ForexClear
Liquidity Risk Margin: LRM
(FX Spots, Forwards and Options)

Methodology Document

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1. Purpose

This document is a technical information specification for ForexClear's *Liquidity Risk Margin* ("*LRM*") add-on. This document provides full details of the *LRM* methodology, specifically focused on G10 FX FX spot, forward, and option contracts.

2. Overview

ForexClear provides an inter-bank foreign exchange clearing service for FX options ("FXOs") and associated FX spot and forward hedges (collectively referred to as the "FXO service").

ForexClear collects Initial Margin ("IM") from each member to cover the potential losses arising from a member's portfolio over a specified close-out period under prevailing market conditions. It represents the potential market risk on any open position. It is called regularly throughout the day and is used to cover an estimate of the worst probable potential future losses in the event of default of a clearing house member, given normal market conditions.

IM measures are based on closing out portfolios within a market's trading capacity. However should a position be very large and beyond the normal market capacity, additional measures are required to deal with this liquidity risk. The LRM represents an additional margin that is called due to portfolio liquidity risk that could materially increase the costs incurred in resolving a default management process.

LRM for FX spot, forward, and option contracts will be calculated independently from the LRM for NDF contracts. This document focuses solely on the calculation of the LRM for spot, forward, and option contracts.

3. Default Management Context

In a default management process, the defaulted member's portfolio is liquidated through hedging and then an auction procedure.

LRM covers the potential incremental cost of hedging large/concentrated positions within the defaulter's portfolio or alternatively, the risk that hedging a position may take longer than five days to close out.

Hedging is performed as soon as a default is announced in order to minimise losses incurred on the defaulter's portfolio. The FXO Default Management Group ("DMG") and LCH.Clearnet will hedge the largest risk in the book in appropriate order, focusing on outright delta risk, gamma risk and vega risk followed by secondary risk such as second order volatility risk and interest rate risk.

By the end of the hedging phase, the underlying currency pair positions must be adequately hedged to ensure that levels of risk are sufficiently reduced to encourage member participation in auctions without requiring significant risk premia. Once a currency pair portfolio is adequately hedged, it will be put to auction during the relevant liquid hours for that currency.

4. Product Scope

In addition to its existing NDF clearing service, ForexClear will clear FX Spots, Forwards and FX Options OTC contracts for the following currency pairs:

- AUD/USD (Australian Dollar vs US Dollar)
- EUR/CHF (Euro vs Swiss Franc)
- EUR/GBP (Euro vs British Pound)
- EUR/JPY (Euro vs Japanese Yen)
- EUR/USD (Euro vs US Dollar)
- GBP/USD (British Pound vs US Dollar)
- USD/CHF (US Dollar vs Swiss Franc)
- USD/JPY (US Dollar vs Japanese Yen).

The tables below outline the product scope for the cleared contracts.

Table 1 - Eligibility Criteria for FX Options

Category	Definition
Product	LCH Deliverable FX Options (single leg or package)
Option Style	European Vanilla
Underlying Asset	Eligible LCH Spot
Expiry Range	Minimum: 1 business day Maximum: 2 years
Cut Times	New York: 10:00 (local time) Tokyo: 15:00 (local time)

Table 2 - Eligibility Criteria for FX Spots/Forwards

Category	Definition
Product	LCH Spot or Forward (single leg or package)
Tenor Range	Minimum: Spot Maximum: 2 years
Settlement	Physical delivery via CLS

Table 3 - FX Options and Spot/Forward Product Conventions

Category	EUR /USD	EUR /CHF	EUR /GBP	EUR /JPY	GBP /USD	AUD /USD	USD /CHF	USD /JPY
Base currency	EUR	EUR	EUR	EUR	GBP	AUD	USD	USD
Term currency	USD	CHF	GBP	JPY	USD	USD	CHF	JPY
Quote basis	Term per Base							
Pip size	0.0001	0.0001	0.0001	0.01	0.0001	0.0001	0.0001	0.01
Spot	T+2	T+2	T+2	T+2	T+2	T+2	T+2	T+2
Bus day calendars	TE, FD	TE, SZ	TE, GB	TE, JN	GB, FD	AU, FD	FD, SZ	FD, JN
Prem-included delta	No	Yes	Yes	Yes	No	No	Yes	Yes
Option premium ccy	Base or Term currency							
Option premium date	Spot or Forward							
ATM vol convention	*Expiry less than 10 years*: Delta-neutral straddle							
Delta convention	*Expiry less than 2 years*: Spot delta *Expiry 2 years or more*: Forward delta							

5. Methodology Description

5.1 Overview

The Liquidity Risk Margin (LRM) is an additional margin add-on. This liquidity margin is considered as the potential incremental execution cost incurred during the default management process.

The first step to compute this LRM is to isolate the FX Spot, Forwards and Options contracts. We then calculate the LRM for these contracts as:

$$LRM = \text{LRM\_Delta} + \text{LRM\_Gamma} + \text{LRM\_Vega} + \text{LRM\_Rega} + \text{LRM\_Sega}$$

Where LRM_ Delta, Gamma, Vega, Rega and Sega represent the hedge transaction cost of each risk in the portfolio.

Note that all references to 'spreads' in this document refer to bid-to-mid (or alternatively ask-to-mid) spreads.

5.2 Methodology

The *LRM Hedge Transaction Cost ("LRM")* is calculated for each currency pair and is levied to simulate the cost of hedging a portfolio's exposure during the default management process. Given that the underlying option contracts are purely vanilla, there exists a perfect hedging strategy to reduce the risk to zero, namely, unwinding each position at a trade level. However, such a hedging strategy would not only be time consuming but would also incur very large spreads.

We therefore calculate the LRM based on a hedging strategy which involves less trades on the more liquid parts of the volatility surface, whilst still substantially reducing the exposure of the portfolio to potential mark-to-market losses before auctioning the portfolio.

Gamma, Vega, Rega and Sega exposures

The following hedging strategies are explicitly accounted for in the LRM methodology as follows:

- Gamma – hedging of short-dated vega (ie. under 1W) using ATM options;
- Vega – hedging of vega longer-dated (ie. beyond 1W) using ATM options;
- Rega – hedging of rega (the sensitivity of the portfolio to a 0.1% change in risk reversal) using 25-delta risk reversals; and
- Sega – hedging of sega (the sensitivity of the portfolio to a 0.1% change in the butterfly) using 25-delta butterflies.

As highlighted above, the cost of vega hedging is separated into two components: the cost of hedging vega out to 1 week, and the cost of hedging vega from 1 week onwards. This is undertaken so that we always account for the cost of hedging local gamma separate from the overall portfolio vega.

The cost associated with the volatility hedging strategies is a function of the bid/ask spread for the ATM, 25-delta risk reversal, and 25-delta butterfly by tenor. These bid/ask spreads are sourced from member price submissions.

Where a portfolio's vega (short-dated or longer-dated considered independently), rega or sega at a currency pair level exceed specified minimum thresholds (to be defined by the ForexClear DMG), position multipliers will be applied which are dependent on the magnitude of the individual risk sensitivities. Separate position multiplier grids will be used to account for each of the four risk metrics listed above. The application of position multipliers takes into account liquidity issues arising from executing increasingly larger volatility trades in the market.

Offsetting positions across different tenors are conservatively accounted for by ignoring tenor sensitivities having a different sign to the portfolio total.

One may argue that the LRM should factor in the cost of hedging the 10-delta smile sensitivities specifically; however, we note that the relationship between the 25-delta and the 10-delta risk reversals (and butterflies) is quite stable (particularly for the currency pairs within scope). Therefore the cost of hedging the total smile exposure (i.e. the sum of the 25-delta and 10-delta sensitivities) using 25-delta instruments gives a reasonable approximation.

Delta exposures

Given the size and liquidity of the FX market, there is significant capacity in the market to execute spot or forward trades for delta hedging purposes. Executing a large spot or forward trade even in stressed market conditions would not be expected to incur a materially large slippage cost (e.g. spot slippage is typically 10bp, whilst forward slippage is typically 1bp). Although we would expect bid/ask spreads to widen marginally with increased trade size, we expect delta would be readily hedged within 24 hours, leaving considerable buffer in the 5-day margin calculation to cover spot execution costs.

However, to ensure that excessive delta exposures are accounted for, ForexClear will apply IM multipliers to reflect the potential additional time required for transacting delta hedges that exceed specific thresholds. Where a portfolio's delta at a currency pair level (each currency pair being assessed independently) exceed specified minimum thresholds, IM multipliers will be applied which are dependent on the magnitude of delta risk.

ForexClear will survey the DMG on a quarterly basis to assess the relevant delta thresholds that can be hedged within a 24 hour period, and IM multipliers will be calibrated to reflect the potential increase in time required to hedge any large exposure.

5.2.1 Calculation Formulae

Each member's portfolio LRM is calculated as follows:

$$LRM = \sum_{Ccy\ Pair} \text{LRM\_Delta}_{\text{Ccy Pair}} + \sum_{Ccy\ Pair} \text{LRM\_Gamma}_{\text{Ccy Pair}} + \sum_{Ccy\ Pair} \text{LRM\_Vega}_{\text{Ccy Pair}} + \sum_{Ccy\ Pair} \text{LRM\_Rega}_{\text{Ccy Pair}} + \sum_{Ccy\ Pair} \text{LRM\_Sega}_{\text{Ccy Pair}}$$

where,

$$\text{LRM\_Delta}_{\text{Ccy Pair}} = \text{IM}_{\text{Ccy Pair}} \times (\text{DeltaIMM}_{\text{CcyPair}} - 1)$$

$$\text{LRM\_Gamma}_{\text{Ccy Pair}} = -\left|\text{Vega}_{\text{CcyPair,1wk}}\right| \times \text{ATMSpread}_{\text{CcyPair,1wk}} \times \text{GammaPosAdj}_{\text{CcyPair}}$$

$$\text{LRM\_Vega}_{\text{Ccy Pair}} =$$

$$\begin{cases} \sum_{\substack{\text{Vega}>0 \\ \text{Tenor}>1wk}} -\left|\text{Vega}_{\text{CcyPair,Tenor}}\right| \times \text{ATMSpread}_{\text{CcyPair,Tenor}} \times \text{VegaPosAdj}_{\text{CcyPair}} & , \text{ if } \text{Vega}_{\text{CcyPair}}^{\text{Tenor}>1wk} > 0 \\ \sum_{\substack{\text{Vega}\leq 0 \\ \text{Tenor}>1wk}} -\left|\text{Vega}_{\text{CcyPair,Tenor}}\right| \times \text{ATMSpread}_{\text{CcyPair,Tenor}} \times \text{VegaPosAdj}_{\text{CcyPair}} & , \text{ if } \text{Vega}_{\text{CcyPair}}^{\text{tenor}>1wk} \leq 0 \end{cases}$$

$$\text{LRM\_Rega}_{\text{Ccy Pair}} =$$

$$\begin{cases} \sum_{\text{Tenor}} -\left|\text{Rega}_{\text{CcyPair,Tenor}}\right| \times \text{RegaSpread}_{\text{CcyPair,Tenor}} \times \text{RegaPosAdj}_{\text{CcyPair}} \times 10 & , \text{ if } \text{Rega}_{\text{CcyPair}} > 0 \\ \sum_{\text{Tenor}} -\left|\text{Rega}_{\text{CcyPair,Tenor}}\right| \times \text{RegaSpread}_{\text{CcyPair,Tenor}} \times \text{RegaPosAdj}_{\text{CcyPair}} \times 10 & , \text{ if } \text{Rega}_{\text{CcyPair}} \leq 0 \end{cases}$$

$$\text{LRM\_Sega}_{\text{Ccy Pair}} =$$

$$\begin{cases} \sum_{\text{Tenor}} -\left|\text{Sega}_{\text{CcyPair,Tenor}}\right| \times \text{SegaSpread}_{\text{CcyPair,Tenor}} \times \text{SegaPosAdj}_{\text{CcyPair}} \times 10 & , \text{ if } \text{Sega}_{\text{CcyPair}} > 0 \\ \sum_{\text{Tenor}} -\left|\text{Sega}_{\text{CcyPair,Tenor}}\right| \times \text{SegaSpread}_{\text{CcyPair,Tenor}} \times \text{SegaPosAdj}_{\text{CcyPair}} \times 10 & , \text{ if } \text{Sega}_{\text{CcyPair}} \leq 0 \end{cases}$$

and,

$\text{IM}_{\text{Ccy Pair}}$ = IM for a given currency pair portfolio (expressed as a negative value, ie. liability)

$\text{DeltaIMM}_{\text{CcyPair}}$ = multiplier from Delta IMM Matrix to account for size of $\text{SpotDelta}_{\text{CcyPair}}$ and concentration of $\text{FwdDelta}_{\text{CcyPair,Tenor}}$

$\text{SpotDelta}_{\text{CcyPair}}$ = FX Spot delta for currency pair *CcyPair* (for a 1 unit shift in spot price, expressed in USD equivalent)

$\text{FwdDelta}_{\text{CcyPair.Tenor}}$ = FX Forward delta for currency pair *CcyPair* and Tenor

$\text{Vega}_{\text{CcyPair}}^{\text{Tenor}>1wk}$ = sum of the vega by tenor for currency pair *CcyPair* excluding tenors less than or equal to 1 week (for a 1% parallel shift in ATM vols, expressed in USD equivalent)

$\text{Rega}_{\text{CcyPair}}$ = sum of the rega by tenor for currency pair *CcyPair* (for a 0.1% change in the 25-delta and 10-delta risk reversals, expressed in USD equivalent)

$\text{Sega}_{\text{CcyPair}}$ = sum of the sega by tenor for currency pair *CcyPair* (for a 0.1% change in the 25-delta and 10-delta butterflies, expressed in USD equivalent)

$\text{Vega}_{\text{CcyPair,Tenor}}$ = vega for currency pair *CcyPair* and *Tenor* (for a 1% change in vol)

$\text{Rega}_{\text{CcyPair,Tenor}}$ = rega for currency pair *CcyPair* and *Tenor* (for a 0.1% change in vol)

$\text{Sega}_{\text{CcyPair,Tenor}}$ = sega for currency pair *CcyPair* and *Tenor* (for a 0.1% change in vol)

$\text{ATMSpread}_{\text{CcyPair,Tenor}}$ = spread from the ATM Spread Matrix for currency pair *CcyPair* and relevant *Tenor* (in vols)

$\text{RegaSpread}_{CcyPair,\text{Tenor}}$ = spread from Rega Spread Matrix for currency pair *CcyPair* and relevant *Tenor* (in vols)

$\text{SegaSpread}_{CcyPair,\text{Tenor}}$ = spread from Sega Spread Matrix for currency pair *CcyPair* and relevant *Tenor* (in vols)

$\text{VegaPosAdj}_{\text{CcyPair}}$ = multiplier to account for the size of $Vega_{CcyPair}^{Tenor>1wk}$

$\text{GammaPosAdj}_{\text{CcyPair}}$ = multiplier to account for the size of $Vega_{CcyPair,1week}$

$\text{RegaPosAdj}_{\text{CcyPair}}$ = multiplier to account for the size of $Rega_{CcyPair}$

$\text{SegaPosAdj}_{\text{CcyPair}}$ = multiplier to account for the size of $Sega_{CcyPair}$

5.2.2 Risk Sensitivities

Delta

Delta measures the sensitivity of the option/portfolio value to a change in the spot rate. Delta is calculated analytically as follows:

$$Call\ Delta = e^{-qT}N(d_1)$$

$$Put\ Delta = e^{-qT}(N(d_1) - 1)$$

where *N(.)* is the standard normal cumulative distribution function, and

$$d_1 = \frac{1}{\sigma\sqrt{T}}\left[ln\left(\frac{S}{K}\right) + \left(r - q + \frac{\sigma^2}{2}\right)T\right]$$

S = FX spot rate expressed as amount of domestic currency per 1 unit of foreign currency
K = option strike expressed as amount of domestic currency per 1 unit of foreign currency
r = domestic currency risk free interest rate
q = foreign currency risk free interest rate
T = time to option expiry

Gamma

Gamma measures the sensitivity of the option/portfolio delta to a change in the spot rate, ie. it is the second derivative of the option/portfolio value with respect to the spot rate. Gamma is calculated analytically as follows:

$$Gamma = \frac{e^{-qT}}{S\sigma\sqrt{T}} \times \frac{1}{\sqrt{2\pi}} e^{\frac{-d_1^2}{2}}$$

Vega

Vega measures the sensitivity of the option/portfolio value to a parallel shift in the implied volatility. Vega is calculated analytically as follows:

$$Vega = Se^{-qT} \times \frac{1}{\sqrt{2\pi}} e^{\frac{-d_1^2}{2}}$$

Rega

Rega measures the sensitivity of the option/portfolio value to a change in the risk reversal price.

In order to calculate the rega for a portfolio, we firstly compute the base valuation of the portfolio using ForexClear reference market data. The 25-delta and 10-delta risk-reversal quotes which are used to build the volatility surface are then bumped up by 0.1% and the portfolio revalued using the new volatility surface. The rega is then calculated as the value of the portfolio using the bumped surface minus the base value of the portfolio.

Sega

Sega measures the sensitivity of the option/portfolio value to a change in the butterfly price.

In order to calculate the sega for a portfolio, we firstly compute the base valuation of the portfolio using ForexClear reference market data. The 25-delta and 10-delta butterfly quotes which are used to build the volatility surface are then bumped up by 0.1% and the portfolio is revalued using the new volatility surface. The sega is then calculated as the value of the portfolio using the bumped surface minus the base value of the portfolio.

5.2.3 Member Sensitivity Matrix

A **Member Sensitivity Matrix** by currency pair and by tenor is calculated (expressed in USD equivalent) in order to identify which tenors should be included in the LRM calculation for each currency pair. Table 4 below shows an example Member Sensitivity Matrix for a single currency pair (EUR/USD).

Table 4 – Member Sensitivity Matrix (single currency pair example only)

Tenor	Delta ($'000s)	Vega ($'000s)	Rega ($'000s)	Sega ($'000s)
Spot	**5,500,000**			
1W	1,000000	-350	0	-5
1M	**1,500,000**	-144	4	21
2M	-500,000	-58	-6	20
3M	600,000	-451	26	-54
6M	390,000	-641	57	113
9M	700,000	-427	-11	71
1Y	550,000	374	59	331
18M	500,000	-5	1	1
2Y	350,000	57	0	-0
TOTAL		**-1,645**	**130**	**498**

Using the Member Sensitivity Matrix above, we identify the following:

- $\boldsymbol{SpotDelta_{CcyPair}}$ for this currency pair (ie. $5,500,000,000)

- The largest absolute $\boldsymbol{FwdDelta_{CcyPair,Tenor}}$ and corresponding tenor for this currency pair (ie. $1,500,000,000 at 1M tenor)
- $\boldsymbol{Vega_{CcyPair,1wk}}$ for this currency pair (ie. -$350,000)
- $\boldsymbol{Vega_{CcyPair}^{Tenor>1wk}}$ for this currency pair (ie. -$1,645,000 + $350,000 = -$1,295,000)
- $\boldsymbol{Rega_{CcyPair}}$ for this currency pair (ie. $130,000)
- $\boldsymbol{Sega_{CcyPair}}$ for this currency pair (ie. $498,000)

And then, for the volatility sensitivities, identify the tenors having the same directional sensitivity as the Total:

- Relevant $\boldsymbol{Vega}_{\boldsymbol{CcyPair,Tenor}}$ for this currency pair are highlighted in green above (where the relevant Total vega in this case is $Vega_{CcyPair}^{Tenor>1wk}$)
- Relevant $\boldsymbol{Rega}_{\boldsymbol{CcyPair,Tenor}}$ for this currency pair are highlighted in purple above
- Relevant $\boldsymbol{Sega}_{\boldsymbol{CcyPair,Tenor}}$ for this currency pair are highlighted in orange above

5.2.4 Delta IMM Matrix

Relevant IM multipliers with respect to delta exposures are obtained from a **Delta IMM Matrix** produced by ForexClear and reviewed by the DMG and LCH.Clearnet 2nd line risk on a quarterly basis.

We assume that for portfolios with large delta's (of the order of magnitude of the size of the delta that can be executed in a day's trading), the IM requirement would be entirely driven by the delta. The IM multiplier takes into account the extra amount of time it could take to exit the delta, assuming the IM grows at sqrt(T).

Table 5 below shows an example Delta IMM Matrix.

Table 5 – Delta IMM Matrix (for example purposes only)

Spot Delta Multipliers				
(USD m eq)	**5000**	**10,000**	**15,000**	**20,000**
1W	1.00	1.09	1.18	1.26
1M	1.00	1.09	1.18	1.26
2M	1.00	1.09	1.18	1.26
3M	1.00	1.09	1.18	1.26
6M	1.00	1.09	1.18	1.26
9M	1.00	1.09	1.18	1.26
1Y	1.00	1.09	1.18	1.26
18M	1.00	1.09	1.18	1.26
2Y	1.00	1.09	1.18	1.26

The appropriate Delta IMM multiplier is determined for each currency pair as follows:

- The relevant *Tenor* row corresponds to the tenor represented by the largest absolute bucketed forward delta $FwdDelta_{CcyPair,Tenor}$.

- If $|SpotDelta_{CcyPair}|$ is below the first size tier, then $DeltaIMM_{CcyPair}$ is equal to the first multiplier corresponding to the relevant tenor.
- If $|SpotDelta_{CcyPair}|$ is above the last size tier, then $DeltaIMM_{CcyPair}$ is equal to the last multiplier corresponding to the relevant tenor.
- Otherwise $DeltaIMM_{CcyPair}$ is linearly interpolated using the neighbouring size tiers on the corresponding tenor row to 4 decimal places.
- $DeltaIMM$: The Delta IMM is calibrated using a root-time approach based on a quarterly survey of the DMG, where the following questions will be asked:

Please provide your views on the amount of delta (in local currency millions) that can be traded with 24 hours under stress market conditions.

5.2.5 Volatility Spread Matrices

ATM Spread Matrix

Relevant ATM volatility spreads are obtained from an **ATM Spread Matrix** produced by ForexClear on a quarterly basis using member submitted quotes and reviewed by the DMG and LCH.Clearnet 2nd line risk.

The ATM volatility spread quarterly results will represent the average ATM volatility spread per maturity bucket per currency observed during the previous quarter.

The ATM volatility spread for a given currency pair and tenor in the matrix is calculated as follows:

$$ATM\ Spread = (\frac{Volatility_{Ask,ATM} - Volatility_{Bid,ATM}}{2})$$

Table 6 below shows an example ATM Spread Matrix.

Table 6 - ATM Spread Matrix (for example purposes only):

	Implied Volatility Spread – ATM (in vols)							
Tenor	**EUR/USD**	**USD/JPY**	**EUR/JPY**	**AUD/USD**	**GBP/USD**	**USD/CHF**	**EUR/CHF**	**EUR/GBP**
1W	0.50	0.65	0.70	0.50	0.50	0.75	1.25	0.70
1M	0.20	0.20	0.35	0.25	0.25	0.30	0.70	0.30
2M	0.20	0.20	0.35	0.25	0.20	0.30	0.60	0.25
3M	0.15	0.20	0.35	0.25	0.20	0.30	0.55	0.25
6M	0.15	0.15	0.30	0.25	0.20	0.30	0.45	0.20
9M	0.15	0.15	0.30	0.25	0.20	0.25	0.45	0.20
1Y	0.15	0.15	0.30	0.25	0.20	0.25	0.45	0.20
18M	0.15	0.15	0.30	0.25	0.20	0.25	0.45	0.20
2Y	0.15	0.15	0.30	0.25	0.20	0.25	0.45	0.20

For each $Vega_{CcyPair,Tenor}$, the appropriate $ATMSpread_{\boldsymbol{CcyPair,Tenor}}$ is taken from the ATM Spread Matrix (eg. based on the EUR/USD example in Table 4, the relevant spreads are highlighted in green in Table 6 above).

Rega Spread Matrix

Relevant rega volatility spreads are obtained from a **Rega Spread Matrix** produced by ForexClear on a quarterly basis using member submitted quotes and reviewed by the DMG and LCH.Clearnet 2nd line risk.

The rega volatility spread quarterly results will represent the average spread on 25-delta risk-reversal quotes submitted by members per tenor, per currency, during the previous quarter. The 25-delta quotes are used due to the fact that the ratio between the risk reversals on different deltas typically remains stable over time and the most liquid and most likely delta for hedging rega is typically on the 25-delta.

The rega volatility spread for a given currency pair and tenor in the matrix is calculated as follows:

$$Rega\ Spread = \left(\frac{Volatility_{Ask,25-RR} - Volatility_{Bid,25-RR}}{2}\right)$$

Table 7 below shows an example Rega Spread Matrix:

Table 7 – Rega Spread Matrix (for example purposes only)

	Implied Volatility Spread - 25 Risk Reversals (in vols)							
Tenor	**EUR/USD**	**USD/JPY**	**EUR/JPY**	**AUD/USD**	**GBP/USD**	**USD/CHF**	**EUR/CHF**	**EUR/GBP**
1W	0.35	0.20	0.25	0.40	0.30	0.50	0.45	0.50
1M	0.15	0.15	0.25	0.15	0.15	0.25	0.40	0.20
2M	0.10	0.15	0.25	0.20	0.15	0.25	0.40	0.20
3M	0.10	0.15	0.25	0.20	0.15	0.25	0.35	0.20
6M	0.10	0.10	0.20	0.15	0.15	0.20	0.30	0.20
9M	0.10	0.10	0.20	0.15	0.15	0.20	0.30	0.20
1Y	0.10	0.10	0.20	0.15	0.15	0.20	0.30	0.20
18M	0.10	0.10	0.20	0.20	0.15	0.20	0.30	0.20
2Y	0.10	0.10	0.20	0.20	0.15	0.20	0.30	0.20

For each $Rega_{CcyPair,Tenor}$, the appropriate $\boldsymbol{RegaSpread_{CcyPair,Tenor}}$ is taken from the Rega Spread Matrix (eg. Based on the EUR/USD example in Table 4, the relevant spreads are highlighted in purple in Table 7 above).

Sega Spread Matrix

Relevant sega volatility spreads are obtained from a **Sega Spread Matrix** produced quarterly by ForexClear using member submitted quotes and reviewed by the DMG and LCH.Clearnet 2nd line risk.

The sega volatility spread quarterly results will represent the average spread on 25-delta butterfly quotes submitted by members per tenor, per currency, during the previous quarter. The 25-delta quotes are used due to the fact that the ratio between the butterflies on different deltas typically remains stable over time and the most liquid and most likely delta for hedging sega is typically on the 25-delta.

The sega volatility spread for a given currency pair and tenor in the matrix is calculated as follows:

$$Sega\ Spread = \left(\frac{Volatility_{Ask,25-FLY} - Volatility_{Bid,25-FLY}}{2}\right)$$

Table 8 below shows an example Sega Spread Matrix:

Table 8 – Sega Spread Matrix (for example purposes only)

	Implied Volatility Spread – 25 Flys (in vols)							
Tenor	**EUR/USD**	**USD/JPY**	**EUR/JPY**	**AUD/USD**	**GBP/USD**	**USD/CHF**	**EUR/CHF**	**EUR/GBP**
1W	0.25	0.25	0.35	0.30	0.25	0.40	0.60	0.40
1M	0.10	0.10	0.20	0.15	0.10	0.15	0.35	0.15
2M	0.10	0.10	0.20	0.15	0.10	0.15	0.30	0.15
3M	0.10	0.10	0.15	0.15	0.10	0.15	0.30	0.15
6M	0.10	0.10	0.15	0.10	0.10	0.15	0.30	0.15
9M	0.10	0.10	0.15	0.10	0.10	0.15	0.30	0.10
1Y	0.10	0.10	0.15	0.10	0.10	0.15	0.25	0.10
18M	0.10	0.10	0.15	0.10	0.10	0.15	0.20	0.10
2Y	0.10	0.10	0.15	0.10	0.10	0.15	0.20	0.10

For each $Sega_{CcyPair,Tenor}$, the appropriate $\boldsymbol{SegaSpread_{CcyPair,Tenor}}$ is taken from the Sega Spread Matrix (eg. Based on the EUR/USD example in Table 4, the relevant spreads are highlighted in orange in Table 8 above).

5.2.6 Position Adjustment Matrices

Gamma, vega, rega and sega concentrations are considered independently of each other for the purposes of calculating position adjustments.

Gamma Position Adjustment Matrix

Gamma Position Adjustment multipliers are obtained from a **Gamma Position Adjustment Matrix**. Table 9 – Gamma Position Adjustment Matrix (for example purposes only)Table 9 below shows an example Gamma Position Adjustment Matrix.

Table 9 – Gamma Position Adjustment Matrix (for example purposes only)

Vega (1 wk)	Vega 1wk Position Adjustment Multipliers							
(USD m eq)	**EUR/USD**	**USD/JPY**	**EUR/JPY**	**AUD/USD**	**GBP/USD**	**USD/CHF**	**EUR/CHF**	**EUR/GBP**
0.25	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.50	1.25	1.25	1.35	1.35	1.25	1.25	1.35	1.35
1.00	1.50	1.50	1.70	1.70	1.50	1.50	1.70	1.70
2.00	2.00	2.00	2.40	2.40	2.00	2.00	2.40	2.40

The appropriate Gamma Position Adjustment Multiplier is determined for each currency pair as follows:

- If $\left|Vega_{CcyPair,1wk}\right|$ is below the first size tier, then $GammaPosAdj_{CcyPair}$ is 1.00.
- If $\left|Vega_{CcyPair,1wk}\right|$ is above the last size tier, then $GammaPosAdj_{CcyPair}$ is equal to the last multiplier (e.g. 2.00 for EUR/USD)
- Otherwise $GammaPosAdj_{CcyPair}$ is linearly interpolated using the neighbouring pillar points of the $\left|Vega_{CcyPair,1week}\right|$ in the Gamma Position Adjustment Matrix to 4 decimal places (eg. for the EUR/USD example, $\left|Vega_{CcyPair,1week}\right|$ of $350,000 incurs a Gamma Position Adjustment Multiplier of 1.1000).

The Gamma Position Adjustment Matrix will be defined based on a quarterly survey of the DMG, where the following questions will be asked:

- *Please provide your views on the proportional increase in spread for trading 1 week ATM Vega for the sizes indicated under stress market conditions.*

Vega Position Adjustment Matrix

Vega Position Adjustment multipliers are obtained from a **Vega Position Adjustment Matrix**. Table 10 below shows an example Vega Position Adjustment Matrix.

Table 10 – Vega Position Adjustment Matrix (for example purposes only)

$Vega_{CcyPair}^{Tenor>1wk}$	Vega Position Adjustment Multipliers							
(USD m eq)	EUR/USD	USD/JPY	EUR/JPY	AUD/USD	GBP/USD	USD/CHF	EUR/CHF	EUR/GBP
1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	1.02	1.02	1.05	1.05	1.02	1.02	1.05	1.05
5	1.04	1.04	1.10	1.10	1.04	1.04	1.10	1.10
10	1.08	1.08	1.20	1.20	1.08	1.08	1.20	1.20

The appropriate Vega Position Adjustment Multiplier is determined for each currency pair as follows:

- If $\left|Vega_{CcyPair}^{Tenor>1wk}\right|$ is below the first size tier, then$VegaPosAdj_{CcyPair}$ is 1.00.
- If $\left|Vega_{CcyPair}^{Tenor>1wk}\right|$ is above the last size tier, then $VegaPosAdj_{CcyPair}$ is equal to the last multiplier (e.g. 2.00 for EUR/USD)
- Otherwise $VegaPosAdj_{CcyPair}$ is linearly interpolated using the neighbouring pillar points of the $\left|Vega_{CcyPair}^{Tenor>1wk}\right|$ in the Vega Position Adjustment Matrix to 4 decimal places (eg. for the EUR/USD example, $\left|Vega_{CcyPair}^{Tenor>1wk}\right|$ of $1,295,000 incurs a Vega Position Adjustment Multiplier of 1.0059).

The Vega Position Adjustment Matrix will be defined based on a quarterly survey of the DMG, where the following questions will be asked:

- *Please provide your views on the proportional increase in spread for trading ATM vega risk for the sizes indicated under stress market conditions.*

Rega Position Adjustment Matrix

Rega Position Adjustment multipliers are obtained from a **Rega Position Adjustment Matrix**. Table 11 below shows an example Rega Position Adjustment Matrix.

Table 11 – Rega Position Adjustment Matrix (for example purposes only)

	Rega Position Adjustment Multipliers							
Rega (USD m eq)	EUR/USD	USD/JPY	EUR/JPY	AUD/USD	GBP/USD	USD/CHF	EUR/CHF	EUR/GBP
0.1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.2	1.02	1.02	1.05	1.05	1.02	1.02	1.05	1.05
0.5	1.04	1.04	1.10	1.10	1.04	1.04	1.10	1.10
1.0	1.08	1.08	1.20	1.20	1.08	1.08	1.20	1.20

The appropriate Rega Position Adjustment multiplier is determined for each currency pair as follows:

1. If $\left|Rega_{CcyPair}\right|$ is below the first size tier, then $RegaPosAdj_{CcyPair}$ is 1.00.
2. If $\left|Rega_{CcyPair}\right|$ is above the last size tier, then $RegaPosAdj_{CcyPair}$ is equal to the last multiplier (e.g. 1.08 for EUR/USD).
3. Otherwise $RegaPosAdj_{CcyPair}$ is linearly interpolated using the neighbouring pillar points of the $\left|Rega_{CcyPair}\right|$ in the Rega Position Adjustment Matrix to 4 decimal places. (eg. for the EUR/USD example, $\left|Rega_{CcyPair}\right|$ of $165,000 incurs a Rega Position Adjustment Multiplier of 1.0130).

The Rega Position Adjustment Matrix will be defined based on a quarterly survey of the DMG, where the following questions will be asked:

- *Please provide your views on the proportional increase in 25-delta risk-reversal spread for trading rega risk for the sizes indicated under stress market conditions.*

Sega Position Adjustment Matrix

Sega Position Adjustment multipliers are obtained from a **Sega Position Adjustment Matrix**. Table 12 below shows an example Sega Position Adjustment Matrix.

Table 12 – Sega Position Adjustment Matrix (for example purposes only):

	Sega Position Adjustment Multipliers							
Sega (USD m eq)	**EUR/USD**	**USD/JPY**	**EUR/JPY**	**AUD/USD**	**GBP/USD**	**USD/CHF**	**EUR/CHF**	**EUR/GBP**
0.1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.2	1.02	1.02	1.05	1.05	1.02	1.02	1.05	1.05
0.5	1.04	1.04	1.10	1.10	1.04	1.04	1.10	1.10
1.0	1.08	1.08	1.20	1.20	1.08	1.08	1.20	1.20

The appropriate Sega Position Adjustment multiplier is determined for each currency pair as follows:

1. If $\left|Sega_{CcyPair}\right|$ is below the first size tier, then $SegaPosAdj_{CcyPair}$ is 1.00.
2. If $\left|Sega_{CcyPair}\right|$ is above the last size tier, then $SegaPosAdj_{CcyPair}$ is equal to the last multiplier (e.g. 1.08 for EUR/USD).
3. Otherwise $SegaPosAdj_{CcyPair}$ is linearly interpolated using the neighbouring pillar points of the $\left|Sega_{CcyPair}\right|$ in the Sega Position Adjustment Matrix to 4 decimal places. (eg. for the EUR/USD example, $\left|Sega_{CcyPair}\right|$ of $615,000 incurs a Sega Position Adjustment Multiplier of 1.0492).

The Sega Position Adjustment Matrix will be defined based on a quarterly survey of the DMG, where the following questions will be asked:

- *Please provide your views on the proportional increase in 25-delta butterfly spread for trading sega risk for the sizes indicated under stress market conditions.*

6. Data Requirements

Data Required	Data Source	Update Regularity	Description
Member Sensitivity Matrix	ForexClear	Every risk run Automatic	Summary of Delta, Vega, Rega and Sega sensitivities within portfolio per currency
Delta IMM Matrix	ForexClear (based on DMG survey)	Quarterly Manual	A grid with defined delta intervals and multipliers indicating the relevant IM multiplier by position size and tenor for each currency pair
ATM Spread Matrix	ForexClear	Quarterly Automatic	Implied volatility spread from the mid implied volatility to the Bid/Ask for each for an ATM Option on each tenor and currency pair
Rega Spread Matrix	ForexClear	Quarterly Automatic	Implied volatility spread from the mid implied volatility to the Bid/Ask for each for a 25-delta risk-reversal on each tenor and currency pair
Sega Spread Matrix	ForexClear	Quarterly Automatic	Implied volatility spread from the mid implied volatility to the Bid/Ask for each for a 25-delta butterfly on each tenor and currency pair
Gamma Position Adjustment Matrix	Survey of DMG	Quarterly Manual	A grid with defined vega (1 week) intervals and multipliers indicating the additional cost to execute a trade of that size for each currency pair
Vega Position Adjustment Matrix	Survey of DMG	Quarterly Manual	A grid with defined vega intervals and multipliers indicating the additional cost to execute a trade of that size and tenor for each currency pair
Rega Position Adjustment Matrix	Survey of DMG	Quarterly Manual	A grid with defined rega intervals and multipliers indicating the additional cost to execute a trade of that size and tenor for each currency pair
Sega Position Adjustment Matrix	Survey of DMG	Quarterly Manual	A grid with defined sega intervals and multipliers indicating the additional cost to execute a trade of that size and tenor for each currency pair

7. Example

This section provides an example of the LRM calculation based on a single currency calculation (EUR-USD example) portfolio and model parameters. All numbers used are for example purposes only.

Member Sensitivity Matrix:

Tenor	Delta ($'000s)	Vega ($'000s)	Rega ($'000s)	Sega ($'000s)
Spot	**5,500,000**			
1W	1,000000	-350	0	-5
1M	**1,500,000**	-144	4	21
2M	-500,000	-58	-6	20
3M	600,000	-451	26	-54
6M	390,000	-641	57	113
9M	700,000	-427	-11	71
1Y	550,000	374	59	331
18M	500,000	-5	1	1
2Y	350,000	57	0	-0
TOTAL		**-1,645**	**130**	**498**

Using the Member Sensitivity Matrix above, we identify the following:

- $\boldsymbol{SpotDelta_{CcyPair}}$ for this currency pair (ie. $5,500,000,000)
- The largest absolute forward delta ($\boldsymbol{FwdDelta_{CcyPair,Tenor}}$) and corresponding tenor for this currency pair (ie. $1,500,000 at 1M)
- $\boldsymbol{Vega_{CcyPair,1wk}}$ for this currency pair (ie. -$350,000)
- $\boldsymbol{Vega_{CcyPair}^{tenor>1wk}}$ for this currency pair (ie. -$1,645,000 + $350,000 = -$1,295,000)
- $\boldsymbol{Rega_{CcyPair}}$ for this currency pair (ie. $130,000)
- $\boldsymbol{Sega_{CcyPair}}$ for this currency pair (ie. $498,000)

And then identify the tenors having the same directional sensitivity as the Total:

- $\boldsymbol{Vega_{CcyPair,Tenor}}$ for this currency pair are highlighted in green above
- $\boldsymbol{Rega_{CcyPair,Tenor}}$ for this currency pair are highlighted in purple above
- $\boldsymbol{Sega_{CcyPair,Tenor}}$ for this currency pair are highlighted in orange above

Delta IMM Matrix for a given currency pair:

Spot Delta Multipliers				
(USD m eq)	**5,000**	**10,000**	**15,000**	**20,000**
1W	1.00	1.09	1.18	1.26
1M	1.00	1.09	1.18	1.26
2M	1.00	1.09	1.18	1.26
3M	1.00	1.09	1.18	1.26
6M	1.00	1.09	1.18	1.26
9M	1.00	1.09	1.18	1.26
1Y	1.00	1.09	1.18	1.26
18M	1.00	1.09	1.18	1.26
2Y	1.00	1.09	1.18	1.26

ATM Spread Matrix:

	Implied Volatility Spread – ATM (in vols)							
Tenor	**EUR/USD**	**USD/JPY**	**EUR/JPY**	**AUD/USD**	**GBP/USD**	**USD/CHF**	**EUR/CHF**	**EUR/GBP**
1W	0.50	0.65	0.70	0.50	0.50	0.75	1.25	0.70
1M	0.20	0.20	0.35	0.25	0.25	0.30	0.70	0.30
2M	0.20	0.20	0.35	0.25	0.20	0.30	0.60	0.25
3M	0.15	0.20	0.35	0.25	0.20	0.30	0.55	0.25
6M	0.15	0.15	0.30	0.25	0.20	0.30	0.45	0.20
9M	0.15	0.15	0.30	0.25	0.20	0.25	0.45	0.20
1Y	0.15	0.15	0.30	0.25	0.20	0.25	0.45	0.20
18M	0.15	0.15	0.30	0.25	0.20	0.25	0.45	0.20
2Y	0.15	0.15	0.30	0.25	0.20	0.25	0.45	0.20

ATM Volatility Spreads for each relevant vega tenor is shaded in green above.

Rega Spread Matrix:

	Implied Volatility Spread - 25 Risk Reversals (in vols)							
Tenor	**EUR/USD**	**USD/JPY**	**EUR/JPY**	**AUD/USD**	**GBP/USD**	**USD/CHF**	**EUR/CHF**	**EUR/GBP**
1W	0.35	0.20	0.25	0.40	0.30	0.50	0.45	0.50
1M	0.15	0.15	0.25	0.15	0.15	0.25	0.40	0.20
2M	0.10	0.15	0.25	0.20	0.15	0.25	0.40	0.20
3M	0.10	0.15	0.25	0.20	0.15	0.25	0.35	0.20
6M	0.10	0.10	0.20	0.15	0.15	0.20	0.30	0.20
9M	0.10	0.10	0.20	0.15	0.15	0.20	0.30	0.20
1Y	0.10	0.10	0.20	0.15	0.15	0.20	0.30	0.20
18M	0.10	0.10	0.20	0.20	0.15	0.20	0.30	0.20
2Y	0.10	0.10	0.20	0.20	0.15	0.20	0.30	0.20

Rega Spreads for each relevant rega tenor is shaded in purple above.

Sega Spread Matrix:

	Implied Volatility Spread – 25 Flys (in vols)							
Tenor	**EUR/USD**	**USD/JPY**	**EUR/JPY**	**AUD/USD**	**GBP/USD**	**USD/CHF**	**EUR/CHF**	**EUR/GBP**
1W	0.25	0.25	0.35	0.30	0.25	0.40	0.60	0.40
1M	0.10	0.10	0.20	0.15	0.10	0.15	0.35	0.15
2M	0.10	0.10	0.20	0.15	0.10	0.15	0.30	0.15
3M	0.10	0.10	0.15	0.15	0.10	0.15	0.30	0.15
6M	0.10	0.10	0.15	0.10	0.10	0.15	0.30	0.15
9M	0.10	0.10	0.15	0.10	0.10	0.15	0.30	0.10
1Y	0.10	0.10	0.15	0.10	0.10	0.15	0.25	0.10
18M	0.10	0.10	0.15	0.10	0.10	0.15	0.20	0.10
2Y	0.10	0.10	0.15	0.10	0.10	0.15	0.20	0.10

Sega Spreads for each relevant sega tenor is shaded in orange above.

Gamma Position Adjustment Matrix :

Vega 1wk	Vega 1wk Position Adjustment Multipliers							
(USD m eq)	EUR/USD	USD/JPY	EUR/JPY	AUD/USD	GBP/USD	USD/CHF	EUR/CHF	EUR/GBP
0.25	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.50	1.25	1.25	1.35	1.35	1.25	1.25	1.35	1.35
1.00	1.50	1.50	1.70	1.70	1.50	1.50	1.70	1.70
2.00	2.00	2.00	2.40	2.40	2.00	2.00	2.40	2.40

The **Gamma Position Adjustment** for the EUR/USD pair exposure is calculated as follows:

$$GammaPosAdj_{EUR-USD} = 1.00 + (1.25 - 1.00) \times \frac{350{,}000 - 250{,}000}{500{,}000 - 250{,}000} = 1.1000$$

Vega Position Adjustment Matrix:

Vega (>1wk)	Vega (>1wk) Position Adjustment Multipliers							
(USD m eq)	EUR/USD	USD/JPY	EUR/JPY	AUD/USD	GBP/USD	USD/CHF	EUR/CHF	EUR/GBP
1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	1.02	1.02	1.05	1.05	1.02	1.02	1.05	1.05
5	1.04	1.04	1.10	1.10	1.04	1.04	1.10	1.10
10	1.08	1.08	1.20	1.20	1.08	1.08	1.20	1.20

The **Vega Position Adjustment** for the EUR/USD pair exposure is calculated as follows:

$$VegaPosAdj_{EUR-USD} = 1.00 + (1.02 - 1.00) \times \frac{1{,}295{,}000 - 1{,}000{,}000}{2{,}000{,}000 - 1{,}000{,}000} = 1.0059$$

Rega Position Adjustment Matrix:

Rega	Rega Position Adjustment Multipliers							
(USD m eq)	EUR/USD	USD/JPY	EUR/JPY	AUD/USD	GBP/USD	USD/CHF	EUR/CHF	EUR/GBP
0.1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.2	1.02	1.02	1.05	1.05	1.02	1.02	1.05	1.05
0.5	1.04	1.04	1.10	1.10	1.04	1.04	1.10	1.10
1.0	1.08	1.08	1.20	1.20	1.08	1.08	1.20	1.20

The **Rega Position Adjustment** for the EUR/USD pair exposure is calculated as follows:

$$RegaPosAdj_{EUR-USD} = 1.00 + (1.02 - 1.00) \times \frac{130{,}384 - 100{,}000}{200{,}000 - 100{,}000} = 1.0061$$

Sega Position Adjustment Matrix:

Sega	Sega Position Adjustment Multipliers							
(USD m eq)	EUR/USD	USD/JPY	EUR/JPY	AUD/USD	GBP/USD	USD/CHF	EUR/CHF	EUR/GBP
0.1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.2	1.02	1.02	1.05	1.05	1.02	1.02	1.05	1.05
0.5	1.04	1.04	1.10	1.10	1.04	1.04	1.10	1.10
1.0	1.08	1.08	1.20	1.20	1.08	1.08	1.20	1.20

The **Sega Position Adjustment** for the EUR/USD pair exposure is calculated as follows:

$$SegaPosAdj_{EUR-USD} = 1.02 + (1.04 - 1.02) \times \frac{498{,}257 - 200{,}000}{500{,}000 - 200{,}000} = 1.0399$$

Calculations:

	Abs. Spot Delta ($'000s)	Largest abs. Fwd Delta	Delta Concentration	Delta IMM multiplier	Ccy Portfolio IM ($'000s)	LRM_Delta_Ccy ($'000s)
LRM Delta	5,500,000	1,500,000	1M	1.0090	-30,000	**-270**

Tenor	Vega ($'000s)	Vol. Spread	Conc. Adj.	LRM ($'000s)
1W	-350	0.50	1.1000	- 193
1M	-144	0.2	1.0059	-29
2M	-58	0.2	1.0059	-12
3M	-451	0.15	1.0059	-768
6M	-641	0.15	1.0059	-97
9M	-427	0.15	1.0059	-64
1Y				
18M	-5	0.15	1.0059	-1
2Y				
TOTAL LRM Gamma				**-193**
TOTAL LRM Vega				**-271**

Tenor	Rega ($'000s)	Vol. Slippage	Conc. Adj.	LRM Rega ($'000s)
1W	0	0.35	1.0061	-0
1M	4	0.15	1.0061	-6
2M				
3M	26	0.10	1.0061	-26
6M	57	0.10	1.0061	-57
9M				
1Y	59	0.10	1.0061	-59
18M	1	0.10	1.0061	-1
2Y	0	0.10	1.0061	-0
TOTAL LRM REGA				-150

Tenor	Sega ($'000s)	Vol. Slippage	Conc. Adj.	LRM Sega ($'000s)
1W				
1M	21	0.10	1.0399	-22
2M	20	0.10	1.0399	-21
3M				
6M	113	0.10	1.0399	-118
9M	71	0.10	1.0399	-74
1Y	331	0.10	1.0399	-344
18M	1	0.10	1.0399	-1
2Y				
TOTAL LRM SEGA				-579

The LRM charge for the EUR/USD currency pair is $1,463,000 ($270,000 + $193,000 + $271,000 + $150,000 + $579,000).