

FINANCIAL BENCHMARKS INDIA PVT LTD.

Methodology Document for FBIL Certificate of Deposit (CD) Curve

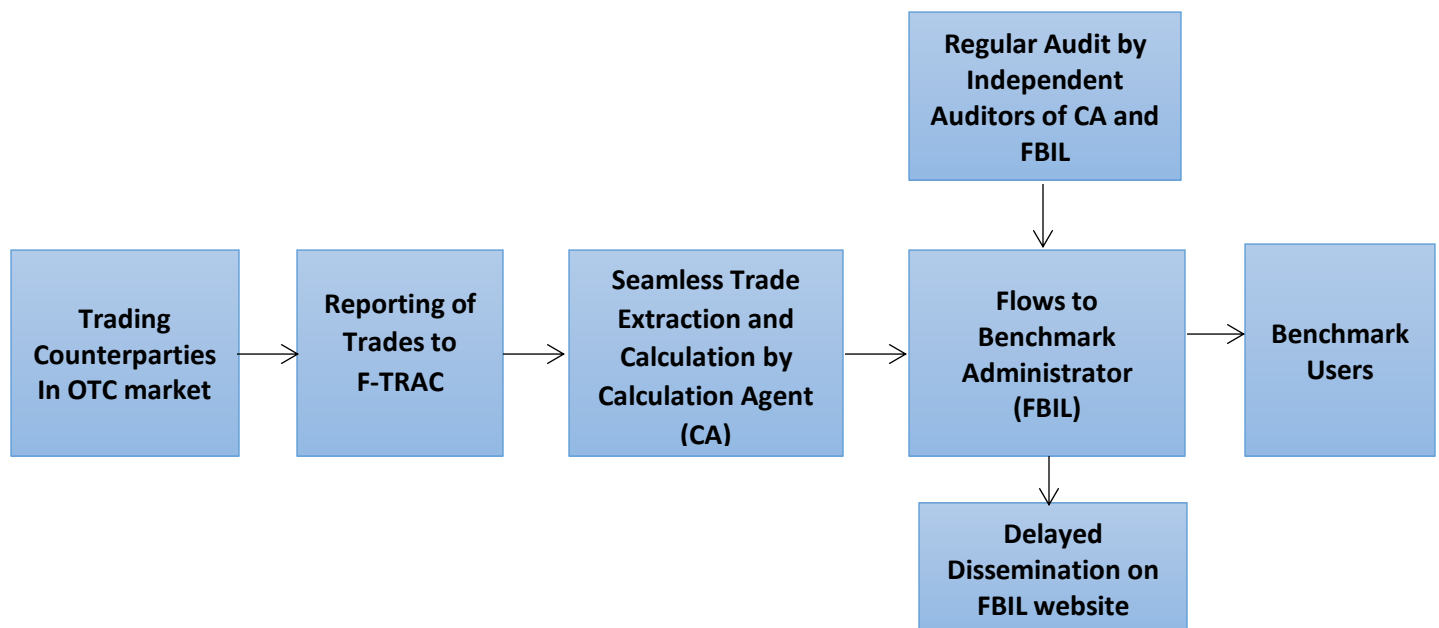
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Version 3

Overview

The FBIL Certificate of Deposit (CD) Curve is constructed with the discount yield / rates associated with key maturity tenor buckets of 14 days, 1 month, 2 months, 3 months, 6 months, 9 months and 12 months. These rates for the key maturity tenor buckets are computed from secondary market CD trades reported to CCIL's F-TRAC Trade Repository (TR) platform. Trades are classified into relevant key maturity tenor buckets based on residual maturity of the traded CD. The rates for key maturity tenor buckets are computed as weighted average rates based on three parameters: (a) distance (based on the absolute day difference between the given residual maturity and the key maturity tenor), (b) volume (based on the share of the number of trades for a given residual maturity in the total number of trades for the key maturity tenor bucket) and (c) amount (based on the share in the sum of the face value for the key maturity tenor bucket). Currently, the CD market lacks sufficient liquidity. Accordingly a fallback mechanism is put in place to compute rates across key maturity tenor buckets.

Structure



Key Features of the Calculation

- FBIL CD Curve (CDCURVE) is constructed based on secondary market CD trades reported to CCIL's F-TRAC TR platform, after such trades are executed in the OTC market.
- Trades reported upto 5:15 PM are taken into consideration.
- Trades with a residual maturity between 1 day to 365 days are used for computation.
- CDs with the highest credit rating are considered. In case the rating of the issue is not available the issuer rating from the database is considered.
- Liquidity checks are put in place such as a minimum traded value of `5 crore¹ per trade and minimum number of three (3) trades in each bucket.
- Trades are classified into key maturity tenor buckets based on their respective residual maturity.
- Key maturity tenor buckets are adjusted to account for the impact of the financial year-end turns (for the last day of March).
- Individual trades in the key maturity tenor buckets will be considered for outlier checks.
- For the purpose of detection of outliers, a two-stage rule is applied:
 - i. Outlier checks are put in place by eliminating individual trades beyond +/-3 standard deviations from the weighted average rate of trades for each respective key maturity tenor bucket.
 - ii. If any of the traded yields in that key maturity tenor bucket passes the first stage, as in (i) above, but is beyond +/-30 basis points from the previous day's published FBIL CD Curve rate for that key maturity tenor bucket, then it will also be excluded. This outlier detection methodology would be reviewed at regular frequency, taking into account all the major developments in the CD market.
- Value Weighted average rate is computed for each surviving traded residual maturity after removal of outlier.
- The CDCURVE rates are computed for the key maturity tenor buckets of 14 days, 1 month, 2 months, 3 months, 6 months, 9 months and 12 months from the surviving trades in each key maturity tenor bucket, provided there are at least 3 surviving trades post outlier elimination.
- CDCURVE rates are computed as a weighted average rate based on the parameters of:

¹ 1 Crore is 10 Million

- i. *Distance*, which is based on the absolute day difference between the residual maturity of security and the key maturity tenor. A value of 0.5 is assigned in case the residual maturity is equal to the key maturity tenor. This ensures higher weight is given to the trades whose residual maturity is closer to the key maturity tenor.
 - ii. *Volume*, which is based on the share of the number of trades in a given residual maturity within a key maturity tenor bucket to the total trades in that key maturity tenor bucket.
 - iii. *Amount*, which is based on the sum of the face value in a given residual maturity within a key maturity tenor bucket to the total face value in that key maturity tenor bucket.
- A fallback mechanism is triggered in case a key maturity benchmark tenor bucket does not fulfill the threshold criteria of minimum 3 surviving trades after outlier elimination.
 - Yields (Rates) are rounded off at every stage to 4 decimal places.

Step by Step Calculation Implemented in the System

Step 1: Consider secondary market transactions reported to F-TRAC TR platform after appropriate filtering by issuer type, rating and settlement date.

Step 2: Filter the transactions based on time (upto 5:15 PM), minimum traded value and applicable residual tenors. Arrange the trades based on residual tenors into various key maturity tenor buckets.

Step 3: Adjust the key maturity tenor buckets to account for the impact of the financial year end turn under various scenarios.

Step 4: Remove outlier trades after filtering each key maturity tenor bucket for a minimum of 3 trades.

Step 5: Check for a minimum of 3 surviving trades post outliers.

Step 6: Compute a Weighted Average Rate considering the parameters of Distance, Volume and Amount.

Step 7: Trigger fallback mechanism to calculate the CDCURVE rate for those key maturity tenor buckets failing to satisfy the minimum 3 trades criteria.

Detailed Methodology

The CDCURVE will be computed on daily basis as per the following methodology:

1. For the purpose of computation of the Benchmark CDCURVE Rates, secondary market transactions pertaining to scheduled commercial banks (excluding Small Finance Banks) and financial institutions issuers, with the highest Credit Rating reported to F-TRAC platform and settling on T+0 and T+1 basis will be considered. All T+1 deals will be discounted by the day's overnight FBIL MIBOR to arrive at the modified price which will be used with T+0 trades (*Annexure 1*) duly taking into account Mumbai non-working days (viz. Friday T+1 trades would be expected to be settled on Monday). All implied yields will be rounded off to 4 decimals.
2. All trades reported upto 5:15 PM in the F-TRAC system would be considered for the computation of CD Curve.
3. All deals having value of `5 crores and above with minimum residual maturity of 1 day and maximum residual maturity of 365 days will be considered as the valid dataset for computation of CDCURVE. The trades would be classified based on their residual maturity from the settlement date. These trades will be put into various key tenor maturity buckets representing the benchmark tenors of 14 days, 1 month, 2 months, 3 months, 6 months, 9 months and 12 months. The trades in each of these buckets will serve as a medium for computation of a benchmark rate to represent a particular key maturity benchmark tenor. The following table will be used for bucketing the transactions.

Table 1: Trades Captured in Tenor Buckets		
Bucket	Residual maturity (days)	Benchmark Tenor
1	1 to 16	14 Days
2	17 to 45	1 Month (30 Days)
3	46 to 71	2 Months (60 Days)
4	72 to 115	3 Months (90 Days)
5	116 to 200	6 Months (180 Days)
6	201 to 300	9 Months (270 Days)
7	>300	12 Months (365 Days)

4. The computation process takes into consideration the year end impact on trading in the CD market by taking into account the following scenarios:
 - a) Compute the March-End residual maturity as the day difference between March 31st and the settlement date.

- b) If the March-End residual maturity falls within a key maturity benchmark tenor bucket and is less than the benchmark tenor, all trades in that bucket with a residual maturity of upto March 31st will be shifted to the previous bucket (*Annexure 2-Scenario 1*). In case the March-End residual maturity falls within the 14Days benchmark tenor bucket and is less than 14 days, trades with a residual maturity upto March 31st will be dropped from the computation.
 - c) If the March-End residual maturity falls within a key maturity benchmark tenor bucket and is greater than or equal to the benchmark tenor, all trades in that bucket with a residual maturity beyond March 31st will be shifted to the next bucket (*Annexure 2-Scenario 2 and 3*).
5. Once the trades are put into their respective tenor buckets, the value weighted average rate of all the individual trades in the key maturity tenor bucket would be computed with the Standard Deviation of the Rates provided there are at least 3 trades in the tenor bucket.
 6. For the purpose of detection of outliers, a two-stage rule is applied:
 - 6.1. Outlier checks are put in place by eliminating individual trades beyond +/-3 standard deviations from the weighted average rate of trades for each respective key maturity tenor bucket.
 - 6.2. If any of the traded yields in that key maturity tenor bucket passes the first stage, as in (6.1.) above, but is beyond +/-30 basis points from the previous day's published CDCURVE rate for that key maturity tenor bucket, then it will also be excluded. This outlier detection methodology would be reviewed at regular frequency, taking into account all the major developments in the CD market.
 7. Using the traded data, the Rates (yields) for each benchmark tenor for the day will be computed, provided the key maturity tenor bucket has at least 3 surviving trades after outlier removal process.
 8. For the purpose of computation of the final CDCURVE Rate for a particular benchmark tenor, the methodology takes into consideration four parameters, namely, the *Distance, Volume, Amount and Rate* (*Annexure 3*).
 - a. **Distance:** To calculate the *Distance* we follow steps i to v as under:
 - i. Calculate the difference between the residual tenors of a given trade with its respective key maturity benchmark tenor. For example, in case of trades with a

residual tenor of 15 days, this difference is computed as 15 minus 14 which equals -1.

- ii. Calculate the absolute value of this difference. Following our example, $|-1|$ is equal to 1.
- iii. Calculate the sum of these absolute differences, for all trades in the relevant maturity bucket. If we have trades with the differences of 12, 8, 6 and 1 day, then this is the sum of 12, 8, 6 and 1 which equals to 27.
- iv. Each tenor is then assigned a weight, based on its percentage share in the sum of these absolute differences in that relevant bucket. In our case, this is equal to 0.0370 i.e. 1 (calculated from Step ii) divided by 27 (calculated from Step iii).
- v. *Distance* is then calculated as the inverse of this percentage share. In our example, this equals to 27 i.e. 1 divided by 0.0370.

Thus, the parameter of *Distance* will vary depending upon the proximity of the residual tenor of a given trade to its key maturity benchmark tenor. Indeed, given the benchmark tenor of 14 Days, trades with a residual tenor of 15 days will have a greater weight (i.e. a weight of 27) vis-à-vis trades with a residual tenor of 2 days (i.e. a weight of 2.25), as it lies closer to the key maturity benchmark tenor.

- b. Volume:** The volume is computed as the percentage share of the number of trades (frequency), for a given residual tenor, in the total number of all the trades within that respective key maturity tenor bucket. As an example, there has been only one trade with a residual maturity of 15 days, within the 14 Days maturity bucket which consists of a cumulative of 5 trades. Hence the weight assigned to this trade is 0.20 (i.e. 1 divided by 5). Thus, larger the number of trades at a given tenor, greater would be its influence on the benchmark rate.
- c. Amount:** For a given key maturity tenor bucket, the third parameter used in computation is the *Amount* (value in `Crores²) of all the trades which have a residual maturity that fall within that maturity bucket. The greater the value of the trades, the larger would be its weight in the computation process. For example, in case of the 1st maturity bucket, the trades with a residual maturity of 8 days and an amount of `70 crores will play a larger role

² 1Crore is 10Million

in influencing the 14 Days benchmark rate vis-à-vis trades with a residual maturity of 15 days and an amount of `5 crores.

9. Having computed the parameters, Weighted Average Rate (WAR) (*Equation-1*) for each benchmark Tenor of the Curve will be:

$$WAR = WAR(\text{Amount}, \text{Distance}, \text{Volume}) = \frac{\sum(\text{Rate} \times \text{Amount} \times \text{Distance} \times \text{Volume})}{\sum(\text{Amount} \times \text{Distance} \times \text{Volume})} \quad (1)$$

10. In case the threshold criteria of a minimum of 3 trades is not fulfilled post outlier elimination for a key maturity tenor bucket, the following Fallback Mechanism will be initiated to compute the Benchmark CDCURVE Rate for the missing tenors:

- 10.1. In case at least one key maturity benchmark tenor bucket is traded and fulfills the minimum 3 trades threshold criteria post outlier elimination, the CDCURVE Rate for the missing benchmark tenor buckets are computed using the previous day's CDCURVE Rate for that tenor bucket plus the average spread (difference between today's CDCURVE Rate for a tenor bucket and yesterday's CD CURVE rate for the same tenor bucket) of two nearby benchmark tenors buckets (traded/calculated). The end points are computed first, using the nearest available traded tenor buckets. The calculation process for the missing values using nearby tenor(s) buckets is given below:

Table 2: Fallback in case of missing tenor buckets							
Date	14D	1M	2M	3M	6M	9M	12M
14-08-18	6.5522	6.6092	6.9012	7.1249	7.4400	7.7000	7.9176
16-08-18	BLANK	6.6653	BLANK	BLANK	7.4961	7.7525	7.9737
16-08-18	6.5522+ (6.6653-6.6092)		=6.9012+((6.6653- 6.6092)+(7.4961- 7.4400))/2	=7.1249+((6.9573- 6.9012)+(7.4961- 7.4400))/2			
	=6.6083		=6.9573	=7.1810			

- 10.2. If the minimum 3 trades threshold criteria is not satisfied for all key maturity benchmark tenor buckets post outlier elimination, the CDCURVE Rates for all the missing tenor buckets across the curve are computed as follows:

- i. Select the following set of CD trades as a part of the fallback mechanism:
 - **Tenor Buckets having minimum 3 trade before the outlier checks and less than three trades Post Outliers:** The Trades in such tenor buckets have passed

through the outlier criteria checks of +/-3 standard deviation and are within the +/-30 bps over the previous day's CDCURVE rate for the applicable tenor.

- **Tenor Buckets having a less than three trades before Outliers:** Trades in such tenor buckets that are within the +/-30 bps threshold over the previous day's CDCURVE rate for the applicable tenor.
- ii. Compute a value weighted average rate of the selected CD trades, from (i) above, across the CDCURVE for the current day, defined as $VWAR_t$.
 - iii. Compute a value weighted average residual maturity of the selected CD trades, from (i) above, for the current day, defined as $VWAM_t$.
 - iv. Use the $VWAM_t$ for the current day, to interpolate/extrapolate the rate associated with this $VWAM_t$ from the previous day's CDCURVE. The interpolated rate is defined as IR_{t-1} .
 - v. Compute the Current day's Spread, defined as $S_t = VWAR_t - IR_{t-1}$.
 - vi. Add the Day's Spread, S_t , as a single spread to the previous day's CDCURVE rate across all the key maturity tenor buckets, to arrive at the CDCURVE rate for the current day.
- 10.3. In case no CD trades are available across the CDCURVE and the CDCURVE rate for a particular tenor is not possible to be computed using the foregoing steps, the CDCURVE will be determined by using the current day's TBCURVE rate for the same tenor and adding to it the spread between the CDCURVE rate and TBCURVE rate for the same tenor of the previous day.
- 10.4. In case no CDCURVE Rate for any benchmark tenor bucket is possible to be estimated for the day using the foregoing steps, the CDCURVE Rate for the previous day would be repeated (maximum upto 2 days).

11. A brief summary of revision is also available at Annexure 4.

Publication of FBIL CDCURVE:

The rate will be published at about 5.45 PM. If the TBill curve estimation is delayed because of market time extension, CD curve Rate publication time may also suitably change.

Reference:

- Estimation Benchmark Certificate Of Deposit (CD) Curve (Technical Document by Golaka C Nath, Member, FBIL OC and Manoel Pacheco, AM, CCIL), Rakshitra, June 2018. [https://www.ccilindia.com/Research/CCILPublications/Lists/1stRakshitraArticles/Attachments/204/Estimation%20of%20A%20Benchmark%20Certificate%20of%20Deposit%20\(CD\)%20Curve.pdf](https://www.ccilindia.com/Research/CCILPublications/Lists/1stRakshitraArticles/Attachments/204/Estimation%20of%20A%20Benchmark%20Certificate%20of%20Deposit%20(CD)%20Curve.pdf)

Abbreviations

- CCIL - The Clearing Corporation of India Ltd.
- CD - Certificate of Deposit
- CDCURVE - FBIL CD Curve
- FBIL- Financial Benchmarks India Pvt Ltd.
- MIBOR - Overnight Mumbai Interbank Outright Rate
- OTC – Over the Counter
- TBCURVE- FBIL T-bill Curve
- TR - Trade Repository
- WAR – Weighted Average Rate

Annexure 1: Conversion of T+1 Trade Price to T+0 Price

Table 3: Conversion of T+1 Trade Price to T+0 Price						
	A	B	C	D	E	F
1	Type	Price	Sett Date	Maturity Date	IMPLIED YLD	PRICE
2	T+1	99.7232	17-Oct-17	2-Nov-17	6.33%	99.7232
3	MIBOR (O/N)	6.05%				
4	T+0 conversion	99.7067	16-Oct-17 ³	2-Nov-17	6.32%	99.7067

The T+1 Price of 99.7232 is discounted using the overnight MIBOR rate of 6.05% to arrive at the T+0 price as follows:

$$99.7232 / (1 + 6.05\% \times \left(\frac{1}{365}\right)) = 99.7067$$

The implied yield from the discounted price is arrived as:

³ Modified Settlement Date

$$\left(\left(\frac{100}{99.7067} \right) - 1 \right) \times \left(\frac{365}{17} \right) \times 100 = 6.32\%$$

Where,

$$17 = (02\text{-Nov-2017}-17\text{-Oct-2017})+1$$

Annexure 2: Year End Adjustment under Different Scenarios

Table 4.1: Scenario 1- When the March End Residual Maturity is less than the Benchmark tenor

Settlement Date	Trade No.	Residual Maturity	Existing Bucket	Yield	March End Date	March End Date-Settlement Date	Bucket Min	Bucket Max	Benchmark Tenor	New Bucket
20-08-18	1	205	9M	7.46	31-03-19	223	201	300	270	6M
20-08-18	2	206	9M	7.50	31-03-19	223	201	300	270	6M
20-08-18	3	218	9M	7.50	31-03-19	223	201	300	270	6M
20-08-18	4	277	9M	7.97	31-03-19	223	201	300	270	9M

Table 4.2: Scenario 2-March End Residual Maturity is beyond the Benchmark tenor

Settlement Date	Trade No.	Residual Maturity	Existing Bucket	Yield	March End Date	March End Date-Settlement Date	Bucket Min	Bucket Max	Benchmark Tenor	New Bucket
25-09-12	1	174	6M	8.67	31-03-13	187	116	200	180	6M
25-09-12	2	185	6M	8.74	31-03-13	187	116	200	180	6M
25-09-12	3	190	6M	8.92	31-03-13	187	116	200	180	9M

Table 4.3: Scenario 3-March End Residual Maturity is equal to the Benchmark tenor

Settlement Date	Trade No.	Residual Maturity	Existing Bucket	Yield	March End Date	March End Date-Settlement Date	Bucket Min	Bucket Max	Benchmark Tenor	New Bucket
31-12-18	1	81	3M	6.90	31-03-19	90	72	115	90	3M
31-12-18	2	85	3M	6.90	31-03-19	90	72	115	90	3M
31-12-18	3	87	3M	6.85	31-03-19	90	72	115	90	3M
31-12-18	4	95	3M	7.75	31-03-19	90	72	115	90	6M

Annexure 3: Computation of Weighted Average Rate

For the purpose of illustration we consider the transactions to be used for computation of the 14 Day key maturity benchmark tenor. These transactions are categorized on the basis of their residual tenor and are aggregated to arrive at a cumulative Amount and Weighted Value (WV) for each residual maturity as indicated in 'Panel A of Table 5'. The number of trades, Amount and WV are then aggregated for those transactions with the same residual tenor as indicated in 'Table 1'.

Table 5: CD Transaction for computation of 14 Days Benchmark Rate								
Panel A				Panel B				
Residual Tenor	Amount (Rs. Cr.)	Yield	WV	Residual Tenor	Number of Trades	Amount (Rs. Cr.)	WV	Rate
	(a)	(b)	(a) x (b)			(a)	(b)	(c) = (b)/(a)
2	10.00	6.6089	66.089	2	2	20.00	132.18	6.6089
2	10.00	6.6089	66.089	6	1	50.00	330.08	6.6015
6	50.00	6.6015	330.08	8	1	70.00	458.64	6.5520
8	70.00	6.5520	458.64	15	1	5.00	32.50	6.4997
15	5.00	6.4997	32.50					

The outliers are removed using a +/- 3SD criteria from the mean weighted average rate in each maturity bucket. Only trades of `5 crores and above are used for computation.

For the purpose of computation of the CDCURVE, the methodology takes into consideration four parameters, namely, the *Distance*, *Volume*, *Amount* and *Rate*. The computation of these parameters is illustrated in 'Table 6' and is explained as follows:

Table 6: Computation of 14 Days WAR					
Variable	Notation	14 Day WAR			
Panel A: Tenor-Wise Information					
Residual Tenor ^s	(a)	2	6	8	15
Benchmark Tenor [@]	(b)	14			
Days	(c) = (a) - (b)	12	8	6	-1
ABS(Days)	(d) = (c)	12	8	6	1
Sum of ABS(Days)	(e) = Σ(d)	27			
Share in ABS(Days)	(f) = (d)/(e)	0.4444	0.2963	0.2222	0.0370
Distance	(g) = 1/(f)	2.2500	3.3750	4.5000	27.0000
No. of trades ^s	(h)	2	1	1	1
Sum of No. of Trades	(i) = Σ(h)	5			
Volume	(j) = (h)/(i)	0.4000	0.2000	0.2000	0.2000
Amount (Rs. Cr.) ^s	(k)	20.00	50.00	70.00	5.00
Rate ^s	(l)	6.6089	6.6015	6.5520	6.4997
Panel B: Computed WAR					
WAR	$\frac{\sum(l) \cdot (k) \cdot (g) \cdot (j)}{\sum(k) \cdot (g) \cdot (j)}$	6.5610			
Rate to Closest Applicable Tenor ^s		6.4997			

Notes: \$ Figures from Panel B of Table 2. @Figures from Table 1.

Annexure 4- Summary of Revision in Calculation of CD Rates

FBIL started publication of FBIL CD Curve (CDCURVE) for 7 tenors (14 days, 1 month, 2 months, 3 months, 6 months, 9 months and 12 months) with effect from 23rd August, 2017. Based on the discussion with market participants, specific revisions were incorporated in the calculation. Brief Summary of revision of calculation of FBIL CD Curve is as under:

Date	Methodology
Extant Methodology	<ul style="list-style-type: none">• Calculation of Fallback Mechanism<ul style="list-style-type: none">○ If the criteria for calculation of CDCURVE rate for a particular tenor are not met, it will be computed by using the previous day's CDCURVE rate for that tenor and adding to it the average spread of CDCURVE rates of two adjacent tenors by way of linear interpolation, provided the CDCURVE rates for the two adjacent tenors have not been calculated using this provision.○ If the CDCURVE rate for a particular tenor is not possible to be computed using the foregoing step, it will be determined by using the day's TBCURVE rate for the same tenor and adding to it the spread between the CDCURVE rate and TBCURVE rate for the same tenor of the previous day.○ If the computation of the CDCURVE rate for a particular tenor is still not possible, it will be determined by using the day's TBCURVE rate for the same tenor and adding to it the spread between the CDCURVE rate and TBCURVE rate for the nearest tenor for the same day.
dd-mmm-yyyy	<ul style="list-style-type: none">• Calculation of a 4-step fallback mechanism specified in Point No. 10 of this document would be considered.• Financial year-end turn adjustment would be considered in the computation.• CD Trades up to 5:15 would be considered.• Outlier detection based on +/-3SD from the weighted average rate and +/-30 bps from the previous day's CD Curve rate would be considered.