

# SwapClear Zero Coupon Rate Curve Construction Methodology

Initial Margin and Variation Margin Zero Coupon Rate Curve Assignments

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# Chapter 1

## Introduction

This paper describes the methods used by LCH in the construction of zero coupon rate curves under a dual curve calibration approach, and the construction of Zero Coupon Inflation Indexed Swap (ZCIIS) Curves. This paper will focus on the technical aspects of the curve construction process. It is not the intention of this paper to detail the theoretical background to all the stages in the zero coupon rate curve building process. LCH SwapClear Risk Management reserves the right to modify the zero coupon rate curve calibration methodology and/or constituent instruments as and when market conditions dictate.

### 1.1 Principles and Approach for Interest Rate Curves

SwapClear adopts the following general principles when deriving the zero coupon rate term structure:

- Determine the financial instruments that will provide the best indication of the zero coupon rate at each maturity point.
- Determine the pricing function between the market price, or rate, of the instrument and the zero coupon rate.
- Determine a functional form to be used to determine the zero coupon rate for maturities other than those specific to the financial instruments used within the calibration process.

Based on the above general principles, SwapClear zero coupon rate curve construction methodology applies the following key elements:

- Primary financial instruments used are money market instruments, short term interest rate futures, forward rate agreements, single currency basis swaps, overnight index swaps and par interest rate swaps.
- The zero coupon rate for the first short term interest rate future / forward rate agreement start date is determined by interpolating between the nearest zero coupon rate generated from the money market instrument strip.

- A bootstrapping technique is used to calculate the zero coupon rates for the remaining short term interest rate future / forward rate agreement instruments.
- Zero coupon rates are calculated for all money market instrument and par swap payment dates that lie between the first short term interest rate future / forward rate agreement start date and the last future / forward rate agreement end date using a predefined interpolation function.
- The remaining zero coupon rates are bootstrapped from the par swap rates.
- Zero coupon rates for maturities between available points are determined using either linear interpolation or natural cubic spline interpolation on the log of discount factors (alternatively on  $r*t$ , where  $r$  is the zero coupon rate and  $t$  is the time to maturity). The following points explain in which cases either interpolation scheme is used. See the appendix for the detailed definition of natural cubic spline interpolation.
- Discount factors for maturities between available points are determined using the interpolated zero coupon rate. These zero coupon rates are converted to discount factors based on an exponential rate quotation using an Actual/365 basis.
- For initial margin, default fund sizing including stress tests, and additional margin add-on calculations, SwapClear uses a single reference curve per currency for valuation and the calculation of risk for all non overnight index swap trades i.e. expected forward rates and discounting are all derived from the same curve. Linear interpolation is used for maturities between available points on these curves.
- For variation margin calculations (subject to individual markets exhibiting sufficient liquidity), SwapClear uses a separate single currency basis adjusted zero coupon rate curve for deriving expected forward rates and an overnight index swap zero coupon rate curve for discounting. Natural cubic spline interpolation on the log of discount factors is used for maturities between available points on these curves.
- For liquidity margin and basis risk add-on margin calculations, SwapClear uses the same curves that are used for variation margin calculations but linear interpolation is used for maturities between available points on these curves.

## 1.2 Principles and Approach for Zero Coupon Inflation Indexed Swap (ZCIIS) Curves

SwapClear uses zero coupon inflation quotes and seasonality quotes obtained directly from the market, together with CPI fixings to construct its curves. No bootstrapping is required because of the direct use of zero coupon rates.

## Chapter 2

# Zero Coupon Interest Rate Curve Construction

SwapClear constructs zero coupon rate curves using an appropriate set of market instruments. Given a user-defined set of reference interest rate sensitive instruments (and market rates) with increasing expiry dates, it is possible to calculate the zero coupon rates corresponding to the expiry dates of each reference instrument.

The zero coupon curve is based on the principle that all instruments belonging to the zero coupon curve have a zero value if priced on the curve. Calculations of the zero coupon rates derived from the input cashflows are made using a Newton-Raphson method. This method is an iterative process starting from a seed zero coupon rates set. At each loop, the algorithm modifies the zero coupon rate set, converging to the unique solution which, given an interpolation formula, implies a zero value for all the instruments on the curve.

### 2.1 Calibration

For the purposes of calibration SwapClear Risk Management defines a family of instruments  $I_i$  which is represented by a set of cashflows  $cf_{ij} : \{I_i\}_{1 \leq i \leq N} \equiv \{cf_{ij}\}_{1 \leq i \leq N; 1 \leq j \leq n_i}$

The zero coupon rate curve is based on the principle that all instruments belonging to the zero coupon rate curve have a zero value if priced on the curve i.e.

$$\sum_{j=1}^{n_i} cf_{ij} \cdot P_{ij} = 0, \forall i \in \{1, \dots, N\} \quad (2.1)$$

It should be noted that all Tenor curves use Contingent Calibration and all non-Tenor curves use Standard Calibration.

## 2.2 Definitions

### 2.2.1 Discount Factor Definition

$$P(t, T) = e^{-z(t, T)\tau(t, T)} \quad (2.2)$$

### 2.2.2 Cashflow Definition

$$cf(T_i^S, T_i^E) = N \cdot R \cdot \tau(T_i^S, T_i^E) \quad (2.3)$$

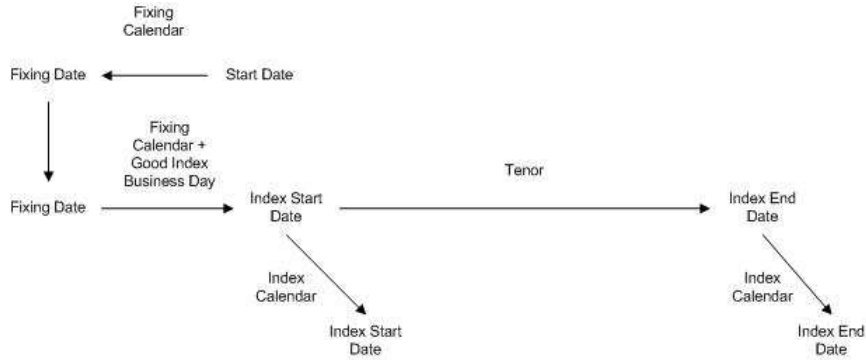
### 2.2.3 Discounted Cashflow Definition

$$PV(T_i^S, T_i^E; t, T_i^P) = cf(T_i^S, T_i^E) \cdot P_d(t, T_i^P) \quad (2.4)$$

### 2.2.4 Floating Index Rate Estimation

The floating rate index estimation start and end dates are determined using the following algorithm:

- The fixing date is derived from the fixing calendar of the floating rate index and the cashflow start date
- The fixing date, the floating rate index offset period along with the fixing calendar returns the floating rate index estimation start date. This date is checked against the union of the fixing and payment calendar to ensure it is an open business day
- Once the floating rate index start date is determined, the floating rate index rate reset frequency is applied to derive the floating rate index end date. The floating rate index end date is also checked against a combination of the fixing and payment calendar to ensure it is an open business day



#### Example

Consider the following example where the USD 3M LIBOR Index floating rate



is required for a cashflow start date of 18/04/2014.

The 18/04/2014 is a good business day in New York but not London. According to the USD 3M LIBOR Index conventions together with the methodology outlined above, this implies a Fixing date of 16/04/2014. Again using the methodology above, this implies a floating rate index estimation start date of 22/04/2014 and a floating rate index estimation end date of 22/07/2014.

### Floating Index Rate Estimation Definition

The floating index rate is defined as:

$$F(t, T_1, T_2) = \left( \frac{P(t, T_1)}{P(t, T_2)} - 1 \right) / \tau(T_1, T_2) \quad (2.5)$$

## 2.3 Curve Instruments

### 2.3.1 Deposit Instruments

$$NPV = -N \cdot P(t_0, T_i^S) + N \cdot (1 + R \cdot \tau(T_i^S, T_i^E)) \cdot P(t_0, T_i^P) \quad (2.6)$$

### 2.3.2 Forward Rate Instruments

$$NPV = N \cdot (R - f) \cdot \tau(T_i^S, T_i^E) \cdot P_f(T_i^S, T_i^E) \cdot P_d(t, T_i^S) \quad (2.7)$$

### 2.3.3 Short Term Interest Rate Futures Instruments

$$NPV = -N \cdot P(t_0, T_i^S) + N \cdot (1 + R \cdot \tau(T_i^S, T_i^E))^\alpha \cdot P(t_0, T_i^E) \quad (2.8)$$

where

$$\alpha = \frac{\tau_{IMM}(T_i^S, T_i^E)}{\tau_{Fwd}(T_i^S, T_i^E)} \quad (2.9)$$

For the purposes of zero coupon rate curve calibration, IMM periods are deemed to be contiguous.

### 2.3.4 Interest Rate Swaps

$$NPV(t) = -NPV(t)_{fix} + NPV(t)_{flt} \quad (2.10)$$

$$NPV(t)_{fix} = \sum_{i=1}^m N \cdot R_{fix} \tau(T_i^S, T_i^E) P_d(t, T_i^P) \quad (2.11)$$

$$NPV(t)_{flt} = \sum_{j=1}^n N \cdot (F_f(t, T_j^S, T_j^E) + S) \tau(T_i^S, T_i^E) P_d(t, T_j^P) \quad (2.12)$$

## 2.4 Implied Interest Rate Swap Par Rate Construction

Where no liquid market exists, LCH SwapClear Risk Management adopts a portfolio approximation to derive implied par interest rate swap rates from the par interest rate swap and single currency basis swap market. The implied par interest rate swap rates are used directly in the zero coupon rate curve calibration methodology as described in section 3.1.

Illustration:

2Y USD LIBOR A 3M	1.3%
2Y USD LIBOR 1M 3M	7bps
2Y USD LIBOR A 1M	1.23%

## 2.5 Implied Overnight Index Swap Par Rate Construction

Where no liquid market exists, LCH SwapClear Risk Management adopts a portfolio approximation to derive implied par overnight index swap rates from the par interest rate swap, single currency basis swap and overnight index swap - basis swap market. The implied par overnight index swap rates are used directly in the zero coupon rate calibration methodology as described in section 3.1.

Illustration:

3Y EURIBOR A 6M	1.53%
3Y EURIBOR 6M 3M (2-swap basis)	16bps
3Y EUR EONIA A EURIBOR 3M	30bps
3Y EUR EONIA	1.07%

## 2.6 Revaluation Rate Curve Global Model Settings

Field	Tenor Curves	Other Zero Coupon Rate Curves	Comment
Interpolation formula	Either Linear or Natural Cubic Spline on $r * t$	Either Linear or Natural Cubic Spline on $r * t$	
Value to interpolate	Zero coupon rate when Linear Interpolation used or (Zero coupon rate)*(time) when Natural Cubic Spline Interpolation used	Zero coupon rate when Linear Interpolation used or (Zero coupon rate)*(time) when Natural Cubic Spline Interpolation used	
Interpolation before first pillar	Flat	Flat	
Interpolation after last pillar	Extrapolation	Extrapolation	
Zero coupon rate convention	Exponential Actual/365	Exponential Actual/365	
Futures	No intermediate interpolation	No intermediate interpolation	Considers the final cash-flow date as being the next contract maturity date
Blocks consistency	According to priorities on Maturity	According to priorities on First date	An instrument with lower priority is ignored if it is between two instruments with higher priorities
Ignore fixings	All	All	Interest rate fixings will always be ignored
Calibration	Contingent Calibration based on Curve Assignments	Standard	The interest rate swap cashflows based on floating rates are not estimated but replaced by two capital flows in the zero coupon rate computation
Maturity step out gap	8	8	7 days before the roll of a future at which the future will be automatically excluded from the curve
Calibration method	Global Newton	Global Newton	The curve is calibrated by minimising the absolute error on the sum of the NPV of all the instruments
Calibration tolerance	0.0001	0.0001	
Calibration iterations	30 10	30	
Accept zero rates	Yes	Yes	

## Chapter 3

# Zero Coupon Inflation Indexed Swaps Curve Construction

SwapClear constructs zero coupon inflation indexed rate curves using zero coupon swap quotes sourced directly from the market. Hence, contrary to the case of interest rate swaps as described above, no curve bootstrapping is needed. Seasonality quotes and CPI fixings are also sourced directly from the market.

There are two Inflation Index curve methodologies that are used in the market, Piecewise and Linear. SwapClear builds the four Inflation Swap curves as follows:

- For the EUR HICPxT and UK RPI curves, the entire curves are built using Piecewise methodology.
- For the FR CPI and US CPI curves, the front end of the curves (up to the 2Y pillar) are built using Piecewise methodology, and the rest of the curves are built using Linear methodology.

SwapClear employs this methodology for FR CPI and US CPI because Linear methodology on the short end of these curves causes instability.

### 3.1 Calibration

The instruments used for calibration of the inflation curves are zero coupon inflation indexed swaps (these are the most liquid instruments in the market and implicitly contain the necessary inflation expectations).

The ZCIIS quotes from these instruments are used to construct the forward CPI level using the following formula:

$$CPI_n = CPI_0 (1 + R_n)^{t_n},$$

where  $t_n$  is the maturity year of pillar  $n$ ,  $R_n$  is the ZCIIS rate for pillar  $n$ ,  $CPI_0$  is the Reference CPI, which is obtained using a 2 month lag for UK RPI and a 3 month lag for EUR HICPxT, US CPI and FR CPI.

### 3.1.1 Reference CPI

$CPI_0$  is obtained using one of two methodologies, depending on whether the inflation index is piecewise or linear:

- For Piecewise Indices,  $CPI_0$  is set equal to the CPI fixing of the lagged month (i.e. Piecewise methodology is used). The lag is 2 months for UK RPI and 3 months for EUR HICPxTm, FR CPI and US CPI.
- For Linear Indices,  $CPI_0$  is linearly interpolated between the nearest two CPI fixings to the lagged month (i.e. Linear methodology is used).

### 3.1.2 Interpolation

For obtaining the CPI on a date that falls between two pillars, first log linear interpolation between these CPI pillars is used to obtain the monthly CPI values between the pillars. Hence the CPI of the  $p^{\text{th}}$  month between two pillars that are  $n$  months apart,

$$CPI_p = S_p \left[ \left( \frac{CPI_1}{S_1} \right)^{1-\frac{p}{n}} \left( \frac{CPI_2}{S_2} \right)^{\frac{p}{n}} \right],$$

where:  $CPI_1$  is the CPI of left pillar closest to month  $p$ ,  $CPI_2$  is the CPI of right pillar closest to month  $p$ ,  $S_p$  is the Seasonality adjustment for month  $p$ ,  $S_1$  is the Seasonality factor for left pillar month,  $S_2$  is the Seasonality factor for right pillar month,  $p$  is the Number of months from the left pillar to the month for which interpolation is being done,  $n$  is the Number of months between left and right curve pillars.

Then, to obtain the CPI on a particular date  $T$ , one of two methodologies is used depending on whether the trade is piecewise or linear:

- For a piecewise trade,  $CPI_T$  is the CPI of the month in which  $T$  falls. Hence all dates in month  $p$  have the same CPI, equal to  $CPI_p$ .
- For a linear trade,  $CPI_T$  is linearly interpolated between the nearest two monthly CPIs that were calculated above.

### 3.1.3 Extrapolation

For obtaining CPI on a date  $T$  before the first pillar of the curve (i.e. where there is no left pillar and therefore interpolation as described above cannot be done), flat extrapolation of the first pillar's ZCHS rate is used. i.e. For pillar  $p < \text{first pillar}$ .

$$CPI_p = S_p \left[ \left( \frac{CPI_1}{S_1} \right)^{1-\frac{p}{n}} \left( \frac{CPI_2}{S_2} \right)^{\frac{p}{n}} \right],$$

where:  $CPI_1$  is the last available fixing,  $CPI_2$  is the CPI of the first pillar of the curve,  $S_p$  is the Seasonality adjustment for month  $p$ ,  $S_1$  is the Seasonality factor for left pillar month,  $S_2$  is the Seasonality factor for right pillar month,  $p$  Number of months from the fixing date  $p$  to  $CPI_1$  pillar,  $n$  Number of months between  $CPI_1$  and  $CPI_2$  curve pillars .

Similarly, for obtaining CPI on a date  $T$  after the last pillar of the curve  $n$  (i.e. where there is no right pillar and therefore interpolation as described above cannot be done), the expected behaviour is to use the last information available and do an extrapolation in time i.e. for pillar  $p > \text{last pillar}$  (30Y in the case of EUR HICPxT, USD CPI and FR CPI and 50Y in the case of UK RPI). The extrapolation formula will be the same as the interpolation except where  $CPI_1 < CPI_2 < CPI_p$  for  $p > n$ .

$$CPI_p = S_p \left[ \left( \frac{CPI_1}{S_1} \right)^{1 - \frac{p}{n}} \left( \frac{CPI_2}{S_2} \right)^{\frac{p}{n}} \right],$$

where:  $CPI_1$  is the CPI before the last CPI of the curve,  $CPI_2$  is the last CPI of the curve,  $S_p$  is the Seasonality adjustment for month  $p$ ,  $S_1$  is the Seasonality factor for left pillar month,  $S_2$  is the Seasonality factor for right pillar month,  $p$  Number of months from the fixing date  $p$  to  $CPI_1$  pillar,  $n$  Number of months between  $CPI_1$  and  $CPI_2$  curve pillars.

## Chapter 4

# Appendix

### 4.1 Initial Margin Curve Assignment

#### 4.1.1 Scope

The following initial margin rate and inflation curves are in scope:

- AUD BBSW (AUD :STD)
- CAD CDOR (CAD :STD)
- CHF LIBOR (CHF :STD)
- CZK PRIBOR (CZK: STD)
- DKK CIBOR (DKK: STD)
- EUR EURIBOR (EUR :STD)
- GBP LIBOR (GBP :STD)
- HKD HIBOR (HKD: STD)
- HUF BUBOR (HUF: STD)
- JPY LIBOR (JPY: STD)
- MXN THE (MXN :STD)
- NOK NIBOR (NOK :STD)
- NZD BBR (NZD :STD)
- PLN WIBOR (PLN :STD)
- SEK STIBOR (SEK :STD)
- SGD SOR (SGD :STD)
- USD LIBOR (USD :STD)
- ZAR JIBAR (ZAR: STD)

- CAD CORRA
- CHF TOIS
- EUR EONIA
- GBP SONIA
- JPY TONA
- USD FEDFUND
- FR ZERO CPI XT NR IM
- GB ZERO RPI AI 2M IM
- HICP ZERO CPI XT NR - IM
- US ZERO CPI AI NSA IM

Note that the above rate curves are used for deriving the expected forward rates and the discounting of future cashflows.

#### 4.1.2 Rate Curve Constituents

##### AUD BBSW (AUD:STD)

Priorities:

Priority	Instrument	Generator
1	Short Future	SFE BAB 90D
2	Swap	AUD BBSW Q 3M
3	Swap	AUD BBSW S 6M
4	Deposit	CASH

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	O/N	6M
Short Future	SFE BAB 90D	...	...
Swap	AUD BBSW Q 3M	2Y	3Y
Swap	AUD BBSW S 6M	4Y	40Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

##### CAD CDOR (CAD:STD)

Priorities:

Priority	Instrument	Generator
1	Short Future	ME CDOR 3M
2	Swap	CAD CDOR S 3M CMP
3	Deposit	CAD DEPOSIT

Zero coupon rate curve constituents:



Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CAD DEPOSIT	O/N	6M
Short Future	ME CDOR 3M	...	...
Swap	CAD CDOR S 3M CMP	2Y	30Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

### **CHF LIBOR (CHF:STD)**

Priorities:

Priority	Instrument	Generator
1	Short Future	LIFFE EURCHF 3M
2	Swap	CHF LIBOR A 6M
3	Deposit	CASH

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	O/N	6M
Short Future	LIFFE EURCHF 3M	...	...
Swap	CHF LIBOR A 6M	2Y	40Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

### **CZK PRIBOR (CZK:STD)**

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	FRA	FRA 3M
3	Swap	CZK PRIBOR A 6M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	O/N	3M
FRA	FRA 3M	...	...
Swap	CZK PRIBOR A 6M	2Y	30Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

### **DKK CIBOR (DKK:STD)**

Priorities:

Priority	Instrument	Generator
1	Short Future	CSE CIBOR FRA 3M
2	Swap	DKK CIBOR A 6M
3	Deposit	CASH

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	O/N	6M
Short Future	CSE CIBOR FRA 3M	...	...
Swap	DKK CIBOR A 6M	2Y	30Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

### EUR EURIBOR (EUR:STD)

Priorities:

Priority	Instrument	Generator
1	Short Future	LIFFE EURIBOR 3M
2	Swap	EURIBOR A 6M
3	Deposit	CASH

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	O/N	6M
Short Future	LIFFE EURIBOR 3M	...	...
Swap	EURIBOR A 6M	4Y	60Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

### GBP LIBOR (GBP:STD)

Priorities:

Priority	Instrument	Generator
1	Short Future	LIFFE EURGBP 3M
2	Swap	GBP LIBOR S 6M
3	Deposit	CASH

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	O/N	6M
Short Future	LIFFE EURGBP 3M	...	...
Swap	GBP LIBOR S 6M	3Y	60Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

### HKD HIBOR (HKD:STD)

Priorities:

Priority	Instrument	Generator
1	Swap	HKD HIBOR Q 3M
2	Deposit	CASH

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	O/N	6M
Swap	HKD HIBOR Q 3M	1Y	15Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

## HUF BUBOR (HUF:STD)

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	FRA	FRA 3M
3	Swap	HUF BUBOR A 6M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	O/N	3M
FRA	FRA 3M	...	...
Swap	HUF BUBOR A 6M	2Y	20Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

## JPY LIBOR (JPY:STD)

Priorities:

Priority	Instrument	Generator
1	Swap	JPY LIBOR S 6M
2	Deposit	CASH
3	Deposit	JPY DEPOSIT (LIBOR)

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	O/N	6M
Swap	JPY LIBOR S 6M	1Y	40Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

## MXN TIIE (MXN:STD)

Priorities:

Priority	Instrument	Generator
1	Swap	MXN TIIE 28D

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Swap	MXN TIIE 28D	28D	10920D

See REP00078 for a detailed breakdown of zero coupon rate curve constituents

## NOK NIBOR (NOK:STD)

Priorities:

Priority	Instrument	Generator
1	Short Future	OMX NIBOR FRA 3M
2	Swap	NOK NIBOR A 6M
3	Deposit	CASH

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	O/N	6M
Short Future	OMX NIBOR FRA 3M	...	...
Swap	NOK NIBOR A 6M	2Y	30Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

### **NZD BBR (NZD:STD)**

Priorities:

Priority	Instrument	Generator
1	Swap	NZD BKBM S 3M
2	Deposit	CASH

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	O/N	6M
Swap	NZD BKBM S 3M	1Y	20Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

### **PLN WIBOR (PLN:STD)**

Priorities:

Priority	Instrument	Generator
1	FRA	FRA 3M
2	Swap	PLN WIBOR A 6M
3	Deposit	CASH

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	O/N	3M
FRA	FRA 3M	...	...
Swap	PLN WIBOR A 6M	2Y	30Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

### **SEK STIBOR (SEK:STD)**

Priorities:

Priority	Instrument	Generator
1	Short Future	OMX STIBOR FRA 3M
2	Swap	SEK STIBOR A 3M
3	Deposit	CASH

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	O/N	6M
Short Future	OMX STIBOR FRA 3M	...	...
Swap	SEK STIBOR A 3M	3Y	30Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

### **SGD SOR (SGD:STD)**

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	Swap	SGD SOR S 6M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	O/N	6M
Swap	SGD SOR S 6M	1Y	40Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

### **USD LIBOR (USD:STD)**

Priorities:

Priority	Instrument	Generator
1	Short Future	CME EURUSD 3M
2	Swap	USD LIBOR A 3M
3	Deposit	CASH

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	O/N	6M
Short Future	CME EURUSD 3M	...	...
Swap	USD LIBOR A 3M	4Y	60Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

### **ZAR JIBAR (ZAR:STD)**

Priorities:

Priority	Instrument	Generator
1	FRA	FRA 3M
2	Swap	ZAR JIBAR Q 3M
3	Deposit	CASH

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	O/N	3M
FRA	FRA 3M	...	...
Swap	ZAR JIBAR Q 3M	2Y	30Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

## AUD AONIA

Priorities:

Priority	Instrument	Generator
1	Swap	AUD AONIA Q 3M
2	Deposit	AUD DEP A/365

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	AUD DEP A/365	O/N	2Y
Swap	AUD AONIA Q 3M	3Y	40Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

## CAD CORRA

Priorities:

Priority	Instrument	Generator
1	Deposit	OIS
2	Swap	CAD CORRA S 6M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	OIS	O/N	1Y
Swap	CAD CORRA S 6M	18M	30Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

## CHF TOIS

Priorities:

Priority	Instrument	Generator
1	Deposit	OIS

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	OIS	O/N	40Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

## EUR EONIA

Priorities:

Priority	Instrument	Generator
1	Swap	EUR EONIA A 3M
2	Deposit	OIS

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	OIS	O/N	2Y
Swap	EUR EONIA A 3M	3Y	60Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

## GBP SONIA

Priorities:

Priority	Instrument	Generator
1	Swap	GBP SONIA S 6M
2	Deposit	OIS

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	OIS	O/N	2Y
Swap	GBP SONIA S 6M	3Y	60Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

## JPY TONA

Priorities:

Priority	Instrument	Generator
1	Deposit	OIS

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	OIS	O/N	40Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

## USD FEDFUND

Priorities:

Priority	Instrument	Generator
1	Swap	USD FEDFUND A 3M
2	Deposit	OIS

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	OIS	O/N	2Y
Swap	USD FEDFUND A 3M	3Y	60Y

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

## FR ZERO CPI XT NR IM

Priorities:

Priority	Instrument	Generator
1	Linear Inflation Swap	FR CPI ZC

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Linear Inflation Swap	FR CPI ZC	1Y	30Y

See REP00134 for a detailed breakdown of zero coupon rate curve constituents.

## GB ZERO RPI AI 2M IM

Priorities:

Priority	Instrument	Generator
1	Piecewise Inflation Swap	GB RPI ZC

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Piecewise Inflation Swap	GB RPI ZC	1Y	50Y

See REP00134 for a detailed breakdown of zero coupon rate curve constituents.

## HICP ZERO CPI XT NR - IM

Priorities:

Priority	Instrument	Generator
1	Piecewise Inflation Swap	HICP ZC

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Piecewise Inflation Swap	HICP ZC	1Y	30Y

See REP00134 for a detailed breakdown of zero coupon rate curve constituents.

## US ZERO CPI AI NSA IM

Priorities:

Priority	Instrument	Generator
1	Linear Inflation Swap	US CPI ZC

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Linear Inflation Swap	US CPI ZC	1Y	30Y

See REP00134 for a detailed breakdown of zero coupon rate curve constituents.

Note that the expiry dates of the swaps in the above curves only relate to the current build of the curve, and should not be used to determine clearing eligibility.

## 4.2 Variation Margin Curve Assignment

### 4.2.1 Scope: Single Currency Basis Adjusted Rate Curves

The following variation margin rate curves are in scope for SwapClear Refresh:

- AUD BBSW 1M
- AUD BBSW 3M
- AUD BBSW 6M



- CAD CDOR 1M
- CAD CDOR 3M
- CZK PRIBOR 3M
- CZK PRIBOR 6M
- DKK CIBOR 3M
- DKK CIBOR 6M
- CHF LIBOR 1M
- CHF LIBOR 3M
- CHF LIBOR 6M
- CHF LIBOR 12M
- EUR EURIBOR 1M
- EUR EURIBOR 3M
- EUR EURIBOR 6M
- EUR EURIBOR 12M
- GBP LIBOR 1M
- GBP LIBOR 3M
- GBP LIBOR 6M
- GBP LIBOR 12M
- HKD HIBOR 3M
- HKD HIBOR 6M
- HUF BUBOR 3M
- HUF BUBOR 6M
- JPY LIBOR 1M
- JPY LIBOR 3M
- JPY LIBOR 6M
- MXN THE 28D
- NOK NIBOR 3M
- NOK NIBOR 6M
- PLN WIBOR 3M
- PLN WIBOR 6M

- SEK STIBOR 3M
- SEK STIBOR 6M
- SGD SOR 3M
- SGD SOR 6M
- USD LIBOR 1M
- USD LIBOR 3M
- USD LIBOR 6M
- USD LIBOR 12M
- FR CPI XT NR
- GB RPI AI 2M
- HICP CPI XT NR
- US CPI AI NSA

Note that the above rate curves are used for deriving the expected forward rates only. Future cashflows are discounted using their respective overnight index rate curves (see section 4.2.4 for details).

LCH SwapClear Risk Management will at their discretion amend the currencies for single currency basis and overnight index swap discounting as liquidity becomes available.

#### 4.2.2 Rate Curve Constituents: Single Currency Basis Adjusted Rate Curves

##### AUD BBSW 1M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	Swap	AUD BBSW Q 1M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	1M	...
Swap	AUD BBSW Q 1M	3M	40Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### AUD BBSW 3M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	Short Future	SFE BAB 90D
3	Swap	AUD BBSW Q 3M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	3M	...
Short Future	SFE BAB 90D	...	...
Swap	AUD BBSW Q 3M	2Y	40Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### AUD BBSW 6M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	Swap	AUD BBSW S 6M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	6M	...
Swap	AUD BBSW S 6M	1Y	40Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### CAD CDOR 1M

Priorities:

Priority	Instrument	Generator
1	Swap	CAD CDOR S 1M CMP
2	Deposit	CASH

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	1M	...
Swap	CAD CDOR S 1M CMP	2M	30Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### **CAD CDOR 3M**

Priorities:

Priority	Instrument	Generator
1	FUT	ME CDOR 3M
2	Swap	CAD CDOR S 3M CMP
3	Deposit	CASH

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	3M	...
FUT	ME CDOR 3M	...	...
Swap	CAD CDOR S 3M CMP	2Y	30Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### **CZK PRIBOR 3M**

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	Swap	CZK PRIBOR A 3M
3	FRA	CZK 3M PRIBOR

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	3M	...
FRA	CZK 3M PRIBOR	...	...
Swap	CZK PRIBOR A 3M	2Y	30Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### **CZK PRIBOR 6M**

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	FRA	CZK 6M PRIBOR
3	Swap	CZK PRIBOR A 6M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	6M	...
FRA	CZK 6M PRIBOR	...	...
Swap	CZK PRIBOR A 6M	2Y	30Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### CHF LIBOR 1M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	Swap	CHF LIBOR A 1M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	1M	...
Swap	CHF LIBOR A 1M	3M	30Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### CHF LIBOR 3M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	Short Future	LIFFE EURCHF 3M
3	Swap	CHF LIBOR A 3M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	3M	...
Short Future	LIFFE EURCHF 3M	...	...
Swap	CHF LIBOR A 3M	2Y	40Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### CHF LIBOR 6M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	FRA	CHF 6M LIBOR
3	Swap	CHF LIBOR A 6M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	6M	...
FRA	CHF 6M LIBOR	...	...
Swap	CHF LIBOR A 6M	2Y	40Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### CHF LIBOR 12M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH 12M
2	Swap	CHF LIBOR A 1Y

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH 12M	12M	...
Swap	CHF LIBOR A 1Y	2Y	40Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### DKK CIBOR 3M

Priorities:

Priority	Instrument	Generator
1	Short Future	CSE CIBOR FRA 3M
2	Deposit	CASH
3	Swap	DKK CIBOR A 3M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	3M	...
Short Future	CSE CIBOR FRA 3M	...	...
Swap	DKK CIBOR A 3M	2Y	30Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### DKK CIBOR 6M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	Swap	DKK CIBOR A 6M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	6M	...
Swap	DKK CIBOR A 6M	1Y	30Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

## EUR EURIBOR 1M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH 1M
2	Swap	EURIBOR A 1M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH 1M	1M	...
Swap	EURIBOR A 1M	2M	60Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

## EUR EURIBOR 3M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	Short Future	LIFFE EURIBOR 3M
3	Swap	EURIBOR A 3M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	3M	...
Short Future	LIFFE EURIBOR 3M	...	...
Swap	EURIBOR A 3M	4Y	60Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

## EUR EURIBOR 6M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	FRA	EUR 6M EURIBOR
3	Swap	EUR EURIBOR A 6M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH 6M	6M	...
FRA	EUR 6M EURIBOR	...	...
Swap	EURIBOR A 6M	2Y	60Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

## EUR EURIBOR 12M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH 12M
2	Swap	EURIBOR A 1Y
3	FRA	EUR 1Y EURIBOR

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	12M	...
FRA	EUR 1Y EURIBOR	...	...
Swap	EURIBOR A 1Y	2Y	60Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

## GBP LIBOR 1M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	Swap	GBP LIBOR A 1M
3	Swap	GBP LIBOR S 1M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH 1M	1M	...
Swap	GBP LIBOR A 1M	2M	1Y
Swap	GBP LIBOR S 1M	2Y	60Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

## GBP LIBOR 3M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	Short Future	LIFFE EURGBP 3M
3	Swap	GBP LIBOR S 3M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH 3M	3M	...
Short Future	LIFFE EURGBP 3M	...	...
Swap	GBP LIBOR S 3M	3Y	60Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.



### GBP LIBOR 6M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	FRA	GBP 6M LIBOR
3	Swap	GBP LIBOR S 6M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH 6M	6M	...
FRA	GBP 6M LIBOR	...	...
Swap	GBP LIBOR S 6M	2Y	60Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### GBP LIBOR 12M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH 12M
2	Swap	GBP LIBOR S 1Y
3	FRA	GBP 1Y LIBOR

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH 12M	12M	...
FRA	GBP 1Y LIBOR	...	...
Swap	GBP LIBOR S 1Y	2Y	60Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### HKD HIBOR 3M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH 3M
2	Swap	HKD HIBOR Q 3M
3	FRA	HKD 3M HIBOR

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH 3M	3M	...
FRA	HKD 3M HIBOR	...	...
Swap	HKD HIBOR Q 3M	2Y	15Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### HKD HIBOR 6M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	Swap	HKD HIBOR Q 6M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH 6M	6M	...
Swap	HKD HIBOR Q 6M	1Y	15Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### HUF BUBOR 3M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	Swap	HUF BUBOR A 3M
3	FRA	HUF 3M BUBOR

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	3M	...
FRA	HUF 3M BUBOR	...	...
Swap	HUF BUBOR A 3M	2Y	20Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### HUF BUBOR 6M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	Swap	HUF BUBOR A 6M
3	FRA	HUF 6M BUBOR

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	6M	...
FRA	HUF 6M BUBOR	...	...
Swap	HUF BUBOR A 6M	2Y	20Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### JPY LIBOR 1M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	Swap	JPY LIBOR A 1M
3	Swap	JPY LIBOR S 1M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH 1M	3M	...
Swap	JPY LIBOR A 1M	2M	1Y
Swap	JPY LIBOR S 1M	2Y	40Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### JPY LIBOR 3M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	FRA	JPY 3M LIBOR
3	Swap	JPY LIBOR S 3M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH 3M	3M	...
FRA	JPY 3M LIBOR	...	...
Swap	JPY LIBOR S 3M	2Y	40Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### JPY LIBOR 6M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	FRA	JPY 6M LIBOR
3	Swap	JPY LIBOR S 6M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH 6M	6M	...
FRA	JPY 6M LIBOR	...	...
Swap	JPY LIBOR S 6M	2Y	40Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### **MXN TIE (MXN:STD)**

Priorities:

Priority	Instrument	Generator
1	Deposit	MXN DEPOSIT
2	Swap	MXN TIE 28D

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	MXN DEPOSIT	28D	...
Swap	MXN TIE 28D	84D	10920D

See REP00078 for a detailed breakdown of zero coupon rate curve constituents

### **NOK NIBOR 3M**

Priorities:

Priority	Instrument	Generator
1	Short Future	OMX NIBOR FRA 3M
2	Deposit	CASH
3	Swap	NOK NIBOR A 3M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	3M	...
Short Future	OMX NIBOR FRA 3M	...	...
Swap	NOK NIBOR A 3M	2Y	30Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### **NOK NIBOR 6M**

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	Swap	NOK NIBOR A 6M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	6M	...
Swap	NOK NIBOR A 6M	1Y	30Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### PLN WIBOR 3M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	Swap	PLN WIBOR A 3M
3	FRA	PLN 3M WIBOR

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	3M	...
FRA	PLN 3M WIBOR	...	...
Swap	PLN WIBOR A 3M	2Y	30Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### PLN WIBOR 6M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	Swap	PLN WIBOR A 6M
3	FRA	PLN 6M WIBOR

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	6M	...
FRA	PLN 6M WIBOR	...	...
Swap	PLN WIBOR A 6M	2Y	30Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### SEK STIBOR 3M

Priorities:

Priority	Instrument	Generator
1	Short Future	OMX STIBOR FRA 3M
2	Deposit	CASH
3	Swap	SEK STIBOR A 3M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	3M	...
Short Future	OMX STIBOR FRA 3M	...	...
Swap	SEK STIBOR A 3M	3Y	30Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### SEK STIBOR 6M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	Swap	SEK STIBOR A 6M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH	6M	...
Swap	SEK STIBOR A 6M	1Y	30Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### SGD SOR 3M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH 3M
2	Swap	SGD SOR S 3M
3	FRA	SGD 3M SOR

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH 3M	3M	...
FRA	SGD 3M SOR	...	...
Swap	SGD SOR S 3M	2Y	40Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### SGD SOR 6M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH 6M
2	Swap	SGD SOR S 6M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH 6M	6M	...
Swap	SGD SOR S 6M	1Y	40Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

## USD LIBOR 1M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	Swap	USD LIBOR A 1M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH 1M	1M	...
Swap	USD LIBOR A 1M	2M	60Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

## USD LIBOR 3M

Priorities:

Priority	Instrument	Generator
1	Short Future	CME EURUSD 3M
2	Deposit	CASH
3	Swap	USD LIBOR A 3M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH 3M	3M	...
Short Future	CME EURUSD 3M	...	...
Swap	USD LIBOR A 3M	4Y	60Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

## USD LIBOR 6M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH
2	FRA	USD 6M LIBOR
3	Swap	USD LIBOR A 6M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH 6M	6M	...
FRA	USD 6M LIBOR	...	...
Swap	USD LIBOR A 6M	1Y	60Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

## USD LIBOR 12M

Priorities:

Priority	Instrument	Generator
1	Deposit	CASH 12M
2	Swap	USD LIBOR A 1Y
3	FRA	USD 1Y LIBOR

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	CASH 12M	12M	...
FRA	USD 1Y LIBOR	...	...
Swap	USD LIBOR A 1Y	2Y	60Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

## 4.2.3 Scope: Zero Coupon Inflation Indexed Swap Curves FR CPI XT NR

Priorities:

Priority	Instrument	Generator
1	Piecewise Inflation Swap	FR CPI ZC PW
2	Linear Inflation Swap	FR CPI ZC

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Piecewise Inflation Swap	FR CPI ZC PW	3M	24M
Linear Inflation Swap	FR CPI ZC	3Y	30Y

See REP00135 for a detailed breakdown of zero coupon rate curve constituents.

## GB RPI AI 2M

Priorities:

Priority	Instrument	Generator
1	Piecewise Inflation Swap	GB RPI ZC

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Piecewise Inflation Swap	GB RPI ZC	3M	50Y

See REP00135 for a detailed breakdown of zero coupon rate curve constituents.



## HICP CPI XT NR

Priorities:

Priority	Instrument	Generator
1	Piecewise Inflation Swap	HICP ZC

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Piecewise Inflation Swap	HICP ZC	4M	30Y

See REP00135 for a detailed breakdown of zero coupon rate curve constituents.

## US CPI AI NSA

Priorities:

Priority	Instrument	Generator
1	Piecewise Inflation Swap	US CPI ZC PW
2	Linear Inflation Swap	US CPI ZC

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Piecewise Inflation Swap	US CPI ZC PW	3M	24M
Linear Inflation Swap	US CPI ZC	3Y	30Y

See REP00135 for a detailed breakdown of zero coupon rate curve constituents.

### 4.2.4 Scope: Overnight Index Rate Curves

The following variation margin rate curves are in scope for SwapClear Refresh:

- AUD AONIA
- CAD CORRA
- CHF TOIS
- EUR EONIA
- GBP SONIA
- JPY TONA
- USD FEDFUND

Note that the above rate curves are used for deriving the expected forward rates and the discounting of future cashflows for overnight index swaps. All the above curves are used for the discounting of single currency basis adjusted cashflows.

## 4.2.5 Rate Curve Constituents: Overnight Index Rate Curves

### AUD AONIA

Priorities:

Priority	Instrument	Generator
1	Swap	AUD AONIA Q 3M
2	Deposit	AUD DEP A/365

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	AUD DEP A/365	O/N	2Y
Swap	AUD AONIA Q 3M	3Y	40Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### CAD CORRA

Priorities:

Priority	Instrument	Generator
1	Deposit	OIS
2	Swap	CAD CORRA S 6M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	OIS	O/N	1Y
Swap	CAD CORRA S 6M	18M	30Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### CHF TOIS

Priorities:

Priority	Instrument	Generator
1	Deposit	OIS

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	OIS	O/N	40Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### EUR EONIA

Priorities:

Priority	Instrument	Generator
1	Swap	EUR EONIA A 3M
2	Deposit	OIS

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	OIS	O/N	2Y
Swap	EUR EONIA A 3M	3Y	60Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

## GBP SONIA

Priorities:

Priority	Instrument	Generator
1	Swap	GBP SONIA S 6M
2	Deposit	OIS

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	OIS	O/N	2Y
Swap	GBP SONIA S 6M	3Y	60Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

## JPY TONA

Priorities:

Priority	Instrument	Generator
1	Deposit	OIS

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	OIS	O/N	40Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

## USD FEDFUND

Priorities:

Priority	Instrument	Generator
1	Swap	USD FEDFUND A 3M
2	Deposit	OIS

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
Deposit	OIS	O/N	2Y
Swap	USD FEDFUND A 3M	3Y	60Y

See REP00099 for a detailed breakdown of zero coupon rate curve constituents.

### 4.2.6 Scope: Other Discounting Rate Curves

The following are variation margin discounting rate curves for the markets where OIS swap are not available:

- MXN USDMXNBASIS

Note that the above rate curve is used for the discounting of the future cashflows for MXN TIE swaps.

## MXN USDMXNBASIS

Priorities:

Priority	Instrument	Generator
1	FX Swap points	USD/MXN
2	Basis swap	MXN-USD 28D-1M

Zero coupon rate curve constituents:

Instrument	Generator	Expiry (First)	Expiry (Last)
FX Swap points	USD/MXN	O/N	18M
Basis swap	MXN-USD 28D-1M	728D	10920D

See REP00078 for a detailed breakdown of zero coupon rate curve constituents.

### 4.2.7 Scope: Other Rate Curves

The following variation margin rate curves are in scope for SwapClear Refresh:

- AUD BBSW (AUD :STD)
- CAD CDOR (CAD :STD)
- CHF LIBOR (CHF :STD)
- CZK PRIBOR (CZK :STD)
- DKK CIBOR (DKK: STD)
- EUR EURIBOR (EUR :STD)
- GBP LIBOR (GBP :STD)
- HKD HIBOR (HKD: STD)
- HUF BUBOR (HUF: STD)
- JPY LIBOR (JPY: STD)
- NOK NIBOR (NOK :STD)
- NZD BBR (NZD :STD)
- PLN WIBOR (PLN :STD)
- SEK STIBOR (SEK :STD)
- SGD SOR (SGD :STD)
- USD LIBOR (USD :STD)
- ZAR JIBAR (ZAR: STD)

Note that the above rate curves are used for deriving the expected forward rates and the discounting of future cashflows.

See section 4.1.2 for a summary of the rate curve constituents.

### 4.2.8 Natural Cubic Spline interpolation

Natural Cubic Spline interpolation is a piecewise interpolation between  $N$  known knot points on the zero yield curve. The interpolant used is the log of discount factor (i.e. rate\* time).

If the zero curve is considered as a set of  $N$  knot points,  $\{z_i, t_i\}, \forall i \in \{1, \dots, N\}$ , then to estimate zero rates between the knot points,  $N - 1$  third degree polynomials are defined as below.

Definition of the polynomial:

$$f_i(t) = a_i + b_i(t - T_i) + c_i(t - T_i)^2 + d_i(t - T_i)^3, \forall i \in \{1, \dots, N\}, T_i \leq t \leq T_{i+1} \quad (4.1)$$

Each polynomial satisfies conditions of smoothness and continuity, where  $a_i, b_i, c_i$  and  $d_i$  are estimated using the following conditions:

$$f_i(T_i) = z_i, f_{N-1}(T_N) = z_N, \forall i \in \{1, \dots, N - 1\} \quad (4.2)$$

$$f_i(T_{i+1}) = f_{i+1}(T_{i+1}), \forall i \in \{1, \dots, N - 2\} \quad (4.3)$$

$$f'_i(T_{i+1}) = f'_{i+1}(T_{i+1}), \forall i \in \{1, \dots, N - 2\} \quad (4.4)$$

$$f''_i(T_{i+1}) = f''_{i+1}(T_{i+1}), \forall i \in \{1, \dots, N - 2\} \quad (4.5)$$

$$f''_1(T_1) = f''_{N-1}(T_N) = 0 \quad (4.6)$$

## 4.3 SwapClear Grid Points on Initial Margin Curves

The SwapClear Initial Margin IRS and OIS Curves are interpolated to a fixed grid. The predefined grid points are currency dependent. Initial Margin IRS Curve grid points are defined as below:

Pillar	Days	AUD	CAD	CHF	CZK	DKK	EUR	GBP	HKD	HUF	JPY	MXN	NOK	NZD	PLN	SEK	SGD	USD	ZAR
O/N	1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
1W	7	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
1M	30	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
2M	60	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
3M	91	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
6M	182	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
9M	273	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
1Y	365	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
18M	547	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
2Y	730	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
3Y	1095	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
4Y	1460	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
5Y	1825	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
6Y	2190	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
7Y	2555	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
8Y	2920	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
9Y	3285	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
10Y	3650	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
12Y	4380	x	x	x	x	x	x	x		x	x	x	x	x	x	x		x	x
15Y	5475	x	x	x	x	x	x	x		x	x	x	x	x	x	x		x	x
20Y	7300	x	x	x	x	x	x	x		x	x	x	x	x	x	x		x	x
25Y	9125	x	x	x	x	x	x	x		x	x		x		x	x		x	x
30Y	10950	x	x	x	x	x	x	x		x	x		x		x	x		x	x
40Y	14600						x	x			x							x	
50Y	18250						x	x										x	
60Y	21900						x	x											

Initial Margin OIS Curve grid points are defined as below:

Pillar	Days	AUD AONIA	CAD CORRA	CHF TOIS	EUR EONIA	GBP SONIA	JPY TONA	USD Fed Fund
O/N	1	x	x	x	x	x	x	x
1W	7	x	x	x	x	x	x	x
2W	14	x	x	x	x	x	x	x
3W	21	x	x	x	x	x	x	x
1M	30	x	x	x	x	x	x	x
2M	60	x	x	x	x	x	x	x
3M	91	x	x	x	x	x	x	x
4M	121	x	x	x	x	x	x	x
5M	152	x	x	x	x	x	x	x
6M	182	x	x	x	x	x	x	x
7M	212	x	x	x	x	x	x	x
8M	243	x	x	x	x	x	x	x
9M	273	x	x	x	x	x	x	x
10M	304	x	x	x	x	x	x	x
11M	334	x	x	x	x	x	x	x
1Y	365	x	x	x	x	x	x	x
15M	456	x	x	x	x	x	x	
18M	547	x	x	x	x	x	x	x
21M	638	x	x	x	x	x	x	
2Y	730	x	x	x	x	x	x	x
3Y	1095	x	x	x	x	x	x	x
4Y	1460	x	x	x	x	x	x	x
5Y	1825	x	x	x	x	x	x	x
6Y	2190			x	x	x	x	x
7Y	2555			x	x	x	x	x
8Y	2920			x	x	x	x	x
9Y	3285			x	x	x	x	x
10Y	3650			x	x	x	x	x
12Y	4380			x	x	x	x	x
15Y	5475			x	x	x	x	x
20Y	7300			x	x	x	x	x
25Y	9125			x	x	x	x	x
30Y	10950			x	x	x	x	x
40Y	14600			x	x	x	x	x
50Y	18250			x	x	x	x	x
60Y	21900					x		

Note that the expiry dates of the swaps in the above curves only relate to the current build of the curve, and should not be used to determine clearing eligibility.

Initial Margin Inflation Curve grid points are defined as below (Please note that for inflation curves, the pillars are floating and not fixed grid). :

Pillar	FR ZERO CPI XT NR - IM	GB ZERO RPI AI 2M - IM	HICP ZERO CPI XT NR - IM	US ZERO CPI AI NSA - IM
1Y	x	x	x	x
2Y	x	x	x	x
3Y	x	x	x	x
4Y	x	x	x	x
5Y	x	x	x	x
6Y	x	x	x	x
7Y	x	x	x	x
8Y	x	x	x	x
9Y	x	x	x	x
10Y	x	x	x	x
12Y	x	x	x	x
15Y	x	x	x	x
20Y	x	x	x	x
25Y	x	x	x	x
30Y	x	x	x	x
40Y		x		
50Y		x		

Note that the expiry dates of the swaps in the above curves only relate to the current build of the curve, and should not be used to determine clearing eligibility.

## 4.4 Convexity Adjustment

SwapClear apply the Hull White( One-Factor) model to internally calculate the futures convexity adjustment for all the contracts required.

Using the model, the following formula is derived to calculate the convexity adjustment:

$$f_{conv}(T_i^S, T_i^E) = \left(1 - e^{-Z(T_i^S, T_i^E)}\right) \left(R(T_i^S, T_i^E) + 1/\tau(T_i^S, T_i^E)\right) \quad (4.7)$$

where  $R(T_i^S, T_i^E)$  is the observable future rate,  $\tau(T_i^S, T_i^E)$  is the time factor between the start and the end of the future period and functions  $Z$  is defined below:

$$Z(T_i^S, T_i^E) = \frac{\sigma^2}{2a} \cdot B(T_i^S, T_i^E) \cdot \left[B(T_i^S, T_i^E) \cdot (1 - e^{2a \cdot T_i^S}) + a \cdot B^2(t_0, T_i^E)\right] \quad (4.8)$$

where

$$B(T_i^S, T_i^E) = \frac{1 - e^{-a \cdot (T_i^E - T_i^S)}}{a} \quad (4.9)$$

$a$  and  $\sigma$  are constants described as:

- $a$  is a mean reversion rate, set up to 0.03 and
- $\sigma$  is an implied volatility

Adjusted future rate then looks like:

$$R'(T_i^S, T_i^E) = R(T_i^S, T_i^E) - f_{conv}(T_i^S, T_i^E) \quad (4.10)$$