Eidgenössische Finanzmarktaufsicht FINMA
Autorité fédérale de surveillance des marchés financiers FINMA
Autorità federale di vigilanza sui mercati finanziari FINMA
Swiss Financial Market Supervisory Authority FINMA

Technical description of the SST standard model reinsurance (StandRe)

Standard model insurance

31 October 2024

Contents

1 Glossary

In the following, we define/explain specific terms used in this document.

- **Insurance Supervisory Ordinance (ISO)**: Aufsichtsverordnung (AVO) / Ordonnance de surveillance (OS); SR 961.011.

- **Insurance Supervisory Ordinance FINMA (ISO-FINMA)**: Aufsichtsverordnung FINMA (AVO-FINMA) / Ordonnance de surveillance FINMA (OS-FINMA); SR 961.011.1.

- **AC1**: annual aggregate conditions of ceded (or outward) retrocession that are related to per risk or per contract event covers, e.g. an annual aggregate limit that comes from limited reinstatements.

- **AC2**: annual aggregate conditions of ceded (or outward) retrocession that are not related to per risk or contract event covers, such as coming from a Stop Loss.

- **Accident year (occurrence year)**: claims occurring (and premiums earned) in the corresponding calendar year. This is (only) from assumed reinsurance contracts that are in in force for some period in the calendar year and may include contracts on risks attaching basis and on losses occurring basis. "Current accident year" refers to the period from $t = 0$ (excluded) to $t = 1$ (included), "prior accident years" to the period until $t = 0$.

- **AE**: abbreviation for the StandRe component "attritional events"

- **AER**: abbreviation for the StandRe component "attritional events reserve risk"

- **AEP**: abbreviation for the StandRe component "attritional events premium risk"

- **AG**: abbreviation for the StandRe component "non-life insurance risk aggregation"

- **Contract event** is an event "in the classical reinsurance sense", i.e. an event that satisfies the definition of "one event" or "one occurrence" according to a relevant reinsurance or retrocession contract (e.g. a flood event within a specific time frame). See also Section 2.6.

- **CV**: coefficient of variation, equal to standard deviation divided by mean

- **Exceedance frequency curve**: see Section 6.14.1

- **Expected exceedance frequency**: see Section 6.14.1

- **Frequency-severity model**: compound Poisson process, see Section 6.14.1

- **Gen Pareto**: see Section 6.14.2

- **Gross**: losses to reinsurer gross of ceded retrocession

- **IE**: abbreviation for the StandRe component "individual events"
- **IE1**: abbreviation for the StandRe component "individual events 1"
- **IE2**: abbreviation for the StandRe component "individual events 2"
- **Info event:** a suitable “package” of information that may become known between $t = 0$ and $t = 1$ and whose occurrence (i.e. the information becoming known) can have an impact on the value of the non-life insurance liabilities at $t = 1$. See also Section 2.6.
- **Assumed (or inward or "active") reinsurance**: this term is used to refer to all assumed business of a reinsurer (i.e. reinsurance, but also insurance or retrocession written by the reinsurer)
- **LOB**: line of business
- **Loss to reinsurer:** this expression is used to denote losses after application of assumed reinsurance to the reinsurer. If not further specified, it denotes losses before ceded retrocession.
- **Material/materiality**: "Wesentlichkeit / Caractère significatif" defined in Article 42 ISO
- **NE**: abbreviation for the StandRe component "nat cat events"
- **Net**: losses to reinsurer net of ceded retrocession
- **Netgross**: with respect to ceded retrocession, net of PEC & AC1 but gross of AC2.
- **Outstanding losses**: includes all outstanding loss payments, regardless of whether they are reported or not. Includes in particular case reserves, ACR (additional case reserves), IBNyR (incurred but not yet reported), IBNER (incurred but not enough reported).
- **Ceded (or outward or "passive") retrocession**: this term is used to refer to all protection of a reinsurer (i.e. retrocession, but also reinsurance to protect potential insurance written by the reinsurer)
- **PEC**: per risk or per event conditions of ceded retrocession.
- **SST currency**: the currency in which risk bearing capital and target capital are expressed for the SST solvency condition.
- $t = 0$: **reference date** of the SST calculation
- $t = 1$: end of the one-year period from the reference date
- **Total losses**: sum of paid and outstanding losses.
- **Underwriting year**: claims arising (and premiums) from any assumed reinsurance contract written (i.e. incepting) in the corresponding calendar year. This may include contracts on risks attaching

basis and on losses occurring basis. "Current underwriting year" refers to the period from $t = 0$ (excluded) to $t = 1$ (included), "prior underwriting years" corresponds to all contracts written until $t = 0$.

- **Ultimate outcomes**: the amount (e.g. relating to cash flows) when it is completely known/ there is no uncertainty about it left (e.g. when a claims is settled or a contract is commuted)

- **XoL**: excess of loss contract

2 Introduction

2.1 Purpose and scope

2.1.1.1 Purpose

StandRe is the SST standard model for the non-life insurance risk for reinsurance and insurance companies writing reinsurance business (in the sequel for simplicity referred to as "reinsurers").

The main purposes of StandRe are:

(a) calculating the one-year risk distribution for non-life insurance risk;

(b) providing transparency on the non-life insurance risk profile of a reinsurer, for the reinsurer itself and for FINMA.

An additional purpose is providing as input to the market risk model the (expected) cash flows corresponding to the balance sheet positions related to (re)insurance business (Section 8).

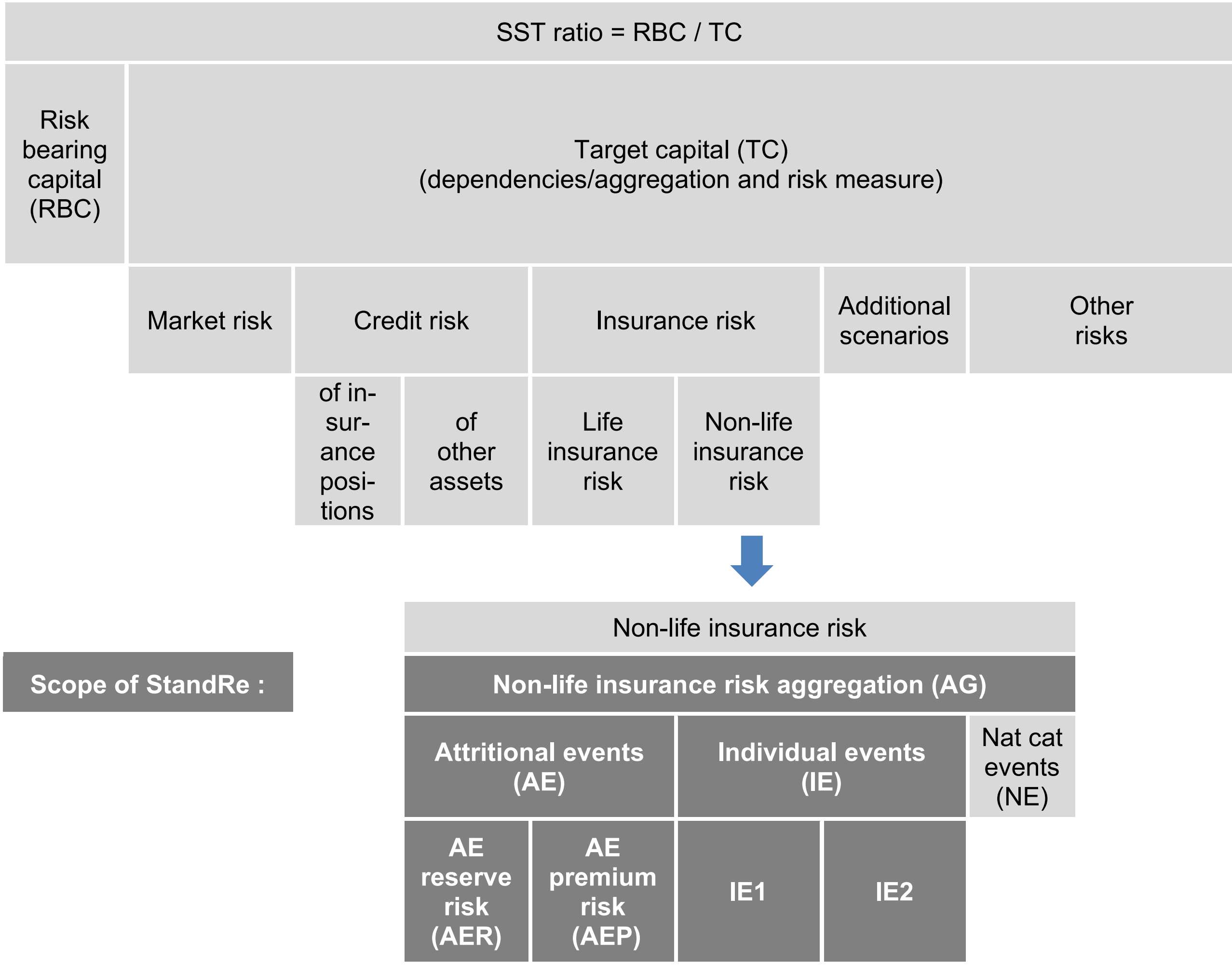
In addition, Section 8.2.4 of this document contains instructions on the balance sheet positions in the SST balance sheet to be used for (re)insurance business (including ceded retrocession and asset positions).

Note: Section 8 of this document (including Section 8.2.4) is potentially **relevant** not only for StandRe users but **for all reinsurers**, including those with an internal model for non-life insurance risk.

2.1.1.2 Scope

StandRe covers the non-life insurance risk of reinsurers. Natural catastrophes (Nat Cat) risk is modeled either in a partial internal model outside of StandRe or in StandRe. StandRe includes the aggregation of Nat Cat risk with the remaining non-life insurance risk.

The following illustration shows StandRe in the context of the overall SST calculation. This is just an illustration; the structure of the models for risk classes shown below might be different, and there might be models for risk classes not shown below. The scope of StandRe corresponds to the dark grey boxes.



As can be seen from the illustration, StandRe contains two main components of non-life insurance risk, “attritional events” (AE) and “individual events” (IE). They are further split into "attritional events reserve risk" (AER), "attritional events premium risk" (AEP), "individual events 1" (IE1) and "individual events 2" (IE2). In the component “non-life insurance risk aggregation” (AG), the outputs from the components AE, IE and “nat cat events” (NE) (from a separate source, out of scope of StandRe) are aggregated together. Ceded retrocession relevant to non-life insurance risk is in scope and needs to be modeled in StandRe.

Life insurance risk, the models for other risk classes such as market and credit risk and their combination with non-life insurance risk are out of scope of StandRe. StandRe does not cover instruments that apply to the entire balance sheet, such as guarantees.

2.2 Specification of the StandRe model

2.2.1 Documents and files provided by FINMA/ to be provided to FINMA

FINMA specifies StandRe through the documents and files described in Sections 2.2.2-2.2.5. Section 2.2.7 provides an overview of the implementation of StandRe. The documents and files are published on the FINMA website on the Swiss Solvency Test page. In the following sections, we also describe the StandRe-specific requirements on the SST reporting to FINMA. For other SST reporting requirements (not StandRe specific), see "Wegleitung für die Erarbeitung des SST-Berichtes" / "Guide pratique pour l'établissement du rapport SST".

2.2.2 Model description (MD)

This is the present document. It contains the complete technical description of StandRe. The main changes between the current and the previous versions of the document are summarized in Section 10.

2.2.3 StandRe template

The Excel file „SST-StandRe-Template" is used for reporting the input data and the (partial) results of the StandRe calculations. It also contains automatic calculations. Other calculations must be performed outside the template. This requires a stochastic simulation engine (Section 2.16).

Two versions of the StandRe template are available:

(i) Version with macros.

(ii) Version without macros.

The version without macros can be used by companies which do not need more than one model segment (Sections 2.8-2.9). Otherwise, the version with macros has to be used. This version allows adjusting the layout and settings of the StandRe template dynamically to account for the relevant number of model segments. The macros allow for customized reporting but do not perform model calculations.

To facilitate understanding of StandRe, it is recommended to study the StandRe template in parallel to reading the model description. The template implements some of the calculations and relationships that are described in the model description and displays relationships visually.

The filled-out StandRe template needs to be submitted to FINMA with the SST report.

2.2.4 Additional documents and files: Reserve risk tool (RRT)

For a part of reserve risk, a standard "benchmark method" is used in StandRe. The folder "Reserve risk tool" contains an implementation of this method in an Excel Spreadsheet and corresponding explanations.

One Excel file by development triangle used (i.e. by "AER parameter segment" as defined in Section 5.6.1) needs to be submitted to FINMA with the SST report.

2.2.5 StandRe calculation documentation (CD)

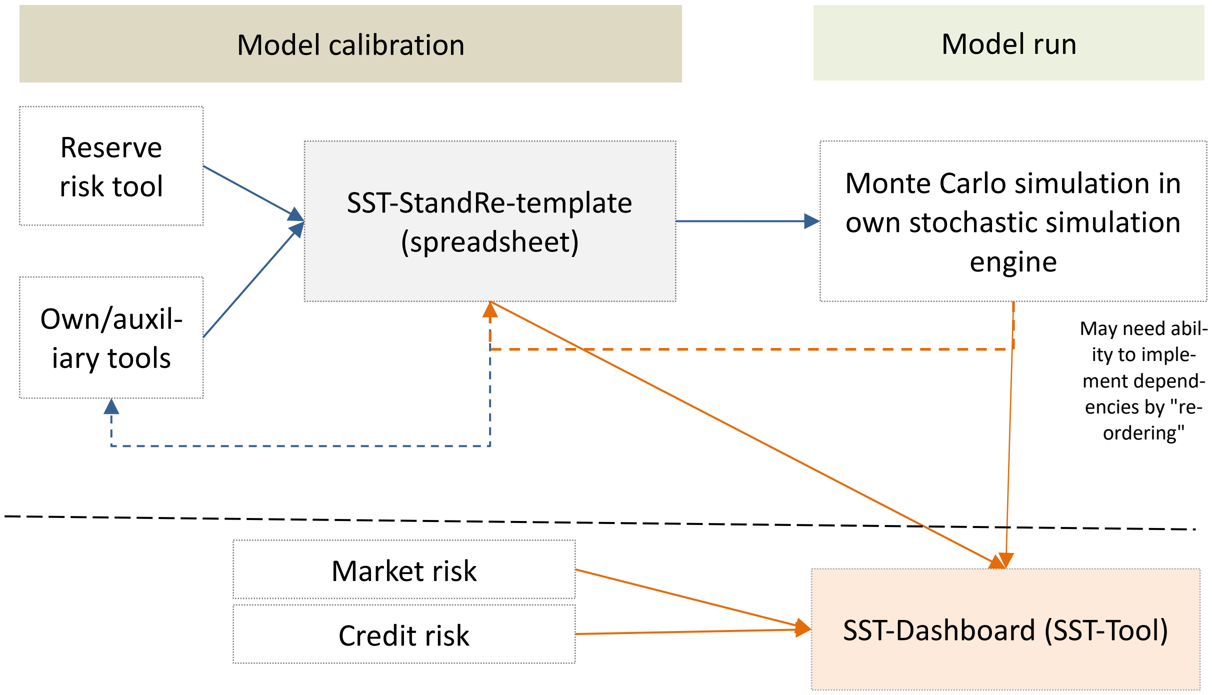
The Word template "StandRe_calculation_documentation" is used for reinsurers to document, explain and justify their specific use of StandRe for the SST calculation, including assumptions, simplifications, and expert judgment. The completed template needs to be submitted to FINMA with the SST report (with answers provided in English or an official Swiss language).

2.2.6 Assumptions and expert judgment

Typically, not all input into the StandRe model consists of objective data, and some input needs to be derived by making assumptions, specifically using expert judgment. This may for example be the case for the calculation of scenarios (Section 9) and the fitting of a severity curve for the IE2 model (Section 6.13). Requirements on assumptions are specified in Article 41 ISO and on expert judgment in Article 13 Paragraph 7 ISO-FINMA.

2.2.7 Implementation overview

The following illustration provides a broad overview of the StandRe calculation and IT implementation and its inclusion into the overall SST calculation.



2.3 Contents of the introduction section

In the following, we first discuss basic concepts for StandRe: the one-year change in Section 2.4, premiums, losses and expenses in Section 2.5 and the concept of info events in Section 2.6.

In Section 2.7, we outline the general model structure of StandRe and the modeling of dependencies, followed in Section 2.8 by an outline of the segmentation and the treatment of assumed reinsurance in Section 2.9 and ceded retrocession in Section 2.10.

In the Sections 2.11 to 2.16, the scope and modeling different components of StandRe and their delimitation is outlined, including simplifications in the treatment of the one-year risk.

In Section 2.17, we comment on adjustments to StandRe that require prior approval by FINMA (formerly callled "compaby-specific adjustments"). Section 2.18 provides links to background and discussion of the model.

2.4 The one-year change incl. expected non-life insurance result

2.4.1.1 The one-year change

In line with its purpose and scope, StandRe quantifies the one-year change (from time $t = 0$ to $t = 1$) in the risk-bearing capital related to non-life insurance risk, net of ceded retrocession, excluding the market value margin. Here, time $t = 0$ is the reference date of the SST calculation, and the risk bearing capital is denominated in the SST currency. The one-year change is given as the discounted risk-bearing capital at $t = 1$ minus the risk-bearing capital at $t = 0$ (in both cases excluding the market value margin).[1] Unless noted otherwise, discounting in this document is always to time $t = 0$.

The scope of the balance sheet at a given time t is defined in Article 3 ISO-FINMA. In line with the simplification from Article 3 Paragraph 5 ISO-FINMA, unless it leads to material deviations, the balance sheet at time t is assumed to contain precisely all business written until time t in the sense that the cover period of this business begins before time t. The following descriptions apply under this simplifying assumption.

With the simplification, the scope of the one-year change consists of all business written by the reinsurer until time $t = 1$. In particular, business from the prior underwriting years, i.e. written until $t = 0$, and new business written between $t = 0$ and $t = 1$ (current underwriting year). Relevant for the one-year change are the outstanding cash flows of $premiums - losses - expenses$, discounted and net of ceded retrocession.

Ignoring the market value margin and with simplified assumptions on the return related to the cash flows between $t = 0$ and $t = 1$, we can write the one-year change as the one-year change in the following best estimates:

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[1] In line with Article 35 ISO, the target capital for the SST is given by the **negative** of the Expected Shortfall ES_α, where the Expected Shortfall corresponds in the continuous case to the mean of the α lowest outcomes, with $\alpha \ll 1$. In this representation, losses are negative numbers. In parts of StandRe where losses S are represented as positive numbers, we define the expected shortfall as $ES_{1-\alpha}(S) \coloneqq -ES_\alpha(-S)$.

$$BE_1(CF^{net}_{\rightarrow 1,0}) - BE_0(CF^{net}_{\rightarrow 0,0})$$

where

- $BE_t(CF^{net}_{\rightarrow s,u})$ = discounted best estimate based on the information at time t and discounted to time t of the cash flows $CF^{net}_{\rightarrow s,u}$ net of ceded retrocession of $premiums - losses - expenses$ that are outstanding at time u for the business written until time s.

To calculate the above one-year change, a model of the stochastic cash flows is required and, for the best estimate at $t = 1$, additionally a model about the information flow between $t = 0$ and $t = 1$.

2.4.1.2 Decomposition into centered one-year change and expected non-life insurance result

In the above expression, the cash flows considered for both best estimates are those outstanding at time 0 (as the cash flows between $t = 0$ and $t = 1$ affect the risk-bearing capital at $t = 1$). Further, we assume that both best estimates are discounted to time $t = 0$. For the best estimate at $t = 1$, the relevant business is the business written until $t = 1$ and, for the best estimate at $t = 0$, the business written until $t = 0$.

For StandRe, it is convenient to rewrite the above one-year change. It is written as the sum of a term Z_{total} that represents the one-year change in best estimate for the same cash flows and the same business written by $t = 1$, and thus has mean zero (i.e. it is "centered"), and a term $BE_0(CF^{net}_{0\rightarrow 1,0})$ that represents the "expected non-life insurance result" for the business of the current underwriting year :

$$Z_{total} + BE_0(CF^{net}_{0\rightarrow 1,0})$$

Here:

- $Z_{total} = BE_1(CF^{net}_{\rightarrow 1,0}) - BE_0(CF^{net}_{\rightarrow 1,0})$ = one-year change in the best estimate of cash flows of $premiums - losses - expenses$ outstanding at time 0 for the business written until time 1 (net of ceded retrocession).

- $BE_0(CF^{net}_{0\rightarrow 1,0})$ = "**expected non-life insurance result**" in terms of $premiums - losses - expenses$ for the "new business", i.e. the business of the current underwriting year , discounted and net of ceded retrocession, including all cash flows outstanding at time $t = 0$ (see also Section 2.5.2).

This can be considered a decomposition into a centered "risk" part (stochastic) and a "deterministic" part. However, note that the two parts are related.

The StandRe components AE, IE and NE are (only) about deriving the distribution of Z_{total}. The expected non-life insurance result is considered in the "non-life insurance risk aggregation" (AG) component of StandRe.

2.5 Premiums, losses, and expenses

2.5.1 Variable features of premiums and expenses

In principle, all material relevant cash flows (premiums, losses, expenses) including their stochasticity need to be modeled. However, if premiums and expenses are deterministic, then in view of the decomposition of the one-year change from Section 2.4, they appear only in the expected non-life insurance result and can be disregarded in the centered "risk" part.

- Unless explicitly mentioned, the remainder of this document is written for the situation that premiums or expenses are deterministic or can be modeled deterministically as a simplification subject to materiality.

In contrast, in this section, we consider the case that premiums and expenses are materially not deterministic. Specifically, we consider variable features of premiums and expenses/commissions of assumed reinsurance and ceded retrocession contracts, i.e. loss-dependent premiums and expenses. Examples are reinstatement premiums in XoL contracts and sliding scale commissions in QS contracts.

Variable features typically reduce the volatility of the reinsurance/retrocession amounts. Hence, not modeling variable features is typically conservative for assumed reinsurance and optimistic for ceded retrocession. Hence,

(1) For assumed reinsurance, the treatment of material variable features of premiums and expenses/commissions in the different components of StandRe including the expected non-life insurance result (Section 2.4) should be described and explained, including when modeled deterministically. If the impact of modeling the variable features of premiums and expenses/commissions is material, this may give rise to an adjustment to StandRe that requires prior approval by FINMA (Section 2.17).

(2) For ceded retrocession, variable features are required to be modeled explicitly where material by appropriately reducing the corresponding recoverable amounts. This needs to be done, as appropriate, either by applying the variable features prior to the AG component or by explicitly modeling them in the variable features.

For further information on the modeling of variable premiums and expenses for assumed reinsurance, see Section 4.6.

2.5.2 Expected non-life insurance result

According to Articles 22 and 30 ISO, the value at time $t = 1$ of the insurance liabilities written until time $t = 1$ is required to include all costs (including administrative and overhead costs) needed for the own fulfillment of the insurance liabilities under the assumptions from Article 2 Paragraphs 2 and 3 ISO-FINMA, in particular without taking on new insurance liabilities. Some of these costs for existing business written until time $t = 0$ are already included in the valuation of the insurance liabilities in the balance sheet at $t = 0$. The expected non-life insurance result needs to include all additional such costs for existing business and all such costs for new business written until time $t = 1$.

2.6 Info events and contract events

2.6.1.1 Info events

In line with Section 2.4, one-year risk is caused by information that becomes known between time $t = 0$ and $t = 1$ and that leads to a change in the best estimate (or more generally the value of insurance liabilities). We identify this with the occurrence of a general type of event that we call "information event" or "info event" for short. Info events are defined in the glossary in Section 1.

Examples of info events are the occurrence of an earthquake, an explosion in an industrial facility or the crash of an aircraft, but also a drop in the oil price, a court decision or an increase in inflation expectation, or the reporting of a full limit loss to a given program.

In line with the one-year view of the SST, the occurrence of an info event does not necessarily imply that the ultimate outcome of a specific loss or claim becomes known. As a simple example, a first info event can consist in the reporting of one or several claims, with no certainty about the ultimate outcome. A second info event can correspond to the settlement of the claims, by which the ultimate outcome becomes known. In this sense, the flow of information until the ultimate outcome corresponds in general to a temporal sequence of info events at different points in time, which we call an "**info event sequence**" and which starts with an "initial info event" and ends with a "terminal info event".

Info events can have an impact on specific contracts, and several info events may affect the same contract.

2.6.1.2 Contract events

Info events need to be distinguished from "contract events". The definition of a contract event can be found in the glossary in Section 1.

- The expression **"per event conditions" (PEC)** of assumed reinsurance or ceded retrocession refers to contract events.

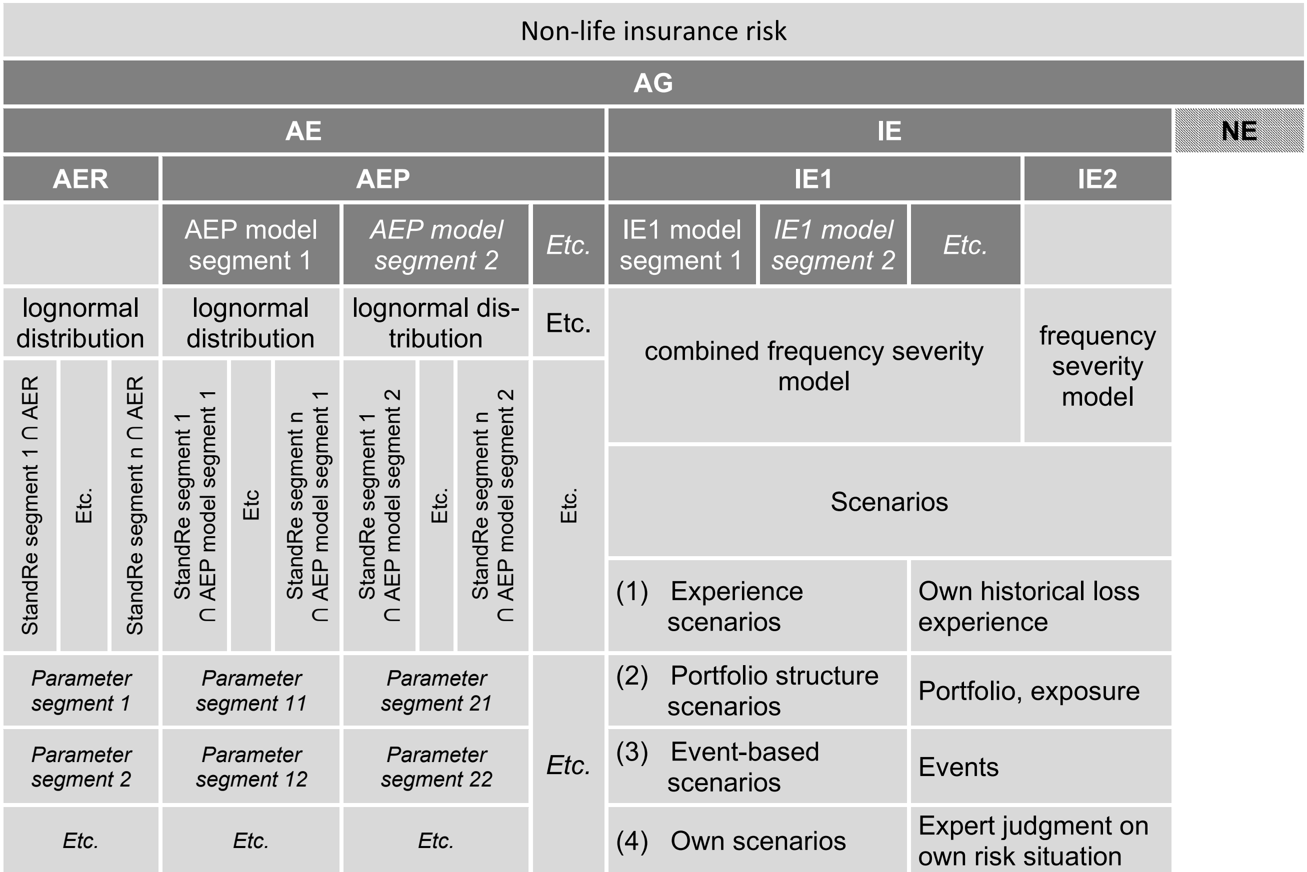
An info event can give rise to several contract events. For example, a drop in an equity index (info event) can lead to an increased number of D&O claims to different companies, which would likely be considered as individual occurrences, i.e. contract events, for the purpose of a reinsurance or retrocession contract. Also, recall the discussion following the 9/11 World Trade Center attacks in 2001 on whether the attacks constituted one or two (contract) events. Conversely, the claims from a contract event can have an entire info event sequence attached.

An info event can also give rise to several contract events that apply to different e.g. ceded retrocession contracts. As an example, consider a ceded retrocession program on "losses occurring" basis that consists of a per event excess of loss (XoL) contract covering the LOB property and another XoL contract covering the LOB commercial liability. An info event given by an explosion in an industrial facility can lead to assumed reinsurance claims on property and on commercial liability business. Therefore, this info event produces one contract event for the property and another for the commercial liability ceded retrocession contract.

2.7 Model structure and dependencies

2.7.1.1 Model structure

The more detailed structure of StandRe, in particular the structure of the components AE and IE, is shown in the following illustration. The terms used in the illustration are explained in following sections. The segmentation in italic is defined by each reinsurer individually. The term "∩" denotes the intersection of two sets.



StandRe is intended to be structured by info events because info events are the causes of risks. The StandRe components AE, IE1, IE2 and NE are intended to cover disjoint sets of info events. AE covers a set of info events, but does not model these info events individually, whereas IE1, IE2, and NE in principle model the info events they cover individually (the actual modeling is somewhat simplified). The different components NE, AE and IE, their modeling, and the delimitation between them are explained in the Sections 2.11 to 2.14.

2.7.1.2 Dependencies

The outputs of the components AE, IE1, IE2 and NE are assumed to be independent.[2] This does not directly follow from their covering disjoint sets of info events, but it is assumed that info events are defined such that dependencies between them are to the extent possible minimal. This implies in particular that info events should also capture possible consequential events (e.g. fire following earthquake) and that their impact should be considered on the entire portfolio. AE is split into the two components AER and AEP, which cover different accident years but not necessarily different info events and may thus in general be dependent.

2.8 Model structure, segmentation, and model segments

2.8.1.1 Model structure and segmentation

For reinsurers with no ceded retrocession or with ceded retrocession that applies to all business (and which do not use the adjustment mentioned in Section 2.9), the model structure for the components AER, AEP, IE1, IE2 and NE is designed so that the output of each of these components consists of exactly one distribution (lognormal distribution or frequency-severity model).

Additionally, StandRe prescribes segmentations of the business into various types of sub-portfolios. This is shown in the above illustration for AER and AEP with the "StandRe segments", which constitute a prescribed segmentation, and the "parameter segments", which are selected by each reinsurer individually. More detail on the prescribed segmentation, including a segmentation for reporting purposes, is provided in Section 3.

2.8.1.2 Ceded retrocession and model segments

If there are more complex ceded retrocession structures that apply to AEP, IE1 and NE, it may be required for their modeling to be materially correct to have a more granular output of AE, IE1 and NE given by corresponding "model segments" for AE, IE1 and NE. As this makes the modeling more involved, it is important that the model segments are suitably selected. This is discussed in more detail in Section 2.10.

2.9 Assumed reinsurance

Within StandRe, the term "assumed reinsurance" (inward or "active" reinsurance) is used to refer to all assumed business of the reinsurer and the term "ceded retrocession" (outward or "passive" retrocession) to all protections though cession of risk (see the glossary, Section 1).

In the default approach, assumed reinsurance is considered in StandRe prior to the calibration of the models for the components and not explicitly subsequently in the AG component. By doing this, annual aggregate conditions of assumed reinsurance are disregarded in the default approach for IE1.

[2] Prior to potential application of ceded retrocession conditions, which may introduce dependencies.

The default approach assumes that the number of assumed reinsurance contracts is reasonably large and without a few contracts dominating the risk profile.

As an adjustment of the model, explicit modeling of assumed reinsurance structures in the AG component may be possible. This may be relevant for reinsurers with only a few assumed reinsurance contracts, e.g. from intra-group cessions, where each covers a considerable number of "risks", specifically if the annual aggregate conditions of the assumed reinsurance contracts are material. This is further described in Section 4.7.

2.10 Ceded retrocession and model segments

Ceded retrocession structures are treated differently for different StandRe components:

2.10.1.1 AER and IE2

For the components AER and IE2, ceded retrocession is considered prior to the calibration of the component models and not explicitly subsequently in the AG component. There is only one model segment for AER and IE2 combining all business.

2.10.1.2 AEP, IE1 and NE

It is assumed that the material aspects of ceded retrocession for the components AEP, IE1 and NE affecting the current accident year can be modeled by:

- first, application of per risk or per event conditions (PEC) and annual aggregate conditions directly linked to the per risk or per event conditions (AC1) (e.g. annual aggregate limit coming from limited reinstatements for an XoL treaty),

- followed by the application of annual aggregate conditions not directly linked to the per risk or per event conditions (AC2) (e.g. a stop loss).

If this assumption is not satisfied, an adjustment to StandRe that requires prior approval by FINMA may be required (Section 2.17).

The AC2 relevant to AEP, IE1 and NE are modeled in the AG component. Depending on their structure, the materially correct modeling of these may require several model segments for AEP, IE1 and NE.

For the modeling of the PEC & AC1 relevant to AEP, IE1 and NE, there are two different approaches:

(1) "Netgross approach": the PEC are applied prior to the calibration of the component models, so that component outputs are netgross (i.e. after application of PEC & AC1 but before application of AC2).[3]

[3] In this case, for IE1, AC1 are not considered.

(2) "Gross approach": the PEC & AC1 are considered in the AG component, so that the component outputs are gross.

If the netgross approach is used, the model segments for AEP, IE1 and NE only need to be sufficiently granular that the material aspects of AC2 can be applied. If the gross approach is used, the model segments for IE1 and NE additionally need to allow modeling the material aspects of the PEC & AC1. Hence, in particular, dependencies between the IE1 model segments need to be modeled. This is further outlined in Section 2.13. The approach for deriving model segments for AEP, IE1 and NE is described in Section 4.3.

2.11 Nat cat events (NE)

2.11.1.1 Definition

The component NE of StandRe refers to those nat cat events that are modeled by a partial internal model. If a reinsurer uses no partial internal model for nat cat risks, there is no component NE. Nat Cat events that are not in scope of the component NE are required to be covered by the other components of StandRe.

The info events covered by NE are assumed to only affect the current accident year (i.e. business earned between $t = 0$ and $t = 1$). Info events affecting prior accident years are covered by other StandRe components.

2.11.1.2 Modeling

The modeling of the component NE by a partial internal model is performed outside of StandRe; its results are then integrated into StandRe in the AG component (see Section 2.16).

For the integration, it is in particular relevant whether there is ceded retrocession that applies jointly to nat cat losses covered in NE and other losses that are modeled in AEP and/or IE1. If material, such ceded retrocession needs to be applied after the integration of the NE internal model in the AG component.

2.12 Attritional events (AE)

2.12.1.1 Definition

The component AE is defined to cover the info events (other than those covered by NE) for which the following conditions hold:[4]

[4] This is a theoretical definition; in practice, the delimitation against the other components is according to Section 2.14.

(a) The impact on the reinsurer over the one-year period of the AE info events in their entirety can be modeled by lognormal distributions parameterized by mean and standard deviation. In particular, there is no need for the explicit modeling of individual info events and assumed reinsurance structures.

(b) The extrapolation from historical aggregate experience of the reinsurer is sufficient to account for the info events in AE, with only high-level consideration of the actual exposures.

AE is decomposed into the two components:

(1) **AE reserve risk (AER)**: the risk from AE info events for the business from the prior accident years (i.e. the business earned at $t = 0$).

(2) **AE premium risk (AEP)**: the risk from AE info events for the business from the current accident year and the business written but not earned at $t = 1$.

AER in particular covers info events affecting nat cat business from prior accident years.

AER and AEP are not disjoint in terms of the info events they cover but in terms of the covered business. This implies that there are no gaps and overlaps between them, but that there can be dependencies.

2.12.1.2 Simplification: modeling by underwriting year

As a simplification,

- it is allowed to model AER by the risk for *prior underwriting years* and AEP by the risk for the *current underwriting year*, provided this does not lead to material deviations.

Note that underwriting years (as well as accident years) are defined in terms of calendar years (Section 1). So e.g. using "underwriting years" defined by the period from 1. Aug to 31 July would not fall under this allowed simplification and may give rise to an adjustment to StandRe that requires prior approval by FINMA (Section 2.17).

Note also that when the decision is made to model by e.g. by underwriting year, it must be made transparent if data used in the calibration of the model is not on this basis (e.g. loss ratios for AEP are by accident year) and materiality needs to be estimated.

The simplification of modeling AE by underwriting year can be seen as:

(a) modeling the business of the current underwriting year (and prior underwriting years) that is not earned at $t = 1$ as premium risk, which tends to be conservative in that this business is not yet in force in the one-year period from $t = 0$ to $t = 1$;

(b) modeling the business written but not earned at $t = 0$ as reserve risk, which tends to be progressive in that this business is in force in the one-year period from $t = 0$ to $t = 1$.

The simplification is based on the assumption that (a) and (b) roughly balance out. This may not be the case if the volume of the business written but not earned at $t = 1$ is significantly different from the volume of the business written but not earned at $t = 0$. In particular, it may underestimate the risk if the former is significantly smaller than the latter, as for example with a company writing significantly less new business.

2.12.1.3 Modeling

The models for AER and AEP are specified in detail in Section 5. In line with the characterization of "attritional events", they are structured along sub-portfolios. The output of AER is discounted best estimates at t =1 net of ceded retrocession; for AEP, it is non-discounted ultimate outcomes netgross.

For AER, and for AEP if there is only one AEP model segment, the output is one lognormal model. Its mean and standard deviation are derived by moment aggregation ("variance-covariance approach") from the means and standard deviations of sub-models in the granularity of so-called "StandRe segments" (Section 3), using a correlation matrix. The means and standard deviations of the sub-models are derived from means and standard deviations in the different granularity of "parameter segments"", which is selected by each reinsurer.

The standard deviations on parameter segments are estimated from historical experience of the reinsurer and expert judgment:

(1) For AER, a benchmark method implemented in a template is provided. It uses a combination of Bornhuetter-Ferguson and Chain Ladder on the claims development triangles. It needs to be calculated, but the selected standard deviations can deviate from its results.

(2) For AEP: no benchmark method is provided, but historical loss ratios and a standard estimator are used to compare the selected standard deviations against.

If there are several AEP model segments, then the output of AEP consists of a lognormal distribution for each AEP model segment, with the dependency modeled by a copula.

The dependency between AER and AEP is intended to cover general, not specifically identified dependencies and is modeled by a copula.

2.13 Individual events (IE)

2.13.1.1 Definition

The IE component covers all info events that are not in scope of NE and AE. They should thus in principle be modeled individually, not primarily by extrapolation from historical experience of the reinsurer, and explicitly considering actual exposures and assumed reinsurance structures.

IE consists of the two components:

(1) **IE1**: covers info events in IE that only impact the current accident year.

(2) **IE2**: covers all info events in IE that are not covered by IE1. These can in general also affect prior and future accident years.

2.13.1.2 Modeling

The models for IE1 and IE2 are specified in detail in Section 6. In line with their definition, the intention is to model individually the info events in scope. In practice, the modeling is by scenario, where a scenario is intended to correspond to a set of info events and its output consists of a scenario severity and a scenario frequency.

Each scenario is assigned to either IE1 or IE2. The different types of scenarios modeled are:

a) Experience scenarios: derived from as-if adjusted large historical event losses of the reinsurer.

b) Portfolio structure scenarios: defined in terms of the assumed reinsurance portfolio of the reinsurer (e.g. a full limit loss to a specific assumed reinsurance program).

c) Event-based scenarios: defined by specific info events (e.g. explosion of a large industrial facility, increase in claims inflation expectation).

d) Own scenarios: defined by each reinsurer individually.

Following the calculation of the scenarios, analytic event frequency-severity models are fitted using expert judgment to the scenario results separately for IE1 and IE2. The purpose of fitting is to account "for all possible" info events in scope, by interpolation between the severities from the scenarios and extrapolation beyond those severities.

If there are several IE1 model segments, then the IE1 output consists of a "frequency-severity model" in which the "severity" consists of the vector of severities per IE1 model segment. This allows capturing possible of co-occurrences of losses to different IE1 model segments.

2.14 Definition and delimitation of the components in practice

In practice, the scope of AE is the complement of scope of IE (and NE) and not the other way around as specified above.

The delimitation between the components AER, AEP, IE1, IE2 and NE (specifically, to avoid double counting) is implemented in practice as summarized by the following matrix:

Delimitation between components	AER	AEP	IE1	IE2
AEP	Cover different accident years			

IE1	IE1 info events only affect the current accident year	Historical large event losses producing IE1 experience scenarios can be excluded from the data used to calibrate AEP		
IE2	It is assumed that through the definition of the scope of IE2 by the IE2 modeling threshold, IE2 and AER are disjoint	AEP only covers the current accident year and different info events	Disjoint info events, implemented through disjoint scenarios	
NE	Current/prior accident year	Historical losses corresponding to info event in NE can be excluded from the data used to calibrate AEP	The scenarios assigned to IE1 do not cover NE info events: historical large event losses relating to info events in NE can be excluded for the experience scenarios, as can non-experience scenarios in scope of NE	Disjoint info events and NE only covers the current accident year

2.15 One-year risk and ultimate risk

AER and IE2 model the one-year risk. On the other hand, AEP, IE1 and NE initially model the ultimate risk. As a simplification, no transformation from ultimate to one-year risk is applied for these components. The use of such a transformation is possible as an adjustment to StandRe that requires prior approval by FINMA (Section 2.17).

2.16 Non-life insurance risk aggregation (AG)

The AG component of StandRe is described in detail in Section 7. It produces the distribution of the one-year change for non-life insurance risk (excluding the market value margin), net of ceded retrocession, discounted and in the SST currency of the reinsurer (Section 3.6), combining the outputs from the components AER, AEP, IE1, IE2 and NE and the "expected non-life insurance result".

This is done by an overall Monte Carlo simulation, in which joint dependent samples are drawn from each of the components AER, AEP, IE1, IE2 and NE. As a current simplification (see Section 2.15), for AEP, IE1 and NE no transformation from ultimate to one-year risk is applied.

StandRe requires stochastic modeling in the AG component and thus typically requires a stochastic simulation engine for Monte Carlo simulations in which joint samples from sub-models can be drawn and further processed. The type of IT application (e.g. R, Igloo, AtRisk, Remetrica etc.) is not prescribed.

Depending on the model segment structure for a specific reinsurer, in particular if there are several IE1 model segments, a "reordering algorithm" may be required for drawing of dependent samples. Information on the reordering of samples can for example be found in the paper: "Philipp Arbenz, Christoph Hummel, Georg Mainik: Copula based hierarchical risk aggregation through sample reordering. Insurance: Mathematics and Economics, 51(1), 2012, 122-133."

2.17 Adjustments to StandRe that require prior approval by FINMA

Article 46 ISO allows for the use of adjustments to standard models (including StandRe) that are subject to prior approval by FINMA. Requirements for such adjustments are formulated in Article 21 ISO-FINMA. In particular, it needs to be shown (Article 11 ISO-FINMA) that the standard model without the adjustment would not sufficiently reflect the risk situation.

2.18 Background on the model

The sub-folder "Auxiliary tools" contains tools that may support specific aspects StandRe. In particular, the document "StandRe model background" contains rationales and the derivation of specific formulas and explains background. These auxiliary tools are provided for information purposes only and do not constitute official StandRe material. They may potentially be updated at any time.

3 Segmentation

3.1 Segmentations in StandRe

StandRe is designed through the components AE, IE, NE (itself out of scope) and their aggregation AG. AE is decomposed into the components AER and AEP and IE into IE1 and IE2.

In addition, StandRe defines several segmentations of the portfolio for reporting and calculation purposes, where some are prescribed and others selected individually by the reinsurers. The main segmentations are:

Segmentation	Main purpose
(1) **Reporting segments**: prescribed segmentation to be used for reporting of reserves and premiums. It is intended to allow for a standardized view of reinsurance contracts with a potentially worldwide scope (specifically for LOBs) and for comparisons between companies and with public data on the insurance industry incl. OECD statistics. It provides information on the exposures independently of the modeling and on areas that may require special focus.	Reporting
(2) **StandRe segments**: a prescribed segmentation to be used for the modeling of the component AE. This granularity is not as fine as the reporting segmentation, specifically with respect to LOBs. (3) **Parameter segments**: parameter segments are selected by each reinsurer for the estimation of parameters in the AE component.	AE
(4) **Model segments**: for each of the components AEP, IE1 and NE, the granularity of the component outputs required for materially correctly modeling ceded retrocession.	Ceded retrocession, AEP, IE1, and NE
(5) **As-if adjustment segments**: used for as-if adjusting historical large event losses for frequency and/or severity to make them representative for the current year.	Experience scenarios in IE

3.2 Reporting and StandRe segments

Reporting and StandRe segments correspond to combinations of

- segment = LOB × region × type of contract

where

a) **LOB** (Section 3.3): three levels of successively finer granularity:

a. StandRe LOB (e.g. “marine, aviation and other transport”), used for StandRe segments;

b. High-level LOB (e.g. “marine and other transport”);

c. Detailed LOB (e.g. “specie and fine arts”).

b) **Region** (Section 3.4): two levels of successively finer granularity:

a. StandRe region;

b. High-level region.

c) **Type of contract**:

a. direct insurance and proportional reinsurance ("prop")

b. non-proportional reinsurance incl. facultative reinsurance ("non-prop").

Reporting segments and StandRe segments are defined by:

- **Reporting segment** = detailed LOB × high-level region × type of contract;
- **StandRe segment** = StandRe LOB × StandRe region × type of contract.

3.3 Lines of business (LOB)

The following table shows LOB segments at different levels of granularity.

<table>
<tr><th>StandRe LOB</th><th>high-level LOB</th><th>detailed LOB</th></tr>
<tr><td rowspan="4">Accident and Health</td><td>Accident</td><td>- Compulsory Accident
- Non-Compulsory Accident</td></tr>
<tr><td>Health</td><td>- Compulsory Health (care)
- Non-Compulsory Health (care)</td></tr>
<tr><td>Workers Compensation, Employers Liability</td><td>- Workers Compensation
- Employers Liability</td></tr>
<tr><td>Other A&H</td><td>- Other/Non-Specific or Combined Accident and Health</td></tr>
<tr><td>Motor</td><td>Motor</td><td>- Motor Hull (and Accident) (commercial and personal
- Motor Liability
- Other/Non-Specific or Combined Motor</td></tr>
<tr><td rowspan="3">Marine, Aviation and Other Transport (MAT)</td><td>Marine and Other Transport</td><td>- Marine Hull (incl. Shipbuilding) (ocean, inland)
- Marine Cargo (goods in transit)
- Marine Liability (incl. Protection & Indemnity PI)
- Specie and Fine Art
- Railway and Other Transport
- Other/Non-Specific or Combined Marine</td></tr>
<tr><td>Aviation</td><td>- Aviation Hull (and Accident)
- Aviation Liability (incl. Aviation Product Liability)
- Space (incl. satellites) (hull)
- Other/Non-Specific or Combined Aviation</td></tr>
<tr><td>Energy Offshore</td><td>- Energy Offshore (incl. BI)</td></tr>
<tr><td rowspan="3">Property</td><td>Energy Onshore</td><td>- Energy Onshore (incl. BI)</td></tr>
<tr><td>Property</td><td>- Personal Property (incl. homeowners)
- Commercial Property (incl. BI)
- Other/Non-Specific or Combined Property</td></tr>
<tr><td>Engineering</td><td>- Engineering/Construction</td></tr>
<tr><td rowspan="3">Financial Losses</td><td>Credit and Surety</td><td>- Credit (incl. export credit, mortgages)
- Surety
- Political Risks</td></tr>
<tr><td>Agriculture</td><td>- Agriculture</td></tr>
<tr><td>Other Financial Losses</td><td>- Other Financial Losses (incl. Income Protection)</td></tr>
<tr><td>General Liability</td><td>General Liability</td><td>- Personal Liability (Public Liability)
- Commercial Liability (Public Liability)
- Product Liability
- Professional Indemnity incl. Errors & Omissions (E&O) (incl. Medical malpractice)
- Directors and Officers (D&O) (management liability)
- Other/Non-Specific or Combined Liability</td></tr>
<tr><td>Other Non-Life</td><td>Other Non-Life</td><td>- Legal Expenses
- Other Non-Life (Assistance, Miscellaneous etc.)
- Multiline</td></tr>
</table>

3.4 Geographical regions

The following table shows the segmentation into geographical regions. The region for a contract is in principle given by the location of the (re)insured risks and not the location of the cedant.

StandRe region	**High-level region**	**Definition**
Europe	Europe	Countries in Europe (geographical, not only EU) Russia
North America	North America	United States Canada
Rest of world	Central and South America	America and Caribbean, excl. United States and Canada
	Middle East and Africa	Middle East and Africa
	Japan	Japan
	Asia and Pacific	Asia and Pacific (excl. Japan, Middle East, Russia)
Not regional	Not regional	Global, worldwide exposures, not geographically located (e.g. some Marine, Space) or unknown

3.5 Reporting of the non-life insurance portfolio

3.5.1.1 Scope

The objective is to obtain a standardized view of the non-life insurance portfolio of reinsurers at $t = 0$ (reference date of the SST calculation) and of the upcoming portfolio at $t = 1$ (end of the one-year period from the reference date) in the prescribed reporting segmentation (Section 3.2) and in the SST currency. Note that nat cat business is included in the reporting requirements.

The figures required to be reported in the StandRe template are the best estimate reserves at $t = 0$ net of ceded retrocession and non-discounted and expected premiums net of ceded retrocession for the current underwriting year, i.e. the business written between $t = 0$ and $t = 1$.

The StandRe template automatically generates summary statistics.

3.5.1.2 Allocation to reporting segments

Reinsurers need to allocate their (re)insurance business to the reporting segments and to describe this allocation. In principle, the allocation is by individual contract. In practice, reinsurers might be able to map internally used segments to the reporting segments. Simplifications /approximations are possible and should be explained and justified. The extent of these explanations and their explanations has to be proportional to their materiality and taking into account the principle of proportionality ("Verhältnissmässigkeit").

The primary objective of the reporting of the portfolio is a transparent representation of the portfolio in terms of the covered business. For this reason, the use of the detailed LOB segments beginning with "Other/Non-Specific or Combined" or the "Multiline" segment may need to be avoided by breaking up (potentially using simplifications) premiums and reserves into the components relating to other detailed LOBs, as this provides better information on the underlying exposures.

For example, if there is a significant volume of combined liability contracts that cover both Commercial Liability and Product Liability, then instead of representing them under "Other/Non-Specific or Combined Liability", they should be allocated to Commercial Liability and Product Liability, where necessary using suitable approximations.

For the Multiline LOB, if its volume is not significant, then it can be represented under the detailed LOB Multiline. If the Multiline volume is significant, the corresponding business should be appropriately broken up into the corresponding LOBs. An approach for this can for example be to allocate Multiline contracts with relatively smaller premiums/reserves to their most material LOB. For Multiline contracts with relatively larger premiums/reserves, the premiums/reserves may have to be allocated to the different LOBs covered by the contract.

For the region, the location of the cedant might be used as a proxy for the location of the risk.

If there is ceded retrocession, it should be explained how the net figures are derived. This might require the use of an allocation principle.

3.6 Currencies

The following currencies are eligible for StandRe:

- CHF, EUR, USD, GBP, JPY

Amounts in other currencies need to be converted to the above currencies using the exchange rate as of the SST reference date. Conversions between the above currencies should use the FINMA-prescribed exchange rate as of the SST reference date.

3.6.1.1 SST currency

This refers to the SST currency ("SST-Währung" / "Monnaie du SST") as defined in Article 4 ISO-FINMA. The choice of the SST currency should be stable over time.

3.6.1.2 Parameter segment currency

In the AE component, in principle, claims payments need to be discounted in the currency in which they are made, using the FINMA-prescribed risk-free interest rate curves where applicable. As a simplification, if reinsurers have material claims payments in currencies that are different from the above eligible currencies, they are converted to eligible currencies.

4 Model structure

4.1 Overview

StandRe contains the components AER, AEP, IE1, IE2 and NE. In this section, we describe how to determine the "model structure" for a specific StandRe model.

This is done by defining for each of the above components:

(1) **Output basis**, which is: gross, netgross or net of ceded retrocession.

(2) **Granularity of output**, which we call the model segmentation (i.e. the sub-portfolios for which the output is separately available).

(3) **Form of output** (e.g. lognormal distribution, frequency-severity model).

(4) **Scope of component**, and related to this, the modeling threshold(s) for IE1 and IE2.

The outputs of the components AER, AEP, IE1, IE2 and NE are subsequently combined in the AG component of StandRe (Section 7) to get discounted amounts net of ceded retrocession.

The output basis encapsulates which ceded retrocession structures are modeled within the components AER, AEP, IE1, IE2, and NE and which in the AG component. For example, if the output of IE1 is gross, then ceded retrocession for IE1 is fully modeled in AG.

Background on the reasons for the specifications on output granularity is provided in the "model background" document (Section 1.1).

4.1.1.1 Adjustment for modeling assumed reinsurance in AG

As explained in Section 4.7, for specific risk situations and under certain conditions, an adjustment to StandRe is possible or may be required, in which the assumed reinsurance structures are modeled explicitly in the AG component.

4.1.1.2 Overview of the model structure

If the adjustment for modeling assumed reinsurance in AG mentioned above is not used, the model structure in terms of output basis, granularity, form and scope of the components AER, AEP, IE1, IE2 and NE is defined as summarized in the following table. The table contains information and references to other sections.

	Output basis	Output granularity	Output form	Component scope and delimitation
AER	net (Section 4.2)	One AER model segment (Section 4.2)	One aggregate distribution (Section 4.2)	Prior accident years (Section 2.12, 2.14)
IE2	net (Section 4.2)	One IE2 model segment (Section 4.2)	One frequency-severity model (Section 4.2)	All business written by t=1 (Section 2.13, 2.14)
AEP	netgross (Section 4.3.3)	*AEP model segments*: depending on the AC2 of ceded retrocession relevant to the current accident year (Section 4.3.4)	One or several aggregate distributions (with copula) (Section 4.4)	Current accident year (Section 2.12, 2.14) Not in NE and not in IE1 by excluding data from calibration (Section 4.5)
IE1	gross or netgross (Section 4.3.3)	*IE1 model segments*: depending on output basis and ceded retrocession relevant to IE1 and the current accident year (Section 4.3.4)	One Frequency-severity model, with severity vector if several IE1 model segments (Section 4.4)	Current accident year (Section 2.13, 2.14) Not in NE and exceeding IE1 model threshold(s) as specific in Section 4.5 (and 4.3.3)
NE	gross or netgross (Section 4.3.3)	*NE model segments*: depending on output basis and ceded retrocession relevant to NE1 and the current accident year (Section 4.3.4)	Not otherwise prescribed (Section 4.4)	Current accident year (Section 2.11, 2.14) As defined by the internal Nat Cat model, but if output of NE is gross, as specified in Section 4.3.3

4.1.1.3 AER and IE2

The components AER and IE2 are treated differently from the components AEP, IE1 and NE. For AER and IE2, the output basis, the model segmentation, the form of the output, and the scope of IE2 and the IE2 modeling threshold are defined in Section 4.2.

4.1.1.4 AEP, IE1, and NE

For AEP, IE1 and NE, the output basis and the model segmentation follow from the ceded retrocession structure of the reinsurer for the current accident year and are thus potentially specific to each reinsurer. This is explained in Section 4.3.

4.1.1.5 No ceded retrocession and no adjustment as in Section 4.7

For reinsurers which have no ceded retrocession covering the current accident year and no assumed reinsurance portfolio of the form considered in Section 4.7, there is

(A) one model segment for each of AEP, IE1 and NE;

(B) no difference between gross and netgross (and net) for AEP, IE1 and NE;

(C) one IE1 modeling threshold defining the scope of IE1 as described in Section 4.5.

Such reinsurers can ignore the specifications on model segmentation from Sections 4.3 and 4.4.

4.1.1.6 Ceded retrocession

For reinsurers with ceded retrocession for the current accident year:

- The output basis (gross or netgross) and the model segmentation for AEP, IE1 and NE are defined in Section 4.3.
- The resulting form of the output for these components in the case of several model segments is described in Section 4.4.
- In Section 4.5, the scope of AEP and IE1 is defined, distinguishing between the case in which there is only one model segment and thus only one IE1 modeling threshold, and the case of several model segments and several IE1 modeling thresholds.

4.1.1.7 Modeling variable features of premiums and expenses

The modeling of variable features of premiums and expenses as introduced in Section 2.5 is described in Section 4.6.

4.2 Model segmentation for AER and IE2, scope of IE2 and IE2 modeling threshold

In StandRe, the form of the output of the component AER is one distribution and for the component IE2 one frequency-severity model. Thus, the model segmentation consists of only one model segment for each of AER and IE2. In particular, there is no separate output for different segments, e.g. LOBs etc. The output basis is net of ceded retrocession for both AER and IE2. The IE2 modeling threshold t_{IE2} is explained in Section 6.13.2. Deviations from this approach for AER and/or IE2 (e.g. modeling AER and IE2 by individual prior accident year) typically give rise to an adjustment that requires prior approval by FINMA (Section 2.17).

Two main reasons for these specifications are:

(1) IE2 info events can correspond to many accident years and contract events, so modeling the corresponding dependencies can be very complicated.

(2) Non-proportional ceded retrocession structures cannot be applied correctly on year-end best estimates or one-year changes but require ultimate outcomes.

4.3 Model segmentation for AEP, IE1 and NE

4.3.1 Assumption on the structure of ceded retrocession

Recall that AEP, IE1 and NE are intended to model the current accident year. We assume that the ceded retrocession that affects the current accident year can be represented in the following form:

(1) First, application of per risk or per event conditions (**PEC**) and annual aggregate conditions directly linked to per risk or per event conditions (**AC1**). An example of AC1 is the annual aggregate limit coming from limited reinstatements for an XoL treaty.

(2) Second, application of annual aggregate conditions not directly linked to per risk or per event conditions (**AC2**). An example is a stop loss. The PEC & AC1 may inure to the benefit of AC2.

If the material aspects of the ceded retrocession cannot be represented in this form, an adjustment to StandRe that requires prior approval by FINMA may be required (Section 2.17).

4.3.2 Overview of model segmentation for AEP, IE1, NE

In the simplest case, the model structure consists of only one model segment, i.e. the output of each of AEP, IE1 and NE consists of only one distribution (or frequency-severity model or event loss set) and the output basis is netgross. In other words:

(A) The PEC are applied in the components AEP, IE1 and NE, and the AC1 are disregarded.

(B) The AC2 are explicitly modeled in the AG component.

In other cases, depending on the structure of the ceded retrocession, a finer granularity of outputs in terms of model segments for AEP, IE1 and NE may be required. Moreover, the PEC & AC1 may need to be modeled in the AG component, i.e. the outputs of IE1 and NE may need to be gross instead of netgross. In the following, we explain:

- Output basis: In Section 4.3.3, we specify when the outputs of AEP, IE1 and NE need to be or can be gross or netgross.

- Output granularity: Based in the output basis, we specify in Section 4.3.4 how to derive the model segments for AEP, IE1 and NE. An example is provided in Section 4.3.5.

- Form of output: In the case of several model segments, the resulting form of the output is described in Section 4.4.

- Scope of component: The scope of the components AEP, IE1 and NE is defined in Sections 4.3.3 and 4.5.

In the AG component, PEC & AC1 are potentially explicitly applied, and AC2 are explicitly applied. Both may require "top-down disaggregation" for different retro years as described in Section 7.

4.3.3 Gross or netgross output for AEP, IE1, and NE

Ceded retrocession conditions of type AC1 (e.g. a limited number of reinstatements) cannot be captured in the model if PEC are modeled in AEP, IE1, or NE, i.e. if the output of AEP, IE1, or NE is netgross instead of gross. The reason is that then the aggregated amount of retro recoverables from the PEC over several info events is not known. Hence:

- **Output basis of IE1 (NE)**: The output of IE1 (or NE) needs to be *gross instead of netgross* if the impact of not modeling the AC1 relevant to IE1 (or NE) is material.
- **Scope of AEP and IE1/ modeling thresholds**: If the output of IE1 is gross, then the modeling threshold(s) for IE1 need to be lower than the attachment points of the relevant PEC (see Section 4.5 for the IE1 modeling thresholds)
- **Scope of NE**: If the output of NE is gross, then the scope of NE has to include all event losses that could exceed the attachment points of the relevant PEC.

The reason for the above condition on the modeling threshold(s) is that then the PEC & AC1 can be calculated only from the outputs of IE1 and NE, not involving AEP. This also means that for AEP in this situation, gross and netgross are the same. Hence,

- **Output basis of AEP**: the output of AEP is always netgross (which is the same as gross if the output of IE1 is gross)

If there are several IE1 model segments (as determined in Section 4.3.4), then the output of IE1 for *all* IE1 model segments is required to be either gross or netgross.

For NE, it is in principle possible to specify for each NE model segment separately whether the output is gross or netgross if that simplifies the calculations and does not produce material distortions.

It is not necessary that the output of both IE1 and NE is either gross or netgross, provided that the material aspects of the ceded retrocession structure can be reflected.

If the above condition on the AC1 is not satisfied, then it is allowed to model the PEC & AC1 in the AG component (i.e. the outputs are gross instead of netgross) if this does not produce additional model segments according to Section 4.3.4.

4.3.4 Derivation of model segments for AEP, IE1 and NE

For a reinsurer with ceded retrocession, the model segmentation for AEP, IE1 and NE is determined by the requirement that the material aspects of ceded retrocession can be correctly reflected. There may be "remainder" model segment to which no retrocession applies. The model segments for AEP, IE1 and NE may potentially be different.

To avoid over-complicating of the modeling, the number of segments should be kept to a necessary minimum. To this end, it is allowed to model the ceded retrocession in a simplified way provided that the impact is not material.

4.3.4.1 Retro year

For the derivation of the model segments, we define:

- A **retro year** for a ceded retrocession contract is defined to consist of the coverage period and the coverage basis (e.g. risks attaching or losses occurring) of the contract.

As an example, the retro year could be given by the coverage period from 1 April to 31 March and the coverage basis "losses occurring", or the period could be from 1 February to 31 January and the basis "risks attaching".

Retro years are defined because the "allocation" of losses to retro years follows a simplified approach ("top-down disaggregation"), which is explained in Section 7.

4.3.4.2 AEP model segments

For the AEP model segments, only the AC2 are relevant. This is because the PEC & AC1 are either modeled within the components AEP, IE1 and NE (with the outputs of each being netgross), or they are only applied to the outputs of IE1 and NE, as explained in Section 4.3.3. The AEP model segments are determined as follows:

- **AEP model segments:** The *AEP model segments* are given by the minimal number of segments needed to correctly model the material aspects of the AC2 of ceded retrocession relevant to the current accident year, if differences in retro years are disregarded.

Disregarding differences in retro years here and below for IE1 and NE means for example that if the current accident year is covered by a ceded retrocession contract on losses occurring basis until March 31 and by another from April 1, this does not give rise to two (AEP) model segments. Note that "retro years are disregarded" applies only to the determination of model segments. Differences between ceded retrocession structures for different retro years are required to be considered and are modeled using "top-down disaggregation" (Section 7).

4.3.4.3 IE1 and NE model segments

For the derivation of the IE1 and NE model segments, the first consideration is whether their output is gross or netgross according to Section 4.3.3.

- **IE1 (or NE) model segments (netgross basis)**: If the output of IE1 (or NE) is *netgross* according to Section 4.3.3, then the *IE1 (or NE) model segments* are given by the minimal number of segments needed to correctly model the material aspects of the AC2 of ceded retrocession relevant to the current accident year and IE1 (or NE), if differences in retro years are disregarded.

In this case, there might be fewer IE1 or NE model segments than AEP model segments. As an illustration, assume no PEC & AC1 ceded retrocession; a Stop Loss that only applies to all Nat Cat losses; and no other AC2 ceded retrocession. Assume that the Nat Cat events are covered by NE and AEP, but not by IE1. Then there are two AEP model segments (one for Nat Cat business and one for the remainder), but only one IE1 model segment and only one NE model segment.

If the output of IE1 or NE is gross according to Section 4.3.3, then the corresponding PEC & AC1 are modeled in the AG component and several additional IE1 or NE model segments may be required:

- **IE1 (or NE) model segments (gross basis)**: If the output of IE1 (or NE) is *gross* according to Section 4.3.3, then the *IE1 (or NE) model segments* are given by the minimal number of segments needed to correctly model the material aspects of the PEC & AC1 and AC2 of ceded retrocessions relevant to the current accident year and IE1 (or NE), if differences in retro years are disregarded.

4.3.4.4 Finer model segmentation

Generally, it is not allowed to select a model segmentation finer than the minimal segmentation derived as described above to prevent over-complicating the model. A finer granularity may potentially be used if required for stability of the model structure over time (e.g. because the ceded retrocession structures are expected to change over time). This needs to be discussed with FINMA in advance and may give rise to an adjustment that requires prior approval by FINMA (Section 2.17).

4.3.5 Example for model segmentation

As an illustrative example, assume the ceded retrocession consists of

- a per event XoL with limited reinstatements that applies to Liability business (PEC & AC1), and
- a Stop-Loss that only applies to Property business (AC2).

If the AC1 is material (see Section 4.3.3), then the output of IE1 needs to be gross, i.e. the XoL is explicitly modeled in the AG component. There are two AEP model segments (one for the Property for modeling the AC2, and one for the remainder); three IE1 model segments (one for Liability for modeling the PEC & AC1, one for Property for modeling the AC2, and one for the remainder). Assuming the PEC & AC1 do not apply to NE, the output of NE is netgross. Further assuming that only Property is exposed to NE, there is only one NE model segment.

If the AC1 is not material, then the output of IE1 and NE is netgross and only the AC2 is modeled in AG. AEP and IE1 have the same two model segments (one for the Property and one for the remainder). Under the above assumptions on NE, its output is netgross and there is one model segment for NE.

4.4 Form of output of AEP, IE1, and NE if there are several model segments

The model segmentation as described in Section 4.3 determines the form of the output of each of the components AEP, IE1 and NE. Where there is more than one model segment for the corresponding component, possible dependencies between the different model segments need to be modeled. For this, the following approaches are used:

(A) **AEP output form**: there is a sub-model distribution for each AEP model segment, with the dependencies between them modeled by a copula. This is further explained in Section 5.9.

(B) **IE1 output form**: a frequency-severity model for IE1 info event losses is used, with a Poisson distributed frequency and a severity vector consisting of dependent severities per IE1 model segment. This is further explained in Section 6.

(C) **NE output form**: output form (as well as basis, granularity and scope) define the required output of the internal Nat Cat model used. The output form is not otherwise prescribed. For example, the output may consist of a joint event loss set.

4.5 Scope of AEP and IE1, and IE1 modeling threshold(s)

4.5.1 Scope of IE1 and AEP

The scope of IE1 if there is only one IE1 model segment is defined by one IE1 modeling threshold and if there are several IE1 model segments by several IE1 modeling thresholds. The IE1 modeling threshold(s) have the same output basis as the output of IE1, i.e. gross if the output is gross and netgross otherwise. Their selection is described in Section 4.5.2. The scope of IE1 also defines the scope of AEP, as explained in Section 2.14.

- **Scope of IE1**: all info events affecting only the current accident year that are not covered by NE and such that:
    - One IE1 model segment: If there is only one IE1 model segment, the info event loss exceeds the IE1 modeling threshold (gross or netgross as determined in Section 4.3.3).
    - Several IE1 model segments: If there are several IE1 model segments, the info event loss to *at least one* IE1 model segment exceeds the IE1 modeling threshold of this IE1 model segment (gross or netgross as determined in Section 4.3.3).
- **Scope of AEP**: consists of all info events affecting only the current accident year that are not in scope of IE1 or NE.
    - In practice, AEP is delimited from IE1 by excluding in the historical data used for the calibration of AEP the historical losses that give rise to IE1 experience scenarios and are thus covered by IE1 (see Section 6.6 for experience scenarios and Section 5.5.5 for the exclusions to AEP).

With this definition, AEP and IE1 (and NE) cover disjoint sets of info events and can be considered independent. If there are several IE1 model segments, then AEP may cover some quite large losses. This is because IE1 covers some but in general not all info event losses exceeding the smallest IE1 modeling threshold and covers all info event losses only in excess of the sum of the IE1 modeling thresholds.

4.5.2 IE1 modeling threshold(s)

The derivation of the IE1 modeling threshold(s) is described in Section 6.6. In terms of the order of the modeling, note that:

(1) Because the scope of AEP is determined from the IE1 modeling threshold(s), these need to be derived and fixed *prior* to the AEP model.

(2) The IE1 modeling threshold(s) are required to be selected such that there are sufficiently many IE1 experience scenarios; their derivation is thus explained in Section 6.6 on experience scenarios.

4.6 Modeling variable features of premiums and expenses

Section 2.5 specifies when variable features, i.e. loss-dependent premiums and/or expenses from assumed reinsurance or ceded retrocession contracts need to be modeled. This section describes the modeling. Note that variable features are typically functions of losses in a specific granularity.

Similar to the modeling of other aspects of assumed reinsurance or ceded retrocession, there are two approaches for modeling the variable features:

(a) *prior to the AG component*, by applying the variable features before fitting to the data used to calibrate the relevant components (e.g. AEP, IE1 and NE). This is always a simplification, which may be acceptable in view of non-materiality.

(b) *in the AG component*, by explicitly modeling and applying the variable features in the AG component.

We consider first (b) and then (a).

4.6.1.1 Explicit modeling in the AG component

The amount from a variable feature is a generally non-linear[5] function of the ultimate loss in a specific granularity. Hence, explicit modeling of variable features in the AG component requires that:

(1) the loss is available (separately from premiums and expenses) in the granularity in which the variable feature applies; and

[5] E.g. sliding scale commission, finite reinstatement premium

(2) the ultimate loss is available (not year-end best estimates or one-year changes).

Point (2) implies that modeling the variable features explicitly in the AG component can be challenging for AER and IE2 (see below). Point (1) implies that appropriate model segments need to be defined for the explicit application in the AG component. As for other features of assumed reinsurance or ceded retrocession, it is possible to apply top-down disaggregation as described in Section 7 for different retro years, which may reduce the number of modeling segments needed (because differences in retro years may potentially be disregarded).

The relevant variable features are then modeled as contractually specified explicitly in the AG component. For example, sliding scale commissions on proportional contracts for the current accident year would be applied to the aggregate of AEP, IE1 and NE.

4.6.1.2 Modeling prior to the AG component

If variable features for e.g. the current accident year are modeled before the AG component, the output of the components AEP, IE1 and NE is after the application of the relevant variable features and thus consists not only of losses but in addition of (variable) premiums and/or expenses. The variable features are applied to the data used to calibrate the relevant component models, i.e. before fitting.

Note that this not always allows modeling the variable features precisely. For example, a sliding scale commission for the current accident year applies to the aggregate of AEP, IE1 and NE, and thus (similar to AC2), cannot be modeled precisely by separate application to AEP, IE1 and NE. Hence, it may have to be modeled explicitly in the AG component.

In the following we describe considerations for two specific variable features for the current accident year:

(i) *Reinstatement premiums on per risk or event non-proportional contracts*: by an appropriate selection of IE1 modeling threshold(s) and the scope of NE, these features do not apply to AEP but only to IE1 and NE. For IE1, they can then be applied to the IE1 scenarios, in the same granularity as for the application of the PEC. Consequently, the IE1 severities not only correspond to losses but also contain the reinstatement premiums.

(ii) *Sliding scale commissions on proportional contracts*: they apply to the aggregate of AEP, IE1 and NE and can thus precisely only be modeled in the AG component. It may be possible as a simplification subject to materiality to consider them only in AEP, by modeling combined ratios instead of loss ratios.

In the sliding scale case (ii), when calibrating the AEP model from historical combined ratios, in particular the following aspects need to be taken into account:

(1) *As-if adjustments*: if the variable features were different (and in particular more pronounced) in the history compared to the current year, as-if adjustments may be needed to get the historical combined ratios to the level of the current year. For example, if the commission level was higher in the history than for the current accident year, not as-if adjusting would lead to an underestimation of the combined ratios.

(2) *Extrapolation*: assume the variable expense is e.g. a sliding scale commission and for the historical combined ratios, only the region where the commission is sliding was affected. Then the extrapolation (for the current year) for the tail implicit in fitting a lognormal distribution could lead to an underestimation by implicitly assuming that the commission will also slide in the tail.

4.6.1.3 Selection of the modeling approach

For AER and IE2, variable features are by default considered before fitting and not in the AG component. A different approach, which may be required, typically gives rise to an adjustment that requires prior approval by FINMA (Section 2.17).

For AEP, IE1 and NE,

(a) If there are a few contracts whose variable features account for the majority of the impact, then an explicit modeling in the AG component may be preferable for those contracts.

(b) If the impact of the variable features is distributed over a larger number of contracts, modeling prior to the AG component may be possible and preferable.

A specific situation is the following: variable features of assumed reinsurance are modeled prior to the AG component, in which case the output of the relevant components contains premiums and/or expenses in addition to losses, but variable features of ceded retrocession are modeled in the AG component, for which only losses need to be available. Such a situation may give rise to an adjustment that requires prior approval by FINMA (Section 2.17).

4.7 Adjustment for modeling assumed reinsurance in AG for specific risk situations

In the default approach of StandRe, assumed reinsurance structures are not explicitly modeled in the AG component, and annual aggregate conditions of assumed reinsurance are disregarded for IE1. This is based on the assumption that the number of assumed reinsurance contracts is reasonably large and without a few contracts dominating the risk profile.

If a reinsurer would like to use the following adjustment to StandRe, it should discuss this with FINMA in advance, as it may give rise to an adjustment that requires prior approval by FINMA (Section 2.17).

4.7.1.1 Conditions for the adjustment

Generally, the adjustment described below can be used for AEP, IE1, and NE if all the following conditions are satisfied:

(1) The portfolio contains only a few assumed reinsurance contracts (e.g. from intra-group cessions).

(2) Each contract covers a considerable number of "risks".

(3) The annual aggregate conditions of the assumed reinsurance contracts are material.

(4) The required data is available, specifically historical losses prior to the application of assumed reinsurance.

4.7.1.2 Description of the adjustment

In the adjustment, assumed reinsurance is for AEP, IE1 and NE essentially treated like ceded retrocession in the default approach. The approach for AER and IE2 remains unchanged. If there is no ceded retrocession, the adjustment consist in the following:

(1) The model segments for AEP, IE1 and NE are defined as described in Section 4.3.4, but with respect to materially correctly capturing the assumed reinsurance structures instead of the ceded retrocession structures.

(2) The as-if adjustments to historical large event losses to derive the experience scenarios for IE1 are performed as described in Section 6.6.11, i.e. on losses to cedant before assumed reinsurance.

(3) The assumed reinsurance structures are then applied in the AG component of StandRe similarly as the ceded retrocession structure in the default case.

This approach can potentially also be used when there is ceded retrocession, provided that the assumed reinsurance and ceded retrocession conditions can materially correctly be modeled.

Background is provided in the "model background" document (Section 3.4).

5 Attritional events (AE)

5.1 Scope

The scope of the AE component AER is defined in Section 2.12 and the scope of AEP in Section 4.5. For modeling AER and AEP in terms of underwriting years, see Section 2.12. In case AER and AEP are defined on accident years, the simplification is made that for AEP the business written but not earned by $t = 1$ is not considered.

5.2 Output

The dependency between AER and AEP is specified in Section 5.9 by a copula $c_{AER,AEP}$.

5.2.1.1 Output of AER

One lognormal distribution for a random variable S_{AER} of

- discounted
- best estimate at $t = 1$ of aggregate outstanding losses at $t = 0$ to reinsurer
- net of ceded retrocession
- in the SST currency

for

- the business from the prior accident years
- losses from AE info events occurring in the current year.

5.2.1.2 Output of AEP

For each AEP model segment l (Section 4.3), one lognormal distribution for a random variable $S_{AEP,l}$ of

- non-discounted
- ultimate outcomes of aggregate outstanding losses at $t = 0$ to reinsurer
- netgross
- in the SST currency

for

- the business from the current accident year for the model segment
- losses from AE info events occurring in the current year.

In addition:

- Discount factor $d_{AEP,l}$ of the AEP model segment l (deterministic, multiplicative) to convert non-discounted amounts to discounted amounts for AEP.

If there are several AEP model segments, then the dependency between their distributions is given by a copula c_{AEP}, see Section 5.9.2.

5.3 Model overview

5.3.1.1 Overview

For the following description, it is assumed that AER and AEP are defined in terms of accident years (for modeling by underwriting years, see Section 2.12).

The model for AER consists of sub-models by StandRe segment (Section 3), each represented by mean and standard deviation. The sub-models are aggregated using a correlation matrix ("variance-covariance approach" or "moment aggregation", Section 5.4). The aggregated distribution is assumed lognormal and is parameterized from the aggregated mean and standard deviation. No assumption about the distributions of the sub-models is made.

For AEP, if there is only one AEP model segment, the same approach as for AER is used. If there are several AEP model segments, then the distribution for each AEP model segment is assumed lognormal and is parameterized by mean and standard deviation. Mean and standard deviation are derived as for AER but replacing StandRe segments by intersections of StandRe segments with AEP model segments. For the parameterization of AEP, data in scope of IE1 and NE can be excluded (Section 5.5.5). The dependency between the AEP model segments is modeled by a copula (Section 5.9).

Correlations/dependency assumptions used in AER and AEP are described in Section 5.8. Discounting is modeled for each relevant parameter segment by an associated discount factor parameter. These discount factors are combined to discount factors by StandRe or model segment (Sections 5.4.4 and 5.7 describe currencies and discounting).

5.3.1.2 Parameter segments

To focus the parameter estimation on the most material segments, the parameters (mean, standard deviation and discounting factor) are initially estimated on the granularity of "parameter segments" (Sections 5.5.1 and 5.6). The parameters for StandRe segments and AEP model segments are derived from the parameters for parameter segments by "aggregation" and "disaggregation" (Section 5.4).

The standard deviations for parameter segments are derived as follows:

(1) *AER parameter segments* (Section 5.6.1): a benchmark method implemented in a spreadsheet needs to be calculated. The final parameters are derived by expert judgment, explaining the rationale relative to the benchmark method.

(2) *AEP parameter segments* (Section 5.6.2): no benchmark method is provided; instead, specific data is used for comparison. The final parameters are derived by expert judgment, explaining the method and the rationale relative to the benchmark data.

5.3.1.3 Currencies and discounting

A currency is assigned to each AER and AEP parameter segment from the list of currencies in Section 3.6. The currency is intended to approximate the currencies in which claims payments for that parameter segment are made.

Based on this currency, the corresponding FINMA-prescribed yield curve and a claims payment pattern, discount factors are derived for each parameter segment assuming deterministic discounting (Section 5.7). From these, discount factors per StandRe segment or AEP model segment are derived (Section 5.4).

5.3.1.4 Structure of the AE model description

The description of the AE model is structured as follows:

- Section 5.4 describes how to derive the parameters (mean, standard deviation and discount factor) for StandRe segments and for AEP model segments from the parameters by AER and AEP model segment.

- Section 5.5 describes the required input data, the derivation of parameter segments and data preparation.

- Section 5.6 describes how to derive mean and standard deviation for AER and AEP parameter segments.

- Section 5.7 describes the derivation of the deterministic discount factors.

- Section 5.8 describes the dependency assumptions.

5.4 Aggregation to AE outputs

5.4.1 Overview

Given the parameters mean, standard deviation, and discount factor for AER and AEP parameter segments, "aggregation" and "disaggregation" as described in Section 5.4.3 for mean and standard deviation and in Section 5.4.4 for discount factors are used to derive the parameters for StandRe segments for AER and for intersections of StandRe segments with AEP model segments for AEP. The part "Overview" of Section 5.3 outlines the subsequent derivation of the lognormal distributions of outputs. The concrete application is described in Section 5.4.5. Note that "disaggregation" is required if parameter segments contain several StandRe (sub-)segments. In this case, the coefficients of variation (CV) of the StandRe (sub-)segments are not simply equal to the CV of the corresponding parameter segment, but generally larger because of diversification. The disaggregation described in Section 5.4.3 provides a simplified method for deriving the CVs of the StandRe (sub-)segments.

5.4.2 Properties of lognormal distributions

Assume X is a lognormal distributed random variable with parameters μ_{lnorm} and σ_{lnorm}, i.e. $(\log(X) - \mu_{lnorm})/\sigma_{lnorm}$ is standard normal distributed. Writing μ_X, σ_X and $CV_X = \sigma_X/\mu_X$ for mean, standard deviation and coefficient of variation of X, respectively, the parameters of the lognormal distribution are given by $\mu_{lnorm} = \log(\mu_X) - 0.5 \cdot \sigma_{lnorm}^2$ and $\sigma_{lnorm} = \sqrt{\log(1 + CV_X^2)}$.

If $X' = d \cdot X$ with $d > 0$, then X' is lognormally distributed with parameters $\mu'_{lnorm} = \mu_{lnorm} + \log(d)$ and $\sigma'_{lnorm} = \sigma$. This property is used for discounting, where $d > 0$ is a deterministic discount factor.

5.4.3 Moment aggregation/variance-covariance approach and disaggregation

Let $X = X_1 + \cdots + X_n$ be a decomposition into n segments. Denote the corresponding mean and standard deviation by $\mu = E[X]$, $\sigma = \sqrt{Var(X)}$, $\mu_i = E[X_i]$ and $\sigma_i = \sqrt{Var(X_i)}$, and let Γ_{ij} for $i, j = 1, \dots n$ be the corresponding correlation matrix. The coefficients of variation are $CV = \mu/\sigma$ and $CV_i = \mu_i/\sigma_i$.

5.4.3.1 Moment aggregation/variance-covariance approach

From mean and standard deviation per segment, aggregated mean and standard deviation are derived by:

$$\mu = \sum_{i=1}^{n} \mu_i \qquad \sigma = \sqrt{\sum_{i,j} \sigma_i \cdot \sigma_j \cdot \Gamma_{ij}}$$

5.4.3.2 Disaggregation

Assume we have an aggregated coefficient of variation CV and want to get the coefficients of variation of the segments CV_k. Based on the assumption that all segments have the same coefficient of variation $CV_k = CV_1$, the disaggregated standard deviation σ_k of a segment k can be derived by:

$$\sigma_k = \sigma \cdot \frac{\mu_k}{\sqrt{\sum_{i,j} \mu_i \cdot \mu_j \cdot \Gamma_{ij}}} \quad \text{or equivalently} \quad CV_k = CV \cdot \frac{\sum_{i=1}^{n} \mu_i}{\sqrt{\sum_{i,j} \mu_i \cdot \mu_j \cdot \Gamma_{ij}}}$$

It follows that the coefficients of variation CV_k of the segments are larger than the aggregated coefficient of variation CV unless all correlations Γ_{ij} are equal to one, i.e. unless all segments have full positive correlation with each other.

5.4.4 Currency conversion and discounting

Let X_i for $i = 1, \dots, n$ be random variables for sub-segments with mean $\mu_i = E[X_i]$ and amounts in the currency of the sub-segments. Let X be the random variable in some currency (e.g. the SST currency) with mean μ of the aggregation of the sub-segments. Let d_i be the discount factor of the sub-segment i and β_i the exchange rate from the currency of sub-segment i to the currency of X (i.e. the amount in currency of X of one unit of currency of the sub-segment). Then the discount factor d in the currency of X of the aggregation of the sub-segments is assumed to be given by:

$$d = \frac{1}{\mu} \cdot (d_1 \, \beta_1 \, \mu_1 + \cdots + d_n \, \beta_n \, \mu_n)$$

5.4.5 Application to AE

In the following, a "segment" refers, as applicable, to a StandRe segment, an AEP model segment, the intersection between a StandRe segment and an AEP model segment or to a StandRe sub-segment. The parameters mean, standard deviation and discount factor of such a segment are derived from the corresponding parameters for parameter segments as follows:

(1) *Means*: the input data for AER in Section 5.5.3 and for AEP in Section 5.5.4 is specified such that the mean of a segment can be obtained simply by addition.

(2) *Standard deviations*: derive the correlation matrices for moment aggregation and disaggregation as described in Section 5.8 for each parameter segment with non-empty intersection with the segment. Then use moment aggregation and disaggregation (Section 5.4.3) as applicable.

(3) *Discount factors*: derived from the discount factors of the applicable parameter segments using the formula from Section 5.4.4.

5.5 Input data and data preparation

This section is structured as follows:

- Section 5.5.1 describes the derivation of parameter segments and Section 5.5.2 introduces notation.
- The required input data for AER is described in Section 5.5.3 and for AEP in Section 5.5.4.
- Section 5.5.5 describes how data that is in scope of IE1 can be excluded for AEP.

5.5.1 Parameter segments

Parameter segments are used to focus the parameterization on the most material parts of the business and are selected by each reinsurer according to its portfolio. Parameter segments can be defined separately for AER and AEP. To each parameter segment is assigned a currency from the list of currencies from Section 3.6 (see below for assignment principles).

If there are several AEP model segments, then each AEP model segment is required to correspond to an AEP parameter segment or a combination of AEP parameter segments (as the AEP model segments should be modeled precisely for the application of ceded retrocession).

Further criteria for selecting parameter segments are:

(1) The number of parameter segments is reasonably small (typically not more than 20 segments) and should remain reasonably stable over time.

(2) We distinguish material and non-material parameters segments. Materiality and homogeneity for defining material parameter segments is assessed based on various indicators, which may include:

   a. magnitude of the best estimate at $t = 0$ of outstanding losses, total losses and/or premium volume, over all prior accident years for AER and the current accident year for AEP;

   b. type and nature of the business (e.g. types of risks covered, geographical regions, proportional or non-proportional);

   c. volatility of historical estimated ultimate loss ratios;

   d. duration of the business (i.e. time until all losses are fully known);

   e. currency: most of the claims payments in the parameter segment are in one of the StandRe currencies (see Section 3.6) or are reasonably approximated by one of the StandRe currencies.

(3) Any material parameter segment is a StandRe segment or a sub-segment of a StandRe segment and for AER parameter segments, the corresponding development triangles should reasonably allow estimating the one-year risk.

(4) In specific justified cases, a material parameter segment may contain several StandRe segments or sub-segments (e.g. for proportional and non-proportional business). It has to be explained why this is considered necessary.

(5) The complement of the material parameter segments is not material for AER and AEP, respectively.

(6) The non-material business, i.e. the business not belonging to the material parameter segments selected by the company according to the above-mentioned principles, is treated as follows. The reinsurer can choose one or both of the following options:

   a. There is one non-material parameter segment combining all non-material business. (In justified cases, there can be more than one non-material parameter segment, e.g. separated by geographical region.)

b. The non-material business is allocated to material parameter segments. In this case, it needs to be described and explained transparently how the allocation works and how the CV of the parameter segment is derived (e.g. using which data).

5.5.2 Notation

We use the following notation:

- $i = 0, \dots, n$ for the prior accident years, where n denotes the most recent prior accident year
- $i = n + 1 = CY$ denotes the current accident year (from $t = 0$)
- $k = 0, \dots, p$ for development years, where the development is assumed to be complete after $p + 1$ development years (no tail factor). For accident year i, the most recent information available at time $t = 0$ is of the development year $min\{n - i, p\}$
- m for parameter segments (Section 5.5.1)

5.5.3 Input data for AER

The following non-discounted data is required for each parameter segment m of AER. The underlying data including the development triangles are in the currency of the parameter segment and the claims payment development pattern is based on this currency. For the data input to the StandRe template, the data is converted to the SST currency, see Section 3.6. For the reserve risk tool (see Section 5.6.1), the data can be in the currency of the parameter segment or in the SST currency.

The data is required to be net of ceded retrocession. In case development triangles are not available on net basis, the approach described in Section 5.6.1 under "Alternative calibration of AER from gross data" can be used.

a) Development triangles of paid or incurred (reported) losses to reinsurer on accident year basis for the prior accident years. Losses are required to be incremental (i.e. per year) and net of ceded retrocession:

$$S_{i,k}^{m,net}$$

The selection of paid or incurred (reported) loss development triangles should be justified, also with reference to the selection for reserving. For example, paid might be preferable for short tail and proportional business, whereas incurred might be preferable for long tail and non-proportional business.

b) Vector of initial a priori best estimates of total losses on accident year basis for the prior accident years, net of ceded retrocession.:

$$U_i^{m,net}$$

c) Best estimates at $t = 0$ of outstanding losses to reinsurer net of ceded retrocession over all prior accident years:

$$BEL_{0\to n}^{m,net}$$

This information is additionally required for every StandRe (sub-)segment contained in the non-material AER parameter segment(s).

d) Losses paid until $t = 0$ ("cumulative") by reinsurer net of ceded retrocession per prior accident year i:

$$C_{i,n-i}^{m,paid,net}$$

e) Incremental claims payment pattern (net of ceded retrocession) for the outstanding losses at the reference date of the SST calculation:

$$\pi_{AER,k}^{m}$$

with $\sum_{k\geq 0} \pi_{AER,k}^{m} = 1$ (k-th entry = expected claims payment in the year k after the current year as percentage of the total amount). The claims payment pattern is derived by the reinsurer and explained. Experience data and/or benchmarks may be used if appropriate.

5.5.4 Input data for AEP

The following non-discounted data is required for each parameter segment m of AEP. Some of the data may be adjusted for info events covered by IE1 and NE as described in Section 5.5.5; see this section also for explanation on "netgross" below.

The underlying data is in the currency of the parameter segment and the claims payment development pattern is based on this currency. For the data input to the StandRe template, the data is converted to the SST currency, see Section 3.6.

a) (Best estimate) premium netgross of ceded retrocession for each prior accident year i:

$$P_{i}^{m,netgross}$$

b) Planned (best estimate) premium netgross of ceded retrocession for the current accident year:

$$BEP_{n+1}^{m,netgross}$$

This information is additionally required for every StandRe (sub-)segment contained in the non-material AEP parameter segment(s) and for every non-empty intersection of a StandRe segment and an AEP model segment.

c) Best estimate loss ratio netgross (potentially with losses excluded according to Section 5.5.5) for each prior accident year i:

$BLR_i^{m,netgross}$

Note that the loss ratio is required to be a best estimate and not just the reported/incurred to date. I.e. it potentially includes IBNR.

d) Best estimate (planned) loss ratio netgross (potentially with losses excluded according to Section 5.5.5) for the current accident year:

$BLR_{n+1}^{m,netgross}$

This information is additionally required for every StandRe (sub-)segment contained in the non-material AEP parameter segment(s) and for every non-empty intersection of a StandRe segment and an AEP model segment.

f) Incremental claims payment pattern (netgross of ceded retrocession) for the current accident year:

$\pi_{AEP,k}^{m}$

with $\sum_{k\geq 0}\pi_{AEP,k}^{m} = 1$ (*k*-th entry = expected claims payment in the year k after the current year as percentage of the total amount). The claims payment pattern is derived by the reinsurer and explained. Experience data and/or benchmarks may be used if appropriate.

5.5.5 Adjustments to AEP input data for IE1 and NE

AEP should exclude losses from info events that are covered by IE1 or NE (see Section 4.5). Hence, for the data used for AEP (Section 5.5.4), such losses can be excluded if the corresponding information is available. The reinsurer is asked to explain and document the derivation.

(1) Historical info event losses that correspond to events covered under NE can be excluded.

(2) All historical info event losses that give rise to IE1 experience scenarios (as described in Section 6) can be excluded from the data for AEP. To be excluded are the historical and not the as-if adjusted losses.[6]

(3) Losses covered by IE1 or NE may be excluded from the best estimate planned netgross loss ratios for the current accident year. The method and assumptions made need to be explained.

Note that the data specified for AEP is netgross. However, if the IE1 output is required to be gross, then after excluding the above data in scope of IE1 according to the definition of the IE1 modeling thresholds, there is no longer any difference between gross and netgross (see Section 4.3.3). Hence it may be easier to start with the gross data for AEP and exclude the gross losses in scope of IE1.

[6] The process is: first historical large info event losses are as-if adjusted and compared with the IE1 modeling threshold(s) to determine which historical losses give rise to IE1 experience scenarios. These historical losses can then be excluded from AEP data.

5.6 Parameterization

5.6.1 Mean and standard deviation for AER parameter segments

5.6.1.1 Method

Using notations and data from Sections 5.5.2 and 5.5.3 , mean μ_{AER}^{m} and standard deviation σ_{AER}^{m} of an AER parameter segment m are estimated as follows:

$$\mu_{AER}^{m} = BEL_{0\rightarrow n}^{m,net}$$

$$\sigma_{AER}^{m} = BEL_{0\rightarrow n}^{m,net} \cdot \widehat{CV}_{AER}^{m\,,net}$$

with the coefficient of variation estimated by:

$$\widehat{CV}_{AER}^{m\,,net} = \frac{\tilde{\sigma}}{\widetilde{BTL} \; - C^{m\,,paid,net}}$$

where

- $C^{m\,,paid,net} = \sum_{i=0}^{n} C_{i,n-i}^{m\,,paid,net}$ is the sum of all payments made until $t = 0$ for all prior accident years relating to losses from attritional events for the parameter segment
- $\widetilde{BTL}$ is a "best estimate" at $t = 0$ of total losses from previous accident years for the parameter segment under consideration
- $\tilde{\sigma}$ is an estimator of the standard deviation of the one-year change of this best estimate over the current year.

The pair $(\widetilde{BTL}, \tilde{\sigma})$ is selected by the reinsurer based on expert judgment (e.g. using a model).

In addition, FINMA prescribes computing a benchmark method called "combined CL-BF projection of losses", which provides a pair $(BTL^{benchmark}\,, \sigma^{benchmark})$ and thus the benchmark $\widehat{CV}_{AER}^{m\,,net,benchmark}$. The selection of the coefficient of variation $\widehat{CV}_{AER}^{m\,,net}$ has to be explained in relation to the results of the benchmark method.

The benchmark method is implemented in a spreadsheet tool, which together with a user manual containing an explanation of the method and examples can be found in the "Reserve risk tool" folder of the zip file for StandRe on the FINMA website.

The benchmark method uses the loss development triangle $\{S_{i,k}^{m\,net}\}$ and the vector $\{U_{i}^{m,net}\}$ of a priori best estimates. It is calibrated by the reinsurer through the selection of a number of development years k_*. This leads to:

a. Bornhuetter-Ferguson reserving method for the first $0, \ldots, k_*$ development years;

b. Chain Ladder reserving method for the following development years $k_* + 1, \dots, p$.

Usually, the benchmark method does not provide the same "best estimates" as those used for the SST balance sheet. The two non-discounted "best estimates" should be compared.

5.6.1.2 Alternative calibration of AER from gross data

If a reinsurer does not have development triangles net but only gross of ceded retrocession, the following approach should be used:

(1) means are derived from net data;

(2) standard deviations are derived from gross data as specified above for net data and assumed to be the same as net.

5.6.2 Mean and standard deviation for AEP parameter segments

Using data and notations from Section 5.5.2 and 5.5.4, mean μ_{AEP}^{m} and standard deviation σ_{AEP}^{m} of an AEP parameter segment m are derived (as premium times loss ratio) as follows:

- Estimated mean:

$$\mu_{AEP}^{m} = BEP_{n+1}^{m,netgross} \cdot BLR_{n+1}^{m,netgross}$$

- Estimated standard deviation:

$$\sigma_{AEP}^{m} = BEP_{n+1}^{m,netgross} \cdot \hat{\sigma}\left(LR_{n+1}^{m,netgross}\right)$$

where $BLR_{n+1}^{m,netgross}$ and $\hat{\sigma}\left(LR_{n+1}^{m,netgross}\right)$ are estimates of mean and standard deviation of the current accident year loss ratio.

$BLR_{n+1}^{m,netgross}$ and $\hat{\sigma}\left(LR_{n+1}^{m,netgross}\right)$ are selected by the reinsurer based on expert judgment. In addition, for information, the following simple estimators of mean and standard deviation based on historical loss ratios are computed:

- $BLR_{n+1}^{m,netgross,hist} = \sum_{i=0}^{n} w_i \cdot BLR_i^{m,netgross}$,

  where $w_i = \frac{P_i^{m,netgross}}{\sum_{j=0}^{n} P_j^{m,netgross}}$

- $\hat{\sigma}^{hist}\left(LR_{n+1}^{m,netgross}\right) = BLR_{n+1}^{m,netgross} \cdot \widehat{CV}_{prem}^{m,netgross,hist}$, where

$$\widehat{CV}_{prem}^{m,netgross,hist} = \frac{1}{BLR_{n+1}^{m,netgross,hist}} \cdot \sqrt{\frac{1}{1-\sum_{i=0}^{n} w_i^2} \cdot \sum_{i=0}^{n} w_i \cdot \left(BLR_i^{m,netgross} - BLR_{n+1}^{m,netgross,hist}\right)^2}$$

5.6.3 Use of other data sources

In some cases, the input data for AER and/or AEP as described in Section 5.5 for the company might be replaced or complemented by data from another source or company. For example, the company under consideration might have existed only for a short time and with low volumes of business, whereas longer history for larger business volumes might be available for the group to which it belongs. Parameters for the company might thus be estimated based on the group data. In such a situation, it needs to be taken into account that CVs decrease with increasing volume (and vice versa) due to diversification. Hence, for example, the CVs estimated from group data might be too low for the company under consideration.

One possibility to account for this is by disaggregation as described in Section 5.4.3. As an illustration for AER, assume that the CV is estimated from an "external" portfolio with best estimate reserves of CHF 100m and the portfolio of the company for which we want to estimate the CV has best estimate reserves of CHF 10m. Estimating the company portfolio CV from the "external" portfolio CV is only reasonable if the two portfolios are "similar". This can for example be expressed by assuming that the "external" portfolio decomposes into $n = 10$ "identical" sub-portfolios, one of which is the company portfolio. "Identical" can be expressed by assuming that the sub-portfolios have the same mean $\mu_k = \mu_0$, CV CV_0 and the same correlation $\Gamma_{kj} = \rho$ between each other. Then by the formula for the CV from Section 5.4.3, the CV CV_0 corresponding to a sub-portfolio and thus to the company portfolio is given by:

$$CV_0 = CV \cdot \frac{\sum_{i=1}^{n} \mu_i}{\sqrt{\sum_{i,j} \mu_i \cdot \mu_j \cdot \Gamma_{ij}}} = CV \cdot \frac{n \cdot \mu_0}{\sqrt{n \cdot {\mu_0}^2 + (n^2 - n) \cdot {\mu_0}^2 \cdot \rho}}$$
$$= CV \cdot \sqrt{\frac{n}{1 + (n-1) \cdot \rho}}$$

If other data sources are used for estimating the parameters for AER and/or AEP, the approach used needs to be clearly described and justified, in particular with respect to the comments above.

5.7 Discounting

Discounting can be expressed by multiplication of non-discounted amounts with a discount factor, which is assumed to be deterministic. Discount factors are derived from those of the parameter segments using the formula given in Section 5.4.4.

For a parameter segment m for AER (and analogously for AEP), the discount factor d_{AER}^{m} is derived using a deterministic claims payment pattern and the FINMA-prescribed yield curve for the relevant currency, by the formula:

$$d_{AER}^{m} = \sum_{k \geq 0} \pi_{AER,k}^{m} \cdot v_{k}^{currency\ of\ m}$$

where

- $\pi_{AER,k}^{m} =$ the k–th entry of the AER payment pattern defined in Section 5.5.3 (and analogously in Section 5.5.4 for AEP);
- $v_{k}^{currency\ of\ m} = 1/\left(1 + r_{0,k+1}\right)^{k+1}$ for the prescribed yield curve $\left(r_{0,1}, r_{0,2}, \dots\right)$ in the currency of the parameter segment m.

5.8 Correlations

5.8.1 Derivation of correlations

Correlations are needed for aggregation and disaggregation at various levels for AER and AEP (Section 5.4). The correlations between StandRe segments are prescribed and described in Sections 5.8.2 to 5.8.5. The principle for the other correlations is:

- Correlations other than between StandRe segments are selected by expert judgment so that they are realistically consistent with the prescribed correlations between StandRe segments.

"Consistency" does not necessarily mean "the same" or simply "more conservative", and consistency does not need to be shown for all types of correlations. As a simple illustrative example for consistency, consider two StandRe segments A and B with assumed prescribed correlation of 0.5. Assume that the business of the company is contained in the two parameter segments P1 and P2, where P1 is a strict subset of A and P2 is identical to B. Denote by P3 the complement of P1 in A and assume that the correlation between P1 and P3 is non-negative. We want to address the question: "Is a correlation of 0.1 between parameter segments P1 and P2 (=B) consistent with the prescribed correlation between StandRe segments A and B?" For this, one can show (using the formula below) that the correlation between A and B of 0.5 can only result if the correlation between P3 and B=P2 is larger than some minimal amount larger than 0.1 (which depends on the ratio of the standard deviations of P1 and P3).[7] So it needs to be assessed whether this is realistic for the concrete business in these segments. If not, the correlations are not consistent.

For showing consistency, the following formula can be useful for the correlation between two segments, each of which is decomposed into sub-segments, denoted $\sum_{i=1}^{n} X_i$ and $\sum_{j=1}^{m} Y_j$:

[7] We have: $\rho\left(X_{P_1} + X_{P_3}, Y_B\right) \leq \frac{\sigma(X_{P_1}) \cdot \rho(X_{P_1}, Y_B) + \sigma(X_{P_3}) \cdot \rho(X_{P_3}, Y_B)}{\sqrt{\sigma(X_{P_1})^2 + \sigma(X_{P_3})^2}}$, which is bounded by $\sqrt{2} \cdot \rho\left(X_{P_1}, Y_B\right) \approx 0.14 < 0.5$ if $\rho\left(X_{P_3}, Y_B\right) \leq \rho\left(X_{P_1}, Y_B\right)$.

$$\rho\left(\sum_{i=1}^{n} X_i, \sum_{j=1}^{m} Y_j\right) = \frac{\sum_{i=1}^{n}\sum_{j=1}^{m}\sigma(X_i)\cdot\rho(X_i,Y_j)\cdot\sigma(Y_j)}{\sqrt{\sum_{i=1}^{n}\sum_{k=1}^{n}\sigma(X_i)\cdot\rho(X_i,X_k)\cdot\sigma(X_k)}\cdot\sqrt{\sum_{j=1}^{m}\sum_{l=1}^{m}\sigma(Y_j)\cdot\rho(Y_j,Y_l)\cdot\sigma(Y_l)}}$$

5.8.2 Structure of the StandRe segment correlation matrices

StandRe segments (Section 3) correspond to combinations of LOB, geographical region and type of contract. The correlation matrices Γ^{AER} for AER and Γ^{AEP} for AEP define the correlations between StandRe segments. They are derived as the Kronecker product of three correlation matrices between LOBs, regions and types of contract, i.e.

$$corr\big((LOB_1, region_1, type\ of\ contract_1), (LOB_2, region_2, type\ of\ contract_2)\big)$$
$$= corr(LOB_1, LOB_2)\cdot corr(region_1, region_2) \cdot\cdot\ corr(type\ of\ contract_1, type\ of\ contract_2)$$

The corresponding prescribed correlation matrices are provided in Section 5.8.3 for LOBs, Section 5.8.4 for geographical regions and Section 5.8.5 for types of contracts. Each of the correlation matrices for LOB, regions and types of contract is positive definite, and the Kronecker product of positive definite matrices is again positive definite.

Background on the correlation matrices is provided in the "model background" document (Section 2.1).

5.8.3 LOB correlations

AER correlation matrix prescribed between LOB:

LOB correlations for AER	Accident and Health	Motor	MAT	Property	Finan-cial Losses	General Liability	Other Non-Life
Accident and Health	1.00						
Motor	0.50	1.00					
MAT	0.25	0.25	1.00				
Property	0.15	0.15	0.25	1.00			
Financial Losses	0.25	0.25	0.15	0.15	1.00		
General Liability	0.25	0.25	0.15	0.15	0.15	1.00	
Other Non-Life	0.25	0.25	0.25	0.25	0.25	0.25	1.00

AEP correlation matrix prescribed between LOB:

LOB correlations for AEP	Accident and Health	Motor	MAT	Property	Finan-cial Losses	General Liability	Other Non-Life
Accident and Health	1.00						
Motor	0.25	1.00					

MAT	0.25	0.15	1.00				
Property	0.15	0.25	0.15	1.00			
Financial Losses	0.25	0.15	0.15	0.15	1.00		
General Liability	0.15	0.25	0.25	0.25	0.15	1.00	
Other Non-Life	0.25	0.25	0.25	0.25	0.25	0.25	1.00

5.8.4 Region correlations

AER correlation matrix prescribed between regions:

Region correlations for AER	Europe	North America	rest of world	not regional
Europe	1.00			
North America	0.50	1.00		
rest of world	0.50	0.50	1.00	
not regional	0.75	0.75	0.75	1.00

AEP correlation matrix prescribed between regions:

Region correlations for AEP	Europe	North America	rest of world	not regional
Europe	1.00			
North America	0.15	1.00		
rest of world	0.15	0.15	1.00	
not regional	0.50	0.50	0.50	1.00

5.8.5 Type of contract correlations

StandRe prescribes two types of contracts:

- **Prop**: proportional business;
- **Non-Prop**: non-proportional business incl. facultative contracts.

The prescribed correlation between Prop and Non-Prop is

- 0.75 for AER;
- 0.65 for AEP.

5.9 Dependency between AE outputs

If there is more than one AEP model segment, then the dependency structure is hierarchical, so that the AEP model segments are aggregated first using the dependency specified in Section 5.9.2, followed by aggregation of the aggregated AEP output with the AER output using the dependency from Section 5.9.1.

Writing $(S_{AEP,l})_l$ for the vector of AEP model segments, the joint dependency between S_{AER} and $(S_{AEP,l})_l$ is not uniquely defined (see e.g. the reference provided in Section 2.16). To make it unique, it is assumed that S_{AER} and $(S_{AEP,l})_l$ are independent conditional on $\sum_l S_{AEP,l}$ ("conditional independence condition").

The actual simulation using these dependencies is performed as part of the AG component (Section 7). As joint samples of S_{AER} and $(S_{AEP,l})_l$ are needed for the application of ceded retrocession, a reordering algorithm may need to be used (see e.g. the reference provided in Section 2.16).

5.9.1 Dependency between AER and AEP

The dependency between the aggregated output of AER and AEP is modeled by a 2-dimensional t-copula $c_{AER,AEP}$ with the following parameters:

- degree of freedom parameter $\nu = 4$
- correlation parameter $\rho = 0.23$

Hence, it is assumed as a simplification that the dependencies do not take account of the underlying composition of AER and AEP in terms of (StandRe) segments.

5.9.2 Dependency between AEP model segments

The dependency between AEP model segments is modeled by a t-copula c_{AEP} with the parameters:

- degrees of freedom parameter $\nu = 4$
- correlation matrix derived as described in Section 5.8.1

The two main reasons for selecting a t-copula instead of a Gauss copula are that in view of the definition of the scope of IE1 (Section 4.5), AEP also contains quite large losses, and that moment aggregation tends to be more conservative than Gauss copula aggregation with the same correlations.

6 Individual events (IE)

6.1 Scope

The scope of the component IE1 is defined in Section 4.5 and the scope of IE2 in Section 4.2. IE considers business from the current year as well as from prior years and includes in particular events from natural catastrophe perils that are not covered by the components AE and NE (Section 2.11).

6.2 Output

The output of IE1 below is assumed to be independent of the output for IE2.

6.2.1 Output of IE2

One frequency-severity model (N_{IE2}, X_{IE2}) of

- discounted
- best estimate at $t = 1$ of outstanding losses (at $t = 0$) to reinsurer by info event
- net of ceded retrocession
- in the SST currency

for

- all business written by $t = 1$
- losses from IE2 info events occurring in the current year
- where the severity exceeds the IE2 modeling threshold

Capping the Gen Pareto severity for IE2 at a maximal amount is possible only in exceptional justified cases if it is shown that the maximum possible net loss to reinsurer over all accident years is limited (also considering that AER losses may be subject to ceded retrocession).

6.2.2 Output of IE1

We distinguish:

- Only one IE1 model segment (Section 4.3): "normal" frequency-severity model (N_{IE1}, X_{IE1})
- Several IE1 model segments: frequency N_{IE1} and dependent severities $B_l \cdot X_{IE1,l}$ per IE1 model segment l (further explained below).

The severity X_{IE1} or $B_l \cdot X_{IE1,l}$ for each model segment $l = 1, \dots, m$ is of

- non-discounted
- estimated ultimate outcomes of per IE1 info event loss to reinsurer (outstanding loss payments at $t = 0$)
- gross or netgross of ceded retrocession (as determined in Section 4.3.3)
- in the SST currency

for

- the business from the current accident year for the IE1 model segment l
- losses from IE1 info events occurring in the current year.

For several IE1 model segments, the IE1 model has the following mathematical form:

(1) Poisson distributed frequency random variable $N = N_{IE1}$ with mean λ

(2) Dependent severities $(B_{i,1} \cdot X_{i,1}, \dots, B_{i,m} \cdot X_{i,m})$ by IE1 model segment $l = 1, \dots, m$ for $i = 1, \dots, N$, where

   (a) Dependent Bernoulli random variables $(B_{i,1}, \dots, B_{i,m}) \sim (B_1, \dots, B_m) \in \{0,1\}^m$ for $i = 1, \dots, N$ independent of N with probabilities $P[B_1 = b_1, \dots, B_m = b_m]$ and $P[B_1 = 0, \dots, B_m = 0] = 0$, i.e. each event loss produces a loss to at least one IE1 model segment exceeding the corresponding IE1 modeling threshold $t_{IE1,l}$.

   (b) Gen Pareto severities $X_{i,l}$ for $i = 1, \dots, N$ and $l = 1, \dots, m$ with the IE1 model segment modeling threshold $t_{IE1,l}$, where $X_{i,l} \sim X_l$ are i.i.d in i and independent of N and $B_{i,l}$. Their dependency is modeled by a copula as specified in Section 6.12.

If the IE1 model segment output is netgross, then the severity for an IE1 model segment can be capped at an amount only if it is shown that, for that IE1 model segment, the amount cannot be exceeded by netgross ultimate outcomes from any IE1 info event. (An IE1 info event can correspond to several contract events, see Section 2.6 and also Section 7 for the breakdown of event losses into contract event losses by "top-down disaggregation").

6.2.3 Additional reporting output

For reporting purposes, the additional output (input, assumptions, calculations, and results) is specified in the StandRe template and in the document "StandRe_calculation_documentation_template".

6.3 Currencies and discounting

In the sequel, unless explicitly mentioned,

- amounts for IE1 are non-discounted;
- amounts for IE2 are discounted.

Scenarios are calculated to have their impact in the SST currency. For the application of the assumed reinsurance and ceded retrocession structures, it needs to be considered that these are contractually not necessarily denominated in the SST currency. For currency conversion, the FINMA prescribed exchange rates as of the SST reference date should be used where available.

6.4 Model overview

6.4.1.1 IE1 and IE2 model

The models for IE1 and IE2 are intended to be frequency-severity models of the losses to reinsurer by info event, with Poisson frequency and Gen Pareto severity. The IE2 model consists of one frequency-severity model, as does the IE1 model in case there is only one IE1 model segment. If there are several IE1 model segments, then the IE1 model consists of a frequency distribution and a severity vector containing the joint severities by IE1 model segment.

6.4.1.2 Calibration from scenario results

The models for IE1 and IE2 are calibrated from the scenarios assigned to IE1 and IE2, respectively. For each scenario, an (expected occurrence) frequency and a severity or a vector of severities by IE1 model segment are calculated.

The Poisson frequencies are calibrated by the expected frequencies:

(1) For IE1, the expected frequencies are in the default case estimated only from the experience scenarios, including a charge for estimation uncertainty due to the limited number of historical event losses available.

(2) For IE2, the expected frequency is estimated from all IE2 scenarios whose severity exceeds the IE2 modeling threshold.

The Gen Pareto severities for IE1 and IE2 are calibrated from the assigned scenarios using expert judgment. A visual comparison of the exceedance frequency curves of the collection of assigned scenarios and the frequency-severity models is used.

6.4.1.3 Structure of the following description

The description is structured as follows:

- Scenarios are described in Section 6.5, with details on the calculation of the different types of scenarios considered in Sections 6.6 to 6.10.

- In Section 6.11, it is explained how the IE1 model is derived from the results of the assigned scenarios in the case in which there is only one IE1 model segment and in Section 6.12 for several IE1 model segments.
- The derivation of the IE2 model from the results of the assigned scenarios is described in Section 6.13.
- Mathematical background on some of the concepts used is provided in Section 6.14.

6.5 Scenarios

6.5.1 Overview and scenario representation

The following illustration shows the types of scenarios for IE.

<table>
<tr><td>Experience scenarios</td><td colspan="3">Scenarios derived from as-if adjusted large historical event losses of the reinsurer by applying as-if adjustments to make them representative for the situation of the current year. See Section 6.6.</td></tr>
<tr><td rowspan="4">Non-experience scenarios</td><td>Portfolio structure scenarios</td><td colspan="2">Scenarios defined in terms of the assumed reinsurance portfolio of the reinsurer, e.g. by calculating the frequency of a full limit loss to a "tower" of XoL layers. See Section 6.7.</td></tr>
<tr><td rowspan="2">Scenarios defined by events</td><td>Damage event scenarios</td><td>Scenarios defined by sudden catastrophic occurrences that typically only affect the current accident year. See Section 6.9.</td></tr>
<tr><td>Other event scenarios</td><td>Scenarios defined by explicit info events other than damage events. Typically affect prior accident years and potentially the current accident year. See Section 6.9.</td></tr>
<tr><td>Own scenarios</td><td colspan="2">Scenarios to be defined and calculated by the reinsurer to cover aspects of its risk situation that are not covered by the other scenarios. See Section 6.10.</td></tr>
</table>

Each scenario is assigned to either IE1 or IE2, where the assignment is prescribed. A scenario s is intended to correspond to a set of info events E_s it is intended to cover.

The scenario results consist of:

(1) $x_s =$ **total scenario severity**: the total info event loss to reinsurer resulting from the occurrence of the scenario s;

(2) f_s = **scenario frequency**: the expected occurrence frequency of the scenario s in the one-year time period under consideration.

If there are several IE1 model segments, then the scenario results for scenarios assigned to IE1 additionally consist of

(3) $(x_{s,1}, \dots, x_{s,m})$ = vector of scenario severities $x_{s,l}$ for each IE1 model segment $l = 1, \dots, m$ (summing up to the total scenario severity x_s).

The scenario severities are:

- for scenarios assigned to IE1: non-discounted ultimate outcomes, as applicable gross or netgross of ceded retrocession (i.e. gross if the IE1 output is required to be gross according to Section 4.3.3 and netgross if it is required to be netgross)
- for scenarios assigned to IE2: discounted best estimates at $t = 1$, net of ceded retrocession.

In addition, it may be required to calculate (see Section 6.5.2):

- x'_s = for IE1 scenarios, the scenario severity netgross if the IE1 output is required to be gross and gross if it is netgross, and for IE2 scenarios, the gross scenario severity.

The intention is that the collection of scenarios to be calculated is specified so that as much information as possible can be used and combined in the modeling. Additionally, the scenario results are intended to provide useful information about the risk profile of a reinsurer.

Section 3.1 in the "model background" document provides a possible classification of non-experience scenarios.

Based on an assessment of a reinsurer's specific risk situation, FINMA can prescribe specific scenarios to be calculated by that reinsurer. Such scenarios are not further discussed in this document.

6.5.2 Which scenarios must be calculated?

The "classical" SST scenarios that only apply to non-life insurance risk are assumed to be covered by the IE scenarios and thus do not need to be considered. Other than this, the prescriptions on whether scenarios need to be calculated/need not to be calculated are:

(1) Scenarios that are covered by NE do not need to be calculated.

(2) Non-experience scenarios assigned to IE1 for which the reinsurer shows for the SST calculation in question that they are not in scope of IE1 (as defined in Section 4.5) do not need to be calculated.

(3) Scenarios assigned to IE2 for which the reinsurer shows for the SST calculation in question that they cannot exceed the IE2 modeling threshold (as defined in Section 6.13.2) do not need to be calculated.

(4) For each event-based scenario (damage event or other event), the field "Computation mandatory?" in the description of the scenario (Section 6.9) specifies whether the scenario calculation is mandatory, mandatory given some conditions, or not mandatory. In any case, (1)-(3) apply.

(5) The number of calculated scenarios that are event-based scenarios mandatory given some conditions, not mandatory event-based scenarios or own scenarios needs to be at least 5.

(6) For all scenarios assigned to IE1, both gross and netgross loss severities, i.e. both x_s and x'_s, need to be calculated for information purposes.

6.6 Experience scenarios

6.6.1 Assignment of the scenarios to IE1 or IE2

In the default case, experience scenarios are assigned to IE1.

6.6.2 Overview

In the following, experience scenarios are calculated from as-if adjusted historical large event losses to reinsurer. The purpose of the as-if adjustments is to make the adjusted losses representative for the current year, both in terms of frequency and severity. In this process, also the IE1 modeling threshold(s) are derived (Section 6.6.8).

In particular, as-if adjustments are applied directly to losses to reinsurer, i.e. after application of assumed reinsurance structures. Background on this is provided in the "model background" document (Section 3.4). The alternative approach of first as-if adjusting "losses to cedant" is allowed under specific conditions and described in Section 6.6.11.

The approach consists of the following steps:

(1) **Required data** (Sections 6.6.3 and 6.6.4): for each historical year in an observation period, all historical large info event losses to reinsurer (gross of ceded retrocession) for that year, with a breakdown of the losses into a sufficiently fine granularity.

(2) **Severity as-if adjustments** (Sections 6.6.5 and 6.6.6, as well as Section 6.6.7): historical large info event losses are as-if adjusted for severity by multiplication with suitable as-if adjustment factors to make them representative for the current year

(3) **Application of PEC** (Section 6.6.7): PEC of ceded retrocession are applied to get netgross losses to reinsurer.

(4) **IE1 modeling threshold and construction of experience scenarios** (Section 6.6.8): the IE1 modeling threshold(s) are derived. Based on this, the experience scenarios are defined.

(5) **Frequency as-if adjustments and consideration of IBNyR** (Sections 6.6.5 and 6.6.9): experience scenarios are as-if adjusted for the frequency and IBNyR is considered. IBNyR refers to losses that may have occurred but have not yet been reported.

(6) **Adjustments to the frequencies** (Section 6.7): after the derivation of the non-experience scenarios, the frequencies of the experience scenarios are adjusted to take into account estimation uncertainty and remove overlaps with the IE1 non-experience scenarios.

The above steps are described in detail in the following.

Note that the reporting thresholds may need to be reduced if it turns out that the number of IE1 experience scenarios resulting from the process is not sufficient. To see why, assume that there is only one IE1 model segment. Then the IE1 experience scenarios are those as-if adjusted historical info event losses that exceed the IE1 modeling threshold. The as-if adjusted reporting thresholds provide lower bounds on the latter (because otherwise not all historical losses that as-if adjusted exceed the IE1 modeling thresholds may be known). So, if there are not enough as-if adjusted losses exceeding the as-if adjusted reporting thresholds, the reporting thresholds may need to be reduced and more historical large info event losses considered.

6.6.3 Selection of the observation period

The required input data consists of historical large info event losses in an observation period of several years $k = 1, \dots, n$, where:

- $n =$ most recent prior year
- $CY = n + 1$: the current year

The observation period is required to be a time interval of years and should be selected to be as long as reasonably possible. The observation period is assumed the same for all segments (e.g. LOBs). This is even though not all segments may have been written for the entire period, or the corresponding historical information, also after as-if adjustments and IBNyR, may no longer be representative for the current accident year, or the recent years may not yet be sufficiently developed (also considering that we account for IBNyR below). To account for such aspects, the corresponding exposure measure (Section 6.6.5) can be reduced or set to zero.

If a year in the observation period for which there is historical experience is excluded by setting the exposure measure to zero, this must be justified and the corresponding loss experience and actual exposure measure be reported.

6.6.4 Required input data

The data required for the experience scenarios consists for each year $k = 1, \dots, n$ in the observation period of all historical IE1 info event losses to reinsurer $x_1^k, \dots, x_{m_k}^k$ in the following form:

(1) Combined by IE1 info event (e.g. combining losses to different LOBs from the same IE1 info event)

(2) Estimated (or known) ultimate outcomes, i.e. including IBNER

(3) Gross of ceded retrocession

(4) Occurred in accident year (occurrence year) k according to the available coverage conditions of the underlying primary insurance policies (e.g. losses occurring or claims made)[8]

(5) All IE1 info event losses for each year k such that:

[8] We assume that no IE1 info event would lead to losses on policies with different occurrence years.

a. *One IE1 model segment*: total severity larger than or equal to a selected (gross) reporting threshold u_k for occurrence year k.

b. *Several IE1 model segments*: the severity to at least one IE1 model segment l is larger than or equal to a selected reporting threshold $u_{k,l}$ for occurrence year k and IE1 model segment l.

(6) With the reporting year, i.e. the year in which the historical event loss was first reported to satisfy the conditions from (5) above.

(7) Excluding historical large event losses that correspond to info events covered under NE.

(8) Decomposition of each IE1 info event loss x_j^k into severity as-if adjustment segments seg:

$$x_j^k = \sum_{seg} x_{j,seg}^k$$

Severity as-if adjustment segments need to be chosen according to the requirements from Section 6.6.6 and such that they are fine enough to apply the applicable PEC of ceded retrocession and at least as fine as the IE1 model segments.[9]

(9) For each frequency as-if adjustment segment, a **frequency exposure measure** is selected according to the specification in Section 6.6.5 and the corresponding exposures e_k^{seg} for each year $k = 1, \dots, n$ and e_{CY}^{seg} for the current year $n + 1$ are required. For years in the observation period in which no claims for a segment could occur (e.g. because there was no in force contract from the segment in the year), the exposure measure should be set to zero. For the most recent prior year, the exposure needs to be reduced from the full year if only part of the year is known.

6.6.4.1 IE1 modeling thresholds and reporting thresholds

To ensure that the frequencies of the IE1 model are not underestimated, the as-if adjusted reporting threshold(s) (by IE1 model segment) have to be a lower bound on the IE1 modeling threshold(s) (by IE1 model segment), see Section 6.6.8. As the IE1 modeling threshold(s) need to be selected such that there are enough experience scenarios (Section 4.5), the reporting thresholds may need to be lowered if it turns out that the initial selection does not produce enough experience scenarios (Section 6.6.8).

6.6.4.2 Use of incomplete data

In principle, for a given historical IE1 info event, the total loss to reinsurer needs to be available and used (e.g. for all LOBs affected), including the corresponding loss to every IE1 model segment.

[9] In principle, IE1 model segments can be finer than the segments needed to apply the PEC of outward retrocession, namely in the case that the AC2 require such a finer granularity.

If for an info event only the loss to specific IE1 model segments is available, then this data can be used as described in Section 6.12.2. If only the total historical info event loss is available, but not the breakdown by IE1 model segment, then this data can be used as described in Section 6.12.4.

6.6.4.3 Use of other data sources

In justified cases it is possible to complement the own historical large loss information with alternative sources of historical losses such as previous companies, group data, industry data or cedant data. The alternative data needs to be relevant, own data needs to have priority, and the need for the alternative data and its use must be explained and justified.

6.6.4.4 Unusually large historical IE1 info event losses

It can be that the loss history in the observation period contains an "unusually large" historical large IE1 info event loss. That is, the loss may be considered unusually large relative to the given observation period, i.e. a loss of such a magnitude would only be expected in a longer time period. If such a loss gives rise to an experience scenario, it is assigned an expected occurrence frequency as set out in Section 6.6.9 and in Section 6.7 and an as-if adjusted severity. The approach for such a loss is:

(1) For a "usually large" historical IE1 info event loss, the frequency and the severity of the resulting experience scenario should be calculated in the same way as for the other historical large IE1 info event losses. In particular, neither the frequency not the severity should be reduced.

(2) To take account of any perceived "unusualness", the fitted IE1 frequency-severity model should be selected such that the fitted exceedance frequency curve of the IE1 frequency-severity model reflects the realistic frequency and/ or severity of the experience scenario.

(3) In the StandRe calculation documentation, the resulting exceedance frequencies should be transparently explained and carefully justified.

The reason that the assigned frequency should not be changed (in particular reduced) is that the expected frequency for the IE1 model is the sum of the frequencies of the experience scenarios (Section 6.7). So e.g. reducing the frequency of an "unusually large" loss would reduce the IE1 expected frequency at a typically considerably smaller threshold. This would imply a lower IE1 expected frequency if an "unusually large" loss occurs instead of a "normally large" loss, which would not be appropriate.

The scenario severity should not be changed because of transparency; because a loss of such a severity has realized, it is clearly possible to incur such a loss.

6.6.5 As-if adjustments, exposure measures

The objective of as-if adjustments is to make the as-if adjusted historical large info event losses representative for the current accident year in terms of frequency and severity. As-if adjustments are applied as applicable to the frequency and/or the severity of the historical large info event losses by multiplication with suitable "as-if adjustment factors". Changes relevant for as-if adjustments consist of portfolio changes (e.g. size of portfolios, average written shares) and exogenous changes (e.g. claims inflation). Where appropriate, as-if adjustment factors for the severity can be calculated as a ratio of exposures using a suitable **exposure measure**.

The multiplication with a constant as-if adjustment factor is based on the assumption that the portfolio has changed approximately homogenously over time with respect to the impact on frequency or severity. This may not hold for the whole portfolio. E.g. if sub-portfolio 1 has doubled and sub-portfolio 2 has reduced by half, then the as-if adjustments applied to losses from sub-portfolio 1 should be different from those applied to sub-portfolio 2.

Hence, as-if adjustment factors should be selected together with suitable as-if adjustment segments such that the following conditions hold approximately on each as-if adjustment segment:

(1) **As-if adjustments for the severity**: for every *hypothetical* event loss in year k in the severity as-if adjustment segment seg, the severity of this event loss in the current year would be equal to the original severity multiplied with the constant as-if adjustment factor a_{seg}^{k} for the severity.

(2) **As-if adjustments for the frequency**: for the frequency as-if adjustment segment seg, a frequency exposure e^{seg} can be assigned to time periods which transfers expected occurrence frequencies f for the time period into constant "frequency rates" $f/_{e^{seg}}$. I.e. if a frequency f_1 corresponds to an exposure e_1, then the frequency f_2 for an exposure of e_2 is $f_2 = f_1 \cdot \frac{e_2}{e_1}$.

Note that, above, these conditions are not only formulated for the actually manifested historical large info event losses, but for every hypothetical large info event loss from the as-if adjustment segment.

The selection of the as-if adjustment factors and the as-if adjustment segments for the severities and the frequencies is made and explained by the reinsurer.

As-if adjustments of the severity are described in Section 6.6.6. As-if adjustments of the frequency are described in Section 6.6.9 together with the consideration of IBNyR, i.e. adjusting the frequencies for losses that have occurred but not yet been reported,

6.6.6 As-if adjustments of the severity

In this section, we describe how to as-if adjust the severities of the historical losses x_j^k. In general, as-if adjustments for the severity are not applied to the event loss severities as a whole, but individually to the components of the info event loss severity corresponding to different severity as-if adjustment segments.

- **Severity as-if adjustment segments** seg should be defined according to the condition for the severity from Section 6.6.5 and such that they contain the granularity of IE1 model segments and, if the output of IE1 is netgross, the granularity required to apply the relevant PEC of ceded retrocession.[10]

- **As-if adjustment factors for the severity**: a_{seg}^{k} for year $k = 1, \dots, n$ in the observation period and severity as-if adjustment segment seg

A historical large info event loss severity x_j^k with occurrence year k is decomposed into severities by segment, $x_j^k = \sum_{seg} x_{j,seg}^k$, where $x_{j,seg}^k$ is the component assigned to as-if adjustment segment seg. The as-if adjusted historical event loss severity $\tilde{x}_j^k$ (gross of ceded retrocession) is then given by:

$$\tilde{x}_j^k = \sum_{seg} \tilde{x}_{j,seg}^k \quad with \quad \tilde{x}_{j,seg}^k = a_{seg}^k \cdot x_{j,seg}^k$$

The as-if adjusted losses $\tilde{x}_{j,l}^k$ per IE1 model segment l are given by:

$$\tilde{x}_{j,l}^k = \sum_{\substack{seg\ relevant\ to \\ IE1\ model\ segment\ l}} \tilde{x}_{j,seg}^k$$

If the output of IE1 is required to be netgross, then the amounts $\tilde{x}_{j,seg}^k$ need to be recorded to apply the PEC of ceded retrocession in Section 6.6.7.

6.6.6.1 As-if adjustment of the reporting thresholds

The as-if adjustments of the severity produce as-if adjusted reporting thresholds $\tilde{u}_{k,l}$ (gross of ceded retrocession) for each year k in the observation period and every IE1 model segment l, where the maximum is taken over all segments intersecting the given IE model segment:

$$\tilde{u}_{k,l} = max\{a_{seg}^k \cdot u_{k,l} | segments\ seg\ intersecting\ IE1\ model\ segment\ l\}$$

If there is only one IE1 model segment $l = 1$, $\tilde{u}_{k,1}$ is simply denoted by $\tilde{u}_k$.

6.6.7 Application of current PEC

Netgross severities $\bar{x}_j^k$ and $\bar{x}_{j,l}^k$ for each IE1 model segment l are calculated by applying the PEC of the *current* (not the historical) ceded retrocession to the as-if adjusted severities $\tilde{x}_j^k$. For simplicity, the PEC structure is denoted by the function h, so formally:

$$\bar{x}_j^k = \sum_{l=1}^{m} \bar{x}_{j,l}^k = h\left(\sum_{seg} \tilde{x}_{j,seg}^k\right)$$

[10] As a simplified illustration, if according to Section 6.6.5 two segments A and B would be needed, but A would intersect two model segments 1 and 2, then A would need to be split up into two corresponding segments A1 and A2. If two different PEC would apply to A1, then A1 would need to be further split up into segments A11 and A12.

In order to calculate the right-hand side, PEC may have to be applied separately by segment seg to the different amounts $\tilde{x}_{j,seg}^{k}$. The segments should have been selected so that this is possible.

If the output of IE1 is required to be netgross (as determined in Section 4.3.3), the netgross as-if adjusted reporting thresholds $\bar{u}_{k,l}$ for the years k in the observation period and the IE1 model segments l are derived similarly, but additionally considering that netgross amounts in general depend on the decomposition of the gross amounts into components to which different PEC apply. Denoting such a decomposition by "retro decomposition" and the corresponding netgross as-if adjusted reporting threshold for simplicity by $h(\tilde{u}_{k,l})$, the netgross as-if adjusted reporting thresholds are given by taken the maximum over all relevant retro decompositions:

$$\bar{u}_{k,l} = max\left\{h(\tilde{u}_{k,l}) \middle| \begin{matrix} all\ retro\ decompositions\ of\ \tilde{u}_{k,l} \\ relevant\ to\ IE1\ model\ segment\ l \end{matrix}\right\}$$

6.6.8 IE1 modeling threshold(s) and construction of experience scenarios

6.6.8.1 Selection of IE1 modeling threshold(s)

For the selection of the IE1 modeling threshold(s) t_{IE1}, $t_{IE1,l}$ per IE1 model segment l, respectively, note that they are gross if the IE1 output is gross and netgross if the IE1 output is netgross (as determined in Section 4.3.3). The selection of the IE1 modeling threshold(s) needs to be explained against the following criteria:

(1) Significant in relation to the risk-bearing capital and the current underwriting year premium.

(2) Sufficiently low that, for each IE1 model segment, there is a sufficiently large number of IE1 experience scenarios whose loss to the IE1 model segment exceeds the corresponding IE1 modeling threshold, but ideally sufficiently high that Gen Pareto is a reasonable assumption for the severity distribution.

(3) No large gap between the IE1 modeling thresholds and the smallest IE1 experience scenario severity.

(4) Larger than the largest as-if adjusted reporting threshold derived in Sections 6.6.6 and 6.6.7, as follows for the different cases:

a. One IE1 model segment, IE1 output gross:

$$t_{IE1} \geq max\{\tilde{u}_k | k = 1, \dots, n\}$$

b. One IE1 model segment, IE1 output netgross:

$$t_{IE1} \geq max\{\bar{u}_k | k = 1, \dots, n\}$$

c. Several IE1 model segments l, IE1 output gross:

$$t_{IE1,l} \geq max\{\tilde{u}_{k,l} | k = 1, \dots, n\}$$

d. Several IE1 model segments l, IE1 output netgross:

$$t_{IE1,l} \geq max\{\bar{u}_{k,l}|k = 1, \dots, n\}$$

(5) If the output of IE1 is gross, then the IE1 modeling threshold for each IE1 model segment must be smaller than the attachment points of the corresponding PEC.

6.6.8.2 Construction of the experience scenarios

A historical large info event loss x_j^k produces an experience scenario if and only if:

(1) the exposure $e_k^{seg} > 0$ for the frequency as-if adjustment segment $seg = seg_j^k$ of x_j^k (see Section 6.6.9)

(2) the as-if adjusted large info event loss is in scope of IE1 as defined in Section 4.5, i.e.

a. *One IE1 model segment*: the as-if adjusted large event loss severity exceeds the IE1 modeling threshold t_{IE1}, where the loss severity is gross ($\tilde{x}_j^k$) if the IE1 output is gross and netgross ($\bar{x}_j^k$) if it is netgross.

b. *Several IE1 model segments*: the as-if adjusted large event loss severity for at least one IE1 model segment l exceeds the corresponding IE1 modeling threshold $t_{IE1,l}$, where the loss severity is gross ($\tilde{x}_{j,l}^k$) if the IE1 output is gross and netgross ($\bar{x}_{j,l}^k$) if it is netgross.

The IE1 experience scenario s corresponding to the historical large info event loss x_j^k is then defined by:

(a) expected occurrence frequency: f_s (derived in Section 6.7.2)

(b) scenario severity: $x_s = \tilde{x}_j^k$ if the IE1 output is required to be gross and $\bar{x}_j^k$ if it is required to be netgross

(c) breakdown of the scenario severity into IE1 model segments l (as applicable gross or netgross)

(d) additional severity: $x_s' = \bar{x}_j^k$ if the IE1 output is required to be gross and to $\tilde{x}_j^k$ if it is required to be netgross.

The derivation of the expected occurrence frequencies f_s is described in Sections 6.6.9 and 6.7.

6.6.9 As-if adjustments of the frequency and consideration of IBNyR

In this section, we describe how to derive as-if adjusted frequencies of the historical losses x_j^k that give rise to experience scenarios, including accounting for IBNyR.

6.6.9.1 Frequency as-if adjustment

The historical large info event losses x_j^k are assigned to suitable frequency as-if adjustment segments $seg = seg_j^k$ with corresponding frequency exposure measures e_k^{seg} and e_{CY}^{seg} from Section 6.6.4. The as-if adjusted frequency $\tilde{f}_j^k$ for x_j^k is then initially given by

$$\tilde{f}_j^k = \frac{e_{CY}^{seg}}{\sum_{k=1}^{n} e_k^{seg}}$$

In other words, the loss x_j^k occurred once in a period with exposure $\sum_{k=1}^{n} e_k^{seg}$, so its expected occurrence frequency for a period with an exposure of e_{CY}^{seg} is equal to $\tilde{f}_j^k$. Note that $\tilde{f}_j^k = \frac{1}{n}$ if the exposures for each year in the observation period and for the current year are the same. For the consideration of IBNyR, the above formula is adjusted as follows.

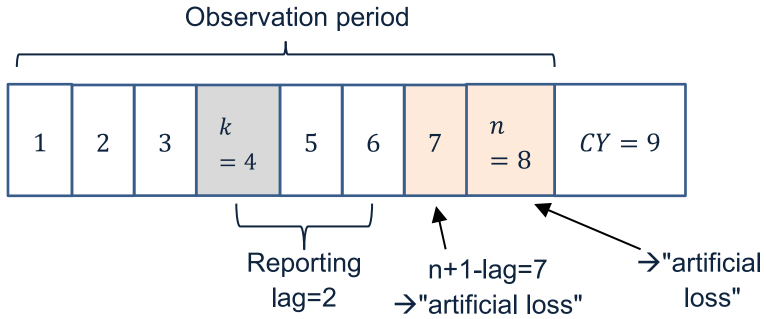
6.6.9.2 Consideration of IBNyR

Define the reporting lag lag_j^k for a loss x_j^k by

- lag_j^k = number of years between the occurrence year and the reporting year of the loss x_j^k, where $lag_j^k = 1$ means that the reporting year is the year following the occurrence year.

IBNyR needs to be accounted for because for example a loss with occurrence year 2015 and reporting lag of 3 would not be known at the start of the year 2017. IBNyR can be accounted for by adding "artificial losses" "induced" by the known historical losses to such years, with frequencies to be derived.

- Let x_j^k be a historical loss with occurrence year $k = 1, \dots, n$, reporting lag $lag = lag_j^k$, and which is assigned to a frequency as-if adjustment segment seg.



Clearly, if $lag = 0$, then all losses in the observation period with reporting lag lag are known, and the loss x_j^k does not contribute to IBNyR. If $lag \geq 1$, then losses with this reporting lag with any occurrence year $k = n + 1 - lag, \dots, n$ would not be known at the start of the current year. So, the relevant exposure for x_j^k is only the sum $\sum_{k=1}^{n-lag} e_k^{seg}$ and not the sum $\sum_{k=1}^{n} e_k^{seg}$ used for the frequency $\tilde{f}_j^k$. Thus, the historical loss x_j^k produces an IBNyR frequency $\tilde{f}_{j,IBNyR}^k$ of

$$\tilde{f}_{j,IBNyR}^{k} = \begin{cases} \tilde{f}_{IBNyR}\left(seg_j^k, lag_j^k\right): & if\ lag_j^k \geq 1 \\ 0: & if\ lag_j^k = 0 \end{cases}$$

where:

$$\tilde{f}_{IBNyR}(seg, lag) = \frac{e_{CY}^{seg}}{\sum_{k=1}^{n-lag} e_k^{seg}} - \frac{e_{CY}^{seg}}{\sum_{k=1}^{n} e_k^{seg}}$$

For the artificial losses from IBNyR considerations, we make the simplifying assumption that their as-if adjusted severity is the same as the as-if adjusted severity of the historical losses that have "produced" them. Hence, if the historical loss leads to an experience scenario, their frequencies can be added to the corresponding IE1 experience scenario.

Hence, the expected occurrence frequency f_s' of the IE1 experience scenario s induced by x_j^k is given by the as-if adjusted frequency including IBNyR:

$$f_s' = \tilde{f}_j^k + \tilde{f}_{j,IBNyR}^{k} = \frac{e_{CY}^{seg}}{\sum_{k=1}^{n-lag} e_k^{seg}}$$

6.6.10 As-if adjustments and trends

Because the objective of as-if adjustments is to make the historical information from the observation period representative for the current year:

- There should be no trends over the observation period in the as-if adjusted severities and frequencies.

A trend may be present for example if the as-if adjusted severities increase over the observation period.

- Hence, the as-if adjusted severities and frequencies must be analyzed for trends over the observation period and, if there are trends, the as-if adjustments need to be reconsidered and potentially adjusted in order to remove such trends.

6.6.11 Model adjustment - as-if adjustment of losses to cedant

In the default approach for experience scenarios, as-if adjustments are applied to *losses to reinsurer*, i.e. after the application of the historical reinsurance structure, and not to “losses to cedant” followed by application of the current assumed reinsurance structure. This has the disadvantage that the impact of the current assumed reinsurance structures is approximated by multiplicative as-if adjustment factors applied after application of the historical assumed reinsurance structure.

The alternative approach outlined in the following can be used in StandRe for the as-if adjustment of historical event losses provided that the conditions from Section 4.7 are satisfied and in conjunction with the approach presented there:

(1) The set of all historical large event losses to cedant that exceed a given reporting threshold is decomposed into a collection of as-if adjustment segments as needed.

(2) As-if adjustments for frequency and severity are applied to these losses to cedant.

(3) The PEC of the current assumed reinsurance structure are applied to the as-if adjusted losses to cedant.

(4) A lower bound for the IE1 modeling threshold(s) is given by applying the assumed reinsurance structure to the maximum of the as-if adjusted reporting thresholds (to ensure all event losses to reinsurer that as-if adjusted would exceed the IE1 modeling threshold(s) are known).

Background is provided in the "model background" document (Section 3.2).

6.7 IE1 model frequency and experience scenario frequencies

6.7.1 Expected frequency for the IE1 model and frequency uncertainty uplift

The expected frequency λ_{IE1} for the IE1 model is estimated from the experience scenarios, additionally reflecting estimation uncertainty given the limited amount of historical data available from the observation period. It is given by the sum of the estimated expected frequency and the estimation uncertainty (the frequency uncertainty uplift):

$$\lambda_{IE1} = \sum_{\substack{experience \\ scenario\ s}} f_s' + \sqrt{\sum_{\substack{experience \\ scenario\ s}} (f_s')^2}$$

where:

- f_s' = expected occurrence frequency of the IE1 experience scenario s, given according to Section 6.6.9 by:

$$f_s' = \frac{e_{CY}^{seg(s)}}{\sum_{k=1}^{n-lag(s)} e_k^{seg(s)}}$$

If this formula is not considered to be applicable and other values for λ_{IE1} are used, this is considered to be an adjustment to StandRe that requires prior approval by FINMA (Section 2.17). The reasons for which the method is not applicable have to explained. It may be the case for a new company with no or only very little experience data.

Detailed background on the above formula is provided in the "model background" document (Section 3.2). The basic underlying idea is that if N_{IE1} is the (unknown) random variable of the relevant number of losses in the current year, and if we denote by $Z = \hat{E}[N_{CY}]$ an estimator of its mean, then λ_{IE1} is set equal to

$$\lambda_{IE1} = Z + \sqrt{\widehat{Var(Z)}}$$

where $\widehat{Var(Z)}$ is an estimator of the variance of the estimator of the mean $Z = \hat{E}[N_{IE1}]$, i.e. an estimate of the uncertainty in the estimate of the mean. The selections for Z and $\widehat{Var(Z)}$ made above are:

$$Z = \sum_{\substack{experience\\ scenario\ s}} \frac{e_{CY}^{seg(s)}}{\sum_{k=1}^{n-lag(s)} e_k^{seg(s)}} \quad and \quad \widehat{Var(Z)} = \sum_{\substack{experience\\ scenario\ s}} \left(\frac{e_{CY}^{seg(s)}}{\sum_{k=1}^{n-lag(s)} e_k^{seg(s)}}\right)^2$$

and can be shown to be unbiased minimum variance estimators under a suitable underlying stochastic model. In the special case in which all exposures are the same and we disregard lags and segments, the above estimators can be written (where n is the length of the observation period):

$$Z = \frac{1}{n}\sum_{k=1}^{n} N_k \quad and \quad \widehat{Var(Z)} = \frac{1}{n^2}\sum_{k=1}^{n} N_k$$

where N_k denotes the random variable of losses occurring in year k.

6.7.2 IE1 experience scenario frequency adjustment

As mentioned in Section 6.7.1, it is assumed that the expected frequency λ_{IE1} for the IE1 model is given only from the IE1 experience scenarios. This is because the frequencies of the experience scenarios are assumed to be the most reliable estimate of the frequency and to avoid an increase in expected frequency if (more and more) non-experience scenarios would be added.

To ensure that the sum of the expected occurrence frequencies over all IE1 scenarios sum up to λ_{IE1} (in particular including the frequency uncertainty uplift), the expected occurrence frequencies of the IE1 experience scenarios are reduced in order to account for the frequencies of the IE1 non-experience scenarios. The new expected occurrence frequency f_s of an IE1 experience scenario s is thus given by:

$$f_s = f_s' \cdot \frac{\lambda_{IE1} - f_{nonexp}}{\lambda_{IE1}} \cdot \frac{\lambda_{IE1}}{\sum_{\substack{experience\\ scenario\ s}} f_s'}$$

where f_s' is from Section 6.7.1 and

- $f_{nonexp} = \sum_{IE1\ non-experience\ scenarios\ s} f_s$ = sum of the expected occurrence frequencies of the non-experience scenarios

In the above formula, the first fraction removes the overlap with the non-experience scenarios and the second fraction accounts for the frequency uncertainty uplift. The sum of f_s over all experience scenarios is then equal to $\lambda_{IE1} - f_{nonexp}$. This corresponds to the assumption that the frequencies of the non-experience scenarios as derived in Sections 6.8 to 6.10 are not adjusted.

Background is provided in the "model background" document (Section 3.5).

6.8 Portfolio structure scenarios

6.8.1 Assignment of the scenarios to IE1 or IE2

Portfolio structure scenarios are assigned to IE1.

6.8.2 Overview

The objective of portfolio structure scenarios is to assess the loss potential through the covers provided in the assumed reinsurance contracts. As a motivation, consider the following question: what is the largest possible event loss to an assumed reinsurance program (e.g. a "stacked tower" of XoL layers for a selected LOB) in the current accident year assumed reinsurance portfolio of the reinsurer, in terms of the covers provided? And what is the return period for such a loss? This idea is generalized in the following.

In principle, we would like to consider IE1 info events and the total loss from such an info event for the entire current accident year assumed reinsurance portfolio, potentially involving contracts with several cedants and several LOBs. However, this requires reinsurer-specific assumptions that may not be easy to make, such as the probability that more than one cedant is affected by an event (for a given LOB). Hence, as a simplification, we consider only losses from contract events instead of IE1 info events (for the distinction, see Section 2.6). Further, for each LOB we consider the contract event losses that could result from all current accident year contracts with one cedant for the selected LOB.

For portfolio structure scenarios, the severity is determined first, by analyzing the assumed reinsurance portfolio, followed by the calculation of the expected exceedance frequency.

For each LOB in the granularity of "high level LOB" (Section 3), two portfolio structure scenarios are required to be calculated by the following steps. Here, "as applicable gross or netgross" means gross if the IE1 output is gross and netgross if it is netgross. For every relevant "high level" LOB,

(1) Consider all programs in the current accident year assumed reinsurance portfolio with one cedant covering the selected LOB.

(2) Select the program P_{max} with the largest possible contract event loss x_{LOB} to reinsurer, where the loss is as applicable gross or netgross. The formula for x_{LOB} is given below.

(3) If x_{LOB} is not in scope of IE1 as defined in Section 4.5, then there is no portfolio structure scenario for the selected LOB.

(4) Otherwise, there are two scenarios. For calculating them, let

   a. f_P = exceedance frequency curve for a program P, with calculation explained below.

(5) The **first portfolio structure scenario** for the selected LOB has frequency f_s and severity x_s given by:

a. $x_s = x_{LOB}$, as applicable gross or netgross. Where applicable, the severity is provided for each IE1 model segment.

b. $f_s = f_{P_{max}}(x_{LOB})$ = expected exceedance frequency for an event loss larger than or equal to x_{LOB}.

c. x_s' = netgross severity $h(x_s)$ (see below for h) if x_s is gross and gross severity $h^{-1}(x_s)$ if x_s is netgross.

(6) The **second portfolio structure scenario** for the selected LOB has frequency f_s and severity x_s given by

a. $x_s = 75\% \cdot x_{LOB}$

b. f_s = sum of the expected exceedance frequencies $f_P(x_s)$ over all programs belonging to the selected LOB whose maximal possible contract event loss x_P (as applicable gross or netgross), see below, is larger than or equal to x_s:

$$f_s = \sum_{\substack{programs\ P \\ covering\ selected\ LOB \\ with\ x_P \geq x_s}} f_P(x_s)$$

c. x_s' = netgross severity $h(x_s)$ (see below for h) if x_s is gross and gross severity $h^{-1}(x_s)$ if x_s is netgross.

The two portfolio structure scenarios overlap, because the events causing the first scenario are a subset of the events causing the second scenario. Hence, the frequency f_s for the second scenario can be reduced by deducting the frequency $f_{P_{max}}(x_{LOB})$ of the first scenario.

For a program P of contracts indexed by k, the maximal possible contract event loss x_P to reinsurer gross of ceded retrocession is given by:

$$x_P^{gross} = \sum_k \beta_k \cdot c_k$$

Where:

- c_k = per risk or per contract event cover of contract k for 100% share. If the cover is unlimited, choose a finite amount and explain the choice.
- β_k = reinsurer's share of contract k.

If the IE1 output is gross, then the maximal possible contract event loss x_P to reinsurer is given by:

$$x_P = x_P^{gross}$$

If the output is netgross, then x_P is:

$$x_P = h\left(x_P^{gross}\right)$$

where h denotes the applicable PEC of the ceded retrocession. It needs to be explained how PEC & AC1 are considered.

The largest possible gross contract event loss x_{LOB} to reinsurer is given by:

$$x_{LOB} = max\{x_P | P \ covers \ the \ LOB\}$$

To calculate the exceedance frequency curve f_P for a given program P, a default method is provided in Section 6.8.3 for a "stacked tower" of XoL layers (or a single XoL layer). The default method is implemented in the (macro-enabled) spreadsheet "StandRe_portfolio_structure_scenarios_default_method_XoL_tower". As an alternative to the default method, the reinsurer can describe and use its own method, provided that its appropriateness is shown. In Section 6.8.4, the incorporation of other contracts than XoL towers is explained.

6.8.3 Default method for calculating the exceedance frequency curve for XoL programs

We consider an XoL program $\tilde{P}$ in the form of a "stacked tower" of XoL layers $k = 1, \dots, k_{max}$ (or a single XoL layer), where k_{max} denotes the top layer and "stacked" means that, for a_k denoting the attachment point (priority) and c_k (as above) the cover (limit) of layer k (for 100% share), for $k = 1, \dots, k_{max} - 1$,

$$a_{k+1} = a_k + c_k$$

6.8.3.1 Default method for reinsurer's shares

The exceedance frequency curve $f_{\tilde{P}}$ for gross losses for the XoL program for the reinsurer's shares is derived from the exceedance frequency curve $f_{\tilde{P}}^1$ of the loss to which the program is applied, where the derivation of the latter is explained below under "Default method for loss to which program is applied". For the derivation of $f_{\tilde{P}}(x)$ for a gross loss x to reinsurer, note that it results from applying the layer structures:

$$x = g_{\tilde{P}}(y) = \sum_k \beta_k \cdot min\{c_k, max\{0, y - a_k\}\}$$

so

$$f_{\tilde{P}}(x) = f_{\tilde{P}}^1\left(g_{\tilde{P}}^{-1}(x)\right)$$

Hence, for a gross loss x to reinsurer, $f_{\tilde{P}}(x)$ is zero if $x > \sum_{j=1}^{k_{max}} \beta_j \cdot c_j$ and otherwise

$$f_{\tilde{P}}(x) = f_{\tilde{P}}^1\left(a_k + \frac{x - \sum_{j=1}^{k-1} \beta_j \cdot c_j}{\beta_k}\right)$$

where the number k is selected such that

$$\sum_{j=1}^{k-1} \beta_j \cdot c_j \leq x \leq \sum_{j=1}^{k} \beta_j \cdot c_j$$

and we set $\sum_{j=1}^{0} \beta_j \cdot c_j = 0$.

The exceedance frequency curve $\bar{f}_{\tilde{P}}$ for netgross losses is derived from the curve $f_{\tilde{P}}$ for gross losses as follows:

$$\bar{f}_{\tilde{P}}(x) = f_{\tilde{P}}\left(h^{-1}(x)\right)$$

Here, h denotes the applicable PEC of the ceded retrocession, i.e. the function that transform gross to netgross losses, and h^{-1} denotes its generalized inverse

$$h^{-1}(x) = inf\{y|h(y) \geq x\}$$

Note that the generalized instead of the normal inverse is needed when the function h is constant on some intervals (e.g. when the reinsurer's share on some layer(s) is zero).

6.8.3.2 Default method for loss to which program is applied

In this section, we explain the default method for deriving the exceedance frequency curve $f_{\tilde{P}}^1$ for the loss to which the program is applied. This uses the expected loss EL_k to each layer k and assumes that the loss severity to which the program is applied is Gen Pareto distributed above the lowest attachment point a_1. The expected loss EL_k can for example be set as the product of expected premium $prem_k$ and expected loss ratio LR_k for every layer $k = 1, \dots, k_{max}$.

The method is based on the following expression for the expected severity to a layer $c_k \; xs \; a_k$ from a Gen Pareto distribution with parameters α_i and α_t (see Section 6.14.2 for the derivation):

$$g(a_k + c_k) - g(a_k) \quad with \;\; g(x) = \frac{a_1}{(1-\alpha_t)} \frac{\alpha_t}{\alpha_i} \left(1 + \frac{\alpha_i}{\alpha_t}\left(\frac{x}{a_1} - 1\right)\right)^{-\alpha_t + 1}$$

The parameters expected exceedance frequency $f_{\tilde{P}}^1(a_1)$ and the two alpha parameters α_i and α_t of the Gen Pareto distribution are selected in two steps, starting with initial values. The reason for this is that the minimization in the second step may otherwise end up in unreasonable local minima.

(1) *Initial values*: select $\alpha_i = \alpha_t = 1.4$ (a relatively low and common value) and calculate $f_{\tilde{P}}^1(a_1)$ such that the expected loss over all layers is matched, i.e.

$$f_{\tilde{P}}^1(a_1) = \frac{\sum_k EL_k}{g\left(a_{k_{max}} + c_{k_{max}}\right) - g(a_1)}$$

(2) *Minimization*: select $f_{\tilde{P}}^1(a_1), \alpha_i$ and α_t to minimize M, the sum over the layers k of the squared differences between the estimated expected loss EL_k for the layer k and the corresponding expected loss resulting from the parameters:

$$M = M\left(f_{\tilde{P}}^1(a_1), \alpha_i, \alpha_t\right) = \sum_k \left(EL_k - f_{\tilde{P}}^1(a_1) \cdot \left(g(a_k + c_k) - g(a_k)\right)\right)^2$$

The exceedance frequency curve $f_{\tilde{P}}^{100\%}$ above the lowest attachment point a_1 is then given for $x \geq a_1$ by (see Section 6.14.1):

$$f_{\tilde{P}}^1(x) = f_{\tilde{P}}^1(a_1) \cdot \left(1 + \frac{\alpha_i}{\alpha_t}\left(\frac{x}{a_1} - 1\right)\right)^{-\alpha_t}$$

6.8.4 Incorporating other contracts

In Section 6.8.3 above, we describe the default method for calculating the exceedance frequency curve $f_{\tilde{P}}$ for a "stacked tower" $\tilde{P}$ of XoL layers. It is possible that a contract event can additionally cause losses to other contracts with the same LOB and cedant, e.g. if there is additionally a quota share inuring to the benefit of the XoL program (i.e. the XoL program is defined on the retention of the quota share). For the additional contracts, no per risk or per contract event model may be available.

To derive the exceedance frequency curve f_P for the whole program P for a gross loss x to reinsurer, it is needed to calculate the loss $y = g^{-1}(x)$ to cedant to which x corresponds, where $x = g(y)$ represents the program structure. Then we can calculate from this the loss $\tilde{x} = \tilde{g}(y)$ to the program $\tilde{P}$, for which the exceedance frequency curve $f_{\tilde{P}}$ is available. I.e.

$$f_P(x) = f_{\tilde{P}}\left(\tilde{g}\left(g^{-1}(x)\right)\right)$$

where the function for the XoL program is

$$\tilde{g}(y) = \sum_k \beta_k \cdot min\{c_k, max\{0, \gamma \cdot y - a_k\}\}$$

where γ is the proportion of the cedant loss subject to the XoL program (e.g. with a quota share inuring to the benefit of XoL program). When using this approach, care must be taken if $g^{-1}(x)$ is in an interval $]-\infty, y_1[,]y_2, y_3[,]y_4, y_5[, \ldots,]y_{2j}, \infty[$ on which $\tilde{g}$ is constant.

The netgross exceedance frequency curve $\bar{f}_P(x)$ for a netgross loss x to reinsurer is derived similarly by

$$\bar{f}_P(x) = f_{\tilde{P}}\left(\tilde{g}\left(g^{-1}\left(h^{-1}(x)\right)\right)\right)$$

6.9 Damage event and other event scenarios

6.9.1.1 Overview of specification of event-based scenarios

The following table specifies the requirements on damage event and other event scenarios. For IE1, "as applicable gross or netgross" means gross if the IE1 output is gross and netgross if it is netgross (Section 4.3).

<table>
<tr><th></th><th>Damage event scenarios</th><th>Other event scenarios</th></tr>
<tr><td>Scenario specifications</td><td>Appendix Section 9.1</td><td>Appendix Section 9.2</td></tr>
<tr><td>Scenarios to be calculated/not calculated</td><td colspan="2">Section 6.5.2</td></tr>
<tr><td>Assignment of scenarios</td><td>Typically to IE1, exceptions are noted in the scenario description</td><td>All scenarios to IE2</td></tr>
<tr><td>Scenario frequency f_s</td><td colspan="2">for some scenarios prescribed and for others to be determined by the reinsurer</td></tr>
<tr><td>Scenario severity x_s</td><td colspan="2">For IE1 scenarios:
(1) severity is non-discounted ultimate outcome, to be calculated both gross and netgross of ceded retrocession.
(2) severity for every IE1 model segment, as applicable gross or netgross.
(3) for each IE1 model segment, the number of contract events for ceded retrocession generated by the scenario.
For IE2 scenarios:
(1) discounted best estimate at t=1 or one-year change as specified in the scenario description, net of ceded retrocession.</td></tr>
<tr><td rowspan="2">Affected business</td><td>Current accident year</td><td>As specified for each scenario</td></tr>
<tr><td colspan="2">If a list of LOBs is provided in a scenario description, it may not be exhaustive and may need to be extended by the reinsurer</td></tr>
<tr><td rowspan="2">Calculation of scenario</td><td colspan="2">The reinsurer should typically choose the specifics of the scenario not explicitly specified based on its specific portfolio to get the largest loss to reinsurer as measured by
(1) IE1 scenarios: ultimate outcomes, as applicable gross or netgross
(2) IE2 scenarios: discounted best estimate at t=1 or one-year change, as specified in the scenario description, net</td></tr>
<tr><td>The loss to reinsurer results from going through the "event loss structure", i.e. by determining:
(1) damaged insured risks and potentially affected LOBs
(2) insurers covering each of (1)
(3) assumed reinsurance programs potentially affected through (2) – which may be several, also for one LOB</td><td>As described in the scenario specification</td></tr>
</table>

	(4) gross loss to reinsurer for each potentially affected program (3) (5) netgross loss to reinsurer by application of relevant PEC.	
Documentation of calculation	The assumptions made in the calculation of each scenario need to be recorded and explained.	

6.9.1.2 Changing scenario specifications

In principle, event-based scenarios that are relevant to a reinsurer must be calculated without changing any of the scenario prescriptions. In case prescriptions are changed, all changes must be identified and described, by documenting in detail any differences, and carefully justified. The impact of the changes in the prescriptions must be estimated. Changes to the scenarios may give rise to an adjustment that requires prior approval by FINMA (Section 2.17).

6.9.1.3 RETROR scenario

The RETROR (retrocession default on reserves) scenario (Section 9.2.6) does not need to be considered in StandRe if the credit risk of the ceded retrocession is modeled in the credit risk standard model with the stochastic one-factor model with separate cash flows per retrocession counterparty.

6.10 Own scenarios

6.10.1 Assignment of the scenarios to IE1 or IE2

Own scenarios are assigned by the reinsurer, explaining the assignment.

6.10.2 Specification of own scenarios

At least two own scenarios need to be defined and calculated by the reinsurer. For scenarios assigned to IE1, both gross and netgross loss severities need to be calculated.

The own scenarios should be selected so that they capture the most material aspects in the tail of the current risk situation that are not captured by the other scenarios considered, including the experience scenarios. Own scenarios can in particular be portfolio structure-based or defined by events and can belong to IE1 or to IE2. If an own scenario is assigned to IE1, then the scenario severities need to be available for every IE1 model segment, as determined by the required IE1 output either gross or netgross.

The selection of own scenarios should be closely linked to the business model of the reinsurer and should consider risks and risk concentrations that result from its specific business model. The business model of the reinsurer should be explained, and the selection of the own scenarios be explained in relation to the business model. For example, an intra-group reinsurer may have specific risk concentrations from the intra-group cessions. As another example, a retail insurer operating in not fully developed markets may have the risk of underestimating the premiums.

6.11 IE1 frequency-severity model - one IE1 model segment

6.11.1 Introduction

In view of the form of the IE1 model as set out in Section 6.2.2, the following random variables need to be derived:

(1) Poisson distributed frequency random variable N_{IE1} with mean λ_{IE1}, which is explained in Section 6.11.2

(2) Gen Pareto severity X_{IE1}, which is explained in Section 6.11.2.

The derivation of the IE1 modeling threshold t_{IE1} is described in Section 4.5.

6.11.2 Derivation of frequency and severity

The mean $\lambda_{IE1} = E[N_{IE1}]$ is derived in Section 6.7.

The Gen Pareto distribution of the severity X_{IE1} is determined by the following parameters (Section 6.14.2)

- t_{IE1} = IE1 modeling threshold (Section 4.5)
- $\alpha_{initial}^{IE1}$ = "initial Pareto-alpha" parameter (at the IE1 modeling threshold) of Gen Pareto
- α_{tail}^{IE1} = "tail Pareto-alpha" parameter (at infinity) of Gen Pareto

The Gen Pareto distribution is fitted to the IE1 scenarios SC^{IE1}. The approach is not prescribed and can involve expert judgment. The main tool for assessing the reasonableness is the comparison of the exceedance frequency curves of the frequency-severity model with the exceedance frequency curve $f_{IE1\,scenarios}$ for the IE1 scenarios as explained in Section 6.11.3. The exceedance frequency curve of the IE1 frequency-severity model is the map

$$x \rightarrow f_{IE1\,model}(x) = E[N_{IE1}] \cdot P[X_{IE1} \geq x]$$

It should be considered that the calculated IE1 scenarios may not cover all possible event losses, i.e. the exceedance frequency curves from the scenarios might underestimate the expected exceedance frequencies.

The reasonableness of the fit is analyzed using the following two comparisons:

(1) table comparing the expected exceedance frequencies at the scenario severities between the scenario exceedance frequency curve and the IE1 frequency-severity model exceedance frequency curve;

(2) graph of the two exceedance frequency curves (two graphs, one with normal axes and the other with both logarithmic axes).

The analysis of the reasonableness of the fit must use expert judgment about the return periods of large amounts based on the knowledge of the business and the portfolio.

6.11.3 Exceedance frequency curve for the IE1 scenarios

The exceedance frequency curve $f_{IE1\,scenarios}$ for the collection of IE1 scenarios (x_s, f_s) is given by

$$f_{IE1\,scenarios}(x) = \sum_s f_s \cdot 1_{\{x_s \geq x\}}$$

where the indicator function $1_{\{x_s \geq x\}} = 1$ if $\{x_s \geq x\}$ and zero otherwise. Note that the selection of "≥" and not ">" is on purpose: it is assumed that the scenario severity could be slightly higher than x_s.

6.12 IE1 frequency-severity model - several IE1 model segments

6.12.1 Overview

We recall the form of the IE1 model as set out in Section 6.2.2 with the random variables to be derived:

(1) Poisson distributed frequency random variable N_{IE1} with mean λ_{IE1}

Total severities by IE1 info event are given as the sum of corresponding severities $X_l = X_{IE1,l}$ by IE1 model segment

$$\sum_{l=1}^{m} B_l \cdot X_l$$

where

(2) $X_l = X_{IE1,l}$ = Gen Pareto severities per IE1 model segment $l = 1, \dots, m$ with the IE1 model segment modeling threshold $t_{IE1,l}$ (Section 4.5) independent of N and B_l. The dependency between the X_l is modeled by a flipped Clayton copula with $\vartheta = 0.5$ (i.e. tail dependency of 25%)[11].

(3) B_l = dependent Bernoulli random variables (values in $\{0,1\}$) for $l = 1, \dots, m$ independent of N and X_l, where $B_l = 1$ means that the loss severity to IE1 model segment l exceeds the IE1 model segment modeling threshold $t_{IE1,l}$ (Section 4.5). This requires determining the probabilities $P[B_1 = b_1, \dots, B_m = b_m]$ for $(b_1, \dots, b_m) \in \{0,1\}^m$, where $P[B_1 = 0, \dots, B_m = 0] = 0$.

The dependency between the Bernoulli random variables B_l accounts for the probability of co-occurrence of losses to several IE1 model segments given an IE1 info event.

[11] If $(U_1, \dots, U_m)$ is Clayton, then the flipped Clayton is $(1 - U_1, \dots, 1 - U_m)$.

The derivation of the above IE1 model consists of the following steps:

(1) Section 6.12.2: derivation of the expected frequency $\lambda_{IE1} = E[N_{IE1}]$ and the severities X_l per IE1 model segment l.

(2) Section 6.12.3: derivation of the dependent Bernoulli random variables B_l, combining the scenario results with prior probabilities. If there are many IE1 model segments, we describe a method that can be used under certain conditions to reduce the number of probabilities to estimate.

(3) Section 6.12.4: calibration of the resulting IE1 model to the IE1 scenario results SC^{IE1}. The fit should be analyzed and, if necessary, improved by changing parameters of the IE1 model.

6.12.1.1 Dependency between the severities per event for different model segments

As mentioned in Section 6.12.1, for any IE1 info event, the dependency between the Gen Pareto severities X_l for the different IE1 model segments $l = 1, \dots, m$ (given that they exceed the corresponding IE1 model segment modeling threshold $t_{IE1,l}$) is modeled by a flipped Clayton copula. Note that this has no impact on the dependency between the severities for different IE1 info events; these are by default assumed to be independent. Instead, it means that, given an IE1 info event and the corresponding values in $\{0,1\}$ of the dependent Bernoulli random variables B_l, the severities X_l for which $B_l = 1$, i.e. the loss severity for the IE1 model segment l exceeds the corresponding IE1 model segment modeling threshold $t_{IE1,l}$, have a dependency that is given by the flipped Clayton copula.

As a potential simplification, the dependency can be implemented as follows: for a given IE1 info event, sample the severities X_l for *all* IE1 model segments (not only those for which $B_l = 1$) according to the flipped Clayton copula (e.g. sample independently and then reorder). Then only keep the severities X_l for the IE1 model segments for which $B_l = 1$.

6.12.2 Derivation of the frequency and the severities by IE1 model segment

The mean $\lambda_{IE1} = E[N_{IE1}]$ is derived in Section 6.7.

The Gen Pareto severities $X_l = X_{IE1,l}$ per IE1 model segment l for loss severities exceeding the IE1 model segment modeling threshold $t_{IE1,l}$ are derived by comparison with the scenario results. However, the comparison is between the cumulative distribution functions (CDF) of the severities only and not between the exceedance frequency curves as in the case in which there is only one IE1 model segment (Section 6.11.2).

The CDF $F_l = F_{IE1\,scenarios,l}$ of the scenarios is derived from the scenario severities $x_{s,l}$ for the IE1 model segment l by (where the sum is over all scenarios assigned to IE1):

$$F_l(x) = 1 - \frac{\sum_s f_s \cdot 1_{\{x_{s,l} \geq x\}}}{\sum_s f_s}$$

Note that the selection of "≥" instead of ">" is on purpose: it is assumed that the scenario severity could be slightly higher than x_s.

It is possible to consider in the CDF for the scenarios for an IE1 model segment also additional data given by as-if adjusted historical losses for which only the loss to the IE1 model segment is known but not the loss from the same IE1 info event for other IE1 model segments.

6.12.3 Derivation of the dependent Bernoulli random variables

The probabilities $P[B_1 = b_1, \dots, B_m = b_m]$ for $(b_1, \dots, b_m) \in \{0,1\}^m$ are derived by Bayesian inference, combining the IE1 scenario results with prior probabilities to get posterior probabilities that can be seen as a weighted average of the prior probabilities and the probabilities implied by the scenario results. This is described by the following four steps. If there are many IE1 model segments, the method described at the end of this section might be used prior to the four steps. Mathematical background on the Bayesian inference used is provided in Section 6.14.3.

6.12.3.1 Step 1: enumerating the probabilities

It is convenient to express the probabilities $P[B_1 = b_1, \dots, B_m = b_m]$ by enumerating/ordering the combinations for $(b_1, \dots, b_m) \in \{0,1\}^m$ using a map $z: \{0,1\}^m \to \{1, \dots, 2^m\}$ with $z(0, \dots, 0) = 2^m$ and defining the probabilities through a discrete random variable $Z \in \{1, \dots, 2^m\}$, so that

$$P[B_1 = b_1, \dots, B_m = b_m] = P[Z = z(b_1, \dots, b_m)]$$

We set:

$$P[B_1 = 0, \dots, B_m = 0] = P[Z = z(0, \dots, 0)] = P[Z = 2^m] = 0$$

The objective then is to derive probabilities of Z for $j = 1, \dots, 2^m - 1$ such that for each $(b_1, \dots, b_m) \in \{0,1\}^m$

$$P[B_1 = b_1, \dots, B_m = b_m] = P[Z = z(b_1, \dots, b_m)]$$

6.12.3.2 Step 2: processing the scenario results

In Step 2, the scenario results are processed to provide realizations, denoted z_q, of the random variable Z. To this end, consider:

- $SC_{exp,dam}^{IE1}$ = set of all IE1 experience and damage event scenarios after the adjustment from Section 6.7.2, enumerated by $q = 1, \dots, r$

Note that portfolio structure scenarios are not considered because by definition they typically do not capture events affecting several IE1 model segments (e.g. LOBs).

From each scenario $q = 1, \dots, r$ in $SC_{exp,dam}^{IE1}$, a realization z_q of Z is derived as follows:

(1) Convert the scenario severities $(x_{q,1}, \dots, x_{q,m})$ to a vector $(b_{q,1}, \dots, b_{q,m}) = \left(1_{\{x_{q,1} \geq t_1\}}, \dots, 1_{\{x_{q,m} \geq t_m\}}\right) \in \{0,1\}^m$ and get the realization z_q of Z by applying the function z:

$$z_q = z\left(1_{\{x_{q,1} \geq t_1\}}, \dots, 1_{\{x_{q,m} \geq t_m\}}\right)$$

where $1_{\{\dots\}}$ is the indicator function.

(2) The scenario frequencies f_q are scaled to "weights" ω_q such that the weight of an IE1 experience scenario with a frequency $\frac{1}{n}$, where n is the length of the observation period (Section 6.6.4), would be equal to 1:

$$\omega_q = n \cdot f_q$$

6.12.3.3 Step 3: selection of prior probabilities

For the prior probabilities $\tilde{p}_j$ for $P[Z = j]$, we could assume that all outcomes are equally likely, i.e. $\tilde{p}_j = \frac{1}{2^m - 1}$. However, a more realistic assumption for the prior probabilities $\tilde{p}_j$ may be that the simultaneous losses to different IE1 model segments occur independently. In this case, the prior probabilities $\tilde{p}_j$ are estimated as follows:

(1) Estimate the expected frequency $\tilde{\lambda}_l$ of the severities to IE1 model segment l exceeding the modeling threshold $t_l = t_{IE1,l}$ from *all* IE1 scenarios (not only those in $SC^{IE1}_{exp,dam}$) by

$$\tilde{\lambda}_l = \sum_{\substack{IE1\ scenarios\ s \\ with\ x_{s,l} \geq t_l}} f_s$$

(2) Estimate from this the probability q_l for $P[B_l = 1]$ by

$$q_l = \frac{\tilde{\lambda}_l}{\lambda}$$

(3) Given j, let $(b_1, \dots, b_m) = z^{-1}(j)$, then the prior probability $\tilde{p}_j$ for $P[Z = j] = P[B_1 = b_1, \dots, B_m = b_m]$ is given by (note that it is conditional on not all $b_l = 0$):

$$\tilde{p}_j = \frac{\prod_{l=1}^m {q_l}^{b_l} \cdot (1 - q_l)^{1-b_l}}{1 - \prod_{l=1}^m (1 - q_l)}$$

6.12.3.4 Step 4: calculation of the posterior probabilities

For $j = 1, \dots, 2^m - 1$, the posterior probabilities $P[Z = j]$ are given by:

$$P[Z = j] = \kappa \cdot \tilde{p}_j + (1 - \kappa) \cdot \frac{\sum_{q=1}^r \omega_q \cdot 1_{\{z_q = j\}}}{\sum_{q=1}^r \omega_q}$$

with the "credibility parameter"

$$0 \leq \kappa = \frac{\alpha}{\alpha + \sum_{q=1}^r \omega_q} \leq 1$$

where the parameter α is by default set equal to $2^m - 1$. Intuitively, the posterior probabilities are given by a "credibility weighted sum" of the prior probabilities $\tilde{p}_j$ and the probabilities resulting from the "observations" given by the scenario results. If α is large relative to the "weighted number of observations" $\sum_{q=1}^{r} \omega_q$, more credibility is given to the prior probabilities.

6.12.3.5 Reduction of parameters if there are many IE1 model segments

If there is a large number m of IE1 model segments, then the number 2^m of probabilities to estimate can become large. A reduction in the number of probabilities is possible if it is known "a priori" that there are disjoint groups of IE1 model segments such that there cannot be an IE1 event that produces simultaneous losses to several of these groups. If this option is used, it needs to be well justified.

Assume that there are g such groups $u = 1, \dots, g$ and denote:

$$P[B_1 = b_1, \dots, B_m = b_m] = P[\vec{B}_1 = \vec{b}_1, \dots, \vec{B}_g = \vec{b}_g]$$

By assumption, this probability is zero if $\vec{b}_u$ is non-zero for more than one group u. Otherwise, if $\vec{b}_u \neq 0, \vec{b}_v = 0 \; for \; v \neq u$, then:

$$\begin{aligned} P[B_1 = b_1, \dots, B_m = b_m] &= P[\vec{B}_u = \vec{b}_u \,|\, \vec{B}_u \neq 0, \vec{B}_v = 0 \; for \; v \neq u] \cdot P[\vec{B}_u \neq 0, \vec{B}_v = 0 \; for \; v \neq u] \\ &= P[\vec{B}_u = \vec{b}_u \,|\, \vec{B}_u \neq 0] \cdot P[\vec{B}_u \neq 0] \end{aligned}$$

So, there are two steps:

(1) Estimate for each group u the probability $P[\vec{B}_u \neq 0]$ that (only) this group incurs a loss.

(2) For each group u, estimate the co-occurrence probabilities $P[\vec{B}_u = \vec{b}_u \,|\, \vec{B}_u \neq 0]$ within this group. This can be done for each group separately by the approach described above, combining the scenario results for that group with prior probabilities.

6.12.4 Calibration of the IE1 model to the IE1 scenario results

The calibration of the IE1 model is assessed by comparing the excess frequencies between the IE1 frequency-severity model (exceedance frequency curve $f_{IE1\,model}$) and the IE1 scenarios after the adjustment from Section 6.7 (exceedance frequency curve $f_{IE1\,scenarios}$), where

- $f_{IE1\,model}$ is derived as in Section 6.11.2 from the frequency-severity model (N, X) with Poisson distributed frequency N with $E[N] = \lambda$ and severity X given by the sum over the severities per IE1 model segment:

$$X = \sum_{l=1}^{m} B_l \cdot X_l$$

The cumulative exceedance distribution function $P[X \geq x]$ is typically estimated from simulations of the IE1 model. Here, the loss to each IE1 model segment l is either zero or larger than the corresponding IE1 modeling threshold $t_{IE1,l}$.

- $f_{IE1\ scenarios}$ is derived as explained in Section 6.11.3 from the total scenario severities, which includes also positive losses to IE1 model segments below the corresponding IE1 modeling thresholds $t_{IE1,l}$. It is possible to consider here as additional data also as-if adjusted historical losses for which only the total IE1 info event loss is known but not the decomposition of the loss into losses by IE1 model segment.

The two exceedance frequency curves should be compared for amounts in excess of the minimum $min\{t_{IE1,l}, l = 1, \ldots, m\}$ of the IE1 model segment modeling thresholds (Section 4.5) and over the entire range, and specifically comparing return periods for high amounts.

It is expected that the exceedance frequency curve of the IE1 model may be more conservative than the curve from the IE1 scenarios, as the IE1 model is intended to account for IE1 info events not covered by the scenarios, specifically with regard to the severities per IE1 model segment and the co-occurrence of such severities.

In Section 6.12.5, we explain how the reasonableness of the fit of the two exceedance frequency curves can be analyzed and, if necessary, improved.

6.12.5 Analyzing and improving the fit of the IE1 model

The two drivers of the IE1 model are:

(1) Distribution of the severities X_l by IE1 model segment

(2) Co-occurrence probabilities, i.e. the joint distribution of the Bernoulli random variables $(B_1, \ldots, B_m)$

The objective of the following is to analyze the impact of the two drivers and the reasonableness of the IE1 model and, if required, to improve the IE1 model by adjusting co-occurrence probabilities until there is a reasonable fit that is consistent with the expert judgment about the nature of the business considered. Adjustments to the severities are possible provided that the resulting fit from Section 6.12.2 is reasonable and are not further discussed.

6.12.5.1 Identifying the most material contributors

For analyzing the IE1 model, it can be helpful to first identify the parameters with the most material contribution to the results:

(1) Identify the most material IE1 model segments on standalone basis, based on the scenario results per IE1 model segment and the fitted severity distributions and the expected occurrence frequencies (see below under "mathematical background" for the derivation)

$$\lambda_l = \lambda \cdot \sum_{\substack{(b_1,\ldots,b_m)\in\{0,1\}^m \\ with\ b_l=1}} P[B_1 = b_1, \ldots, B_m = b_m]$$

(2) Identify the co-occurrence probabilities of the most material IE1 model segments. E.g. for two IE1 model segments l and j, for $c_l, c_j \in \{0,1\}$:

$$P\left[B_l = c_l, B_j = c_j\right] = \sum_{\substack{(b_1,\ldots,b_m)\in\{0,1\}^m \\ with\ b_l=c_l\ and\ b_j=c_j}} P[B_1 = b_1, \ldots, B_m = b_m]$$

If several IE1 model segments have a similar "standalone magnitude", then the co-occurrence probability for a simultaneous loss to all of them might be the most material.

The most material co-occurrence probabilities should be assessed for example by comparing them to the probabilities implied by the scenario results and expert judgment about the nature of the business and simultaneous losses.

It can also be useful to assess the probability of co-occurrence of large losses, which combines severities and co-occurrence probabilities:

(3) Expected frequency of co-occurrence of large losses to IE1 model segments l and j:

$$\lambda_{IE1} \cdot P\left[X_l\ is\ large\ and\ X_j\ is\ large\right] \cdot P\left[B_l = 1\ and\ B_j = 1\right]$$

6.12.5.2 Adjustments to the co-occurrence probabilities

Co-occurrence probabilities can be adjusted by adjusting the prior or the posterior probabilities. In the following, we focus on the adjustment of the posterior probabilities. The challenge with adjusting co-occurrence probabilities is that changing one probability or one set of probabilities may have an impact on other probabilities (in particular, all probabilities (obviously) need to be non-negative and add up to 1).

It may be that one wants to adjust one or several co-occurrence probabilities involving only some but not all IE1 model segments, e.g. $P\left[B_l = 1, B_j = 1\right]$, where, as above,

$$P\left[B_l = c_l, B_j = c_j\right] = \sum_{\substack{(b_1,\ldots,b_m)\in\{0,1\}^m \\ with\ b_l=c_l\ and\ b_j=c_j}} P[B_1 = b_1, \ldots, B_m = b_m]$$

Illustrated by this case, it may be reasonable first to decide on how to adjust the probability on the left hand side and then adjust the probabilities on the right hand side by multiplication with a common factor.

As a further example, assume that the two IE1 model segments l and j have been identified and that their bivariate co-occurrence probabilities $P\left[B_l = 1, B_j = 1\right]$, $P\left[B_l = 0, B_j = 1\right]$, $P\left[B_l = 1, B_j = 0\right]$ and

$P[B_l = 0, B_j = 0]$ should be changed. These four probabilities obviously have to add up to 1, and we have for example:

$$P[B_l = 1] = P[B_l = 1, B_j = 1] + P[B_l = 1, B_j = 0]$$

So if it is assumed for example that the probability $P[B_l = 1]$ for "single occurrences" should not change, then $P[B_l = 1, B_j = 0]$ has to be changed by the negative of the change of $P[B_l = 1, B_j = 1]$. If for example also $P[B_j = 1]$ should not change, then the four probabilities are e.g. determined by the change of $P[B_l = 1, B_j = 1]$. On the other hand, if e.g. $P[B_l = 1, B_j = 1]$ is increased and $P[B_l = 0, B_j = 0]$ decreased by the same amount, then the probabilities $P[B_l = 1]$ and $P[B_j = 1]$ both increase.

6.12.5.3 Mathematical background

For the IE1 model as described in Section 6.12.1, relationships between the expected occurrence frequency of a probabilistic event A and probabilities of such events and the expected frequency $\lambda_{IE1} = E[N_{IE1}]$ can be derived by conditioning on N_{IE1}:

$$E[\#\{occurrences\ of\ event\ A\}] = \sum_{n\geq 0} E[\#\{occurrences\ of\ event\ A\}|N_{IE1} = n] \cdot P[N_{IE1} = n]$$

and using that $E[N_{IE1}] = \sum_{n\geq 0} n \cdot P[N_{IE1} = n]$. Specifically, the expected number of realizations of a sequence $(b_1, \dots, b_m) \in \{0,1\}^m$ is given by

$$E\left[\sum_{i=1}^{N_{IE1}} 1_{\{B_1=b_1,\dots,B_m=b_m\}}\right] = \lambda_{IE1} \cdot P[B_1 = b_1, \dots, B_m = b_m]$$

and the expected number λ_l of positive losses per IE1 model segment l is

$$\lambda_l = \lambda_{IE1} \cdot P[B_l = 1] = \lambda_{IE1} \cdot \sum_{\substack{(b_1,\dots,b_m)\in\{0,1\}^m \\ with\ b_l=1}} P[B_1 = b_1, \dots, B_m = b_m]$$

6.13 IE2 frequency-severity model

6.13.1 Introduction

In view of the form of the IE2 model as set out in Section 6.2.1, the following need to be derived:

(1) IE2 modeling threshold t_{IE2}, which is explained in Section 6.13.2

(2) Poisson distributed frequency random variable N with mean λ, which is explained in Section 6.13.3

(3) Gen Pareto severity X with the IE2 modeling threshold t_{IE2}, which is explained in Section 6.13.3.

6.13.2 Derivation of the IE2 modeling threshold

For deriving the IE2 modeling threshold t_{IE2}, the following two quantities are calculated:

(1) the minimum of the IE2 scenario severities: $u_1 = min\{x_s | IE2\ scenario\ s\ \}$

(2) the 95% quantile of the distribution of S_{AER} minus its mean: $u_2 = q_{95\%}(S_{AER}) - E[S_{AER}]$

The IE2 modeling threshold t_{IE2} is then selected in relation to u_1 and u_2 by the reinsurer, explaining the choice. There should be no large gap between the IE2 modeling thresholds and the smallest IE2 scenario exceeding the threshold (otherwise, the frequency at this IE2 scenario may be underestimated).

The rationale for u_2 is that the IE2 model should model info events with a return period of 20 years or higher, corresponding to a 95% quantile, which should not already be included in the AER model to avoid double counting.

6.13.3 Derivation of frequency and severity

The mean $\lambda_{IE2} = E[N_{IE2}]$ of the frequency N_{IE2} is derived by summing the expected occurrence frequencies of the IE2 scenarios that exceed the IE2 modeling threshold:

$$\lambda_{IE2} = \sum_{\substack{IE2\ scenarios\ s \\ with\ x_s \geq t_{IE2}}} f_s$$

The Gen Pareto distribution of the severity X_{IE2} is determined by the following parameters (Section 6.14.2)

- t_{IE2} = IE2 modeling threshold
- $\alpha_{initial}^{IE2}$ = "initial Pareto-alpha" parameter (at the IE2 modeling threshold) of Gen Pareto

- α_{tail}^{IE2} = "tail Pareto-alpha" parameter (at infinity) of Gen Pareto

The Gen Pareto distribution is fitted to the IE2 scenarios SC^{IE2}. The approach is analogous to the approach from Section 6.11.2 and may involve expert judgment to a larger degree as there may be fewer IE2 scenarios.

6.13.4 Exceedance frequency curve for the IE2 scenarios

The exceedance frequency curve for the IE2 scenarios (x_s, f_s) is given by the map $x \to g(x)$ with

$$g(x) = \sum_s f_s \cdot 1_{\{x_s \geq x\}}$$

where the sum is over all scenarios assigned to IE2 and the indicator function is defined as $1_{\{x_s \geq x\}} = 1$ if $\{x_s \geq x\}$ and zero otherwise. Note that the selection of "≥" and not ">" is on purpose: it is assumed that the scenario severity could be slightly higher than x_s.

6.14 Mathematical background

For random variables of losses, we generally use the convention that a positive amount corresponds to a loss.

6.14.1 Frequency-severity model, exceedance frequency curve

Two important tools for the model are frequency-severity models and exceedance frequency curves, which are defined as follows:

(1) **Frequency-severity model**: consists of a frequency distribution and a severity distribution for individual losses per event in a year, with the assumptions of the collective model, i.e. frequency and severity are independent and severities are identically and independently distributed.

(2) **Exceedance frequency curve**: for every amount, the exceedance frequency curve provides the expected annual frequency for an event loss that is larger than or equal to the amount.[12] An exceedance frequency curve can be represented by a map $x \to f(x)$ from amount (x-axis) to expected exceedance frequency (y-axis).

Frequency-severity model and exceedance frequency curve are closely related and equivalent for a Poisson-distributed frequency. This is best explained with more mathematical notation:

- $N =$ frequency of the frequency-severity model (number of annual event losses)
- $X =$ severity of the frequency-severity model (given there is a positive loss)
- $N_x = \#\{X_i \geq x \text{ for } i = 1, \dots, N\}$ = exceedance frequency of the frequency-severity model = number of annual event losses larger than or equal to x
- Expected exceedance frequency $= E[N_x]$
- Exceedance frequency curve = the map $x \to f(x) = E[N_x]$

The following formula is the basis for the relationship between frequency-severity model and exceedance frequency curve:

$$E[N_x] = E[N] \cdot P[X \geq x].$$

It follows directly from this formula that the exceedance frequency curve can be constructed from the frequency-severity model. For the converse, the distribution of X can be derived from the exceedance frequency curve using the above formula. The distribution of N is uniquely determined if it is determined by its mean $E[N]$, which is the case for a Poisson distributed frequency.

[12] Note that on purpose we define the exceedance frequency curve by "≥" and not, as is more common, by ">".

6.14.2 Generalized Pareto (Gen Pareto) distribution

6.14.2.1 Standard parameterization

We use the following parameterization of the Gen Pareto distribution for the cumulative distribution function F: for $x \leq x_0$, $F(x) = 0$, and for $x \geq x_0$:

$$F(x) = 1 - \left(1 + \frac{\alpha_i}{\alpha_t} \cdot \left(\frac{x}{x_0} - 1\right)\right)^{-\alpha_t}$$

where:

- x_0 = threshold (scale parameter)
- α_i = "initial Pareto-alpha"
- α_t = "tail Pareto-alpha"

The Pareto distribution is the special case with $\alpha_t = \alpha_i =: \alpha$, where α is also called "shape parameter".

The names given to the alpha parameters are explained as follows:

- Let "log-log plot" be the plot of $log(x)$ against $-log\big(1 - F(x)\big)$. The log-log plot of a Pareto distribution with Pareto α is a straight line with slope equal to α.
- The log-log plot of a Gen Pareto distribution with the above parameters is a curve with slope of the tangent at x_0 equal to α_i and slope of the tangent at infinity equal to α_t, where the slope of the tangent, denoted $\alpha(x)$ below, is strictly monotone between x_0 and infinity.
- So the Gen Pareto distribution can be interpreted as starting at the threshold as a Pareto α_i-distribution and monotonously converging at infinity to a Pareto α-distribution.

Denote by $\alpha(x)$ the "instant Pareto-α at the amount x", which is defined to be the slope of the tangent to the log-log plot at the amount $x > x_0$ and gives for the Gen Pareto distribution:

$$\alpha(x) \;=\; -\frac{d}{dy}_{|y=log(x)} log\big(1 - F(e^y)\big) \;=\; \alpha_t \cdot \left(\frac{\frac{x}{x_0}}{\frac{\alpha_t}{\alpha_i} + \frac{x}{x_0} - 1}\right)$$

The inverse of the CDF of Gen Pareto is given by

$$F^{-1}(p) = x_0 \cdot \left(1 + \frac{\alpha_t}{\alpha_i} \cdot \left((1-p)^{-1/\alpha_t} - 1\right)\right)$$

6.14.2.2 Changing the threshold

Given losses with a Gen Pareto distribution with parameters $(x_0, \alpha_i, \alpha_t)$ and given $x_1 > x_0$, the conditional distribution of losses larger than x_1 is again Gen Pareto distributed with parameters $(x_1, \alpha(x_1), \alpha_t)$, where $\alpha(x)$ is given by the formula above. This can be shown by calculating the conditional exceedance probability, conditional on being larger than x_1.

It follows that if we have a Poisson-Gen Pareto frequency-severity model with parameters $(x_0, \lambda_0, \alpha_i = \alpha_0, \alpha_t)$, where x_0 is the threshold and λ_0 the expected exceedance frequency at the threshold, and $x_1 > x_0$, then the conditional model of losses larger than x_1 is again a Poisson-Gen Pareto frequency-severity model with parameters $(x_1, \lambda_1, \alpha_i = \alpha_1, \alpha_t)$, where

$$\lambda_1 = \lambda_0 \cdot \left(1 + \frac{\alpha_0}{\alpha_t} \cdot \left(\frac{x_1}{x_0} - 1\right)\right)^{-\alpha_t}$$

$$\alpha_1 = \alpha(x_1) = \alpha_t \cdot \left(\frac{\frac{x_1}{x_0}}{\frac{\alpha_t}{\alpha_0} + \frac{x_1}{x_0} - 1}\right)$$

6.14.2.3 Expected severity to layer

Given a Gen Pareto distributed random variable X with threshold x_0 and alpha parameters α_i and α_t, the expected severity to a layer with attachment point (priority) $a > x_0$ and cover (limit) c is given by:

$$g(a+c) - g(a) \quad with \quad g(x) = \frac{x_0}{(1-\alpha_t)} \cdot \frac{\alpha_t}{\alpha_i} \cdot \left(1 + \frac{\alpha_i}{\alpha_t} \cdot \left(\frac{x}{x_0} - 1\right)\right)^{-\alpha_t + 1}$$

This follows by integration from:

$$E\left[min\left\{c, max\{0, X-a\}\right\}\right] = \int_a^{a+c} \left[1 + \frac{\alpha_i}{\alpha_t} \cdot \left(\frac{x}{x_0} - 1\right)\right]^{-\alpha_t} dx$$

using that $min\left\{c, max\{0, X-a\}\right\} = (X-a)_+ - (X-a-c)_+$.

6.14.2.4 Alternative parameterization

A common alternative parameterization of the Gen Pareto distribution
is as follows:

- $\mu \in \mathbb{R}$: "location" parameter (substantially the threshold)
- $\sigma > 0$: "scale" parameter
- $\xi \in \mathbb{R}$.: "shape" parameter

The distribution in this case is given by:

$$F(x) = 1 - \left(1 + \xi\frac{x-\mu}{\sigma}\right)^{-\frac{1}{\xi}}$$

The parameters of the two parameterizations are related to each other by:

- $x_0 = \mu$
- $\alpha_t = {}^{1}/_{\xi}$
- $\alpha_i = {}^{\mu}/_{\sigma}$

6.14.3 Bayesian inference

The following explanations refer to the situation and notations from Section 6.12.3, which is not recalled in the following.

Mathematically, we use Bayesian inference by combining prior probabilities assumed to be Dirichlet distributed with the scenario results to get posterior probabilities that are again Dirichlet distributed (the dependencies we try to estimate correspond to a "categorical distribution", which is the "conjugate prior" of the Dirichlet distribution).

The prior probabilities $\tilde{P}_j$ for $j = 1, \dots, K = 2^m - 1$ are assumed to follow a Dirichlet distribution $Dir(\vec{\tilde{\alpha}})$ with $\vec{\tilde{\alpha}} = (\tilde{\alpha}_1, \dots, \tilde{\alpha}_K)$, where the parameters are related to the means of the prior probabilities $\tilde{P}_j$ by

$$\tilde{\alpha}_j = \alpha \cdot E[\tilde{P}_j]$$

with a positive scalar α, which by default is equal to K.

The posterior probabilities P_l are again Dirichet distributed, with parameter $\vec{\alpha} = (\alpha_1, \dots, \alpha_K)$ given by

$$\alpha_j = \tilde{\alpha}_j + \sum_{z_q = j \text{ for } q=1,\dots,r} \omega_q$$

Note that the sum above corresponds to $\#\{z_q = j \text{ for } q = 1, \dots, r\}$ if all "weights" ω_q are 1.

The probabilities $P[Z = j]$ are assumed to be given by the means of the posteriors P_l, i.e.

$$P[Z = j] = E[P_j] = \frac{\alpha_j}{\sum \alpha_j} = \frac{\tilde{\alpha}_j + \sum_{z_q = j \text{ for } q=1,\dots,r} \omega_q}{\sum \tilde{\alpha}_j + \sum_{q=1}^{r} \omega_q}$$

So, as $\sum E[\tilde{P}_j] = 1$:

$$P[Z = j] = \frac{\alpha \cdot E[\tilde{P}_j] + \sum_{z_q = j \text{ for } q=1,\dots,r} \omega_q}{\alpha + \sum_{q=1}^{r} \omega_q}$$

Note that α, which by default is equal to K, is related to the variance of the prior distribution: if α is large, then the variance is small, i.e. the priors are "rigid" and the impact of the observations is smaller. If α is small, then the variance is large, and the impact of the observations relative to the priors is higher. In this sense, α incorporates the degree of confidence in the priors relative to the observations.

7 Non-life insurance risk aggregation (AG)

7.1 Scope

Non-life insurance risk aggregation (AG)		
Attritional events (AE)	Individual events (IE)	Nat Cat events (NE)

The scope of the AG component is the derivation of the one-year change in the risk-bearing capital (net of ceded retrocession, discounted) related to non-life insurance risk (excluding the one-year change in the market value margin) by aggregating the outputs of the components AER, AEP, IE1, IE2, and NE, applying PEC & AC1 and AC2 of ceded retrocession and discounting, where applicable.

The following description does not include the adjustment for considering the assumed reinsurance structures from Section 4.7.

7.2 Output

The model output of the AG component is the distribution of the one-year change in the risk-bearing capital (net of ceded retrocession and discounted, excluding the change in the market value margin) related to non-life insurance risk and in the SST currency of the reinsurer, and more specifically the "one-year non-life insurance risk".

The additional output required for reporting purposes is specified in the StandRe template.

7.3 Input and notation

The following lists the input of AG, with amounts in SST currency:

- **Expected non-life insurance result** $BE_0\left(CF_{0\to 1,0}^{net,disc}\right)$: for the current underwriting year business, as defined in Section 2.4. *Comment*: if the expected insurance result is calculated taking into account the losses (and/or expenses) given by the IE1 model, then the frequency uplift (Section 6.7.1) for the expected frequency λ_{IE1} of the IE1 model does not need to be taken into account for calculating the expected non-life insurance result. I.e., it is possible here to only use the first term in the formula for λ_{IE1} from Section 6.7.1, without the term with the square root.

- **AER**: the output of AER as specified in Section 5.2, i.e. the lognormal distribution of S_{AER} (net of ceded retrocession)

- **AEP**: the output of AEP as specified in Section 5.2, i.e. the lognormal distributions of $S_{AEP,l}$ per AEP model segment l (netgross, which in some cases is the same as gross), the discount factors $d_{AEP,l}$ and the copula c_{AEP} between the AEP model segments
- Copula $c_{AER,AEP}$ between AER and AEP (see also Section 5.9)
- **IE1 with only one IE1 model segment**: the output of IE1 as specified in Section 6.2, as applicable gross or netgross, i.e. Poisson-Gen Pareto frequency-severity model (N_{IE1}, X_{IE1})
- **IE1 with several IE1 model segments**: the output of IE1 as specified in Section 6.2, i.e.
    - Poisson frequency distribution N_{IE1}
    - dependent severities $(B_{i,1} \cdot X_{i,1}, \dots, B_{i,m} \cdot X_{i,m})$ by IE1 model segment l
    - $B_{i,l} \sim B_i$ i.i.d. in i and $(B_1, \dots, B_m)$ are dependent Bernoulli random variables
    - $X_{i,l} \sim X_i$ i.i.d. in i and Gen Pareto severities $(X_1, \dots, X_m)$ with copula as specified in Section 6.12
- **IE2**: the output of IE2 as specified in Section 6.2, i.e. the Poisson-Gen Pareto frequency-severity model (N_{IE2}, X_{IE2}) (net)
- **NE**: the output of NE (event loss table or frequency-severity model(s) per NE model segment), as applicable gross or netgross
- **Ceded retrocession structures:** as applicable, the PEC & AC1 and AC2 of the ceded retrocession relevant to the current accident year

Where dependencies between random variables are not explicitly stated, the corresponding random variables are assumed to be independent.

7.4 Model overview

The AG component of StandRe is implemented by a Monte Carlo simulation in a suitable IT application. The following illustration provides an overview of the AG component. The sequence of individual steps in the illustration is from top to bottom. The notation used for the variables is defined in Section 7.3.

Typically, the inputs into AG from AE, IE and NE have losses as positive numbers. For the risk-bearing capital and for the expected non-life insurance result, on the other hand, losses are negative numbers. So the inputs into AG from AE, IE and NE need to be adjusted to get losses as negative numbers (see below).

For the application of ceded retrocession, the component contains "top-down disaggregation" as explained in Sections 7.5 and 7.6. This is used to split up the losses for the current accident year modeled by AEP, IE1 and NE by contract event and retro year, also allowing the application of ceded retrocession structures that differ by retro year. Ceded retrocession contracts that also cover prior accident or underwriting years can only be considered if the relevant recoverables and receivables from the ceded retrocession from prior years are available and are explicitly taken into account in the calculations.

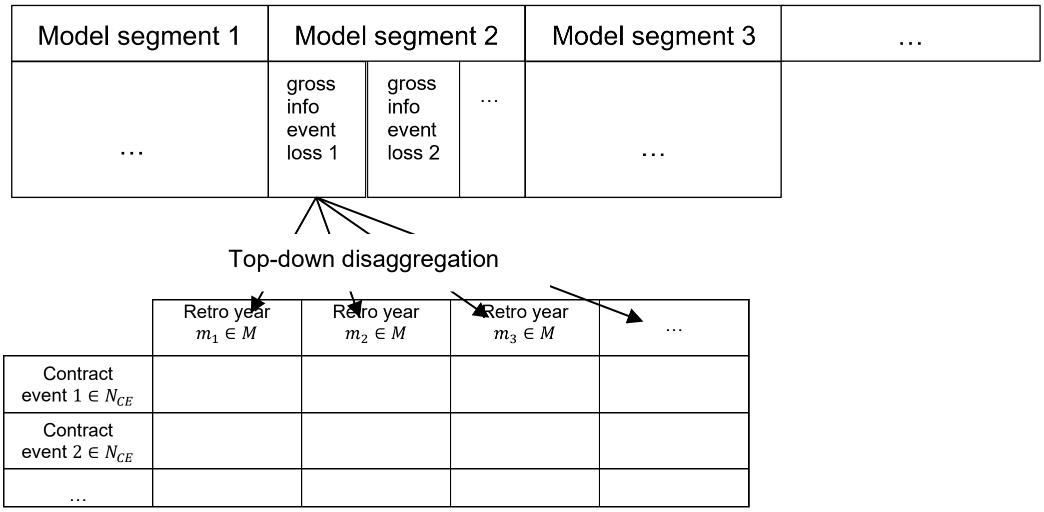
<table>
<tr><th></th><th colspan="5">AG</th></tr>
<tr><th></th><th>IE2</th><th>AER</th><th>AEP</th><th>IE1</th><th>NE</th></tr>
<tr><td>Input</td><td>• Frequency-severity model (N_{IE2}, X_{IE2})
• Net, discounted
• Independent of the other components</td><td colspan="2">• AER: lognormal distribution S_{AER} (net, discounted)
• $S_{AEP,l}$ (netgross, non-discounted) by AEP model segment l, with copula c_{AEP} from Section 5.9 and discount factor $d_{AEP,l}$
• Dependency between AER and AEP by copula $c_{AER,AEP}$ from Section 5.9
• Independent of the other components</td><td>• Frequency-severity model with frequency N_{IE1} and severity gross or netgross, non-discounted:
• If one IE1 model segment: one severity amount X_{IE1}
• If several IE1 model segments: vector of severities $(B_1 \cdot X_1, \ldots, B_m \cdot X_m)$
• Independent of the other components</td><td>• Event loss table or frequency severity model
• Gross or netgross, non-discounted
• Potentially several NE model segments
• Independent of the other components</td></tr>
<tr><td>Step 1</td><td colspan="5">• Draw joint dependent samples from the involved random variables. This may for example be done using a "reordering algorithm" (Section 2.16) for implementing the dependencies defined by copulas.
• For IE1 and NE, if PEC & AC1 are to be applied, then the severity samples in the granularity required for the application of the PEC & AC1 need to be retained.</td></tr>
<tr><td>Step 2</td><td>$S_{IE2} = \sum_{i=1}^{N_{IE2}} X_{IE2}$</td><td>$S_{AER}$</td><td>$S_{AEP,l}$ per AEP model segment l</td><td colspan="2">• Application of PEC & AC1 per IE1 and NE model segment as applicable to get netgross losses $\bar{X}_{i,l}$ and recoverables $\bar{R}_{i,l}$ (including impact on variable premiums and/or expenses/commissions)
• This may require first performing top-down disaggregation into contract events and retro years (see Section 7.5 for IE1)</td></tr>
</table>

				• Sum netgross losses for IE1 and NE to the level of AEP model segments to get $\bar{S}_l$
Step 3	S_{IE2}	S_{AER}	• Application of AC2 per model segment as applicable to get net losses $\bar{\bar{S}}_l$ and recoverables $\bar{\bar{R}}_l$ by AEP model segment l (including impact on variable premiums and/or expenses/commissions) • This may require first performing top-down disaggregation into retro years (see Section 7.6 for AEP, IE1 and NE)	
Step 4	S_{IE2}	S_{AER}	Aggregation and discounting of net losses to S_{AGR} and retrocession recoverables to R_{AGR}, as applicable, using for all the discounting factor d_{AEP} for simplicity: $S_{AGR} = d_{AEP} \cdot \sum \bar{\bar{S}}_l, \qquad R_{AGR} = d_{AEP} \cdot \sum\left(\bar{\bar{R}}_l + \sum_i \bar{R}_{i,l}\right)$	
Step 5	Sum all discounted net amounts to S_{total} $S_{total} = S_{IE2} + S_{AER} + S_{AGR}$			
Step 6	Calculate the mean $E[S_{total}]$ and deduct it (making losses to negative numbers) to get the (centered) one-year non-life insurance risk $Z_{total} = E[S_{total}] - S_{total}$			
Step 7	Add the "expected non-life insurance result" (losses are negative) to the one-year non-life insurance risk $Z_{total} + BE_0\left(CF_{0\to1,0}^{net,disc}\right)$			

In addition, the outputs required for reporting purposes from Section 7.2 are derived.

7.5 Top-down disaggregation for IE1 by info event

The "top-down disaggregation" is visualized by the following illustration, which is further explained in the following:

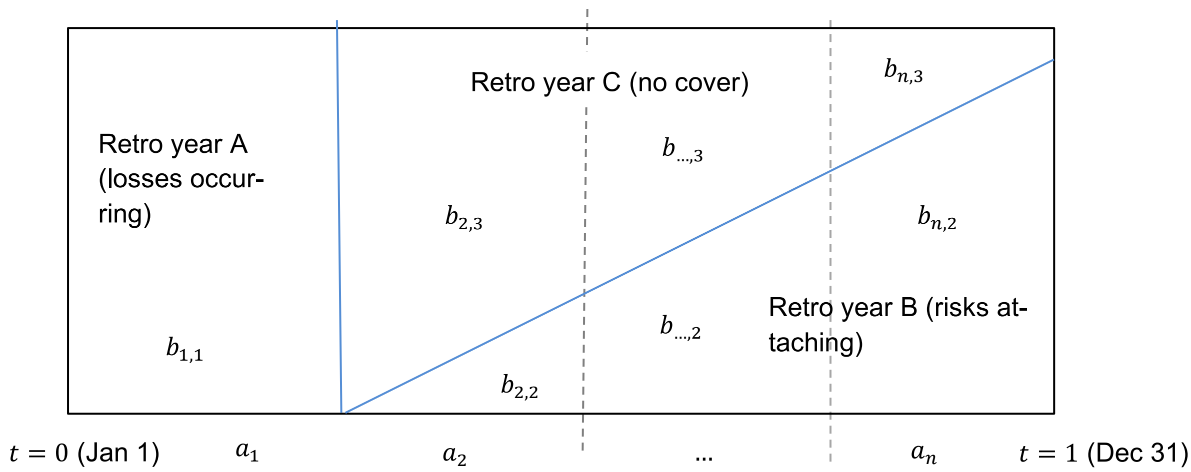


For the description of the top-down disaggregation, we fix an IE1 model segment l. The IE1 component produces IE1 info event losses $X_{CAY,l}$ for the current accident year. For the application of the relevant PEC & AC1 of ceded retrocession, it is relevant that an IE1 info event loss $X_{CAY,l}$ for the IE1 model segment l,

- may consist of several contract event losses (Section 2.6) for the purposes of the PEC & AC1,
- that the current accident year may be covered by several different PEC & AC1 ceded retrocession contracts corresponding to different "retro years" (i.e. different coverage periods and/or different coverage types such as "losses occurring" or "risks attaching") (Section 4.3.4).

The second point is illustrated by the following example, which is further explained below.

Current accident year (CAY)



To derive the decomposition by contract event and retro year, we define:

- $N_{CE,l}$ = random variable of the number of contract events per IE1 info event for the IE1 model segment l (assumed to be independent of $X_{CAY,l}$). Its distribution can be estimated using expert judgment from the number of contract events for the different IE1 scenarios for the IE1 modeling segment (where contract events are not distinguished by retro year).
- M_l = the set of all PEC & AC1 ceded retrocession contracts indexed by $m \in M_l$ affected by the current accident year for the IE1 model segment l in terms of cover period and coverage conditions, potentially including an additional "dummy contract" for no cover.

In the following, for simplicity of notation, we suppress the index l.

Depending on the occurrence dates of the contract events in the current year, the contract event losses $X_{CAY,j}$ for $j = 1, \ldots, N_{CE}$ corresponding to an IE1 info event loss X_{CAY} may be covered with different proportions by different ceded retrocession contracts/retro years $m \in M$, giving corresponding contract event losses $X_{CAY,j,m}$ per retro year m.

To capture these proportions, we decompose the current accident year time period from $t = 0$ to $t = 1$ into $k = 1, \ldots, n$ disjoint intervals of length a_k ($\sum_k a_k = 1$) such that on each interval k, the proportion of a contract event loss occurring in the interval k covered by the ceded retrocession contract $m \in M$ is approximately equal to $b_{k,m} \geq 0$ (with $\sum_m b_{k,m} = 1$), as illustrated in the figure above.

Then the stochastic decomposition of X_{CAY} into $X_{CAY,j,m}$ for $m \in M$ and $j = 1, \ldots, N_{CE}$ is given as follows:

$$X_{CAY,j,m} = X_{CAY} \cdot \frac{U_j}{\sum_{j=1}^{N_{CE}} U_j} \cdot b_{Z_j,m}$$

where:

- Z_j are independent and identically distributed random variables independent of X_{CAY} and N_{CE}, which take each of the values $k = 1, \ldots, n$ with probability a_k. If all contract event losses are assumed to occur on the same date, then the same $Z_j = Z$ can be chosen for all j.
- U_j for $j = 1 \ldots N_{CE}$ are i.i.d. uniform on $[0,1]$ and independent of X_{CAY}, N_{CE} and Z_j.

By the following calculation, we indeed get a decomposition of X_{CAY}:

$$\sum_{j=1}^{N_{CE}} \sum_{m \in M} X_{CAY,j,m} = X_{CAY} \cdot \sum_{j=1}^{N_{CE}} \frac{U_j}{\sum_{j=1}^{N_{CE}} U_j} \cdot \sum_{m \in M} b_{Z_j,m} = X_{CAY} \cdot \sum_{j=1}^{N_{CE}} \frac{U_j}{\sum_{j=1}^{N_{CE}} U_j} = X_{CAY}$$

The decomposition is based on the following assumptions:

(1) Each IE1 model segment event loss decomposes into a random number of contract event losses, where each contract event loss severity is a random proportion of the IE1 model segment event loss severity.

(2) Each contract event loss affects all ceded retrocession contracts in force at the date of the contract event loss, according to the deterministic proportion of the contracts at that date.

7.6 Top-down disaggregation for AEP, IE1 and NE for annual aggregates

In the following we describe how to stochastically disaggregate, for given model segments for AEP, IE1 and NE, losses aggregated by the current accident year into losses by retro year relevant to AC2. As the relevant amounts are annual aggregates, only proportional allocation to retro years is used. The method is a simplification of the method from Section 7.5 and consists of the following steps:

(1) Denote by S_{CAY} the aggregate loss from AEP, IE1 and NE for the current accident year.

(2) Determine the different ceded retrocession contracts/retro years m relevant to AC2 that are affected by the current accident year in terms of coverage period and coverage condition (e.g. "losses occurring" or "risks attaching").

(3) Determine the "share" b_m of each retro year m of the current accident year in terms of the proportion of the aggregate loss covered by m (with $\sum_m b_m = 1$).

(4) For each retro year m, the disaggregated loss $S_{m,CAY}$ for the retro year is given by:

$$S_{m,CAY} = S_{CAY} \cdot b_m.$$

8 Specification of the required input for the SST-Template

8.1 Scope and IT implementation

The *SST-Template* requires input on reinsurance business for the market risk standard model, the aggregation of the risk categories, and the MVM calculation (and the credit risk standard model). Some of this input is also required for reinsurers using an internal model for non-life insurance risk (see below). For StandRe users, the input comes from the *SST-StandRe-Template*. The following table provides an overview of the data or information, to whom it is applicable, where it is found in the *SST-StandRe-Template* and where it is specified.

Type of input to the *SST-Template*	Relevant for users of the following standard model	Relevant sheet in the *SST-StandRe-Template*	Specification provided in
SST balance sheet positions to be used for reinsurance business	All reinsurers	n/a	Section 8.2.4
Cash flows from reinsurance business-related balance sheet positions (in the following called "insurance cash flows")	Market risk standard model	RE_insurance_cash_flows	Section 8.2
(a) (Centered) non-life insurance risk distribution (b) Expected non-life insurance result	Aggregation standard model	RE_input_SST_Template	(a) RE_input_SST_Template (b) Section 2.4; premiums to reinsurer as positive numbers; in millions of SST currency
MVM component MVM_{reins} for non-life insurance risk, insurance position credit risk and scenarios, and input for non-hedgeable market risk	MVM standard model	RE_MVM	Section 8.3
All input required for the *SST-Template*, to be copied into the *SST-Template*		RE_input_SST_Template	See above

For users of an internal model for non-life insurance risk, there exist dedicated input fields or cells in which links to other cells in the *SST-StandRe-Template* have to be overwritten.

8.2 Input for the market risk standard model (cash flows)

8.2.1 Form of the input

The input for the market risk standard model consists of:

- One sequence of "insurance cash flows" for each of five currencies, as specified in Section 8.2.3

The required cash flows are the cash flows from all reinsurance business-related balance sheet positions and includes ceded retrocession and outstanding assumed reinsurance premium cash flows, in particular some asset positions.

The insurance cash flows are net of ceded retrocession and combine the cash flows from asset and liability positions. This corresponds to the simplification that in the market risk standard model, default risk is not considered for the valuation of the corresponding asset positions, specifically retrocession recoverables.

For both reinsurers using StandRe and reinsurers using an internal model for non-life insurance risk, the input for the insurance cash flows per currency is specified in Section 8.2.3 with the specification in Section 8.2.4 of the positions in the SST balance sheet to which the cash flows are intended to correspond. The specification is based on the "stationary portfolio assumption" explained in Section 8.2.2.

For StandRe users, the sheet *RE_insurance_cash_flows* of the *SST-StandRe-Template* automatically calculates an estimate of the cash flows. This estimate is based on the default approach described in Section 8.2.5 and uses StandRe data and the values of the SST balance sheet positions described in Section 8.2.4. It is possible, also for StandRe users, to deviate from the default approach. This is required in particular if the default approach produces materially incorrect figures.

8.2.2 Stationarity assumption

The approach specified in Sections 8.2.3 and 8.2.4 is based on the stationarity assumption of a stationary portfolio from time $t = 0$ to $t = 1$ (for investments as well as insurance business[13]), and consequently, as a simplification, the market risk is calculated on the balance sheet at time $t = 0$ (for both the investments and the insurance liabilities). For the stationary portfolio assumption ("Stationaritätsannahme"), see the document "*Technische Beschreibung Standardmodell Marktrisiko* ".

If the stationary portfolio assumption is materially wrong (as for example for a start-up or generally a company growing significantly in the current year), then generally an adjustment that requires prior approval by FINMA is required.

[13] In the following, insurance business is intended to include reinsurance (and retrocession).

8.2.3 Specification of the insurance cash flows

The insurance cash flows consist of five sequences of cash flows, with one sequence for each of the currencies CHF, EUR, USD, GBP, and JPY, as follows:

- (Best estimate) cash flow for each year after the SST reference date $t = 0$;
- For all insurance business in the balance sheet at time $t = 0$ (earned as well as unearned);
- With the convention that the cash flows are due at the end of the corresponding years (e.g. the cash flow for the first year is due just before time $t = 1$);
- See Section 8.2.4 for the positions in the SST balance sheet that are intended to be covered by the cash flows.

The cash flow amounts are specified as:

- Loss, expense and premium payments (incoming and outgoing),
- Losses to the reinsurer are positive numbers,
- Nominal (i.e. non-discounted),
- In millions of original currency (CHF, EUR, USD, GBP or JPY),
- Net of ceded retrocession (i.e. with ceded retrocession cash flows included).

8.2.4 Link to the SST balance sheet and consistency requirement

The cash flows from Section 8.2.3 are considered to correspond to the positions in the SST balance sheet at $t = 0$ listed in the following table together with their default assigned position in the sheet with title "SST Balance Sheet" in the *SST-Template*.

The table below also provides a specification of the SST balance sheet positions to be used for reinsurance business that applies to all reinsurers.

Consistency between the cash flows and the balance sheet positions is required as follows:

- The result of discounting the insurance cash flows for each currency with the FINMA-prescribed risk-free yield curve for that currency, converting to SST currency, and summing up over currencies, is compared to the sum of liabilities minus sum of assets of the relevant SST balance sheet positions. Deviations between the two amounts need to be explained.

Assets					
Name	Number in SST balance sheet of the default position	Position number (EHP-AVO-Kontenplan) of the default position	Description (German) in the SST balance sheet of the default position	Description	Possible simplified assumptions for deriving the corresponding cash flows
Retro receivables	115)	110'200'100	Forderungen gegenüber Versicherungsgesellschaften: abgegebene	Receivables from retrocessionaires for ceded retrocession claims payments for already paid assumed reinsurance claims	Whole amount is due at the end of the current year
Retro recoverables	101) 102), 103)	106'203'000	Aktive Rückversicherung: Schadenversicherungsgeschäft (number 101) split into "verdientes Geschäft" (number 102) and "unverdientes Geschäft" (number 103)	Receivables from retrocessionaires for ceded retrocession claims payments for not yet paid assumed reinsurance claims (split into earned and unearned due to Article 5 Paragraph 3 letter b ISO-FINMA)	Separate patterns for the earned and the unearned portion of this amount. Can as a simplification be the same patterns as for the position "reinsurance provisions"
Reinsurance premium receivables	116)	110'200'200	Forderungen gegenüber Versicherungsgesellschaften: übernommene	Receivables from cedants (or intermediaries) for assumed reinsurance premium payments	Whole amount is due at the end of the current year
Reinsurance deposits	86)	104'000'000	1.4 Depotforderungen aus übernommener Rückversicherung	Receivables from cedants (or intermediaries) for assumed reinsurance premium deposits	Separate patterns for the earned and the unearned portion of this amount. Can as a simplification be the same patterns as for the

					position "reinsurance provisions"

Liabilities					
Name	Number in SST balance sheet of the default position	Position number (Kontenplan) of the default position	Description (German) in the SST balance sheet of the default position	Description	Possible simplified assumptions for deriving the corresponding cash flows
Reinsurance provisions (reserves)	151) 152), 153), 154)	201'203'000	Aktive Rückversicherung: Schadenversicherungsgeschäft (number 151) split into "verdientes Geschäft" (number 152), "unverdientes Geschäft" (number 153), "sonstige" (number 154)"	Obligations towards cedants for assumed reinsurance claims payments (gross) (split into earned, unearned, other)	Separate patterns for the earned and the unearned portion of this amount.
Retro premium liabilities	189)	207'000'000 – 207'300'200	Sonstige Verbindlichkeiten aus dem Versicherungsgeschäft	Obligations towards retrocessionaires for ceded retrocession premium payments	Whole amount is due at the end of the current year
Retro deposit liabilities	186)	206'000'000	2.6 Depotverbindlichkeiten aus abgegebener Rückversicherung	Obligations towards retrocessionaires for ceded retrocession premium deposits	Separate patterns for the earned and the unearned portion of this amount. Can as a simplification be the same patterns as for the position "reinsurance provisions"

The right-most column in the table above specifies the simplifying assumptions that can be taken for deriving the cash flows corresponding to the balance sheet position using payment patterns.

The default approach for StandRe users for deriving the insurance cash flows described in Section 8.2.5 in addition assumes as a simplification:

- The payment pattern for the unearned business is equal to the payment pattern for the current accident year business (i.e. the business earned in the current year, including new business).

8.2.5 Calculation of the insurance cash flows from the StandRe template

8.2.5.1 General comments

In the following, we describe the default approach for StandRe users implemented in the sheet *RE_insurance_cash_flows* of the *SST-StandRe-Template* for calculating the insurance cash flows for each of the currencies CHF, EUR, USD, GBP, and JPY corresponding to the SST balance sheet positions from Section 8.2.4. This is presented in the form implemented in the spreadsheet such that adjustments to some of the parameters are possible.

The default approach is based on StandRe data for Attritional Events Reserve Risk (AER) and Attritional Events Premium Risk (AEP), where it is assumed that AER covers the prior accident years (PAY) and AEP the current accident year (CAY). StandRe users that define AER as prior underwriting years and AEP as current underwriting year can use these figures as a simplification (subject to materiality).

If a StandRe user uses a different approach, the consistency requirement from Section 8.2.4 with the SST balance sheet figures and the consistency with the StandRe figures in the SST-StandRe-Template need to be shown.

8.2.5.2 Description of the default approach

In the sequel, all amounts are in SST currency using FINMA-prescribed exchange rates as of the SST reference date $t = 0$. Unless indicated by the index "*disc*", amounts are non-discounted (i.e. nominal).

The input for the SST-Template is required to be in original currency, more precisely in one of the currencies $CCY =$ CHF, EUR, USD, GBP and JPY (see Section 8.2.3). Hence, the cash flows derived as described below must be converted at the end from SST currency to original currency by conversion with the FINMA-prescribed exchange rate from SST currency to the currency CCY at the SST reference date $t = 0$. This step is implemented in the *SST-StandRe-Template* but not described below.

For each of the currencies $CCY =$ CHF, EUR, USD, GBP, and JPY, we denote the insurance cash flows[14] that have the original currency CCY, but with amounts in SST currency, by

$$\left(CF_{k,CCY}\right)_{k\geq 1}$$

[14] Recall that this refers to the cash flows from all reinsurance business-related balance sheet positions.

where, by assumption, the first cash flow $CF_{k=1,CCY}$ is due at the end of the current year (time $t = 1$). The cash flows by currency are the sum of the cash flows for the share of the currency of each of the SST balance sheet positions from Section 8.2.4, with a minus for assets in line with Section 8.2.3.

In the default approach, the balance sheet positions are grouped into:

- "short-term cash flows";
- "longer-term earned cash flows";
- "longer-term unearned cash flows".

The information on the balance sheet positions is summarized in the following table:

Name	Value from SST balance sheet	Cash flows (by currency CCY)	Short-term or longer term
Assets			
Retro receivables	$BE_{disc}^{retro\ receiv}$	$CF_{k,CCY}^{retro\ receiv}$	Short-term
Retro recoverables	$BE_{disc}^{retro\ recov}$	$CF_{k,CYY}^{retro\ recov,earned}$ $CF_{k,CYY}^{retro\ recov,unearned}$	Longer-term
Reinsurance premium receivables	$BE_{disc}^{reins\ receiv}$	$CF_{k,CCY}^{reins\ receiv}$	Short-term
Reinsurance deposits	$BE_{disc}^{reins\ deposit}$	$CF_{k,CCY}^{reins\ deposit,earned}$ $CF_{k,CCY}^{reins\ deposit,unearned}$	Longer-term
Liabilities			
Reinsurance provisions (reserves)	$BE_{disc}^{reins\ res}$	$CF_{k,CCY}^{reins\ res,earned}$ $CF_{k,CCY}^{reins\ res,unearned}$	Longer-term
Retro premium liabilities	$BE_{disc}^{retro\ liab}$	$CF_{k,CCY}^{retro\ liab}$	Short-term
Retro deposit liabilities	$BE_{disc}^{retro\ deposit}$	$CF_{k,CCY}^{retro\ deposit,earned}$ $CF_{k,CCY}^{retro\ deposit,unearned}$	Longer-term

Hence, the total cash flows are given by summing over short-term and longer-term (un)earned cash flows:

$$CF_{k,CCY} = CF_{k,CCY}^{short-term} + CF_{k,CCY}^{longer-term,earned} + CF_{k,CCY}^{longer-term,unearned}$$

where the three summands on the right-hand side are given by

$$CF_{k,CCY}^{short-term} = CF_{k,CCY}^{retro\ liab} - CF_{k,CCY}^{retro\ receiv} - CF_{k,CCY}^{reins\ receiv}$$

$$CF_{k,CCY}^{longer-term,(un)earned} = CF_{k,CCY}^{reins\ res,(un)earned} + CF_{k,CCY}^{retro\ deposit,(un)earned} - CF_{k,CYY}^{retro\ recov,(un)earned} - CF_{k,CCY}^{reins\ deposit,(un)earned}$$

We denote for the balance sheet values corresponding to the three cash flows:

$$BE_{disc}^{short-term} = BE_{disc}^{retro\ liab} - BE_{disc}^{retro\ receiv} - BE_{disc}^{reins\ receiv}$$

$$BE_{disc}^{longer-term,earned} = e_{earned}^{reins\ res} \cdot BE_{disc}^{reins\ res} + e_{earned}^{retro\ deposit} \cdot BE_{disc}^{retro\ deposit} - e_{earned}^{retro\ recov} \cdot BE_{disc}^{retro\ recov} - e_{earned}^{reins\ deposit} \cdot BE_{disc}^{reins\ deposit}$$

$$BE_{disc}^{longer-term,unearned} = \left(1 - e_{earned}^{reins\ res}\right) \cdot BE_{disc}^{reins\ res} + \left(1 - e_{earned}^{retro\ deposit}\right) \cdot BE_{disc}^{retro\ deposit} - \left(1 - e_{earned}^{retro\ recov}\right) \cdot BE_{disc}^{retro\ recov} - \left(1 - e_{earned}^{reins\ deposit}\right) \cdot BE_{disc}^{reins\ deposit}$$

where

- e_{earned}^{BSP} = share of the earned portion of the total amount of balance sheet position BSP.

This share is for simplicity assumed not to depend on the currency CCY. The share is calculated where available by default as the ratio of the earned amount and the total amount in the SST balance sheet, and is otherwise required as an additional input.

8.2.5.3 General formula

The general idea is that the cash flows $\left(CF_{k,CCY}^{BSP,(un)earned}\right)_{k\geq 1}$ for a specific balance sheet position BSP and either earned or unearned are assumed to be given by the formula:

$$CF_{k,CCY}^{BSP,(un)earned} = \pi_{k,CCY}^{BSP,(un)earned} \cdot \rho_{CCY}^{BSP,(un)earned} \cdot BE_{nominal}^{BSP,(un)earned,StandRe} \cdot \kappa^{(un)earned}$$

where:

- $\pi_{k,CCY}^{BSP,(un)earned}$ = incremental payment pattern for the year k for the position BSP and either earned or unearned, with $\sum_{k\geq 1} \pi_{k,CCY}^{BSP,(un)earned} = 1$
- $\rho_{CCY}^{BSP,(un)earned}$ = share of the currency CCY of the total amount for the (un)earned part of the position BSP, with $\sum_{CCY} \rho_{CCY}^{BSP,(un)earned} = 1$; assumed to be independent of the year k
- $BE_{nominal}^{BSP,(un)earned,StandRe}$ = non-discounted (nominal) best estimate for the (un)earned part of the position BSP from StandRe data (where available) (in SST currency)

- $\kappa^{(un)earned}$ = scaling factor to ensure consistency with the amount from the SST balance sheet. Assumed to be independent of the position BSP, the year k and the currency CCY.

For the sequel, we denote:

- r_k^{CCY} = FINMA-prescribed risk-free rate for maturity k and currency CCY.

8.2.5.4 Short-term cash flows

For the cash flows $CF_{k,CCY}^{short-term}$, it is assumed as a simplification that the whole amount is due at time $t = 1$. For the default approach, the additional simplification is made that the cash flows are all assumed to be in SST currency, i.e. in the default approach, no split into currencies CCY is considered. The cash flows for year k in SST currency are thus given by

$$CF_{k,SST\ currency}^{short-term} = \begin{cases} \left(1 + r_1^{SST\ currency}\right) \cdot BE_{disc}^{short-term}: k = 1 \\ 0:\ k \geq 2 \end{cases}$$

and $CF_{k,CCY}^{short-term} = 0$ for any other currency. Companies can deviate from the default approach and instead manually input the split of short-term cash flows into currencies CCY in the corresponding cells in the spreadsheet. This needs to be described and justified in the calculation documentation.

8.2.5.5 Longer-term cash flows

In the default approach, we assume for the longer-term cash flows $CF_{k,CCY}^{longer-term,(un)earned}$ that the four corresponding balance sheet positions BSP have the same payment pattern, but with different patterns for earned and unearned and for the currency CCY, i.e.

$$\pi_{k,CCY}^{BSP,(un)earned} = \pi_{k,CCY}^{(un)earned}$$

8.2.5.6 Longer-term cash flows – earned

For the earned part, we make the simplifying assumption that it is sufficient to consider the prior accident years (PAY) covered by the AER model, and that this data provides the correct currency split. We can then use the following information on parameter segment level from the StandRe sheets, where each parameter segment m has one of the relevant currencies CCY assigned:

- Incremental payment patterns $\pi_k^{m,PAY}$ for each AER parameter segment m from the sheet "RE_AE_discount_factors"

- Non-discounted net best estimate $BEL_{PAY}^{m,net}$ of outstanding losses for each AER parameter segment m (in SST currency) from the sheet "RE_AER_parameter_segments"

Then the cash flows for the earned part for the currency CCY are given by (for $k \geq 1$):

$$CF_{k,CCY}^{longer-term,earned} = \sum_{m\ with\ currency\ CCY} \pi_k^{m,PAY} \cdot BEL_{PAY}^{m,net} \cdot \frac{BE_{disc}^{longer-term,earned}}{\sum_{\tilde{m}} BEL_{PAY,disc}^{\tilde{m},net}}$$

where the sum in the denominator on the right is over all parameter segments $\tilde{m}$ and, denoting by $CCY(\tilde{m})$ the currency of parameter segment $\tilde{m}$,

$$BEL_{PAY,disc}^{\tilde{m},net} = BEL_{PAY}^{\tilde{m},net} \cdot \sum_{k\geq 1} \frac{\pi_k^{\tilde{m},PAY}}{\left(1 + r_k^{CCY(\tilde{m})}\right)^k}$$

In the SST-StandRe-Template, the option is provided to enter inputs manually differing from what is calculated using StandRe figures, and for this reason we represent the above formula for $CF_{k,CCY}^{longer-term,earned}$ in the following equivalent form:

$$CF_{k,CCY}^{longer-term,earned} = BE_{disc}^{longer-term,earned} \cdot \frac{1}{d_{longer-term,earned}} \cdot \rho_{CCY}^{longer-term,earned} \cdot \pi_{k,CCY}^{longer-term,earned}$$

with the following terms with their default expression:

- Discount factor: $d_{longer-term,earned} = \frac{\sum_m BEL_{PAY,disc}^{m,net}}{\sum_m BEL_{PAY}^{m,net}}$
- Currency share: $\rho_{CCY}^{longer-term,earned} = \frac{\sum_{m\ with\ currency\ CCY} BEL_{PAY}^{m,net}}{\sum_m BEL_{PAY}^{m,net}}$
- Payment pattern:

$$\pi_{k,CCY}^{longer-term,earned} = \sum_{m\ with\ currency\ CCY} \pi_k^{m,PAY} \cdot \frac{BEL_{PAY}^{m,net}}{\sum_{\tilde{m}\ with\ currency\ CCY} BEL_{PAY}^{\tilde{m},net}}$$

8.2.5.7 Longer-term cash flows – unearned

For the unearned part of the longer-term cash flows, we make the simplifying assumption that it is sufficient to consider the current accident year (CAY) covered by the AEP model (the business earned in the current year including new business, with netgross figures). In particular, the CAY covered by the AEP model is assumed to provide the correct payment pattern and the correct split between currencies for the balance sheet positions considered. We can then use the following information on parameter segment level from the SST-StandRe-Template sheets, where each parameter segment m has one of the relevant currencies CCY assigned:

- Incremental payment patterns $\pi_k^{m,CAY}$ for each parameter segment m for AEP from the sheet "RE_AE_discount_factors"
- Non-discounted netgross expected premium $BEP_{CAY}^{m,netgross}$ for each AEP parameter segment m (in SST currency) from the sheet "RE_AEP_parameter_segments"

- Non-discounted netgross loss ratio $LR_{CAY}^{m,netgross}$ for each AEP parameter segment m from the sheet "RE_AEP_parameter_segments"

Then the cash flows for the unearned part for the currency CCY are given by (for $k \geq 1$):

$$CF_{k,CCY}^{longer-term,unearned} = \sum_{m \text{ with currency } CCY} \pi_k^{m,CAY} \cdot BEL_{CAY}^{m,netgross} \cdot \frac{BE_{disc}^{longer-term,unearned}}{\sum_{\tilde{m}} BEL_{CAY,disc}^{\tilde{m},netgross}}$$

where the sum in the denominator on the right is over all parameter segments $\tilde{m}$ and

$$BEL_{CAY}^{m,netgross} = BEP_{CAY}^{m,netgross} \cdot LR_{CAY}^{m\ netgross}$$

and, denoting by $CCY(\tilde{m})$ the currency of parameter segment $\tilde{m}$,

$$BEL_{CAY,disc}^{\tilde{m},,netgross} = BEL_{CAY}^{\tilde{m},netgross} \cdot \sum_{k\geq 1} \frac{\pi_k^{\tilde{m},CAY}}{\left(1 + r_k^{CCY(\tilde{m})}\right)^k}$$

In the sheet *RE_insurance_cash_flows* of the *SST-StandRe-Template* we provide the option to enter inputs manually differing from what is calculated using StandRe figures, and for this reason we represent the above formula for $CF_{k,CCY}^{longer-term,unearned}$ in the following equivalent form:

$$CF_{k,CCY}^{longer-term,unearned} = BE_{disc}^{longer-term,unearned} \cdot \frac{1}{d_{longer-term,unearned}} \cdot \rho_{CCY}^{longer-term,unearned} \cdot \pi_{k,CCY}^{longer-term,unearned}$$

with the following terms with their default expression:

- Discount factor: $d_{longer-term,unearned} = \frac{\sum_m BEL_{CAY,disc}^{m,netgross}}{\sum_m BEL_{CAY}^{m,netgross}}$

- Currency share: $\rho_{CCY}^{longer-term,unearned} = \frac{\sum_{m \text{ with currency } CCY} BEL_{CAY}^{m,netgross}}{\sum_m BEL_{CAY}^{m,netgross}}$

- Payment pattern:

$$\pi_{k,CCY}^{longer-term,unearned} = \sum_{m \text{ with currency } CCY} \pi_k^{m,CAY} \cdot \frac{BEL_{CAY}^{m,netgross}}{\sum_{\tilde{m} \text{ with currency } CCY} BEL_{CAY}^{\tilde{m},netgross}}$$

8.3 Market value margin (MVM)

The standard model for the MVM is described in the document "Technische Beschreibung SST-Standardmodell Aggregation und Mindestbetrag" in the section on the MVM. This includes the description of the standard method for calculating the component of the MVM for the non-hedgeable market risk.

In the *SST-Template*, the number relating to the MVM to be input in the sheet "General Inputs" is the component of the MVM denoted MVM_{reins} for non-life insurance risk, the credit risk of insurance positions including ceded retrocession, and scenarios. The MVM is then calculated in the *SST-Dashboard (SST-Tool)*, which takes the *SST-Template* as input, by combining this with the component of the MVM for the non-hedgeable market risk, which is calculated in the tool automatically, using the inputs from the *SST-Template* described in Section 8.3.2.

The component MVM_{reins} to be input into the *SST-Template* has to have the following form:

- in millions of SST currency,
- typically positive,
- considers all risks relevant for the MVM with the exception of the non-hedgeable market risk,
- discounted to time $t = 0$.

8.3.1 Standard method for the component MVM_{reins} for non-life insurance risk, insurance position credit risk, and scenarios

The standard method for reinsurers for the MVM component MVM_{reins} for non-life insurance risk, credit risk of insurance positions (including ceded retrocession), and scenarios corresponds to the method for primary non-life insurers. The starting point for the calculation is the following formula for the discounted MVM from the technical description of the standard model for aggregation and MVM, written for MVM_{reins} and with the component of the target capital denoted $ZK_k^{(0,k)\text{reins}}$ for $ZK_k^{(0,k)\text{Schaden}}$:

$$MVM_{reins} = \sum_{k\geq 1} \frac{\eta_{CoC} \cdot ZK_k^{(0,k)\text{reins}}}{\left(1 + r_{0,k+1}\right)^{k+1}}$$

Here, η_{CoC} denotes the cost of capital rate, $r_{0,k+1}$ the risk-free interest rate, and $ZK_k^{(0,k)\text{reins}}$ is the component of the target capital (calculated in terms of the expected shortfall) for year k for non-life insurance risk, insurance position credit risk, and scenarios. The year k refers to the one-year period from time k to time $k + 1$. In the following, we denote:

- $SCR_k^{reins} \equiv ZK_k^{(0,k)\text{reins}}$

The basic approach in the standard method is to decompose SCR_k^{reins} for $k = 0,1,2, \ldots$ into a sum over "risk charges" SCR_k^{RC} for suitable "risk classes" RC:[15]

$$SCR_k^{reins} = \sum_{RC} SCR_k^{RC}$$

[15] In general, for continuous random variables for simplicity, the expected shortfall of a sum of random variables (e.g. corresponding to one-year changes due to different risk categories) is equal to the sum of the *contribution shortfalls* over the risk categories, where a contribution shortfall is the expectation of the random variable conditional on the sum of the random variables being "in the shortfall area" of the sum. If the random variables are comonotone, the contribution shortfalls become the expected shortfalls.

We explain the risk charges SCR_k^{RC} first in more generality because this makes the underlying assumptions more transparent and is needed for the specific approach set out in Section 8.3.1.5. The risk charges SCR_k^{RC} for risk class RC for future years $k = 1,2, \ldots$ are calculated by:

$$SCR_k^{RC} = int_k^{RC} \cdot \delta_k^{RC} \cdot E_0^{RC}$$

where the "risk intensity" int_k^{RC} is equal to the "risk" (as measured by the centered, i.e. mean-zero expected shortfall) divided by the "exposure" $E_k^{RC} = \delta_k^{RC} \cdot E_0^{RC}$ for year k, with the "reference exposure" E_0^{RC} and the "run-off factors" δ_k^{RC}. As an example for illustration, the risk intensity may be high for non-proportional high excess Nat Cat business and lower for proportional Motor Hull business.

The main assumption made (and theoretical requirement for selecting δ_k^{RC} and E_0^{RC}) is:

- Assumption: the risk intensity remains constant over time:

  $$int_k^{RC} = int_0^{RC} = \overline{SCR}_0^{RC} / E_0^{RC}$$

  where $\overline{SCR}_0^{RC}$ denotes the centered expected shortfall for the risk class RC.

As background, note that according to Article 22 ISO and Article 2 Paragraph 2 ISO-FINMA, no new business is written after $t = 1$, so the target capital contains an expected result from new business only for the current year. Hence, for the current year 0, the centered expected shortfall is a better reference for the (centered) risks of future year k than the non-centered expected shortfall.

The above assumption implies that the above can be written as:

$$SCR_k^{RC} = int_0^{RC} \cdot \delta_k^{RC} \cdot E_0^{RC} = \delta_k^{RC} \cdot \overline{SCR}_0^{RC}$$

The selection of the "risk classes" RC is on the one hand given by the different "risk categories", e.g. non-life insurance risk or insurance position credit risk. On the other hand, the selection should be made by taking into account differences in risk intensity int_0^{RC} ("high or low") and run-off factors δ_k^{RC} ("long or short tail").

8.3.1.1 Risks in scope, risk classes

In view of the technical description of the standard model for aggregation and the MVM, the risks in scope of MVM_{reins} are:

- non-life insurance risk,
- insurance position credit risk, primarily the credit risk of ceded retrocession receivables/ recoverables,
- scenarios in scope.

These risks are represented by the risk classes $RC \in \{PY, CY, URR, ICR, scenario\ l\}$, where ICR denotes the insurance position credit risk, and the risk classes PY, CY, and URR, respectively, correspond to a decomposition of the non-life insurance risk for the year k into the components:

- PY_k = PY risk of year k: the risk from losses occurring[16] before time k;
- CY_k = CY risk of year k: the risk from losses occurring between time k and $k+1$;
- URR_k = URR risk of year k: the risk from losses occurring after time $k+1$, where URR stands for unexpired risk reserves.

In general, from time k to time $k+1$, the following happens:

- The CY risk for year k is "fully earned" at time $k+1$ and thus is PY risk for year $k+1$.
- The portion of the URR risk that is earned in year $k+1$ is CY risk for year $k+1$.

The following table shows how the PY, CY, and URR risk of year k results from the PY, CY, and URR risk of year 0:

<table>
<tr><th colspan="5">Breakdown of SST one-year risk along existing (i.e. written) business at $t = 0$ and new business between $t = 0$ and $t = 1$</th></tr>
<tr><th colspan="3">One-year risk for year 0 (i.e. $t = 0$ to $t = 1$)</th><th colspan="2">One-year risk for year $k \geq 1$ (i.e. $t = k$ to $t = k + 1$)</th></tr>
<tr><td>Reserve risk</td><td>PY</td><td>existing at $t = 0$ and earned at $t = 0$</td><td>Same as on the left</td><td rowspan="5">PY_k</td></tr>
<tr><td rowspan="5">Premium risk</td><td rowspan="2">CY</td><td>existing at $t = 0$ and unearned at $t = 0$ but earned at $t = 1$</td><td>Same as on the left</td></tr>
<tr><td>new between $t = 0$ and $t = 1$ and earned at $t = 1$</td><td>Same as on the left</td></tr>
<tr><td rowspan="3">URR</td><td rowspan="3">existing at $t = 0$ and unearned at $t = 1$

new between $t = 0$ and $t = 1$ and unearned at $t = 1$</td><td>existing at $t = 0$ and unearned at $t = 1$ but earned at $t = k$</td></tr>
<tr><td>new between $t = 0$ and $t = 1$ and unearned at $t = 1$ but earned at $t = k$</td></tr>
<tr><td>existing at $t = 0$ and unearned at $t = k$ but earned at $t = k + 1$</td><td>CY_k</td></tr>
</table>

[16] The expression "loss occurring at time t" is used here and in the following for simplicity, to avoid having to introduce another expression that would cover both "losses occurring" and "claims made" covers. For "claims made" covers, the expression should be understood to mean "claim made at time t".

			new between $t = 0$ and $t = 1$ and unearned at $t = k$ but earned at $t = k + 1$	
			existing at $t = 0$ and unearned at $t = k + 1$	URR_k
			new between $t = 0$ and $t = 1$ and unearned at $t = k + 1$	

8.3.1.2 Standard method overall

In the set-up from Section 8.3.1 and the selected risk classes RC, we get:

(A) $SCR_k^{reins} = SCR_k^{PY} + SCR_k^{CY} + SCR_k^{URR} + SCR_k^{ICR} + \sum_l SCR_k^{scenario\ l}$

According to the assumption of the standard method, for each risk class $RC \in \{PY, CY, URR, ICR, scenario\ l\}$:

(B) $SCR_k^{RC} = int_0^{RC} \cdot \delta_k^{RC} \cdot E_0^{RC} = \delta_k^{RC} \cdot \overline{SCR}_0^{RC} \qquad for\ k = 1,2, \ldots$

We assume:

(C) For the non-life insurance risk classes $RC \in \{PY, CY, URR\}$, the default exposure E_0^{RC} is the (non-discounted) best estimate of the outstanding loss payments for the RC at time 0, and the run-off factor δ_k^{RC} is the ratio of the (non-discounted) best estimate of the outstanding loss payments for the RC at time k in the denominator and at time 0 in the numerator.

The MVM component MVM_{reins} for non-life insurance risk, insurance position credit risk, and scenarios is thus:

$$MVM_{reins} = \eta_{CoC} \cdot \sum_{k \geq 1} \frac{\overline{SCR}_0^{PY} \cdot \delta_k^{PY} + \overline{SCR}_0^{CY} \cdot \delta_k^{CY} + \overline{SCR}_0^{URR} \cdot \delta_k^{URR} + \overline{SCR}_0^{ICR} \cdot \delta_k^{ICR} + \sum_l \overline{SCR}_0^{scen\ l} \cdot \delta_k^{scen\ l}}{(1 + r_{0,k+1})^{k+1}}$$

Currently, the insurance position credit risk $\overline{SCR}_0^{ICR}$ for the MVM can still be calculated with Basel III.

8.3.1.3 Discussion of the assumptions

- The risk charges for the different risk categories are added up according to (A) above, corresponding to an assumption of co-monotonicity, i.e. no benefit for diversification. This can be considered conservative.

- Diversification within a risk category typically decreases over time due to the run-off of the risks, i.e. the risk intensity increases, but the projection approach (B) and (C) above assumes constant risk intensity. This be considered optimistic.

8.3.1.4 Standard method for risk classes, run-off factors

In the following table, we summarize the approach including simplifications applied for StandRe and the formulas for the run-off factors δ_k^{RC}. The following assumptions/ simplifications are made, which are set out in detail below:

- The URR risk for years $k = 1,2, \ldots$ is disregarded.
- For the CY risk for years $k = 1,2, \ldots$ the reference exposure used is the best estimate of the CY for year 0; the run-off factors are estimated by the earnings pattern of the URR (at $t = 1$); and the risk intensity is the ratio of the centered risk and the best estimate for the CY for year 0.
- For the PY risk for years $k = 1,2, \ldots$ the reference exposure used is the best estimate of the PY for year 0; the run-off factors are estimated by a more complicated expression involving PY, CY and URR; and the risk intensity is the ratio of the centered risk and the best estimate for the PY for year 0.

Name of risk class	Definition of risk class (relative to year k)	Simplified definition within StandRe	Notation for year k risk charge	Formula for run-off factor
PY risk	The non-life insurance risk from losses occurring before time k	Risk from $AER + IE2$, net of ceded retro, discounted (independent aggregation)	SCR_k^{PY}	$\delta_k^{PY} = \frac{\bar{S}_{PY,k}}{\bar{S}_{PY,0}}$ See below for the definition and derivation of the terms on the right-hand side
CY risk	The non-life insurance risk from losses occurring between time k and time $k+1$	Risk from $AEP + IE1 + NE$, net of ceded retro, discounted (independent aggregation)	SCR_k^{CY}	$\delta_k^{CY} = \frac{\bar{S}_{CY,k}}{\bar{S}_{CY,0}} = \frac{\epsilon_k^{URR} \cdot \bar{S}_{URR,0}}{\bar{S}_{CY,0}}$ See below for the definition of terms and derivation
URR (FY) risk	The non-life insurance risk from losses occurring after time $k+1$, where URR stands for unexpired risk reserves	Disregarded by default	SCR_k^{URR}	$\delta_k^{URR} = \frac{\bar{S}_{URR,k}}{\bar{S}_{URR,0}} = 1 - \sum_{l=1}^{k} \epsilon_l^{URR}$ See below for the definition of terms and derivation
ICR	Credit risk of insurance positions (incl. ceded retrocession)	NA	SCR_k^{ICR}	to be selected as appropriate
scenario	Risk from scenarios in scope (three scenarios can be considered in the template)	NA	$\sum_l SCR_k^{scenario}$	$\delta_k^{scenario\ l}$ to be selected as appropriate

It remains to define for $k \geq 0$ the quantities $\bar{S}_{PY,k}$, $\bar{S}_{CY,k}$ and $\bar{S}_{URR,k}$, which correspond to the best estimate outstanding loss payments for PY, CY, and URR risk, respectively, for the year k. To this end, we define:

- $\bar{S}_{PY,k}$ = (non-discounted) best estimate of the outstanding loss payments at time $t = k$ for the business earned at $t = k$.[17]
  - Default simplification for StandRe: $\bar{S}_{PY,0} = E[S_{AER}]$.
- $\bar{S}_{CY,k}$ = (non-discounted) best estimate of the outstanding loss payments at time $t = k$ for the business earned between $t = k$ and $t = k + 1$.
  - Default simplification for StandRe: $\bar{S}_{CY,0} = E[S_{AEP}]$.
- $\bar{S}_{URR,k}$ = (non-discounted) best estimate of the outstanding loss payments at time $t = k$ for the business written but not earned at $t = k + 1$.
  - StandRe: $\bar{S}_{URR,0}$ is an additional input to be provided by the reinsurer.
  - Default simplification for StandRe: $\bar{S}_{URR,k} = 0$ for $k \geq 1$.
- ϵ_k^{URR} = incremental earnings pattern for the URR, i.e. for $k \geq 1$, $\epsilon_k^{URR} \cdot \bar{S}_{URR,0}$ is earned in year k, i.e. which is then under CY risk for year k, with $\sum_{k\geq 1} \epsilon_k^{URR} = 1$.
- π_k^{RC} for $RC \in \{PY, CY\}$ = incremental paid pattern, i.e. the expected fraction of the total (non-discounted) payments for RC that is paid in year $k \geq 0$, i.e. at time $k + 1$.
- $(\pi_k^{URR})_{k\geq 1}$ = (relative) incremental paid pattern for any accident year portion $\epsilon_l^{URR} \cdot \bar{S}_{URR,0}$ of the initial UPR, where π_{j-l+1}^{URR} = expected fraction of $\epsilon_l^{URR} \cdot \bar{S}_{URR,0}$ that is paid out at the end of the year $j \geq l$.

  Default simplifications for StandRe:

  - π_k^{PY} = payment pattern for AER (weighted mean over AER parameter segments),
  - π_k^{CY} = payment pattern for AEP (weighted mean over AEP parameter segments),
  - $\pi_k^{URR} = \pi_{k-1}^{CY}$.

So, for the URR, we assume that any amount $\epsilon_k^{URR} \cdot \bar{S}_{URR,0}$ has the same payment pattern relative to the time it is earned, and as default simplification for StandRe, the same relative pattern as for the CY.

[17] After the payment for year $k - 1$, which is assumed to take place at time k.

As we assume payments to occur at year end, payments only occur after business is earned, so:[18]

$$\bar{S}_{CY,k} = \epsilon_k^{URR} \cdot \bar{S}_{URR,0} \quad \text{for } k \geq 1$$

and

$$\bar{S}_{URR,k} = \left(\sum_{l \geq k+1} \epsilon_l^{URR} \right) \cdot \bar{S}_{URR,0} = \left(1 - \sum_{l=1}^{k} \epsilon_l^{URR} \right) \cdot \bar{S}_{URR,0} \quad \text{for } k \geq 1.$$

It remains to determine $\bar{S}_{PY,k}$. For the year $k = 1$, the CY business of year $k = 0$ has become PY business and payments have been made at the end of year $k = 0$, so the best estimate of outstanding payments is given by:

$$\bar{S}_{PY,1} = (1 - \pi_0^{PY}) \cdot \bar{S}_{PY,0} + (1 - \pi_0^{CY}) \cdot \bar{S}_{CY,0}$$

For a year $k \geq 2$, we additionally need to consider the portion of the initial URR business that has become PY business. For any year $k \geq 2$ and any $1 \leq l \leq k-1$, the portion $\epsilon_l^{URR} \cdot \bar{S}_{URR,0}$ has been earned and is thus PY, and the cumulative payments from it up to the start of year for k are:

$$\epsilon_l^{URR} \cdot \bar{S}_{URR,0} \cdot \sum_{j=l}^{k-1} \pi_{j-l+1}^{URR}$$

Hence the best estimate of the outstanding payments from $\bar{S}_{URR,0}$ at the start of year $k \geq 2$ is:

$$\sum_{l=1}^{k-1} \epsilon_l^{URR} \cdot \bar{S}_{URR,0} \cdot \left(1 - \sum_{j=l}^{k-1} \pi_{j-l+1}^{URR} \right) = \sum_{l=1}^{k-1} \epsilon_l^{URR} \cdot \bar{S}_{URR,0} \cdot \left(1 - \sum_{j=1}^{k-l} \pi_j^{URR} \right)$$

In conclusion, we get:

$$\bar{S}_{PY,k} = \left(1 - \sum_{l=0}^{k-1} \pi_l^{PY} \right) \cdot \bar{S}_{PY,0} + \left(1 - \sum_{l=0}^{k-1} \pi_l^{CY} \right) \cdot \bar{S}_{CY,0} + \sum_{l=1}^{k-1} \epsilon_l^{URR} \cdot \bar{S}_{URR,0} \cdot \left(1 - \sum_{j=1}^{k-l} \pi_j^{URR} \right)$$

8.3.1.5 Standard method for URR SPEC (to split off part of the URR)

In the MVM calculation described so far, the risk classes PY, CY, and URR (at $t = 1$) are each considered in total, and for the URR (at $t = 1$), as it becomes CY and PY risk in future years, the risk intensity is the same as for the CY at year 0, the run-off factors for future CY risk are the specific earnings pattern for the URR (at $t = 1$), and for future CY risk, these and the shifted PY payment pattern are used.

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[18] As an intuition, recall that, over time, business moves from URR to CY to PY.

This approach, which is a simplification that can be used subject to immateriality, may not be justified if one part of the URR at $t = 1$ behaves much differently than another part or differently than the CY at year 0. In particular, with respect to high/ low risk intensity and/ or long/ short tail. This could for example be the case if there is significant multi-year business with different characteristics. The MVM standard method implemented in the SST-StandRe-template allows splitting off part of the URR (at $t = 1$) and to assign this part its own risk intensity and run-off factors. A split should primarily be between:

- high risk intensity short tail business (e.g. Nat Cat),
- lower risk intensity longer tail business.

We refer to the URR (at $t = 1$) to be split off by "URR SPEC". The following quantities need to be provided as input:

- $\bar{S}_{URR,0}^{SPEC}$ = (non-discounted) best estimate of the outstanding loss payments at time 0 for URR SPEC.
- $int_0^{URR,SPEC}$ = risk intensity for URR SPEC, calculated from the CY risk for that business for year 0.
- $\epsilon_k^{URR,SPEC}$ = incremental earnings pattern for URR SPEC. I.e. for $k \geq 1$, $\epsilon_k^{URR,SPEC} \cdot \bar{S}_{URR,0}^{SPEC}$ is earned in year k, i.e. which is then under CY risk for year k.
- $\pi_k^{URR,SPEC}$ = incremental payment pattern for URR SPEC.

8.3.2 Input for the non-hedgeable market risk component of the MVM

The inputs to be provided to the *SST-Template* for the calculation of the non-hedgeable market risk component of the MVM are (with the notation from the document "Technische Beschreibung SST-Standardmodell Aggregation und Mindestbetrag" in the section on the MVM):

- $\widetilde{BE}_{Rück}$ = "BE Tilde Reinsurance"
- $\chi_{Rück}$ = "Chi Reinsurance"

where $\chi_{Rück}$ is defined in the the document "Technische Beschreibung SST-Standardmodell Aggregation und Mindestbetrag".

The quantities $\widetilde{BE}_{Rück}$, $BE_{Rück}^{(N)}$ and $BE_{Rück,">15"}^{(N)}$ in the expression for $\chi_{Rück}$ are given by:

- $BE_{Rück}^{(N)} = \sum_{CCY \in \{CHF,EUR,USD,GBP,JPY\}} \sum_{k \geq 1} \widetilde{CF}_{k,CCY}$
- $BE_{Rück,">15"}^{(N)} = \sum_{CCY \in \{CHF,EUR,USD,GBP,JPY\}} \sum_{k \geq 16} \widetilde{CF}_{k,CCY}$

and (as a simplification, using $BE^{(N)}_{\text{Rück}}$ instead of $BE_{\text{Rück}}$):

- $$\widetilde{BE}_{\text{Rück}} = \begin{cases} BE^{(N)}_{\text{Rück}} & \text{if } BE^{(N)}_{\text{Rück}} \geq 0 \\ \max\left(BE^{(N)}_{\text{Rück},">15"}; 0\right) & \text{if } BE^{(N)}_{\text{Rück}} < 0 \end{cases}$$

Here, $\widetilde{CF}_{k,CCY}$ denotes the (non-discounted) longer-term cash flow for the losses net of ceded retrocession for the year k (where $k = 1$ corresponds to the SST one-year period $t = 0$ to $t = 1$) in the currency CCY. It corresponds to the cash flows from all balance sheet positions from the table in Section 8.2.5 that are "longer-term" according to the table.

8.4 Input for the "Other Data" sheet of the SST-Template

The insurance risk input requires a decomposition of the StandRe results net of ceded retrocession into "reserve risk" and "new claims risk", where the latter is further split into "normal claims", "large claims" and "Nat Cat". This type of decomposition does not directly correspond to the structure of StandRe. Moreover, not all required outputs are requested in the *SST-StandRe-Template*. One reason for this is that, on net basis, a split into "normal claims", "large claims" and "Nat Cat" may not be available without an allocation assumption on the recoverables from ceded retrocession.

In the *SST-StandRe-Template*, a simplified approach is implemented. In this, AER and IE2 are identified with "reserve risk" and AEP, IE1, and NE with "new claims risk". Further, numbers in the decomposition are sometimes "netgross" instead of "net".

Note that the figures for the "*Other Data*" sheet are given for information purposes for the Fundamental Data Sheet and do not affect the calculation of risk-bearing capital or target capital.

9 Appendix A: Scenario specifications

9.1 Damage event scenarios

9.1.1 CYBR: "Cyber risk"

Scenario name	Cyber Risk
Assignment	IE1 damage event
Computation mandatory?	Mandatory if the written premium for affirmative cyber covers for the current underwriting year is at least 3% of the total written premium for the current underwriting year.
Narrative of scenario	A series of simultaneous cyber-attacks are launched on large multinational organizations across a sector (e.g. banks & insurance companies, information & communication, energy, retail business, etc.) with the intention of causing a major disruption and financial losses to the organizations. During the attacks, customer data (e.g. IP addresses, credit card details and other information) is lost. The attacks target vulnerabilities in the operating systems, web applications and/or software used by these organizations. We assume that the 10 largest companies in a sector are affected and that a significant volume of client data of these organizations is lost. The attacks cause the following damages: (1) First party losses to the organizations, such as a) breach management costs, including crisis management, b) business interruption / loss of profit, c) repair and update of the IT infrastructure, d) regulatory defense, legal fees, and fines, (2) third party liability losses due to loss of data, In general, it is assumed that cyber policies are affected as well as other policies if cyber is not explicitly excluded (see below).

	Examples: US internet attack (2016), Sony (2014), Yahoo (2013), US Data Breach (2015).
Specification of scenario	**Affected LOBs:** The following coverage categories should be considered (it is assumed that no primary insurance policies other than from the 10 companies are affected): a) Affirmative Standalone Cyber Covers - specific policies for data breach, liabilities, property damage, and other losses resulting from information technology failures, either accidental or malicious. These covers would typically cover both (1) and (2) above. b) Affirmative Cyber Endorsements: cyber endorsements that extend the coverage of a traditional insurance product, such as commercial general liability, to cover cyber-induced losses, typically privacy breaches. These covers would typically cover both (1) and (2) above. c) Silent Cyber Exposure – gaps in Explicit Cyber Exclusions: there is a range of traditional policies, such as commercial property insurance, that have exclusion clauses for malicious cyber-attacks, except if arising from certain nominated perils such as: Fire; Lightning; Explosion and Aircraft Impact (FLEXA). These policies have exposure to a cyber-attack if one of the nominated perils were triggered to cause a loss, however unlikely this might be. The potential for Silent Cyber Exposure should be considered for all LoBs covering (1) or (2). d) Silent Cyber Exposure – policies without Cyber Exclusions: many insurance lines of business incorporate 'All Risks' policies without explicit exclusions or endorsements for losses that might occur via cyber-attacks. Insurance business sectors that may contain silent cyber exposure include Property; General Liability; Energy; Marine, Aviation and Other Transport; Motor; and others. The potential for Silent Cyber Exposure should be considered for all LoBs covering (1) or (2).
Calculation of scenario by reinsurer	1. Select region and sector such that the largest loss to the reinsurer (as applicable gross or netgross) results and explain selection. 2. Analyze your assumed reinsurance portfolio with respect to the potential exposure to cyber risk according to the categories a)-d) from "specification of scenario" and document this. 3. Make and explain your assumptions about the number of contract events this scenario would cause for the purposes of assumed reinsurance and ceded retrocession.

	4. Calculate gross and netgross loss to reinsurer. The **scenario severity** is as applicable the gross or the netgross loss to reinsurer.
Affected business	Current accident year business.
Return period	1/50 years.
Reference to sources	Lloyd's Realistic disaster scenarios https://www.lloyds.com/~/media/files/the%20market/tools%20and%20resources/exposure%20management/rds/rds_january%202016.pdf "Managing cyber insurance accumulation risk", University of Cambridge, February 2016 cambridgeriskframework.com/getdocument/39

9.1.2 CONST: "Failure of construction project"

Scenario name	Failure of Construction Project
Assignment	IE1 damage event
Computation mandatory?	Not mandatory.
Narrative of scenario	The construction project with the highest exposure in the portfolio of the reinsurer is assumed to fail during the construction phase. It causes the following damages to insured risks: (1) collapse of the construction resulting in a full loss of insured value, (2) damage of nearby property, (3) casualties to construction workers and nearby population, Examples of similar events: The Lotus Riverside Complex, Shanghai (2009); The Sampoong Department Store, Seoul (1995); The Hyatt Regency, Kansas City (1981); The

	Willow Island Disaster, West Virginia (1978); The Teton Dam, Idaho (1976); The Quebec Bridge, Quebec (1907, 1916); The South Fork Dam, Johnstone, Pennsylvania (1889).
Specification of scenario	**Affected LOBs by damaged insured risk:** assume: a) collapse of the construction (1) and damage of nearby property (2) may be covered by Engineering/Construction, Commercial Liability of the construction company, and Surety policies, b) employers' casualties (3) may be covered by Engineering/Construction, Worker's Compensation and Employers Liability policies. Nearby population casualties (3) may be covered by Engineering, Construction and Commercial Liability policies.
Calculation of scenario by reinsurer	1. Select the construction project and the reason for the project failure and with it the affected LOBs such that the highest loss to the reinsurer results (as applicable gross or netgross) and explain selection. 2. Determine and explain the amount of damage for (1) and (2) and the number of casualties for (3). 3. Make and explain your assumptions about the number of contract events this scenario would cause for the purposes of assumed reinsurance and ceded retrocession. 4. Calculate gross and netgross loss to reinsurer. The **scenario severity** is as applicable the gross or the netgross loss reinsurer.
Affected business	Current accident year business
Return period	1/40 years
Reference to sources	Lloyd's Realistic disaster scenarios https://www.lloyds.com/~/media/files/the%20market/tools%20and%20resources/exposure%20management/rds/rds_january%202016.pdf The Lotus Riverside Complex, Shanghai (2009) https://failures.wikispaces.com/Lotus+Riverside+Block+7+Collapse The Sampoong Department Store, Seoul (1995)

	https://en.wikipedia.org/wiki/Sampoong_Department_Store_collapse The Hyatt Regency, Kansas City (1981) https://en.wikipedia.org/wiki/Hyatt_Regency_walkway_collapse The Willow Island Disaster, West Virginia (1978) https://en.wikipedia.org/wiki/Willow_Island_disaster The Teton Dam, Idaho (1976) https://en.wikipedia.org/wiki/Teton_Dam The Quebec Bridge, Quebec (1907, 1916) https://en.wikipedia.org/wiki/Quebec_Bridge The South Fork Dam, Johnstone, Pennsylvania (1889) http://madridengineering.com/johnstown-flood-engineering-failure/

9.1.3 POL: "Political risk"

Scenario name	Political Risk/ Country Risk
Assignment	IE1 damage event
Computation mandatory?	Mandatory if the sum of the written premiums for Political Risk and Credit & Surety for the current underwriting year is at least 3% of the total written premium for the current under-writing year.
Narrative of scenario	Assume a political incident occurs, such as: • A significant political incident takes place in an emerging country, such that all assets in the country owned by the 10 largest multinational companies are lost. • A war event occurs in a mid-developed country resulting in significant damage to assets, downgrading of credit and credit losses. • Other political incident such as revolution, insurrection, sovereign default etc. leading to non-transferability of funds, expropriation, inconvertibility of foreign

	currency, repudiation of contracts, currency devaluation, currency controls, regulatory changes (see references below) Examples: Venezuela oil sector (2010), Ukraine (2014).
Specification of scenario	**Affected LOBs by damaged insured risk:** assume: • Political Risks • Credit and Surety • Any other LOB where Political Risks/War is not explicitly excluded (e.g. Property, Marine).
Calculation of scenario by reinsurer	1. Select the country to which you have a significant exposure from a political incident and which is sensitive to such incidents, define the political incident, determine the affected LOBs and assumed reinsurance contracts and explain the selection. 2. Make and explain your assumptions about the number of contract events this scenario would cause for the purposes of assumed reinsurance and ceded retrocession. 3. By default, assume that the loss to reinsurer for each affected assumed reinsurance program is the maximal possible loss. Alternatively, make and explain your different assumptions. 4. Calculate gross and netgross loss to reinsurer. The **scenario severity** is as applicable the gross or the netgross loss reinsurer.
Affected business	Current accident year business
Return period	1/50 years
Reference to sources	Political risk insurance, Wikipedia https://en.wikipedia.org/wiki/Political_risk_insurance Political risk insurance, Investopedia http://www.investopedia.com/terms/p/political-risk-insurance.asp Political risk insurance, Marsh & McLennan

	http://www.oliverwyman.com/content/dam/marsh/Documents/PDF/US-en/Political%20Risk%20Implications%20of%20Instability%20in%20Ukraine%20Russia-03-2014.pdf Country risk classification, Euler Hermes: http://www.eulerhermes.com/economic-research/country-risks/Pages/country-reports-risk-map.aspx

9.1.4 FM: "Implications of financial market downturn"

Scenario name	Implications of financial market downturn
Assignment	IE2 damage event
Computation mandatory?	Mandatory if the sum of the written premiums for the StandRe LOB "Financial Losses", D&O, E&O and Legal Expenses for the current underwriting year is at least 3% of the total written premium for the current underwriting year.
Narrative of scenario	This scenario assumes a global economic downturn. A global recession leads to falls in stock prices, consumption, investments, and property prices. Economic output falls across a number of regions including the euro area, emerging market economies and the US. The marked reduction of the economy causes a further reduction in commodity prices. The global recession increases losses stemming from defaults and bankruptcies of companies over all industrial sectors. It is assumed that the scenario has the following implications on insurance risk: (1) For the Credit & Surety LOB, due to increase of company defaults and bankruptcy, the loss ratios for Credit doubles[19] and the loss ratios for Surety increase by 50%. (2) Increase of legal action against management, which increases D&O, E&O and Legal Expense loss ratios by 50%. (3) The downturn also affects other LOBs due to e.g. increased fraud, criminal activity, unemployment, sickness and corporate failures. It is assumed as a simplification that there is a 5% increase in ultimate claims for all other LOBs.

[19] Based on observed increase of loss ratios during 2008/2009.

	Examples: Global recessions (1975, 1982, 1991 and 2009).
Specification of scenario	**Affected LOBs by damaged insured risk:** assume: a) (1) affects Credit & Surety, b) (2) affects D&O, E&O and Legal Expenses, c) (3) affects all other LOBs.
Calculation of scenario by reinsurer	1. Estimate the loss amount for Credit & Surety from a 100% (relative) increase in the assumed gross loss ratio for Credit and 50% (relative increase) for Surety. 2. Estimate the loss amount from a 50% (relative) increase in the assumed gross loss ratios for D&O, E&O and Legal Expenses. 3. Estimate the loss amount from a 5% (relative) increase in the assumed gross loss ratios for all other LOB's. 4. Calculate the net loss to reinsurer by estimating the impact of ceded retrocession. The **scenario severity** is the difference between the net loss to reinsurer with and without the event.
Affected business	All business written by $t = 1$ and not earned at $t = 0$
Return period	1/25 years
Reference to sources	General Insurance Stress Test 2015, Bank of England http://www.bankofengland.co.uk/pra/Documents/supervision/activities/generalinsurancestresstestingjuly2015.pdf Global recession, Wikipedia https://en.wikipedia.org/wiki/Global_recession Wegleitung betreffend Szenarien im SST (31.10.2016) https://www.finma.ch/en/supervision/insurers/cross-sectoral-tools/swiss-solvency-test-sst/ Non-life insurance claims in a recession, Milliman

	http://www.milliman.com/insight/Research/perspective/research/pdfs/Non-life-insurance-claims-in-a-recession/?lng=undefined/RK=0/ Insurance and the economic downturn: Forces at work http://www.schanz-alms.com/files/down-loads/10d9acd8764c611f386a00f1490b2962/MEIR_April2009.pdf Impact of the Financial Turmoil, OECD http://www.oecd.org/pensions/insurance/45044788.pdf

9.1.5 SCBI: "Supply chain business interruption"

Scenario name	Supply Chain Business Interruption
Assignment	IE1 damage event
Computation mandatory?	Mandatory if the written premium for Contingent Business Interruption for the current underwriting year is at least 3% of the total written premium for the current underwriting year.
Narrative of scenario	A global leading supplier for an industry (examples below) suffers an event which causes major disruption to the supply chain such that many companies in the industry suffer significant business interruption. The event causes the following damages: (1) Physical damage for supplier and resulting business interruption of the supplier, (2) Business interruption for companies in the supply chain caused by business interruption of the supplier. Examples of industries: aviation, car manufacturing, construction, telecommunication & information technology, food industry. Examples of such events: Earthquake Japan (2011), Thai floods (2011), Explosion Intel plant (2011).

Specification of scenario	**Affected LOBs by damaged insured risk:** assume: a) (1) is covered under Commercial Property (incl. BI), b) (2) is covered by Contingent Business Interruption.
Calculation of scenario by reinsurer	1. Identify a supplier and an industry with the largest exposure under business interruption and contingent business interruption covers for your portfolio (as applicable gross or netgross) and explain the selection. 2. Make and explain your assumptions about the number of contract events this scenario would cause for the purposes of assumed reinsurance and ceded retrocession. 3. Determine the amount of damages arising from the event assuming BI for two weeks. 4. Calculate gross and netgross loss to reinsurer. The **scenario severity** is as applicable the gross or the netgross loss to reinsurer.
Affected business	Current accident year business
Return period	1/30 years
Reference to sources	General Insurance Stress Test 2015, Bank of England http://www.bankofengland.co.uk/pra/Documents/supervision/activities/generalinsur-ancestresstestingjuly2015.pdf Global Claims Review 2015, Allianz http://www.agcs.allianz.com/assets/PDFs/Reports/AGCS-Global-Claims-Review-2015.pdf Supply Chain and Contingent Business Interruption (CBI), SCOR https://www.scor.com/images/focus_cbi.pdf

9.1.6 MTPL: “Motor accident with liability"

Scenario name	Motor accident with liability

Assignment	IE1 damage event
Computation mandatory?	Mandatory.
Narrative of scenario	Assume a major car accident occurs on a congested road with commercial traffic (e.g. over a bridge or inside a tunnel). Several (~ 30) vehicles are involved in the accident and are stuck, including passenger vehicles, trucks and rescue vehicles. An explosion takes place due to flammable material contained in one or more of the trucks and rapidly spreads to other vehicles (due to strong wind in the case of a bridge or very narrow space in a tunnel). Assume the following damages to insured risks: (1) A truck containing valuable artworks is seriously damaged and the artworks are completely destroyed. (2) Other trucks with goods are damaged. The loss from this and (1) amount to EUR 100m. (3) Damages to other passenger vehicles (4) Severe damages to the infrastructure: road and tunnel (roof, columns, security system…) or bridge (guardrail, foundations…) with a loss amount of EUR 100m. (5) As a consequence, the part of the road (bridge or tunnel) cannot be used for the next 3 days. (6) 10 workers dead, 10 severely injured (7) 20 other people dead, 20 severely injured (8) 50 other people report minor injuries (intoxication…) Examples of such event: Mont-Blanc Tunnel (1999), Wiehltal bridge (2004).
Specification of scenario	**Affected LOBs**: assume that the damages other than to the car causing the accident are covered by the motor liability policy of the car causing the accident. If the motor liability policy is limited, assume that other LOB may be affected for the excess amount: a. damage to artworks (1) and other material goods (2) is covered by Specie and Fine Art and Marine Cargo b. damage to the infrastructure (4) and business interruption (5) is covered by Property incl. BI, CBI c. injury and death of workers (6) covered by Workers Compensation d. injury and death of other people (7) and (8) covered by Accident.
Calculation of scenario by reinsurer	1. Select region and location such that the largest loss to reinsurer results, and explain selection Consider that MTPL may be unlimited (e.g. if accident occurs on French territory. 2. Where relevant, make and explain your assumptions about how many of the affected insurers for each LOB are your cedants.

	3. By default, assume that the loss to reinsurer for each affected program is the maximal possible loss. Alternatively, make and explain your different assumptions. 4. Calculate gross and netgross loss to reinsurer. The **scenario severity** is as applicable the gross or the netgross loss to reinsurer.
Affected business	Current accident year business
Return period	1/80 years
Reference to sources	**Mont Blanc (1999)** http://www.mace.manchester.ac.uk/project/research/structures/strucfire/CaseStudy/HistoricFires/InfrastructuralFires/mont.htm **Wiehltal bridge (2004)** https://en.wikipedia.org/wiki/Wiehltal_bridge

9.1.7 DROU: "Drought and water shortage"

Scenario name	Drought and water shortage
Assignment	IE1 damage event
Computation mandatory?	Mandatory if the written premium for Agriculture for the current underwriting year is at least 3% of the total written premium for the current underwriting year.
Narrative of scenario	This scenario assumes that a severe drought takes place. The effects of the drought are absence of rainfalls, drastic reduction of water levels in all the rivers and other water basins. and crops are lost. The reinsurer should appropriately select the geographical region and the return period of the scenario (also considering climate change). The insured risks are assumed to be: (1) Crop (2) Livestock (herds, etc.) Examples of such events: Australia (1995-2009), Brazil (2014-2016), India (2016), etc.
Specification of scenario	**Affected LOBs**: Agriculture.

Calculation of scenario by reinsurer	1. Select region and location such that the largest loss to reinsurer results, and explain selection. In the case of Europe, several countries may be affected. For example, if the reinsurer covers adjacent geographical regions, such as part of Germany and France, than it should consider damages coming from both countries. For countries such USA, Brazil, China and India, only a sub-region may be affected. 2. By default, assume that the loss to reinsurer is the maximal possible loss for each affected program. Alternatively, make and explain your different assumptions. 3. Calculate gross and netgross loss to reinsurer. The **scenario severity** is as applicable the gross or the netgross loss to reinsurer.
Affected business	Current accident year business
Return period	To be specified and justified by the reinsurer based on the selected region. Assume an event with a return period between 30 and 100 years.
Reference to sources	**Drought definition** https://en.wikipedia.org/wiki/Drought **Seven recent water crisis** https://www.theguardian.com/global-development-professionals-network/2015/jun/12/decade-of-drought-a-global-tour-of-seven-recent-water-crises **Livestock damages** http://www.swissre.com/reinsurance/insurers/agriculture/drought_insurance_mexico.html **Top producing countries** http://www.investopedia.com/financial-edge/0712/top-agricultural-producing-countries.aspx

9.1.8 PROD: "Product Liability event"

Scenario name	Product Liability event
Assignment	IE1 damage event
Computation mandatory?	Not mandatory.
Narrative of scenario	The scenario considers multiple product liability losses arising from a common cause (e.g. same basic substance or method). It is assumed that 3-5 companies operating in the same sector are affected. Examples may include: (1) Technical products: e.g. car industry, cell phones, etc. (2) Drugs/pharmaceutical devices: patients may suffer consequences and the company may have to pay compensations to all patients under treatment (e.g. defective hip replacement, dangerous chemical substances, medication etc.).

Specification of scenario	**Affected LOBs**: The following LOBs may be affected: a) Product Liability, including potential legal expenses, which may increase the loss above the policy limits b) D&O (the directors and officers may be sued by shareholders for investment losses resulting from the product liability case) c) E&O d) Potentially other LOB as applicable
Calculation of scenario by reinsurer	1. Select the product liability event such that the largest loss to reinsurer results and explain selection. 2. Make and explain your considerations about how many of the affected insurers for each LOB are your cedants. 3. By default, assume that the loss to reinsurer for each affected program is the maximal possible loss. Alternatively, make and explain your different assumptions. 4. Calculate gross and netgross loss to reinsurer. The **scenario severity** is as applicable the gross or the netgross loss to reinsurer.
Affected business	All business written by $t = 1$ and not earned at $t = 0$
Return period	1/50 years
Reference to sources	Largest cases of Product Liability in the U.S. http://www.investopedia.com/slide-show/5-largest-us-product-liability-cases/

9.1.9 CONC: "Concentration Risk"

Scenario name	Concentration Risk
Assignment	IE1 damage event
Computation mandatory?	Not mandatory.
Narrative of scenario	Consider that a big industrial conglomerate that sells its products worldwide and is covered by a large number of primary insurers (likely through co-insurance contracts) has an unexpected, but insured loss. The reinsurer should select the directly insured company and the affected LOBs according to its maximal exposure by back tracing its shares of insurance treaties (including facultative insurance) and evaluate the maximal possible loss coming from all of ceding companies. If the corresponding event is already covered by other damage event scenarios, the reinsurer should select the situation with the second largest exposure, etc.
Specification of scenario	**Affected LOBs**: The reinsurer should select the affected LOB according to the event considered and explain the assumptions.

Calculation of scenario by reinsurer	1. Select the company towards which the reinsurer has the highest exposure. 2. Select the largest set of LOBs that could be affected and explain your assumptions. 3. Make and explain your assumptions about how many of the affected insurers for each LOB are your cedants. 4. By default, assume that the loss to reinsurer for each affected program is the maximal possible loss. Alternatively, make and explain your different assumptions. 5. Calculate gross and netgross loss to reinsurer. The **scenario severity** is as applicable the gross or the netgross loss to reinsurer.
Affected business	Current accident year business
Return period	1/50 years
Reference to sources	

9.1.10 MA: "Collision between a major cruise vessel and a fully laden tanker"

Scenario name	Collision between a major cruise vessel and a fully laden tanker
Assignment	IE1 damage event
Computation mandatory?	Mandatory if the written premium for Marine for the current underwriting year is at least 3% of the total written premium for the current underwriting year.

Narrative of scenario	Assume a fully laden tanker collides with a cruise vessel carrying 4000 passengers and 200 staff and crew. 50% tanker owner / 50% cruise vessel apportionment of negligence. The incident involves the explosion of the oil tanker followed by sinking and tanker spilling its cargo (i.e. oil) and loss of lives aboard both vessels, causing the following damages to insured risks: (1) damage to tanker (USD 500m) and cruise vessel (USD 500m) (2) cost to the tanker and cruise vessel owners of the oil pollution of USD 2bn. This would lead to oil pollution recoveries on the International Group of P&I Associations' General Excess of Loss Reinsurance Programme (IG Reinsurance Programme) of USD 1bn from the tanker owner and USD 0.5bn from the cruise owner. (3) 80 fatalities, 100 persons with serious injuries and 250 persons with minor injuries among passengers and crew members, with average compensation of USD 2m for each fatality, USD 3m for each person with serious injuries and USD 0.75m for each person with minor injuries. (4) loss of oil cargo (5) removal of wreck (USD 1bn) (6) loss of property of passengers is considered negligible. Example of possible collision is SS Andrea Doria (1956).
Specification of scenario	**Affected LOBs**: a) (1) is covered under Marine Hull b) (2), (3) and (5) are covered under Protection & Indemnity (marine liability) c) (4) is under Marine Cargo
Calculation of scenario by reinsurer	1. The reinsurer should select either the cruise vessel or the laden tanker (one of the two, not both) towards which the reinsurer has the highest exposure. 2. Make and explain your assumption about how many of the affected insurers for each LOB are your cedants. 3. By default, assume that the loss to reinsurer is the maximal possible loss for each affected program. Alternatively, make and explain your different assumptions. 4. Calculate gross and netgross loss to reinsurer. The **scenario severity** is as applicable the gross or the netgross loss to reinsurer.
Affected business	Current accident year business
Return period	1/100 years

Reference to sources	Ocean Liner "Andrea Doria" (1956) https://en.wikipedia.org/wiki/SS_Andrea_Doria

9.1.11 TR: "Bomb explosions and shootings in different locations of a city"

Scenario name	Bomb explosions and shootings in different locations of a city
Assignment	IE1 damage event
Computation mandatory?	Not mandatory.
Narrative of scenario	Assume that an act of terrorism takes place in a highly populated city in the form of a major explosion to a symbolic building (parliament, monuments, bank headquarter, religion community centers, etc.), a series of minor bomb explosions and shootings in various crowded locations, such as a city center, malls, stadiums, concert halls or cinemas, causing the following damages to insured risks: (1) damage of property with partial collapse of one building targeted by the major explosion, (2) damage to private automobiles, considered to be negligible due to their relatively small number, (3) 50 (of which 25 workers) people dead and 50 (of which 25 workers) injured from collapse, bombings, shootings and subsequent panic, (4) business interruption/loss of profit for the partially collapsed building (for the entire period covered) and for a large number of local businesses (for 4 days). (5) Short-term drop in equity markets. Examples of such events: Mumbai 26/11/2008, Paris 13/11/2015, Jakarta 14/01/2016.
Specification of scenario	**Affected LOBs**: a) Property damage (1) and business interruption (4) are covered under Property incl. BI. b) Injury and death of people (3) under Workers Compensation for workers and (non-compulsory) Accident for others. c) Consider if Political Risk may be affected
Calculation of scenario by reinsurer	1. Select the location (any highly populated city) such that the largest loss to reinsurer from terrorism coverage may result and explain selection. 2. Make and explain assumption about how many of the affected insurers for each LOB are your cedants. 3. Make and explain your assumptions about how many of the affected insurers for each LOB are your cedants. 4. Make and explain your assumptions about the size of the loss to reinsurer from the affected programs. 5. Special terrorism retrocessions in the selected location (like Pool Re in Great Britain, TRIA in the USA or Extremus in Germany) on which you participate are to be applied on gross claims.

	6. Calculate gross and netgross loss to reinsurer. The **scenario severity** is as applicable the gross or the netgross loss to reinsurer.
Affected business	Current accident year business
Return period	1/40 years
Reference to sources	**Mumbai (2008)** https://en.wikipedia.org/wiki/2008_Mumbai_attacks **Paris (2015)** https://en.wikipedia.org/wiki/November_2015_Paris_attacks **Jakarta (2016)** https://en.wikipedia.org/wiki/2016_Jakarta_attacks

9.1.12 PR1: "Fire or explosion in building"

Scenario name	Fire or explosion in building with many people
Assignment	IE1 damage event
Computation mandatory?	Mandatory to compute the more severe of the scenarios PR1 and PR2.
Narrative of scenario	Assume a fire or an explosion takes place in a large building complex with a high accumulation of people (e.g. big building such as hotel, shopping mall, disco, theatre etc.), causing the following damages to insured risks: (1) severe damage to the building (2) business interruption/ loss of profit (3) 25 workers dead and 50 severely injured (4) 50 other people dead and 100 severely injured Total insured loss assumed to be around USD 1 bn. Assumed costs per fatality 2m USD, per severe injury 3m USD and per minor injury 0.75m USD.

Specification of scenario	**Affected LOBs**: assume: a) damage to building (1) and business interruption (2) is covered by Property incl. BI and incurs an insured loss of around USD 1-3 bn. b) injury and death of workers (3) covered by Workers Compensation c) injury and death of other people (4) covered by Commercial Liability (of operator or construction or design company, which is assumed to be large multinational). **Affected insurers by LOB**: assume: (i) up to 10 insurers on Property incl. BI covering a) (ii) up to 5 insurers on Workers Compensation covering b) (iii) up to 10 insurers on Commercial Liability covering c).
Calculation of scenario by reinsurer	1. Select region and location such that the largest loss to reinsurer (as applicable gross or netgross) results and explain selection. 2. Make and explain your assumptions about how many of the affected insurers for each LOB are your cedants. 3. By default, assume that the loss to reinsurer for each affected assumed reinsurance program for (i), (ii), (iii) is the maximal possible loss. Alternatively, make and explain your different assumptions. 4. Calculate gross and netgross loss to reinsurer. The **scenario severity** is as applicable the gross or the netgross loss to reinsurer.
Affected business	Current accident year business
Return period	1/40 years
Reference to sources	
Alternative scenario	If the above scenario is not relevant to a reinsurer, the reinsurer is asked to define its own scenario leading to simultaneous large losses to at least two standard lines (Property, Motor, Accident & Health, Commercial Liability) and maybe other LOBs.

9.1.13 PR2: "Fire or explosion in industrial complex"

Scenario name	Fire or explosion in a large industrial complex
Assignment	IE1 damage event
Computation mandatory?	Mandatory to compute the more severe of the scenarios PR1 and PR2.

Narrative of scenario	An explosion (or a series of explosions) takes place in a large industrial complex (e.g. harbor, factory etc.), sending a fireball and shockwaves across several kilometers, causing the following damages to insured risks: (1) severe damage to building complex (2) business interruption/ loss of profit (3) other production facilities (4) residential buildings (5) 30 workers killed, 60 severely injured (6) 50 other people with minor injuries (7) potentially pollution (8) if in harbor: port facilities (cranes, rail tracks), cargo e.g. in containers, automobiles The total insured loss is assumed to be around USD 5bn. Examples of such events: Toulouse (Atufina, 21. Sept 2001), Tianjin (China, harbor, Aug 2015), Seveso (Milan, July 10, 1976), Bhopal disaster (Union Carbide, India, 3 December 1984).
Specification of scenario	**Affected LOBs**: assume a) damage to building complex (1) and business interruption (2) are covered under Property incl. BI b) injury and death (5) of workers covered under Workers Compensation c) injury of other people (6) covered under Commercial Liability d) pollution (7) covered under Commercial Liability. e) Assume by default that damage to other property (3)-(4) and port facilities, cargo and automobiles (8) are reimbursed under Commercial Liability. Please explain if you consider a different assumption more realistic. **Affected insurers by LOB**: assume: (i) up to 10 insurers on Property incl. BI covering a) (ii) up to 5 insurers on Workers Compensation covering b) (iii) up to 10 insurers on Commercial Liability covering c), d) and e)
Calculation of scenario by reinsurer	1. Select region and location such that the largest loss to reinsurer (as applicable gross or netgross) results and explain selection. 2. Make and explain assumption about how many of the affected insurers for each LOB are your cedants. 3. By default, assume that the loss to reinsurer is the maximal possible loss for each affected assumed reinsurance program for (i), (ii) and (iii). Alternatively, make and explain your different assumptions. 4. Calculate gross and netgross loss to reinsurer. The **scenario severity** is as applicable the gross or the netgross loss to reinsurer.

Affected business	Current accident year business
Return period	1/40 years
Reference to sources	
Alternative scenario	If the above scenario is not relevant to a reinsurer, the reinsurer is asked to define its own scenario leading to simultaneous large losses to property, commercial liability, and potentially other LOBs.

9.1.14 AV: "Crash of aircraft into major city"

Scenario name	Crash of aircraft into major city
Assignment	IE1 damage event
Computation mandatory?	Mandatory if the written premium for Aviation for the current underwriting year is at least 3% of the total written premium for the current underwriting year.
Narrative of scenario	An aircraft crashes into a major city, causing the following insured damages: • aircraft damage: (1) total loss of aircraft (USD 300m) (2) 300 people on aircraft killed (average indemnity USD 2m by person) • on the ground caused by aircraft: (3) Industrial/commercial/residential property severely damaged (USD 600m) (4) business interruption/loss of profit from damaged property (USD 600m) (5) 100 people killed (average compensation USD 2m) and 200 severely injured (average compensation USD 3m) (6) pollution and/or health damage (e.g. emission of toxic fumes) (USD 2bn) An example of such an event is a crash into an oil storage facility near an airport.
Specification of scenario	**Affected LOBs**: assume: a) (1) is covered under Aviation Hull b) (2) under Aviation Liability (airline or manufacturer) c) (3)-(6) are covered under Aviation Liability up to the legal limit of the Aviation Liability coverage, the remainder for (3) and (4) under Property, for (5) under Workers Compensation, (6) is not covered. **Affected insurers by LOB:** assume: (i) Aviation Hull covering a): up to 10 insurers (ii) Aviation Liability covering b) and c): up to 10 insurers (iii) Property covering c): up to 10 insurers (iv) Workers Compensation covering c): up to 5 insurers

Calculation of scenario by reinsurer	1. Select a location/city for the crash of the aircraft and the affected airline/manufacturer and explain your selection in view of your portfolio. 2. Make and explain your assumption about how many of the affected insurers for each LOB are your cedants. 3. By default, assume that the loss to reinsurer for each affected assumed reinsurance program for (i), (ii), (iii), (iv) is the maximal possible loss. Alternatively, make and explain your different assumptions. 4. Calculate gross and netgross loss to reinsurer. The **scenario severity** is as applicable the gross or the netgross loss to reinsurer.
Affected business	Current accident year business
Return period	1/100 years
Reference to sources	

9.1.15 ENERG: "Explosion of oil platform"

Scenario name	Explosion of oil platform
Assignment	IE1 damage event
Computation mandatory?	Mandatory if the written premium for Energy Offshore for the current underwriting year is at least 3% of the total written premium for the current underwriting year.
Narrative of scenario	An explosion of oilrig platform occurs, followed by oil spill and the sinking of the oil rig. It causes the following damages to insured risks: • damages from the platform: (1) total loss of oil rig and wreck removal (USD 4 bn insured loss) (2) business interruption (USD 200m loss) (3) death (100, average insured compensation USD 2m) and severe injuries (60, average insured compensation USD 3m) • other damages: (4) urgent measures to limit the damages resulting from the oil spill by limiting its spreading (USD 1bn insured loss) (5) pollution (e.g. clean up of coasts, industries close to the coast, e.g. fisheries) (USD 15bn, may not all be insured). Examples are Abakun-A (2015, USD 650-700m), Deepwater Horizon (2010, USD 60bn, not all insured) Piper Alpha (1988, USD 15bn, not all insured), Exxon Valdez (1989).
Specification of scenario	**Affected LOBs**: assume: a) damage to platform and wreck removal (1) is covered by Energy Offshore b) BI (2) is potentially covered by Energy Offshore c) death and injury to workers on platform (3) is covered by Workers Compensation

	d) pollution and measures to limit damage (4) and (5) are covered by Energy Offshore **Affected insurers by LOB:** assume: (i) Energy Offshore: ca. 20 insurers (for all insured members of the joint venture) (ii) Workers Compensation from c): up to 5 insurers
Calculation of scenario by reinsurer	1. Select the platform such that the largest loss to reinsurer (as applicable gross or netgross) results and explain selection. 2. Make and explain your assumption about how many of the affected insurers for each LOB are your cedants. 3. By default, assume that the loss to reinsurer for each affected assumed reinsurance program is the maximal possible loss. Alternatively, make and explain your different assumptions. 4. Calculate gross and netgross loss to reinsurer. The **scenario severity** is as applicable the gross or the netgross loss to reinsurer.
Affected business	Current accident year business
Return period	1/50 years
Reference to sources	

9.1.16 HAIL: "Giant hailstorm over a major city"

Scenario name	Giant hailstorm over a major city
Assignment	IE1 damage event
Computation mandatory?	Mandatory if the event is not covered by the NE component.

Narrative of scenario	A hailstorm, stretching over a large territory, e.g. 20 km wide and 250 km long, strikes a major city or major urban center. Hail stones up to 10 centimeters in diameter and weighing as much as 300 grams falling with speeds of over 150 km/h; additionally there are high-speed horizontal winds. The hailstorm causes damage to the following insured risks: (1) Buildings: the hailstorm leaves 70'000 homes without roof and causes other property damages to these homes. It is assumed to impact the modern residential buildings as they are considerably more exposed to hail than traditional buildings; (2) Content: damage to the highly fragile rolling shutters, annexes and shading elements on modern buildings. In the city, there is also a concentration of photovoltaic and/or solar thermal systems strongly affected by hail. (3) Business interruption /loss of profit: only short time interruption; considered negligible. (4) Transport: The hailstorm seriously damages more than 200'000 automobiles (with ca. 150 dents for each damaged car) and about 100 aircraft in the local airport. (5) Accident: more than 200 people are injured. Examples of such events: Hailstorm Munich in 1984, Hailstorm South Germany in 2013 (region around Reutlingen and Tübingen, south of Stuttgart)
Specification of scenario	**Affected LOBs**: • damage to buildings (1) and content (2) is covered by Property; • repair cost for hail damaged cars (4) covered under Motor; • damaged airplanes (4) are covered under Aviation; • Injuries (5) are covered under Workers Compensation and Accident.
Calculation of scenario by reinsurer	1. Select the region of the hailstorm with the highest loss potential for you (as applicable gross or netgross) based on an analysis of your business that is exposed to such an event. 2. Determine all programs that are exposed to the event in the selected region for the above affected LOBs. 3. Assume that all programs that can be exposed to the hail event incur losses. 4. Take as the loss to reinsurer from each program the following percentage of the maximum possible loss for the program: • 5% for Property, • 20% for Motor, • 10% for Aviation • 5% for Accident and Workers Compensation 5. Calculate gross and netgross loss to reinsurer. The **scenario severity** is as applicable the gross or the netgross loss to reinsurer.

Affected business	Current accident year business
Return period	1/30 years
Reference to sources	AIR Worldwide: "*Germany's Billion-Euro Hailstorms Highlight Loss Potential in Central Europe*" GenRE: "*Storm Front Andreas – A 15-Minute Hailstorm With Catastrophic Consequences*" National center of atmospheric research: "*Multicell stage of the Munich storm of 12 July 1984*"

9.2 Other event scenarios

9.2.1 INFL A, B: "Global shock to expected claims inflation"

Scenario name	Global shock to expected claims inflation
Scenario type	Severity (& frequency)
Assignment	IE2 other event
Computation mandatory?	Mandatory. By default, both scenarios INFL A and INFL B are assigned a return period of once in 100 years and it is only required to take into account the scenario with the larger impact. However, StandRe users are encouraged to assess the relevance of these inflation shocks at the reference date for their portfolio and, depending on the result, to consider taking both scenarios into account and/or select a shorter return period if considered appropriate.
Narrative of scenario	The two scenarios INFL A and INFL B are automatically calculated from the input provided in the sheets *RE_scenario_INFL_A* and *RE_scenario_INFL_B* of the SST-StandRe-template. Both scenarios assume an inflation shock of the following form: (1) the realized inflation between $t = 0$ and $t = 1$ is higher than expected at $t = 0$, and (2) the expected inflation for a number of subsequent one-year periods increases from $t = 0$ to $t = 1$. The inflation shock is assumed to have the following implications: • higher best estimate cash flows of the insurance liabilities of the current and the prior underwriting years due to the increase in inflation expectation. • in case the inflation shock is not expected to be short-term, an up-shift of the risk-free interest rate curve due to the expectation that central banks would intervene by raising (very short-term) risk-free interest rates. The two inflation scenarios are: • **INFL A**: significant increase in the actual inflation during the one-year period in combination with longer-term change in inflation expectation for subsequent periods; increase of the risk-free interest rate curve at the end of the one-year period reflecting (the expectation of) central bank intervention. • **INFL B**: strong increase in the actual inflation during the one-year period that considered to be short-term, i.e. with only slight short-term change in inflation expectation for subsequent periods. Thus, no (expected) central bank intervention and consequently no change in risk-free interest rates. The two scenarios are assumed to apply globally to all currencies and all segments (LOBs, type) for the prior underwriting years and the current underwriting year.

The scenarios are defined in terms of an expected change in CPI (Consumer Price Index) inflation. The relationship between CPI inflation and claims inflation is assumed to be different for different segments of LOB and type of business (proportional or non-proportional) and is expressed by segment-specific "impact factors" g_{seg}. (These factors may not capture the impact of index clauses, see below.)

Examples: oil crises 1973 and 1979, Switzerland in 1989-1990 (-1994).

Specification of scenario

Affected LOBs: by default, all LOBs are assumed to be affected.

The parameters for the formula for the impact of the scenario in "Calculation of scenario by reinsurer " below are:

- $(\Delta\pi_t^1)$ = change in the inflation expectation for the year t from time 0 to time 1 defining the inflation shock (in percentage points):

$\Delta\pi_t^1$	$t = 0$	1	2	3	4	5	6	7	...
INFL A	3.5%	5.0%	3.5%	1.5%	0.5%	0%	0%	…	
INFL B	4.5%	1.0%	0%	0%	…	…			

- (Δi_t^1) = change in the risk-free interest rate curve for term t (years) from time 0 to 1 in the scenario, given as spot rate (in percentage points):

Δi_t^1	$t = 1$	2	3	4	5	6	7	8	9	10	$11 \ldots 49$
INFL A	3.0%	2.5%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0% etc.
INFL B	0%	0%	…	…	…	…					

- g_{seg} = "impact factors" per segment (LOB, type):

$StandRe\ LOB$	$g_{LOB,prop}$	$g_{LOB,NP}$
Accident and Health	1.3	1.5
Motor	1.2	1.8
Marine, Aviation and Other Transport	1.0	1.1
Property	1.1	1.2
Financial Losses	0.8	1.2
General Liability	1.15	1.5
Other Non-Life	1.0	1.5

The prescribed impact factors g_{seg} do not consider the impact of any index clauses (stability, inflation, or indexation clauses) on the cash flows. If index clauses apply, they can be taken into account to make the scenario impact more realistic; the method to do this should be explained in the StandRe calculation documentation.

Calcu-lation of sce-nario by rein-surer	The **scenario severity** is the sum over all segments (LOB, type) of the impact of the scenario. The impact of the scenario, i.e. the "change in best estimate", for one specific segment and the specific currency is given by: $$\sum_{t=0}^{\infty} CF_t^0 \cdot \left(\frac{\prod_{j=0}^{t}\left(1 + g_{seg} \cdot \Delta\pi_j^1\right)}{(1 + i_1^0) \cdot (1 + i_t^0 + \Delta i_t^1)^t} - \frac{1}{(1 + i_{t+1}^0)^{t+1}} \right)$$ with: • $t =$ year from time t to time $t+1$, starting with year $t = 0$; • $CF_t^0 =$ best estimate loss and expense cash flows at the reference date (time 0) for year t assumed to be paid at time $t+1$, for all business in the balance sheet at time 1 (i.e. prior underwriting years and current underwriting year) for the segment and in the cur-rency. The assumption is made that the expected inflation at $t = 0$ is already considered in the reserves and the loss estimates for the current underwriting year; • $(i_t^0) =$ risk-free interest rate curve at the reference date (time 0), as prescribed for the corresponding SST; • $(\Delta\pi_t^1) =$ change in the inflation expectation for the year t from time 0 to time 1 defining the inflation shock (in percentage points); • $(\Delta i_t^1) =$ change in the risk-free interest rate curve for term t (years) from time 0 to 1for the scenario, given as spot rate (in percentage points); • $g_{seg} =$ "impact factors" per segment (LOB, type). The parameters $(\Delta\pi_t^1)$, (Δi_t^1), and g_{seg} are provided in the tables above. In the cash flows CF_t^0, contracts can be excluded if their payments do not depend on inflation. In this situation, report the contracts and explain the reason.
Af-fected busi-ness	• Prior underwriting years business and • current underwriting year business
Return period	1/100 years (by default; higher frequencies should be selected if considered more appropriate)
Refer-ence to sources	Inflation risk http://www.theactuary.com/features/2014/09/the-hidden-risk-of-inflation/ Index clauses https://www.irmi.com/articles/expert-commentary/reinsurance-index-clause

Background

We consider the best estimate for one specific segment of business with associated "impact factor" g_{seg} and in a specific currency. In the following, we suppress the segment and the currency in the notation for the other quantities for ease of notation. We write the best estimate at time 0 (expectation and cash flows outstanding at time 0, but for all business written by time 1, i.e. including new business) as

$$BE_0 = \sum_{t=0}^{\infty} \frac{CF_t^0}{(1+i_{t+1}^0)^{t+1}} = \sum_{t=0}^{\infty} \frac{CF_t^{"nom"} \cdot \prod_{j=0}^{t}\left(1+g_{seg} \cdot \pi_j^0\right)}{(1+i_{t+1}^0)^{t+1}}$$

In this formula, CF_t^0 denotes the expected cash flows for the year from time t to $t+1$ assumed to be paid at time $t+1$ for the segment under consideration, where we assume that the inflation expectations $g_{seg} \cdot \pi_j^0$ at time 0 for the segment for the year from time j to $j+1$, for $j=0$ to $j=t$, are already captured in the cash flows CF_t^0. Here, $CF_t^{"nom"}$ denotes the "nominal" cash flows and π_j^0 denotes the CPI inflation.[20] So, for example, for $t=1$, for the cash flows CF_1^0 due at time $t+1=2$, the inflation expectation rates $g_{seg} \cdot \pi_0^0$ from time $j=0$ to $j+1=1$ and $g_{seg} \cdot \pi_1^0$ from time $j=1$ to $j+1=2$ are relevant. Further, i_t^0 denotes the nominal (risk-free) interest rate at time 0 for a term of t one-year periods.

Assuming that an inflation shock has occurred in the period from time 0 to 1, leading to new inflation (expectations) (π_t^1), the cash flow at time 1 is

$$CF_0^1 = CF_0^{"nom"} \cdot \left(1+g_{seg} \cdot \pi_0^1\right) \approx CF_0^0 \cdot \left(1+g_{seg} \cdot \Delta\pi_0^1\right)$$

with the inflation expectation change $\Delta\pi_t^1 = \pi_t^1 - \pi_t^0$. For $t=0$, at time 1, $\Delta\pi_0^1$ is the realized change in inflation vs. the expectation at time 0. Similarly, the best estimate at time 1 of the cash flows that are outstanding at time 1 is

$$BE_1 = \sum_{t=1}^{\infty} \frac{CF_t^1}{(1+i_t^1)^t} \approx \sum_{t=1}^{\infty} \frac{CF_t^0 \cdot \prod_{j=0}^{t}\left(1+g_{seg} \cdot \Delta\pi_j^1\right)}{(1+i_t^1)^t}$$

where i_t^1 denotes the nominal interest rate at time 1 for a term of t one-year periods; i_t^1 is the interest rate after the occurrence of the scenario. The impact on the one-year change in the risk-bearing capital that comes from the change in the best estimate due to the inflation scenario (with above approximations) is, with the definition $i_0^1 = 0$:

$$\frac{1}{1+i_1^0} \cdot (CF_0^1 + BE_1) - BE_0 \approx \sum_{t=0}^{\infty} \frac{CF_t^0 \cdot \prod_{j=0}^{t}\left(1+g_{seg} \cdot \Delta\pi_j^1\right)}{(1+i_1^0)\cdot(1+i_t^1)^t} - \sum_{t=0}^{\infty} \frac{CF_t^0}{(1+i_{t+1}^0)^{t+1}}$$
$$= \sum_{t=0}^{\infty} CF_t^0 \cdot \left(\frac{\prod_{j=0}^{t}\left(1+g_{seg} \cdot \Delta\pi_j^1\right)}{(1+i_1^0)\cdot(1+i_t^1)^t} - \frac{1}{(1+i_{t+1}^0)^{t+1}}\right)$$

In general, the change in the inflation expectation $(\Delta\pi_t^1)$ and the risk-free interest rate curve (i_t^1) at time 1 after the inflation shock are interrelated. This is mainly due to the assumption that the changed interest rates reflect the expectation of the market that the central banks will increase interest rates (at the short end) in line with their mandate of keeping the inflation rates within a target range. This is at least as long as central banks believe that the inflation shock will not

[20] We implicitly assume for this scenario that the "nominal" expected cash flows do not change from time 0 to time 1.

only be short term. The relationship between the change in inflation expectation and the risk-free interest rates assumed in the inflation scenario is:

$$i_t^1 = i_t^0 + \Delta i_t^1 \ \ with \ \ \Delta i_t^1 = \Delta\tilde{\pi}_t^1 + c_t$$

where

$$\prod_{j=1}^{t}\left(1+\Delta\pi_j^1\right) = \left(1+\Delta\tilde{\pi}_t^1\right)^t$$

i.e. $\Delta\tilde{\pi}_t^1 = \sqrt[t]{\prod_{j=1}^{t}\left(1+\Delta\pi_j^1\right)} - 1$, and

- c_t reflects the deviation from a full impact of the change in inflation expectation on the interest rates or a change in risk premiums.

The implemented formula for the impact of the scenario is thus:

$$\sum_{t=0}^{\infty} CF_t^0 \cdot \left(\frac{\prod_{j=0}^{t}\left(1+g_{seg}\cdot\Delta\pi_j^1\right)}{\left(1+i_1^0\right)\cdot\left(1+i_t^0+\Delta i_t^1\right)^t} - \frac{1}{\left(1+i_{t+1}^0\right)^{t+1}}\right)$$

It depends on the following parameters:

- the risk-free interest rate curve (i_t^0) at time 0
- the "impact factors" g_{seg} per segment of business
- the change in the inflation expectation $(\Delta\pi_t^1)$ from time 0 to time 1 defining the inflation shock
- the change in the risk-free interest rate curve (Δi_t^1) from time 0 to 1 for the scenario

9.2.2 EMLA: "Emerging liability cat"

Scenario name	Emerging Liability Cat
Scenario type	Frequency & severity
Assignment	IE2 other event
Computation mandatory?	Mandatory.

Narrative of scenario	The scenario is that latent claims develop from a generic emerging risk (e.g. E-cigarettes, nanotechnology/nanoparticles, electromagnetism, obesity, tobacco, alcohol, aspartame, endocrine disruptors, genetically modified crops, self-driving cars, construction material causing cancer, food additive causing cancer etc.). It is assumed that, in the current year, information on an emerging risk becomes known that leads to the expectation of new claims on liability business from prior years and the current year, leading to an increase in the year-end best estimate. The scenario is assumed to impact the 10 prior underwriting years (losses occurring type triggers) and the current underwriting year (also claims made type triggers). Total ultimate market losses are CHF 100bn in the US and CHF 30bn in Europe. It is assumed that the discounting factor is 80% and that 35% of the ultimate amount emerges during the current year, resulting in a total one-year reserve increase of CHF 28bn for the US and CHF 8.4bn for Europe. Historical examples: Asbestos, environmental pollution in the USA, tobacco (mostly not insured), Agent Orange, pharmaceutical litigation.
Specification of scenario	**Affected LOBs:** assume: • Product Liability is affected as the latent claims stem from products sold to customers or companies. • Assume spillover of claims to Commercial Liability due to public exposure to the product and to Workers Compensation and Employer's Liability due to employees exposed to the product.
Calculation of scenario by reinsurer	1. Estimate your average market share (in terms of premiums) of Product Liability, Commercial Liability and Employer's Liability/Workers Compensation insurance for the last 10 underwriting years (which may include years with share zero) and the current underwriting year, separately for US and Europe and for proportional and non-proportional business and explain the assumptions made. 2. Multiply your average market share assumption by the assumed market one-year reserve increase of CHF 28bn for the US and CHF 8.4bn for Europe, with an additional multiplicative factor of 2 for non-proportional business: $28bn \cdot (share_{USA,prop} + 2 \cdot share_{USA,non-prop}) + 8.4bn \cdot (share_{Europe,prop} + 2 \cdot share_{Europe,non-prop})$ 3. Adjust for ceded retrocession if necessary to obtain the net loss to reinsurer. This is the **scenario severity**.

Affected business	Prior underwriting years and current underwriting year business
Return period	1/75 years
Reference to sources	Emerging Risks in the Global Insurance Industry, KPMG https://assets.kpmg.com/content/dam/kpmg/ca/pdf/2016/10/ca-emerging-risks-global-insurance.pdf Emerging Liability Risks, Lloyd’s https://www.lloyds.com/~/media/files/news%20and%20insight/risk%20insight/2015/emerging%20liability%20risks20151130.pdf Asbestos Losses Continue to Haunt P/C Insurers, A.M. Best http://www.insurancejournal.com/news/national/2016/11/29/433383.htm Asbestos Claims in Europe, The Actuary http://www.theactuary.com/archive/old-articles/part-3/asbestos-claims-in-europe/

9.2.3 BOINJ: "Bodily injury award legislation change"

Scenario name	Bodily injury award legislation change
Scenario type	Severity
Assignment	IE2 other event
Computation mandatory?	Mandatory.
Narrative of scenario	There are multiple changes to the bodily injury legislation in one country or region (for example Switzerland, UK, EU, US) resulting in a 25% increase in the average severity of payments awarded for bodily injury claims. This may be for example due to changes in life expectancy, discount rate, methodology used to estimate lump sum payments or annuities (e.g. PPO).

	Examples: Changes to Ogden tables in the UK, UVG discount rate in CH, or an increase in life-expectancy in several countries.
Specification of scenario	**Affected LOBs**: any LOB where bodily injury awards are present are assumed to be affected, e.g. Motor Liability, Workers' Compensation, Employers Liability, Compulsory/Non-Compulsory Accident, Personal Liability, Commercial Liability etc.
Calculation of scenario by reinsurer	1. Select country or region where you have the largest reserves of open claims for bodily injuries (net of ceded retrocession). An assumption may need to be made (and justified) on the proportion of reserves related to bodily injury. 2. Assume for all affected LOBs a simultaneous 25% increase in reserves (gross of ceded retrocession) for all open bodily injury claims and related IBNR and the same increase for the best estimate of total losses for the current underwriting year. 3. Adjust for ceded retrocession if necessary to obtain the net loss to reinsurer. The **scenario severity** is the difference between the net loss with and without the event.
Affected business	Current underwriting year and prior underwriting years business
Return period	1/20 years
Reference to sources	Third UK bodily injury awards study, The Actuary http://www.theactuary.com/archive/old-articles/part-1/third-uk-bodily-injury-awards-study/ Comment on the UK Government's decision to change the discount rate for personal injury damages, Willis Towers Watson https://www.willistowerswatson.com/en/press/2017/02/Comment-on-the-UK-Governments-decision-to-change-the-discount-rate-for-personal-injury-damages

9.2.4 PINCR: "Prior year event loss increase"

Scenario name	Non-nat cat prior year event loss increase
Scenario type	Severity

Assignment	IE2 other event
Computation mandatory?	Mandatory.
Narrative of scenario	In the current year, a reported loss event from a prior accident year develops worse than expected. All claims from the selected loss event increase so that they reach the program limits of the assumed reinsurance or ceded retrocession.
Specification of scenario	**Affected LOBs:** Not prescribed, results from the event selected by the reinsurer.
Calculation of scenario by reinsurer	1. Assess open loss events from prior accident years and their potential maximum adverse development net of ceded retrocession, i.e. the impact if all claims from the event exceed assumed reinsurance program limits or ceded retrocession limits. 2. Select the loss event for which the impact of the maximum adverse development would be the greatest, and for which such a development is feasible. 3. The **scenario severity** is the corresponding maximum adverse development, i.e. the difference between the net loss with and without the event.
Affected business	Prior accident years business
Return period	1/40 years
Reference to sources	-

9.2.5 TF: "Tail factor increase"

Scenario name	Tail Factor Increase
Scenario type	Frequency & severity

Assignment	IE2 other event
Computation mandatory?	Mandatory.
Narrative of scenario	It is assumed that information revealed in the current year indicates that the selected paid and incurred (i.e. reported) tail factors for a long-tailed line of business have been significantly underestimated. If the company has no LOBs where tail factors are used due to non-development based reserving methods or sufficient historical data, then this scenario is not evaluated.
Specification of scenario	**Affected LOBs:** not prescribed, selected by the reinsurer.
Calculation of scenario by reinsurer	1. Identify the reserving LOB for which squaring the employed tail factors has the largest impact on the reserves net of ceded retrocession assuming no other changes to reserving assumptions or selected methodologies. A reserving LOB is defined to be a segment on which the reserving actuaries estimate the best estimate reserves. Usually, paid and incurred triangles are available per reserving segment. 2. Square the assumed tail factors for paid and incurred development methods and, making no other changes to reserving assumptions or selected methodologies, evaluate the impact on reserves for all prior accident years. The impact of the change in tail factor should flow through your reserving models, affecting all methods for which the tail-factor assumption has been used (for example Chain-Ladder or Bornhuetter-Fergusson). Where the change has secondary indirect impacts on results (for example, methods using selected loss ratios which are based on historical Chain-Ladder ultimate loss ratios), these should also be allowed for. 3. Adjust for retrocession cover if necessary to obtain the net loss to reinsurer. The **scenario severity** is the difference between the net loss with and without the event.
Affected business	Prior underwriting years business
Return period	1/25 years
Reference to sources	-

9.2.6 RETROR: "Retrocession default on reserves"

Scenario name	Retrocession default on reserves
Scenario type	Frequency & severity
Assignment	IE2 other event
Computation mandatory?	Mandatory if at least 5% of the total reserves are retroceded.
Narrative of scenario	It is assumed that the two retrocessonaires with the highest ceded technical reserves at $t = 0$ default in the current year, with 100% loss given default. The reinsurer needs to increase its net technical reserves by the defaulted ceded reserves exposed to the two defaulted retrocessionaires.
Specification of scenario	**Affected LOBs:** not prescribed, selected by the reinsurer.
Calculation of scenario by reinsurer	Select the two retrocessonaires with the highest ceded technical reserves and set the **scenario severity** equal to the retroceded amounts with those two retrocessionaires.
Affected business	Prior underwriting years business

Return period	The return period depends on the ratings of the defaulted retrocessionaires, where the lower of the two ratings is selected for the return period of the scenario. The following return periods are based on S&P ratings. If ratings from other rating agencies are used, a reasonable mapping should be assumed: (i) 1/1000 years: for a rating of AA or higher, (ii) 1/800 years: for a rating of at least A but lower than AA, (iii) 1/400 years: for a rating of at least BBB but lower than A, (iv) 1/100 years: for a rating of at least BB but lower than BBB, (v) 1/20 years: for a rating of at least B but lower than BB, and no rating, (vi) 1/4 years: for a rating of CCC and lower.
Reference to sources	2015 Annual Global Corporate Default Study And Rating Transitions, S&P http://www.spratings.com/documents/20184/774196/2015+Annual+Global+Corporate+Default+Study+And+Rating+Transitions/6d311074-5d56-4589-9ef8-a43615a6493b p.85 for insurance companies

9.2.7 NATR: "Nat cat reserving event"

Scenario name	Nat Cat Reserving Event
Scenario type	Severity
Assignment	IE2 other event
Computation mandatory?	Not mandatory.
Narrative of scenario	A Nat Cat event that occurred in a preceding year is assumed significantly under-reserved. It is assumed that the reserves gross of ceded retrocession for this event need to be increased by 50%.

Specification of scenario	**Affected LOBs:** Not prescribed, usually Personal Property or Commercial Property, but in the end selected by the reinsurer.
Calculation of scenario by reinsurer	1. Select the Nat Cat event with the largest reserve volume (gross of ceded retrocession) from one of the prior accident years and increase the reserves by 50%. 2. Adjust for ceded retrocession if necessary to obtain the net loss to reinsurer. The **scenario severity** is the difference between the net loss with and without the event.
Affected business	Prior accident years business
Return period	1/40 years

9.2.8 UND: "Under-pricing"

Scenario name	Underpricing
Scenario type	Frequency & severity
Assignment	IE2 other event
Computation mandatory?	Mandatory.
Narrative of scenario	Underwriting/pricing has underestimated the loss ratios used for reserving by 20% (relative to the assumed loss ratio) for the previous two underwriting years.
Specification of scenario	**Affected LOBs:** Not prescribed, selected by the reinsurer.

Calculation of scenario by reinsurer	1. Select the reserving LOBs with the highest premium volume (gross of ceded retrocession) where loss ratio-based methods (e.g. Expected Loss Ratio or Bornhuetter-Ferguson) have been used. A reserving LOB is defined to be a segment on which the reserving actuaries estimate the best estimate reserves. 2. Increase assumed initial expected loss ratios (Prior Loss Ratios, gross of ceded retrocession) for the previous two underwriting years by 20%, making no other changes to reserving assumptions or selected methodologies. Evaluate the resulting impact on reserves. 3. Adjust for retrocession cover if necessary to obtain the net loss to reinsurer. The **scenario severity** is the difference between the net loss with and without the event.
Affected business	Prior underwriting years business
Return period	1/30 years

10 Appendix B: Record of changes to StandRe

The purpose of this section is to maintain a record of the most important changes to StandRe over time. Recorded changes:

10.1.1.1 Changes from v5.0 to v6.0

(1) For the modeling of premiums, losses and expenses (Section 2.5 of v6.0), clearer formulation of the requirements. In Section 7.4, explicit formulation of the need to consider variable premiums or expenses/commissions when applying outward retrocession.

(2) Clearer explanation of the two options for the split between AER and AEP by accident years or by underwriting years, where in the first case only, the business written but not earned by t=1 is currently disregarded as a simplification (Sections 2.12, 5.1, 5.2 and 5.3).

(3) For the reporting of the non-life portfolio (Section 3.5), further guidance on the "allocation to reporting segments" for contracts covering several detailed LOBs, incl. Multiline.

(4) Change to the formulation of the criteria for the complement of the material parameter segments (Section 5.5.1).

(5) Experience scenarios: new method for calculating the frequency uncertainty uplift (Section 6.7), changes to the description of frequency as-if adjustments (Section 6.6.9) and changes in the ordering of Section 6.6.

(6) Scenario "FM: Implications of financial market downturn" (Section 9.1.4): reduction of percentage for "all other LOBs" from 10% to 5%.

10.1.1.2 Changes from v6.0 to v6.1

(7) In Section 2.5, added that the modeling of variable expenses/premiums can lead to a company-specific adjustment.

(8) In Section 7.3, added that the frequency uncertainty uplift does not need to be taken into account for the calculation of the expected non-life insurance result.

(9) In Section 7.5, attempted to improve the description by small changes.

10.1.1.3 Changes from v6.1 to version 31.10.2018

(10) Section 1: for outstanding losses, corrected definition of IBNyR and IBNER, added definitions of $t = 0$ and $t = 1$.

(11)Section 2.1: added to the purpose of StandRe, in particular in respect of the additional content for the cash flow input to the market risk, and the balance sheet positions in the SST balance sheet to be used for reinsurance business.

(12)Section 2.1: added references to internal Nat Cat model guidance.

(13)Section 2.2: new section, which includes content from the discarded Wegleitung (guidance) on StandRe and the discarded Section 2.19 on "Model implementation".

(14)Section 2.4: added the explicit specification of the scope of the balance sheet underlying the one-year change.

(15)Section 2.5: added to the specification on variable features of premiums and expenses in a new section 2.5.1.

(16)In Section 2.12: on attritional events, added in particular a paragraph on the simplified modeling of attritional events by underwriting years, making clear that this is only allowed if it does not lead to material deviations and that underwriting years in this context refer to calendar years from Jan 1 to Dec 31.

(17)Section 2.16: on non-life insurance risk aggregation, added text on stochastic simulation engine that was previously in the now discarded Section 2.19 on "Model implementation".

(18)Section 2.18: extended on background material on StandRe.

(19)Section 4: changed "quantity of output" to "output basis" and used the terminology from Section 4.1 more consistently throughout Section 4. Changed title of Sections 4.3.1 and 4.4.

(20)Section 4.6: new section on the modeling of variable features of premiums and/or losses (e.g. sliding scale commission, reinstatement premium).

(21)Section 5.4.1: added text to emphasize when disaggregation is to be used.

(22)Section 5.4.3: added explanatory text on disaggregation.

(23)Section 5.5.1: based on the SST 2018 experience, the definition of parameter segments has been adjusted. Apart from a change in the ordering of the criteria, a new criterion has been added in (6), which allows including non-material business in material parameter segments.

(24)Sections 5.5.3 and 5.5.4: added some clarification on the input data.

(25)Section 5.5.5: added comments on exclusions for the current accident year.

(26)Section 5.6.3: new section on the use of "external" data sources, i.e. other than strictly from the company itself, highlighting in particular the dependency of the CV on the volume.

(27) Section 5.8.1: more precise explanation of the requirement that own correlations need to be consistent with the prescribed StandRe correlations.

(28) Section 6.6.4: changed specification for severity as-if adjustment segments relative to the granularity needed to apply the PEC and the IE1 model segments.

(29) Sections 6.7 and 6.7.2: changed section title to better describe content of sections.

(30) Section 6.8.2: rewritten introduction to portfolio structure scenarios to improve understanding.

(31) Section 6.8.3: corrected formula for $f_{\tilde{P}}^{1}(a_1)$ (the inverse has been provided previously by mistake).

(32) Section 6.9: for event-based scenarios, added paragraph about changing their prescriptions.

(33) Section 6.11.2: emphasize that the reasonableness of the fit needs to be analyzed through expert judgment.

(34) Section 6.12.2: corrected the formula for the severity CDF, which previously mistakenly had ">" instead of "≥".

(35) Section 6.13.2: added requirement that the IE2 modeling threshold should not be too far away from the largest IE2 scenario exceeding the threshold.

(36) Section 8: completely new section, which describes the different inputs into the SST-Template and, for some inputs, their derivation. In particular, balance sheet positions to use in the SST balance sheet for reinsurance business, derivation of the cash flows for reinsurance-related balance sheet positions, MVM. Description comes from the field test 2018.

(37) Section 9.1.4: changed the "affected business" for the scenario "Implications of financial market downturn".

(38) Section 9.1.8: changed the "affected business" for the scenario "Product liability event".

(39) Section 9.2.5: changed the "affected business" for the scenario "Tail factor increase".

(40) Section 9.2.6: changed the "affected business" for the scenario "Retrocession default on reserves" and the time from $t = 1$ to $t = 0$.

10.1.1.4 Changes from version 31 Oct 2018 to version 30 Jan 2019

(41) Title page: changed document title to be in line with other such documents

(42) Section 8.3.1: description of the standard method for the MVM component for all risks other than non-hedgeable market risk

(43) Section 4.1: table providing an overview of the model structure by StandRe component

10.1.1.5 Changes from version 30 Jan 2019 to version 31 Oct 2019

(44) Section 8.2.4: updated names and codes of items from the SST balance sheet

(45) Section 8.3.1: adjusted specific features of the MVM calculation (AER+IE2 independent aggregated, AEP+IE1+NE net)

10.1.1.6 Changes from version 31 Oct 2019 to version 31 Oct 2020

(46)Cover page: changed to new FINMA layout.

(47)New section 2.2.6 on assumptions and expert judgment.

(48)New section for the case that the opt-in new credit risk standard model is used for the SST 2021.

(49)Section 8.2: updated names, especially referring to "insurance cash flows" and codes of items from the SST balance sheet, and some cosmetic changes.

(50) Section 8.3: removed references to SST 2020 computation and more precise specification of the scope within the MVM calculation.

10.1.1.7 Changes from version 31 Oct 2020 to version 31 Jan 2021

(51)Section 8.3.1.5: new section that describes the calculation of the MVM component for CY risk of the years 1, 2, … for multi-year contracts

10.1.1.8 Changes from version 31 Jan 2021 to version 31 Oct 2021

(52)Section 6.6.4.4: new section explaining the treatment of "unusually large" IE1 info event losses in the IE1 model.

(53)Section 6.9.1.3: new section explaining how to capture the credit risk of outward retrocession between the RETROR scenario and the new credit risk standard model.

(54)Section 6.12.1.1: for the IE1 model, new section explaining more precisely the dependency between the severities for different IE1 model segments for an IE1 info event in the IE1 model and how to model this.

(55)Section 8.3: for the MVM, improved description in the entire section and new method in Section 8.3.1.5 that allows splitting off part of the URR (at t=1), which is more general than the prior approach for multi-year contracts

(56)Section 9.2.1: update of the section specifying the INFL (inflation shock) scenario to the two new scenarios INFL A and INFL B. Additional text on the background of the new scenarios.

10.1.1.9 Changes from version 31 Oct 2021 to version 31 Oct 2022

(57) Section 2.2.7: removed this section as it refers to the SST 2021 and its content is covered in Section 6.9.

(58) Section 6.14.2: added the Section title 6.14.2.1 and extended Section 6.14.2.2 to provide the formula for calculating a Poisson-Gen Pareto frequency-severity model at a higher threshold.

(59) Section 8.2.5.4: for the cash flows for insurance positions for the market risk standard model, updated to reflect that it is newly facultatively possible to split the short-term cash flows by currency instead of the default approach that all are in SST currency.

(60) Section 8.3.2: update to reflect the adjustment of the standard model for the non-hedgeable market risk component of the MVM as described in the *technical description standard model aggregation and market value margin.*

10.1.1.10 Changes for version 31 Oct 2023

(61) Several smaller changes coming from the revised Insurance Supervisory Ordinance (ISO, Aufsichtsverordnung AVO / Ordonnance de surveillance OS; SR 961.011) version of 1 January 2024. Inserted reference to ISO in Section 1. Updated references to regulation where necessary; reflecting the new definition of risk-bearing capital and target capital; and modeling of one-year change in risk-bearing capital excluding the market value margin.

10.1.1.11 Changes for version 31 Oct 2024

(62) Replaced references to FINMA circular 2017/3 "SST" with the applicable references to the new versions of ISO and ISO-FINMA.

(63) Replaced the terms inward reinsurance and outward retrocession with assumed reinsurance and ceded retrocession, respectively.

(64) Section 2.17 and elsewhere: replaced the term "company-specific adjustment" by "adjustment that requires prior approval from FINMA" following Article 9 Paragraph 3 Letter a ISO-FINMA.

(65) Section 2.5.2: updated references and improved description.

(66) Section 8.2.4: updated references to updated SST balance sheet in the SST template.

(67) Sections 8.3: slightly improved description.

(68) Section 9.2.1: improved description and updated the interest rate shock for INFL A to the current situation.