

## Memorandum

**To:** All Life Insurance Practitioners  
**From:** Micheline Dionne, Chairperson  
Committee on Life Insurance Financial Reporting  
**Date:** October 2005  
**Subject:** **Guidance for the 2005 Valuation of Policy Liabilities of Life Insurers**

*Document 205110*

The purpose of this letter is to provide guidance to actuaries in several areas affecting the valuation of the 2005 year-end policy liabilities of life insurers for Canadian Generally Accepted Accounting Principles (GAAP) purposes. The guidance in this letter represents a majority view of members of the Committee on Life Insurance Financial Reporting (hereafter referred to as CLIFR in this note) of appropriate practice consistent with CIA Standards of Practice (Standards). This letter has gone through due process as documented in section 4.2 of the CIA Due Process paper (November 2001). However, in accordance with that paper, this letter is “not binding”.

CLIFR has published the educational note entitled “Best Estimate Assumption for Expenses” (January 2005). It provides guidance in determining the best estimate assumption for expenses used in the valuation of GAAP policy liabilities of life insurers.

CLIFR has also published a draft educational note on Margins for Adverse Deviations (MfAD) (February 2005). It provides guidance to the actuary in the selection of the level of the deterministic MfAD appropriate for the company’s particular products or circumstances. It is intended to apply for the selection of the margin for guaranteed products. It covers the selection of margins for both economic and non-economic assumptions. Although still in draft stage, CLIFR recommends that the actuaries take this educational note into consideration for year-end 2005.

CLIFR has also revised the Standards. Revisions to section 2300 were published in June 2005 to improve guidance on establishing appropriate MfAD in particular and to improve the wording quality in general. Revisions to section 2330 were published as an exposure draft in June 2005 to allow the reinvestment interest rates to be more responsive when current rates are near, at, or outside the prescribed ranges. Revisions to section 2330 are further discussed under section 3 on Scenario Assumptions – Interest rates.

CLIFR has revised the educational note entitled “Valuation of Segregated Fund Investment Guarantees” (October 2005) to reflect revisions to the Total Balance Sheet Requirements referred to in the note.

Other recent CLIFR guidance includes:

Educational Note: Approximations to the Canadian Asset Liability Method (CALM) (September 2004)

Educational Note: Selection of Interest Rate Models (December 2003)

Educational Note: Aggregation and Allocation of Policy Liabilities (September 2003)

Educational Note: Future Income and Alternative Taxes (December 2002)

Expected Mortality: Fully Underwritten Canadian Individual Life Insurance Policies (July 2002)

For your convenience all of these educational notes can be found on the CLIFR website in the members section (Organization/Practice Standards Council/Committees and Task Forces/Committee on Life Insurance Financial Reporting).

As outlined in Section 1220 of the Standards, the “*actuary should be familiar with relevant educational notes and other designated educational material,*” considering that a practice described “for a situation is not necessarily the only accepted practice for that situation and is not necessarily accepted actuarial practice for a different situation.”

The key topics covered in this letter are listed below. Some guidance provided last year is still appropriate, and has been duplicated in this letter. Other guidance has been slightly modified either to reflect recent developments, or to add clarity. In addition, new guidance is provided on other topics.

The topics covered are the following ones:

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### **1. Insurance Mortality (*Slightly modified*)**

Currently no guidance exists with respect to levels of future mortality improvement. CLIFR intends to publish such guidance in the near future and has commissioned a research study in concert with the Society of Actuaries (SOA) to help in this regard. Preliminary results of the SOA research were presented at the Appointed Actuary Seminar and are available on the CIA website.

In the Appointed Actuary's Report, the actuary is encouraged to clearly document the best estimate base mortality assumption, the best estimate mortality improvement, if any, and the level of MfAD including the justification and support for such assumptions.

### **2. Annuity Mortality (*Modified*)**

Standard 2350.11 states, "It is prescribed that the actuary's best estimate includes a secular trend toward lower mortality rates as promulgated from time to time."

CLIFR has created a sub-committee to review the appropriateness of the mortality improvement scale AA. This scale is applicable to both individual and group annuitants. CLIFR has commissioned a research study in concert with the SOA to review mortality improvement rates. Results of the SOA research to-date indicate that the future mortality improvement rates from the AA Scale are more than likely to be insufficient and CLIFR, therefore, recommends using the AA Scale with a minimum improvement of 1.5% for attained ages up to 50, and 1% for attained ages between 51 and 80 as illustrated in Appendix A.

For markets other than Canada and the US, the improvement scale to be used in conjunction with annuitant mortality would be at least as conservative as the scale used in Canada unless experience indicates otherwise.

For all jurisdictions, the use of higher rates of mortality improvements is appropriate if the experience indicates it is required.

### **3. Scenario Assumptions – Interest Rates (*Modified*)**

Standard 2320.08 states, "*The scenarios of interest rate assumptions should comprise*

*a base scenario which, unless otherwise promulgated, assumes continuance of reinvestment and inflation rates at the balance sheet date, and, unless there is explicit reason to assume otherwise, the insurer's then current investment strategy,*

*each of the prescribed scenarios in a deterministic application,*

*ranges which comprehend each of the prescribed scenarios in a stochastic application, and*

*other scenarios appropriate for the circumstances of the insurer."*

CLIFR believes that the appropriate practice is to test the seven prescribed scenarios (Standard 2330.18 to Standard 2330.27). However, Prescribed Scenarios 1 and 2 refer to a single reinvestment rate at and after the 20th anniversary of the balance sheet date independent of the term of the reinvestments. In accordance with the exposure draft of the revision of section 2330, CLIFR recommends that the reinvestment rate used at and after the 20th anniversary of the balance sheet date be reflective of the term of the reinvestment using a lower bound rate of 3% for short-term and 5% for long-term reinvestments in scenario 1 and a higher bound rate of 10% for short-term and 12% for long-term reinvestments in scenario 2. The uniform transition

between the balance sheet rates and the 20th anniversary of the balance sheet rates would still apply.

Interest rates between the short- and long-term bounds would be determined using yield rates that are appropriate for the terms of those assets, in accordance with the historic relationship between the rates of these assets and the short- and long-term interest rates.

The plausible range of default-free interest rates is defined in the Standards. For Canada, the plausible range is defined as 3% to 10% for short-term rates and 5% to 12% for long-term rates (Standard 2330.06).

The plausible range is extended whenever actual default-free interest rates at the balance sheet date approach or are outside the boundaries of the plausible range (Standard 2330.06). CLIFR believes that it is appropriate to address extensions to the plausible range through the testing of additional scenarios of the actuary's own design that are appropriate to the circumstances of the case (Standard 2330.28).

In the context of deterministic testing in Canada, each of the prescribed scenarios is considered plausible and the actuary is required to establish policy liabilities that are not less than those required under a) the Base Scenario and b) the most adverse prescribed scenario. In today's interest rate environment, CLIFR suggests testing additional scenarios, one of which would be a modification of Scenario 1 with a drop in default-free interest rates to 75% of current rates over the first year followed by a linear increase back into the ultimate 3% short-term rate and 5% long-term rate at the 20th anniversary of the balance sheet date. Further additional scenarios might also be warranted.

CLIFR is concerned that the guidance on the selection of interest rate models for stochastic testing is limited<sup>1</sup> and that no calibration criteria have been established. This may result in an inappropriately wide range of practice.

In the context of stochastic testing, the Conditional Tail Expectation (CTE) (60%) to CTE (80%) defines the range of policy liabilities (Standard 2320.51). CLIFR is currently working on an educational note on interest rate risk modeling and expects that this note will include calibration criteria. Pending their development, CLIFR recommends that the actuary continue to perform scenario testing using the seven prescribed scenarios in addition to the testing performed on a stochastic basis and consider holding actuarial liabilities at least equal to the result under the worst prescribed scenario.

The decision to establish a policy liability that is less than required under the worst prescribed scenario needs to be supported by a clearly documented rationale.

In this context, CLIFR recommends that the actuary ensure the following:

- the stochastic interest rate model including any parameters required are appropriately selected for use in determining policy liabilities for Canadian life insurance financial reporting purposes;
- the range of stochastic scenarios encompasses the seven prescribed scenarios;

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<sup>1</sup> CLIFR recommends that the actuary be familiar with the educational note on the *Selection of Interest Rate Models* that was published in December 2003.

- the model parameters are reviewed to confirm their appropriateness if the policy liabilities required under the worst prescribed scenario are greater than the policy liabilities at CTE (80%);
- the range of stochastic scenarios covers the range of plausible default-free interest rates including any extensions required to reflect actual interest rates at the balance sheet date that approach or are outside the boundaries of the plausible range as defined under Standard 2330.06; and
- the policy liability is at least equal to the result under the Base Scenario.

#### **4. Scenario 7 (*New*)**

Section 2330.27 states that in Prescribed Scenario 7, the default-free interest rates after the balance sheet date are the forward interest rates implied by an equilibrium market yield rate at that date.

Default-free interest rates are generally not observable in the market for very long terms (i.e., beyond 30 years) and are highly influenced by supply and demand toward the end of the observable horizon. It is, therefore, acceptable to retain the default-free yield curve up to the point, in the long end (typically after 20 years), where the spot rate is at its peak ('the yield curve horizon'). Past the yield curve horizon, CLIFR recommends that the actuary assume a continuation of the last observed spot rate and calculate forward rates consistent with that assumption. This will produce forward rates that are equal to the last observed spot rates, for terms beyond the yield curve horizon. An example of the process used to derive forward rates is illustrated in Appendix B.

#### **5. Reinvestment Strategies (*Unchanged*)**

Standard 2330.03 states:

“The investment strategy defines reinvestment and disinvestment practice for each type, default risk classification, and term of the invested assets which support policy liabilities. Assumption of the insurer’s current investment strategy implies investment decisions of reinvestment and disinvestment in accordance with that strategy and, hence, the risk inherent in that strategy.”

Standard 2330.12 states:

“For a prescribed scenario, if the net cash flow forecasted for a period is positive, . . . , the actuary may assume reinvestment in non-debt investments

not to exceed their proportion of investments at the balance sheet date if the insurer controls investment decisions and if such reinvestment is consistent with its investment policy, or

in the proportion expected to be selected by policyholders if policyholders control investment decisions.”

When using non-debt investments, CLIFR recommends that the actuary ensure that the proportion of non-debt investments, at each duration, is in accordance with the insurer’s current investment policies (regardless of whether net cash flows for the period are positive or negative). The review is performed without taking into consideration any business issued after the valuation

date (new sales) even for a valuation done on a going concern basis as stipulated in Standard 2130.02.

This may create a situation where the actuary needs to divest non-debt investments. This disinvestment is not limited to non-debt instruments acquired after the valuation date.

CLIFR encourages the actuary to pay particular attention to the following situations:

- The overall investment limits may apply to more than one block of business for which separate CALM projections are done. The reserve pattern may vary significantly over time and/or the maturity of the blocks may be very different creating situations where it is more difficult to verify the application of the investment policy's limits.
- The investment policy may include limits that vary over time. As an example, an investment policy may assume that investment in non-debt investments may be 20% of the total asset portfolio but reduces to 0% if the cash flows are within a certain number of years of maturity.
- The investment policy of some blocks of business may be more complex to model. As an example, modeling the investment policy of a UL Level COI block of business considers an investment strategy for the assets supporting the policyholder funds (under the control of the policyholders) and a different one for the insurance reserve (under the control of the company). Those two investment policies may be subject to different limits.

## **6. Lapse Study - Universal Life (*Unchanged*)**

The CIA published a study on the Lapse Experience under Universal Life Level COI policies in June of 2003. The scope of the study was limited to guaranteed Level COI coverages. This study has significant amounts of experience for the first 5-policy durations. Unfortunately, the study does not include analysis by UL-specific drivers (e.g., fund values, credited rates, interest environment, etc.). It is suggested that the actuary consider the applicability of this study to the business being valued.

Universal Life lapse-supported policies frequently exhibit some of the following characteristics:

- minimum funded policies,
- policies purchased for tax considerations,
- joint last to die,
- presence of persistency bonuses

and may result in ultimate lapse rates similar to stand alone T-100 products.

CLIFR suggests that the actuary review the degree of lapse support within its Universal Life portfolio and assesses the applicability of the CIA lapse study on lapse-supported products.

## **7. Balance Sheet Allowance for Acquisition Expenses (*Modified*)**

Key References:

- Standard 2320.16 to 2320.27 inclusive which define "Term of the liabilities";
- Standards 2320.23 and .24 in particular which define when it is appropriate to extend the "term" to offset acquisition expenses and criteria for amortization of deferred acquisition expenses respectively; and

- Educational Note titled, “Aggregation and Allocation of Policy Liabilities” issued in September 2003.

Acquisition expenses are expenses incurred in the acquisition of new and renewal insurance policies and annuity contracts. They are expenses that are both primarily related to the acquisition of policies and contracts, and consistently allocated to new business in product pricing and internal company expense allocations.

For some types of contracts (e.g., segregated fund contracts), it may be reasonable to expect the insurer to recover acquisition expenses from revenue received beyond the term of the policy liabilities. In such circumstances, the cash flows for a policy may extend beyond the term of its policy liabilities, offsetting some or all remaining non-recovered portion of such acquisition expenses (Standard 2320.23). These cash flows would be projected using valuation assumptions, including margins for adverse deviation.

However, this extension cannot result in a more favourable balance sheet position than would be the case if no acquisition expense had been incurred, and no extension of the cash flows beyond the term of the liability had taken place.

Standard 2320.22 defines the term of the liability at the policy level. However, such a determination may not be practical and some level of aggregation may be warranted. The key consideration for determining the appropriate level of aggregation is the homogeneity of policies with respect to key risk parameters (market performance, product features, lapse, mortality, guarantee resets behaviour, and so forth). Recoverability testing is usually done at the same level of aggregation.

It would be good practice to identify and document the net future cash flows generated by the selected grouping of policies to offset the deferred acquisition expenses at issue of this grouping. These cash flows are the basis for establishing a locked in amortization schedule for the deferred acquisition expenses as per Standard 2320.24. The amortization schedule would result in a write-down pattern that is reasonably matched with the net cash flows available to offset expenses at inception.

Going forward, recoverability would be tested at least annually as per Standard 2320.24. Recoverable means that the present value of remaining cash flows identified to amortize the Allowance for Acquisition Expense (AAE) is equal to or exceeds the remaining unamortized AAE balance. If the remaining unamortized AAE balance is not recoverable, then it is reduced to the level, which is recoverable, with the result of such reduction being a charge to income and the remaining future amortization charges being proportionately reduced.

There are two ways to value additional benefits or guarantees associated with policies for which an AAE is being amortized. The amount produced before AAE is reported as a policy liability only if it exceeds \$0 at the level of aggregation chosen:

1. Bifurcated Approach: Determine the policy liability using appropriate aggregate methodology (for the selected grouping) and the net cash flows available excluding those allocated to amortize the remaining unamortized AAE; or
2. Whole Contract Approach: Determine the policy liability using appropriate aggregate methodology (for the selected grouping) and all net cash flows available. To the preliminary result produced, add the current remaining unamortized AAE balance to get the policy liability for the additional benefits and guarantees.

## **8. Currency Risks (*Modified*)**

Standard 2340.16 and 2340.17 address the determination of currency risks best estimates and margin.

As further guidance, CLIFR continues to recommend the use of integrated multi-currency interest rate models to value portfolios with material currency mismatch. However, when such models are not available, CLIFR recommends that the exchange rate best estimate be based on currency forwards and if not available, determined based on interest rate differentials. Moreover, CLIFR recommends that the low and high ends for the MfADs be 5% and 50%, respectively. Among other considerations, the low end would be appropriate for shorter maturities in currencies of highly integrated economies. Conversely, the high end would apply for longer maturities in currencies that are not well integrated or where one of the currencies is that of a developing country.

## **9. Policy Liabilities for Cyclical Risks (*Modified*)**

For any assumption for which there is credible evidence that risk is cyclical in nature (possible examples are asset defaults and disability incidence rates), the best estimate assumption can be projected to change in the future, consistent with the expected cyclical behaviour. This is more appropriate than assuming current experience will persist indefinitely. Some actuaries have developed long-term expected assumptions and, for valuation purposes assume that expected experience moves from current levels to long-term expected levels over the appropriate cycle period. Others reflect the projected cyclical behaviour more explicitly. For example, disability incidence and termination rates sometimes exhibit seasonality and some actuaries have developed non-level monthly incidence rates based on experience over a cycle of typically 12 months.

In some circumstances, it may be reasonable to establish additional positive or negative short-term provisions or margins to reflect the impact of an economic or behavioural cycle. A cyclical provision could be established by special modifications to the short-term cash flows, or as a separate stand-alone provision.

In keeping with the principles of the Standards, CLIFR's view is that the following guidelines reasonably apply to liabilities for cyclical risks:

1. For this purpose the cycle considered is relatively short term and is expected to be no more than five (5) years.
2. The determination of the liability is based on a forward-looking assessment of expected experience.
3. The liability would only include favourable or adverse experience caused by the cyclical behaviour. Other expected improvements or deteriorations in experience would be reflected in the expected long-term assumptions. The liability is calculated on a consistent basis from period to period.
4. The actuary establishes and documents a policy for setting liabilities for cyclical risks. This policy addresses the purpose of and justification for the liability, how it is established and funded and the criteria used to release amounts out of the liability.

In addition, the actuary ensures that the liability is determined consistently with any accounting provisions and the long-term assumptions in the policy liabilities.

## **10. Selection of CTE Coverage Level (*Modified*)**

Sections 2320.51 and 2320.52 of the Standards describe the general approach of establishing the policy liabilities when the valuation uses stochastic methods. Specifically, the actuary adopts a scenario whose policy liabilities are within the range defined by CTE (60%) and CTE (80%). PfADs (in experience) are provided for in the policy liabilities (a) in the case of scenario-tested assumptions, by selection of the effective CTE coverage level, and (b) in the case of non-scenario-tested assumptions, through the application of explicit MfADs.

The suggested approach establishes the PfADs for stochastic variables (i.e., the scenario-tested assumptions) based on coverage of a plausible range of outcomes using the CTE risk measure. Establishing the appropriate CTE “coverage level” for the policy liabilities is an important consideration. Guidance for the selection of the level of deterministic MfADs can be found in the standards and in the draft MfAD educational note, but no similar guidance exists for the choice of an appropriate CTE “coverage level”.

In selecting an appropriate CTE “coverage level”, considerations are given to sources of uncertainties in the parameters and in the model. Greater uncertainties result in selection of a larger coverage level.

### ***Parameter uncertainty***

The parameters used in the stochastic model are necessarily estimates. As stated in the Standards, the estimates used here are best estimates as the PfAD is covered through selection of the CTE coverage level. Misestimation of the mean or volatility has been shown to have a greater impact on the CTE level when a policy is out of the money than when it is in the money. Time to maturity can also be an important factor. More research is needed to develop guidance in this area.

### ***Model risk***

Notwithstanding the provisions incorporated for the stochastic model processes and parameter uncertainty, some residual model uncertainty remains. As such, a margin for model error is typically needed, and would not normally change period to period. Sources of uncertainties include:

- basis risk;
- inability of the model to capture exactly all relevant contract terms;
- use of approximations whose conservatism is not well understood in the valuation scenarios;
- omission of known risk factors, whose effect on the valuation is not well understood;
- missing or unknown risk factors; and
- number of scenarios run.

In deciding which coverage level is appropriate to account for the various components of uncertainty, the actuary would need to be particularly mindful of the margins in the valuation assumptions (explicit or otherwise) and the aggregate degree of conservatism in the model itself (including the parameters).

Many actuaries have sought guidance on whether the coverage level can reasonably change between reporting periods. CLIFR believes that such changes, if designed to achieve a measure

of stability in the policy liabilities, are not appropriate. Where these changes are recognizing a change in the level of risk in the result (e.g., the degree to which the policy is in the money has changed) this practice could be appropriate. In designing methods to reflect changes in risk, a reasonable method would:

- be non-manipulative – that is, it does not allow the actuary subjectively to manipulate the current period income; to this end, it would be laid out in advance and applied on a formula basis;
- be consistently applied from period to period, and would not be changed without good reason (and disclosure);
- produce a policy liability within the CTE60 – CTE80 level consistent with the Standards;
- need to be actuarially sound by producing a change in the provision for adverse deviations that is consistent with the change in the level of risks; and
- need to be well documented.

Resulting future returns are still the best estimate and should be reasonable in that context.

### **11. Long-Term Equity Returns (*Modified*)**

Standards section 2340.11 bounds the upper limit of the best estimate of investment return on a non-fixed income asset to a benchmark based on historical performance.

CLIFR has investigated how to define the most appropriate historical period to determine the best estimate of investment return and has concluded that the longest possible period would be the most appropriate as the projection period is often very long and even possibly longer than the longest reliable historical period. It provides for a more stable projection. It runs over multiple shock periods and shocks will no doubt recur although in an unexpected fashion. An ideal historical period would also cover both increasing and decreasing interest rate periods.

In the Canadian market, data prior to 1956 is limited. So, as a practical consideration and for the reasons cited above, CLIFR recommends using January 1956 to current year data as the historical period to establish historical returns for Canadian equities.

The historical benchmark would be routinely updated at least annually.

When using deterministic scenarios, the historical benchmark return is the geometric average of historical returns over a sufficiently long period. It is appropriate to use the geometric mean rather than the arithmetic mean due to the asymmetric distribution of long-term returns.

When using stochastic scenarios, the historical benchmark return is the arithmetic average of historical returns over a sufficiently long period, as the stochastic process captures the asymmetric distribution directly.

### **12. Value of Minimum Interest Guarantees and Embedded Options (*Unchanged*)**

With continuing low interest rates, it is suggested that actuaries assess and make appropriate provision for the potential cost of any minimum interest guarantees or other embedded economic options (e.g., guaranteed purchase options). These costs may not be appropriately captured in the deterministic base and prescribed scenarios within the Standards, as these scenarios may continue to ascribe zero value to these features when in reality near to or in the money guarantees or

options can have a substantial value. Stochastic modelling or option pricing techniques (stochastic or mathematical) could, therefore, ascribe material value to these features in the current interest environment. While the actuary is not required to model these features stochastically, the actuary would review the exposure to minimum interest guarantees and other embedded options in the business being valued, and determine whether an increase in the policy liabilities is warranted.

## APPENDIX A

### AA Scale

Attained Age	AA Scale		AA Scale modified as per section 2	
	Male	Female	Male	Female
1	0.02	0.02	0.02	0.02
2	0.02	0.02	0.02	0.02
3	0.02	0.02	0.02	0.02
4	0.02	0.02	0.02	0.02
5	0.02	0.02	0.02	0.02
6	0.02	0.02	0.02	0.02
7	0.02	0.02	0.02	0.02
8	0.02	0.02	0.02	0.02
9	0.02	0.02	0.02	0.02
10	0.02	0.02	0.02	0.02
11	0.02	0.02	0.02	0.02
12	0.02	0.02	0.02	0.02
13	0.02	0.02	0.02	0.02
14	0.019	0.018	0.019	0.018
15	0.019	0.016	0.019	0.016
16	0.019	0.015	0.019	0.015
17	0.019	0.014	0.019	<b>0.015</b>
18	0.019	0.014	0.019	<b>0.015</b>
19	0.019	0.015	0.019	0.015
20	0.019	0.016	0.019	0.016
21	0.018	0.017	0.018	0.017
22	0.017	0.017	0.017	0.017
23	0.015	0.016	0.015	0.016
24	0.013	0.015	<b>0.015</b>	0.015
25	0.01	0.014	<b>0.015</b>	<b>0.015</b>
26	0.006	0.012	<b>0.015</b>	<b>0.015</b>
27	0.005	0.012	<b>0.015</b>	<b>0.015</b>
28	0.005	0.012	<b>0.015</b>	<b>0.015</b>
29	0.005	0.012	<b>0.015</b>	<b>0.015</b>
30	0.005	0.01	<b>0.015</b>	<b>0.015</b>
31	0.005	0.008	<b>0.015</b>	<b>0.015</b>
32	0.005	0.008	<b>0.015</b>	<b>0.015</b>
33	0.005	0.009	<b>0.015</b>	<b>0.015</b>
34	0.005	0.01	<b>0.015</b>	<b>0.015</b>
35	0.005	0.011	<b>0.015</b>	<b>0.015</b>
36	0.005	0.012	<b>0.015</b>	<b>0.015</b>
37	0.005	0.013	<b>0.015</b>	<b>0.015</b>
38	0.006	0.014	<b>0.015</b>	<b>0.015</b>
39	0.007	0.015	<b>0.015</b>	0.015

Attained Age	AA Scale		AA Scale modified as per section 2	
	Male	Female	Male	Female
40	0.008	0.015	<b>0.015</b>	0.015
41	0.009	0.015	<b>0.015</b>	0.015
42	0.01	0.015	<b>0.015</b>	0.015
43	0.011	0.015	<b>0.015</b>	0.015
44	0.012	0.015	<b>0.015</b>	0.015
45	0.013	0.016	<b>0.015</b>	0.016
46	0.014	0.017	<b>0.015</b>	0.017
47	0.015	0.018	0.015	0.018
48	0.016	0.018	0.016	0.018
49	0.017	0.018	0.017	0.018
50	0.018	0.017	0.018	0.017
51	0.019	0.016	0.019	0.016
52	0.02	0.014	0.02	0.014
53	0.02	0.012	0.02	0.012
54	0.02	0.01	0.02	0.01
55	0.019	0.008	0.019	<b>0.01</b>
56	0.018	0.006	0.018	<b>0.01</b>
57	0.017	0.005	0.017	<b>0.01</b>
58	0.016	0.005	0.016	<b>0.01</b>
59	0.016	0.005	0.016	<b>0.01</b>
60	0.016	0.005	0.016	<b>0.01</b>
61	0.015	0.005	0.015	<b>0.01</b>
62	0.015	0.005	0.015	<b>0.01</b>
63	0.014	0.005	0.014	<b>0.01</b>
64	0.014	0.005	0.014	<b>0.01</b>
65	0.014	0.005	0.014	<b>0.01</b>
66	0.013	0.005	0.013	<b>0.01</b>
67	0.013	0.005	0.013	<b>0.01</b>
68	0.014	0.005	0.014	<b>0.01</b>
69	0.014	0.005	0.014	<b>0.01</b>
70	0.015	0.005	0.015	<b>0.01</b>
71	0.015	0.006	0.015	<b>0.01</b>
72	0.015	0.006	0.015	<b>0.01</b>
73	0.015	0.007	0.015	<b>0.01</b>
74	0.015	0.007	0.015	<b>0.01</b>
75	0.014	0.008	0.014	<b>0.01</b>
76	0.014	0.008	0.014	<b>0.01</b>
77	0.013	0.007	0.013	<b>0.01</b>
78	0.012	0.007	0.012	<b>0.01</b>
79	0.011	0.007	0.011	<b>0.01</b>
80	0.01	0.007	0.01	<b>0.01</b>

<b>Attained Age</b>	<b>AA Scale</b>		<b>AA Scale modified as per section 2</b>	
	<b>Male</b>	<b>Female</b>	<b>Male</b>	<b>Female</b>
81	0.009	0.007	0.009	0.007
82	0.008	0.007	0.008	0.007
83	0.008	0.007	0.008	0.007
84	0.007	0.007	0.007	0.007
85	0.007	0.006	0.007	0.006
86	0.007	0.005	0.007	0.005
87	0.006	0.004	0.006	0.004
88	0.005	0.004	0.005	0.004
89	0.005	0.003	0.005	0.003
90	0.004	0.003	0.004	0.003
91	0.004	0.003	0.004	0.003
92	0.003	0.003	0.003	0.003
93	0.003	0.002	0.003	0.002
94	0.003	0.002	0.003	0.002
95	0.002	0.002	0.002	0.002
96	0.002	0.002	0.002	0.002
97	0.002	0.001	0.002	0.001
98	0.001	0.001	0.001	0.001
99	0.001	0.001	0.001	0.001
100	0.001	0.001	0.001	0.001
Over 100	0	0	0	0

## APPENDIX B

### Generation of Forward Rates, given a set of spot rates

The theoretical spot-rate curve is constructed from the yield curve based on the observed yields of Treasury bills and Government of Canada Bonds. The spot rates are solved, such that the value of the Treasury coupon security is equal to the value of the package of zero-coupon Treasury securities that replicates the bond's cash flow.

Spot rates can be obtained from various sources, such as Bloomberg or JP Morgan, as well as the Bank of Canada website.

Given a spot curve as of the valuation date, the implied forwards can be determined. A forward rate  $F(n,m)$  is the yield on a Treasury bill purchased "n" months from now and maturing in n+m months.

Define  $spot(m)$  as the yield (as of the valuation date) on a zero-coupon Treasury bill maturing in "m" months.

The forward rate is defined by the formula:

$$F(n,m) = \{[1+spot(m+n)]^{(m+n)}\} / \{[1+spot(n)]^{(n)}\}^{(1/m)} - 1$$

Please refer to the attached spreadsheet which illustrates the sample calculation of 15 year forward rates, from the current spot curve. The calculation is done in five steps:

Step 1: Obtain current spot curve from various data sources.

Step 2: Interpolate the spot curve where spot rates are not directly available.

Step 3: Determine the yield curve horizon as the duration, 20 or later, where the spot rate has reached a maximum level.

Step 4: Extrapolate for durations past the horizon by setting the spot rate equal to the spot rate at the horizon.

Step 5: Determine the implied forwards using the formula above.

## APPENDIX B

### Sample calculation of 15 year forward rates

Step 1:		Step 2:		Step 3 and 4:		Step 5:		
Spot curve as of valuation date:		Interpolated		Adjusted				
Maturity (t)	Spot rates <sup>1</sup> :	Maturity	Spot rates: <sup>2</sup>	Spot rates: <sup>3</sup>		Year (t)	1 yr forwa	15 yr forward
						0	2.836%	4.147%
1	2.8360%	1	<b>2.8360%</b>	2.8360%		1	3.112%	4.270%
2	2.9740%	2	<b>2.9740%</b>	2.9740%		2	3.455%	4.379%
3	3.1340%	3	<b>3.1340%</b>	3.1340%		3	3.458%	4.470%
4	3.2150%	4	<b>3.2150%</b>	3.2150%		4	3.836%	4.565%
5	3.3390%	5	<b>3.3390%</b>	3.3390%		5	4.224%	4.638%
6	3.4860%	6	<b>3.4860%</b>	3.4860%		6	4.237%	4.644%
7	3.5930%	7	<b>3.5930%</b>	3.5930%		7	4.541%	4.649%
8	3.7110%	8	<b>3.7110%</b>	3.7110%		8	5.397%	4.634%
9	3.8970%	9	<b>3.8970%</b>	3.8970%		9	3.637%	4.562%
10	3.8710%	10	<b>3.8710%</b>	3.8710%		10	4.480%	4.607%
15	4.1470%	11	3.9262%	3.9262%		11	4.591%	4.596%
20	4.3120%	12	3.9814%	3.9814%		12	4.701%	4.577%
30	4.3070%	13	4.0366%	4.0366%		13	4.812%	4.551%
		14	4.0918%	4.0918%		14	4.923%	4.518%
		15	<b>4.1470%</b>	4.1470%		15	4.676%	4.477%
		16	4.1800%	4.1800%		16	4.742%	4.453%
		17	4.2130%	4.2130%		17	4.809%	4.424%
		18	4.2460%	4.2460%		18	4.875%	4.391%
		19	4.2790%	4.2790%		19	4.941%	4.354%
		20	<b>4.3120%</b>	4.3120%		20	4.312%	4.312%
		21	4.3115%	<b>4.3120%</b>		21	4.312%	4.312%
		22	4.3110%	<b>4.3120%</b>		22	4.312%	4.312%
		23	4.3105%	<b>4.3120%</b>		23	4.312%	4.312%
		24	4.3100%	<b>4.3120%</b>		24	4.312%	4.312%
		25	4.3095%	<b>4.3120%</b>		25	4.312%	4.312%
		26	4.3090%	<b>4.3120%</b>		26	4.312%	4.312%
		27	4.3085%	<b>4.3120%</b>		27	4.312%	4.312%
		28	4.3080%	<b>4.3120%</b>		28	4.312%	4.312%
		29	4.3075%	<b>4.3120%</b>		29	4.312%	4.312%
		30	<b>4.3070%</b>	<b>4.3120%</b>		30	4.312%	4.312%
		31	4.3070%	<b>4.3120%</b>		31	4.312%	4.312%
		32	4.3070%	<b>4.3120%</b>		32	4.312%	4.312%
		33	4.3070%	<b>4.3120%</b>		33	4.312%	4.312%
		34	4.3070%	<b>4.3120%</b>		34	4.312%	4.312%
		35	4.3070%	<b>4.3120%</b>		35		
		36	4.3070%	<b>4.3120%</b>		36		
		37	4.3070%	<b>4.3120%</b>		37		
		38	4.3070%	<b>4.3120%</b>		38		
		39	4.3070%	<b>4.3120%</b>		39		
		40	4.3070%	<b>4.3120%</b>		40		
		41	4.3070%	<b>4.3120%</b>		41		
		42	4.3070%	<b>4.3120%</b>		42		
		43	4.3070%	<b>4.3120%</b>		43		
		44	4.3070%	<b>4.3120%</b>		44		
		45	4.3070%	<b>4.3120%</b>		45		
		46	4.3070%	<b>4.3120%</b>		46		
		47	4.3070%	<b>4.3120%</b>		47		
		48	4.3070%	<b>4.3120%</b>		48		
		49	4.3070%	<b>4.3120%</b>		49		

1. Spot curve can be obtained from various sources (e.g., Bloomberg). The rates should be converted to effective annual rates, if not already in that form.
2. Spot rates may not be available for all term structure. If not available, interpolation is appropriate.
3. If spot rates beyond decline beyond duration 20, it would be appropriate to set the spot rate at the last observed peak (duration 20 in this example).