Guideline

Title	Life Insurance Capital Adequacy Test (2023) - Chapter 11 Aggregation and Diversification of Risks
Category	Capital Adequacy Requirements
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Risk aggregation is the approach used to calculate the total of each and all of the risk elements. A diversification credit or benefit results when the aggregation of risks produces results that are less than the total of the individual risk elements.

11.1. Within-risk diversification

Diversification credits are applied to specific components of the mortality and morbidity requirements calculated in Chapter 6. The credit in section 11.1.1 is calculated net of registered reinsurance. Within the calculation of the Base Solvency Buffer used to determine the LICAT ratios, the statistical fluctuation factors in section 11.1.2 are calculated net of registered reinsurance. For the solvency buffers SB_1 , SB_2 and SB_3 defined in section 6.8, statistical fluctuation factors are calculated net of registered reinsurance and additional elements specific to the calculation. Since the requirements for participating business are calculated on a standalone basis (q.v. section 9.1.2), there are no within-risk diversification benefits between similar risks in participating blocks and non-participating blocks.

11.1.1 Mortality level and trend risk - diversification credit between life supported and death supported business

A diversification credit is calculated between individually underwritten life supported and individually underwritten death supported business. The diversification credit is determined by first calculating mortality level and trend risk components for individually underwritten life supported business and death supported business in aggregate. The aggregate component for level and trend mortality risk assumes a correlation factor of -75% between life and death supported business and is calculated as:

$$RC_{aggregate} = RC_L^2 + RC_D^2 - 1.5 \times RC_L \times RC_D$$

where:

- $RC_{aggregate}$ is the aggregate component for mortality level and trend risk (after diversification) for all life and death supported business;
- RC_L is the sum of the individual risk charges for mortality level risk and mortality trend risk for life supported business as determined in sections 6.2.2 and 6.2.3, respectively;
- RC_D is the sum of the individual risk charges for mortality level risk and mortality trend risk for death supported business as determined in sections 6.2.2 and 6.2.3, respectively.

The diversification credit is the difference between the sum of the individual mortality level and trend risk components for life supported and death supported business (qq.v. sections 6.2.2 and 6.2.3) and the aggregate component for mortality level and trend risk calculated using the formula above:

$$\text{Diversification credit} = RC_{L} + RC_{D} - RC_{aggregate}$$

11.1.2 Morbidity risk credits

The capital requirements for morbidity risk determined in section 6.4 for certain products are reduced by multiplying the requirement by a statistical fluctuation factor (SFF). For each SFF, exposures are aggregated by product within each geographic region before the SFF is applied. For example, all disability exposures within a geographic region are aggregated (individual active DI, individual active WP, individual disabled DI, group disabled LTD, individual and group disabled WP and group active and disabled STD) before the SFF is applied.

11.1.2.1 Credit for level risk

Morbidity SFFs for level risk are calculated as follows:

Disability

$$SFF(RC) = \begin{cases} 1, & \text{if } RC \le \$42{,}000{,}000 \\ 0.9 + \dfrac{648}{\sqrt{RC}}, & \text{if } RC > \$42{,}000{,}000 \end{cases}$$

where RC is the capital requirement for level risk.

CI

$$SFF(FA) = \begin{cases} 1, & \text{if } FA \le \$300{,}000{,}000 \\ 0.15 + \dfrac{14{,}722}{\sqrt{FA}}, & \text{if } FA > \$300{,}000{,}000 \end{cases}$$

where FA is the total face amount.

LTC

$$SFF(RC) = \begin{cases} 1, & \text{if } RC \le \$75{,}000{,}000 \\ 0.5 + \dfrac{4{,}330}{\sqrt{RC}}, & \text{if } RC > \$75{,}000{,}000 \end{cases}$$

where RC is the capital requirement for level risk.

11.1.2.2 Credit for volatility risk

Morbidity SFFs for volatility risk are calculated as follows:

Disability

$$SFF \quad RC = \quad 1, \ \text{if } RC \le \$\ 6{,}000{,}000 \quad 0.7 + 734 \quad RC, \ \text{if } RC > \$\ 6{,}000{,}000$$

where *RC* is the capital requirement for volatility risk.

CI

$$SFF \quad FA = \quad 1, \ \text{if } FA \le \$\ 300{,}000{,}000 \quad 0.15 + 14{,}722 \quad FA, \ \text{if } FA > \$\ 300{,}000{,}000$$

where *FA* is the total face amount.

LTC

$$SFF \quad RC = \quad 1, \ \text{if } RC \le \$\ 3{,}000{,}000 \quad 0.3 + 1{,}212 \quad RC, \ \text{if } RC > \$\ 3{,}000{,}000$$

where *RC* is the capital requirement for volatility risk.

Travel and credit

$$SFF \quad RC = \quad 1, \ \text{if } RC \le \$\ 5{,}000{,}000 \quad 0.2 + 1{,}788 \quad RC, \ \text{if } RC > \$\ 5{,}000{,}000$$

where *RC* is the capital requirement for volatility risk.

Medical/Dental (including other A&S)

$$SFF \quad RC = \quad 1, \ \text{if } RC \le \$\ 3{,}000{,}000 \quad 0.7 + 519 \quad RC, \ \text{if } RC > \$\ 3{,}000{,}000$$

where *RC* is the capital requirement for volatility risk.

11.1.3 Mortality and morbidity risks – portfolio volume credit

A credit is given for diversification across geographic regions in the level risk component of the mortality and morbidity requirements. For each of the mortality, morbidity incidence, and morbidity termination requirements for a block of business within a region, the component for level risk may be reduced by:

$$0.5 \times (L_0 - L_1)$$

where L_0 is the level risk component for the block calculated using the volatility and statistical fluctuation factors for its region, and L_1 is the level risk component for the block calculated using volatility and statistical fluctuation factors based on business volumes aggregated across all geographic regions. Both L_0 and L_1 are calculated net of all reinsurance.

11.2 Between-risk diversification

After the individual risk components have been calculated, they are aggregated in three stages. First, a post-diversification requirement for insurance risk (*I*) is calculated. Then, an unadjusted diversified requirement for all risks (*D*) is calculated by aggregating the net requirement for insurance risk with the requirements for credit risk and market risk. This unadjusted diversified requirement is compared against the undiversified requirement (*U*) calculated as the sum of individual risk components. The adjusted diversified requirement (*K*) is calculated based on *D* and *U* .

If an insurer wishes to take credit for participating or adjustable products (q.v. Chapter 9), or for unregistered reinsurance or reinsurance claims fluctuation reserves (q.v. section 6.8), it will be necessary to calculate the quantities *I* , *D* , *U* and *K* for one or more subsets of the insurer's book of business.

11.2.1 Insurance Risk Requirement (I)

The requirement for insurance risk *I* is calculated by aggregating the components of insurance risk using a correlation matrix. The formula for *I* is:

$$I = \sqrt{\sum_{i,j=1}^{7} \rho_{ij} \times \left(IR_i - 0.5 \times LT_i\right) \times \left(IR_j - 0.5 \times LT_j\right)} + PC$$

where:

- IR_i is the required capital for insurance risk *i* , before credit for participating and adjustable products,

- LT_i is the sum of the level and trend components for insurance risk i (LT_7 , the level and trend component for expense risk, is zero)
- PC is the requirement for any P&C risks arising from consolidated subsidiaries that write both life and P&C business (q.v. section 6.7)
- ρ_{ij} is the correlation factor between insurance risks i and j , as specified by the following correlation matrix:

Correlation Factor Between Insurance Risks

i\j	Mortality	Longevity	Morbidity incidence and claims	Morbidity termination	Lapse sensitive	Lapse supported	Expense
Mortality	1	-0.25	0.5	-0.25	0.25	0	0.5
Longevity	-0.25	1	-0.25	0.5	0.25	-0.25	0.25
Morbidity incidence and claims	0.5	-0.25	1	0.25	0.5	0	0.5
Morbidity termination	-0.25	0.5	0.25	1	0.5	-0.25	0.5
Lapse sensitive	0.25	0.25	0.5	0.5	1	-0.5	0.5
Lapse supported	0	-0.25	0	-0.25	-0.5	1	-0.25
Expense	0.5	0.25	0.5	0.5	0.5	-0.25	1

However, I may not be lower than the highest value of $IR_i - 0.5 \times LT_i + PC$ for any insurance risk i included in the correlation matrix.

11.2.2 Diversified Risk Requirement (D)

The unadjusted diversified requirement D for all risks is calculated by aggregating the requirements for credit and market risks with the insurance risk requirement. The correlation assumed between the two classes of risks is 50%. Consequently:

$$D = A^2 + AI + I^2$$

where:

- A is the sum of the requirements for credit risk (for both on- and off-balance sheet items) and market risk, and
- I is the insurance risk requirement from the previous section.

11.2.3 Undiversified Risk Requirement (U)

The undiversified risk requirement U is calculated as:

$$U = \sum_{i=1}^{7} IR_i + PC + A$$

where IR_i, A and PC are as defined in sections 11.2.1 and 11.2.2.

11.2.4 Adjusted Diversified Requirement (K)

After the diversified and undiversified risk requirements D and U have been computed, the adjusted diversified requirement K for insurance, credit and market risk is calculated as:

$$K = \frac{4}{5} U + \frac{1}{10} LT + \max\left(\frac{14U - 7LT - 62D}{60} + \frac{2D^2}{2U - LT}, 0 \right)$$

where:

$$LT = \sum_{i=1}^{7} LT_i$$

Example: Calculation of the Adjusted Diversified Requirement

Suppose that the life insurance risk requirements for a non-participating block of business in a geographic regions, with corresponding level and trend components, are as follows:

Life insurance risk	Gross component (IR_i)	Level and trend components (LT_i)
Mortality	1,000,000	700,000
Longevity	3,000	3,000
Morbidity incidence	50,000	10,000
Morbidity termination	2,500	1,000
Lapse sensitive	300,000	150,000
Lapse supported	100,000	40,000
Expense	10,000	0
Totals	1,465,500	904,000

Suppose as well that the block's other risk requirements are as follows:

Risk	Component
Credit risk	200,000
Market risk	75,000
Property and casualty risk	25,000

In order to calculate the total requirement K for the block, it is first necessary to calculate the quantities $IR_i - 0.5 \times LT_i$ for each of the life insurance risks:

Insurance risk	$IR_i - 0.5 \times LT_i$
Mortality	650,000
Longevity	1,500
Morbidity incidence	45,000
Morbidity termination	2,000
Lapse sensitive	225,000
Lapse supported	80,000
Expense	10,000

The insurance risk requirement I is calculated by aggregating the components of the above using the correlation matrix specified in section 11.2.1, and adding the requirement for property and casualty risks:

$$I = \sum_{i,j=1}^{7} \rho_{ij} \times (IR_i - 0.5 \times LT_i) \times (IR_j - 0.5 \times LT_j) + PC = 764{,}421 + 25{,}000 = 789{,}421$$

Since the highest value of $IR_i - 0.5 \times LT_i + PC$ is 675,000, the value of I is not increased to account for this minimum.

The requirements for credit and market risk are summed to obtain A:

$$A = 200{,}000 + 75{,}000 = 275{,}000$$

after which it is possible to compute the diversified risk requirement D:

$$D = A^2 + AI + I^2 = 957{,}027$$

The undiversified risk requirement U is:

$$U = \sum_{i=1}^{7} IR_i + PC + A = 1{,}465{,}500 + 25{,}000 + 275{,}000 = 1{,}765{,}500$$

The last quantity needed to calculate K is LT, given by:

$$LT = \sum_{i=1}^{7} LT_i = 904,000$$

With D, U and LT known, the final adjusted diversified requirement K is calculated as:

$$K = \frac{4}{5}U + \frac{1}{10}LT + \max\left(\frac{14U - 7LT - 62D}{60} + 2D\ 2\ \ 2U - LT,\ 0\right) = 1,517,653$$

11.3 Base Solvency Buffer

The Base Solvency Buffer is equal to:

$$\gamma \times \left(\sum K_{non\text{-}par} + \sum_i \left(K_{par\ i} - CP_i\right) - \sum_j CA_j - CG + SFG + OR\right)$$

where:

- γ is the scalar defined in section 1.1.5
- $\sum K_{non\text{-}par}$ is the sum of the requirements K calculated for the non-participating block in each geographic region
- The second sum is taken over all qualifying participating blocks, and the third sum is taken over all qualifying adjustable products
- $K_{par\ i}$ is the standalone adjusted diversified requirement K for qualifying participating block i
- CP_i is the par credit for participating block i calculated under section 9.1.2
- CA_j is the adjustable credit for adjustable product j calculated under section 9.2.2
- CG is the total of all credits for policyholder deposits and group insurance business under sections 6.8.2 and 6.8.3
- SFG is the capital requirement for segregated fund guarantee risk
- OR is the capital requirement for operational risk.