SR-NFX-2019-19 Exhibit D

**Nasdaq Futures, Inc. (NFX)
Combination Orders**

**Reference Guide**

Version1.02 **|** 2019-5-1

****

**CONFIDENTIALITY/DISCLAIMER**

This  Reference Guide is being forwarded to you strictly for informational purposes and solely for the purpose of developing or operating systems for your use that interact with systems of NASDAQ Futures, Inc. (NFXSM) and its affiliates (collectively, NFX).  This specification is proprietary to NFX.

NFX reserves the right to withdraw, modify, or replace this Reference Guide at any time, without prior notice.  No obligation is made by NFX regarding the level, scope or timing of NFX’s implementation of the functions or features discussed in this specification. The Reference Guide is provided “AS IS,” “WITH ALL FAULTS”. NFX makes no warranties to this Reference Guide or its accuracy, and disclaims all warranties, whether express, implied, or statutory related to the Reference Guide or its accuracy. This document is not intended to represent an offer of any terms by NFX. While reasonable care has been taken to ensure that the details contained herein are true and not misleading at the time of publication, no liability whatsoever is assumed by NFX for any incompleteness or inaccuracies.  By using this Reference Guide you agree that you will not, without prior written permission from NFX, copy or reproduce the information in this Reference Guide except for the purposes noted above. You further agree that you will not, without prior written permission from NFX, store the information contained in this Reference Guide in a retrieval system, or transmit it in any form or by any means, whether electronic, mechanical, or otherwise except for the purposes noted above. In addition you agree that you will not, without prior written permission from NFX, permit access to the information contained herein except to those with a need-to-know for the purposes noted above.

NFX℠ is a servicemark of Nasdaq Futures, Inc.

© Copyright 2016, Nasdaq Futures, Inc. All rights reserved.

Table of Contents

[1 Overview 4](#_Toc423941699)

[2 Standard Combinations by Product 4](#_Toc423941700)

[2.1 Brent crude and wti crude futures 4](#_Toc423941701)

[2.2 Heating Oil and Gasoil Futures 5](#_Toc423941702)

[2.3 RBOB Gasoline Futures 5](#_Toc423941703)

[2.4 Natural gas futures 6](#_Toc423941704)

[3 Inter-Commodity Standard Combinations 6](#_Toc423941705)

[3.1 Overview 6](#_Toc423941706)

[3.2 Standard inter-commodity combination listing 8](#_Toc423941707)

[4 Combination Strategies](#_Toc423941708) 9

# 1 Overview

This document describes NFX Combination Orders (“Combinations”) in detail by Product. Certain Combinations will be pre-populated in the Trading System for Futures and/or Options and be comprised of the most liquid Intra-Commodity Contracts(e.g., NFX WTI Crude Oil Financial Futures: March versus June contract) and Inter-Commodity combinations (e.g., NFX WTI Crude Oil Financial Futures versus NFX RBOB Gasoline Financial Futures versus NFX Heating Oil Financial Futures “Crack Spread”). All standard Combinations consist of NFX Futures Combination Order Contracts and do not have their own trading symbol. Custom Combinations Orders (“Tailor-Made Combination” or “TMC”) for Futures and/or Options which are not already defined in the Order Book may also be created with up to four Instruments.

See Section 3.10 of the General Reference Guide for further discussion on Combination Orders. See also Tailor Made Combinations Reference Guide.

# 2 Standard Combinations by Product

## 2.1 Brent crude and wti crude futures

The Standard Combinations for the NFX Brent Crude Futures (BFQ) and the NFX WTI Crude Penultimate Futures (TQ) consist of the following Combination Orders:

* All possible calendar spreads Combination Orders for the first twelve contract months (Expiries)
* One months serial spreads: month 13 to month 18
* Additonal spreads are listed below as follows: (these do not include spreads described above)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Month1/Month2 |  | Month3/Month4 |  | Month6/Month7 |  | Month12/Month13 |
| Month1/Month3 |  | Month3/Month5 |  | Month6/Month8 |  |  |
| Month1/Month4 |  | Month3/Month6 |  | Month6/Month9 |  | Month13/Month14 |
| Month1/Month5 |  | Month3/Month7 |  | Month6/Month10 |  |  |
| Month1/Month6 |  | Month3/Month8 |  | Month6/Month11 |  | Month14/Month15 |
| Month1/Month7 |  | Month3/Month9 |  | Month6/Month12 |  |  |
| Month1/Month8 |  | Month3/Month10 |  |  |  | Month15/Month16 |
| Month1/Month9 |  | Month3/Month11 |  | Month7/Month8 |  |  |
| Month1/Month10 |  | Month3/Month12 |  | Month7/Month9 |  | Month16/Month17 |
| Month1/Month11 |  |  |  | Month7/Month10 |  |  |
| Month1/Month12 |  | Month4/Month5 |  | Month7/Month11 |  | Month17/Month18 |
|  |  | Month4/Month6 |  | Month7/Month12 |  |  |
| Month2/Month3 |  | Month4/Month7 |  |  |  | Additional Spreads: |
| Month2/Month4 |  | Month4/Month8 |  | Month8/Month9 |  | Dec/Mar  |
| Month2/Month5 |  | Month4/Month9 |  | Month8/Month10 |  | Dec/Jun |
| Month2/Month6 |  | Month4/Month10 |  | Month8/Month11 |  | Mar/Jun  |
| Month2/Month7 |  | Month4/Month11 |  | Month8/Month12 |  | Jun/Sep  |
| Month2/Month8 |  | Month4/Month12 |  |  |  | Jun/Dec |
| Month2/Month9 |  |  |  | Month9/Month10 |  | Sep/Dec  |
| Month2/Month10 |  | Month5/Month6 |  | Month9/Month11 |  | Jun/Jun  |
| Month2/Month11 |  | Month5/Month7 |  | Month9/Month12 |  | Dec/Dec - 2 years |
| Month2/Month12 |  | Month5/Month8 |  |  |  |  |
|  |  | Month5/Month9 |  | Month10/Month11 |  |  |
|  |  | Month5/Month10 |  | Month10/Month12 |  |  |
|  |  | Month5/Month11 |  |  |  |  |
|  |  | Month5/Month12 |  | Month11/Month12 |  |  |

## 2.2 Heating Oil and Gasoil Futures

The Standard Combinations for the NFX Heating Oil Penultimate Futures (OQ) and the Low Sulphur Gasoil Futures (GOQ) consist of the following Combination Orders:

* All possible calendar spreads Combination Orders for the first six contract months (Expiries)
* One months serial spreads: month 7 to month 14 (OQ to month 15)
* Additonal spreads listed below as follows: (these do not include spreads described above)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Month1/Month2 |  | Month6/Month7 |  | Additional Spreads: |
| Month1/Month3 |  |  |  | Dec/Mar  |
| Month1/Month4 |  | Month7/Month8 |  | Dec/Jun |
| Month1/Month5 |  |  |  | Mar/Jun  |
| Month1/Month6 |  | Month8/Month9 |  | Jun/Dec  |
|  |  |  |  | Sep/Dec  |
| Month2/Month3 |  | Month9/Month10 |  | Jun/Jun  |
| Month2/Month4 |  |  |  | Dec/Dec - 2 years |
| Month2/Month5 |  | Month10/Month11 |  |  |
| Month2/Month6 |  |  |  |  |
|  |  | Month11/Month12 |  |  |
| Month3/Month4 |  |  |  |  |
| Month3/Month5 |  | Month12/Month13 |  |  |
| Month3/Month6 |  |  |  |  |
|  |  | Month13/Month14 |  |  |
| Month4/Month5 |  |  |  |  |
| Month4/Month6 |  | Month14/Month15 |  |  |
|  |  |  |  |  |
| Month5/Month6 |  |  |  |  |

## 2.3 RBOB Gasoline Futures

The Standard Combinations for the NFX RBOB Gasoline Penultimate Futures (RQ) consist of the following Combinations Orders:

* All possible calendar spreads Combination Orders for the first six contract months (Expiries)
* One months serial spreads: month 7 to month 12

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Month1/Month2 |  | Month3/Month4 |  | Month7/Month8 |
| Month1/Month3 |  | Month3/Month5 |  |  |
| Month1/Month4 |  | Month3/Month6 |  | Month8/Month9 |
| Month1/Month5 |  |  |  |  |
| Month1/Month6 |  | Month4/Month5 |  | Month9/Month10 |
|  |  | Month4/Month6 |  |  |
| Month2/Month3 |  |  |  | Month10/Month11 |
| Month2/Month4 |  | Month5/Month6 |  |  |
| Month2/Month5 |  |  |  | Month11/Month12 |
| Month2/Month6 |  | Month6/Month7 |  |  |

## 2.4 Natural gas futures

The Standard Combinations for the NFX Natural Gas Futures – 10,000 (HHQ) and the NFX Natural Gas Futures – 2,500 (NNQ) consist of the following Combinations Orders:

* All possible calendar spreads Combination Orders for the first six contract months (Expiries)
* One months serial spreads: month 7 to month 16

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Month1/Month2 |  | Month3/Month4 |  | Month7/Month8 |  | Month12/Month13 |
| Month1/Month3 |  | Month3/Month5 |  |  |  |  |
| Month1/Month4 |  | Month3/Month6 |  | Month8/Month9 |  | Month13/Month14 |
| Month1/Month5 |  |  |  |  |  |  |
| Month1/Month6 |  | Month4/Month5 |  | Month9/Month10 |  | Month14/Month15 |
|  |  | Month4/Month6 |  |  |  |  |
| Month2/Month3 |  |  |  | Month10/Month11 |  | Month15/Month16 |
| Month2/Month4 |  | Month5/Month6 |  |  |  |  |
| Month2/Month5 |  |  |  | Month11/Month12 |  |  |
| Month2/Month6 |  | Month6/Month7 |  |  |  |  |

# 3 Inter-Commodity Standard Combinations

## Overview

An important part of the NFX Energy Product offering is Inter-Commodity Combinations Orders. NFX has developed Trading System functionality to offer unique and efficient pricing of these Combination Orders traded within the Combination Order Book and OTC trade reports (Off-Exchange, i.e., Block and EFRP transactions).

Trading System functionality reflects more granular Combination Order pricing, resulting in leg prices that may be traded in smaller price increments than are available for outright Futures trading. The specific NFX Futures Contracts that will support this more granular leg pricing, solely for Inter-Commodity Combination Orders, are WTI Crude Oil (TQ), Brent Crude (BFQ), and Gasoil (GOQ) Futures. The chart below lists the specific Inter-Commodity standard Combination Orders that NFX will support, and highlights specific Contracts with extended granularity for each specific Combination Order.

NFX Standard Inter-Commodity Combination Orders:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Combo Name | Leg1 | Leg 2 | Combo Ratio | Combo Tick Size | Leg Tick Size |
| Heating Crack | WTI (TQ)\* | Heating Oil (OQ) | 1:1 | $0.0001 | $0.0001 |
| Gasoline Crack | WTI (TQ)\* | RBOB (RQ) | 1:1 | $0.0001 | $0.0001 |
| Brent Heating Crack | Brent (BFQ)\* | Heating Oil (OQ) | 1:1 | $0.0001 | $0.0001 |
| Brent Gasoline Crack | Brent (BFQ)\* | RBOB (RQ) | 1:1 | $0.0001 | $0.0001 |
| HOGO | Heating Oil (OQ) | Gasoil (GOQ)\* | 3:4 | $0.0001 | $0.0001 |
| Widow Maker | Heating Oil (OQ) | RBOB (RQ) | 1:1 | $0.0001 | $0.0001 |
| Gasoil Crack | Brent (BFQ)\* | Gasoil (GOQ)\* | 3:4 | $0.0001 | $0.0001 |
| Crude Hedge | WTI (TQ) | Brent (BFQ) | 1:1 | $0.0100 | $0.0100 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Combo Name | Leg1 | Leg 2 | Leg 3 | Combo Ratio | Combo Tick Size | Leg Tick Size |
| Diversified Crack | WTI (TQ)\* | RBOB (RQ) | Heating Oil (OQ) | 5:3:1 | $0.0001 | $0.0001 |

\*Contracts that will support more granular Inter-Commodity Combination Order leg pricing.

All Standard Inter-Commodity Combinations (SICC) Order transactions will result in positions in the individual leg Contracts. All Exchange-defined individual leg Contracts of each Standard Combination Order will be of the same contract month (Expiry). If one of the individual leg Contracts expires, the expiring month’s SICC will no longer trade as a Combination Order and will be replaced by an additional SICC for the next available contract month (Expiry).

## Standard inter-commodity combination listing

|  |  |  |
| --- | --- | --- |
| **Heating Crack** |  | **Brent Gasoline Crack** |
| TQ Month1/OQ Month1 |  | BFQ Month1/RQ Month1 |
| TQ Month2/OQ Month2 |  | BFQ Month2/RQ Month2 |
| TQ Month3/OQ Month3 |  | BFQ Month3/RQ Month3 |
| TQ Month4/OQ Month4 |  | BFQ Month4/RQ Month4 |
| TQ Month5/OQ Month5 |  | BFQ Month5/RQ Month5 |
| TQ Month6/OQ Month6 |  | BFQ Month6/RQ Month6 |
| TQ Month7/OQ Month7 |  | BFQ Month7/RQ Month7 |
|  |  |  |
| **Gasoline Crack** |  | **Gasoil Crack (3:4)** |
| TQ Month1/RQ Month1 |  | BFQ Month1/GOQ Month1 |
| TQ Month2/RQ Month2 |  | BFQ Month2/GOQ Month2 |
| TQ Month3/RQ Month3 |  | BFQ Month3/GOQ Month3 |
| TQ Month4/RQ Month4 |  |  |
| TQ Month5/RQ Month5 |  | **HOGO (3:4)** |
| TQ Month6/RQ Month6 |  | OQ Month1/GOQ Month1 |
| TQ Month7/RQ Month7 |  | OQ Month2/GOQ Month2 |
|  |  | OQ Month3/GOQ Month3 |
| **Brent Heating Crack** |  |  |
| BFQ Month1/OQ Month1 |  | **Crude Hedge** |
| BFQ Month2/OQ Month2 |  | TQ Month1/BFQ Month1 |
| BFQ Month3/OQ Month3 |  | TQ Month2/BFQ Month2 |
| BFQ Month4/OQ Month4 |  | TQ Month3/BFQ Month3 |
| BFQ Month5/OQ Month5 |  | TQ Month4/BFQ Month4 |
| BFQ Month6/OQ Month6 |  |  |
| BFQ Month7/OQ Month7 |  |  |
|  |  |  |
| **Widow Maker** |  | **Diversified Crack (3:2:1)** |
| OQ Month1/RQ Month1 |  | TQ Month1/RQ Month1/OQ Month1 |
| OQ Month2/RQ Month2 |  | TQ Month2/RQ Month2/OQ Month2 |
| OQ Month3/RQ Month3 |  | TQ Month3/RQ Month3/OQ Month3 |

1.

# Combination Strategies

The Trading System supports the trading of Strategies also referred to as Combination Orders, which will trade in a separate Order Book. The Exchange may list Combination Orders comprised of either Futures or Options, but not both Futures and Options, and users may create their own tailor made combinations (TMC) for Futures or Options combinations not already defined in the Trading System. Combination Orders consisting solely of Call or Put Options of the same underlying and Expiry but with different strikes must include at least one buy and one sell leg. Market participants may submit Combination Orders that, if matched, will simultaneously trade the referenced single leg Instruments according to the specified strategy without execution risk. Combination Orders will first execute against respective legs of Orders before executing against other Combination Orders within the Combination Order Book. Once implemented, a TMC Order Book is visible to the entire market and lives throughout its defined lifetime from one to ten days (or less, if a single leg expires). Orders are permitted in Combination Order Books.

|  |  |
| --- | --- |
| **Instruments** | A TMC Order may be comprised of a minimum of two, but not exceed four Instruments within the same or from different underlying Instruments. It is possible to have a relative ratio of up to 4:1 between the included Instruments. Inter-Commodity Spreads may be formed with a minimum of two Instruments but may not exceed four Instruments. |
| **No Execution** | Strategies that are TMC or pre-defined Combination Orders all Instruments will be simultaneously executed at a net price without execution risk, for each Instrument respectively including underlying legs. |
| **Price** | The price for an Order shall be stated as a common net price, i.e. the premium times the ratio for the Instrument to be bought minus the premium times the ratio for the Instrument to be sold. |
| **Combination Order Book** | When the TMC Order is created, it will appear in a Combination Order Book which is visible to the entire market. |
| **Easy to Use** | Users create the TMC Order by defining the Instruments, Expiry and Contract. A User would then identify the ratio between the Instruments as well as the number of contracts and the net price. |
| **~~Implied-In Orders~~** | ~~Implied-in Order prices are automatically calculated by the Trading System but are not published. When a TMC Order is entered, the Order will be matched in the Order Book utilizing Implied-In Order prices from the respective leg Order Book.~~ |
| **~~Implied-Out Orders~~** | ~~Implied-out Orders are automatically generated by the Trading System, except for Tailor Made Combination Orders.~~ |

## Introduction to Combination Strategies

Representative types of Combination Orders accepted by the Trading System, which may be comprised of a minimum of two, but not exceed four, legs are as follows:

* **Call (Put) Spreads** – Buy and sell two call (put) Options of the same underlying and expiration but with different strikes.
* **Calendar (Horizontal) Spreads** – Buy and sell two call (put) Options of the same underlying and strike, but with different expirations.
* **Straddles** – Buy a call Option and a put Option of the same underlying, expiration and strike.
* **Strangles** – Buy a call Option and a put Option of the same underlying and expiration, but with different strikes.
* **Butterfly Spread** – A Contract strategy consisting of three legs either for Futures or Options. Butterfly Option Spreads consist of three put and/or call Contracts. Butterfly Futures Spreads consist of three Contracts.
* **Condor and Iron Condor Spreads** – A Contract strategy consisting of four legs. Condor Options Spreads consist of four Options Contracts (all put or all callContracts). Condor Futures Spreads consist of four Futures Contracts. Iron Condor Options Spreads consist of four Options Contracts (two put and two call Contracts).
* **Intra-Commodity (Time) Spread** – Combinations may be formed by buying and selling two Futures of the same underlying, but with different expirations. Combinations may be formed by two different Future Expiries (NFX WTI Crude Oil Penultimate Financial Futures, March versus June contract).
	+ The price ratio for the underlying legs will be configured to an integer of one. There will be no change to the trading tick size.
* **Inter-Commodity Spread** – Combinations may be formed of two or three different underlying Futures Contracts (NFX WTI Crude Oil Penultimate Financial Futures versus NFX RBOB Gasoline Financial Futures versus NFX Heating Oil Penultimate Financial Futures ”Crack Spread”).
	+ The price ratio for the underlying legs will be configured to an integer of less than one, but rounded to four decimal places to the right from an initial calculation of fourteen places. Accordingly, the minimum price interval for a respective leg price is one hundredth of a cent ($0.0001) versus its outright leg trading tick which may be 0.01.

An example of a Time Spread NFX WTI Crude Oil Financial Future:

• Buy 1 NFX WTI Crude Oil Financial Future April 2017 contract

• Sell 1 NFX WTI Crude Oil Financial Future March 2017contract

Combination Orders are traded in a Combination Order Book.  It is possible that the Combination Order can execute against another Combination Order, or (if configured) can execute against Orders in the single Order Book legs.

If not executable on entry, Combination Orders are stored in the Combination Order Book until such time as they are executable.

## Combination Orders

Combination Orders require that a Combination Order Book be pre-defined in the Trading System by the Exchange. An example of a Combination Order within the Combination Order Book could be:

Combination Order Book Time Spread NFX WTI Crude Oil Financial Future:

• Buy 1 NFX WTI Crude Oil Financial Future April 2017 contract

• Sell 1 NFX WTI Crude Oil Financial Future March 2017 contract

Combination Orders are stored in the Combination Order Book until they are executed, either in the Order Book legs or directly in the Combination Order Book itself (i.e. a Combination to Combination match). It is configurable if integration with single Order Books (legs) by Contract should occur.

Combination Orders specify a quantity and whether they are buying or selling the Combination. Combination Order Books are priced using a net price method described below.

### Defining Combination Order Books

Combination Order Books can be either Exchange-defined (“Standard”) or participant-defined (“Tailor-Made”) Combination Order Books. The Exchange-defined Combination Order Books, described herein, may be created by NFX Market Operations, or otherwise automatically generated by the Trading System for the more popular Combinations (based on underlying prices and time), Futures Participants may create their own Combination Order Books for Combinations they want to trade subject to the rules of the Exchange. Once a user defined Combination Order Book has been defined, trading will be subject the same rules as trading any other Combination Order.  A Combination Order Book is made up of multiple respective single Order Book leg(s). For each leg, a side (whether to buy or sell) and ratio must be specified (how much to buy or sell of the leg per unit of the Combination) when entering the Order into the Trading System.

A Combination Order Book may specify both buys and sells of its single Order Book legs (e.g. buying the Combination equals buy leg A and sell leg B). For each leg, selling the Combination will always mean the opposite to buying the Combination. The convention of "buying and selling" the Combination as such makes trading in Combinations more comparable to trading in single Order Books.

For example:

Buying Combination Order Book Time Spread NFX WTI Crude Oil Financial Future (Order Book C):

• Buy 1 NFX WTI Crude Oil Financial Future April 2017 contract

• Sell 1 NFX WTI Crude Oil Financial Future March 2017 contract

A buyer of Order Book C would be buying NFX WTI Crude Oil Financial Future April 2017 Future and selling the March 2017 Future.

A seller of Order Book C would  be selling NFX WTI Crude Oil Financial Future April 2017 Future and buying the March 2017 Future

#### Ratios 928

A ratio is defined for each leg of the Combination Order. Ratios define the quantity of the leg relative to the quantity of the Combination Order and are reflected in a given net price of the Combination Order (see also Pricing Combinations).

For example:

Buy Combination Order Book C:

Buy 1 unit of Order Book leg A (current BBO is 14-15)

Sell 2 units of Order Book leg B (current BBO is 5-6)

where 1 and 2 are the ratios for the legs

A buyer of Order Book C would pay a net price of 5 per unit ((1 \* 15) - (2 \* 5)).

A seller of Order Book C (i.e. Sell 1 unit leg A and Buy 2 units of leg B) would receive a net price of 2 per unit (-(1 \* 14) + (2 \* 6))

The ratio for the legs should always be given with the smallest common denominator. A Combination Order to buy 10 contracts of Order Book leg A, and sell 20 contracts of Order Book leg B, is instead set up to buy 1 of A, sell 2 of B, and then the lot size for the Combination Book is set to 10 contracts.

#### Order Book Handling

##### Combination to Single Leg

When Combination Orders are traded against single Orders, the rules of the single Order Book are followed.

The calculated quantity of each leg (e.g. Combination Order Quantity \* Leg Ratio) must be valid in regards to the lot type of the single Order Book leg.

### Pricing Combinations 934

The Trading System supports the net price “Net Price” method for pricing Combination Orders:

Net Price is the sum of the Price \* Ratio for all legs.

If buying the Combination Order, the price of a bought leg is added and the price of a sold leg is subtracted:

Buy Net Price = Buy - Sell

For example:

A Combination Order Book, C is defined as

- Buy 2 units of Order Book leg A (current BBO is 7-8)

- Sell 1 unit of Order Book leg B (current BBO is 11-12)

for each bought contract of the Combination Order:

where 1 and 2 are the ratios for the legs

A buyer of Order Book C would pay a net price of 5 per unit , ((2\*8) - (1\*11))

If selling the Combination Order, the reverse is true:

Sell Net Price = Sell - Buy

A seller of Order Book C (i.e. Sell 2 unit leg A and Buy 1 units of leg B) would *receive* a net price of 2 per unit ((2\*7) - (1 \* 12))

If buying the Combination Order, the price of a bought leg (which is a buy-leg in the Combination Order definition) is added, and the price of a sold leg is subtracted. The result of this is that the price for a Combination Order is:

* a positive value, when
	+ The participant is buying the Combination Order and is willing to pay, or
	+ The participant is selling the Combination Order and wants to be paid
* a negative value, when
	+ The participant is buying the Combination Order and wants to be paid, or
	+ The participant is selling the Combination Order and is willing to pay

When using Net Price, legs could have a pricing unit (“Pricing Unit”) of Price or Percent of Nominal, but all legs should have the same Pricing Unit, to get a relevant result.  All legs, as well as the Combination Orders must have ascending price ranking. Note that the positive and negative value behavior described above do not always hold true when a Combination Order is made up of legs with different contract sizes.

### Matching - Combination-to-Combination 948

If Combination Orders are matched against other Combination Orders, the matching follows the defined ranking and matching rules (see Ranking & Matching) for the Combination Order Book itself.

Note that trades to clearinghouses (The Options Clearing Corporation or OCC) are reported in the single Order Books.  For Combination-to-Combination matches, the Trading System calculates the prices and quantities in the legs needed for the downstream Trading Systems and processes.

The split of Combination to Combination strategies “aka deals” is made by a downstream process. One effect of that, is that such a trade will never update the last match price in the single Order Books, and can therefore not cause triggering of Orders dependent of that price.

Another effect of that, is that such a trade will never update the last match price in the single Order Books, and cannot update the price limits for last price.

Following is an example of a Combination-to-Combination Order match.

Given the following Combination Order traded in net price:

Buy Instrument A ratio = 1, Sell Instrument B ratio = 1

|  |
| --- |
| **Combination Order Book** |
| 100 | $8.50 | $9.10 | 110 |
| 50 | $8.45 | $9.20 | 100 |

A Combination Order comes in to sell 120 @ 8.40

Order matches both buy Orders.

##### Try to find two-way leg prices 961

If any of the legs do not have two-way prices, try to find prices, by using a reference price as guided in the next section, and applying a theoretical spread.

###### Reference Price Definition 962

One of the following prices, as prioritized below, will be the Reference Price:

* Current BBO;
* Historic BBO;
* Last paid price;
* Closing price;
* Reference Price received from external source via the FIX API;
* Manually entered by NFX Market Operations; or
* Last auction price.

If several Reference Prices are available, then the last updated Reference Price will be selected by the Trading System. For example, if an auction has been completed, this Reference Price will be used instead of the Closing Price. A subsequent manual update by NFX Market Operations will supersede the last auction price, and so on.

###### Calculate a theoretical spread 963

*Find bid and ask prices for all legs, to use in coming price validations*

Theoretical Spread in Number of Ticks = ThSpTicks. This will be set equal to the largest existing spread for any of the legs + 1 tick, always rounded to an even number of ticks, or if none of the legs has a current BBO, to 20 ticks.

For each leg:

 if Bid exists, but not Ask, set

o Ask = Bid increased with ThSpTicks number of ticks

 if Ask exists, but not Bid, set

o Bid = Ask decreased with ThSpTicks number of ticks

 if neither Bid nor Ask exist set, but Bid did exist as last previous Order, set

o Ask = Last previous Bid increased with ThSpTicks number of ticks

 if neither Bid nor Ask exist set, but Ask did exist as last previous Order, set

o Bid = Last previous Ask decreased with ThSpTicks number of ticks

 if neither Bid nor Ask exist, and no previous Bid or Ask did exist, set

o Bid = Reference decreased with (ThSpTicks/2) number of ticks

o Ask = Reference increased with (ThSpTicks/2) number of ticks

o If no reference price exists and the configuration parameter Leg Prices Outside BBO allowed is set to YES, Bid = Lowest Tick and Ask = $100.00

#### Break Combination Matches into Single Legs

When Combination-to-Combination Orders deals should be split into deals in single legs, an algorithm for finding prices and quantities for the single legs is applied. The algorithm chooses prices for the legs, so that they are within the current spread to the largest possible point. The algorithm allows for multiple matches in one single Order Book, if this is necessary to find appropriate prices which are at tick.

##### Leg-Price Algorithm

###### General assumptions

The algorithm for calculating leg prices for Combination-Combination Order matches is based on a few preconditions and assumptions on acceptable leg prices.  The algorithm will provide a solution in a fixed number of steps given that the preconditions are fulfilled.

* Prices are available for all legs in all cases. This means that if current bid and ask figures are missing, a Reference Price will be used to calculate a spread and if no Reference Price exists and the configuration parameter Leg Prices Outside BBO Allowed is set to YES, the spread of Lowest Tick - $100.00 is used.
* If net price is within the derived Combination Order spread, the algorithm strives to find single prices that are within single spread, and on tick sizes. To help achieve this, multiple trades can be written for one leg, and/or prices on single legs can be off tick size.
* The Order in which prices are decided for the legs, follows the principles below:
* Find prices for legs where the tick size is large.
* For legs with the same tick size, start with legs where the price spread is small
* Please note, that even if current bid is $0.00 (which is not uncommon for deep-out options, that they have a BBO of $0.00 - $0.05), we cannot create single trades at $0.00, they must have a price.

###### Requirements on calculated leg prices

The calculated leg prices must sum up to the given net price for the Combination Order.

The algorithm shall as first priority create prices on tick. To achieve this, two trades may be created in the individual legs which give the calculated average price.

As a last resort, if creating two trades does not give a correct solution, then the algorithm shall create trades off-tick prices to reach the Combination Order net price.

###### Price Calculation Rules

In the following sections, descriptions on how to find price and quantities are described, per defined Combination Order:

* Ratio is a positive value, taken from Reference Data for the defined Combination Order Book. BSRatio (BuySellRatio) is defined as follows:
	+ If the leg is sold,  BSRatio = -1 \* Ratio
	+ If the leg is bought, BSRatio = Ratio
	+ Ratio is specified per Combination leg
* Abbreviations for reference data parameters used in calculation text below:
	+ Implied Multiplier (based on Price Quotation Factor\*) = IM
	+ Leg Prices Outside BBO Allowed = LegPriceOutsideBBO.

*Step 1 - Find bid and ask prices to use in coming calculations.*

For each leg:

         if neither Bid nor Ask exist (are given in the message), set

o        Bid = Reference – ThSpTicks/2 \* ticksize (at reference price)

o        Ask = Reference + ThSpTicks/2 \* ticksize  (at reference price)

         if Bid exists, but not Ask, set

o        Ask = Bid + ThSpTicks \* ticksize (at Bid)

         if Ask exists, but not Bid, set

o        Bid = Lowest Tick

If the extended limit price is inside the calculated Bid - Ask spread, then adjust the spread so that the extended limit price is not violated.

This means that the calculated prices in the legs have to be better than or equal to the extended limit price according to the ranking rules.

*Step 2 - Find the lowest possible contribution to the Combination price, that would still have leg prices at the spread, by letting buy legs use leg-bid, and selling legs use leg-ask, and the highest possible contribution, by letting buy legs use leg-ask, and selling legs use leg-bid.*

         If BSRatio > 0, calculate:

o        Ratio Leg Low  = BSRatio \* Bid

o        Ratio Leg High   = BSRatio \* Ask

         If BSRatio is not > 0, calculate:

o        Ratio Leg Low  = BSRatio \* Ask

o        Ratio Leg High  = BSRatio \* Bid

*Step 3 -* *Find the lowest and highest possible Net price, by summarizing the leg contributions.*

For Combination:

         Calculate

o        Combination Bid = SUM(Ratio Leg Low)

o        Combination Ask = SUM(Ratio Leg High)

*Step 4 – Decide order to find price.*

Sort legs according to the following principles:

* Start with legs where there is no spread (i.e. bid and ask are equal after step 1)
* Then, take legs the in order of their tick size, starting with the largest tick size.
* For legs with the same tick size, take legs in order of their spread, starting with small spreads.

*Step 5 – Find Prices for all legs*

For each leg, in determined order:

A: Find % distance from Combo-Net to Combo-Bid

The basic idea behind the algorithm, is to try to stay with the same distance (in percent) from the Combination Bid  Price to the Combination net for all legs. If pursued, the possibility of finding leg prices within the spread, even for the last legs is improved. There might be other restrictions though that must be taken care of as well.

Calculate:

1.  Combination Spread (CombSpr) = Combination Ask – Combination Bid

2a.  If CombNet is within CombSpread:

* Percent = (CombNet – Comb Bid)/CombSpr
* LegRatioPrice = Percent \* (Ratio Leg High – Ratio Leg Low) + Ratio Leg Low

2b.  If CombNet is not within CombSpread:

2b.1.   If LegPriceOutsideBBO, calculate

* Percent = (CombNet – Comb Bid)/CombSpr
* LegRatioPrice = Percent \* (Ratio Leg Ask – Ratio Leg Bid) + Ratio Leg Bid

2b.2  Else (*Leg Price is* ***not*** *allowed to be outside spread, set it* ***at*** *the spread)*

* If Net > Comb Ask
	+ LegRatioPrice = Ratio Leg Ask
* Else
	+ LegRatioPrice = Ratio Leg Bid

B: Round calculated leg price

1.  If this is not last leg *–* round LegRatioPrice to tick size

C: Try to find 1 match

Try to see if a rounded leg price (without ratio) to an even tick size is possible to find without pushing the Combination Net for the remaining legs to be outside the remaining Combination Order spread:

1. Calculate two possible leg prices, one rounding up and one rounding down:

* LegPricePerContractLow = Round down to closest tick.  (example: trunc ( (LegRatioPrice / Ratio) / Tick Size, 0) \* Tick Size )
* LegPricePerContractHigh = Round up to closest tick.  (example: roundUp ( (LegRatioPrice / Ratio) / Tick Size, 0) \* Tick Size)
* If LegPricePerContractLow is outside the leg spread and LegPricePerContractHigh is inside the spread, then the low price is not a possible choice, and therefore
	+ LegPricePerContractLow = LegPricePerContractHigh
* OR if If LegPricePerContractHigh is outside the leg spread and LegPricePerContractLow is inside the spread, then the high price is not a possible choice, and therefore
	+ LegPricePerContractHigh = LegPricePerContractLow
* NewCombination Bid = Combination Bid – Ratio Leg Bid
* NewCombination Ask = Combination Ask – Ratio Leg Ask
* NewCombinationMid = (New Combination Ask - New Combination Bid) / 2    (50%)
* CombNetLow = CombNet – LegPricePerContractLow \* BSRatio
* CombNetHigh = CombNet - LegPricePerContractHigh \* BSRatio

2. To decide which one to use - choose the tick which gives the best "remaining" CombNet, where best means closest to midpoint of CombSpread.

* If CombNetLow is outside New Combination Spread and CombNetHigh is inside, use **LegPricePerContractHigh**
* If CombNetHigh outside New Combination Spread and CombNetLow is inside, use **LegPricePerContractLow**
* If CombNet before this leg was within spread and now both CombNetLow and CombNetHigh are outside New Combination Spread, use algorithm which creates two trades:
	+ **Move to algorithm in D for this leg.**
* If CombNet before this leg was outside spread and now both CombNetLow and CombNetHigh are outside, or if both CombNetLow and CombNetHigh are within spread, use the one most favourable for coming calculations, by doing the following:
* ABSPercentLow = ABS(New Combination Mid - CombNetLow)
* ABSPercentHigh = ABS(New Combination Mid - CombNetHigh)
* If  (ABSPercentLow > ABSPercentHigh), let LegPricePerContract be = **LegPricePerContractHigh**, otherwise LegPricePerContract = **LegPricePerContractLow**
* Create one trade:
	+ Price = LegPricePerContract
	+ Quantity = Combination\_qty \* Ratio \* IM

End of calculation for this leg, move to next leg.

*Next leg will use the combined spread prices for all legs not yet calculated, and the net price adjusted by the price determined for this leg. This will give the effect that the price of the last leg is more likely to be outside the spread than the others.*

* Combination Bid = Combination Bid – Ratio Leg Bid
* Combination Ask = Combination Ask – Ratio Leg Ask
* LegPricePerContract from above
* CombNet = CombNet – LegPricePerContract \* BSRatio

D: Create Two Trades 980

1. LegPricePerContract = LegRatioPrice / Ratio

2. LegPrice1= LegPricePerContractLow

3. LegPrice2 = LegPricePerContractHigh

4. Quantity 2 = (LegPricePerContract - LegPrice1) \* Ratio \* IM \*  Combination\_qty/ tick\_size

5. Quantity 2 = Round down to integer value. (example: TRUNC(Quantity 2, 0))

6. Quantity 1 = Ratio \* IM \* Combination\_qty – Quantity 2

End of calculation for this leg

*Next leg will use the combined spread prices for all legs not yet calculated, and the net price adjusted by the price determined for this leg. This will give the effect that the price of the last leg is more likely to be outside the spread than the others.*

* Combination Bid = Combination Bid – Ratio Leg Bid
* Combination Ask = Combination Ask – Ratio Leg Ask
* CombNet = CombNet – LegPricePerContract \* BSRatio

Go back to A for next leg

*Step 6 – Check if leg prices are OK*

If any Leg Price is outside the leg spread, and LegPriceOutsideBBO = False, redo calculation by repeating step 4, but divide all leg tick sizes by 10 first. A prerequisite for this, is that Trading System has not let any trade match occur if net price was outside combined spread. If net is inside combined spread, the only reason that leg prices are outside leg spread, is that the tick size is too large.

###### Example 1 983

**BREAK COMBINATION MATCHES INTO SINGLE LEGS – EXAMPLE 1:**

|  |
| --- |
| **Combination Order Book C – Buy 2 X A, Sell 1 X B** |
|   |   | 16.00 | 100 |

And the following Order Book Legs

|  |
| --- |
| **Order Book A (Tick Size = 0.50)** |
| 500 | 10.00 | 12.00 | 500 |

|  |
| --- |
| **Order Book B (Tick Size = 0.10)** |
| 500 | 5.00 | 6.00 | 500 |

**Step 1:**

Not applicable

**Step 2:**

Ratio Leg A:          Low = 2 X 10 = 20

                                High = 2 X 12 = 24

Ratio Leg B:          Low = -1 X 6 = -6

                                High = -1 X 5 = -5

**Step 3:**

The derived Combination Order spread:

(20 – 6) to (24 – 5)

14 – 19 (Combination match price is 16 and therefore in between)

**Step 4:**

Sequence of the legs:

Leg A first

Leg B second

**Step 5A: Start with Leg A**

The spread of the derived Combination is 5 (19 – 14)

**A: Find %-distance from CombNet…**

(1) Calculate percentage within the spread.

(16 – 14) / 5 = **40%**

(2a) Use same percentage to find initial price: 40 % X (24-20) + 20 = **21.6**

(2b) Not applicable

**5B: Round price**

(1) Round price found in step A, to tick if needed

(21.6 / .5 , 0) = 43.2, giving (43 X 0.5) = **21.5**

**5C: Try to get one match only**

(1) Calculate leg price per contract

21.5 / 2 = **10.75**

Round Low price down and High Price up =>

LowPrice = 10.50

HighPrice 11.00

Combination Bid (excluding A) = 14 – (2\*10) = -6

Combination Ask (excluding A)  = 19 – (2\*12) = -5

Comb Mid (excluding A) = -5.50

CombNetLow = 16 – 2\* 10.50 = - 5.00

CombNetHigh = 16 – 2\*11 = -6.00

(2) Find which one of tested prices to use

Both CombNetHigh and CombNetLow are inside (actually at) the new Combination Spread (excluding A), 10.50 and 11.00 are both fine.

**LowPrice = 10.50** is used according to the algorithm

**5D: Algorithm for finding two different prices is not needed in this example**

*(2) Calculate leg price per contract*

*21.5 / 2 =* ***10.75***

*(3) Round to tick if needed*

*(19.75 / 0.5, 0) = 21.5 giving 21 X 0.5 =* ***10.50***

*4 (a) Calculate trade prices of Leg A*

*10.50+ 0.5 = 11*

*(10.75 – 10.50) \* 2 \* 1\* 100 / 0.5*

|  |
| --- |
| *100 @ 11.00**100 @ 10.50* |

**MOVE TO NEXT LEG (FINAL LEG)**

**Step 5A: Leg B**

New adjusted spread is

(21 – 6) to (21 – 5)

(16 – 15) / 1 = 10**0%**

Leg B spread is (-6) - (-5), therefore using 100%, gives a price of:

|  |
| --- |
| **100 @ 5** |

and a result of:

**Leg A 200 @ 10.50**

**Leg B 100 @ 5**

###### Performance 1002

Unlike other routines for finding single leg prices, this algorithm only performs a given number of calculations per included leg - it is O(n), which makes it not to heavy from a performance aspect.

### Updating Combination Orders

Participants can update their Combination Orders by specifying the Trading System Trading Order identifier.

Conditions for Combination Orders:

Combination Orders can be Limit or Market Orders and support the following conditions (including what is mandatory and optional).

|  |  |  |
| --- | --- | --- |
| **COMBINATION ORDERS** | **Limit** | **Market** |
| **Time-in-Force** | M | M |
| DAY | O | O |
| GTC | O | O |
| GTD | O | O |
| FOK | O | O |
| IOC | O | O |
| **Triggering Conditions** | O | O |
| Last Paid Update  | O | O |

# 5 Help

If you have any questions associated with NFX Combinations please contact:

NFX Operations at NFXOps@nasdaq.com or 215-496-5409

****

© Copyright 2016, Nasdaq, Inc. All rights reserved