the earthquake reserve complement which may be required in covering an insurer's exposure to this risk. The Guideline on Capital Adequacy Requirements provides details about earthquake reserves.

c) Reinsurance

While most insurers will use a catastrophe reinsurance treaty, other reinsurance, such as a surplus, quota share or excess of loss (per risk or aggregate) treaty may provide substantial coverage for some insurers. When an insurer includes non-catastrophe reinsurance in its determination of available financial resources, it needs to be prepared to demonstrate that it has appropriately considered per event limits and other circumstances, terms and conditions that could exhaust coverage provided by these other types of reinsurance. In the case of whole account excess of loss reinsurance, insurers may need to use a full stochastic model.

Formal reinsurance agreements, evidenced by written documents between related insurers, constitute an acceptable traditional mechanism which insurers may use to manage their insurance exposure, including their earthquake risk exposure. Note, however, that other supporting financial arrangements, such as letters of credit or guarantee facilities, cannot be used.

Reinsurance programs and agreements should be arranged following the reinsurance guideline.¹⁴ Insurers that participate in a global catastrophe reinsurance program must consider:

- ongoing protection for Canadian operations (e.g., exhaustion of layers by other events);
- adequacy and recoverability if other regions are impacted by the same event.

¹² For the purpose of this guideline, gross PML is used to calculate earthquake exposure. It is the PML amount after deductibles but before reinsurance ceded.

¹³ Autorité des marchés financiers, *Guideline on Capital Adequacy Requirements, Property and Casualty Insurance*.

¹⁴ Autorité des marchés financiers, *Reinsurance Risk Management Guideline*.

d) Financing

Insurers can enter into innovative financing transactions designed to hedge their risk for a catastrophic event. In some cases, these are standby capital market financing facilities that become operative when a catastrophe occurs. Insurers should be aware that the AMF's authorization is required before these instruments are used to ensure that they can be recognized as a financial resource under the Guideline on Capital Adequacy Requirements.

5.2 Business Continuity Plan

In accordance with the Business Continuity Management Guideline, insurers must have a business continuity plan in place in order to ensure continued effective business operations in the case of a catastrophe, including an earthquake. The plan should address the key elements of claims management, such as alternative communications links, availability and adequacy of claims settlement personnel, off-site systems back-up and access to all files, including reinsurance records.