

# LME Closing Price methodology blueprint

## 1 Introduction

### 1.1 Purpose of this document

This LME Closing Price methodology blueprint (“**Pricing Blueprint**”) is designed to form the basis of market engagement to support the evolution of the calculation methodology for establishing the LME’s Closing Prices based on electronic data. This Pricing Blueprint will form the starting point for the activities of a Closing Price working group (the “**CPWG**”). The role of the CPWG will be to suggest practical enhancements or alternatives to this methodology in order to ensure that the future electronic Closing Price methodology is as reliable and representative as possible.

Following the work of the CPWG, the proposed evolved Closing Price methodology will be subject to consultation, as appropriate, in accordance with applicable regulatory requirements (including, amongst others, under the UK Benchmarks Regulation).

### 1.2 Overview

Section 2 of this document outlines the principles the LME considers relevant in evolving the pricing methodology. It then lays out how these principles should specifically apply to the LME Closing Price methodology. This section then goes on to explain the process that the LME will follow in order to evolve the methodology, provides further detail on the CPWG and gives a high-level overview of the LME’s current thinking on pricing methodology.

Section 3 of this document provides more detail on the LME’s proposed approach to support the discussion. The LME differentiates between the front-of-curve (“**FC**”) methodology (which is used as a shorthand term, but does not include all prompt dates at the front of the curve), and rest-of-curve (“**RC**”) methodology. For the FC methodology the LME provides a detailed explanation of the proposed calculation. For the RC methodology the LME outlines a number of considerations and possible approaches (including a currently preferred approach), including some key advantages and disadvantages of each in order to support the discussion.

Section 4 then provides a number of detailed pricing examples to illustrate the proposed FC methodology and to support the discussion.

Any stakeholder wishing to volunteer for involvement with the CPWG should email [market.engagement@lme.com](mailto:market.engagement@lme.com). To form the CPWG the LME is looking to select a broad group of stakeholders reflecting a cross-section of LME members and the wider market participant population, to ensure that a broad range of views is represented. In order to give participants time to digest the proposals, the LME intends to hold the first CPWG meeting in early July 2021, with further meetings intended to be held fortnightly over July and August.

Although the Pricing Blueprint is not the subject of formal consultation at this time, the LME welcomes any informal views from market stakeholders on the matters set out in the Pricing Blueprint. Any feedback should be sent to [market.engagement@lme.com](mailto:market.engagement@lme.com).

This document has been written primarily to inform participants who have experience of LME terminology and trading practices and it may therefore include technical terminology. Where there are any terms or specifics that require clarification, please contact the LME to discuss.



## 2 Overview of pricing evolution

### 2.1 Background

The LME creates a daily Closing Price forward curve in order to provide valuations to its members and clients, and crucially, to the LME's clearing house, LME Clear, for valuation and risk management purposes. This methodology is designed to reflect the prevailing market price of each point on the curve as closely as possible given the available, relevant information.

It is important that any evolution of the methodology takes into consideration industry standard techniques to price electronic markets, as well as capturing any nuances of the LME curve structure and market dynamics.

The development of such a methodology should not only produce a robust valuation curve, but should be designed having considered the impacts on trading behaviour, systems, processes and all appropriate compliance and regulatory implications.

### 2.2 Key considerations of pricing

In the Discussion Paper on Market Structure (the "**Discussion Paper**"), the LME outlined the key considerations in optimising a pricing process for the benefit of the market as a whole: access for participants, transparency, and volume.

Based on these fundamental considerations, the LME has identified five key principles that it believes are specifically relevant in evolving the Closing Price methodology:

1. The pricing curve should reflect prevailing prices at the end of the day
2. The methodology should generally be based on trades, with it being preferable that higher volumes are captured
3. The methodology should be transparent and repeatable for the same set of input data limiting the need for judgement-based decisions
4. The methodology should be robust and consistent in generating valuations
5. The methodology should be replicable, in order to ensure that participants are able to fully understand how their trading impacts the process, and appropriately hedge efficiently

These principles must be balanced against each other, taking into account wider market considerations, in order to inform the evolution of the Closing Price methodology.

### 2.3 Approach to evolving the Closing Price methodology

The LME welcomes views from stakeholders to help evolve the Closing Price methodology, and will take these views into account in the context of the LME's regulatory obligations as both the operator of a recognised investment exchange and a benchmark administrator. To balance the need for transparency in the evolution of the methodology, as well as ensuring compliance with its regulatory obligations, the LME has identified a series of next steps to finalise the proposed evolved Closing Price methodology for CPWG consideration, following which the CPWG proposal will be subject to public consultation:

1. Pricing Blueprint to be discussed by the CPWG and consider preferred approaches
2. LME to consider feedback from CPWG and any other informal feedback received from market stakeholders more broadly, and confirm proposed methodology for consultation
3. Consultation on new methodology ahead of adoption (subject to regulatory approval)
4. Methodology will continue to be reviewed by the LME over time to ensure its effectiveness. Any necessary further refinement will be considered alongside further market engagement and/or public consultation where appropriate

### 2.4 Closing Price Working Group

As previously mentioned, the LME will establish the CPWG in order to discuss the Pricing Blueprint and to develop an evolved pricing methodology for subsequent public consultation (see further below). Stakeholders interested in participating in the CPWG are asked to contact the LME at



[market.engagement@lme.com](mailto:market.engagement@lme.com). To form the CPWG the LME is looking to select a broad group of stakeholders reflecting a cross-section of LME members and the wider market participant population, to ensure that a broad range of views is represented.

Following engagement with the CPWG (and considering other feedback received) the LME will develop a new pricing methodology. This new methodology will be subject to formal public consultation. The LME anticipates that this consultation will be undertaken during the second half of 2021, which would allow the new methodology to be adopted sometime in early 2022 (subject to the outcome of the consultation, and subject to obtaining any required regulatory approvals).

It is worth noting that the LME considers it is likely that the FC methodology could be relatively easily adopted by the market in a fully formed and highly deterministic methodology in 2022. However, it is most likely appropriate to develop the rest of curve (“RC”) methodology over time. This will give market participants time to adapt to the methodology changes, and to adjust trading practices and business models, where required.

## **2.5 Overview of the LME proposal for evolving the pricing methodology for the LME Closing Prices**

### **2.5.1 Front-of-curve methodology**

In outlining the proposal to evolve the pricing methodology, the LME has identified a set of liquid contracts at the front-of-curve for which it believes, based on its initial analysis, that there is already sufficient electronic liquidity to consistently price using a highly deterministic industry standard methodology adjusted to suit the LME’s unique date structure. The LME’s thinking on this part of the curve has been informed by significant feedback into the Discussion Paper on Market Structure, and other informal feedback obtained through ongoing market engagement. This FC methodology is highly deterministic, such that in general, prices can be calculated by applying a known formula rather than requiring interpretation or expert judgement.

Based on the LME’s initial analysis using recent data, the FC methodology, outlined in detail in section 3 of this document, generates stable and deterministic pricing for the 3-month (3m) contract, and the first four monthly contracts (M1, M2, M3, M4) for the core six base metals (aluminium, copper, lead, nickel, tin and zinc). While there are differences in the liquidity of these metals, in the LME’s view using the front four monthly dates, represents a balanced approach that ensures sufficient liquidity for robust pricing and provides market participants with a simple, replicable methodology.

The FC methodology establishes the most liquid 3-month price, then according to a defined order, values the monthly contracts based on trades in the carry contracts linking the monthly contract in question with the already priced instrument(s). The LME has performed some initial testing for the FC methodology, and is confident that it meets the principles of pricing outlined in section 2 of this document.

### **2.5.2 Rest-of-curve methodology**

For the rest of the curve, which covers the longer dated monthly contracts and the daily prompt dates (within the prices already set by the FC methodology), the LME is of the view that, due to the high number of data points and fluctuating liquidity, a fully deterministic ruleset may be challenging for the market to adopt, and certainly in the short term.

In order to evolve the pricing methodology in line with the principles outlined above, the LME believes it is important to have a clear approach to resolving pricing conflicts, though a level of expert judgement may still be required due to the complexity of the LME’s date structure.

The LME has however outlined a number of possible priority approaches for the RC that could enhance determinism and transparency, alongside an analysis of the key advantages and disadvantages of each approach. While the intention is to also create more determinism for this RC methodology, it is accepted that the ability to apply a level of expert judgement is likely to be required in order to ensure Closing Prices continue to most accurately reflect prevailing prices in the broadest range of circumstances possible.

The LME’s current preferred approach, subject to CPWG consideration and ultimately, to public consultation, would be to use a combined set of priorities. Initially a series of “prime carries” that take precedence would



be calculated using a volume weighted average price methodology (for example Cash-M1 and carries between Mar, Jun, Sep and Dec sequentially beyond the fourth monthly). For other prompt dates, an order of priority could be established (such as shorter carries taking precedence), while also giving consideration to volume.

### 3 Detailed explanation of the LME's proposed Closing Price pricing methodology

The following section gives a more detailed explanation of the LME's proposed pricing methodology for the LME's Closing Prices, including detailed examples for the FC methodology and an analysis of the strengths and weaknesses of alternative pricing approaches to support the discussion around the RC methodology.

As noted previously, this document will form the basis of the discussion with the CPWG whereby market participants will be able to discuss the merits of the various approaches and, where appropriate, suggest changes to the logic or alternative methodologies ahead of the LME finalising the pricing methodology, which will then be put to a public consultation.

Therefore, some areas of the methodology may be further evolved or changed in some regards prior to finalisation. The detail below represents the LME's current working hypothesis of how best to evolve the pricing methodology, and the LME welcomes further input from market participants via the CPWG or via email to [market.engagement@lme.com](mailto:market.engagement@lme.com).

#### 3.1 Front-of-curve methodology

This front-of-curve methodology establishes a deterministic approach for pricing the liquid contracts at the front of LME forward curves. It is based on a volume weighted average price ("VWAP") calculation of trades during pricing windows. The FC framework below has been written in a flexible manner, with the intention that it is scalable and could be applied to additional prompt dates if necessary. The approach set out in the Pricing Blueprint to price the front of the curve is to:

1. Establish the 3-month price (anchor contract) using a VWAP calculation during a short pricing window.
2. Then, in a defined order, price each third Wednesday monthly contract using the carries between that month and all other contracts that have already been priced. So, for example, 3m outright first, then M1-3m to establish M1, then use both M2-3m and M1-M2 to establish M2 etc.

The carry prices will be established over a longer pricing window to allow for more volume to contribute to stable price establishment. As such, no outright trades for prompts other than 3-month will be included in the calculation as otherwise the outright prices for the monthly contracts may not align to the 3-month pricing window.

If a contract being priced does not have any trades in the appropriate instruments (the carries described above) during the relevant pricing window, then a Time Weighted Average Price ("TWAP") of an "Indicator Reference Price" ("IRP") is used. This IRP reflects the last trade (or previous day's close if there are no trades), dragged higher or lower by a respective better bid or offer (during the carry pricing window).

The key parameters, and the detail of the calculation of the FC methodology is explained below. For detailed pricing examples please see section 3 of this document.



### 3.1.1 Parameters (FC methodology)

#### Anchor contracts:

Anchor point	Month
Primary:	3-month (3m)
Other:	None

#### Carry VWAP Contract order:

	If current date is before (inclusive of) the 1st Wednesday of the current month OR after (inclusive) the 3rd Wednesday of the current month	If current date is after the 1st Wednesday of the current month AND before the 3rd Wednesday of the current month
1	1st 3rd Wednesday (M1)	2nd 3 <sup>rd</sup> Wednesday (M2)
2	2nd 3rd Wednesday (M2)	3rd 3rd Wednesday (M3)
3	3rd 3rd Wednesday (M3)	4th 3rd Wednesday (M4)
4	4th 3rd Wednesday (M4)	1st 3rd Wednesday (M1)

This order ensures that the nearest option expiry month is always the first contract priced after 3-month, to give options traders a simple pricing method, while avoiding having very near dated contracts high up the priority order which is sub optimal because liquidity can reduce closer to the prompt date.

#### Pricing windows:

	Anchor Contract Pricing Window	Carry Contract Pricing Window
Aluminium	16:30:00:000 – 16:34:59:999	16:00:00:000 – 16:29:59:999
Copper	16:45:00:000 – 16:49:59:999	16:15:00:000 – 16:44:59:999
Lead	16:15:00:000 – 16:19:59:999	15:45:00:000 – 16:14:59:999
Nickel	16:55:00:000 – 16:59:59:999	16:25:00:000 – 16:54:59:999
Tin	16:05:00:000 – 16:09:59:999	15:35:00:000 – 16:04:59:999
Zinc	15:55:00:000 – 15:59:59:999	15:25:00:000 – 15:54:59:999



**Rounding:**

	<b>Anchor Contract</b>	<b>Carry VWAP Contract</b>
Aluminium	\$0.5/mt	\$0.25/mt
Copper	\$0.5/mt	\$0.25/mt
Lead	\$0.5/mt	\$0.25/mt
Nickel	\$5/mt	\$2.5/mt
Tin	\$5/mt	\$2.5/mt
Zinc	\$0.5/mt	\$0.25/mt

**Minimum volume requirements:**

	<b>Outright MVR</b>	<b>Carry MVR</b>
Aluminium	1	1
Copper	1	1
Lead	1	1
Nickel	1	1
Tin	1	1
Zinc	1	1

These minimum volume requirements have been included to allow the methodology to be flexible, and are for discussion. The LME believes there is an advantage to having all MVRs set as 1, such that any trades during the respective pricing window will always take precedence.

**3.1.2 Calculation (FC methodology)**

**Anchor Contracts**

Each Anchor Contract is priced based on the following waterfall:

1. If the total volume of trades during the Anchor Contract Pricing Window is above the Outright MVR, the price will be the VWAP of outright trades in the Anchor Contract during the Anchor Contract Pricing Window
2. If the total volume of trades during the Anchor Contract Pricing Window is below the Outright MVR, use a TWAP of the Indicator Reference Price for the Anchor Contract during the Anchor Contract Pricing Window



## Carry VWAP Contracts

In order as listed, each Carry VWAP Contract is priced using the following waterfall:

1. VWAP of all carry trades during the Carry Contract Pricing Window between the Carry VWAP Contract and a contract which has already had its price established (because it is either an Anchor Contract or a Carry VWAP Contract), where the price used in the VWAP will be the traded carry price, applied to the already established price for the other contract.
2. If the total volume of all trades considered in this calculation is below the respective Carry MVR, use a TWAP of Indicator Reference Price during the Carry Contract Pricing Window for the spread between the respective Carry VWAP Contract and the nearest already established Carry VWAP Contract (or the Primary Anchor Contract when pricing the first Carry VWAP Contract), applied to the already established price.

### Indicator Reference Price (“IRP”)

If no trades during current day:

If [Current Bid > Previous Close] Then [IRP = Current Bid]

If [Current Offer < Previous Close] Then [IRP = Current Offer]

Otherwise [IRP = Previous Close]

If trades have occurred during current day:

If [Current Bid > Last Trade] Then [IRP = Current Bid]

If [Current Offer < Last Trade] Then [IRP = Current Offer]

Otherwise [IRP = Last Trade]

## 3.2 Rest of curve (RC) methodology

When pricing the rest of the forward curve, including both the daily prompt dates, and the longer dated monthly contracts, there are a number of considerations worth highlighting. The LME has provided some analysis below, and then created a number of tables outlining some of the advantages and disadvantages of some potential pricing approaches in order to inform understanding.

**Input data used to establish pricing** – historically the LME has used a “last price” methodology, which uses the last traded price (or bid if this is higher, or offer if this is lower) in order to establish the Closing Price. This is a simple methodology that is particularly well suited to open outcry trading, where it is easy for all participants to see where prices are currently trading, and easy to interact with the pricing process. Most electronic futures markets have moved to using some form of VWAP methodology (as has the LME for establishing the 3-month Closing Price when using the electronic venue). A VWAP methodology ensures that many trades are used to establish the Closing Price, and weights them by volume so that the Closing Price reflects where the majority of risk was transferred. The advantage of a VWAP methodology is that it is generally less influenced by individual trades, and does not encourage traders to focus on the end of the pricing window in order to target the Closing Price, thereby encouraging more consistent liquidity and stable price formation. Some advantages and disadvantages of both VWAP and last price methods are shown in the below table.





	<u>Advantages</u>	<u>Disadvantages</u>
<b>Last price</b>	<ul style="list-style-type: none"> <li>Existing methodology well understood by the market</li> <li>Supports members in guaranteeing Closing Price order</li> </ul>	<ul style="list-style-type: none"> <li>Can lead to a high number of conflicts (which require expert judgment in order to resolve)</li> <li>Does not take volume into account, so prices can be influenced by small orders and trades late in the pricing window</li> <li>Less representative of the fair value of an instrument over the entire pricing window</li> </ul>
<b>VWAP</b>	<ul style="list-style-type: none"> <li>More deterministic approach</li> <li>Encourages consistent participation throughout the pricing window</li> <li>Prices reflect the value of the instrument over the entire pricing window</li> <li>Makes less likely that individual trades or orders will influence prices</li> <li>Each trade's influence on the reference price is proportionate to its size</li> </ul>	<ul style="list-style-type: none"> <li>More difficult for small orders to replicate the price</li> <li>The calculation including all input data becomes more complex as you move further down the curve (as you consider carries from every previously priced instrument)</li> <li>It may be difficult to monitor the multiple component instruments involved in pricing any individual instrument</li> </ul>

**Resolving pricing conflicts** – the majority of pricing methods will need a way to resolve conflicts in the data. Conflicts arise as a natural product of trading activity in different linked carries across the forward curve, and while some conflicts are caused by arbitrage opportunities existing (e.g. Jun-Jul bid at \$4, Jul-Aug bid at \$4 and Jun-Aug offered at \$7), this is normally quickly arbitrated away by market participants. More commonly, pricing conflicts are a result of simple bid-offer spreads, and moving markets (e.g. both Jun-Jul and Jul-Aug are showing 4 bid at 5 offered, Jun-Aug is showing 8 bid at 10 offered, then Jun-Jul and Jul-Aug both trade at 4, while Jun-Aug trades at 10).

These pricing conflicts should be resolved by having an established method for giving priority to one price over another. There are a number of ways of establishing this priority, and the LME has outlined a few of the key ways in a table below to inform the basis of engagement with the market, but is keen to hear feedback on whether there are any other methods which participants think should be considered. Each method has a number of advantages and disadvantages concerning how they are likely to impact the Closing Prices, and the market more generally. The LME does have a view on the most appropriate path forward (set out below) but is very much open to evolving the methodology in line with feedback to this Pricing Blueprint with the CPWG.





**Consideration of priority approaches to resolve pricing conflicts:**

	<u>Advantages</u>	<u>Disadvantages</u>
<p><b>Carry order</b></p> <p>Establish a fixed order of priority for carries eg quarterly spreads (Mar/Jun/Sep/Dec) take precedent over monthly spreads, with other carries coming after. Alternatively shorter dated carries always take precedence over longer dated.</p>	<ul style="list-style-type: none"> <li>• Clear and simple methodology that market participants can easily understand</li> <li>• Significantly reduces the number of instruments that contribute towards an individual valuation</li> <li>• Predictable to monitor where Closing Prices are likely to be valued during the pricing period</li> <li>• Encourages liquidity to pool in certain spreads that are highest in the priority order, which ensures the highest priority carries have the most accurate pricing</li> </ul>	<ul style="list-style-type: none"> <li>• Carries that are not high priority will not necessarily have Closing Prices that exactly reflect the pricing activity during the pricing window (where it conflicts with higher priority carry data)</li> <li>• This may mean it is difficult to replicate Closing Prices for carries that are lower priority in in the waterfall</li> </ul>
<p><b>Volume priority</b></p> <p>All carries are ordered by their volume during the pricing window. Priority is given to the carry with greatest volume.</p>	<ul style="list-style-type: none"> <li>• The priority is based on the most liquid carries , those who trade more volume are more likely to closely achieve the Closing Price</li> </ul>	<ul style="list-style-type: none"> <li>• Complex calculation that requires market participants to monitor a variable set of instruments each day during the pricing window</li> <li>• The calculation can become very unstable where multiple instruments have volumes that are very close to one another, a small trade late in the window could change the priority and impact the Closing Prices</li> </ul>
<p><b>Time priority</b></p> <p>Priority given to the order that was entered earliest</p>	<ul style="list-style-type: none"> <li>• Encourages participants to enter interests as early as possible during the pricing window, which supports volume and transparency</li> </ul>	<ul style="list-style-type: none"> <li>• Ignores volume, a small trade can take priority over a very large trade in a conflict situation due to it having been executed earlier</li> </ul>

It is possible (and potentially advantageous) to combine a number of different approaches in order to establish the Closing Prices. This type of hybrid approach could take the benefits of a number of the approaches, but also becomes significantly more complicated operationally, and may lead to less certainty in terms of the potential outcomes of the pricing process.

**LME proposal for pricing the rest-of-curve methodology**

The LME currently believes that a combined approach is likely to be most appropriate as a first step, where a number “prime” carries (eg Cash-M1 & quarterly carries beyond M4) are established first on the basis of VWAPs. Following this, the remaining contracts can be established on the basis of expert judgement, taking into account a number of factors and some priority guidelines (such as prioritising volume, shorter carries over longer carries etc). However, the LME welcomes market feedback in this area, and this will be discussed during the CPWG.



## 4 Pricing examples for the front-of-curve methodology

The below example prices copper on 15 April 2021 (eg after 1st Wednesday of respective month AND before 3rd Wednesday of respective month). The prices used are for example only, and are not the prices which traded on 15 April 2021.

- 3-month Closing Price calculated by a VWAP of all 3-month trades between 16:45-16:50 eg \$9,201  
May (M2), Jun (M3), Jul (M4) and Apr (M1) are then all calculated in this order using trades between 15:45 and 16:45:
- May21 price is calculated as VWAP of all May21-3m carry trades, applied to 3m:

Instrument	Volume (lots)	Carry price	Known basis price	Price used in VWAP i.e. the 3m price +/- the carry price	VWAP price * volume
May21-3m	100	\$5	\$9,201	\$9,206	\$920,600
May21-3m	50	\$4		\$9,205	\$460,250
May21-3m	200	\$4.5		\$9,205.5	\$1,841,100
May21-3m	25	\$5		\$9,206	\$230,150
TOTAL	375				\$3,452,100

Established May21 price: \$9,205.75 (rounded from  $\$3,452,100 / 375 = \$9,205.60$ )

- Jun21 price is then calculated as VWAP of all May21-Jun21 trades, and Jun21-3m trades:

Instrument	Volume (lots)	Carry price	Known basis price	Price used in VWAP	VWAP price * volume
May21-Jun21	50	\$2.25	\$9,205.75	\$9,203.5	\$460,175
May21-Jun21	250	\$2.5	\$9,205.75	\$9,203.25	\$2,300,812.5
Jun21-3m	5	\$1.5	\$9,201	\$9,202.5	\$46,012.5
Jun21-3m	15	\$2.5	\$9,201	\$9,203.5	\$138,052.5
Total	320				\$2,945,052.5



Established Jun21 price: \$9,203.25 (rounded from \$9,203.29)

4. Jul21 price is then calculated as VWAP of all May21-Jul21, Jun21-Jul21 and 3m-Jul21 trades:

Instrument	Volume	Carry price	Known basis price	Price used in VWAP	VWAP price * volume
May21-Jul21	5	\$6	\$9,205.75	\$9,199.75	\$45,998.75
May21-Jul21	1	\$4	\$9,205.75	\$9,201.75	\$9,201.75
Jun21-Jul21	500	\$3	\$9,203.25	\$9,200.25	\$4,600,125
3m-Jul21	100	\$1	\$9,201	\$9,200	\$920,000
3m-Jul21	70	\$1.5	\$9,201	\$9,199.5	\$643,965
Total	676				\$6,219,290.5

Established Jul21 price: \$9,200.25 (rounded from \$9,200.13)

5. Apr21 price is then calculated as VWAP of all Apr21-May21 Apr21-Jun21, Apr21-3m and Apr-Jul21 trades. If we assume there were no trades, then Apr21 is priced as the TWAP of the Indicator Reference Price of Apr21-May21.

So given the following activity on Apr21-May21:

Previous day's close \$3.65

10 lot Bid entered at 16:20 of \$4 (no orders in the book prior to this)

10 lot Offer entered at 16:30 of \$4.5

100 lot Offer entered at 16:10 at \$4 (trades and offered over)

50 lot Offer entered at 16:30 at \$3.5

Then the TWAP of IRP for the following periods is:



Time Period	Duration of period	IRP of carry	IRP used in Apr TWAP (i.e. 3m price + IRP of spread)	Duration * IRP used in Apr TWAP
16:15 – 16:20	5 minutes	\$3.65 (no trades today, so use yesterday's close)	\$9,209.4	\$46,047
16:20 – 16:30	10 minutes	\$4 (bid is higher than previous close and the higher \$4.5 offer does not change the IRP)	\$9,209.75	\$92,097.5
16:30 – 16:35	5 minutes	\$4 (current offer and Last Trade)	\$9,209.75	\$46,048.75
16:35 – 16:45	10 minutes	\$3.5 (current offer is below Last Trade)	\$9,209.25	\$92,092.5
<b>Total</b>	<b>30 minutes</b>			<b>\$276,285.75</b>

Established Apr21 price: \$9,209.50 (rounded from  $\$276,285.75 / 30 \text{ minutes} = \$9209.53$ )

Whole minutes are used in this example for simplicity. The calculation will actually be done at a millisecond level as per market data timestamping.