BANK OF THAILAND

# A User's Guide to Thai Overnight Repurchase Rate

Financial Markets Department, Bank of Thailand

February 2022

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The Bank of Thailand (BOT) publishes *A User's Guide to Thai Overnight Repurchase Rate* to explain how market participants can use the Thai Overnight Repurchase Rate (THOR) as a reference rate in financial products, which includes how to calculate an interest rate for each interest period from the overnight rate to align with international standard.

## 1. Introduction

The London Interbank Offered Rate (LIBOR) scandal in 2012 exposed flaws, vulnerabilities to rate manipulation and deficiencies in regulatory oversight and governance. Regulators tried to improve the transparency in the rate calculation and regain credibility of the rate by switching from a submission-based rate to a transaction-based rate. Although regulators have tried to make significant improvements to LIBOR, these efforts were not very successful due to the significant decline in volume of term borrowing and lending transactions after the Global Financial Crisis. Subsequently, the UK Financial Conduct Authority, the regulator of LIBOR, signaled the possibility of future permanent discontinuation or loss of representativeness of LIBOR.

Central banks, regulators, and market participants are collaborating to minimize the effects of LIBOR discontinuation. Many countries chose to develop an alternative reference rate as a replacement or as an additional reference rate in the financial market. In the earlier stages, these new rates are overnight rates because transactions are concentrated in the overnight market. Moreover, there are insufficient term transactions to build a reliable term benchmark on a daily basis.

**Table 1 Reference rates in foreign markets**

| | LIBOR | Overnight rate to replace LIBOR | | | | |
|---|---|---|---|---|---|---|
| | | SOFR | SONIA | SARON | ESTR | TONA |
| **Currency** | 5 major currencies[1] | US Dollar (USD) | Sterling Pounds (GBP) | Swiss Francs (CHF) | Euro (EUR) | Yen (JPY) |

[1] LIBOR is currently published across 5 currencies which are United States dollar (USD LIBOR), British pound sterling (GBP LIBOR), European euro (EUR LIBOR), Japanese yen (JPY LIBOR), and Swiss franc (CHF LIBOR)

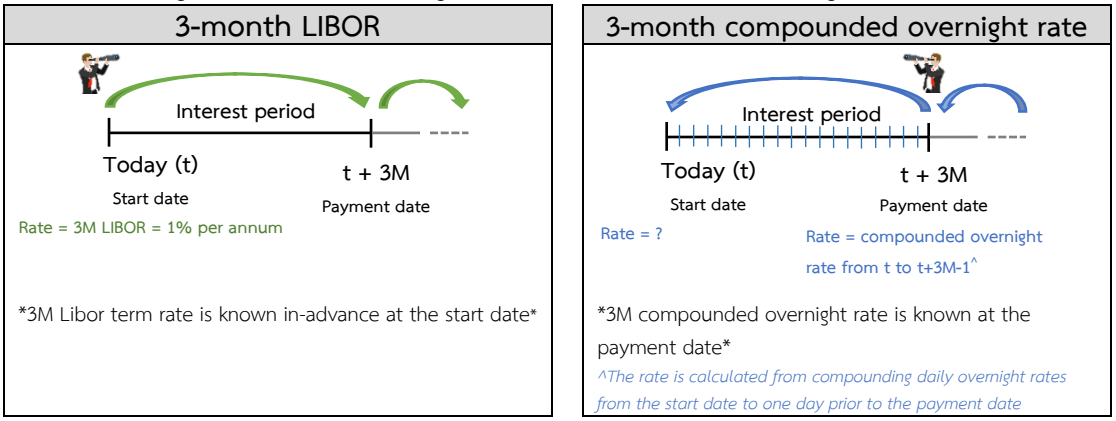
| **Rate type** | unsecured interbank rate | secured treasury repo rate | unsecured wholesale rate | secured interbank repo rate | unsecured wholesale rate | uncollateralized overnight call rate |
|---|---|---|---|---|---|---|
| **Rate origin** | survey-based | transaction-based | | | | |
| **Term** | O/N, 1 week, 1/2/3/6 months and 1 year | O/N | | | | |

## 2. The calculation methodology of the backward-looking term rate from the overnight rate

Alternative reference rates which are recently developed are available only for the overnight tenor, unlike the widely-used reference rates such as LIBOR which are the forward-looking term rates and could be known at the beginning of the interest period. In order to derive term rates (e.g. 1 month, 3 months, or any specific interest payment periods) from daily overnight rates, there are 2 calculation approaches, namely simple average and compound average. Both approaches result in a backward-looking term rate.

Despite referencing to an overnight rate, payments are usually settled periodically on a monthly, quarterly, or annual basis. Therefore, the interest rate for each period should be calculated using the compound average approach to account for time value of money (more details in BOX). Compound average approach is a global standard for international financial market and is recommended by the BOT to be used when calculating a backward-looking term rate for financial contracts such as loan, bond, structured note, and derivative.

**Figure 1 Forward-looking term rate and backward-looking term rate**



In general, overnight rates have low volatility. Users are able to approximate the compounded overnight rate for the period without the need to wait until the last day of the period. This is possible because the occurrences that would cause sudden volatility in the overnight rates are infrequent. In addition, the impact of these occurrences on the overall compounded overnight rate are so minimal that we may not observe any significant difference in the compounded rate. In order to allow sufficient time for operational matters before the payment date, there are several interest calculation and settlement-related market conventions which parties could choose to adopt (more details in section 4).

**BOX: Applying the compound average approach on overnight rates to derive periodic term rates**

For financial products referencing an overnight rate, such as loans, the term rate for each interest period will be derived from every overnight rate throughout that period and by using the following compound average formula:

$$\text{Compounded overnight rate}_t = \left[\prod_{i=1}^{d_0}\left(1+\frac{\text{overnight rate}_i \times n_i}{365}\right)-1\right] \times \frac{365}{d}$$

Where $n_i$ equals the number of calendar days in the relevant Calculation Period for which the rate is overnight $\text{rate}_i$ (in the case that i falls on a Friday, overnight $\text{rate}_i$ would be the rate for Friday, Saturday and Sunday. Thus, ni equals 3).

Using the compound average methodology to obtain the backward-looking term rate is based on theory of finance and standard practices in global financial markets.

Financial contracts referencing overnight rate benchmarks typically do not require borrowers to make interest payment on a daily basis, but rather on a periodic basis (i.e. at the end of the interest period such as 1 month). This means that borrowers could earn income by investing the interest that has accrued in between interest payment dates. In the meantime, lenders only receive interest at the end of each interest period, consequently losing out on the opportunity to reinvest throughout the interest period. Thus, we adopt the compounding approach in the calculation of interest rate for each interest period to account for the effect of time value of money and to be fair for lenders and borrowers, which is a financial concept accepted in global financial markets.

The compounding of overnight rates is merely the calculation methodology to acquire *a term rate* for each interest period, then adding up margin to get *a contractual interest rate* which will be used to calculate interest payment amount for each period.

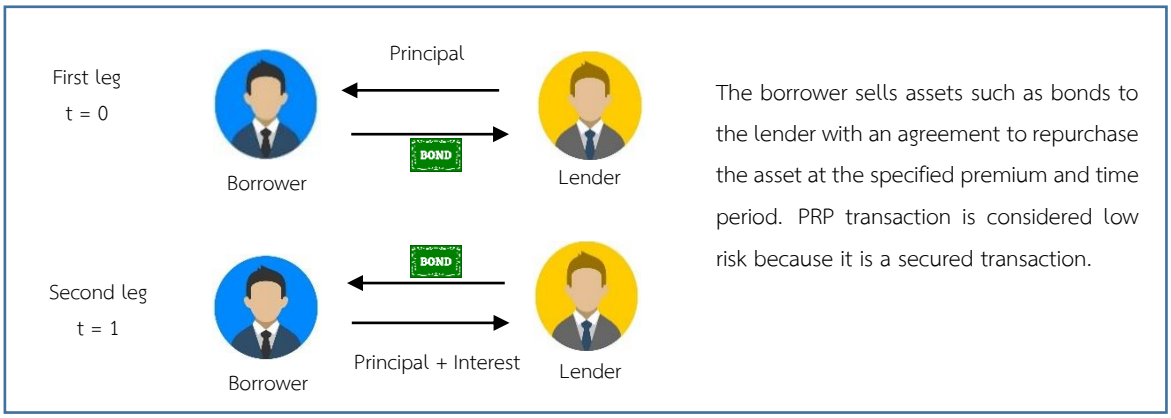
| THOR | Term rate | Margin (reflecting borrower's credit risk and other factors) | Contractual interest rate |
|---|---|---|---|
| daily rate | 0.87579% | 2% | 2.87579% |

Therefore, the compounding methodology does not violate Section 655 of the Thai Civil and Commercial Code (which states that interest should not bear interest). In principle, Section 655 of the Thai Civil and Commercial Code aims to prevent lenders from misusing the compounding methodology to charge borrowers unreasonably high interest rates. Following this notion, the compounding of overnight rate within the period is simply a process to determine the *term rate*, which is an element of the *contractual interest rate*. It is different from adding the interest of the previous period(s) to the principal amount, and subsequently accruing interest on that sum. In conclusion, the compounded overnight rate does not violate Section 655 of the Thai Civil and Commercial Code.

## 3. Development of Thai Interest Rate Benchmark Reform

The financial market conditions in Thailand is similar to that of other countries, particularly with respect to the concentration of transactions in the overnight tenor. Term transactions in the market are sparse due to excess liquidity in money market which allows day-to-day liquidity management. Thus, there are insufficient term transactions to build a reliable term benchmark on a daily basis. The majority of the money market transactions in the Thai financial market are private repurchase transactions (PRP). The daily volume for overnight PRP transactions in 2019 totaled to greater than 100 billion baht. High liquidity in the PRP market, particularly in the overnight interbank PRP market, makes it a suitable new alternative reference rate. It reflects the domestic money market liquidity conditions and is not sensitive to USD liquidity constraints. It also moves correspondingly with the monetary policy rate, which allows it to support the monetary policy transmission mechanism.

**Figure 2 Private Repurchase Market**



Therefore, the Thai Overnight Repurchase Rate (THOR) is developed as the new reference rate for the Thai financial market. THOR[2] is the interbank overnight private repurchase rate. The Bank of Thailand (BOT) is the rate administrator and the Thai Bond Market Association (ThaiBMA) is the calculation agent. THOR is published on the BOT's website[3], ThaiBMA's website, Bloomberg (Ticker: TTHORON Index) and Refinitiv (Ric: THONRP=BKTH) every Bangkok business day at 5.00 pm[4].

THOR differs from other existing reference rates such as the Thai Baht Interest Rate Fixing (THBFIX) and the Bangkok Interbank Offered Rate (BIBOR) in terms of the underlying market. The underlying market for THBFIX is the USDTHB interbank swap market. THBFIX is the synthetic cost of borrowing the Thai Baht, obtained by borrowing US dollar for the same maturity, and swapping out the US dollar in return for the Thai Baht. USD is used as collateral for the FX swap transactions which causes the THBFIX to be sensitive to the USD liquidity condition. Additionally, LIBOR permanent cessation puts THBFIX at risk as LIBOR is a component in the calculation of THBFIX. BIBOR is an uncollateralized interbank lending rate which is vulnerable to low volume of underlying transactions.

**Table 2 The characteristics of interest rate benchmarks in the Thai financial market**

| | THOR | THBFIX | BIBOR |
|---|---|---|---|
| **Status** | New reference rate | THBFIX will cease publication once LIBOR cessation event occurs. "Fallback THBFIX" will be published as the fallback rate for THBFIX. | Remains unchanged |
| **Underlying market** | interbank private repurchase | USDTHB swap | unsecured interbank |
| **Data collection** | transaction-based | transaction-based (since 2019) | survey-based |
| **Term** | O/N | O/N, 1 week, 1/3/6 months and 1 year (Fallback THBFIX will only have 1/3/6 month term rates) | O/N, 1 week, 1/2/3/6 months and 1 year |

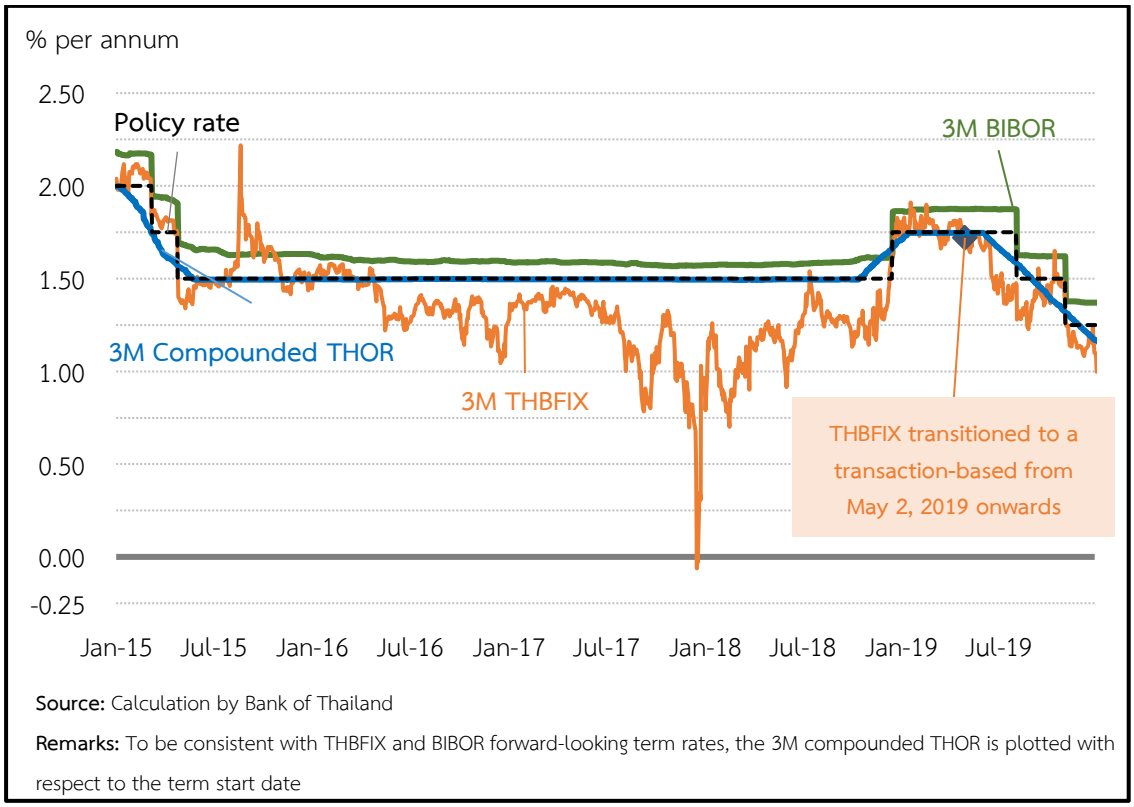
[2] THOR metadata https://app.bot.or.th/THOR/SharedFiles/FM_RT_013_ENG.PDF

[3] THOR publication page https://app.bot.or.th/THOR/en
Historical THOR data publication page
https://app.bot.or.th/BTWS_STAT/statistics/BOTWEBSTAT.aspx?reportID=945&language=Eng

[4] THOR may be revised at 9.30 am on the following business day, if the underlying PRP data are adjusted and the adjustment results in at least a 1 basis point change in THOR

| | THOR | THBFIX | BIBOR |
|---|---|---|---|
| **Determination date of an interest rate for each interest period** | End of each interest period (a backward-looking term rate calculated from daily THOR rates) | Beginning of each interest period (THBFIX is a forward-looking rate) | Beginning of each interest period (BIBOR is a forward-looking rate) |
| **Movement in correlation with policy rate** | ☑ | ☒ Impacted by USD liquidity | ☑ Term rates do not reflect future rate expectations due to low transaction volume. |

**Figure 3 Reference rates in the Thai financial market**




**Source:** Calculation by Bank of Thailand

**Remarks:** To be consistent with THBFIX and BIBOR forward-looking term rates, the 3M compounded THOR is plotted with respect to the term start date

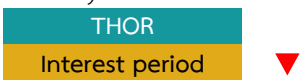
## 4. THOR as a reference rate for financial products

Using overnight rates as reference for financial products is not uncommon in the Thai financial market. The Minimum Lending Rate (MLR) that is commonly used in loan contracts has similar characteristics to THOR. MLR is also a floating rate that can change over the duration of the contract. However, MLR does not fluctuate as often as overnight rates, making it easier to forecast the interest payment due at the settlement date for MLR-linked.

### 4.1 Conventions for financial contracts referencing THOR

For financial contracts referencing THOR or other overnight rate benchmarks, the interest rate is calculated from compounding the daily overnight rates of the interest period, excluding the payment date. Thus, the interest due is only known on the last day of the interest period. In order to allow for sufficient time for parties involved in the contract to prepare for payment settlement, users of the THOR or other overnight rate benchmarks can explore interest calculation and settlement-related market conventions as described in the following table.

**Table 3 Interest calculation and settlement-related market conventions for THOR-linked financial contracts**[5]

| Approaches | Advantages | Disadvantages |
|---|---|---|
| **In-arrears Approach**<br>- Plain<br>  <br>THOR compounding period used to calculate compounded THOR (observation period) matches the interest period. | - THOR compounding period perfectly matches the interest period | - There is no buffer time to prepare for the settlement of interest payments |
| - Payment Delay<br>  <br>THOR compounding period used to calculate compounded THOR (observation period) matches the interest period but interest payment is due a number of days following the interest period. | - THOR compounding period perfectly matches the interest period<br>- Some buffer time to prepare for the settlement of interest payment | - Increased counterparty credit risk<br>- No compensation for 'time value of money' in the delayed payment amount |
| - Lookback<br>  <br>Compounded THOR calculated from THOR for the period beginning and ending a certain number of days before the interest period (typically 1-5 days). There are 2 sub-approaches under this method. | - Some buffer time to prepare for the settlement of interest payment | - THOR compounding period does not exactly match the interest period |

[5] Example of compounded interest calculation in each convention:
https://www.bot.or.th/content/dam/bot/fmd/thor/Overnight%20rate%20convention%20example%20eng.xlsx

| Approaches | Advantages | Disadvantages |
|---|---|---|
| (1) **Lookback with observation shift (Backward shift)** Compounded THOR is calculated from the daily THOR and the actual number of calendar days (weight) in the observation period.<br>(2) **Lookback without observation shift** Compounded THOR is calculated from the daily THOR in the observation period. The actual number of calendar days (weight) aligns with the interest period . | | |
| - Lockout or Suspension period<br>  <br>THOR is not updated for the final few days (lockout period of typically 1-5 days) of the interest period. Daily compounding of THOR begins at start of the interest period and the final observed THOR is used in the calculation throughout the lockout period. | - Some buffer time to prepare for the settlement of interest payment | - The final THOR observed at the start of the lockout period may not be a representative rate for the entire lockout period |
| **In-advance Approach**<br>  <br>Compounded THOR is calculated from THOR observed from the previous interest period. | - Compounded THOR is known at the beginning of the interest period | - THOR compounding period does not match the interest period<br>- Difficult to hedge interest rate risk |

To assist commercial banks to start developing loans referencing THOR, BOT has conducted a survey across banks in Thailand and issued a THOR Pilot Lending Practice based on the majority views. Most commercial banks viewed that the backward shift approach is the suitable convention for THOR-linked loans. In any case, commercial banks and their clients should negotiate the terms of financial contract to mutually agree upon a convention. Issuers of both corporate bonds and government bonds also have the liberty to set the appropriate conventions for their bonds. For instance, the Bank of Thailand THOR Floating Rate Note (BOT TFRN) uses a backward shift approach as well. Parties of the financial contract that are looking to hedge against interest rate risk through derivatives should also take into account the derivative market conventions.

**4.2 Facilitation tools to calculate an interest rate for each interest period from THOR**

To facilitate market adoption of THOR, BOT has published THOR Index and THOR Calculator. Market participants can use these tools to calculate the compounded THOR for any given tenor.

**A. THOR Index**[6] represents the cumulative value of compounding THOR over time, with an initial value of 100 on April 1, 2020. THOR Index reflects the effect of compounding THOR each business day and taking the simple average on non-business day. THOR Index is published by rounding to ten decimal places. Although THOR Index is calculated daily, BOT publishes THOR Index only on business days at 9.30 am. The Index for non-business days will be published on the following Bangkok business day. The data is also available on ThaiBMA, Bloomberg[7] (Ticker: TTHRINDX Index) and Refinitiv (Ric: .THOR).

THOR Index can be used to obtain the compounded rate for the THOR compounding period or observation period. The calculation method is as follows:

$$\text{Compounded THOR per annum} = \left(\frac{\text{THOR Index}_{t+n}}{\text{THOR Index}_{t}} - 1\right) \times \frac{365}{n}$$

where $t$ is the start date of the observation period

$n$ is the number of calendar days in the observation period

This calculation method works even if the start or end date falls on a non-business day. However, it does not work for contracts that employ the Lookback without observation shift convention and the Lockout or Suspension period convention.

In general, the result from this method will be equal to the compounded THOR obtained by compounding the daily THOR from the start date (t) until the final day prior to the end date (t + n – 1). However, these two calculation methods may sometimes result in slightly different final rates due to rounding differences.

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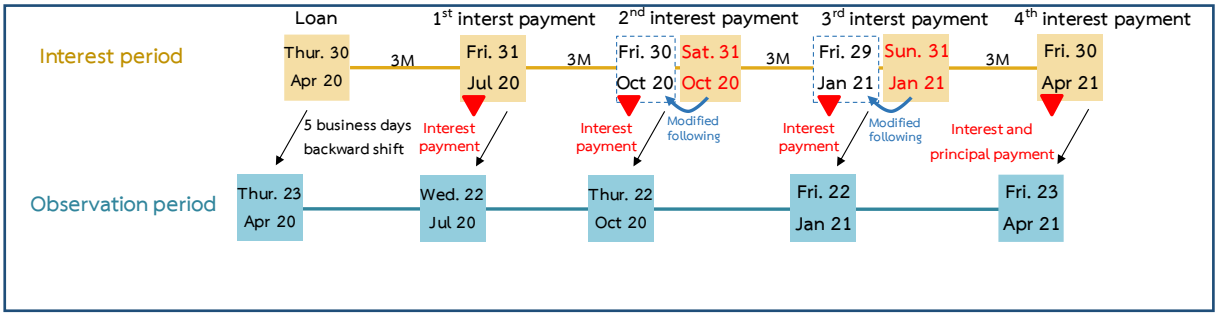
[6] THOR Index publication page https://app.bot.or.th/THOR/en
Historical THOR Index data publication page
https://app.bot.or.th/BTWS_STAT/statistics/BOTWEBSTAT.aspx?reportID=946&language=Eng
THOR Index metadata https://app.bot.or.th/THOR/SharedFiles/FM_RT_014_ENG.PDF

[7] Please note that Bloomberg needs to scale the THOR Index to 10,000 and rounded off to 8 decimal places, in order to maintain the same degree of precision as the THOR Index published on the BOT Website.

**Example for calculating the compounded THOR using the THOR Index**

To illustrate the calculation method, we refer to this example of a 1-year loan contract, with interest settlement at the final business day of every 3 months using a 5 business day backward shift approach.

**Figure 4 Example for calculating the compounded THOR using the THOR Index**




Using the 5 business day backward shift approach, the observation period for the first interest period is from April 23, 2020 to July 22, 2020. The compounded THOR per annum for first interest period is $\left(\frac{\text{THOR Index}_{22\text{ July }20}}{\text{THOR Index}_{23\text{ Apr }20}} - 1\right) \times \left(\frac{365}{90}\right)$

For the other interest periods,

$$\text{Compounded THOR}_{\text{interest period 2}} = \left(\frac{\text{THOR Index}_{22\text{ Oct }20}}{\text{THOR Index}_{22\text{ July }20}} - 1\right) \times \left(\frac{365}{92}\right)$$

$$\text{Compounded THOR}_{\text{interest period 3}} = \left(\frac{\text{THOR Index}_{22\text{ Jan }21}}{\text{THOR Index}_{22\text{ Oct }20}} - 1\right) \times \left(\frac{365}{92}\right)$$

$$\text{Compounded THOR}_{\text{interest period 4}} = \left(\frac{\text{THOR Index}_{23\text{ Apr }21}}{\text{THOR Index}_{22\text{ Jan }21}} - 1\right) \times \left(\frac{365}{91}\right)$$

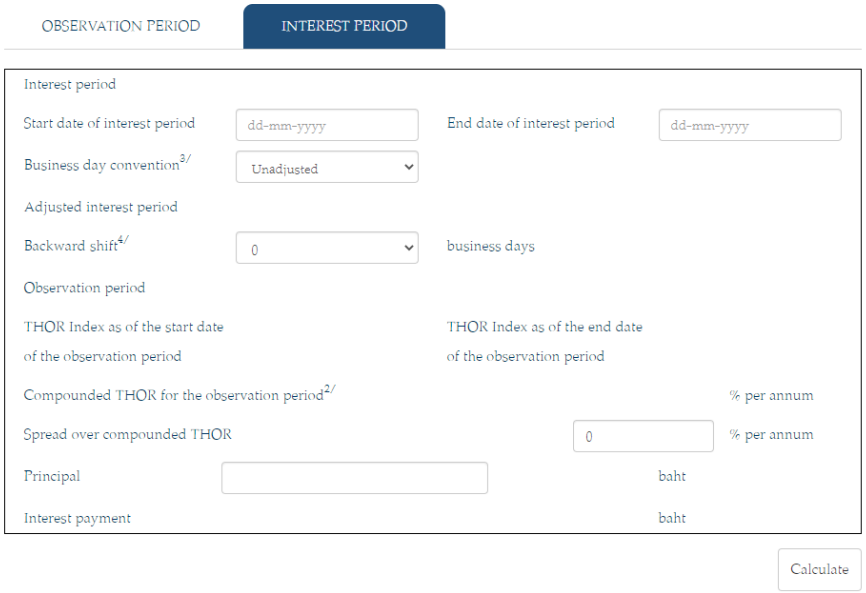
**B. THOR Calculator**[8] is a tool for calculating the compounded THOR for a specified period, which is obtained from THOR Index. Similarly, THOR Calculator is compatible with all THOR-linked financial contract conventions except for Lookback without observation shift and Lockout or Suspension period conventions. The 2 models of THOR Calculator are as follows:

1) **Observation Period Model** is recommended when the period referencing THOR is known.

[8] THOR Calculator https://app.bot.or.th/THORCalculator/en
THOR calculator manual https://app.bot.or.th/thorcalculator/sharedFile/THOR_Calculator_Manual_EN.PDF


By selecting April 23, 2020 as the start date and July 22, 2020 as the end date, we can calculate the compounded THOR of the first observation period for the example in Figure 4. The compounded THOR obtained is equivalent to $\left(\frac{\text{THOR Index}_{22\text{ July }20}}{\text{THOR Index}_{23\text{ Apr }20}} - 1\right) \times \left(\frac{365}{90}\right)$.

2) **Interest Period Model** is recommended when interest period indicated in the contract is known. Lookback with observation shift *(*Backward shift*)* may be applied in order to calculate compounded THOR for the specified observation period.




The following steps illustrate how to calculate the compounded THOR for the first interest period in Figure 4:

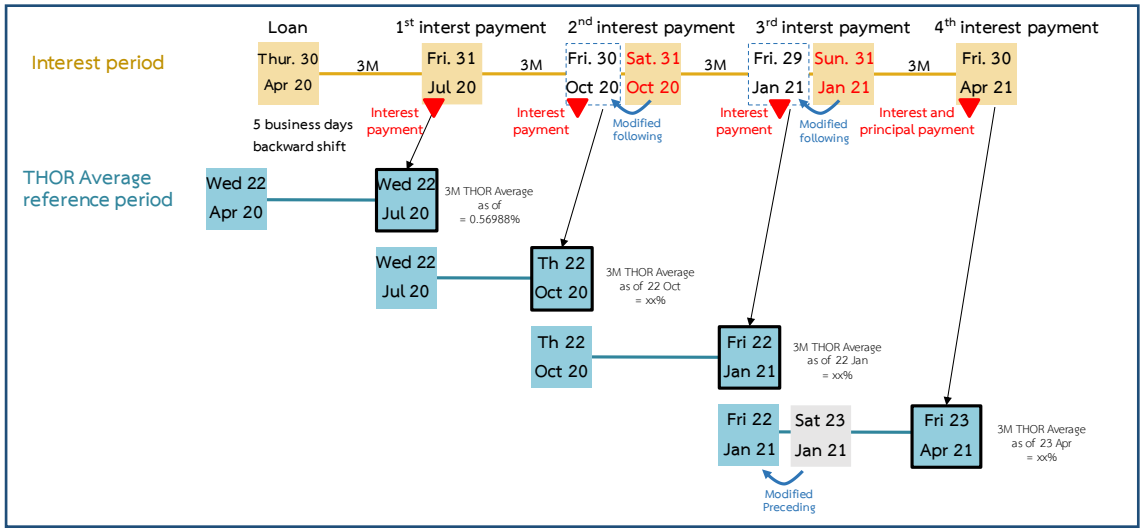
1. Select the start date *(April 30, 2020)* and end date *(July 31, 2020)* of the interest period as indicated in the contract
2. Select the business day convention *(Modified Following)*
3. Select the number of business days applicable for the backward shift approach *(5 business days)*
4. Users may input principal amount and spread over compound THOR, if applicable

**4.3 THOR Average** is the term rate obtained from compounding the daily values of THOR (compound setting in arrears method) for the following tenors: 1 month, 3 months and 6 months. It is published on the BOT and ThaiBMA website[9] at 9.30 am every Bangkok business day. The data is also available on Bloomberg (Ticker: TTHORA1M Index, TTHORA3M Index, TTHORA6M Index) and Refinitiv (Ric: TH1MRP= BKTH, TH3MRP= BKTH, TH6MRP= BKTH). The start date[10] for each THOR Average tenor is determined by referring to the corresponding numerical dates and the modified preceding[11] business day convention is applied to the start date if the start date falls on a non-business day. THOR Average is calculated by applying the compounding methodology (as outlined in section 2) on daily THOR from the start date until the final business day prior to the publication date.

**Example for calculating the interest payment using the THOR Average**

Figure 5 illustrates the calculation method of interest payment settled every 3 months for a 1-year loan contract by observing 3-month THOR Average on 5 business days prior to the payment date.

**Figure 5 Example for calculating the Compounded THOR using the 3M THOR Average**




[9] THOR Average publication page https://app.bot.or.th/THOR/en
Historical THOR Average data publication page
https://app.bot.or.th/BTWS_STAT/statistics/BOTWEBSTAT.aspx?reportID=945&language=Eng

[10] For example, the 3 month THOR Average published on July 22, 2020 has a start date of April 22, 2020. For start date that falls on a non-business day, THOR for that day would equal to THOR on the preceding business day.

[11] If the start date falls on a non-business day, the date will be the first preceding day that is a Business Day, unless the first preceding Business Day is in the previous calendar month, in which case that date will be the first following day that is a Business Day.

As shown in Figure 5, the first interest settlement date is July 31, 2020. Interest payment for the first interest period can be calculated by multiplying the 3M THOR Average on July 22, 2020 with the number of calendar days in the interest period[12]. 3M THOR Average published on July 22, 2020 was calculated by compounding the daily values of THOR from April 22, 2020 to July 21, 2020. For the following interest periods, the relevant 3M THOR Average rates are published on October 22, 2020, January 22, 2021, and April 23, 2021 respectively.

Table 4 shows the advantages and disadvantages of using THOR and THOR Average.

**Table 4 Advantages and disadvantages of using THOR and THOR Average**

| | Advantages | Disadvantages |
|---|---|---|
| **THOR** | 1. Flexibility to calculate compounded THOR for any given tenor, even odd tenors such as 14-days or 2 months.<br>2. The start date of the compounding period may fall on a non-business day. This is suitable for financial contracts that do not apply business day adjustment conventions.<br>3. Applicable to all Interest calculation and settlement-related market conventions. | Users must individually compound the daily THOR to obtain the compounded THOR for the interest period. |
| **Tools**<br>**- THOR Index**<br>**- THOR calculator** | These tools facilitate the calculation of compounded rates for any given tenor**.** | Not applicable for financial contracts that employ the Lookback without observation shift and Lockout or Suspension period conventions. |
| **THOR Average** | THOR Average rates are ready-to-use term rates for calculating interest payment. | 1. THOR Average rates are standardized and not customizable. For example, THOR Average has no tenors other than 1, 3, and 6 months and there are no rates published on non-business days. Therefore, THOR Average may not be suitable for some financial contracts. |

[12] Interest payment for the interest period = $\frac{\text{Principal} \times \text{THOR Average} \times \text{Number of calendar days in the interest period}}{365}$

| | | |
|---|---|---|
| | | 2. The reference periods for THOR Average may be different from the interest period of derivatives. Therefore, users may not perfectly hedge their financial contracts with derivatives. |

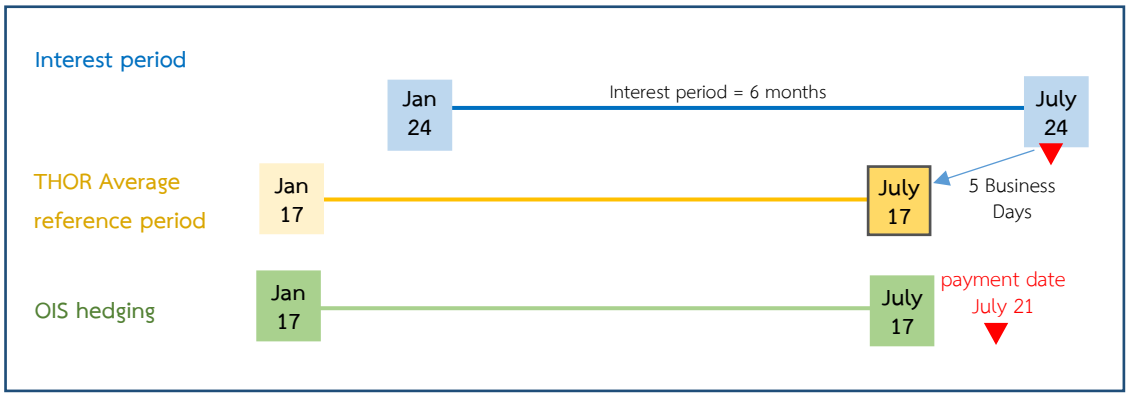
**5. Hedging instruments to manage overnight interest rate risk**

Although THOR moves in line with the policy rate and experiences low volatility, market participants may still face rate volatility, especially for long term contracts. To hedge against overnight interest rate risk, BOT and market participants have started developing the "overnight index swaps" (OIS).

OIS is an interest rate swap agreement where a fixed rate is swapped against a floating rate, which is an index of an overnight reference rate. According to the standard OIS convention and the compounded THOR methodology outlined in the Supplement number 65 and 77 to the 2006 ISDA Definitions, the floating leg is obtained from taking the compound average on business days and the simple average on non-business days for the period of interest. The BOT, on behalf of the Steering Committee on Commercial Banks' Preparedness on LIBOR Discontinuation, has issued a guideline for the conventions of OIS and USDTHB Cross-Currency Swap (CCS) referencing THOR for the Interbank market. According to the guideline, the net settlement for the floating leg and fixed leg is two business days after the period end date (payment delay) to allow for sufficient time to prepare for payment. For long term contracts, interest will be settled every 3 months, using the modified following business day convention.

To effectively hedge the overnight rate risk for THOR-linked loans using OIS, we should match the observation periods of the two contracts as closely as possible. Nevertheless, the payment dates can still differ no matter how closely the observation period of loans matches the OIS interest period. This is because OIS uses a 2 business day payment delay convention. Meanwhile, loan contracts may use other conventions and a different length of buffer time to prepare payment settlement. To illustrate this point, Figure 6 provides an example of a 6-months loan contract from January 24, 2020 to July 24, 2020, using 5-business day backward shift convention. The observation period is from January 17, 2020 to July 17, 2020. By matching the OIS interest period to the loan's observation period, the OIS settlement is 3 days before the loan payment date.

Figure 6: OIS hedging for loan referencing THOR Average



## Annex 1: Methods to calculate an interest rate for each interest period from an overnight rate

Reference rates for financial transactions in global market have been changed from a forward-looking term rate, such as LIBOR, to an overnight rate, such as SOFR, SONIA, ESTR, and THOR.

Although a financial contract references an overnight rate, its interest payment schedule is usually longer than a daily basis. Therefore, the interest rate for each interest period must be calculated from the overnight rates. Two approaches are available, namely (A) compound average approach and (B) simple average approach.

### A. Compound Average Approach

The compound average approach is a method to calculate an interest rate in each interest period by compounding the overnight rates to allow for time value of money. This method is available in 2 options.

**Option 1** Annualized Cumulative Compounded Daily Rate

**Option 2** Daily Non-Cumulative Compounded Overnight Rate; comprising 3 steps:

Step 1: Annualized Cumulative Compounded Daily Rate (The same method as Option 1)

Step 2: Unannualized Cumulative Compounded Daily Rate

Step 3: Daily Non-Cumulative Compounded Overnight Rate

The details of both options vary according to conventions when applying the overnight rate, e.g. Lookback with Observation Shift, Lookback without Observation Shift, Lock-out.

### 1. Lookback with Observation Shift

**Daily Non-Cumulative Compounded THOR Rate**

**Step 1: Annualized Cumulative Compounded Daily Rate (ACCDRi)**

$$\left[\prod_{i=1}^{d_0}\left(1+\frac{DailyRate_i \times n_i}{dcc}\right)-1\right]\times\frac{dcc}{tn_i}$$

The ACCDR for any Business Day during that Interest Period (the "**Cumulated Business Day**") is the percentage rate per annum (rounded to [5] decimal places) calculated as set out above where:

"$d_0$" means the number of Business Days in the OP Cumulation Period;

"**OP Cumulation Period**" means the period from, and including, the Corresponding OP Day for the first day of the IP Cumulation Period to, and including, the Corresponding OP Day for the last day of the IP Cumulation Period;

"**Corresponding OP Day**" means, in relation to any Business Day "**bd**" during that Interest Period, the Business Day which:

(a) is in the Observation Period; and

(b) falls the applicable Lookback Period prior to that Business Day "**bd**";

"**Observation Period**" means the period from and including the day falling the applicable Lookback Period prior to the first day of that Interest Period and ending on, but excluding, the day falling the applicable Lookback Period prior to the last day of that Interest Period;

"**Lookback Period**" or "**LP**" means [five] Business Days;

"**IP Cumulation Period**" means the period from, and including, the first Business Day of that Interest Period to, and including, that Cumulated Business Day;

"**i**" means a series of whole numbers from one to $d_0$, each representing the relevant Business Day in chronological order in the OP Cumulation Period;

"**DailyRate$_i$**" means, for any Business Day "**i**" in the OP Cumulation Period, the Daily Rate for that Business Day "**i**";

"**$n_i$**" means, for any Business Day "**i**" in the OP Cumulation Period, the number of calendar days from, and including, that Business Day "**i**" up to, but excluding, the following Business Day;

"**dcc**" means 365; and

"**$tn_i$**" means the number of calendar days from, and including, the first day of the OP Cumulation Period to, but excluding, the Business Day which immediately follows the last day of the OP Cumulation Period.

| **Step 2: Unannualised Cumulative Compounded Daily Rate (UCCDR$_i$)** | $ACCDR_i \times \frac{tIPn_i}{dcc}$ |
|---|---|

The "**Unannualised Cumulative Compounded Daily Rate**" for any Cumulated Business Day during that Interest Period is the result of the above calculation (without rounding, to the extent reasonably practicable for the Lender performing the

calculation, taking into account the capabilities of any software used for that purpose) where:

"**ACCDR**" means the ACCDR for that Cumulated Business Day;

"**tIPn$_i$**" means the number of calendar days from, and including, the first day of the IP Cumulation Period to, but excluding, the Business Day which immediately follows the last day of the IP Cumulation Period;

"**IP Cumulation Period**" has the meaning given to that term in Step 1; and

"**dcc**" means 365.

| **Step 3: Daily Non-Cumulative Compounded THOR Rate$_i$ (DNCR$_i$)** | $(UCCDR_i - UCCDR_{i-1}) \times \frac{dcc}{IPn_i}$ |
|---|---|

The "**DNCR**" for any Business Day "**i**" during an Interest Period for a Loan is the percentage rate per annum (without rounding, to the extent reasonably practicable for the Lender performing the calculation, taking into account the capabilities of any software used for that purpose) calculated as set out above where:

"**UCCDR$_i$**" means UCCDR$_i$ for that Business Day "**i**";

"**UCCDR$_{i-1}$**" means, in relation to that Business Day "**i**", the UCCDR$_i$ for the immediately preceding Business Day (if any) during that Interest Period;

"**dcc**" means 365; and

"**IPn$_i$**" means the number of calendar days from, and including, that Business Day "**i**" up to, but excluding, the following Business Day.

**2. Lookback without Observation Shift**

**Daily Non-Cumulative Compounded THOR Rate**

| **Step 1: Annualized Cumulative Compounded Daily Rate (ACCDRi)** | $\left[\prod_{i=1}^{d_0}\left(1+\frac{DailyRate_{i-LP} \times n_i}{dcc}\right)-1\right] \times \frac{dcc}{tn_i}$ |
|---|---|

The ACCDR for any Business Day during that Interest Period (the "**Cumulated Business Day**") is the percentage rate per annum (rounded to [5] decimal places) calculated as set out above where:

"**$d_0$**" means the number of Business Days in the Cumulation Period;

"**Lookback Period**" or "**LP**" means [five] Business Days;

"**Cumulation Period**" means the period from, and including, the first Business Day of that Interest Period to, and including, that Cumulated Business Day;

"**i**" means a series of whole numbers from one to $d_0$, each representing the relevant Business Day in chronological order in the Cumulation Period;

"**DailyRate$_{i-LP}$**" means, for any Business Day "**i**" in the Cumulation Period, the Daily Rate for the Business Day which is the Lookback Period prior to that Business Day "**i**";

"**$n_i$**" means, for any Business Day "**i**" in the Cumulation Period, the number of calendar days from, and including, that Business Day "**i**" up to, but excluding, the following Business Day;

"**dcc**" means 365; and

"**$tn_i$**" means the number of calendar days from, and including, the first day of the Cumulation Period to, but excluding, the Business Day which immediately follows the last day of the Cumulation Period.

| **Step 2: Unannualised Cumulative Compounded Daily Rate (UCCDR$_i$)** | $ACCDR_i \times \frac{tn_i}{dcc}$ |
|---|---|

The "**Unannualised Cumulative Compounded Daily Rate**" for any Cumulated Business Day during that Interest Period is the result of the above calculation (without rounding, to the extent reasonably practicable for the Lender performing the calculation, taking into account the capabilities of any software used for that purpose) where:

"**ACCDR$_i$**" means the ACCDR for that Cumulated Business Day;

"**$tn_i$**" has the meaning given to that term in Step 1;

"**Cumulation Period**" has the meaning given to that term in Step 1; and

"**dcc**" means 365.

| **Step 3: Daily Non-Cumulative Compounded THOR Rate$_i$ (DNCR$_i$)** | $(UCCDR_i - UCCDR_{i-1}) \times \frac{dcc}{n_i}$ |
|---|---|

The "**DNCR**" for any Business Day "**i**" during an Interest Period for a Loan is the percentage rate per annum (without rounding, to the extent reasonably practicable

for the Lender performing the calculation, taking into account the capabilities of any software used for that purpose) calculated as set out above where:

"**UCCDR$_i$**" means UCCDR$_i$ for that Business Day "**i**";

"**UCCDR$_{i-1}$**" means, in relation to that Business Day "**i**", the UCCDR$_i$ for the immediately preceding Business Day (if any) during that Interest Period;

"**dcc**" means 365; and

"**n$_i$**" means the number of calendar days from, and including, that Business Day "**i**" up to, but excluding, the following Business Day.

**3. Lock-out**

**Daily Non-Cumulative Compounded THOR Rate**

| | |
|---|---|
| **Step 1: Annualized Cumulative Compounded Daily Rate (ACCDRi)** | $\left[\prod_{i=1}^{d_0}\left(1+\frac{DailyRate_i \times n_i}{dcc}\right)-1\right]\times\frac{dcc}{tn_i}$ |

The ACCDR for any Business Day during that Interest Period (the "**Cumulated Business Day**") is the percentage rate per annum (rounded to [5] decimal places) calculated as set out above where:

"**d$_0$**" means the number of Business Days in the Cumulation Period;

"**Cumulation Period**" means the period from, and including, the first Business Day of that Interest Period to, and including, that Cumulated Business Day;

"**i**" means a series of whole numbers from one to d$_0$, each representing the relevant Business Day in chronological order in the Cumulation Period;

"**DailyRate$_i$**" means, for any Business Day "**i**" in the Cumulation Period, the Daily Rate for that Business Day "**i**";

"**n$_i$**" means, for any Business Day "**i**" in the Cumulation Period, the number of calendar days from, and including, that Business Day "**i**" up to, but excluding, the following Business Day;

"**dcc**" means 365; and

"**tn$_i$**" means the number of calendar days from, and including, the first day of the Cumulation Period to, but excluding, the Business Day which immediately follows the last day of the Cumulation Period.

| **Step 2: Unannualised Cumulative Compounded Daily Rate (UCCDRi)** | $ACCDR_i \times \frac{tn_i}{dcc}$ |
|---|---|

The "**Unannualised Cumulative Compounded Daily Rate**" for any Cumulated Business Day during that Interest Period is the result of the above calculation (without rounding, to the extent reasonably practicable for the Lender performing the calculation, taking into account the capabilities of any software used for that purpose) where:

"**ACCDR$_i$**" means the ACCDR for that Cumulated Business Day;

"**tn$_i$**" has the meaning given to that term in Step 1;

"**Cumulation Period**" has the meaning given to that term in Step 1; and

"**dcc**" means 365.

| **Step 3: Daily Non-Cumulative Compounded THOR Rate (DNCRi)** | $(UCCDR_i - UCCDR_{i-1}) \times \frac{dcc}{n_i}$ |
|---|---|

The "**DNCR**" for any Business Day "**i**" during an Interest Period for a Loan is the percentage rate per annum (without rounding, to the extent reasonably practicable for the Lender performing the calculation, taking into account the capabilities of any software used for that purpose) calculated as set out above where:

"**UCCDR$_i$**" means UCCDR$_i$ for that Business Day "**i**";

"**UCCDR$_{i-1}$**" means, in relation to that Business Day "**i**", the UCCDR$_i$ for the immediately preceding Business Day (if any) during that Interest Period;

"**dcc**" means 365; and

"**n$_i$**" means the number of calendar days from, and including, that Business Day "**i**" up to, but excluding, the following Business Day.

**B. Simple Average Approach**

The simple average approach is a method to calculate an interest rate in each interest period by disregarding the time value of money.

$$\left[\sum_{i=1}^{d_b}\left(\frac{Daily\ Rate_i \times n_i}{dcc}\right)\right] \times \frac{dcc}{d_c}$$

"**$d_b$**" means the number of Business Days in the Interest Period;

"**i**" means a series of whole numbers from one to $d_b$, each representing the relevant Business Day in chronological order in the Interest Period;

"**DailyRate$_i$**" means, for any Business Day "**i**" in the period, the Daily Rate for that Business Day "**i**";

"$n_i$" means, for any Business Day "i" in the Interest Period, the number of calendar days from, and including, that Business Day "i" up to, but excluding, the following Business Day;

"**dcc**" means 365; and

"**$d_c$**" means the number of calendar days in the Interest Period.

As the simple average approach does not factor in the concept of time value of money, an interest rate calculated by this approach may not precisely represent relevant financial costs. Also, an additional cost may arise as a result of basis when a loan contract bases on the simple average approach but its hedging contract employs the compounding approach which is a standard practice for derivatives. Therefore, both counterparties should carefully decide which approach to be applied in a lending/borrowing transaction.

## Annex 2: THOR Pilot Lending Practice

The BOT, on behalf of the Steering Committee on Commercial Banks' Preparedness on LIBOR Discontinuation (the committee), has conducted a survey for opinions across banks in Thailand, ranging from those participating in the committee as well as those outside of the committee.

This Pilot Lending Practice is provided to assist commercial banks to start developing their loans referencing Thai Overnight Repurchase Rate (THOR) based on the majority of views that were provided. Commercial banks and their clients may choose to use other conventions for loans referencing THOR they deem suitable.

### Pilot Lending Practice

| | |
|---|---|
| **Floating Rate** | THOR (compounded) |
| **Convention** | Lookback with observation shift (Backward Shifted Observation) |
| **Number of Days for Lookback** | 5 Bangkok Business Days |
| **Interest Rate Floor** | Floor is applied to compounded THOR at the end of each calculation period (before adding margin) |
| **Fallback Rate for THOR** | BOT's Recommended Rate |

## Annex 3: THOR Derivative Conventions for Interbank

The BOT, on behalf of the steering committee on commercial banks' preparedness on LIBOR discontinuation (the committee), has conducted a survey for opinions across banks in Thailand, ranging from those participating in the committee as well as those outside of the committee.

This document is provided as a guideline for the conventions of Overnight Interest Rate Swap (OIS) and USDTHB Cross-Currency Swap (CCS) referencing Thai Overnight Repurchase Rate (THOR) for the Interbank market based on the majority of views that were provided. (Different conventions may be applied for non-interbank counter parties)

### Recommended THOR OIS Conventions

| | |
|---|---|
| **Trade Date** | T |
| **Effective Date** | 2 Business Days following Trade Date (T+2) |
| **Reset Date** | The last day of each calculation period |
| **Floating Rate** | THOR (Daily compounding over each calculation period) |
| **Interest Convention** | Actual/365 |
| **Delayed Payment** | 2 Business Days |
| **Payment Frequency** | Shorter than 1-year maturity: At maturity<br>1-year maturity and longer: Quarterly |
| **Business Days** | Bangkok |
| **Business Day Convention** | Modified Following |

### Recommended THOR – SOFR CCS Conventions

| | |
|---|---|
| **Trade Date** | T |
| **Effective Date** | 2 Business Days following Trade Date (T+2) |
| **Initial Exchange** | Effective Date |
| **Final Exchange** | Termination Date |
| **Reset Date** | The last day of each calculation period |
| **Floating Rates** | THOR and SOFR (Daily compounding over each calculation period) |
| **Interest Convention** | Actual/365 for THOR and Actual/360 for SOFR |
| **Delayed Payment** | 2 Business Days |
| **Payment Frequency** | Shorter than 1-year maturity: At maturity<br>1-year maturity and longer: Quarterly |
| **Business Days** | Bangkok and New York |
| **Business Day Convention** | Modified Following |

## Annex 4: BOT THOR Floating Rate Notes Term Sheet and Calculation Convention

| | |
|---|---|
| **Issuer** | Bank of Thailand |
| **Currency** | THB |
| **Par** | 1,000 |
| **Interest Type** | Floating Rate |
| **Benchmark** | Thai Overnight Repurchase Rate (THOR), compounded in arrears or "Compounded THOR" |
| **FRN Structure** | 5-day Backward Shifted Observation Period |
| **Reset Frequency** | Every Bangkok business day |
| **Coupon Rate** | Compounded THOR + Quoted Margin (QM)<br>Please note that coupon rate will be floored at zero |
| **Quoted Margin (QM)** | As determined by BOT |
| **Coupon Frequency** | 1-year and under 1-year tenor (CBF): Pay at maturity<br>Longer than 1-year tenor (BOTF): Pay quarterly |
| **Day Count Convention** | Actual/365 |
| **Business Day Convention** | Following, Adjusted<br>If any scheduled interest payment date, other than the maturity date falls on a day that is not a business day, such interest payment date will be postponed to the following business day.<br>If the scheduled final interest payment date or the maturity date falls on a day that is not a business day, the payment of principal and interest will be made on the next succeeding business day, but the final interest payment date will not be postponed and interest on that payment will not accrue during the period from and after the scheduled final interest payment date. |
| **Auction Technique** | Bid discount margin (DM) or spread above benchmark rate (can be negative, zero or positive) |
| **Secondary Market Trading** | Quote discount margin (DM) or spread above benchmark rate (can be negative, zero or positive) |