NHA MBS INDEMNITY CALCULATION METHODOLOGY

Canada

INTRODUCTION

The following document outlines the methodology to calculate the NHA MBS indemnity payments due to investors for the 965, 970 and 975 pool types.

The document is divided into the following four sections.

1.0 NHA MBS Pricing Formulas for Indemnity Assessment Purposes

This section outlines the cash flow and pricing calculations for NHA MBS consisting of a single tranche. This document also illustrates how a single-tranche approach to price NHA MBS can be easily generalized to price a multi-tranche NHA MBS. This methodology was developed to calculate the NHA MBS price for indemnity assessment purposes only.

2.0 Methodology to Determine the Government of Canada Yield

This section outlines the methodology to determine the Government of Canada Yield.

3.0 NHA MBS Pricing Assumptions for Indemnity Assessment Purposes

This section summarizes the NHA MBS pool data and pricing assumptions required to calculate the NHA MBS price for indemnity assessment purposes.

4.0 Calculating the Indemnity Payment to Investors – A Numerical Example

This section outlines a numerical example of how to calculate the indemnity payment due to investors of a 975 pool.

1.0 NHA MBS Pricing Formulas for Indemnity Assessment Purposes

The following formulas outline the cash flow and pricing calculations for NHA MBS consisting of a single tranche. This document also illustrates how a single-tranche approach to price NHA MBS can be easily generalized to price a multi-tranche NHA MBS. These formulas must be used to calculate the NHA MBS price for indemnity assessment purposes. Any reference to NHA MBS price in this document relates to the NHA MBS price calculated for indemnity assessment purposes only.

1.1 Calculating the Mortgage Pool Cash Flows

The following formulas are used to calculate the mortgage pools monthly cash flows.

1.1.1 Monthly Weighted Average Mortgage Coupon

A typical Canadian fixed-rate residential mortgage has a fixed monthly payment and a mortgage rate compounded semi-annually. To convert the annual weighted average mortgage coupon to a monthly equivalent apply the following formula:

$$r_0^{\text{MTG}} = \left(1 + \frac{WAC_0}{200}\right)^{1/6} - 1$$

Where,

$r_0^{MTG} =$ Monthly mortgage rate at the beginning of the month for which the Indemnity Factor calculation applies (i.e. time t=0).

$WAC_0 =$ Annual weighted average mortgage rate at the beginning of the month for which the Indemnity Factor calculation applies (i.e. time t=0).

1.1.2 Monthly Payments of the Mortgage Pool

Prior to maturity (up to *M-1*), the scheduled monthly mortgage payment of the mortgage pool at time *t* is:

$$MTG_t^{MP} = MINIMUM \left[\frac{RP_0 * r_0^{MTG} * (1-q)^{t-1}}{1 - \left[\frac{1}{(1+r_0^{MTG})^{RAM_0}}\right]}, RP_{t-1} * (1 + r_0^{MTG}) \right]$$

Where,

$MTG_t^{MP} =$ The scheduled monthly payment on the mortgage pool for month t (where t=1 is the month the Indemnity Factor is applied to).

$RAM_0 =$ Remaining average amortization of the mortgage pool at the beginning of the month for which the Indemnity Factor calculation applies (i.e. time t=0).

$RP_0 =$ 1.0

$q =$ Monthly core liquidation rate

When a mortgage in the pool liquidates, there is one less mortgage contributing to the scheduled monthly mortgage payment on the NHA MBS. Thus, the scheduled monthly mortgage payment must be reduced to account for liquidations. If q denotes the constant fraction of mortgages that liquidate each month, then 1-q denotes the fraction remaining.

At maturity (M), the scheduled monthly mortgage payment of the mortgage pool is:

$$MTG_M^{MP} = RP_{M-1} * (1 + r_0^{\text{MTG}})$$

Mortgage Interest Payment at t is:

$$MTG_t^{INT} = RP_{t-1} \cdot r_0^{MTG}$$

Scheduled Mortgage Principal Payment at t is:

$$MTG_t^{P} = MTG_t^{MP} - MTG_t^{INT}$$

1.1.3 Mortgage Pool Monthly Prepayments

The Partial Prepayment Rate ("PPR") and Core Liquidation Rate ("LQR") are assumed to remain constant over the life of the NHA MBS when calculating the NHA MBS price for indemnity assessment purposes.

The monthly rates are calculated from the annualized rates as follows:

$$p = 1 - (1 - PPR)^{1/12}$$
$$q = 1 - (1 - LQR)^{1/12}$$

Where,

p = monthly partial prepayment rate

q = monthly core liquidation rate

PPR = annualized partial prepayment rate

LQR = annualized core liquidation rate

Partial prepayment and liquidation dollar amounts for month t are:

$$Q_t = [RP_{t-1} - MTG_t^P] \cdot q$$

$$P_t = [RP_{t-1} - MTG_t^P - Q_t] \cdot p$$

Where,

P_t = monthly partial prepayments amount
Q_t = monthly core liquidations amount

The Remaining Principal Balance for month t is:

$$RP_t = RP_{t-1} - MTG_t{}^P - Q_t - P_t$$

1.2 Calculating NHA MBS Monthly Cash Flows

To calculate the fixed-rate NHA MBS cash flows, it is necessary to convert the NHA MBS annual coupon to their monthly equivalent rates:

$$r^{MBS} = \left(1 + \frac{C}{200}\right)^{1/6} - 1$$

Where,

r^{MBS} = monthly NHA MBS coupon rate

C = annual NHA MBS coupon rate

NHA MBS coupon payment for month t is:

$$MBS_t{}^{CPN} = RP_{t-1} \cdot r^{MBS}$$

NHA MBS principal payment for month t is:

$$MBS_t{}^P = MTG_t{}^P + P_t + Q_t$$

NHA MBS cash flow for month *t* is:

$$MBS\_CF_t = MBS_t{}^{CPN} + MBS_t{}^{P}$$

1.3 Calculating the NHA MBS Price

The following formulas are used to calculate the NHA MBS price for indemnity assessment purposes.

1.3.1 Full Price of NHA MBS

The full price of the NHA MBS, assuming a single tranche that repays at time M, is calculated:

$$Full\ Price = \sum_{t=1}^{M} \frac{MBS\_CF_t}{\left(1 + \frac{Y_s}{200}\right)^{\frac{t+a-1}{6}}}$$

Where,

$$a = \frac{\text{Number of days from Settlement Date to the 15th of next month}}{\text{Number of days in settlement month}}$$

$$Y_s = Government\ of\ Canada\ Yield + Prepayment\ Spread$$

1.3.2 NHA MBS Accrued Interest

Accrued interest is calculated:

$$AI = r^{MBS} * d$$

Where,

$$d = \frac{\text{Number of days from 1st of settlement month to the Settlement Date}}{\text{Number of days in settlement month}}$$

1.3.3 NHA MBS Clean Price

The NHA MBS Clean Price is simply the full MBS price less accrued interest:

$$NHA\ MBS\ Clean\ Price = Full\ Price - AI$$

1.3.4 Pricing Multi-Tranche NHA MBS

The preceding formulas can be used to price a multi-tranche NHA MBS by treating each tranche as though it were a separate security. The cash flow equations allow us to calculate a price for each tranche. Once we obtain prices for each tranche, we calculate the NHA MBS price as an average of the individual tranche prices weighted by the dollar amount of the tranches:

$$NHA\ MBS\ Clean\ Price = \frac{\sum_{i=0}^{5}((NHA\ MBS\ Clean\ Price)_{M-i} * TR_{M-i})}{\sum_{i=0}^{5} TR_{M-i}}$$

Where,

TR_{M-i} = remaining principal balance at t=0 of the tranche maturing i months before maturity M.

The NHA MBS Clean Price used to determine the Indemnity Factor should be calculated to five (5) decimal places. Rounding of the last decimal place occurs upward if the sixth digit is greater than or equal to five (5).

1.4 Calculating the Indemnity Payment

The Indemnity Factor is calculated using the following formula:

$$Indemnity\ Factor = Max\ [\ (NHA\ MBS\ Clean\ Price - 1)\ , 0\ ]$$

The Indemnity Payment to investors is calculated using the following formula:

$$Indemnity\ Payment = Indemnity\ Factor * Prepayments\ that\ Attract\ Indemnities$$

Prepayments that attract indemnity payments are based on disclosures made in the NHA MBS Information Circular for the specific NHA MBS.

2.0 Methodology to Determine the Government of Canada Yield

This section outlines the methodology to determine the Government of Canada Yield used in the NHA MBS indemnity calculation.

2.1 The Weighted Average Life of the NHA MBS

Issuers are required to calculate the Weighted Average Life ("WAL") of the NHA MBS.

The WAL of the NHA MBS is calculated using the following formula.

$$Weighted\ Average\ Life\ of\ NHA\ MBS = \frac{1}{12} \sum_{t=1}^{M} (t + a - 1) * P_t$$

Where,

P_t, is the fraction of original principal returned in month t under the projected prepayment rate (e.g. for the 965 pool type: 0% PPR and 0% LQR, for the 970/975 pool types: 1% PPR and 4% LQR). Note that $P_1 + P_2 + ... + P_M = 1$.

$$a = \frac{Number\ of\ days\ from\ Settlement\ Date\ to\ the\ 15th\ of\ next\ month}{Number\ of\ days\ in\ settlement\ month}$$

t, refers to the time period.

The WAL of the NHA MBS should be rounded to three decimal places. Rounding of the last decimal place occurs upward if the fourth digit is greater than or equal to five (5).

The above formula generates a WAL denominated in years. It can be converted into an average life date as follows:

$$Weighted\ Average\ Life\ of\ NHA\ MBS\ (Date) = SettlementDate + Round(WAL * 365.25,0)$$

The WAL of the NHA MBS should be used to establish the maturity reference point to determine the Government of Canada Yield.

2.2 Government of Canada Bond and Bill Selection

To construct the Government of Canada curve Issuers should select Government of Canada Bills and Bonds identified in the Canadian Dollar Canada Sovereign Curve Index reported by Bloomberg.

The specific Government of Canada curve components include the following:

Government of Canada Curve Components	Bloomberg Function
Bank of Canada Overnight Rate	CABROVER Index HP <GO>
Government of Canada Bills (3M, 6M, 12M)	YCGT0007 Index MEMB <GO>
Government of Canada Bonds (2Y-10Y, 20Y, 30Y)	YCGT0007 Index MEMB <GO>

The Bank of Canada Overnight Rate is obtained using the Bloomberg function **CABROVER Index HP <GO>**. The close of day Bank of Canada Overnight Rate as of the third last business day of the month prior to the month the prepayment is passed through to investors should be used by Issuers.

The "Government of Canada Bills and Bonds" identified by Bloomberg through the CAD Canada Sovereign Curve Index function **(YCGT0007 Index MEMB> <GO>)** should be used for the remainder of the Government of Canada curve. The parameters of this page should be specified as follows:

- The date should be set as the third last business day of the month prior to the month the prepayment is passed through to investors.
- The pricing source (PCS) should be set as the Bloomberg Generic Price (BGN).
- Close of day Mid Yields should be used.

An example of the Bloomberg screen shot is provided in the Figure below.

Figure: CAD Canada Sovereign Curve (**YCGT0007 Index MEMB <GO>**)

If a Government of Canada Bill or Bond is missing from the Bloomberg CAD Canada Sovereign Curve Index Issuers should ignore that tenor along the Government of Canada curve.

The mid yields obtained from the **YCGT0007 Index MEMB <GO>** function should be collected after the Bloomberg Generic pricing source closing times. For Government of Canada Bills and Bonds this is approximately 5:45 p.m. Toronto time.

2.3 Linear Interpolation Methodology to Calculate Government of Canada Yield

Issuers should calculate the Government of Canada Yield as follows:

   i.   If the WAL of the NHA MBS (Date) is equal to the maturity date of a Government of Canada Bills or Bonds then the closing Mid Yield rate of the Government of Canada Bill or Bond should be used as the Government of Canada Yield.

   ii.   If the WAL of the NHA MBS (Date) is not equal to the maturity date of a Government of Canada Bills or Bonds, the Government of Canada Yield must be determined through simple linear interpolation.

The linear interpolation equation is the following:

$$Government\ of\ Canada\ Yield\ = b + \frac{(a - b)}{(x - y)} * (z - y)$$

Where,

a = Close of day Mid Yield for the longer Government of Canada Bill or Bond
b = Close of day Mid Yield for the shorter Government of Canada Bill or Bond
x = Maturity Date of the longer Government of Canada Bill or Bond
y = Maturity Date of the shorter Government of Canada Bill or Bond
z = WAL of the NHA MBS (Date)
(x-y)= Number of days between the maturity date of the longer Government of Canada Bill or Bond and the maturity date of the shorter Government of Canada Bill or Bond.
(z-y)= Number of days between the WAL of NHA MBS expressed as date and the maturity date of the shorter Government of Canada Bill or Bond.

The Government of Canada Yield should be rounded to three decimal places. Rounding of the last decimal place occurs upward if the fourth digit is greater than or equal to five (5).

The Bank of Canada Overnight Rate and the yields of the Government of Canada Bills are expressed on an annual compounded basis. The annual compounded rates must be expressed as a semi-annual rate prior to performing the interpolation calculations.

The annual rates should be converted to a bond-equivalent yield using the following formula:

$$Y_S = \left[\left(1 + Y_{mmkt} * \frac{t}{36500}\right)^{\frac{182.5}{t}} - 1\right] * 200$$

Where,

t =   Number of day between the Maturity Date of Government of Canada Treasury Bill and the Settlement Date Assumption

Y_{mmkt} = Yield of Government of Canada Bill (simple interest on an actual/365 basis)

3.0 NHA MBS Pricing Assumptions for Indemnity Assessment Purposes

The NHA MBS pool characteristics and pricing assumptions required to calculate the NHA MBS price for indemnity assessment purposes are outlined below.

3.1 NHA MBS Pool Characteristics

To calculate the NHA MBS price for indemnity assessment purposes Issuers are required to use the NHA MBS pool data from the most recent reporting period. For instance if the prepayments and indemnity payments will be passed through to investors on February 15, 2013 Issuers are required to use NHA MBS pool data reported to the Central Payor and Transfer Agent as of December 2012 month end.

The following NHA MBS pool characteristics are required in order to calculate the NHA MBS price for indemnity assessment purposes:
- NHA MBS Maturity Date
- NHA MBS Coupon
- Weighted Average Mortgage Coupon
- Remaining Amortization of Mortgages
- Principal Outstanding by Maturing Tranche
- Maturity Date by Maturing Tranche

3.2 NHA MBS Pricing Assumptions for Indemnity Assessment Purposes

The following Prepayment Rate assumptions are required in order to calculate the NHA MBS price for indemnity assessment purposes:
- Partial Prepayment Rate assumption
- Core Liquidation Rate assumption

Other relevant assumptions required to calculate the NHA MBS price for indemnity assessment purposes include:
- The Government of Canada Yield
- Prepayment Spread
- Settlement Date

The following tables outline all of the required NHA MBS pricing assumptions to perform the indemnity assessment by NHA MBS pool type.

3.2.1 The 965 NHA MBS Pool Type

NHA MBS Pricing Assumptions	For 965 Pools Issued on or after November 1, 2014
Partial Prepayment Rate	0% per annum
Core Liquidation Rate	0% per annum
Government of Canada Yield	The Government of Canada Yield assumption will be determined using the new methodology to determine the Government of Canada Yield (refer to Section 2.0).
Date that the Government of Canada Yield is determined	The date the Government of Canada Yield is determined will be the third last business day of the month prior to the month the prepayment is passed through to investors.
Prepayment Spread	0 basis points
Settlement Date	Last business day of the month prior to the month the prepayment is passed through to investors.

3.2.2 The 970/975 NHA MBS Pool Types

NHA MBS Pricing Assumptions	For 970/975 Pools Issued on or after November 1, 2014
Partial Prepayment Rate	1% per annum
Core Liquidation Rate	4% per annum
Government of Canada Yield	The Government of Canada Yield assumption will be determined using the new methodology to determine the Government of Canada Yield (refer to Section 2.0).
Date that the Government of Canada Yield is determined	The date the Government of Canada Yield is determined will be the third last business day of the month prior to the month the prepayment is passed through to investors.
Prepayment Spread	25 basis points
Settlement Date	Last business day of the month prior to the month the prepayment is passed through to investors.

4.0 Calculating the Indemnity Payment to Investors – A Numerical Example

The following is a numerical example of how to calculate the indemnity payment due to investors for a 975 NHA MBS pool.

Step 1 – Determine the Weighted Average Life of the NHA MBS

In this example the indemnity payment will flow through to investors on February 15, 2013. Consequently, NHA MBS pool information reported as of December month end is used to calculate the NHA MBS price for indemnity assessment purposes. NHA MBS pool information as of month end December 2012 is provided below.

NHA MBS Pool Information:

Pool Number	**975 XXX XXX**
NHA MBS Coupon	**2.00%**
Maturity Date	**01-September-2017**
Reporting Month	**December 2012**
Weighted Average Mortgage Coupon	**3.25%**
Remaining Amortization (in months)	**325.115**
Mortgage Balance at Maturity	**$80,000,000**
Mortgage Balance Prior to Maturity - 1 Month	**$100,000,000**
Mortgage Balance Prior to Maturity - 2 Month	**$40,000,000**
Mortgage Balance Prior to Maturity - 3 Month	**$7,000,000**
Mortgage Balance Prior to Maturity - 4 Month	**$10,000,000**
Mortgage Balance Prior to Maturity - 5 Month	**$20,000,000**

NHA MBS Indemnity Pricing Assumptions

Partial Prepayment Rate Assumption	**1.0%**
Core Liquidation Rate Assumption	**4.0%**
Prepayment Spread Assumption	**25 basis points**
Settlement Date	**31-January-2013**

Based on the NHA MBS Pool Information and the NHA MBS Indemnity Pricing Assumptions the WAL of the NHA MBS is **3.812 years** and the WAL of the NHA MBS expressed as a date is **November 23, 2016.**

Step 2 – Determine the Government of Canada Yield

Once the Weighted Average Life of the NHA MBS has been calculated the next step is to determine the appropriate GoC Yield to use to calculate the NHA MBS price for indemnity assessment purposes (please refer to the Section 2.0 for the methodology).

The NHA MBS Information Circular for this pool states that the Government of Canada Yield should be taken as of the "third last business day of the month prior to the month the prepayment is passed through to investors."

Mid Yield Government of Canada Bills and Bonds as at January 29, 2013

Government of Canada Bill/Bond	Government of Canada Bill/Bond Selected		Annual Mid Yield (%)	Bond Equivalent Mid Yield (%)
	Coupon %	Maturity Date		
Overnight Rate	0	31-Jan-2013	**1.000**	
Bill – 3 month	0	11-Apr-2013	**0.909**	
Bill – 6 month	0	20-Jun-2013	**0.965**	
Bill – 1 Year	0	19-Dec-2013	**1.063**	
Bond – 2 Year	1.00	01-Feb-2015		**1.160**
Bond – 3 Year	1.50	01-Aug-2015		**1.250**
Bond – 4 Year	2.00	01-Jun-2016		**1.363**
Bond – 5 Year	1.50	01-Sep-2017		**1.501**
Bond – 6 Year	4.25	01-Jun-2018		**1.563**
Bond – 7 Year	3.75	01-Jun-2019		**1.692**
Bond – 8 Year	n/a	n/a		**n/a**
Bond – 9 Year	3.25	01-Jun-2021		**1.897**
Bond – 10 Year	2.75	01-Jun-2022		**1.994**
Bond – 20 Year	5.75	01-Jun-2033		**2.530**
Bond – 30 Year	4.00	01-Jun-2041		**2.566**

Source: Bloomberg YCGT0007 Index MEMB <GO> and CABROVER Index <GO>

The Government of Canada Yield that should be used to price the NHA MBS pool is **1.416%**

Step 3 – Calculate the NHA MBS Price for Indemnity Assessment Purposes

Use the NHA MBS Pool Information, the NHA MBS Indemnity Pricing Assumptions and the Government of Canada Yield to calculate the NHA MBS price for indemnity assessment purposes (please refer Section 1.0 for detailed instructions).

The discount rate used to calculate the NHA MBS price for indemnity assessment purposes is **1.666%** (i.e. Government of Canada Yield + 25 basis points).

The NHA MBS Clean Price for the pool is **1.01144**

Step 4 – Calculate the Indemnity Payment Due to Investors

Based on the disclosures provided in the NHA MBS Information Circular and prepayments arising during the January 2013 reporting period determine which partial principal prepayments and mortgage liquidations trigger an indemnity payment to investors.

Use the following formula to determine the Indemnity Factor:

$$Indemnity\ Factor = Max\ [\ (NHA\ MBS\ Clean\ Price - 1)\ , 0\ ]$$

$$Indemnity\ Factor = Max\ [\ (1.01144 - 1)\ , 0\ ]$$

$$Indemnity\ Factor = 0.01144$$

Use the following formula to determine the dollar amount of indemnities due to investors:

$$Indemntiy\ Payment = Indemnity\ Factor\ * Prepayments\ that\ Attract\ Indemnities$$

$$Indemnity\ Payment = 0.01144 * \$2,000,000$$

$$Indemnity\ Payment = \$22,880.00$$