1. **FRTB internal model based approach** uses Expected shortfall metric to calculate regulatory market risk capital requirement for trading book.
2. **What are modellable risk factors ?**
   Answer: There is a risk factor eligibility test:
   https://www.bis.org/basel_framework/chapter/MAR/31.htm?inforce=20230101&published=20200605#paragraph_MAR_31_20230101_31_1

bis.org/basel_framework/chapter/MAR/31.htm?inforce=20230101&published=20200605#paragraph_MAR_31_20230101_31_1

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31.13

To pass the RFET, a risk factor that a bank uses in an internal model must meet either of the following criteria on a quarterly basis. Any real price that is observed for a transaction should be counted as an observation for all of the risk factors for which it is representative.

(1) The bank must identify for the risk factor at least 24 real price observations per year (measured over the period used to calibrate the current ES model, with no more than one real price observation per day to be included in this count).[2 3] Moreover, over the previous 12 months there must be no 90-day period in which fewer than four real price observations are identified for the risk factor (with no more than one real price observation per day to be included in this count). The above criteria must be monitored on a monthly basis; or

(2) The bank must identify for the risk factor at least 100 real price observations over the previous 12 months (with no more than one real price observation per day to be included in this count).

So if the bank has 100 real price observations over the previous 12 months then the risk factor passes the model lability test. The 2nd criteria above is dovish compared to criteria 1 and banks are most likely to choose criteria 2 for risk factor eligibility test.

3. **Frequency of ES calculations** -daily at 97.5% one tailed confidence with base horizon of 10 days
4. **What does Liquidity horizon mean** ?
   LH means on an average Bank can liquidate or hedge the risk factor in this many days. That's the reason highly liquid risk factors like rates and equities have lower LH.
5. **ES methodology**: ES is calculated based on a methodology where risk factors of portfolio are divided on liquidity horizons and ES is calculated by keeping lowest liquidity horizon risk factors constant and using scenarios for only higher LH risk factors. Base horizon is 10 days. So we get ES for each liquidity horizon and higher LH ES is scaled to actual LH for that risk factor using square root rule.
6. What are different applicable risk factors and their liquidity horizons:

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Liquidity horizon n by risk factor — Tabl

Risk factor category	n	Risk factor category	n
Interest rate: specified currencies - EUR, USD, GBP, AUD, JPY, SEK, CAD and domestic currency of a bank	10	Equity price (small cap): volatility	60
Interest rate: unspecified currencies	20	Equity: other types	60
Interest rate: volatility	60	Foreign exchange (FX) rate: specified currency pairs[1]	10
Interest rate: other types	60	FX rate: currency pairs	20
Credit spread: sovereign (investment grade, or IG)	20	FX: volatility	40
Credit spread: sovereign (high yield, or HY)	40	FX: other types	40
Credit spread: corporate (IG)	40	Energy and carbon emissions trading price	20
Credit spread: corporate (HY)	60	Precious metals and non-ferrous metals price	20
Credit spread: volatility	120	Other commodities price	60
Credit spread: other types	120	Energy and carbon emissions trading price: volatility	60
		Precious metals and non-ferrous metals price:	60

https://www.bis.org/basel_framework/chapter/MAR/33.htm?inforce=20230101&published=20200605

7. **Why Stressed ES is required**:
   Answer: ES must be calibrated to stressed period on which bank faced maximum losses. Risk factors applicable in historical stressed period period must be able to explain 75% of ES based on previous(current) risk factor scenarios. So $\frac{ES(Stressed)}{ES(Current)} > 75\%$
8. **There are many versions of ES required as below**. I had to calculate all below 12 ES

Sr. No	ES	Diversified ?	All Risk classes ?	Risk factors(Current or Stressed period) ?	Full Risk factors or Reduced ?
1	$ES_{F,C}$	Yes	All	Current	Full
2	$ES_{R,C}$	Yes	All	Current	Reduced
3	$ES_{R,S}$	Yes	All	Stressed	Reduced
4	$ES_{F,C}$	No	Equity	Current	Full
5	$ES_{R,C}$	No	Equity	Current	Reduced
6	$ES_{R,S}$	No	Equity	Stressed	Reduced
7	$ES_{F,C}$	No	Credit Spread	Current	Full
8	$ES_{R,C}$	No	Credit Spread	Current	Reduced

9	$ES_{R,S}$	No	Credit Spread	Stressed	Reduced
10	$ES_{F,C}$	No	Interest rates	Current	Full
11	$ES_{R,C}$	No	Interest rates	Current	Reduced
12	$ES_{R,S}$	No	Interest rates	Stressed	Reduced

If there are more risk classes in portfolio then more ES would be required.
ES formula below:

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(8) LH_j is the liquidity horizon j, with lengths in the following table:

Liquidity horizons, j

j	LH_j
1	10
2	20
3	40
4	60
5	120

$$ES = \sqrt{\left(ES_T(P)\right)^2 + \sum_{j\geq 2}\left(ES_T(P,j)\sqrt{\frac{\left(LH_j - LH_{j-1}\right)}{T}}\right)^2}$$

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9. Diversified ES formula: The circled ratio is floored to 1 so this cannot scale down ES.

$$ES = ES_{R,S} \times \frac{ES_{F,C}}{ES_{R,C}}$$

10. Final trading book regulatory capital requirement: Final capital is calculated from full portfolio ES and risk class specific ES. Full portfolio ES is diversified ES because it incorporates all correlations. Risk class specific ES is undiversified ES. So basically we need diversified ES undiversified ES . Half portion of capital comes from diversified ES and half from diversified i.e. $\rho = 0.5$

IMCC(C) = Diversified Internally modellable capital charge ES. This has to be calculated daily

IMCC(C_i) = Undiversified Internally modellable capital charge ES for broad risk classes. This can be calculated weekly. Ratio $\frac{IMCC(C)}{IMCC(All\ asset\ classes)}$ may not need to be calculated daily, so even a weekly calculation will do.

$$\rho = 0.5$$

$$IMCC = \rho\left(IMCC\left(C\right)\right) + \left(1-\rho\right)\left(\sum_{i=1}^{B} IMCC\left(C_i\right)\right)$$

$$where\ \ IMCC\left(C\right) = ES_{R,S}\frac{ES_{F,C}}{ES_{R,C}}\ \ and\ IMCC\left(C_i\right) = ES_{R,S,i}\frac{ES_{F,C,i}}{ES_{R,C,i}}$$

https://www.bis.org/basel_framework/chapter/MAR/33.htm?inforce=20230101&published=20200605