Guideline

Title	Life Insurance Capital Adequacy Test (2023) - Chapter 7 Segregated Fund Guarantee Risk
Category	Capital Adequacy Requirements
Date	July 31, 2022
Sector	Life Insurance and Fraternal Companies
Effective date	January 1, 2023

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This component is for the risk associated with investment or performance-related guarantees on segregated funds or other similar products. The risk is determined using prescribed or approved factors, or, subject to an insurer obtaining prior approval, an internal model.

OSFI permits, subject to materiality considerations, criteria and explicit prior approval, the use of internal models for the development of segregated fund capital requirements. Insurers seeking to use internal models should follow the requirements outlined in OSFI's Instruction Guide: *Use of Internal Models for Determining Required Capital for Segregated Fund Risks (LICAT)* dated March 2002, Advisory: *Revised Guidance for Companies that Determine Segregated Fund Guarantee Capital Requirements Using an Approved Model* dated December 2010 and revised July 2022, and Advisory: *Supplementary Information for Life Insurance Companies that Determine Segregated Fund Guarantee Capital Requirements Using an Approved Model* dated April 2009.

7.1. Products

Capital factors are provided for a variety of standardized product forms for guaranteed minimum death and maturity benefits commonly offered for segregated fund guarantee products in Canada and the United States. Below is a general description of the product forms modeled. More details can be found in Table 4 of section 7.5.

Guaranteed Minimum Death Benefit (GMDB) forms modeled include the following:

1. **Return of Premium (ROP):** provides a death benefit guarantee equal to the higher of the account value or the premiums paid.
2. **5% Annual Roll-up (ROLL):** provides a guaranteed benefit that increases 5% per annum compounded at each contract anniversary with the guarantee frozen at age 80.
3. **Maximum Anniversary Value/Annual Ratchet (MAV):** automatic annual reset of guarantee at each contract anniversary with resets frozen at age 80.

4. **10-year Rollover Contract (GMDB_10):** guarantee can reset and term-to-maturity also will reset to 10 years. No resets are permitted in the final 10 years prior to contract maturity.

Guaranteed Minimum Maturity Benefits (GMMB) forms modeled include:

1. **Fixed Maturity Date (FIXED):** guarantee is level and applies up to the fixed maturity date.
2. **10-year Rollover Maturity Benefit (GMMB_10):** guarantee can be reset and term-to-maturity also resets to 10 years. No resets are permitted in the 10 years prior to contract maturity.
3. **Guaranteed Minimum Surrender Benefit After 10 Years (GMSB_10):** guarantee comes into effect 10 years after contract issue. If the guaranteed value at 10 years is greater than the account value at surrender, a "top-up" benefit equal to the difference is paid.

7.2. Documentation and reporting

Given the complexity of this calculation, for auditing purposes the Appointed Actuary is required to keep supporting schedules of all the calculations for each step building up to the final amounts detailed in the *LICAT Quarterly Return* and pages 70.100 and 70.200 of the *LICAT Annual Supplement*. Additionally, the Appointed Actuary is required to detail the calculation in the segregated fund section of the Appointed Actuary's Report.

The columns of the reporting form on page 70.100 are completed as follows:

Column 01 - Guaranteed Value

This is the amount guaranteed in all segregated funds. If the funds are subject to guarantees of differing amounts, for example 100% on death and 75% on maturity, report the larger amount here.

Column 02 - Market Value

This is the market value of all segregated funds.

Column 03 - Total Gross Calculated Requirements

This is the total gross calculated requirement for all segregated funds.

Column 04 - Credit for Reinsurance Ceded

Report credit for amounts ceded in column 04. Note that aggregate positive liabilities ceded under unregistered reinsurance (q.v. section 10.1), net of the available credit for reinsurance (q.v. section 10.3), must be deducted from Available Capital/Margin on page 20.030 of the *LICAT Quarterly Return* or *LICAT Annual Supplement*. Eligible Deposits held for unregistered reinsurance, for a period not less than the remaining

guarantee term, may be recognized subject to the limit in section 6.8.1.

Column 05 - Net Requirements

This is determined as:

(Total Gross Calculated Requirements − Credit for Reinsurance Ceded)

Column 06 – Credit for OSFI-Approved Hedging Programs

This is the dollar equivalent of the maximum allowable reduction. It is determined as:

(Maximum allowable percentage reduction × Net Requirements)

where the maximum percentage reduction is the reduction that was determined at the time of approval. See the OSFI Advisory: *Recognition of Hedge Contracts in the Determination of the Segregated Fund Guarantee Capital Requirement for Life Insurance Companies* dated December 2008.

This column may also be used to enter the amount of a negative Guaranteed Minimum Withdrawal Benefit Hedging Liability (enter the amount as a positive value in this column) to effectively floor this negative value at zero in determining the Net Required Component in Column 8.

Column 07 - Net Actuarial Liabilities Held

This is the total net actuarial liability (including risk adjustment and contractual service margin) held on the balance sheet for segregated fund contracts with guarantee risks.

Column 08 - Net Required Component

This is determined as:

(Net Requirements (column 5) − Credit for OSFI-Approved Hedging Programs (column 6) − Net Actuarial Liabilities Held (column 7)) × 1.25

The net required component is multiplied by 1.25 to bring required capital to the supervisory target level.

Line 920 must not be less than zero in total.

The columns of the reporting form on page 70.200 are completed as follows:

Column 01 - Factor Requirements on Business

This is the gross calculated requirement based on the OSFI-approved factors.

Column 02 - OSFI Approved Internal Model Requirements

For OSFI-approved models, this is the gross calculated requirement based on company-specific internal models.

Column 03 - Total Gross Calculated Requirements

For OSFI-approved models, transition rules apply:

In the first year of approval, Total Gross Calculated Requirements = 50% of the Factor Requirements + 50% of the Internal Model Requirements.

Thereafter, Total Gross Calculated Requirements = 100% of the Internal Model Requirements.

Otherwise, Total Gross Calculated Requirements = 100% of the Factor Requirements.

Column 04 - Credit for Reinsurance Ceded

Report credit for amounts ceded in column 04. Note that aggregate positive liabilities ceded under unregistered reinsurance (q.v. section 10.1), net of the available credit for reinsurance (q.v. section 10.3), must be deducted from Available Capital/Margin on page 20.030 of the LICAT Quarterly Return or LICAT Annual Supplement. Eligible Deposits held for unregistered reinsurance, for a period not less than the remaining guarantee term, may be recognized subject to the limit in section 6.8.1.

Column 05 - Net Requirements

This is determined as:

(Total Gross Calculated Requirements (column 3) − Credit for Reinsurance Ceded (column 4))

Column 06 - Credit for OSFI-Approved Hedging Programs

This is the dollar equivalent of the maximum allowable reduction. It is determined as:

(Maximum allowable percentage reduction × Net Requirements (column 5))

where the maximum percentage reduction is the reduction that was determined at the time of approval. See the OSFI Advisory: *Recognition of Hedge Contracts in the Determination of the Segregated Fund Guarantee Capital Requirement for Life Insurance Companies* dated December 2008.

This column may also be used to enter the amount of a negative Guaranteed Minimum Withdrawal Benefit Hedging Liability (enter the amount as a positive value in this column) to effectively floor this negative value at zero in determining the Net Required Component in Column 8.

Column 07 - Net Actuarial Liabilities Held

This is the total net actuarial liability (including risk adjustment and contractual service margin) held on the balance sheet for segregated fund contracts with guarantee risks.

Column 08 - Net Required Component

This is determined as:

(Net Requirements (column 5) − Credit for OSFI Approved Hedging Programs (column 6) − Net Actuarial Liabilities Held (column 7)) × 1.25

The net required component is multiplied by 1.25 to bring required capital to the supervisory target level.

Note that the amount reported on page 70.100, column 08 should be the same as the amount reported on page 70.200, column 08.

7.3. Total gross calculated requirement

7.3.1. Overview

It is expected that the LICAT methodology for Total Gross Calculated Requirement (" *TGCR* ") will be applied on a policy-by-policy basis (i.e., seriatim). If the company adopts a cell-based approach, only materially similar contracts should be grouped together. Specifically, all policies composing a "cell" must display substantially similar characteristics for those attributes expected to affect risk-based capital (e.g., definition of guaranteed benefits, attained age, policy duration, years-to-maturity, market-to-guaranteed value, and asset mix). The TGCR for the purpose of determining capital requirements for segregated funds using prescribed or approved factors should not include deferred income taxes.

The portfolio *TGCR* is the sum of the *TGCR* calculations for each policy or cell. The result for any given policy (cell) may be negative, zero or positive. In total, the TGCR cannot be negative.

The *TGCR* for a given policy is equal to:

$$TGCR = GV \times f^{(\theta\sim)} - AV \times g^{(\theta\sim)}$$

where:

- *GV* = current guaranteed minimum benefit,
- *AV* = current account balance,
- $f^{(\theta\sim)}$ = benefit cost factor,

- g ^ (θ ~) = margin offset factor and
- θ ~ is a vector that defines the risk characteristics for the policy.

The factors f ^ (θ ~) and g ^ (θ ~) are described more fully in section 7.7.1. The *TGCR* is calculated separately for each guaranteed minimum benefit (i.e., death, maturity and surrender).

The model assumptions for the *TGCR* Factors are documented in section 7.3.2.

There are four (4) major steps in determining the *TGCR* for a given policy/cell:

a. Classify the asset exposure (section 7.4);
b. Determine the risk attributes (section 7.5);
c. Retrieve the appropriate nodes (section 7.6);
d. Use the supplied functions to determine the requirement (section 7.7).

The first step requires the company to categorize the asset value for the given policy/cell by mapping the entire exposure to one of the prescribed "fund classes" as described in section 7.4. *TGCR* factors are provided for each asset class.

The second step requires the company to determine (or derive) the appropriate attributes for the given policy or cell. The attributes needed to access the factor tables and calculate the required values are:

1. Product form ("Guarantee Definition"), *P* .
2. Guarantee level, *G* .
3. Adjustment to guaranteed value upon partial withdrawal ("GMDB/GMMB Adjustment"), *A* .
4. Fund class, *F* .
5. Attained age of the policyholder, *X* , (for GMDB only, use a 4-year setback for female lives).
6. Contract maturity age, *M* , (for GMDB only, use a 4-year setback for female lives).
7. Time-to-next maturity date, *T* .
8. Ratio of account value to guaranteed value, *Ø* .
9. Total "equivalent" account-based charges, *MER* ("management expense ratio").
10. Reset utilization rate, *R* (where applicable).

11. In-the-money termination rate, S (guaranteed surrender benefits only).

Other required policy values include:

12. Total account value on which the guaranteed benefit is calculated, AV.
13. Current $GMDB$, $GMMB$ and/or $GMSB$.
14. Total net spread available to fund guaranteed benefits ("margin offset"), α.

The next steps – retrieving the appropriate nodes and using the supplied functions to determine the requirement – are explained in sections 7.6 and 7.7. Software tools have been developed to assist companies in these efforts. If an insurer is unable to use the supplied tools, it will be required to develop software of its own. In such a situation, the insurer should contact OSFI for specific guidance on how to develop its own lookup and extraction routines. A calculation example demonstrating the application of the various component factors to a sample policy is provided in section 7.7.2.

In this chapter, $GMDB$, $GMMB$, $GMSB$ are generically denoted by GV. AV generically denotes either Account Value or Market Value. The total "equivalent" account charges should include *all* amounts assessed against policyholder accounts, expressed as a level spread per year (in basis points). This quantity is called the Management Expense Ratio ("MER") and is defined as the average amount (in dollars) charged against policyholder funds in a given year divided by average account value. Normally, the MER would vary by fund class and be the sum of investment management fees, mortality & expense charges, guarantee fees/risk premiums, and other items. The total spread available to fund the guaranteed benefits (i.e., GMDB, GMMB, GMSB costs) is called the "margin offset" (denoted by α) and should be net of spread-based costs and expenses (e.g., net of maintenance expenses, investment management fees, trailer commissions, and amounts required to provide for amortization of deferred acquisition costs). Section 7.8 describes how to determine MER and α.

The GMDB/GMMB/GMSB definition for a given policy/cell may not exactly correspond to those provided. In some cases, it may be reasonable to use the factors/formulas for a different product form. In other cases, the company might determine the TGCR based on two different guarantee definitions and interpolate the results to obtain an appropriate value for the given policy/cell. However, if the policy form is sufficiently different from those provided and there is no practical or obvious way to obtain a reasonable result, the insurer should follow the instructions

outlined in section 7.10.

The general form of the *TGCR* may be written as:

$$TGCR = GV \times h(\tilde{\theta}) \times w(\tilde{\theta}) \times f(\tilde{\theta}) - \alpha\, 100 \times AV \times g(\tilde{\theta})$$

where:

- GV = current guaranteed minimum benefit (dollars)
- AV = current account value (dollars)
- $f(\tilde{\theta})$ = cost factor per $1 of GV
- $g(\tilde{\theta})$ = margin offset factor per $1 of AV (assuming 100 bps of available spread)
- $h(\tilde{\theta})$ = asset mix diversification factor
- $w(\tilde{\theta})$ = time diversification factor

Under this notation, $\tilde{\theta}$ is used to generically represent the risk attribute set (e.g., product form, guaranteed level, asset class, attained age, etc.) for the policy, or some relevant subset thereof. α is the company-determined net spread ("margin offset", in basis points per annum) available to fund the guaranteed benefits.

Where more than one feature (i.e., guaranteed benefit) is present in a product, unless the company has a justifiable alternative for allocating the total available spread between the benefit types (e.g. explicitly defined risk charges), the split should be based on the proportionate gross guaranteed benefit costs. An example is provided in section 7.7.2 to illustrate this concept.

In practice, $f(\tilde{\theta})$, $g(\tilde{\theta})$, $h(\tilde{\theta})$ and $w(\tilde{\theta})$ are values interpolated from the factor grid. The use of the factor grid is discussed more fully in section 7.7. The factor grid is a large pre-computed table developed using stochastic modeling for a wide array of combinations of the risk attribute set. The risk attribute set is defined by those policy/product characteristics that affect the risk profile (exposure) of the business: product form (guarantee definition), fund class, attained age, AV/GV ratio, time-to-maturity, etc.

7.3.2. Assumptions for TGCR methodology published factors

Each node in the factor grid is effectively the modeled result for a given "cell" assuming a $100 single deposit.

Table 1: Model Assumptions & Product Characteristics

Account Charges (MER)	Vary by fund class. See Table 2 later in this section.
Base Margin Offset	100 basis points per annum.
GMDB Description	• ROP = return of premium. • ROLL = 5% compound roll-up, frozen at age 80. • MAV = annual ratchet (maximum anniversary value), frozen at age 80. • GMDB_10 = 10-year rollover contract.
GMMB & GMSB Descriptions	• FIXED = fixed maturity date. • GMSB_10 = 10-year guaranteed surrender benefit. • GMMB_10 = 10-year rollover maturity benefit.
GV Adjustment on Withdrawal	"Pro-Rata by Market Value" and "Dollar-for-Dollar" are tested separately.
Surrender Charges	Ignored (i.e., zero).
Base Policy Lapse Rate	6% p.a. at all policy durations. See also "Dynamic Lapse Multiplier".
Partial Withdrawals	Flat 4% p.a. at all policy durations (as a % of AV). No dynamics.
Rollover (Renewal) Rate	85% at the end of each 10-year term (GMDB_10 and GMMB_10 only).
Dynamic Lapse Multiplier	Actual lapse rate = $\lambda \times$ [Base Policy Lapse Rate], where: $\lambda = \text{MIN}\left(\lambda^{+}, \text{MAX}\left(\lambda^{-}, a + b \times \frac{AV}{GV} \times c + d \times \text{MIN}\left(h, T\right)\right)\right)$ $\lambda^{+} = 1.6667$, $\lambda^{-} = 0.3333$, $a = -0.0952$, $b = 0.8010$, $c = 0.6279$, $d = 0.0654$ $h = 10$ and T = time-to-next maturity
Mortality	100% of CIA 1986–92 ALB Male Aggregate Ultimate.
Fixed Expenses, Annual Fees	Ignored (i.e. zero).
Discount Rate	5.5% annual effective (non-dynamic).
Elective Reset of GV	Whenever the AV/GV ratio exceeds 115% (maximum 2 resets per year). No resets are permitted in the 10 years prior to the final "contract" maturity date.

In-The-Money Surrender (GMSB_10 only)	Whenever the benefit is payable (i.e., 10 years after issue or last reset) and the AV/GV ratio is less 85%.

Notes on Factor Development:

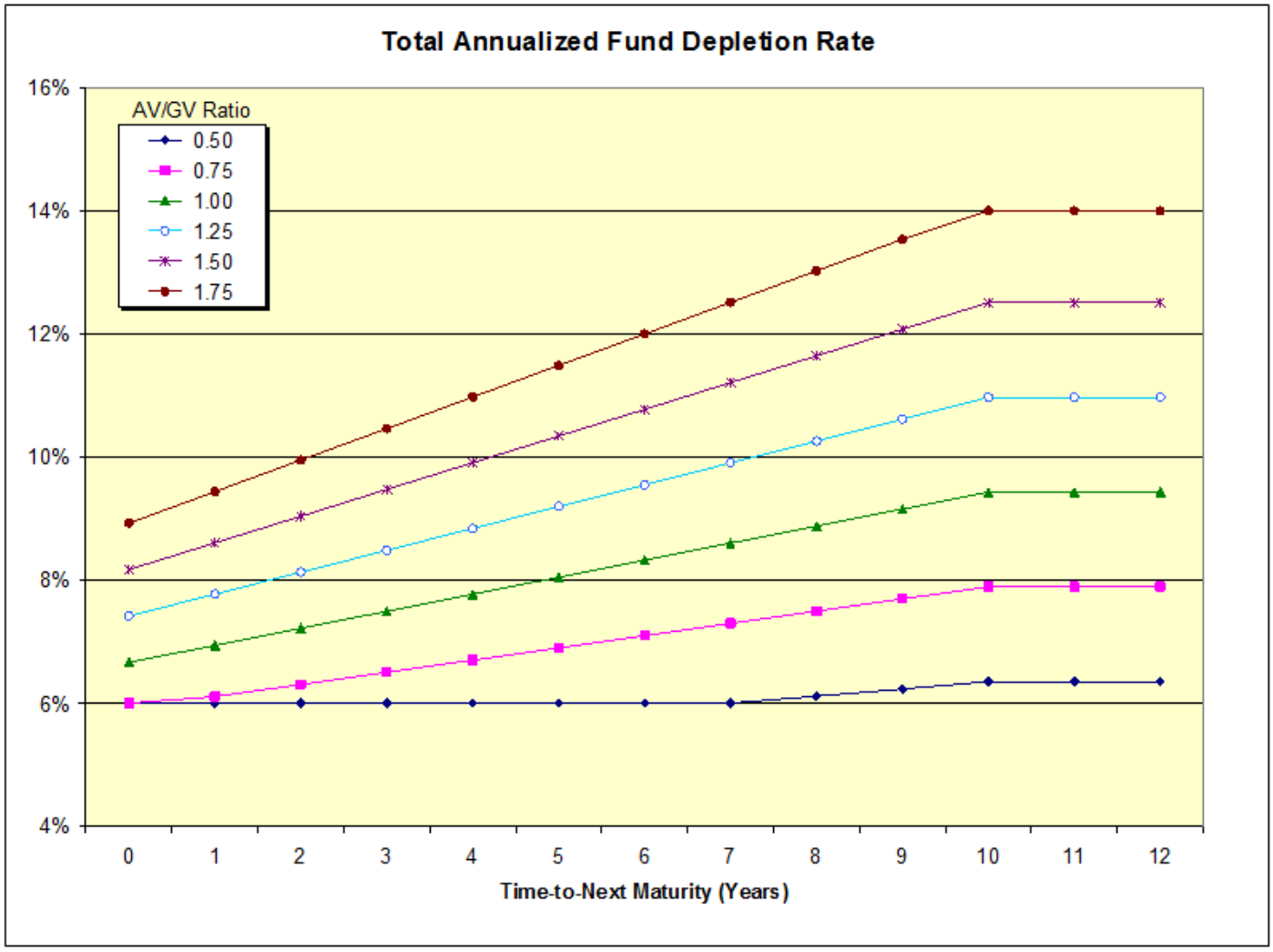
1. The GMDB roll-up is compounded (not simple interest, not stepped at each anniversary) and is applied to the previous roll-up guaranteed value.
2. The "Base Policy Lapse Rate" is the rate of policy termination (surrenders). Policy terminations (surrenders) are assumed to occur throughout the policy year (not only on anniversaries).
3. Partial withdrawals are assumed to occur at the end of each time period (quarterly).
4. Account charges ("MER") represent the total amount (annualized, in basis points) assessed against policyholder funds (e.g., sum of investment management fees, mortality and expense charges, risk premiums, and policy/administrative fees). They are assumed to occur throughout the policy year (not only on anniversaries).
5. For the GMDB_10 and GMMB_10 products, the contract rolls over (renews) at the end of each 10-year term for another 10 years. The guaranteed benefit resets to Z% of MV (after payment of any top-up maturity benefit for in-the-money maturity guarantees) where Z is typically 75 or 100.
6. The guaranteed minimum surrender benefit (GMSB_10) comes into effect 10 years after contract issue. If the guaranteed value at 10 years is greater than the account value at surrender, a "top-up" benefit equal to the difference is paid.

Table 2: Account-Based Fund Charges (bps per annum)

Asset Class / Fund	Account Value Charges (MER)
Money Market	110
Fixed Income (Bond)	200
Balanced	250
Low Volatility Equity	265
Diversified Equity	265
Intermediate Risk Equity	280
Aggressive or Exotic Equity	295

The annualized total fund depletion rates (i.e., including the fixed 4% per annum partial withdrawal) are illustrated in Figure 1 for various AV/GV ratios and times to maturity.

Figure 1: Fund Depletion Rates (Lapse + Partial Withdrawal) by AV/GV Ratio & Time-to-Maturity



Total Annualized Fund Depletion Rate - Chart description

The graph shows annualized fund depletion rates (lapses plus partial withdrawals) by time to maturity for six different levels of AV/GV. When AV/GV is 0.5, the depletion rate is approximately 6% for all times to maturity. When AV/GV is 1, the depletion rate starts at 6.5% for maturity zero and increases linearly to 9.5% at maturities 10 years and higher. When AV/GV is 1.75, the depletion rate starts at 9% for maturity zero and increases linearly to 14% at maturities 10 years and higher.

7.4. Classifying the asset exposure

7.4.1. Definition of asset classes

The following criteria should be used to select the appropriate factors, parameters and formulas for the exposure represented by a specified guaranteed benefit. When available, the volatility of the long-term annualized total return for the fund(s) – or an appropriate benchmark – should conform to the limits presented. For this purpose, "long-term" is defined as twice the average projection period that would be applied to test the product in a stochastic model (generally, at least 25 years).

Where data for the fund or benchmark are too sparse or unreliable, the fund exposure should be moved to the next higher volatility class than otherwise indicated. In reviewing the asset classifications, care should be taken to reflect any additional volatility of returns added by the presence of currency risk, liquidity (bid-ask) effects, short selling and speculative positions.

All exposures/funds must be categorized into one of the following seven (7) asset classes:

1. Money Market/Short-Term
2. Fixed Income
3. Balanced
4. Low Volatility Equity
5. Broad-Based Diversified Equity
6. Intermediate Risk Equity
7. Aggressive or Exotic Equity

Money Market/Short-Term

The fund is invested in money market instruments with an average remaining term-to-maturity of less than 365 days.

Fixed Income

The fund is invested primarily in investment grade fixed income securities. Up to 25% of the fund within this class may be invested in diversified equities or high-yield bonds. The expected volatility of the fund returns will be lower than the Balanced fund class.

Balanced

This class is a combination of fixed income securities with a larger equity component. The fixed income component should exceed 25% of the portfolio. Additionally, any aggressive or 'specialized' equity component should not exceed one-third (33.3%) of the total equities held. Should the fund violate either of these constraints, it should be categorized as an equity fund. These funds usually have a long-term volatility in the range of 8% − 13%.

Low Volatility Equity

This fund is comparable to the Broad-Based Diversified Equity class with the additional attributes noted below. Only funds that otherwise would be classified as Broad-Based Diversified Equity are candidates for this fund classification. For foreign funds, volatility should take into account the impact of currency fluctuations.

The expected volatility of the fund should be less than 15.5% (annualized) and the aggressive/exotic equity component of the equity holdings should be less than 33.3% of the total equities by market value. Further, the overall asset holdings should satisfy at least one of the following conditions:

1. The fund permanently maintains a relatively large cash or fixed income position (greater than 10% of the market value of assets) as part of its investment strategy;
2. The fund is "income" oriented and contains a significant (greater than 10% of the market value of assets) proportion of stocks paying material and regular dividends that are automatically reinvested in the fund.

Broad-Based Diversified Equity

The fund is invested in a well-diversified mix of Canadian, U.S. or global equities. The foreign equity component must be comprised of liquid securities in well-developed markets. Funds in this category would exhibit long-term volatility comparable to that of the TSX. These funds should usually have a long-term volatility in the range of 13% −

19%.

Intermediate Risk Equity

The fund has a mix of characteristics from both the Diversified and Aggressive Equity Classes. These funds have a long-term volatility in the range of 19% − 25%.

Aggressive or Exotic Equity

This class comprises more volatile funds where risk can arise from: (a) underdeveloped markets, (b) uncertain markets, (c) high volatility of returns, (d) narrow focus (e.g., specific market sector), and other sources. The fund (or market benchmark) either does not have sufficient history to allow for the calculation of a long-term expected volatility, or the volatility is very high. This class would be used whenever the long-term expected annualized volatility is indeterminable or exceeds 25%.

7.4.2. Selecting appropriate investment classes

The selection of an appropriate investment type should be done at the level for which the guarantee applies. For guarantees applying on a deposit-by-deposit basis, the fund selection is straightforward. However, where the guarantee applies across deposits or for an entire contract, the approach can be more complicated. In such instances, the approach is to identify for each policy where the "grouped holdings" fit within the categories listed and to classify the associated assets on this basis.

A seriatim process is used to identify the "grouped" fund holdings, to assess the risk profile of the current fund holdings (possibly calculating the expected long-term volatility of the funds held with reference to the indicated market proxies), and to classify the entire "asset exposure" into one of the specified choices. Here, "asset exposure" refers to the underlying assets (segregated and/or general account investment options) on which the guarantee will be determined. For example, if the guarantee applies separately for each deposit year within the contract, then the classification process would be applied separately for the exposure of each deposit year.

In summary, mapping the benefit exposure (i.e., the asset exposure that applies to the calculation of the guaranteed minimum benefits) to one of the prescribed asset classes is a multi-step process:

1. Map each separate and/or general account investment option to one of the prescribed asset classes. For some funds, this mapping will be obvious, but for others it will involve a review of the fund's investment policy, performance benchmarks, composition and expected long-term volatility.
2. Combine the mapped exposure to determine the expected long-term volatility of current fund holdings. This will require a calculation based on the expected long-term volatilities for each fund and the correlations between the prescribed asset classes as given in Table 3.
3. Evaluate the asset composition and expected volatility (as calculated in step 2) of current holdings to determine the single asset class that best represents the exposure, with due consideration to the constraints and guidelines presented earlier in this section.

In step 1, the company should use the fund's actual experience (i.e., historical performance, inclusive of reinvestment) only as a guide in determining the expected long-term volatility. Due to limited data and changes in investment objectives, style and/or management (e.g., fund mergers, revised investment policy, and different fund managers), the company may need to give more weight to the expected long-term volatility of the fund's benchmarks. In general, the company should exercise caution and not be overly optimistic in assuming that future returns will consistently be less volatile than the underlying markets.

In step 2, the company should calculate the "volatility of current fund holdings" (for the exposure being categorized) by the following formula using the volatilities and correlations in Table 3.

$$\sigma = \sum_{i=1}^{n} \sum_{j=1}^{n} w_i \, w_j \, \rho_{ij} \, \sigma_i \, \sigma_j$$

where $w_i = AV_i \Big/ \sum_k AV_k$ is the relative value of fund i expressed as a proportion of total contract value, ρ_{ij} is the correlation between asset classes i and j and σ_i is the volatility of asset class i (see Table 3).

Table 3: Volatilities and Correlations for Prescribed Asset Classes

Annual Volatility		General Account	Money Market	Fixed Income	Balanced	Low Vol Equity	Diverse Equity	Interm Equity	AGGR Equity
1%	General Account	**1**	0.50	0.15	0	0	0	0	0
1%	Money Market	0.50	**1**	0.20	0	0	0	0	0
6%	Fixed Income	0.15	0.20	**1**	0.50	0.25	0.25	0.20	0.10
11%	Balanced	0	0	0.50	**1**	0.80	0.95	0.75	0.65
15%	Low Vol Equity	0	0	0.25	0.80	**1**	0.80	0.75	0.65
17%	Diverse Equity	0	0	0.25	0.95	0.80	**1**	0.75	0.65
22%	Interm Equity	0	0	0.20	0.75	0.75	0.75	**1**	0.70
26%	AGGR Equity	0	0	0.10	0.65	0.65	0.65	0.70	**1**

Example: Fund Categorization

Suppose three funds (Fixed Income, Diversified Equity and Aggressive Equity) are offered to clients on a product with a contract level guarantee (i.e., across all funds held within the policy). The current fund holdings (in dollars) for five sample contracts are as follows:

	1	2	3	4	5
MV Fund X (Fixed Income):	5,000	6,000	8,000	-	5,000
MV Fund Y (Diversified Equity):	9,000	5,000	2,000	5,000	-
MV Fund Z (Aggressive Equity):	1,000	4,000	-	5,000	5,000
Total Market Value:	$15,000	$15,000	$10,000	$10,000	$10,000
Total Equity Market Value:	$10,000	$9,000	$2,000	$10,000	$5,000
Fixed Income % (*A*):	33%	40%	80%	0%	50%
Fixed Income Test (*A* >75%):	No	No	Yes	No	No
Aggressive % of Equity (B):	10%	44%	n/a	50%	100%
Balanced Test (*A* >25% & *B* <33.3%):	Yes	No	n/a	No	No
Volatility of Current Fund Holdings:	12.0%	12.1%	6.5%	19.6%	13.6%
Fund Classification:	**Balanced**	**Diversified**1	**Fixed Income**	**Intermediate**	**Diversified**

The "Volatility of Fund Holdings" for policy #1 is calculated as $A + B = 12.04\%$ where:

$$A = \left(\frac{5}{15} \times 0.06\right)^2 + \left(\frac{9}{15} \times 0.17\right)^2 + \left(\frac{1}{15} \times 0.26\right)^2 \quad A = 1.1104\% \quad B = 2 \cdot \left(\frac{5}{15} \cdot \frac{9}{15}\right) 0.25 \times 0.06 \times 0.17 + 2 \cdot \left(\frac{5}{15} \cdot \frac{1}{15}\right) 0.10 \times 0.06 \times 0.26 + 2 \cdot \left(\frac{9}{15} \cdot \frac{1}{15}\right) 0.65 \times 0.17 \times 0.26 \quad B = 0.3388\%$$

Importantly, the volatility would be understated if we assumed zero correlation (e.g. if all market returns are independent) since B contributes materially to the final value.

7.5. Determining the risk attributes

The "Tabular" approach for the *TGCR* component creates a multi-dimensional grid (array) by testing a very large number of combinations for the policy attributes. The results are expressed as factors. The *TGCR* is calculated by looking into (based on a "key") the large, pre-computed multi-dimensional tables and using multi-dimensional linear interpolation. The lookup "key" depends on the risk attributes for the policy $\theta \sim = (P, G, A, F, X, M, T, \Phi, \Delta, R,$

S) where Φ is the AV/GV ratio for the benefit exposure under consideration, Δ is the "MER Delta", R is the utilization rate of the elective reset option (if applicable) and S is the "in-the-money" termination rate on GMSB_10 policies. The "MER Delta" is calculated based on the difference between the actual MER and that assumed in the factor testing (see Table 2), subject to a cap (floor) of 100 bps (-100 bps). See Table 4 for more details.

For GMDB, there are 4 × 2 × 2 × 7 × 4 × 4 × 5 × 7 × 3 × 2 = 376,320 "nodes" in the "Basic Factor" grid. Interpolation will only be permitted across the six (6) dimensions: Contract Maturity Age (M), Attained Age (X), Time to Next Maturity (T), AV/GV Ratio (Φ), MER Delta (Δ) and Reset Utilization Rate (R). The "In-the-Money" termination rate (S) is not used for GMDBs.

For GMMB, there are 3 × 2 × 2 × 7 × 1 × 7 × 5 × 7 × 3 × 2 × 2 = 246,960 "nodes" in the "Basic Factor" grid. Interpolation will only be permitted across the six (6) dimensions: Contract Maturity Age (M), Time to Next Maturity (T), AV/GV Ratio (Φ), MER Delta (Δ), Reset Utilization Rate (R) and In-the-Money Termination Rate (S). The "In-the-Money" termination rate (S) is only applies to the "GMSB_10" product form. The testing for guaranteed minimum maturity and surrender benefits assumed all lives were attained age 55 at the calculation date.

Functions are available to assist the company in applying the *TGCR* Methodology. More fully described in section 7.7, these functions perform the necessary factor table lookups and associated multi-dimensional linear interpolations. If the insurer is unable to use the supplied functions, it will be required to develop its own. In such a case, the insurer should contact OSFI for specific details.

The GMDB and GMMB/GMSB factors are respectively contained in the files "**GMDBFactors_CTE95.csv**" and "**GMMBFactors_CTE95.csv**". These are comma-separated value text files where each "row" represents the factors for a test policy as identified by its lookup key. Rows are terminated by new line and line feed characters. Factors are also provided at the CTE80 confidence level – the factor files are "**GMDBFactors_CTE80.csv**" and "**GMMBFactors_CTE80.csv**". For the determination of capital requirements, the "**GMDBFactors_CTE95.csv**" and "**GMMBFactors_CTE95.csv**" factors are to be used.

Each row in the factor tables consists of three entries, described further below.

1	2	3
Test Case Identifier (Key)	Basic Cost or Diversification Factor	Basic Margin Offset Factor or Zero (N/A)

An individual test case (i.e., a node on the multi-dimensional matrix of factors) can be uniquely identified by its key, which is the concatenation of the relevant individual policy attribute keys (or some subset thereof) prefixed by a leading "factor code". The factor codes are shown below.

Factor Code	Description
1	Basic GMDB "Cost" and "Margin Offset" factors.
2	Basic GMMB and GMSB "Cost" and "Margin Offset" factors.
3	Asset Mix Diversification factors for GMDB options.
4	Asset Mix Diversification factors for GMMB and GMSB options.
5	Time Diversification factors for GMDB options.
6	Time Diversification factors for GMMB and GMSB options.

Basic Cost Factor. This is the term $f(\theta\sim)$ in the formula for *TGCR* . The values in the factor grid represent CTE95 (or CTE80) of the sample distribution2 for the present value of guaranteed minimum benefit cash flows (in excess of account value) in all future years (i.e., to the earlier of contract maturity and 30 years), normalized by current guaranteed value3. The policy attribute keys for the Cost factors are shown in Table 4.

Basic Margin Offset Factor. This is the term $g(\theta\sim)$ in the formula for *TGCR* . The values in the factor grid represent CTE95 (or CTE80) of the sample distribution for the present value of margin offset cash flows in all future years (i.e., to the earlier of contract maturity and 30 years), normalized by current account balance. The Basic Margin Offset Factors assume $\alpha\hat{}=100$ basis points of "margin offset" (net spread available to fund the guaranteed benefits). The policy attribute keys for the Margin Offset factors are shown in Table 4.

Asset Mix Diversification Factor. This is the term $h(\theta\sim)$ in the formula for *TGCR* . $h(\theta\sim)=h(P,G,R,S)$ is an adjustment factor that reflects the benefits of fund diversification (asset mix) at the company (i.e., total portfolio) level. Note that $h(\theta\sim)\leq 1$ depends on product form " *P* ", guarantee level " *G* ", reset utilization rate " *R* " (where

applicable) and in-the-money termination rate " S " (GMSB only). The lookup keys for the Asset Mix Diversification factors are given in Table 5.

DF should be set equal to 1 in the GetCost and GetTGCR functions (q.v. section 7.7.1).

Time Diversification Factor. This is the term $w(\theta \sim)$ in the formula for $TGCR$. $w(\theta \sim) = w(P, G, F, R, S)$ is an adjustment factor that attempts to capture the benefits (i.e., net reduction in guaranteed benefit costs) of a dispersed maturity profile. This adjustment applies on to maturity benefit factors only; it does not apply to death benefit factors. Note that $w(\theta \sim) \leq 1$ also depends on fund class " F ". If the company does not satisfy the time diversification criteria, then $w(\theta \sim) = 1$ (i.e., no time diversification benefit). Although the structure permits otherwise, the time diversification factors for GMDB are set to 1. The lookup keys for the Time Diversification factors are given in Table 6.

This factor is set either to zero or one, based on the results of a time diversification test.

To perform the test, the in-force maturity dates for each product/maturity guarantee form are grouped by "quarter-to-maturity" (i.e., 1, 2, ..., N). For limited-term contracts that offer the client the opportunity to renew ("rollover"), the next maturity date should be used (not final contract maturity). Using current market value (at the calculation date), the current market value in each future 3-month time period is determined.

If the current market value in any given quarter exceeds 10% of the total, then the portfolio **fails** the test. If the current market value in **each** quarter is less than or equal to 10% of the total, the portfolio passes the test. If the portfolio fails the test, DT is set equal to zero in the GetCost and GetTGCR functions (q.v. section 7.7.1). Otherwise, DT is set equal to one.

Table 4: Grid of Cost and Margin Offset Factors

Policy Attribute		Key : Possible Values & Description
Product Definitions, *P* .	GMDB	• 0 : Return-of-premium. • 1 : Roll-up (5% per annum). • 2 : Maximum Anniversary Value (MAV). • 3 : 10-year rollover.
	GMMB & GMSB	• 0 : Fixed maturity date. • 1 : 10-year CSV (benefit paid on surrender) • 2 : *Not used*. • 3 : 10-year rollover.
Guarantee Level (% of deposits), *G* .		• 0 : 75% • 1 : 100%
GV Adjustment Upon Partial Withdrawal, *A* .		• 0 : Pro-rata by market value. • 1 : Dollar-for-dollar.
Fund Class, *F* .		• 0 : *Not used*. • 1 : Money Market. • 2 : Fixed Income (Bond). • 3 : Balanced Asset Allocation. • 4 : Low Volatility Equity. • 5 : Diversified Equity. • 6 : Intermediate Risk Equity. • 7 : Aggressive / Exotic Equity.
Contract Maturity Age, *M* . (years from valuation date)	GMDB	• 0 : 5 years • 1 : 15 years • 2 : 25 years • 3 : 30 years

GMMB & GMSB		• 0 : 1 year • 1 : 3 years • 2 : 5 years • 3 : 8 years • 4 : 10 years • 5 : 20 years • 6 : 30 years
Attained Age (Last Birthday), X .	GMDB	• 0 : 35 • 1 : 55 • 2 : 65 • 3 : 75
	GMMB & GMSB	• 0 : 55
Time to Next Maturity, T . (years from valuation date)		• 0 : 1 year • 1 : 3 years • 2 : 5 years • 3 : 8 years • 4 : 10+ years
Account Value-to-Guaranteed Value Ratio, Φ .		• 0 : 0.25 • 1 : 0.50 • 2 : 0.75 • 3 : 1.00 • 4 : 1.25 • 5 : 1.50 • 6 : 2.00

Annualized Account Charge Differential from Table 2 Assumptions ("MER Delta"), Δ		• 0 : -100 bps • 1 : 0 bps • 2 : +100 bps
Reset Utilization Rate, R .		• 0 : 0% • 1 : 100%
In-the-Money Surrender Rate (GMSB only), S .		• 0 : 0% • 1 : 100%

It is important to note that the lookup keys for the factor tables define certain values differently from the parameters (arguments) passed to the lookup/retrieval functions, as indicated in the following table. More details are provided in section 7.7.

Policy Attribute	Key Interpretation	Function Arguments
Contract Maturity Age, M.	Years from Valuation Date. Equal to [Contract Maturity Age] less [Attained Age].	Actual contract maturity age.
AV/GV Ratio, Φ .	Ratio of current Account Balance (AV) to Guaranteed Value (GV).	AV and GV are provided separately.
MER Delta, Δ.	[Actual MER] less [Assumed MER], in basis points. The "Assumed MERs" are shown in Table 2.	MER (annualized, in basis points p.a.) is passed directly.

Table 5: Grid of Asset Mix Diversification Factors

Policy Attribute		Key : Possible Values & Description
Product Definitions, *P* .	GMDB	• 0 : Return-of-premium. • 1 : Roll-up (5% per annum). • 2 : Maximum Anniversary Value (MAV). • 3 : 10-year rollover.
	GMMB & GMSB	• 0 : Fixed maturity date. • 1 : 10-year CSV (benefit paid on surrender). • 2 : *Not used*. • 3 : 10-year rollover.
Guarantee Level (% of deposits), *G* .		• 0 : 75% 1 : 100%
Reset Utilization Rate, *R* .		• 0 : 0% 1 : 100%
In-the-Money Surrender Rate (GMSB only), *S* .		• 0 : 0% 1 : 100%

Table 6: Grid of Time Diversification Factors

Policy Attribute		Key : Possible Values & Description
Product Definition, *P* .	GMDB	• 0 : Return-of-premium. • 1 : Roll-up (5% per annum). • 2 : Maximum Anniversary Value (MAV). • 3 : 10-year rollover.
	GMMB & GMSB	• 0 : Fixed maturity date. • 1 : 10-year CSV (benefit paid on surrender). • 2 : *Not used*. • 3 : 10-year rollover.
Guarantee Level (% of deposits), *G* .		• 0 : 75% 1 : 100%
Fund Class, *F* .		• 0 : *Not used*. • 1 : Money Market. • 2 : Fixed Income (Bond). • 3 : Balanced Asset Allocation. • 4 : Low Volatility Equity. • 5 : Diversified Equity. • 6 : Intermediate Risk Equity. • 7 : Aggressive / Exotic Equity.
Reset Utilization Rate, *R* .		• 0 : 0% 1 : 100%
In-the-Money Surrender Rate (GMSB only), *S* .		• 0 : 0% 1 : 100%

7.6. Retrieving the appropriate nodes

Table 7 provides some sample lookup keys (assuming the annualized fund based charges equal the base assumption, hence Δ = 0), while Table 8 shows the "Basic Cost" and "Basic Margin Offset" values from the factor grid for some sample GMDB and GMMB policies. All sample policies in Table 8 use a 100% guarantee level, base MERs and no resets. As mentioned earlier, the Base Margin Offset factors (in the tables) assume 100 basis points of "available spread". The "Margin Offset Factors" are therefore scaled by the ratio $\alpha \ 100$, where α is the actual

margin offset (in basis points per annum) for the policy being valued. Hence, the margin factor for the 7th policy is exactly half the factor for node '11105214210' (the 4th sample policy in Table 8). That is, 0.02093 = 0.5 × 0.04187.

Where more than one feature (i.e., guaranteed benefit) is present in a product, unless the company has a justifiable alternative for allocating the total available spread between the benefit types (e.g. explicitly defined risk charges), the split should be based on the proportionate gross guaranteed benefit costs. An example of this allocation is provided in section 7.7.2.

Table 7: Sample Lookup Keys

Key	Node Type	Product / GV%	GV Adjust	Fund Class	Att.. Age / Mat. Age	Next Mat.	AV/GV	Reset Util.%	ITM Term%
10103214110	A	GMDB-ROP / 100%	Pro-rata	Balanced Allocation	65 / 80	10+	50%	0%	n/a
200150444110	A	GMMB-Fixed / 75%	$-for-$	Diverse Equity	55 / 75	5	125%	100%	n/a
3311	B	GMDB_10 / 100%	n/a	n/a	n/a	n/a	n/a	100%	n/a
43100	B	GMMB_10 / 100%	n/a	n/a	n/a	n/a	n/a	0%	n/a
611411	C	GMSB_10 / 100%	n/a	Low Vol. Equity	n/a	n/a	n/a	100%	100%

A = Basic Cost and Margin Offset Factors; B = Asset Mix Diversification Factors; C = Time Diversification Factors.

Table 8: Sample Nodes on the Basic Factor Grids

Key	Product	GV Adjust	Fund Class	Att. Age / Mat.Age	Next Mat.	AV/GV	Offset	Cost Factor	Margin Factor
10113124310	GMDB ROP	$-for-$	Balanced Allocation	55 / 80	10+	1.00	100	0.01802	0.05762
10113214310	GMDB ROP	$-for-$	Balanced Allocation	65 / 80	10+	1.00	100	0.03926	0.04747
10113302310	GMDB ROP	$-for-$	Balanced Allocation	75 / 80	5	1.00	100	0.04443	0.02653
11105214210	GMDB 5% Rollup	Pro-rata	Diverse Equity	65 / 80	10+	0.75	100	0.16780	0.04187
11105214310	GMDB 5% Rollup	Pro-rata	Diverse Equity	65 / 80	10+	1.00	100	0.13091	0.04066
11105214410	GMDB 5% Rollup	Pro-rata	Diverse Equity	65 / 80	10+	1.25	100	0.09925	0.03940
11105214210	GMDB 5% Rollup	Pro-rata	Diverse Equity	65 / 80	10+	0.75	50	0.16780	0.02093
231050513100	GMMB_10	Pro-rata	Diverse Equity	55 / 75	3	1.00	100	0.32250	0.05609
231050523100	GMMB_10	Pro-rata	Diverse Equity	55 / 75	5	1.00	100	0.25060	0.05505
231050533100	GMMB_10	Pro-rata	Diverse Equity	55 / 75	8	1.00	100	0.16758	0.05545

7.7. Use of supplied functions to determine the requirement

7.7.1. Function descriptions

Special functions have been supplied in the file **OSFIFactorCalc.dll** (C++ dynamic linked library) to retrieve the "cost", "margin offset" and "diversification" factors from the factor files *and* perform the multi-dimensional linear interpolation. Cover functions in the Microsoft® Visual Basic "Add-In" are provided in the file **OSFIFactorCalc.xla** so

that the C++ routines are callable from Microsoft Excel through VBA4. The function arguments are described in Table 9. Not all parameters apply to all functions (i.e., some are optional and/or not applicable). The keys for the input parameters are given in Table 4.

Installation instructions are given later in this section. A call to an Excel function (built-in or VBA) must be preceded by a "+" or "=" character.

Table 9: Input Parameters (Arguments) to Supplied Lookup/Retrieval Functions

Input Parameter – Variable Name	Variable Type	Description
B – BenefitType	Long Integer	Benefit Type code (1=GMDB, 2=GMMB/GMSB).
P – ProductCode	Long Integer	Product Definition code.
G – GuarCode	Long Integer	Guarantee Level code.
A – GVAdjustCode	Long Integer	GV Adjustment Upon Partial Withdrawal.
F – FundCode	Long Integer	Fund Class code.
M – FinalMatAge	Floating Point Double	Contract Maturity Age of annuitant (in years).
X – AttainedAge	Floating Point Double	Attained Age of annuitant (in years).
T – TimeToMat	Floating Point Double	Time to Next Maturity Date (in years).
MVGV – MVGV	Floating Point Double	Ratio of Account Balance to Guaranteed Value (AV/GV).
MER – MER	Floating Point Double	Total Equivalent Account Charges (annualized, in bps).
R – ResetUtil	Floating Point Double	Reset Utilization Rate (from 0 to 1).
S – SurrenderUtil	Floating Point Double	In-The-Money Termination Rate (from 0 to 1).
RC – RiskCharge	Floating Point Double	Margin Offset (annualized, in basis points).
AV – AccountValue	Floating Point Double	Current Account Balance, in dollars.
GV – GuarValue	Floating Point Double	Current Guaranteed Value, in dollars.

Input Parameter – Variable Name	Variable Type	Description
DF – FundDivAdj	Floating Point Double	The fraction of the Asset Mix Diversification adjustment reflected in the Adjusted Cost Factor (from 0 to 1).
DT – TimeDivAdj	Floating Point Double	The fraction of the Time Diversification adjustment reflected in the Adjusted Cost Factor (from 0 to 1).

Refer to section 7.5 for instructions on setting the parameters for DF and DT.

Using the notation given earlier,

$$TGCR = GV \times h(\theta\sim) \times w(\theta\sim) \times BasicCostFactor - \alpha(100) \times AV \times BasicMarginFactor$$

$$TGCR = GV \times h(\theta\sim) \times w(\theta\sim) \times f(\theta\sim) - \alpha(100) \times AV \times g(\theta\sim)$$

$$TGCR = GV \times f^{\wedge}(\theta\sim) - AV \times g^{\wedge}(\theta\sim)$$

$$TGCR = F^{\wedge}(\theta\sim) - G^{\wedge}(\theta\sim)$$

The VBA functions are:

GetCost **(B, P, G, A, F, M, X, T, AV, GV, MER, R, S, RC, DF, DT)**

- Returns the *Adjusted Dollar Cost* $F^{\wedge}(\theta\sim)$, interpolating between nodes where necessary. *S* and *RC* are required arguments, but *RC* is ignored in the calculations (i.e., the margin offset does not affect the "cost" component). Also, *S* is ignored for GMDB calculations (i.e., $S = 0$ if $B = 1$). *DF* and *DT* are optional, but assumed to be zero if not supplied.

GetMargin **(B, P, G, A, F, M, X, T, AV, GV, MER, R, S, RC, DF, DT)**

- Returns the *Adjusted Dollar Margin Offset* $G^{\wedge}(\theta\sim)$, interpolating between nodes where necessary. *S* is required, but ignored for GMDB calculations (i.e., $S = 0$ if $B = 1$). *DF* and *DT* are optional, but ignored regardless (i.e., the diversification factors only apply to the "cost" component).

GetTGCR **(B, P, G, A, F, M, X, T, AV, GV, MER, R, S, RC, DF, DT)**

- Returns the *Adjusted Dollar TGCR* $F^{\wedge}(\theta\sim) - G^{\wedge}(\theta\sim)$, interpolating between nodes where necessary. *S* is required, but ignored for GMDB calculations (i.e., $S = 0$ if $B = 1$). *DF* and *DT* are optional, but

assumed to be zero if not supplied.

To retrieve the *Basic Cost Factor* $f^{(\theta\sim)}$ simply use the function GetCost with **AV = AV/GV, GV = 1** and **DF = DT = 0**. Similarly, the *Basic Margin Factor* $g(\theta\sim)$ may be obtained by calling GetMargin with **GV = GV/AV, AV = 1** and **RC = 100**.

For reference, the underlying C++ routines are listed below. These tools are also available as VBA functions where the name is prefixed with an "x" (e.g., xGetGMDBCostFactor).

GetGMDBCostFactor **(P, G, A, F, M, X, T, MVGV, MER, R)**

- Returns the GMDB *Basic Cost Factor* $f(\theta\sim)$, interpolating between nodes where necessary.

GetGMDBMarginFactor **(P, G, A, F, M, X, T, MVGV, MER, R, RC)**

- Returns the GMDB *Scaled Margin Offset Factor* $g^{(\theta\sim)}$, interpolating between nodes where necessary. In this case, the Basic (i.e., tabular) Margin Offset Factor has already been scaled by the ratio $\frac{\alpha}{100}$ to account for the actual available spread. To extract the tabular factor $g(\theta\sim)$, use *RC* = 100.

GetGMDBFundDiversification **(P, G, R)**

- Returns the GMDB *Asset Mix Diversification Factor* $h(\theta\sim)$, interpolating between nodes where necessary.

GetGMDBTimeDiversification **(P, G, F, R)**

- Returns the GMDB *Time Diversification Factor* $w(\theta\sim)$, interpolating between nodes where necessary. Currently, $w(\theta\sim)$, for all nodes, so this function call is unnecessary for GMDB.

GetGMMBCostFactor **(P, G, A, F, M, X, T, MVGV, MER, R, S)**

- Returns the GMMB/GMSB *Basic Cost Factor* $f(\theta\sim)$, interpolating between nodes where necessary.

GetGMMBMarginFactor **(P, G, A, F, M, X, T, MVGV, MER, R, S, RC)**

- Returns the GMMB/GMSB *Scaled Margin Offset Factor* $g^{(\theta\sim)}$, interpolating between nodes where necessary. In this case, the Basic (i.e., tabular) Margin Offset Factor has already been scaled by the ratio α 100 to account for the actual available spread. To extract the tabular factor $g(\theta\sim)$, use *RC* = 100.

GetGMMBFundDiversification **(P, G, R, S)**

- Returns the GMMB/GMSB *Asset Mix Diversification Factor* $h(\theta\sim)$, interpolating between nodes where necessary.

GetGMMBTimeDiversification **(P, G, F, R, S)**

- Returns the GMMB/GMSB *Time Diversification Factor* $w(\theta\sim)$, interpolating between nodes where necessary.

7.7.2. Installing and using the OSFI factor calculation routines

The files shown in Table 10 comprise the "OSFI Factor Calculation" tools, supplied by OSFI to assist the company in calculating the *TGCR* for *GMDB*, *GMMB* and *GMSB* options.

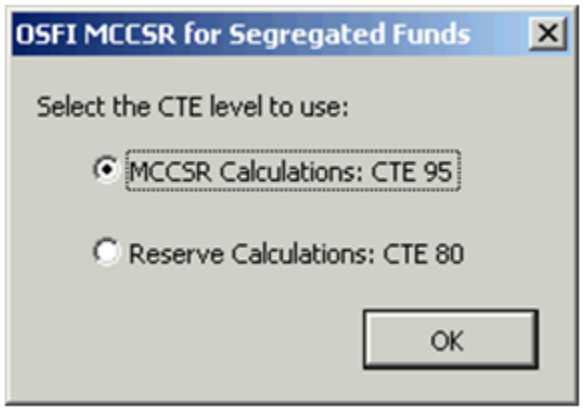
Table 10: OSFI Factor Calculation Tools – Required Files

File Name	Description
Setup.exe	Windows® setup program to unzip and install the calculation tools.
OSFIFactorCalc.xla	Microsoft® Excel Visual Basic Add-In. This functionality 'wraps' the C++ routines, allowing them to be called directly from Microsoft Excel workbooks (i.e., can be invoked the same way as built-in Excel functions).
OSFIFactorCalc.dll	The C++ dynamic linked library that contains the lookup and interpolation functions as described in this section.
GMDBFactors_CTE95.csv GMMBFactors_CTE95.csv	Comma separated value (flat text) files containing the factors and parameters described in section 7.5. Each "row" in the file corresponds to a test policy as identified by the lookup keys shown in Table 4. Each row consists of three entries and is terminated by new line and line feed characters. Q.V. section 7.5 for more details. Files are also provided at the CTE80 confidence level.

To install the OSFI factor calculation routines, run the setup utility and follow the instructions. This will unzip (decompress) the files and register the **DLL** in the Windows program registry.

The Microsoft Add-In must be loaded (into Excel) before the VBA functions can be called. The factor files and the Microsoft Excel Add-In (***.xla**) must reside in the same folder. Simply open "**OSFIFactorCalc.xla**" from Microsoft Excel. To view the VBA program, press [**Alt-F11**].

The following dialog should appear when the Add-In "OSFIFactorCalc.xla" is loaded, prompting the user to select the appropriate CTE confidence level for calculation (either CTE95 or CTE80). This controls which factor tables are read into memory. For a given workbook, only a single set of factor files can be accessed (i.e., either CTE80 *or* CTE95).



Example: Calculation Tool

Suppose we have the policy/product parameters as specified in the table below. Further assume that the portfolio satisfies the criteria in order to apply the "Time Diversification" factors.

Parameter / Attribute	Value	Description and/or Notes
Account Value (AV)	$90.00	Total account value at valuation date, in dollars.
Original Deposit	$100.00	Original deposit, in dollars.
GMDB (GV)	$100.00	Current guaranteed death maturity benefit, in dollars.
GMMB (GV)	$100.00	Current guaranteed minimum maturity benefit, in dollars.
Guarantee Level	100%	Initial guaranteed value as % of original deposit.
Gender	Female	Use 4-year age setback for X and M (GMDB only).
Actual Attained Age (X)	62	Attained age at the valuation date (in years).
Contract Maturity Age (M)	85	Contract maturity age (in years).
Time to Next Maturity (T), GMDB	23	Time to next maturity/rollover date (in years).
Time to Next Maturity (T), GMMB	3	Time to next maturity/rollover date (in years).
GV Adjustment	Pro-Rata	GV adjusted pro-rata by MV upon partial withdrawal.
Fund Class	Diversified Equity	Contract exposure mapped to Diversified Equity as per the Fund Categorization instructions in section 7.4.
MER	265	Total charge against policyholder funds (bps).
GMDB Product Code (P)	0	Product Definition code as per lookup key in Table 4.
GMMB Product Code (P)	3	Product Definition code as per lookup key in Table 4.
Guarantee Level Code (G)	1	Guarantee Code as per key in Table 4.
GV Adjustment Code (A)	0	GV Adjustment Upon Partial Withdrawal as per Table 4.
Fund Code (F)	5	Fund Class code as per lookup key in Table 4.
GMMB Reset Utilization (R)	0.35	Reset utilization rate (from 0 to 1).

Parameter / Attribute	Value	Description and/or Notes
In-The-Money Termination (S)	0	In-the-money termination rate (from 0 to 1).
Total Allocated Spread (RC)	80	Total margin offset (bps p.a.) for GMDB & GMMB combined.
Asset Mix Diversification (DF)	1	Credit for asset mix diversification.
Time Diversification (DT)	1	Credit for time diversification (GMMB).

Using the notation from section 7.7.1,

$$TGCR = GV \times h\left(\theta\sim\right) \times w\left(\theta\sim\right) \times BasicCostFactor - \alpha\left(100\right) \times AV \times BasicMarginFactor \quad TGCR = GV \times h\left(\theta\sim\right) \times w\left(\theta\sim\right) \times f\left(\theta\sim\right) - \alpha\left(100\right) \times AV \times g\left(\theta\sim\right) \quad TGCR = GV \times f\left(\theta\sim\right) - AV \times g\hat{}\left(\theta\sim\right) \quad TGCR = F\hat{}\left(\theta\sim\right) - G\hat{}\left(\theta\sim\right)$$

$$f\hat{}\left(GMDB\left(\theta\sim\right)\right) = GetCost\left(1, 0, 1, 0, 5, 81, 58, 23, 0.9, 1, 265, 0, 0, 80, 1, 1\right) \quad f\hat{}\left(GMDB\left(\theta\sim\right)\right) = 0.04592$$

$$f\hat{}\left(GMMB\left(\theta\sim\right)\right) = GetCost\left(2, 3, 1, 0, 5, 85, 62, 3, 0.9, 1, 265, 0.35, 0, 80, 1, 1\right) \quad f\hat{}\left(GMMB\left(\theta\sim\right)\right) = 0.32849$$

In the absence of specific and well-defined risk charges for each guaranteed benefit, we allocate the total spread by the claims cost and obtain (in bps per annum):

$$\alpha\left(GMDB\right) = 0.04592 \div \left(0.04592 + 0.32849\right) \times 80 = 0.12264 \times 80 = 9.81$$ basis points per annum available to fund the GMDB claims and $\alpha\left(GMMB\right) = 80 - 9.81 = 70.19$ bps p.a. to fund GMMB payouts.

$$F\hat{}\left(GMDB\left(\theta\sim\right)\right) = GetCost\left(1, 0, 1, 0, 5, 81, 58, 23, 90, 100, 265, 0, 0, 9.81, 1, 1\right) \quad F\hat{}\left(GMDB\left(\theta\sim\right)\right) = \$4.59 = 0.04592 \times \$100$$

$$F\hat{}\left(GMMB\left(\theta\sim\right)\right) = GetCost\left(2, 3, 1, 0, 5, 85, 62, 3, 90, 100, 265, 0.35, 0, 70.19, 1, 1\right) \quad F\hat{}\left(GMMB\left(\theta\sim\right)\right) = \$32.85 = 0.32849 \times \$100$$

For reference, the *Basic Cost Factors* (i.e., before diversification adjustments) are:

f GMDB θ ~ = GetCost 1, 0, 1, 0, 5, 81, 58, 23, 0.9, 1, 265, 0, 0, 9.81 f GMDB θ ~ = 0.04794

f GMMB θ ~ = GetCost 2, 3, 1, 0, 5, 85, 62, 3, 0.9, 1, 265, 0.35, 0, 70.19 f GMMB θ ~ = 0.36461

g GMDB θ ~ = GetMargin 1, 0, 1, 0, 5, 81, 58, 23, 0.9, 1, 265, 0, 0, 100 g GMDB θ ~ = 0.04227 = 0.04697 × 0.9

g GMMB θ ~ = GetMargin 2, 3, 1, 0, 5, 85, 62, 3, 0.9, 1, 265, 0.35, 0, 100 g GMMB θ ~ = 0.06201 = 0.06890 × 0.9

G ^ GMDB θ ~ = GetMargin 1, 2, 1, 2, 5, 81, 58, 23, 90, 100, 265, 0, 0, 9.81 G ^ GMDB θ ~ = $ 0.41 = 0.04697 × $ 90 × 9.81 100

G ^ GMMB θ ~ = GetMargin 2, 3, 1, 0, 5, 85, 62, 3, 90, 100, 265, 035, 0, 70.19 G ^ GMMB θ ~ = $ 4.35 = 0.06890 × $ 90 × 70.19 100

TGCR GMDB = GetTGCR 1, 0, 1, 0, 5, 81, 58, 23, 90, 100, 265, 0, 0, 9.81, 1, 1 TGCR GMDB = $4.18

TGCR GMDB = $4.59 − $0.41

TGCR GMMB = GetTGCR 2, 3, 1, 0, 5, 85, 62, 3, 90, 100, 265, 0.35, 0, 70.19, 1, 1 TGCR GMMB = $28.50

TGCR GMMB = $32.85 − $4.35

Finally, the *TGCR* for the policy is $4.18 + $28.50 = $32.68

If desired, the Asset Mix and Time Diversification Factors may be obtained through additional function calls by setting *DF* or *DT* to zero as required and solving for the other factor. For example, if we set *DF* = 1 and *DT* = 0, we obtain for the *GMMB* component:

0.34307 = GetCost (2, 3, 1, 0, 5, 85, 62, 3, 0.9, 1, 265, 0.35, 0, 80, 1, 0)

However, with *DF* = 1 and *DT* = 1 we obtained f ^ GMMB θ ~ = 0.32849 (see earlier in this section).

Hence, the *GMMB Time Diversification* Factor is equal to 0.9575 = 0.32849 0.34307

7.8. Margin Offset Adjustment

The total equivalent account charge ("MER") is meant to capture *all* amounts that are deducted from policyholder funds, not only those that are commonly expressed as spread-based fees. The MER, expressed as an equivalent annual basis point charge against account value, should include (but not be limited to) the following: investment management fees, mortality & expense charges, administrative loads, policy fees and risk premiums. It may be necessary to estimate an equivalent MER if there are fees withdrawn from policyholder accounts that are not expressed as basis point charges against account value.

The margin offset, α , represents the total amount available to fund the guaranteed benefit claims and amortization of the unamortized surrender charge allowance after considering most other policy expenses (including overhead). The margin offset, expressed as an equivalent annual basis point charge against account value, should be deemed permanently available in all future scenarios. However, the margin offset should not include per policy charges (e.g., annual policy fees) since these are included in fixed expenses. It is often helpful to interpret the margin offset as $\alpha = MER - X$, where X is the sum of:

a. Investment management expenses and advisory fees;
b. Commissions, bonuses (dividends) and overrides;
c. Maintenance expenses; and
d. Amounts required to amortize unamortized acquisition costs (net of available surrender charges).

7.9. Credit for reinsurance ceded or capital markets hedging

A reduction in the *TGCR* or recognition of Eligible Deposits may be available on account of risk mitigation strategies, including reinsurance and hedging.

For registered reinsurance of segregated fund liabilities that is directly expressible in terms of the component factors, ceding companies may take credit through an appropriate reduction of the factors.

For more complex reinsurance that cannot be expressed using the factors, the impact will need to be modeled (q.v. section 7.10) and submitted to OSFI for approval. For example, a reinsurance treaty that has the ceding company retain losses to a predetermined level (a "deductible"), with the reinsurer assuming losses above this level, but with a cap on the reinsurance claims (e.g. a maximum annual payment cap under the treaty) would normally require the use of a suitable internal model.

Aggregate positive policy liabilities ceded under unregistered reinsurance (q.v. section 10.1), net of any credit available for unregistered reinsurance (q.v. section 10.3), should be reported on page 20.030 by Canadian insurers, and on page 12.200 by branches of foreign insurers.

Eligible Deposits held for unregistered reinsurance per section 10.3, for a period not less than the fund guarantee term remaining, may be recognized subject to the limit in section 6.8.1. For Canadian business, the deposits must be held in Canada, and OSFI must have given the company permission to recognize the deposits.

7.10. Custom factors and internal models

7.10.1. Custom factors

Should an insurer be evaluating a product type that is materially different from those presented in the tables, or where an insurer needs to evaluate a complex reinsurance or hedging arrangement, it will be necessary to use stochastic modeling to calculate factors for the particular product or treaty.

The use of modeling to calculate factors specific to a product requires approval by the Actuarial Division of OSFI. Life Insurers should contact OSFI's Actuarial or Capital Division for specific details.

Approved factors apply until new factors or an internal model are approved by OSFI.

7.10.2. Internal models

OSFI permits, subject to criteria, the use of internal models for the development of segregated fund capital requirements. Insurers seeking to use their internal models should follow the requirements outlined in OSFI's *Instruction Guide on Use of Internal Models for Determining Required Capital for Segregated Fund Risks (LICAT)*. Internal

model usage requires OSFI's prior written approval and is subject to materiality considerations. The requirements also include transitional rules: in the first year of approval, only 50% credit is permitted (i.e., the Total Gross Calculated Requirement is equal to 50% of the value calculated under the approved internal model plus 50% of the value calculated using the factor requirements). However, in subsequent years, the requirement is based 100% upon the value determined by the approved internal model.

1 Although the volatility suggests “Balanced Fund”, the Balanced Fund criteria were not met. Therefore, this exposure is moved “up” to Diversified Equity. For those funds classified as Diversified Equity, additional analysis would be required to assess whether they can be reclassified as “Low Volatility Equity”. In the examples above, none qualify.

2 Technically, the sample distribution for “present value of net cost” = PV[benefit claims] − PV[Margin Offset] was used to determine the scenario results that comprise the CTE95 risk measure. Hence, the “Cost Factors” and “Base Margin Offset Factors” are calculated from the same scenarios.

3 In other words, the *Basic Cost Factors* are expressed “per $1 of current guaranteed benefit” and the *Margin Offset Factors* are “per $1 of account balance”, assuming 100 basis points (per annum) of available spread.

4 Visual Basic for Applications.