US Options

Opening Process

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Contents

1   Overview

The Cboe-affiliated US Options Exchanges offer customers the ability to queue orders during the pre-market and regulatory halt periods ("Queuing Period"), after which the Opening Process matches crossable interest at a designated Opening Price and transitions to normal trading.

The BZX Options (BZX), Cboe Options (C1), C2 Options (C2), and EDGX Options (EDGX) Exchanges use a Price Forming Opening Process where opening prices are determined through a matched contracts maximizing and imbalance minimizing process that is collared by external markets for series for which external markets exist.

A distinct Opening Process applies to Complex instruments on the EDGX, C2, and C1 Options Exchanges. Complex instruments open/re-open in a process dependent on the state of the constituent Single Leg Books. Specifically, Complex instruments open/re-open when all constituent Single Leg books transition to the open state and the Complex book opening price is within the synthetic best bid / best offer range formed from the Single Leg book markets. See the 'US Option Complex Book Process' for more detail on the Complex Instruments opening process.

2 Price Forming Opening Process

A price forming opening process is used on all Cboe US Options Exchanges (BZX, C1, C2, and EDGX Options) to open proprietary and multi-list option series at the beginning of Global Trading Hours (GTH), Regular Trading Hours (RTH), and to re-open after regulatory halts. GTH is only supported on the C1 Exchange.

The price forming opening process applies to the following four distinct categories of classes:

Table 1 – *C1 options class categories*

Option class category	Description
Multi-list	Classes that trade on away markets and an Away Best Bid / Offer (ABBO) exists. Multi-list series trade RTH only and do not trade in GTH or Curb sessions.
No-GTH Proprietary	Proprietary classes that trade in RTH only, and as a result, there is no GTH continuous book coincident with the RTH pre-open Queuing book. In addition, these classes do not have a Curb trading session.
GTH-Enabled Proprietary (C1 only)	Proprietary classes that trade in GTH and RTH sessions. The Queuing period for GTH and RTH sessions start at the same time. GTH queuing starts at 8:00 p.m. ET. The GTH session ends 15 minutes before the RTH session begins. The same opening process is used for the opening of the GTH and RTH sessions, except for SOQ Constituent series (below).
SOQ Constituent Series (C1 only)	A subset of GTH-Enabled Proprietary Classes that on specific dates are constituent series of a Volatility Derivative expiration Special Opening Quote (SOQ). Constituent series RTH opening uses a restrictive form of the Opening Process known as the Volatility Opening Process.

For all class categories, the following applies:

- Match Trade Prevention (MTP) is not in-effect during the matching phase of crossed-book openings.

- QRM Risk Limits are in-effect during the Opening Process. However, risk limit trips during the matching phase of crossed-book series openings will not interrupt the opening of that series.

  - Three distinct sets of QRM Risk Limits are made available for users to provision; GTH, RTH, Curb, and Volatility:
    - GTH Risk Limits are in-effect during the GTH Opening (and during GTH live trading)
    - RTH Risk Limits are in-effect during the RTH Opening (and during RTH live trading)
    - Curb session Risk Limits are in-effect during Curb live trading
    - Volatility Risk Limits are in-effect during the RTH Opening for SOQ Constituent Series (a subset of GTH/Curb-Enabled Proprietary Series on Volatility Expiration Dates)
- Opening triggers, specific to each category, must be observed in order to initiate the opening process (defined in respective sections below).

- The Volume Maximizing Imbalance Minimizing (VMIM) algorithm is used to determine the opening price for crossed books, with category-specific collars and width checks as defined below.

- For a period of time during the queuing period in all class categories, `Options Auction Update` messages are disseminated on PITCH, TOP and Opening Process Data Feeds that provide expected opening price, size and imbalance information (see 'VMIM Algorithm' and 'Auction Update Message' sections below for more detail on `Options Auction Update` message content).

- For SOQ Constituent Series, a cutoff time exits after which special Settlement Liquidity Orders on the Open (SLOO) orders are accepted and restrictions on updates to existing orders are in place (see Section 3.9.3 – Volatility Opening Cutoff Time for details).

2.1   Composite Market Definition

The term 'Composite Market' is used below in the presentation of Opening Information Dissemination, Maximum Width Checks and establishing Opening Collars. The following are the functions of the Composite Market in the Opening Process, all of which are described in associated sections of this document:

- The Composite Market Bid Price is used to look-up Maximum Width and Opening Collar Width values from published parameter tables.
- The width of the Composite Market is the width against which Maximum Width Checks are applied
- Opening Collars are positioned by centering the Opening Collar Width on the midpoint of the Composite Market.

The following table defines the Composite Market associated with each type of option class:

Table 3 – *Composite Market definitions*

Class / Session Type	Composite Market Definition
Multi-list	Composite Market bid is the higher of the Appointed Market Maker Quote best-bid and the Away Best Bid (ABB), and the Composite Market offer is the lower of the Appointed Market Maker Quote best-offer and the Away Best Offer (ABO). Note the Appointed Market Maker on each side of the best Appointed Market Maker Quote may be different.
GTH Openings and RTH Opening of classes that (1) do not trade GTH; and (2) are not listed on another Exchange	Composite Market is the best Appointed Market Maker Quote Bid and Offer in the book. Note the Market Maker on each side may be different.

RTH opening of GTH-Enabled classes	Composite Market is the best Appointed Market Maker Quote Bid and Offer in the book. Prior to the end of the GTH Session, the Appointed Market Maker Quotes are the union of such quotes across both the live GTH book and the queuing RTH book. After the end of the GTH session, the best Appointed Market Maker Quote is sourced from the RTH queuing book exclusively. Note the Market Maker on each side may be different.

2.2   Volume Maximizing Imbalance Minimizing (VMIM) Algorithm

The opening price for a series, as well as prices disseminated in `Options Auction Update` messages during the Queuing Period, are computed using the Volume Maximizing Imbalance Minimizing (VMIM) algorithm for both uncollared and collared openings. The VMIM algorithm is summarized as follows:

1. Select the price that maximizes the number of contracts matched on the open.

2. If there are multiple prices at which the same maximum contracts will be matched, select the price that minimizes the absolute imbalance, which is defined as the cumulative contracts at or above the price to buy minus the cumulative contracts at or below the price to sell.

3. If there are multiple prices at which the same maximum contracts will be matched and with the equivalent minimized absolute imbalance, and the imbalance is not zero, use the sign of the imbalance to select either the highest of the prices (positive imbalance) or the lowest of the prices (negative imbalance)

4. If there are multiple prices at which the same maximum contracts will be matched and zero imbalance, select the price closest to the Volume-Based Tie Breaker (VBTB), which is set to the midpoint of the opening collar.

Numerical examples illustrating the VMIM algorithm in several scenarios are presented in '*Appendix 1 – VMIM Algorithm Examples*'.

2.3   Opening Information Dissemination

2.3.1   Queuing Period and Opening Information Dissemination Start Times

Table 4 below presents the start of the Queuing Period and the time at which `Options Auction Update` message dissemination begins by option class category. The start of the Queuing Period is the time at which the system begins accepting orders for queuing.

Table 4 – *Queuing Period start times by option class category*

Cboe Options (C1)		
Option Class Category	**Queuing Period Start Time**	**Start of Auction Update Dissemination**
Multi-list	RTH: 07:30 a.m. ET	RTH: 08:30 a.m. ET
No-GTH Proprietary	RTH: 07:30 a.m. ET	RTH: 08:30 a.m. ET
GTH-Enabled Proprietary	GTH: 08:00 p.m. ET RTH: 02:00 a.m. ET	GTH: 08:00 p.m. ET RTH: 08:30 a.m. ET (*)
C2 and EDGX		
Option Class Category	**Queuing Period Start Time**	**Start of Auction Update Dissemination**
Multi-list	RTH: 07:30 a.m. ET	RTH: 08:30 a.m. ET
No-GTH Proprietary	RTH: 07:30 a.m. ET	RTH: 08:30 a.m. ET

(*) The Start of Auction Update Dissemination for RTH opening of Complex series on GTH-Enabled Proprietary classes begins at 9:15 a.m. ET.

2.3.2 Queuing Period Expected Opening Information

During a portion of the Queuing Period (defined in each class category section below) `Options Auction Update` messages are disseminated on TOP, PITCH and Opening Process (C1 only) data feeds with information regarding expected opening price, size and imbalances. Table 5 below presents fields of the `Options Auction Update` message (see the US Options Multicast PITCH specification for `Options Auction Update` message detail):

Table 5 – *Auction Update message fields*

Field	Description
Auction-Only Price	Uncollared VMIM price computed on the queuing book only.
Reference Price	Collared VMIM price computed on the queuing book only. Reference Price will be zero if there is no crossing interest within the opening collars and/or the collar reference price cannot be calculated (i.e. there is no composite market or the composite market is crossed).
Indicative Price	Collared VMIM price computed on the combined queuing book and the continuous book. For opening scenarios that do not include a continuous book trading (i.e., Multi-list and non-GTH Proprietary) the Indicative Price and the Reference Price are identical. Indicative Price will be zero if there is no crossing interest within the opening collars and/or the collar reference price cannot be calculated (i.e. there is no composite market or the composite market is crossed).
Buy Contracts	Cumulative Buy contracts at the Indicative Price and above. If Indicative Price is zero and Auction-Only Price is non-zero, then the Buy Contracts will be calculated from the perspective of the Auction-Only Price.
Sell Contracts	Cumulative Sell contracts at the Indicative Price and below. If Indicative Price is zero and Auction-Only Price is non-zero, then the Buy Contracts will be displayed from the perspective of the Auction-Only Price.

Opening Condition	Indication of the state of the opening process. "Would open" indicates that width checks and collars will not prevent opening. "Need quote to Open" indicates that the width check failed and the opening will not occur until the relevant market width narrows. "Need more buyers" and "Need more sellers" are used specifically in the context of Volatility Openings where unfilled Market order contracts and collar violations prevent series openings. "Crossed Composite Market" indicates that the Composite Market is crossed, which is a condition under which series will not open.
Composite Market Bid Price	Bid price of the prevailing Composite Market.
Composite Market Offer Price	Offer Price of the prevailing Composite Market.

2.3.3 Opening Price and Size

At the conclusion of a successful series opening an `Auction Summary` message is disseminated on TOP, PITCH, Auction and Opening Process (C1 only) data feeds with summary trade information. The fields include the Auction Type, Price, and Contracts executed in the related Opening. See the US Options Multicast PITCH specification for `Auction Summary` message detail.

2.4 Maximum Width Checks

Maximum Composite Width (MCW) checks are applied to all Option Class Category openings. MCW checks prevent a given series from opening if the best available Composite Market (CM) for the series is too wide. Further, a series will not open if the CM is crossed (i.e., CM Bid is greater than CM Offer).

A series will not open if the CM is crossed. If a crossed CM exists an `Options Auction Update` message is disseminated with an *Opening Condition* value of 'C' (crossed composite market).

On width check failure an `Options Auction Update` message is disseminated with an *Opening Condition* value of 'Q' (need quote to open). The system will periodically retry series openings until the width check succeeds.

If the CM is wider than the MCW, a series will still open as long as all of the following three conditions exist:

1. The series is not a Constituent Series for a Volatility Opening; and
2. There are no quotes/orders that lock or cross with each other; and
3. There are no non-Market Maker quotes/orders that cross the CM midpoint.

OTC classes on C1 Options have a MCW that uses a 3.0 multiplier from the base widths that are described in Table 6 for C1 Options.

Table 6 below defines the MCW as a function of the CM bid:

Table 6 – *Maximum Composite Width vs. Composite Market Bid Price*

Composite Market Bid Price	Max Composite Width (C1 and C2 Options)	Max Composite Width (BZX and EDGX Options)
0.00 – 1.99	0.50	1.50
2.00 – 5.00	0.80	2.40
5.01 – 10.00	1.00	3.00
10.01 – 20.00	2.00	6.00
20.01 – 50.00	3.00	9.00
50.01 – 100.00	5.00	15.00
100.01 – 200.00	8.00	24.00
>= 200.01	12.00	36.00

2.4.1   Forced Openings

Any multi-list series will be eligible to be forced open without conducting an opening auction after a configurable period of time. The force open timer starts after the Opening Trigger has been received and after the one-second opening delay is complete. The force open timer is configured for thirty seconds.

At the conclusion of the force open timer the system will evaluate whether an unopened series is eligible to be forced open. A series that does not pass the MCW check described above and also has non-Market Maker orders/quotes that cross the CM midpoint, will be eligible to be forced open. The system will force open the series upon the detection of a non-zero offer ABBO.

No opening auction will be conducted in series with a forced open. Orders that are not cancelled will be rolled into the book in time priority and processed subject to normal order handling based on order instructions and the NBBO at the time.

If at any time the conditions are met to allow the opening to conclude with either an opening auction or a forced opening, then the series will open. Otherwise, a series must remain closed with *Opening Condition* = Q until the necessary conditions are met for either an opening auction or a forced opening, or the Trade Desk manually intervenes.

2.5   Opening Collars

Opening collars are applied to all Option Class Category openings to ensure that the Opening Price falls within a reasonable distance from the midpoint of the CM, and in the case of Multi-list, to ensure that the Opening Price does not violate the Away Market Best Bid and Offer (ABBO).

The collar is the midpoint of the CM plus/minus half of the Opening Collar Width (OCW), with a zero floor. Opening trades occur at a VMIM price within the prevailing Opening Collar. The OCW is determined through a table lookup vs. the CM bid, which is defined in Table 6 below.

Note that the Volume-Based Tie Breaker (VBTB) for the VMIM algorithm as presented in 'Section 3.1 – Volume Maximizing Imbalance Minimizing (VMIM) Algorithm' above is set to the midpoint of the CM for all Option Class Categories.

OTC classes on C1 Options have an OCW that uses a 3.0 multiplier from the base widths that are described in Table 7 for C1 Options.

Table 7 below defines the OCW as a function of the Composite Market Bid Price:

Table 7 – *Opening Collar Width vs. Composite Market Bid Price*

Composite Market Bid Price	Opening Collar Width (C1 and C2 Options)	Opening Collar Width (BZX and EDGX Options)
0.00 – 1.99	0.50	1.50
2.00 – 5.00	0.80	2.40
5.01 – 10.00	1.00	3.00
10.01 – 20.00	2.00	6.00
20.01 – 50.00	3.00	9.00
50.01 – 100.00	5.00	15.00
100.01 – 200.00	8.00	24.00
>= 200.01	12.00	36.00

2.6   Opening Triggers

For each option class category, one or more Opening Triggers are used to transition series from Trading State 'Q' (Queuing) to Trading State 'R' (Opening Rotation). Trading State 'R' is an intermediate state to indicate that that the system is attempting to open the series. Series will transition to Trading State 'T' (Trading) upon successful opening. Table 8 below defines the Opening Trigger for each option class category and session:

Table 8 – Opening Trigger by option class category and session

Option Class Category	Opening Trigger
Multi-list	RTH: 1. Observation of the first round-lot print in the underlying from the primary exchange after 09:30 a.m. ET 2. Observation of the opening two-sided Bid/Ask in the underlying from the primary exchange after 09:30 a.m. ET. The receipt of one of the two triggers above will result in a one minute delay followed by the transition to "Opening Rotation". The receipt of both triggers will allow a class to transition to the "Opening Rotation" trading state immediately without a delay.
No-GTH Proprietary	RTH: Observation of the first underlying index value after 09:30 a.m. ET
GTH-Enabled Proprietary (excludes VIX options) (C1 only)	GTH: Time-based RTH: Observation of the first underlying index value after 09:30 a.m. ET
VIX Options and Options with OTC Underlier	GTH: Time-based (VIX Options only) RTH: Time-based

2.7   Risk Limits During the Opening

During the Price Forming Opening Process, risk limits for either GTH or RTH trading are in effect. However, within the context of a series opening, executions in the matching phase that cause a risk limit to be exceeded will not be stopped. In other words, risk limit trips will not prevent a series from opening. As a result risk limits can be exceeded as a result of a series opening. Immediately after the series opening in which the risk limit was tripped (exceeded), associated live orders are cancelled, from both simple and complex series books still in the Queuing state and those that have transitioned to regular GTH or RTH trading.

New orders received after the risk limit is tripped and before a risk reset operation is effected through FIX/BOE are rejected.
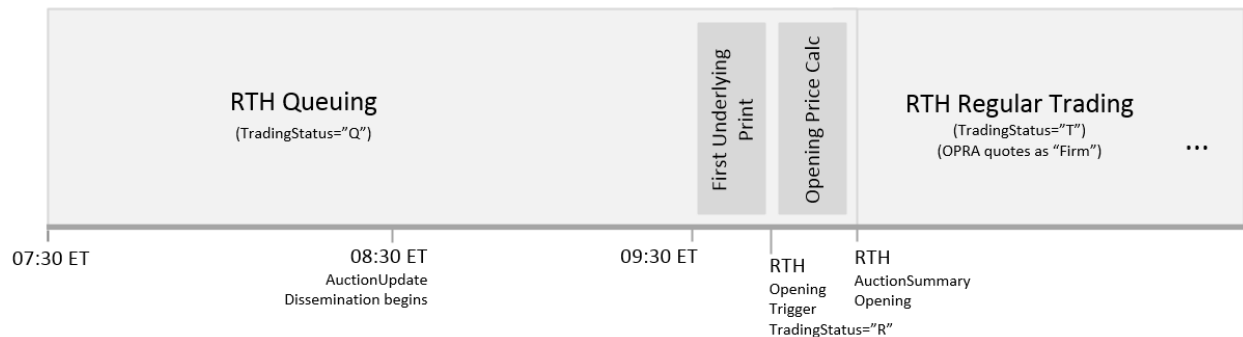
Mass Cancel functionality exists in the Queuing Periods, the same as in GTH and RTH trading.

Refer to the US Options Risk Management Specification for more detail on configuring GTH and RTH risk limits.

2.8   Multi-list Opening

Figure 4 below illustrates Multi-list class category Opening Process:

Figure 1 – *Multi-list Opening Process*

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2.9 No-GTH Proprietary Opening

Figure 5 below illustrates No-GTH Proprietary class category Opening Process:

Figure 2 – *No-GTH Proprietary opening process*
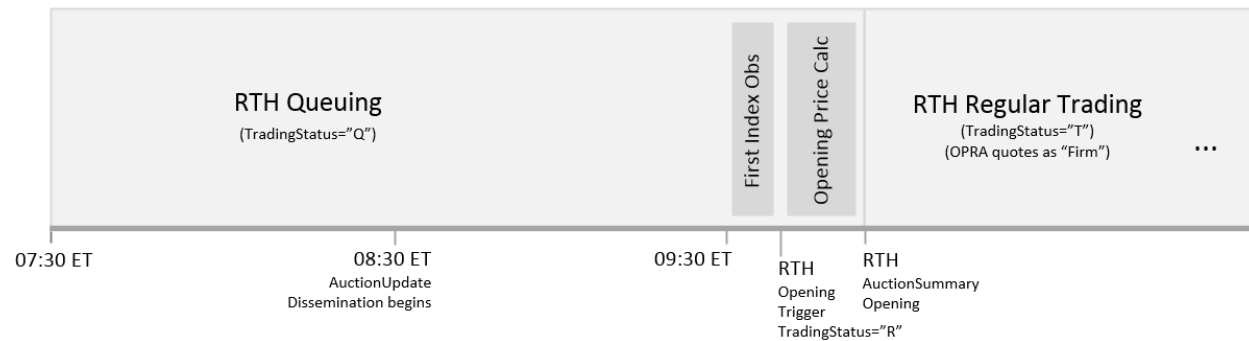
2.10 GTH-Enabled Proprietary Opening (C1 Only)

Figures 6 and 7 below illustrate the GTH-Enabled Proprietary class category Opening Process, which operates on a 24x5 trading schedule. Shown below is both the GTH and RTH session openings. The GTH opening is time-triggered, whereas the RTH opening is triggered by an observation of an index value after 9:30 a.m. ET. On C1 for VIX options only, the RTH opening is time-triggered at 9:30 a.m. ET. The GTH session stops at 9:15 a.m. ET, at which time orders active in the GTH book join the RTH Queuing book and participate in the RTH opening. For SPX, VIX, and XSP series, GTH Queuing begins at 8:00 p.m. ET Monday through Thursday, GTH regular trading begins at 8:15 p.m., and the GTH session stops at 9:15 a.m. ET.

RTH queuing is available beginning at the same time as GTH queuing (i.e. 8:00 p.m. ET) for all GTH-enabled proprietary options.

The Curb Trading session is available in C1 Options for GTH-Enabled proprietary options.

Figure 3 – *GTH-Enabled Proprietary opening process*
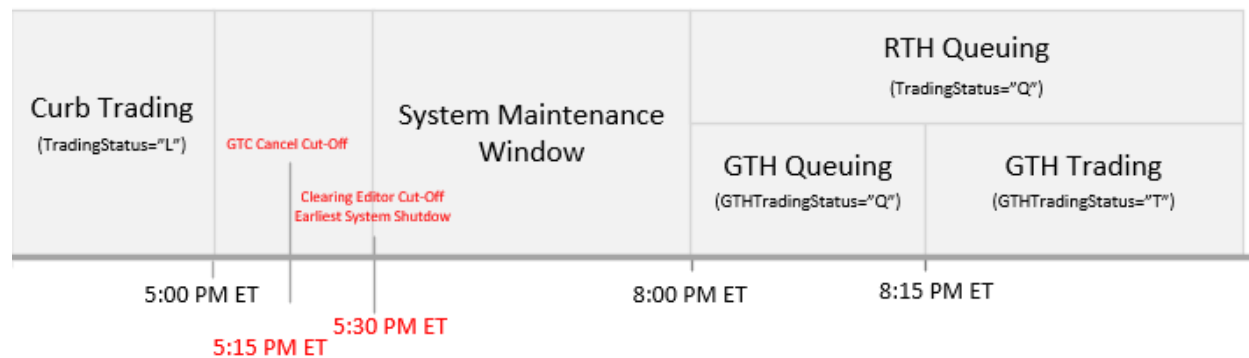
Figure 7 – *GTH-Enabled Proprietary RTH transition*

2.11 Volatility Opening Process (Constituent Series) (<mark>C1 Only</mark>)

Constituent Series of a Volatility Opening are series of GTH-Enabled proprietary classes that participate in the special RTH opening used to calculate the settlement price for expiring VIX derivatives in the Volatility Expiration Special Opening Quote (SOQ). These series open for GTH session trading in the same manner as all other GTH-Enabled proprietary series. The RTH opening of Constituent Series differs from RTH opening of other GTH-Enabled proprietary series in the following ways:
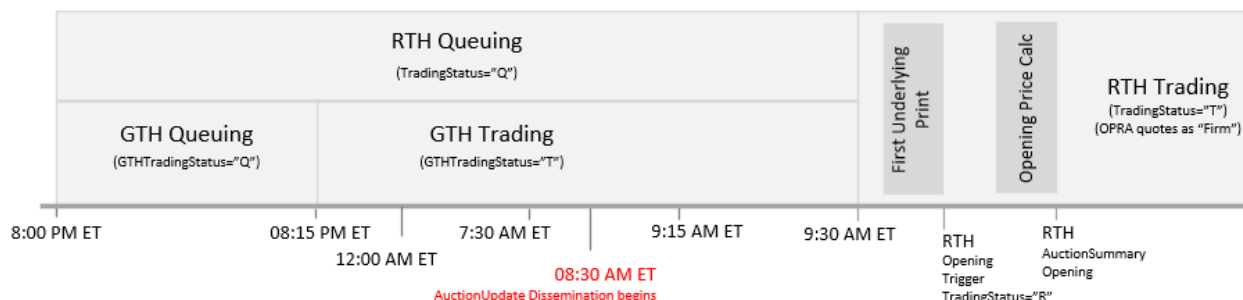
- Tighter Maximum Composite Width values for Volatility Openings (defined below).

- Tighter Opening Collar Width values for Volatility Openings (defined below).

- Series do not open if the uncollared VMIM price exceeds prevailing collar prices. `Options Auction Update` messages are disseminated with "Need more buyers"/"Need more sellers" indications to solicit liquidity for limit orders priced more aggressively than opposite side collars.

- Series do not open if there are unfilled Market Order contracts (including both RTH Only and Market on Open). `Options Auction Update` messages are disseminated with "Need more buyers"/"Need more sellers" indications to solicit liquidity for unfilled market order contracts.

- A time point prior to the Opening Trigger of the RTH opening known as the "Cutoff Time" exists after which a special order type called Settlement Liquidity on Open (SLOO) orders are accepted and order types other than Appointed Market Maker Quotes submitted before the cutoff cannot be modified.

2.11.1 Accessing Constituent Series Definition

On Volatility Expiration dates, a subset of SPX or SPXW series will be classified as "Constituent Series" for which the Volatility Opening Process will be in effect for the RTH Opening. On all other dates, there will be zero Constituent Series (i.e., no series to which Volatility Opening Process applies). Participants may access the list of Constituent Series for a trading date using File Download or Data Feeds in the same manner standard symbol mappings are accessed on Cboe Options markets. The following describes use of the two mechanisms to access Constituent Series definitions.

File Download – To download a file containing a list of constituent series on a given date, navigate to the Cboe Markets website reference data page, then select the link for Constituent Series (CSV) for the Cboe Options exchange, which will cause the file defining constituent series to be downloaded. Alternatively, the following URL can be used directly to access the Constituent Series symbol reference file:

> *https://cdn.cboe.com/data/us/options/market_statistics/symbol_reference/cone-constituent.csv*

The format of the Constituent Series Symbol Reference file is the same as the standard Symbol Reference file with the addition of a field, 'SOQ', which identifies the Volatility Settlement SOQ in which the series is participating.

Data Feeds – Unsequenced `Constituent Symbol Mapping` messages are sent on US Options Multicast PITCH, US Options Multicast TOP, US Options Opening Process, and US Options Auction data feeds, with one message sent for each Constituent Series in a continuous loop as bandwidth allows. Each data feed specification contains a description of the `Constituent Symbol Mapping` message. The `Constituent Symbol Mapping` message is identical to the standard `Symbol Mapping` message with the addition of one field, 'SOQ Identifier', which specifies the Volatility Settlement SOQ in which the series is participating.

2.11.2 Accessing Expected Opening Information

Starting at 08:30 a.m. ET, Expected Opening Information (EOI) is disseminated on US Options Multicast PITCH, US Options Multicast TOP, US Options Opening Process and US Options Auction data feeds in the form of `Options Auction Update` messages, with the final series opening information disseminated in `Auction Summary` messages. Refer to the data feed specifications for message details. Constituent Series EOI can be filtered from the stream of `Options Auction Update` and `Auction Summary` messages using the *Auction Type* field value of 'V' (volatility auction).

In addition, the following methods of access to EOI information specifically for Constituent Series on Volatility Settlement SOQ dates are provided which do not require data feed processing:

Volatility Settlement EOI Webpage – On Volatility Settlement dates EOI for SOQ, constituent series will be presented on both the Cboe and CFE websites at the following locations:

> Cboe: *https://www.cboe.com/us/options/market_statistics/volatility_settlement_eoi/?mkt=cone*

> CFE: *https://www.cboe.com/us/futures/market_statistics/volatility_settlement_eoi*

Both sources can also be accessed through site navigation to Market Statistics for US Options and Futures at cboe.com/data. Both present identical, dynamically-updated information comprising the latest EOI for all series participating in a Volatility Settlement. Prior to 08:30 a.m. ET, the presentation will be empty. Starting at 08:30 a.m. ET and all the way up to the completion of the SOQ, the latest EOI for each series are presented.

Public JSON endpoint – Those wishing to programmatically access the same information presented on the website during the pre-open without processing data feeds may do so via a public JSON endpoint which returns a current JSON formatted snapshot of the latest EOI for all constituent series:

https://www.cboe.com/us/options/market_statistics/volatility_settlement_eoi/json/?mkt=cone

Identical to the website, the JSON endpoint presents dynamically updated EOI for all series participating. See 'Appendix 2 - Constituent Series EOI JSON Format Example' for an example of the JSON formatted EOI data.

2.11.3 Accessing SOQ Strike Range Information

The low and high strikes that define the range of strikes used in the Volatility Settlement SOQ calculation are established by the exchange on the Volatility Settlement Date. The Strike Range to be used in the SOQ will be established and disseminated at 8:45 a.m. ET. If market conditions warrant, the Strike Range may be updated between 8:45 a.m. ET and 9:15 a.m. ET. The Strike Range will not be updated after 9:15 a.m. ET.

The Strike Range is accessible in three ways:

Data Feeds – `SOQ Strike Range Update` messages are sent on US Options Multicast PITCH, US Options Multicast TOP, US Options Opening Process, and US Options Auction data feeds to announce the SOQ Strike Range.

Volatility Settlement EOI Webpage – The Volatility Settlement EOI webpage display described above includes the currently effective low and high strikes comprising the SOQ Strike Range.

Public JSON endpoint – The JSON endpoint for accessing Volatility Settlement EOI described above includes the currently effective low and high strikes comprising the SOQ Strike Range.

2.11.4 Volatility Opening Maximum Composite Widths

Table 8 below defines Maximum Composite Width values in effect for Volatility Openings:

Table 8 – *Volatility Opening specific Maximum Composite Width vs. CM Bid*

CM Bid	Max Composite Width
0.00 – 0.25	0.25
0.26 – 0.50	0.30
0.51 – 1.00	0.35
1.01 – 2.00	0.40
2.01 – 5.00	0.60
5.01 – 10.00	0.70
10.01 – 20.00	1.00
20.01 – 30.00	1.80
30.01 – 40.00	2.40
40.01 – 50.00	3.00
50.01 – 100.00	6.00

100.01 – 200.00	9.00
>= 200.01	14.00

2.11.5 Volatility Opening Collar Widths

Table 9 below defines Opening Collar Width values in-effect for Volatility Openings:

Table 9 – *Volatility Opening specific Opening Collar Width vs. CM Bid*

CM Bid	Opening Collar Width
0.00 – 0.25	0.25
0.26 – 0.50	0.30
0.51 – 1.00	0.35
1.01 – 2.00	0.40
2.01 – 5.00	0.60
5.01 – 10.00	0.70
10.01 – 20.00	1.00
20.01 – 30.00	1.80
30.01 – 40.00	2.40
40.01 – 50.00	3.00
50.01 – 100.00	6.00
100.01 – 200.00	9.00
>= 200.01	14.00

2.11.6 Cutoff Time and Settlement Liquidity on Open (SLOO) Orders

The RTH Opening for Constituent Series defines a cutoff time at 09:20 a.m. ET after which several constraints and order type behaviors are enforced, including the introduction of a Volatility Opening specific order type Settlement Liquidity Order on Open (SLOO). The following summarizes Volatility Opening behavior before and after the cutoff time:

- Appointed Market Maker Quotes have no restrictions before and after the cutoff time (i.e., they can be added, cancelled, and modified before and after the cutoff time).

- Prior to the cutoff, add, cancels, and modifications of all order and quote types except SLOO Orders are accepted. SLOO Orders are rejected prior to the cutoff time.

- After the cutoff, new orders, cancels, and modifications of orders and non-Appointed Market Maker Quotes submitted prior to the cutoff are rejected. Mass cancelations and purge requests, including those with risk lockout enabled, will not cancel Constituent Series in the RTH pre-open.

- After the cutoff, only SLOO Orders and Appointed Market Maker Quotes are accepted and can be cancelled and modified.

- The following describes specification of SLOO Orders using the FIX and BOE order entry protocols:

  o For FIX order entry protocol, *TimeInForce* (59) is set to '2' (At the Open), and *ExecInst* (18) is set to 'r' (Settlement Liquidity).

- o For BOE order entry protocol, *TimeInForce* is set to '2' (At the Open), and *ExecInst* is set to 'r' (Settlement Liquidity).

SLOO Orders are orders that are designed to enable imbalance satisfying orders to be submitted while ensuring orderly markets leading up to the series opening. The Composite Market midpoint defines the Opening Collar reference, which is defined by the Appointed Market Maker Best Bid and Offer prices. Since Appointed Market Maker Quotes can be modified after the cutoff, Opening Collars are able to adapt to changing market conditions after the cutoff time. A SLOO Order is submitted like a regular Limit Order. If the specified Limit Price on a SLOO Order is more aggressive than the instantaneous Opening Collar midpoint, the SLOO Order will be adjusted to the Opening Collar midpoint. As the Opening Collar moves with a changing Composite Market midpoint, SLOO Orders will be adjusted to the Opening Collar midpoint up to their originally specified Limit Price and never at a more aggressive price than the originally specified Limit Price.

An exception to the SLOO adjustment behavior exists for low priced series. When the Opening Collar midpoint is less than or equal to $0.175, Sell SLOO Orders will work at their originally specified limit price, which will enable aggressive Sell SLOO Orders to trade with low limit price Buy orders on the book. Buy SLOO Orders will never adjust more aggressively than the Opening Collar midpoint regardless of the Opening Collar midpoint level.

As SLOO Orders are adjusted with a changing Opening Collar midpoint, order restatements are sent to the originator over the same FIX or BOE session from which the order received, as follows:

BOE - `Order Restated` message with *RestatementReason* set to 'P' (Price Sliding Reprice) is returned to the originator.

FIX - `Execution Report` message with *ExecType*(150) set to 'D' (Restated) and *ExecRestatementReason*(378) set to '3' (Repricing of order) is returned to the originator.

In the event the Composite Market midpoint does not fall on a valid increment, Buy SLOO Orders adjust to the Opening Collar midpoint rounded up to the nearest valid increment and Sell SLOO Orders adjust to the midpoint rounded down to the nearest valid increment.

SLOO Orders not filled in the series opening are cancelled back to the submitter.

Appendix 1 – VMIM Algorithm Examples

In Example 1 below, the price at which the most contracts are matched is $1.96 (400 contracts) and as a result the equilibrium price is $1.96. Since there is only a single price that maximizes the matched contracts, that price is selected as the VMIM price.

Example 1 – *Simple VMIM price calculation*

CumBid	BidQty	Price	AskQty	CumAsk	Match	Imb
0	0	mkt (bid)				
0		2.00	100	8,500	0	(8,500)
0		1.99	1,000	8,400	0	(8,400)
100	100	1.98	3,000	7,400	100	(7,300)
200	100	1.97	4,000	4,400	200	(4,200)
700	**500**	**1.96**	**100**	**400**	**400**	**300**
1,700	1,000	1.95	100	300	300	1,400
2,200	500	1.94	100	200	200	2,000
3,200	1,000	1.93	100	100	100	3,100
4,400	1,200	1.92		0	0	4,400
4,900	500	1.91		0	0	4,900
5,000	100	1.90		0	0	5,000
		mkt (ask)	0	0		

In Example 2 below, multiple prices are associated with the same maximum number of matched contracts. In this scenario the price with the minimum imbalance is selected as the VMIM price. In this example, both the $1.97 and $1.96 price levels result in 400 contracts being executed. Since there is a 4,000 contract sell imbalance at the $1.97 price level and a zero imbalance at the $1.96 price level, the system will select $1.96 as the VMIM price.

Example 2 – *Imbalance minimizing price*

CumBid	BidQty	Price	AskQty	CumAsk	Match	Imb
0	0	mkt (bid)				
0		2.00	100	8,500	0	(8,500)
0		1.99	1,000	8,400	0	(8,400)
0		1.98	3,000	7,400	0	(7,400)
400	400	1.97	4,000	4,400	400	(4,000)
400		**1.96**	**100**	**400**	**400**	**0**
1,400	1,000	1.95	100	300	300	1,100
1,900	500	1.94	100	200	200	1,700
2,900	1,000	1.93	100	100	100	2,800
4,100	1,200	1.92		0	0	4,100
4,600	500	1.91		0	0	4,600
4,700	100	1.90		0	0	4,700
		mkt (ask)	0	0		

In Example 3 below, which includes a market order to sell 100 contracts, multiple prices are associated with the same maximum number of matched contracts and the same absolute non-zero imbalance. In this case the VMIM algorithm selects the highest price in the range since the sign of the imbalance is positive, which is $1.97.

Example 3 – *Imbalance sign-based tie breaker*

CumBid	BidQty	Price	AskQty	CumAsk	Match	Imb
0	0	mkt (bid)				
0		2.00	100	4,200	0	(4,200)
0		1.99	1,000	4,100	0	(4,100)
0		1.98	3,000	3,200	0	(3,200)
200	**200**	**1.97**		**100**	**100**	**100**
200		1.96		100	100	100
200		1.95		100	100	100
700	500	1.94		100	100	600
1,800	1,100	1.93		100	100	1,700
3,000	1,200	1.92		100	100	2,900
3,500	500	1.91		100	100	3,400
3,600	100	1.90		100	100	3,500
		mkt (ask)	100	100		

Example 4 below includes market orders with a quantity of 100 to buy and sell. The result is that there is a set of prices (1.95, 1.96 and 1.97) that all maximize the matched contracts and minimize the imbalance, which is zero. Further, assume that the prevailing collar midpoint is $1.90. The VMIM algorithm selects the price closest the to the Volume-Based Tie Breaker, which is the collar midpoint ($1.90). As a result, the opening price is $1.95.

Example 4 – *Volume-based tie breaker*

CumBid	BidQty	Price	AskQty	CumAsk	Match	Imb
100	100	mkt (bid)				
100		2.00	100	4200	100	(4,100)
100		1.99	1,000	4100	100	(4,000)
100		1.98	3,000	3100	100	(3,000)
100		1.97		100	100	0
100		1.96		100	100	0
100		**1.95**		**100**	**100**	**0**
600	500	1.94		100	100	500
1,700	1,100	1.93		100	100	1,600
2,900	1,200	1.92		100	100	2,800
3,400	500	1.91		100	100	3,300
3,500	100	1.90		100	100	3,400
		mkt (ask)	100	100		

Example 5 below shows a $0.30 wide collar centered on the midpoint price of $0.85. The matched contract maximizing price of $1.10 exceeds the upper collar price of $1.00. As a result, the VMIM algorithm restricts focus to the prices within the collar range. In this example, both $0.95 and $1.00 both maximize matched contracts (10) with minimized absolute imbalance (10). As a result, the sign of the imbalance (positive) is used to select the upper price of $1.00 as the opening price.

Example 5 – *Collared price with positive imbalance sign-based tie-breaker*

CumBid	BidQty	Price	AskQty	CumAsk	Match	Imb
20	20	mkt (bid)				
20		1.10	10	20	20	0
20		1.05		10	10	10
20		1.00		10	10	10
20		0.95	10	10	10	10
20		0.90		0	0	20
20		0.85		0	0	20
20		0.80		0	0	20
20		0.75		0	0	20
20		0.70		0	0	20
20		0.65		0	0	20
20		0.60		0	0	20
		mkt (ask)	0	0		

In Example 6 below, the matched contract maximizing price of $0.60 violates the lower collar price of $0.70. As a result the VMIM, the VMIM algorithm restricts focus to the prices within the collar range. In this example the prices from $0.70, $0.75 and $0.80 all maximize matched contracts with minimized absolute imbalance of negative 10. As a result, the sign of the imbalance (negative) is used to select from the lower price of $0.70 as the opening price.

Example 6 – *Collared price with negative imbalance sign-based tie-breaker*

CumBid	BidQty	Price	AskQty	CumAsk	Match	Imb
0	0	mkt (bid)				
0		1.10		20	0	(20)
0		1.05		20	0	(20)
0		1.00		20	0	(20)
0		0.95		20	0	(20)
0		0.90		20	0	(20)
10	10	0.85		20	10	(10)
10		0.80		20	10	(10)
10		0.75		20	10	(10)
10		0.70		20	10	(10)
10		0.65		20	10	(10)
20	10	0.60		20	20	0
		mkt (ask)	20	20		

In Example 7 below, all prices shown result in the same number of matched contracts but only the prices $0.65, $0.70 and $0.75 minimize the absolute imbalance, and in this case the imbalance associated with these prices is zero. The VMIM algorithm selects the price within the collar that is closest to the Volume-Based Tie Breaker, which is the midpoint of the prevailing collar ($0.85). As a result, the selected opening price is $0.75.

Example 7 – *Collared price with zero imbalance volume-based tie-breaker*

CumBid	BidQty	Price	AskQty	CumAsk	Match	Imb
20	20	mkt (bid)				
20		1.10		25	20	(5)
20		1.05		25	20	(5)
20		1.00		25	20	(5)
20		0.95		25	20	(5)
20		0.90		25	20	(5)
20		0.85		25	20	(5)
20		0.80	5	25	20	(5)
20		0.75		20	20	0
20		0.70		20	20	0
20		0.65		20	20	0
30	10	0.60		20	20	10
		mkt (ask)	20	20		

Appendix 2 – Constituent Series EOI JSON Format Example

```json
{
  "eois" : [
    {
      "index": "VXS",
      "class": "SPX",
      "expiration": "2019-06-21",
      "minStrike": 2600.00,
      "maxStrike": 3300.00,
      "series": [
        {
          "time": "09:22:23",
          "symbolId": "01ani0",
          "putCall": "P",
          "strike": 2600.00,
          "included": true,
          "state": "Pre-Open",
          "openPrice":  0.0,
          "auctionOnlyPrice": 3.90,
          "referencePrice": 3.90,
          "indicativePrice": 3.90,
          "buyContracts": 3210,
          "sellContracts": 2800,
          "openCondition": "O",
          "compositeMarketBid": 3.75,
          "compositeMarketOffer": 4.00
        }, {
          "time": "09:22:23",
          "symbolId": "01ani1",
          "putCall": "P",
          "strike": 2650.00,
          "included": true,
          "state": "Pre-Open",
          "openPrice": 0.0,
          "auctionOnlyPrice": 3.90,
          "referencePrice": 3.90,
          "indicativePrice": 3.90,
          "buyContracts": 3210,
          "sellContracts": 2800,
          "openCondition": "O",
          "compositeMarketBid": 3.75,
          "compositeMarketOffer": 4.00
        }
        …
      ]
    }
  ]
}
```

Revision History

Version	Date	Description
2.0.0	11/16/18	Version 1.x retired in favor of new format and to include support for Cboe Options Exchange.
2.0.1	01/22/19	Updated presentation of Maximum Composite Width and Opening Collar Width to include values vs. reference price tables and specific value in-effect for Volatility Openings. Added examples of calculation of collared opening prices. Added detail for post-cutoff time order type constraints for Volatility Openings.
2.0.2	01/30/19	Added VMIM algorithm examples showing the imbalance sign based price selection in both uncollared and collared scenarios. Moved numerical VMIM examples to an Appendix.
2.0.3	04/16/19	Updated to reflect early stop of the GTH session. Updated to reflect use of Appointed Market Maker Quotes in the determination of the Composite Market. Updated Volatility Opening section to reflect Settlement Liquidity order type design.
2.0.4	05/02/19	Price Forming Opening Process will be used on C2 and EDGX effective with C1 Feature Pack 7. Updates to descriptions of Maximum Width Checks and Opening Collars to harmonize with Feature Pack 7 notice. Added Risk Limits section to Price Forming Opening Process.
2.0.5	05/14/19	Added section defining the Composite Market for all options categories. Opening Information Dissemination updated to reflect *Opening Condition* = "C" (Crossed Composite Market) and two additional fields: Composite Market Bid Price and Composite Market Offer Price. Clarified that SLOO orders slide in both directions with movements in the midpoint of the Composite Market but will never work more aggressive than the original SLOO limit price.
2.0.6	05/20/19	Added specification of data feed and web/file-based access to constituent series identification on Volatility Settlement dates. Added specification of three methods to access Expected Opening Information for constituent series during the RTH pre-open on Volatility Settlement dates; data feed, website and public JSON endpoint. Added description of SOQ Strike Range specification and methods for accessing SOQ Strike Range information. Added additional specification of SLOO orders including sliding behavior, working price rounding and FIX/BOE restatements. Updated MCW and OCW tables for Volatility Opening.
2.0.7	06/06/19	Updated description of SOQ Strike Range dissemination. EOI information JSON interface specification update.
2.0.8	06/21/19	Modified the specification of the restatement reason codes provided in FIX and BOE restatements received when pegged SLOO order is repriced. Updated the Price Forming Opening Process Opening Trigger for Multi-list to observation of the first underlying round-lot print from the primary exchange.
2.0.9	07/09/19	Updated notes to indicate Price Forming Opening Process is now implemented on EDGX and C2 Options.
2.0.10	08/09/19	Clarification added to Maximum Width Check indicating a series will not open when the Composite Market is crossed. Constituent Series for Volatility Openings are not eligible to reopen in any circumstances when MCW check fails.

2.0.11	08/14/19	Added clarifying note regarding start of auction update dissemination for RTH opening of complex instruments on classes with GTH. Mass cancelations and purge requests are not honored on Constituent Series after the cutoff.
2.0.12	09/17/19	Added detail around when the Indicative Price or Reference Price would be zero.
2.0.13	10/14/19	Buy Contracts and Sell Contracts will be calculated from perspective of Auction-Only Price when Indicative Price is zero and the Auction-Only Price is non-zero. Updated description of the SLOO adjustment reference to be the mid of the Opening Collar rather than the mid of the Composite Market.
2.0.14	11/12/19	Added notes indicating GTH will be sunset for EDGX and C2 (effective 11/22/19).
2.0.15	11/15/19	Added information detailing opening trigger for VIX options will be time-based, set to 9:30 a.m. ET (effective on C1 12/9/19).
2.0.16	11/27/19	Updated one MWC requirement for series opening (effective 12/5/19 for EDGX, effective 12/6/19 for C1 and C2).
2.0.17	12/18/19	Updated opening trigger requirements for Multi-list options (non-index products) (effective 1/16/20 for EDGX and 1/17/20 for C1 and C2).
2.0.18	01/02/20	Updated Max Composite Width and Opening Collar Width for EDGX Options (effective 1/19/20)
2.0.19	01/03/20	Added note indicating that VMIM Opening Process will be effective on BZX 01/30/20.
2.0.20	02/04/20	Removed Midpoint Uncross Opening Process section as BZX now uses Price Forming Opening Process to align with all other options exchanges.
2.0.21	08/27/20	Updated Opening Trigger description to note that options with an underlier that trades OTC will open on a timer.
2.0.22	01/14/21	Corrected Example 3 in Appendix 1.
2.0.23	02/10/21	Added new 'Section 2.4.1 – Forced Openings' describing new forced opening feature of the Multi-list opening process. Updated MCW table to reflect that OTC classes will always be 3x the configured width of C1 Options. (effective on EDGX 3/12/21, effective on BZX, C1, C2 3/15/21).
2.0.24	03/25/21	Updated to include GTH/Curb-Enabled Proprietary category to class categories. Added notes indicating a new Curb Risk Limit will be introduced to support Curb session. Added Curb information to Table 4 - Queuing Period start times by option class category. Added Curb information to Table 8 - Opening Trigger by option class category and session. Added new 'Section 2.11 – GTH/Curb-Enabled Proprietary Opening'. Effective 11/21/21 ~~Q4 2021~~. Added notes indicating expanded GTH hours. Added expanded GTH information to Table 4 - Queuing Period start times by option class category. Effective 11/21/21 ~~Q4 2021~~.
2.0.25	5/13/21	Added note about the Opening Collar Widths for OTC products. Updated Curb session effective date to ~~TBD~~ 09/27/21.
2.0.26	06/15/21	Updated extended GTH session effective date to 11/21/21.
2.0.27	08/24/21	Updated Curb session effective date to ~~TBD~~.
2.0.28	09/20/21	Updated Figure 7 with Curb Trading Status value "L". Updated Technical Specification hyperlinks.

2.0.29	11/04/21	Removed references to Curb session as Curb will not have an opening process upon launch. Updated Figure 7.
2.0.30	12/9/21	Removed old GTH session effective dates.
2.0.31	01/14/22	Clarified RTH queuing is available beginning at the same time as GTH queuing (i.e. 8:00 p.m. ET) for all GTH-enabled proprietary options.
2.0.32	02/02/22	Updated Curb session effective date to 04/25/22 ~~TBD~~.
2.0.33	04/04/22	Updated Curb session effective date to 04/25/22.
2.0.34	11/07/22	Added XSP to GTH and Curb sessions (effective 12/11/22).
2.0.35	03/01/24	Updated constituent series symbol reference file link.