*Educational Note*

# Duration Considerations for P&C Insurers

## Committee on Property and Casualty Insurance Financial Reporting

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*Members should be familiar with educational notes. Educational notes describe but do not recommend practice in illustrative situations. They do not constitute standards of practice and are, therefore, not binding. They are, however, intended to illustrate the application (but not necessarily the only application) of the Standards of Practice, so there should be no conflict between them. They are intended to assist actuaries in applying standards of practice in respect of specific matters. Responsibility for the manner of application of standards of practice in specific circumstances remains that of the members.*

# MEMORANDUM

**To:** Members in the property and casualty insurance area

**From:** Pierre Dionne, Chair
Practice Council

Raul Martin, Chair
Committee on Property and Casualty Insurance Financial Reporting

**Date:** March 7, 2017

**Subject:** **Educational Note: Duration Considerations for P&C Insurers**

This educational note has been prepared by the Committee on Property and Casualty Insurance Financial Reporting in accordance with the Institute's Policy on Due Process for the Approval of Guidance Material other than Standards of Practice and Research Documents, and received final approval for distribution from the Practice Council on February 28, 2017.

This guidance was published previously in the 2013-2015 Guidance to the Appointed Actuary for Property & Casualty Insurers, and going forward will be available as a stand-alone educational note.

As outlined in subsection 1220 of the Standards of Practice, "The actuary should be familiar with relevant Educational Notes and other designated educational material". That subsection explains further that a "practice that the Educational Notes describe for a situation is not necessarily the only accepted practice for that situation and is not necessarily accepted actuarial practice for a different situation". As well, "Educational Notes are intended to illustrate the application (but not necessarily the only application) of the standards, so there should be no conflict between them".

Questions or comments regarding this educational note may be directed to Raul Martin at jscp@jscp.com.

PD, RM

**Introduction and Scope**

The Committee on Property and Casualty Insurance Financial Reporting (PCFRC) of the Canadian Institute of Actuaries (CIA) prepared this educational note to provide guidance to actuaries doing work for property and casualty (P&C) insurers related to duration of the insurer's interest rate sensitive claim liabilities, premium liabilities and assets.

In this document, the term "P&C returns" refers to the uniform returns approved by the Canadian Council of Insurance Regulators. The term "MCT Guideline" refers to the Minimum Capital Test (MCT) Guideline issued by the Office of the Superintendent of Financial Institutions (OSFI) or the version approved for use by provincial regulatory authorities.

Duration has become an increasingly relevant topic for a variety of reasons, including but not limited to the following:

- The MCT Guideline requires the calculation of estimated duration of insurer's interest-rate-sensitive assets, claim liabilities, and premium liabilities for purposes of the interest rate risk margin;
- Duration may be required for the estimation and selection of the margin for investment return rates in applying concepts from the educational note Margins for Adverse Deviations for Property and Casualty Insurance;
- Many insurers are employing the strategy to duration match liabilities to assets to help immunize the impact of relatively small shifts in the market yield curve on surplus; and
- Duration is a consideration in modelling market risk.

Furthermore, there are different interpretations on how duration is to be determined for certain asset classes (e.g., preferred shares).

**Duration Defined**

Duration is a concept or tool that is used to measure both the average maturity of a series of fixed future cash flows, as well as to measure the sensitivity that interest rate changes have on the present value of a series of future cash flows. The calculation of the duration will depend on the duration measure chosen. The three most common types of duration measures are the following:

- *Macaulay duration* is computed as the weighted average of the time to each cash flow payment, using the present value of the future cash flow payment as weights. The Macaulay duration is calculated as follows:

- Macaulay Duration $= \frac{\sum_{t=0}^{n} t \times \text{PVCF}_t}{k \text{ x } \sum_{t=0}^{n} \text{PVCF}_t}$
- Where:

| | | |
|---|---|---|
| *t* | = | time to future cash flow payment |
| yield | = | market value yield to maturity of the cash flows consistent with *k* time period definition |
| *k* | = | number of periods, or payments, per year (e.g., k=2 for semi-annual periods) |
| n | = | number of periods until maturity (i.e., number of years to maturity times *k*) |
| $\text{PVCF}_t$ | = | present value of the cash flow in period *t* discounted at the yield rate or market value of securities |

- **Modified duration** measures the sensitivity of the present value of a series of fixed future cash flows to changes in interest rates. It is calculated as the following:
  - Modified Duration $= \frac{\text{Macaulay Duration}}{1+\text{Yield}}$
- **Effective duration** also measures the sensitivity of the present value of a series of fixed future cash flows and will give a similar estimate as the modified duration approach. In addition, the effective duration measures the fair value sensitivity of assets where interest rate changes would change future cash flows, such as in the case of interest rate derivatives, callable bonds, option embedded assets, etc. For example, bonds with embedded options may be called early, and therefore the yield to maturity would change on the bond and so the modified duration formula would no longer be an appropriate measure to use. The effective duration is calculated as the following:
  - Effective Duration $= \frac{\text{Fair value if yields decline} - \text{fair value if yields rise}}{2 \times \text{initial price} \times \text{change in yield in decimal}}$
  - or Effective Duration $= \frac{V_- - V_+}{2 \times V_0 \times \Delta y}$
  - Where:

| | | |
|---|---|---|
| Δy | = | change in yield in decimal |
| $V_0$ | = | initial fair value |
| $V_-$ | = | fair value if yields decline by Δy |
| $V_+$ | = | fair value if yields increase by Δy |

It is important to note that for the purpose of the MCT, the Macaulay duration is an intermediate step in the calculation of the interest rate sensitivity of an asset or liability and is *not* a measure of duration accepted by regulators. It is also necessary that the duration be

measured on an annual basis for the MCT interest rate margin calculation, as the application of the interest rate shock is measuring the impact of annual interest rate sensitivities. In other words, the definition of the duration needs to be consistent with the definition of the yield rate in terms of period of time, otherwise the results will be incorrect.

Also worth mentioning is that both the modified and effective durations provide only approximations of the sensitivity that changes in interest rates have on the present value of future cash flows. Both of these duration measures provide exact percentage changes for very small changes in interest rate (e.g., one basis point), but are generally less accurate for large changes, as the relationship between the change in interest rate and the change in present value of future cash flows is not linear. More accurate approximations of the impact of changes in interest rates on the present value of future cash flows can be achieved through considering the curvature (or convexity) of the price-yield relationship.

In an attempt to manage the effect that changes in interest rates have on their surplus position, insurers often endeavour to match the duration of their liabilities and assets. This approach is considered good practice. However, it can be demonstrated that there may be future cash flow shortfalls even in situations where the duration of liabilities and assets are perfectly matched. Accordingly, actuaries would consider future net cash flows as well as durations. The value of doing so is demonstrated in the educational note Discounting and Cash Flow Considerations for Property and Casualty Insurers (May 2016).

In the calculation of the interest rate risk margin, an interest rate shock factor is applied to the fair value of interest rate sensitive assets and liabilities and their duration. Actuaries are often involved in the calculation of the duration of liabilities and depending on the size of the insurer, may also be asked for support on the duration of assets.

Instructions on the calculation of the interest rate risk margin are provided in the MCT Guideline. The key points for the calculation of the duration are the following:

- Insurers may use either the modified duration or the effective duration to calculate the duration of assets and liabilities. However, the same duration methodology would apply to all assets and liabilities under consideration. Moreover, the same methodology is to be used consistently from year to year.
- Effective duration is the required measure when interest rate changes may change the expected cash flows.
- The portfolio duration can be obtained by calculating the weighted average of the duration for the assets or liabilities in the portfolio with the weights being proportional to the fair value of the cash flows or securities.

The following sections describe the theory and include some examples behind the calculations of duration of liabilities (both premium and claim) as well as assets.

**Duration of Interest-Rate-Sensitive Liabilities**

When evaluating the duration of the claim and premium liabilities, actuaries would consider the following:

- Assumptions underlying the duration calculation would be consistent with those underlying the discounting calculation (e.g., timing of payout) from the actuary's valuation work.
- The duration may be calculated by line of business using the payout patterns used for discounting. The line of business durations would then be weighted, using actuarial present value (APV) as weights, to derive the total premium or claim liabilities duration. This point is illustrated in appendix A, sheets 2 through 4.
- Alternatively, the duration may be evaluated for all lines of business on a combined basis, with the use of the effective duration approach. This point is illustrated for the duration of premium liabilities in appendix C.
- When the change in interest rate is small, the modified duration and effective duration are approximately the same, and the effective duration can be used to assess the reasonableness of the calculation of the modified duration, or even as a proxy for modified duration if appropriate.
- For premium liabilities, the following additional considerations apply:
  - The calculation would be adjusted for the future accident date; and
  - The future accident date would be adjusted to reflect policy terms of other than 12 months.
- For the purposes of input into the MCT calculation, the duration would be net of reinsurance and net of salvage and subrogation.

Interest-rate-sensitive liabilities include those for which the values are determined on a present value (PV) or actuarial present value basis. In accordance with the MCT Guideline, the interest-rate-sensitive liabilities to be included in the calculation of the interest rate risk margin are those for which their fair value will change with movements in interest rates. The following liabilities are considered sensitive to interest rates and are to be included:

- Net unpaid claims and adjustment expenses; and
- Net premium liabilities.

Other interest-rate-sensitive liabilities may include certain types of structured settlements. As per the OSFI guideline D5 Accounting for Structured Settlements, insurers may be required to recognize Type II structured settlement arrangements as an unpaid claim liability on the balance sheet (versus Type I structured settlements which have a disclosure-only requirement). The challenge to actuaries is that the value of the purchased annuities for Type II settlements will flow through the actuarial data as a single lump sum payment which could cause an understatement of the overall duration if not adjusted for. The additional challenge to actuaries is that embedded in the settlement structure value is the assumption of the prevailing interest rate (which is an input into the modified duration calculation). So, in the absence of the real future cash flows and the interest rate, the actuary may need to make a simplified yet reasonable assumption on the underlying payment pattern in order to reasonably approximate

the underlying future cash flows, and may want to consider using the valuation discount rate to complete the modified duration calculation.

P&C insurers may require supervisory approval in order to be able to consider other liabilities in the calculation of the interest rate risk margin.

Refer to appendix A (sheets 2–3) for an example of the duration calculations for unpaid claim liabilities, and to appendix A (sheet 4) for an example of the duration calculations for premium liabilities. Appendix A (sheet 5) shows how the durations calculated in sheets 3 and 4 may be carried into the calculation of the interest rate risk margin in P&C returns.

Refer to appendix B for an illustration of the cash flow matching model to derive the duration of the claim and premium liabilities.

Appendix C is similar to appendix A (sheet 4) except that it illustrates the duration calculation for premium liabilities on an all-lines-combined basis using the effective duration approach. The interest rate risk margin would be amended to reflect the appropriate fields from appendix C.

**Duration of Interest-Rate-Sensitive Assets**

Actuaries may be asked to calculate the duration of the interest-rate-sensitive assets in the insurer's portfolio, including for purposes of the calculation of the interest rate risk margin that is part of the MCT calculation. For most insurers, the main classes of interest-rate-sensitive assets are bonds and preferred shares. Refer to appendix A (sheet 1) for an illustrative duration calculation for fixed income securities.

Retractable preferred shares, and preferred shares with rate reset options, may lend themselves to the same duration calculation approach as bonds, particularly if a redemption date or rate reset date can be considered as equivalent to the maturity date of a bond.

As an alternative to the duration calculations referred to above, or to supplement the calculations for other classes of interest-rate-sensitive assets, actuaries may use estimates derived by the insurer's investment specialists. Before using the work of the investment specialist, the actuary would review the information for reasonableness, and identify which duration formula was used (i.e., Macaulay duration, modified duration, or effective duration) in order to ensure consistency between asset and liability durations.

**Appendices**

The examples in the appendices are provided to assist actuaries in calculating durations for the purpose of the interest rate risk margin in the P&C returns. They are intended to be illustrative, rather than prescriptive. Also included is an example of the use of those estimates in the calculation of the interest rate risk margin in accordance with the MCT Guideline (see appendix A, sheet 5).

Recognizing the link between concepts addressed in this educational note and those addressed in other recently issued educational notes, the appendices include exhibits taken from those other educational notes, as indicated below:

| Exhibit | Description | Reference |
|---|---|---|
| Appendix A | | |
| Sheet 1 | Duration of bonds | 2015 Year-end memo[1] |
| Sheets 2-3 | Duration of unpaid claim liabilities | 2015 Year-end memo[1] |
| Sheet 4 | Duration of premium liabilities | N/A |
| Sheet 5 | Interest Rate Risk Margin | 2015 P&C return[2] |
| Appendix B | Net cash flow matching model | Discounting ed. note[3] |
| Appendix C | Duration of premium liabilities | Premium liabilities ed. note[4] |

(1) Educational Note: 2015 Guidance to the Appointed Actuary for Property and Casualty Insurers (October 2015). Appendix B (Sheets 2-4)

(2) 2015 P&C Return – Page 30.66 – Capital (Margin) Required for Interest Rate Risk

(3) Revised Educational Note: Discounting and Cash Flow Considerations for Property and Casualty Insurers (May 2016). Appendix B (Sheet 4)

(4) Second Revision – Educational Note: Premium Liabilities (July 2016)

Appendix D, Sheet 1 is a deterministic approach to demonstrate that the duration of the net premium liabilities can be derived from the duration of a future accident year. Appendix D, Sheet 2 summarizes the results of testing performed by the PCFRC to assess the effect of various approximations of the Macaulay duration.

## Duration of Bonds

**Appendix A**
**Sheet 1**

Year-end Information

| Description | Bond #1 | Bond #2 | Bond #3 |
|---|---|---|---|
| Valuation Date | 2015/12/31 | 2015/12/31 | 2015/12/31 |
| Maturity Date | 2016/12/31 | 2017/06/30 | 2018/06/30 |
| Coupon Rate | 2.50% | 6.60% | 4.65% |
| Coupon # (k) | 2 | 2 | 2 |
| Par value | 1,250.0 | 1,875.0 | 1,125.0 |
| Market value | 1,265.0 | 2,010.0 | 1,140.0 |
| Semi-annual Coupon $ | 15.6 | 61.9 | 26.2 |
| Yield (y) on a semi-annual basis | 0.644% | 0.859% | 2.042% |
| *Excel Yield (for comparison)* | *0.644%* | *0.859%* | *2.042%* |

Step 1: Future payment for assets

| | Cash flows | | |
|---|---|---|---|
| Year | Bond #1 | Bond #2 | Bond #3 |
| 2016.0 | (1,265.0) | (2,010.0) | (1,140.0) |
| 2016.5 | 15.6 | 61.9 | 26.2 |
| 2017.0 | 1,265.6 | 61.9 | 26.2 |
| 2017.5 | - | 1,936.9 | 26.2 |
| 2018.0 | - | - | 26.2 |
| 2018.5 | - | - | 1,151.2 |

Step 2: Calculation of duration for assets

**Semi-annual (1 basis point) Δy =** **0.01%**

| | Annual (yrs) (1) | Semi-Annual Periods (2) | Cash Flows (3) | Present Value Factor (4) | Discounted Cash Flows (5) | PV Factor with -Δy (9) | PV Factor with +Δy (10) | Discounted Cash Flows with -Δy (11) | Discounted Cash Flows with +Δy (12) |
|---|---|---|---|---|---|---|---|---|---|
| Bond #1 yield: | 0.64% | | | | | | | | |
| | 0.50 | 1 | 15.6 | 0.9936 | 15.5 | 0.9937 | 0.9935 | 15.5 | 15.5 |
| | 1.00 | 2 | 1,265.6 | 0.9872 | 1,249.5 | 0.9874 | 0.9870 | 1,249.7 | 1,249.2 |
| | 1.50 | 3 | - | 0.9809 | - | 0.9812 | 0.9806 | - | - |
| | 2.00 | 4 | - | 0.9746 | - | 0.9750 | 0.9743 | - | - |
| | 2.50 | 5 | - | 0.9684 | - | 0.9689 | 0.9679 | - | - |
| | Total | | | | 1,265.0 | | | 1,265.2 | 1,264.8 |
| (6) Macaulay duration | 0.99386 | 1.98773 | | | | (13) Effective duration (semi-annual periods) | | | 1.9750 |
| (7) Modified duration | 0.98750 | 1.97500 | | | | (14) Effective duration (annual basis) | | | 0.98750 |
| *(8) Excel Duration (comparison):* | *0.99386* | | | | | | | | |
| Bond #2 yield: | 0.86% | | | | | | | | |
| | 0.50 | 1 | 61.9 | 0.9915 | 61.3 | 0.9916 | 0.9914 | 61.4 | 61.3 |
| | 1.00 | 2 | 61.9 | 0.9830 | 60.8 | 0.9832 | 0.9829 | 60.8 | 60.8 |
| | 1.50 | 3 | 1,936.9 | 0.9747 | 1,887.8 | 0.9750 | 0.9744 | 1,888.4 | 1,887.3 |
| | 2.00 | 4 | - | 0.9664 | - | 0.9668 | 0.9660 | - | - |
| | 2.50 | 5 | - | 0.9582 | - | 0.9586 | 0.9577 | - | - |
| | Total | | | | 2,010.0 | | | 2,010.6 | 2,009.4 |
| (6) Macaulay duration | 1.45435 | 2.9087 | | | | (13) Effective duration (semi-annual periods) | | | 2.8839 |
| (7) Modified duration | 1.44197 | 2.8839 | | | | (14) Effective duration (annual basis) | | | 1.44197 |
| *(8) Excel Duration (comparison):* | *1.45435* | | | | | | | | |
| Bond #3 yield: | 2.04% | | | | | | | | |
| | 0.50 | 1 | 26.2 | 0.9800 | 25.6 | 0.9801 | 0.9799 | 25.6 | 25.6 |
| | 1.00 | 2 | 26.2 | 0.9604 | 25.1 | 0.9606 | 0.9602 | 25.1 | 25.1 |
| | 1.50 | 3 | 26.2 | 0.9412 | 24.6 | 0.9414 | 0.9409 | 24.6 | 24.6 |
| | 2.00 | 4 | 26.2 | 0.9223 | 24.1 | 0.9227 | 0.9220 | 24.1 | 24.1 |
| | 2.50 | 5 | 1,151.2 | 0.9039 | 1,040.5 | 0.9043 | 0.9034 | 1,041.0 | 1,040.0 |
| | Total | | | | 1,140.0 | | | 1,140.5 | 1,139.5 |
| (6) Macaulay duration | 2.38980 | 4.7796 | | | | (13) Effective duration (semi-annual periods) | | | 4.68397 |
| (7) Modified duration | 2.34198 | 4.6840 | | | | (14) Effective duration (annual basis) | | | 2.34198 |
| *(8) Excel Duration (comparison):* | *2.38980* | | | | | | | | |

Step 3: Market Value Weighted Duration of Assets

| | Market Value | Modified Duration | Effective Duration |
|---|---|---|---|
| Bond #1 | 1,265.0 | 0.98750 | 0.98750 |
| Bond #2 | 2,010.0 | 1.44197 | 1.44197 |
| Bond #3 | 1,140.0 | 2.34198 | 2.34198 |
| Total | **4,415.0** | **1.54415** | **1.54415** |

(4) = 1 / (1 + y) ^ (2)
(5) = (3) x (4)
(6) Sumproduct of columns (2) and (5) divided by (5) Total; for annual basis divide by 2
(7) = (6) / (1 + y); for annual basis divide by 2
(8) DURATION (Valuation Date, Maturity Date, Coupon Rate, Annual Yield Rate, Coupon Frequency, basis)
(9) = 1 / (1 + y - Δy) ^ (2)
(10) = 1 / (1 + y + Δy) ^ (2)
(11) = (3) x (8)
(12) = (3) x (9)
(13) = [(11) total - (12) total] / [ 2 x Δy ] / [(5) total]
(14) = (13) / 2

## Duration of Unpaid Claim Liabilities

**Appendix A**
**Sheet 2**

Year-end Information

Unpaid as at December 31, 2015

| Accident Year | Property | Liability |
|---|---|---|
| 2011 | - | 32 |
| 2012 | - | 86 |
| 2013 | - | 127 |
| 2014 | 16 | 186 |
| 2015 | 137 | 258 |

Accident Year Payment Pattern

| Age | Property | Liability |
|---|---|---|
| 12 | 80% | 35% |
| 24 | 95% | 68% |
| 36 | 100% | 80% |
| 48 | 100% | 85% |
| 60 | 100% | 90% |
| 72 | 100% | 95% |
| 84 | 100% | 99% |
| 96 | 100% | 100% |

**Yield (y)= 1.75%**
**Annual Δy = 0.10%**

Unearned Premium Reserve for Property: 550
Unearned Premium Reserve for Liability: 380
Maintenance Expense Ratio (% UPR) = 3.50%
Maintenance Expenses should be paid during the time the UPR is being earned

Expected Loss Ratio for Property = 65.0%
Expected Loss Ratio for Liability = 80.0%

Step 1: Future payment for claims liabilities

**Property**

| | | Paid in | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Accident Year | Unpaid | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
| 2011 | - | | | | | | | |
| 2012 | - | | | | | | | |
| 2013 | - | | | | | | | |
| 2014 | 16.0 | 16.0 | - | - | - | - | - | |
| 2015 | 137.0 | 102.8 | 34.3 | - | - | - | - | - |
| Total | 153.0 | 118.8 | 34.3 | - | - | - | - | - |

payout for AY 2015 @ 2016 = 137 / (1-80%) * (95% - 80%)
payout for AY 2015 @ 2017 = 137 / (1-80%) * (100% - 95%)
payout for AY 2014 @ 2016 = 16 / (1-95%) * (100% - 95%)

**Liability**

| | | Paid in | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Accident Year | Unpaid | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
| 2011 | 32.0 | 16.0 | 12.8 | 3.2 | | | | |
| 2012 | 86.0 | 28.7 | 28.7 | 22.9 | 5.7 | | | |
| 2013 | 127.0 | 31.8 | 31.8 | 31.8 | 25.4 | 6.4 | | |
| 2014 | 186.0 | 69.8 | 29.1 | 29.1 | 29.1 | 23.3 | 5.8 | |
| 2015 | 258.0 | 131.0 | 47.6 | 19.8 | 19.8 | 19.8 | 15.9 | 4.0 |
| Total | 689.0 | 277.2 | 149.9 | 106.8 | 80.0 | 49.4 | 21.7 | 4.0 |

payout for AY 2015 @ 2016 = 258 / (1-35%) * (68% - 35%)
payout for AY 2015 @ 2017 = 258 / (1-35%) * (80% - 68%)
payout for AY 2014 @ 2016 = 186 / (1-68%) * (80% - 68%)
etc.

## Duration of Unpaid Claim Liabilities

**Appendix A**
**Sheet 3**

Step 2: Calculation of duration for claims liabilities

| Year (1) | Lag (yrs) (2) | Payment (3) | Present Value Factor (4) | Discounted Payment (5) | PV Factor with -Δy (8) | PV Factor with +Δy (9) | Discounted Cash Flows with -Δy (10) | Discounted Cash Flows with +Δy (11) |
|---|---|---|---|---|---|---|---|---|
| **Property** | | | | | | | | |
| 2016 | 0.5000 | 118.8 | 0.9914 | 117.7 | 0.9919 | 0.9909 | 117.8 | 117.7 |
| 2017 | 1.5000 | 34.3 | 0.9743 | 33.4 | 0.9758 | 0.9729 | 33.4 | 33.3 |
| 2018 | 2.5000 | - | 0.9576 | - | 0.9599 | 0.9552 | - | - |
| 2019 | 3.5000 | - | 0.9411 | - | 0.9443 | 0.9379 | - | - |
| 2020 | 4.5000 | - | 0.9249 | - | 0.9290 | 0.9208 | - | - |
| 2021 | 5.5000 | - | 0.9090 | - | 0.9139 | 0.9041 | - | - |
| 2022 | 6.5000 | - | 0.8934 | - | 0.8991 | 0.8877 | - | - |
| Total | | | | 151.1 | | | 151.2 | 151.0 |
| | 0.7209 | (6) Macaulay duration | | | | | (12) Effective duration | 0.7085 |
| | 0.7085 | (7) Modified duration | | | | | | |
| **Liability** | | | | | | | | |
| 2016 | 0.5000 | 277.2 | 0.9914 | 274.8 | 0.9919 | 0.9909 | 274.9 | 274.6 |
| 2017 | 1.5000 | 149.9 | 0.9743 | 146.1 | 0.9758 | 0.9729 | 146.3 | 145.8 |
| 2018 | 2.5000 | 106.8 | 0.9576 | 102.3 | 0.9599 | 0.9552 | 102.5 | 102.0 |
| 2019 | 3.5000 | 80.0 | 0.9411 | 75.3 | 0.9443 | 0.9379 | 75.6 | 75.1 |
| 2020 | 4.5000 | 49.4 | 0.9249 | 45.7 | 0.9290 | 0.9208 | 45.9 | 45.5 |
| 2021 | 5.5000 | 21.7 | 0.9090 | 19.7 | 0.9139 | 0.9041 | 19.8 | 19.6 |
| 2022 | 6.5000 | 4.0 | 0.8934 | 3.5 | 0.8991 | 0.8877 | 3.6 | 3.5 |
| Total | | | | 667.4 | | | 668.6 | 666.2 |
| | 1.8176 | (6) Macaulay duration | | | | | (12) Effective duration | 1.7863 |
| | 1.7863 | (7) Modified duration | | | | | | |

Step 3: Weighted duration for claims liabilities

| | PV of Unpaid Claims | PFAD | APV of Unpaid Claims | Modified Duration | Effective Duration |
|---|---|---|---|---|---|
| Property | 151.1 | 5 | 156 | 0.7085 | 0.7085 |
| Liability | 667.4 | 115 | 782 | 1.7863 | 1.7863 |
| Total | 818.5 | 120 | **938** | **1.6070** | **1.6070** |

(3) From Appendix A, Sheet 2
(4) = 1 / (1 + y) ^ (2)
(5) = (3) x (4)
(6) Sumproduct of columns (2) and (5) divided by (5) Total
(7) = (6) / (1 + y)
(8) = 1 / (1 + y - Δy) ^ (2)
(9) = 1 / (1 + y + Δy) ^ (2)
(10) = (3) x (8)
(11) = (3) x (9)
(12) = [(10) total - (11) total] / [2 x Δy ] / [(5) total]

## Duration of Premium Liabilities

**Appendix A**
**Sheet 4**

Yield (y) = 1.75%
Annual Δy = 0.10%

| Year (1) | Lag to Time Zero (yrs) (2) | AY Incremental Payment Pattern (3) | Present Value Factor (4) | Discounted to Time Zero (5) | PV Factor with -Δy (13) | PV Factor with +Δy (14) | Discounted with -Δy (15) | Discounted with +Δy (16) |
|---|---|---|---|---|---|---|---|---|
| **Property** | | | | | | | | |
| 2016 | 0.5000 | 80.0% | 0.9914 | 79.31% | 0.9919 | 0.9909 | 79.35% | 79.27% |
| 2017 | 1.5000 | 15.0% | 0.9743 | 14.61% | 0.9758 | 0.9729 | 14.64% | 14.59% |
| 2018 | 2.5000 | 5.0% | 0.9576 | 4.79% | 0.9599 | 0.9552 | 4.80% | 4.78% |
| 2019 | 3.5000 | 0.0% | 0.9411 | 0.00% | 0.9443 | 0.9379 | 0.00% | 0.00% |
| 2020 | 4.5000 | 0.0% | 0.9249 | 0.00% | 0.9290 | 0.9208 | 0.00% | 0.00% |
| 2021 | 5.5000 | 0.0% | 0.9090 | 0.00% | 0.9139 | 0.9041 | 0.00% | 0.00% |
| 2022 | 6.5000 | 0.0% | 0.8934 | 0.00% | 0.8991 | 0.8877 | 0.00% | 0.00% |
| 2023 | 7.5000 | 0.0% | 0.8780 | 0.00% | 0.8845 | 0.8715 | 0.00% | 0.00% |
| Total | | | | 98.71% | | | 98.78% | 98.64% |
| | 0.7451 | (6) Macaulay Duration | | | | | | |
| | 0.7322 | (7) Modified Duration | | | | | | |
| | 0.5000 | (8) Mean Accident Date of an AY | | | | | 0.5000 | 0.5000 |
| | 0.3333 | (9) Mean Accident Date of UPR | | | | | 0.3333 | 0.3333 |
| | 0.9900 | (10) Discount Factor at Time Zero of Prem Liab | | | | | 0.9905 | 0.9894 |
| | 0.5784 | (11) Macaulay Duration | | | | | (17) Effective Duration: | 0.5684 |
| | 0.5684 | (12) Modified Duration | | | | | | |
| **Liability** | | | | | | | | |
| 2016 | 0.5000 | 35.0% | 0.9914 | 34.7% | 0.9919 | 0.9909 | 34.71% | 34.68% |
| 2017 | 1.5000 | 33.0% | 0.9743 | 32.2% | 0.9758 | 0.9729 | 32.20% | 32.10% |
| 2018 | 2.5000 | 12.0% | 0.9576 | 11.5% | 0.9599 | 0.9552 | 11.52% | 11.46% |
| 2019 | 3.5000 | 5.0% | 0.9411 | 4.7% | 0.9443 | 0.9379 | 4.72% | 4.69% |
| 2020 | 4.5000 | 5.0% | 0.9249 | 4.6% | 0.9290 | 0.9208 | 4.65% | 4.60% |
| 2021 | 5.5000 | 5.0% | 0.9090 | 4.5% | 0.9139 | 0.9041 | 4.57% | 4.52% |
| 2022 | 6.5000 | 4.0% | 0.8934 | 3.6% | 0.8991 | 0.8877 | 3.60% | 3.55% |
| 2023 | 7.5000 | 1.0% | 0.8780 | 0.9% | 0.8845 | 0.8715 | 0.88% | 0.87% |
| Total | | | | 96.67% | | | 96.85% | 96.48% |
| | 1.9282 | (6) Macaulay Duration | | | | | | |
| | 1.8950 | (7) Modified Duration | | | | | | |
| | 0.5000 | (8) Mean Accident Date of an AY | | | | | 0.5000 | 0.5000 |
| | 0.3333 | (9) Mean Accident Date of UPR | | | | | 0.3333 | 0.3333 |
| | 0.9695 | (10) Discount Factor at Time Zero of Prem Liab | | | | | 0.9712 | 0.9678 |
| | 1.7615 | (11) Macaulay Duration | | | | | (17) Effective Duration: | 1.7312 |
| | 1.7312 | (12) Modified Duration | | | | | | |
| **Maintenance Expenses** | | | | | | | | |
| 2016 | 0.5000 | 100% | 0.9914 | 99.1% | 0.9919 | 0.9909 | 99.19% | 99.09% |
| 2017 | 1.5000 | 0% | 0.9743 | 0.0% | 0.9758 | 0.9729 | 0.00% | 0.00% |
| Total | | | | 99.1% | | | 99.19% | 99.09% |
| | 0.5000 | (6) Macaulay Duration | | | | | | |
| | 0.4914 | (7) Modified Duration | | | | | | |
| | 0.5000 | (8) Mean Accident Date of an AY | | | | | 0.5000 | 0.5000 |
| | 0.3333 | (9) Mean Accident Date of UPR | | | | | 0.3333 | 0.3333 |
| | 0.9942 | (10) Discount Factor at Time Zero of Prem Liab | | | | | 0.9946 | 0.9939 |
| | 0.3333 | (11) Macaulay Duration | | | | | (17) Effective Duration: | 0.3276 |
| | 0.3276 | (12) Modified Duration | | | | | | |

| | UPR | ELR | Undiscounted Prem Liabilities | Discount Factor | PV of Prem Liabilities | Total PFAD | APV of Prem Liabilities | Modified Duration | Effective Duration |
|---|---|---|---|---|---|---|---|---|---|
| Property | 550 | 65.0% | 357.5 | 0.9900 | 353.9 | 12 | 365.9 | 0.5684 | 0.5684 |
| Liability | 380 | 80.0% | 304.0 | 0.9695 | 294.7 | 51 | 345.7 | 1.7312 | 1.7312 |
| Maintenance | | 3.50% | 32.6 | 0.9942 | 32.4 | - | 32.4 | 0.3276 | 0.3276 |
| Total | 930 | | 694.1 | | 681.0 | 63 | **744.0** | **1.0983** | **1.0983** |

(2) Assume that all policies have 12-month terms with equal earning
(3) From Appendix A, Sheet 2
(4) [ 1 + y ]^-(2)
(5) = (3) x (4)
(6) = Sumproduct of columns (2) and (5) divided by (5) total
(7) = (6) / [ 1 + y ]
(8) Average accident date of a future accident year (July 1st)
(9) Mean average accident date of premium liabilities (May 1st).
(10) = (5) total x ( 1 + y )^ [ (8) - (9) ]
(11) = (6) - (8) + (9)
(12) = (11) / [ 1 + y ]
(13) = [ 1 + y - Δy ]^-(2)
(14) = [ 1 + y + Δy ]^-(2)
(15) = (3) x (13)
(16) = (3) x (14)
(17) [Discount Factor with +Δy - Discount Factor with -Δy ] / [2 x Δy ] / (10)

**30.66**

**2015**

Date

**MCT (BAAT) MARKET RISK CAPITAL (MARGIN) REQUIREMENTS**
**($'000)**

| | | | | Interest rate shock factor 0.01250 | (0.01250) |
|---|---|---|---|---|---|
| **Capital (Margin) Required for Interest Rate Risk** | | | | | |
| (55) | | **Fair value** (01) | **Modified or effective duration** (02) | **Dollar fair value change (01)x(02)xΔy** (03) | **Dollar fair value change (01)x(02)x(-Δy)** (04) |
| **Interest rate sensitive assets:** | | | | | |
| Term deposits | 01 | | | 0 | 0 |
| Bonds and debentures | 02 | 4,415.0 | 1.5441 | 85 | -85 |
| Commercial paper | 03 | | | 0 | 0 |
| Loans | 04 | | | 0 | 0 |
| Mortgages | 05 | | | 0 | 0 |
| MBS and ABS | 06 | | | 0 | 0 |
| Preferred shares | 07 | | | 0 | 0 |
| Other (specify) | 08 | | | 0 | 0 |
| **Total interest rate sensitive assets** | **09** | 4,415.0 | | 85 | -85 |
| **Interest rate sensitive liabilities:** | | | | | |
| Net unpaid claims and adjustment expenses | 10 | 938.5 | 1.6070 | 19 | -19 |
| Net premium liabilities | 11 | 744.0 | 1.0983 | 10 | -10 |
| Other as approved by OSFI | 12 | | | 0 | 0 |
| **Total interest rate sensitive liabilities** | **19** | 1,682.5 | | 29 | -29 |
| **Allowable interest rate derivatives:** | | **Notional value** (05) | | **Dollar fair value Δy** (06) | **Dollar fair value - Δy** (07) |
| Long positions | 20 | | | | |
| Short positions | 21 | | | | |
| **Total allowable interest rate derivatives** | **29** | | | 0 | 0 |
| Capital required for Δy shock increase | 30 | | | 56 | |
| Capital required for Δy shock decrease | 31 | | | | 0 |
| **Total interest rate risk margin** | **39** | | | | 56 |

Note: Δy = 1.25%

Row 02 from Appendix A, Sheet 1
Row 10 from Appendix A, Sheet 3
Row 11 from Appendix A, Sheet 4

**Appendix B**

**ABC INSURANCE COMPANY**

**31 DECEMBER 2015**

**CASH FLOW MATCHING MODEL**

**Cash Flow (in $000's) for Determination of Discount Rate**

| | | |
|---|---|---|
| Reinvestment Rate | | 1.000% |
| Internal Rate of Return (IRR) on Cash Flows: | IRR per Col (4) | 2.153% |
| Estimated investment expense ratio | | 0.250% |
| Indicated discount rate net of expenses | | 1.903% |

| | Cash In-flow from Assets | | | | | Cash Outflow | | | Net Inflow (Excess) | | | | Reinvested Funds | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (4a) | (4b) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) |
| Year | Cash from Investment<br>Sheet 3 | (To)/ From Reinvestment<br>See below | Total Inflow<br>= (2) + (3) | Payment of Net Claim Liabilities | Payment of Net Prem Liabilities | Payment of Net Policy Liabilities<br>Sheet 3 | Cash Withdrawal<br>= (4) - (5) | Total Outflow<br>= (5) + (6) | Net inflow No Reinv/WD<br>= (2) - (5) | Cumulative Excess<br>Based on (8) | Net inflow With Reinv/WD<br>= (4) - (7) | Cumulative Excess<br>Based on (10) | Opening Balance<br>= (15) prior year | Interest Earned on Reinv.<br>=(12) * Reinv. Rate | Deposit / (Withdrawal)<br>= -(3) | Closing Balance<br>=(12) + (13)+ (14) |
| From Sheet 1 | -349,985 | 0 | -349,985 | -275,865 | -43,219 | | | -349,985 | | | | | | | | |
| 2016 | 140,960 | -10,932 | 130,028 | 110,075 | 19,953 | 130,028 | 0 | 130,028 | 10,932 | 10,932 | 0 | 0 | 0 | 0 | 10,932 | 10,932 |
| 2017 | 87,733 | -15,886 | 71,847 | 59,385 | 12,462 | 71,847 | 0 | 71,847 | 15,886 | 26,817 | 0 | 0 | 10,932 | 109 | 15,886 | 26,926 |
| 2018 | 54,773 | -7,523 | 47,250 | 41,720 | 5,530 | 47,250 | 0 | 47,250 | 7,523 | 34,340 | 0 | 0 | 26,926 | 269 | 7,523 | 34,718 |
| 2019 | 2,648 | 27,826 | 30,473 | 27,400 | 3,073 | 30,473 | 0 | 30,473 | -27,826 | 6,514 | 0 | 0 | 34,718 | 347 | -27,826 | 7,240 |
| 2020 | 17,648 | 5,975 | 23,622 | 21,665 | 1,957 | 23,622 | 0 | 23,622 | -5,975 | 540 | 0 | 0 | 7,240 | 72 | -5,975 | 1,338 |
| 2021 | 32,033 | -6,866 | 25,166 | 12,925 | 1,086 | 14,011 | 11,155 | 25,166 | 18,022 | 18,561 | 0 | 0 | 1,338 | 13 | 6,866 | 8,217 |
| 2022 | 893 | 8,299 | 9,191 | 8,715 | 476 | 9,191 | 0 | 9,191 | -8,299 | 10,263 | 0 | 0 | 8,217 | 82 | -8,299 | 1 |
| 2023 | 35,893 | -3,391 | 32,502 | 4,875 | 273 | 5,148 | 27,354 | 32,502 | 30,745 | 41,007 | 0 | 0 | 1 | 0 | 3,391 | 3,392 |
| 2024 | 0 | 3,010 | 3,010 | 2,895 | 115 | 3,010 | 0 | 3,010 | -3,010 | 37,997 | 0 | 0 | 3,392 | 34 | -3,010 | 416 |
| 2025 | 0 | 400 | 400 | 345 | 55 | 400 | 0 | 400 | -400 | 37,597 | 0 | 0 | 416 | 4 | -400 | 20 |
| 2026 | 0 | 20 | 20 | 0 | 20 | 20 | 0 | 20 | -20 | 37,577 | 0 | 0 | 20 | 0 | -20 | 0 |
| Total ex 2015 | 372,577 | 932 | 373,509 | 290,000 | 45,000 | 335,000 | 38,509 | 373,509 | 37,577 | | 0 | | | | | |

**Underlying Duration Calculation**

| | | | |
|---|---|---|---|
| IRR on Cash Flows (y): | 2.257% | 1.903% | 1.903% |
| Payment Lag (EOP) | Disc Factor | | |
| 1 | 0.978 | 0.981 | 0.981 |
| 2 | 0.956 | 0.963 | 0.963 |
| 3 | 0.935 | 0.945 | 0.945 |
| 4 | 0.915 | 0.927 | 0.927 |
| 5 | 0.894 | 0.910 | 0.910 |
| 6 | 0.875 | 0.893 | 0.893 |
| 7 | 0.855 | 0.876 | 0.876 |
| 8 | 0.836 | 0.860 | 0.860 |
| 9 | 0.818 | 0.844 | 0.844 |
| 10 | 0.800 | 0.828 | 0.828 |
| 11 | 0.782 | 0.813 | 0.813 |
| Macaulay Duration | 2.747 | 2.617 | 2.122 |
| Modified Duration | **2.687** | **2.568** | **2.082** |

Notes

Cells in red are expansions to the educational note *Discounting and Cash Flow Considerations for P&C Insurers* .

(4a) See Revised Educational Note: Discounting and Cash Flow Considerations for P&C Insurers - Appendix B, Sheet 3, row 17.

(4b) See Revised Educational Note: Discounting and Cash Flow Considerations for P&C Insurers - Appendix B, Sheet 3, row 28.

(5) = (4a) + (4b)

**ABC Insurance Company of Canada**
**Premium Liabilities Analysis**
**Net Basis**
**As of December 31, XXXX**
**(000s)**

| Class of Insurance | (1) Direct UPR | (2) Assumed UPR | (3) Gross UPR | (4) Ceded UPR | (5) Net UPR | (6) Expected Reinsur. Premium | (7) Selected Undisc. Loss Ratio (% Prem) | (8) Losses + ALAE | (9) Selected ULAE Ratio (% Loss + ALAE) | (10) ULAE | (11) Undisc. Losses + LAE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Personal Property | 10,000 | 0 | 10,000 | 500 | 9,500 | 500 | 86.0% | 7,740 | -- | 383 | 8,123 |
| Commercial Property | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% | - | -- | - | - |
| Aircraft | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% | - | -- | - | - |
| Auto - Liability - Regular | 50,000 | 0 | 50,000 | 1,000 | 49,000 | 3,000 | 98.0% | 45,080 | -- | 2,250 | 47,330 |
| Auto - PA - Regular | 25,000 | 0 | 25,000 | 3,000 | 22,000 | 1,500 | 115.0% | 23,575 | -- | 1,350 | 24,925 |
| Auto - Other - Regular | 30,000 | 0 | 30,000 | 500 | 29,500 | 1,000 | 67.0% | 19,095 | -- | 918 | 20,013 |
| Auto - Liability - Facility | 1,500 | 0 | 1,500 | 0 | 1,500 | 0 | 93.3% | 1,400 | -- | - | 1,400 |
| Auto - PA - Facility | 750 | 0 | 750 | 0 | 750 | 0 | 93.3% | 700 | -- | - | 700 |
| Auto - Other - Facility | 750 | 0 | 750 | 0 | 750 | 0 | 93.3% | 700 | -- | - | 700 |
| Boiler & Machinery | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% | - | -- | - | - |
| Credit | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% | - | -- | - | - |
| Credit Protection | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% | - | -- | - | - |
| Fidelity | 0 | 0 | 0 | 0 | (0) | 0 | 0.0% | - | -- | - | - |
| Hail | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% | - | -- | - | - |
| Legal Expense | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% | - | -- | - | - |
| Liability - Total | 0 | 5,000 | 5,000 | 1,000 | 4,000 | 250 | 73.0% | 2,738 | -- | 169 | 2,906 |
| Other Approved Products | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% | - | -- | - | - |
| Surety - Total | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% | - | -- | - | - |
| Title | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% | - | -- | - | - |
| Marine | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% | - | -- | - | - |
| Accident & Sickness | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% | - | -- | - | - |
| **Total** | **118,000** | **5,000** | **123,000** | **6,000** | **117,000** | **6,250** | **91.8%** | **101,028** | **--** | **5,069** | **106,097** |

(1) From Prem Liab Ed Note, appendix B, sheet 1, column (1)
(2) From Prem Liab Ed Note, appendix B, sheet 1, column (2)
(3) = (1) + (2)
(4) From company accounting department or annual return
(5) = (3) - (4)
(6) From company
(7) Similar calculation as gross analysis (see Prem Liab Ed Note)
(8) = [ (5) - (6) ]x (7)
(9) n/a
(10) Prem Liab Ed Note, appendix B, sheet 1, column (10)
(11) = (8) + (10)

**ABC Insurance Company of Canada**
**Premium Liabilities Analysis**
**Net Basis**
**As of December 31, XXXX**
**(000s)**

| | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) | (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Class of Insurance** | **Discount Factor** | **Discounted Losses + LAE** | **Discount Factor (with MfAD)** | **Discounted Losses + LAE (with Int. PfAD)** | **Interest Rate PfAD** | **Claims Dev't. MfAD** | **Claims Dev't. PfAD** | **Ceded Discounted Losses +ALAE** | **Reinsur. MfAD** | **Reinsur. PfAD** | **Total PfAD** | **Discounted Losses with PfADs** |
| Personal Property | 0.983 | 7,984 | 0.987 | 8,015 | 31 | 7.0% | 559 | 749 | 1.0% | 7 | 597 | 8,581 |
| Commercial Property | -- | 0 | -- | 0 | 0 | 0.0% | 0 | 0 | 1.0% | 0 | 0 | 0 |
| Aircraft | -- | 0 | -- | 0 | 0 | 0.0% | 0 | 0 | 1.0% | 0 | 0 | 0 |
| Auto - Liability - Regular | 0.922 | 43,647 | 0.943 | 44,642 | 994 | 11.0% | 4,801 | 4,277 | 1.0% | 43 | 5,838 | 49,485 |
| Auto - PA - Regular | 0.932 | 23,234 | 0.953 | 23,758 | 524 | 10.0% | 2,323 | 5,833 | 1.0% | 58 | 2,906 | 26,140 |
| Auto - Other - Regular | 0.977 | 19,553 | 0.988 | 19,773 | 220 | 7.0% | 1,369 | 1,275 | 1.0% | 13 | 1,601 | 21,154 |
| Auto - Liability - Facility | 0.929 | 1,300 | 0.929 | 1,300 | 0 | 15.4% | 200 | 0 | 1.0% | 0 | 200 | 1,500 |
| Auto - PA - Facility | 0.929 | 650 | 0.929 | 650 | 0 | 15.4% | 100 | 0 | 1.0% | 0 | 100 | 750 |
| Auto - Other - Facility | 0.929 | 650 | 0.929 | 650 | 0 | 15.4% | 100 | 0 | 1.0% | 0 | 100 | 750 |
| Boiler & Machinery | -- | 0 | -- | 0 | 0 | 0.0% | 0 | 0 | 1.0% | 0 | 0 | 0 |
| Credit | -- | 0 | -- | 0 | 0 | 0.0% | 0 | 0 | 1.0% | 0 | 0 | 0 |
| Credit Protection | -- | 0 | -- | 0 | 0 | 0.0% | 0 | 0 | 1.0% | 0 | 0 | 0 |
| Fidelity | -- | 0 | -- | 0 | 0 | 0.0% | 0 | 0 | 1.0% | 0 | 0 | 0 |
| Hail | -- | 0 | -- | 0 | 0 | 0.0% | 0 | 0 | 1.0% | 0 | 0 | 0 |
| Legal Expense | -- | 0 | -- | 0 | 0 | 0.0% | 0 | 0 | 1.0% | 0 | 0 | 0 |
| Liability - Total | 0.937 | 2,724 | 0.953 | 2,771 | 47 | 10.0% | 272 | 890 | 1.0% | 9 | 328 | 3,052 |
| Other Approved Products | -- | 0 | -- | 0 | 0 | 0.0% | 0 | 0 | 1.0% | 0 | 0 | 0 |
| Surety - Total | -- | 0 | -- | 0 | 0 | 0.0% | 0 | 0 | 1.0% | 0 | 0 | 0 |
| Title | -- | 0 | -- | 0 | 0 | 0.0% | 0 | 0 | 1.0% | 0 | 0 | 0 |
| Marine | -- | 0 | -- | 0 | 0 | 0.0% | 0 | 0 | 1.0% | 0 | 0 | 0 |
| Accident & Sickness | -- | 0 | -- | 0 | 0 | 0.0% | 0 | 0 | 1.0% | 0 | 0 | 0 |
| **Total** | **0.940** | **99,742** | **0.957** | **101,558** | **1,816** | **9.7%** | **9,725** | **13,024** | **1.0%** | **130** | **11,671** | **111,413** |

(12) Similar calculation as gross analysis (see Prem Liab Ed Note)
(13) = (11) x (12)
(14) Similar calculation as gross analysis (see Prem Liab Ed Note)
(15) = (11) x (14)
(16) = (15) - (13)
(17) Claims development MfAD used for the valuation of claims liabilities
(18) = (13) x (17)
(19) See Prem Liab Ed Note, Appendix C, Sheet 2
(20) Reinsurance MfAD used for the valuation of claims liabilities
(21) = (19) x (20)
(22) = (16) + (18) + (21) [input for P&C annual return Page 30.64, Col (14) ]
(23) = (13) + (22)

**ABC Insurance Company of Canada**
**Premium Liabilities Analysis**
**Net Basis**
**As of December 31, XXXX**
**(000s)**

| | (24) | (25) | (26) | (27) | (28) | (29) | (30) | (31) | (32) | (33) | (34) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Class of Insurance** | **Maint. Expense Ratio (% Gross Prem.)** | **Maint. Expenses** | **Contingent Comm. Rate (% Gross Prem.)** | **Contingent Comm.** | **Premium Liabilities** | **Unearned (Ceded) Comm.** | **Equity in UPR** | **Max. Allowable DPAE** | **Initial DPAE** | **Booked DPAE** | **Premium Deficiency** |
| Personal Property | 3.00% | 300 | 0.00% | 0 | 9,381 | 129 | | | | | |
| Commercial Property | 3.00% | 0 | 0.00% | 0 | 0 | 0 | | | | | |
| Aircraft | 3.00% | 0 | 0.00% | 0 | 0 | 0 | | | | | |
| Auto - Liability - Regular | 3.00% | 1,500 | 0.00% | 0 | 53,985 | 258 | | | | | |
| Auto - PA - Regular | 3.00% | 750 | 0.00% | 0 | 28,390 | 774 | | | | | |
| Auto - Other - Regular | 3.00% | 900 | 0.00% | 0 | 23,054 | 129 | | | | | |
| Auto - Liability - Facility | 3.00% | 45 | 0.00% | 0 | 1,545 | 0 | | | | | |
| Auto - PA - Facility | 3.00% | 23 | 0.00% | 0 | 773 | 0 | | | | | |
| Auto - Other - Facility | 3.00% | 23 | 0.00% | 0 | 773 | 0 | | | | | |
| Boiler & Machinery | 3.00% | 0 | 0.00% | 0 | 0 | 0 | | | | | |
| Credit | 3.00% | 0 | 0.00% | 0 | 0 | 0 | | | | | |
| Credit Protection | 3.00% | 0 | 0.00% | 0 | 0 | 0 | | | | | |
| Fidelity | 3.00% | 0 | 0.00% | 0 | 0 | 0 | | | | | |
| Hail | 3.00% | 0 | 0.00% | 0 | 0 | 0 | | | | | |
| Legal Expense | 3.00% | 0 | 0.00% | 0 | 0 | 0 | | | | | |
| Liability - Total | 3.00% | 150 | 0.00% | 0 | 3,452 | 258 | | | | | |
| Other Approved Products | 3.00% | 0 | 0.00% | 0 | 0 | 0 | | | | | |
| Surety - Total | 3.00% | 0 | 0.00% | 0 | 0 | 0 | | | | | |
| Title | 3.00% | 0 | 0.00% | 0 | 0 | 0 | | | | | |
| Marine | 3.00% | 0 | 0.00% | 0 | 0 | 0 | | | | | |
| Accident & Sickness | 3.00% | 0 | 0.00% | 0 | 0 | 0 | | | | | |
| **Total** | **3.00%** | **3,690** | **0.00%** | **0** | **121,353** | **1,549** | **(2,804)** | **0** | **20,000** | **0** | **2,804** |

(24) From Prem Liab Ed Note, appendix B, sheet 6, row (10)
(25) = (3) x (24)
(26) Based on company budget and projected loss ratios
(27) = (3) x (26)
(28) = (6) + (23) + (25) + (27)
(29) From company accounting department or annual return
(30) = (5) - (28) + (29)

(31) = max [ (30) , 0 ]
(32) From company accounting department
(33) = min [ (31) , (32) ] [input for P&C return 20.10, row(43)]
(34) = - min [ (30) , 0 ] [input for P&C return 20.20, row (15)]

**ABC Insurance Company of Canada**
**Premium Liabilities Analysis**
**Net Basis**
**As of December 31, XXXX**
**(000s)**

| | (35) | (36) | (37) |
|---|---|---|---|
| **Class of Insurance** | **Premium Liabilities Δy= +0.1%** | **Premium Liabilities Δy= -0.1%** | **Premium Liabilities Effective Duration** |
| Personal Property | | | |
| Commercial Property | | | |
| Aircraft | | | |
| Auto - Liability - Regular | | | |
| Auto - PA - Regular | | | |
| Auto - Other - Regular | | | |
| Auto - Liability - Facility | | | |
| Auto - PA - Facility | | | |
| Auto - Other - Facility | | | |
| Boiler & Machinery | | | |
| Credit | | | |
| Credit Protection | | | |
| Fidelity | | | |
| Hail | | | |
| Legal Expense | | | |
| Liability - Total | | | |
| Other Approved Products | | | |
| Surety - Total | | | |
| Title | | | |
| Marine | | | |
| Accident & Sickness | | | |
| **Total** | **120,997** | **121,920** | **3.803** |

(35) = recalculation of (28) using discount rate + 0.1%
(36) = recalculation of (28) using discount rate - 0.1%
(37) = [(36)-(35)] / [2 x 0.1% ] / (28)

## Premium Liabilities Macaulay Duration

The following is a deterministic approach to demonstrate that the duration of the net premium liabilities can be derived from the duration of a future accident year.

Assume the following:

- i = yield-to-maturity discount rate.
- Assume losses are uniformly distributed and premiums are annual and evenly distributed.
- Let t = timing of payments of a future accident year (0.5/1.5/2.5/etc.) from the valuation or calculation date. For simplification, assume there is only one payment made each year and that the first payment is made at the average accident date.
- $P_t$ is your cash flow payment at time t.
- Let x = difference between the mean accident date of a future accident year and the mean accident date underlying the unearned premium reserve = 1/6 (0.50 less 0.333).

$$Macaulay\ Duration_{AY} = \frac{\sum_t\ tP_t\,(1+i)^{-t}}{\sum_t\ P_t\,(1+i)^{-t}}$$

$$Duration_{NPL} \approx \frac{\sum_t\ (t-x)P_t\,(1+i)^{-(t-x)}}{\sum_t\ P_t\,(1+i)^{-(t-x)}} = \frac{(1+i)^x\sum_t\ tP_t\,(1+i)^{-t} - x(1+i)^x\sum_t\ P_t\,(1+i)^{-t}}{(1+i)^x\sum_t\ P_t\,(1+i)^{-t}}$$

$$\approx Macaulay\ Duration_{AY} - x$$

- Modified duration can then be calculated by dividing by (1+i).

The following table summarizes the results from the monthly testing of the duration of the premium liabilities performed by the Sub-committee on Premium Liabilities Ed Note Revisions of the Committee on Property and Casualty Insurance Financial Reporting (PCFRC) against the following:

1. Previous CIA interpolation approach with the median average accident date;
2. Previous CIA interpolation approach with the mean average accident date;
3. New approximation using the duration of a future accident year minus an adjustment for accident dates using the mean (.3333); and
4. New approximation using the duration of a future accident year minus an adjustment for accident dates using the median (.2929).

**Summary of Results - Difference versus exact monthly calculation**

| | Macaulay Duration of the Premium Liabilities | | | |
|---|---|---|---|---|
| | YE 2014 CIA approx using interpolation w/ median AAD | YE 2014 CIA approx using interpolation w/ mean AAD | New Approx assuming w/ mean AAD | New Approx w/ median AAD |
| yield rate 20.00% | | | | |
| Stable Pattern | -10.3% | -7.1% | -0.8% | -2.5% |
| Decreasing Pattern | -13.0% | -8.7% | -1.1% | -3.5% |
| Long Tail | -11.1% | -7.8% | -0.8% | -2.4% |
| Short Tail | -15.4% | -5.2% | -0.8% | -9.8% |
| yield rate 10.00% | | | | |
| Stable Pattern | -9.2% | -6.2% | -0.4% | -2.0% |
| Decreasing Pattern | -11.8% | -7.8% | -0.6% | -2.8% |
| Long Tail | -10.0% | -6.8% | -0.4% | -2.0% |
| Short Tail | -15.2% | -5.1% | -0.5% | -9.4% |
| yield rate 3.50% | | | | |
| Stable Pattern | -8.5% | -5.6% | -0.1% | -1.7% |
| Decreasing Pattern | -11.0% | -7.1% | -0.2% | -2.4% |
| Long Tail | -9.2% | -6.2% | -0.1% | -1.7% |
| Short Tail | -15.0% | -5.0% | -0.2% | -9.0% |
| yield rate 0.00% | | | | |
| Stable Pattern | -8.1% | -5.3% | 0.0% | -1.5% |
| Decreasing Pattern | -10.5% | -6.7% | 0.0% | -2.1% |
| Long Tail | -8.8% | -5.8% | 0.0% | -1.5% |
| Short Tail | -14.9% | -4.9% | 0.0% | -8.7% |