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OFFICE OF THE SECRETARIAT  
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September 25, 2009

Mr. David Stawick  
Office of the Secretariat  
Commodity Futures Trading Commission  
Three Lafayette Centre  
1155 21st Street, N.W.  
Washington, D.C. 20581

**RE: Amendments to CME Rule 580  
Deletion of CME Rules 581, 582, 584 and  
Related Interpretations  
CBOT/NYMEX Adoption of New Rule 580  
CME/CBOT/NYMEX Submission No. 09-216**

Dear Mr. Stawick:

Chicago Mercantile Exchange Inc. ("CME"), The Board of Trade of the City of Chicago, Inc. ("CBOT") and The New York Mercantile Exchange, Inc. ("NYMEX") (collectively, "the Exchanges") hereby notify the Commodity Futures Trading Commission of various rule amendments and deletions with respect to the Globex<sup>®</sup> matching algorithms applicable to various products. Currently, Chapter 5 of the CME Rulebook contains overly detailed descriptions of the algorithms which are difficult to keep accurate as the Exchanges make minor modifications to the manner in which the algorithms operate. As a result, CME has modified Rule 580 ("Globex Trade Matching Algorithms"), which is also being newly adopted by CBOT and NYMEX. The text of Rule 580 now provides links to the Globex Price Banding document (which provides, among other things, the particular trade matching algorithm applicable to each product trading on Globex) and to a section on the CME Group website which provides additional information on the operation of the matching algorithms.

The amendments begin on the next page, with additions underlined and deletions overstruck. The rule amendments will be made effective immediately.

The Exchanges certify that the amendments comply with the Commodity Exchange Act and regulations thereunder.

If you have any questions regarding these changes, please contact Robert Sniegowski, Associate Director, Market Regulation, 312.341.5991 or me at 312.648.5422. Please reference CME/CBOT/NYMEX Submission No. 09-216 in any related correspondence.

Sincerely,

/s/ Stephen M. Szarmack  
Director and Associate General Counsel

## CME Amendments:

### 580.    **GLOBEX TRADE MATCHING ALGORITHMS**

The Globex platform employs multiple predefined sets of matching algorithms used to match trades on the platform. Information concerning the matching algorithm applicable to a particular product is set forth in the CME Globex Price Banding document available on cmegroup.com at [www.cmegroup.com/globex/files/PriceBanding.pdf](http://www.cmegroup.com/globex/files/PriceBanding.pdf). Information on the operation of the matching algorithms is available on cmegroup.com at [www.cmegroup.com/globex/introduction](http://www.cmegroup.com/globex/introduction).

- ~~1. Market orders that are entered into the Globex system shall be converted into limit orders at a price at or above (in the case of a buy order) or at or below (in the case of a sell order) the last price shown on the Globex system. Any part of such order that is not filled at the limit price or better shall remain as a resting order at such limit price until filled or cancelled.~~
- ~~2. Stop limit orders are activated and placed into the order book when the order's specified stop price is traded, at which time the order may be executed at the best available price at or between the specified limit price and the specified stop price. Any part of such order that is not filled shall remain as a resting order at such limit price until filled or cancelled.~~
- ~~3. If the execution of a stop order would result in an execution price that is above (below) the last traded price plus (minus) X ticks, the market shall be placed in a "reserved state." During the reserved state, orders may be entered, modified or cancelled but orders may not be executed. The Globex system will disseminate an "Indicative Opening Price" (IOP) during the reserved state representing the price at which the market could trade if the reserved state were to conclude immediately. If, at the conclusion of the initial reserved state period, the IOP is within a range bounded by the last traded price plus or minus two times (2x) X ticks, then normal execution of trades shall resume. If the IOP is outside such range, the market shall remain in a reserved state for a subsequent period. A series of reserved state periods shall ensue until either (i) the IOP is within a range bounded by the last traded price plus (minus) the number of reserved state periods, plus one times X ticks at the conclusion of such reserved state periods, at which point normal trading shall resume; or (ii) a total of twelve (12) reserved state periods are concluded, after which normal trading shall resume regardless of the opening price.  
  
— This process shall be applied to such markets as determined by the Exchange. The value X and the duration of a reserved state period shall be determined by the Exchange.~~
- ~~4. Unless otherwise specified by the Exchange, orders entered into the Globex system will be matched in accordance with an algorithm that gives first priority to orders at the best price and that gives priority among orders entered at the same price based on their time of entry into the system, with the first order entered receiving first priority, the second order entered receiving second priority, etc. (First In, First Out or "FIFO" Allocation Algorithm). The Exchange may use a different matching algorithm for particular contracts by giving written notice of such algorithm to members and firms using Globex at least ten days before use of such algorithm is implemented. See Interpretation of Rule 580 GLOBEX TRADE ALGORITHMS at the end of Chapter 5.~~
- ~~5. Request for quote (RFQ) messages soliciting bids and/or offers for a contract or a combination of contracts traded pursuant to Rule 580 may be entered into the Globex system. Upon receiving the RFQ, the Exchange shall immediately disseminate the message as part of its market data dissemination. The Globex trade matching process will continue independent of the RFQ messaging activity.~~

### 581.    **GLOBEX LEAD MARKET MAKER PROGRAM**

~~The Exchange shall establish a Globex Lead Market Maker Program to remain in effect for a period determined by Exchange staff. The Exchange shall establish the requirements and the number of participants eligible for the Lead Market Maker Program. Any individual or entity that is eligible for Globex terminals, pursuant to Exchange rules, is eligible to submit an application to Exchange staff to become a Globex Lead Market Maker. Exchange staff shall have the discretion to approve or deny an application based on the applicant's business reputation, financial resources and trading activity in relevant futures, options or related cash markets. Any individual or entity accepted into the program must comply with the conditions established by Exchange staff.~~

~~The Exchange may offer participants in the Lead Market Maker Program trading and financial incentives. Trading incentives may include the deployment of the Lead Market Maker Matching Algorithm in either of its formats as described in Rule 580 and Interpretations thereto.~~

### 582.    **GLOBEX SWITCH TRADE MATCHING ALGORITHM**

~~The following Switch trade matching algorithm shall be applied to such markets as determined by the Exchange.~~

- ~~1. A Switch market is defined as a call market where:
  - ~~a. A series of expirations for a specific contract, e.g. Three Month Eurodollar futures, are available for trading;~~
  - ~~b. For each session, all the trades of the same expiration shall be consummated at the same price, at the same time;~~
  - ~~c. The prices at which trades are executed are derived from an algorithm or formula based upon prevailing prices in related markets, e.g. interpolated yield curve based upon quarterly and serial Three month Eurodollar Futures and other related markets;~~
  - ~~d. For each session and for each account, each contract bought shall be accompanied by a sale of a contract with a different expiration available for trading for the session, and each contract sold shall be~~~~

accompanied by a purchase of a contract with a different expiration.

2. For the purpose of Rule 582, the Pricing Algorithm for a Switch market is defined as the algorithm or formula for determining the prices of each eligible contract for a Switch market trading session. Prior to operating a Switch market, the Exchange shall disclose the Pricing Algorithm and the method of determining the inputs to the Pricing Algorithm.
3. Orders shall be good only during the specific trading session for which they are entered. Unexecuted orders and any unfilled residuals of partially filled orders shall be cancelled following the conclusion of the trade matching process.
  - The Pricing Algorithm shall be used to identify a single contract price at which all executed orders for a particular contract expiration shall be filled. The Exchange shall disseminate the price of each contract expiration prior to the trade matching process by an interval X. Upon determination of prices for all contract expirations, valid orders are deemed to have bid and offer prices identical to the published prices as determined by the Pricing Algorithm. Order entry, modification and cancellation shall be allowed until the commencement of the trade matching process.
  - The interval X and the price determination algorithm for each Switch market shall be determined and published by the Exchange.
4. The trade matching process will employ the following mathematical algorithm to match orders to buy and orders to sell. The algorithm maximizes, for the entire set of eligible expirations, the total number of contracts traded, subject to the constraint that for each account, the total number of contracts bought is equal to the total number of contracts sold. If there are multiple possible allocations of the long and short positions that maximize the total number of contracts traded, the allocation with the broadest distribution across accounts shall be utilized. See Interpretation of Rule 582—GLOBEX SWITCH TRADE MATCHING ALGORITHM at the end of Chapter 5.

#### 584. CME GLOBEX OPTIONS VOLATILITY QUOTE TRADING

For contracts deemed eligible by the exchange, CME Globex provides for quoting and trading of outright options and options strategies (e.g., options combinations such as straddles, strangles, verticals, and any other options strategies deemed approved by the exchange) in terms of volatility quotes in addition to premium quotes. Any outright option or option strategy so traded will be designated as a single instrument on the CME Globex system. Any outright option or options strategy may trade simultaneously as separate instruments on CME Globex using volatility quotes and premium quotes.

The options volatility quoting convention allows for bids and offers in terms of annualized implied volatility (e.g., 12.450% bid at 12.550% offer).

Volatility quoted option trades shall be matched at the option instrument level according to the first priority for best price and FIFO matching algorithm described in Rule 580—GLOBEX TRADE ALGORITHMS and its Interpretation, except for trades involving pre-execution communications which must comply with the requirements of Rule 539.C.4. and which shall be matched pursuant to Rule 585 and its Interpretation. Further, volatility quoted option bids shall be matched only with volatility quoted option offers (premium quoted options will not be matched with volatility quoted options). At the time of an options volatility match, CME Globex will utilize standard options pricing models to convert the options volatility trade into a premium quoted option for clearing, and where applicable, create accompanying risk reducing futures contracts as a delta neutral hedge for the matched position.

For more details concerning volatility options quotes and trading, see the individual options contract Price Increments rules in applicable product chapters and the "Interpretations & Special Notices Relating to Chapter 5" at the end of Chapter 5.

#### 585. GLOBEX CALL MARKET TRADING ALGORITHM

The following Globex Call Market Trading Algorithm shall be applied to such contract markets as determined by the Exchange, including, but not limited to, all options on futures. This rule supersedes, if applicable, other Exchange rules governing trading on Globex, including, but not limited to, Rule 580 and its interpretations.

1. For the purpose of Rule 585:
  - a. an eligible contract means a contract deemed eligible to trade pursuant to the algorithm stipulated hereunder; an eligible combination of contracts means a combination of eligible contracts deemed eligible to trade pursuant to the algorithm stipulated hereunder;
  - b. an eligible combination of futures and options contracts shall be defined by the quantity per combination of each option bought or sold by the combination buyer, and the net long or short futures positions per combination per contract month to be assumed by the combination buyer, with the futures prices for each month defined within the combination. The combination shall be quoted in terms of net options premium, with the futures traded at the defined price, except for volatility quoted options in which case the combination shall be quoted in volatility terms, which implies the appropriate combination of options premium and futures prices as defined in Rule 584;
  - c. an eligible terminal means a device capable of transmitting to and receiving from Globex Requests For Quotes ("RFQ"), and sending order instructions in response to RFQs to Globex;
  - d. an RFQ means an electronic message soliciting bids and offers for a contract or a combination of contracts;
  - e. a trading session means a trading session in which Rule 585 applies. The hours of the trading session may be determined by the Exchange independent of the trading hours of the identical contracts not traded pursuant to this rule;

2. An RFQ for an individual eligible contract or an eligible combination of contracts may be entered into Globex through an eligible terminal. The RFQ shall be disseminated by Globex to all eligible terminals for the purpose of quote solicitation.
3. Following the dissemination of an RFQ, limit bids and limit offers for the specified contract or combination of contracts may be entered into Globex through an eligible terminal. In particular, the party initiating the RFQ may also enter orders. Globex shall not recognize any order other than limit orders.
4. Solicitation of bid(s) and/or offer(s) through private discussion for an eligible contract or an eligible combination of contracts must comply with the provisions of Rule 530.C.4.
5. Trade matching occurs whenever tradable pair(s) of bid and offer can be identified in the order book. Trade matching shall be executed in accordance with an algorithm that gives first priority to orders at the best price. In the event that multiple orders with the same price are eligible to execute against an opposing order, an allocation algorithm shall be employed to match the trade. See Interpretation of Rule 585—Globex Call Market Trading Algorithm at the end of Chapter 5. Unexecuted and partially-executed orders shall remain in the order book until the conclusion of the trading session unless instructions to cancel the orders have been received.
6. Trades of eligible combinations of contracts consummated pursuant to Rule 585 shall not trigger any conditional orders, e.g. stop orders, stop limit orders, MIT orders, etc., in the contract markets not trading pursuant to Rule 585.
7. The Exchange may establish Market Maker Programs specific to Globex Call Markets for specific sets of contracts. These programs may be deployed in conjunction with or independent of similar programs for identical contracts not traded pursuant to Rule 585 established pursuant to Rule 584.
8. In accordance with a Market Maker Program, designated Lead Market Makers may be required to regularly provide price indications for some contracts or combinations of contracts eligible for trading pursuant to Rule 585. These price indications are provided for informational purposes only and shall not be construed as actual bids or offers for the contracts. In response to any RFQs, Market Makers may enter bids or offers at any price, irrespective of what price indication the Market Maker may have provided prior to the RFQ.

#### INTERPRETATION OF RULE 580.— GLOBEX TRADE ALGORITHMS

##### Pro Rata Allocation Algorithm

The Exchange has determined to use a Pro Rata Allocation Algorithm to match orders in Eurodollar futures, Euroyen futures and One Month LIBOR futures contracts entered in the Globex Electronic Trading System. Unless specifically referenced in this Interpretation, all other futures and options contracts, including Eurodollar options, will continue to use the default matching algorithm based on price and time priority. Eurodollar futures contracts were chosen to use the Pro Rata Allocation Algorithm because they usually trade in a narrow price range, and each price level is represented by size. The Pro Rata Allocation Algorithm operates as follows:

- After the opening, Time Priority is assigned to the first order at a price that betters the market when the order is received (the "TOP order"). Only one buy order and one sell order can have Time Priority at any given time. Orders with Time Priority (TOP orders) are matched first regardless of size.
- An order will lose Time Priority when an order at a better price is entered. Example: An order to buy 50 contracts is entered at 105. This order is the first order in at this price level. Another order comes in and betters the market, buy 25 contracts at 106. The order at the 106 level has Time Priority now and is the TOP order. The market sells off and the bid for 25 contracts at 106 is hit. The bid for 50 contracts at 105 does not regain its Time Priority and will be allocated according to size along with all the other 105 bids.
- After the Time Priority or TOP order is filled, the Pro Rata Allocation Algorithm is applied to the remainder of the resting orders at that price level. The Algorithm will attempt to match quantities to orders in proportion to the size of each order. Example: There are orders to buy 10 and 20 contracts at the same price, and neither order has Time Priority. A sell order for 15 contracts at that price is entered. The Algorithm will match the sell order against the buy orders so that 50% of each buy order is matched. The minimum quantity the Pro Rata Allocation Algorithm will allocate is two contracts.
- If the "Initial Allocation" results in a fraction, the Algorithm will "Round Down" or drop the fractional amount. Any contracts still to be allocated after the "Initial Allocation" has run will be allocated on a first in, first out basis.

##### Implied Order Algorithm

The Exchange has determined to use an Implied Order Algorithm to create orders for selected individual contracts, calendar spreads, and butterfly spreads in Eurodollar futures, Euroyen futures and One Month LIBOR futures contracts, and in selected individual contracts and calendar spreads in agricultural futures contracts, and calendar spreads in CME Eurozone HICP futures contracts, and calendar and inter-commodity spreads in CME Housing futures contracts entered in the Globex Electronic Trading System.

Eurodollar Futures, Euroyen Futures and One Month LIBOR Futures Contracts: For the purpose of this rule interpretation, buying one butterfly spread (butterfly) means simultaneously buying and selling contracts with three different expirations in the following proportion: buying one contract with the most nearby of the three expirations, selling two contracts with the second of the three expirations and buying one contract with the most deferred of the three expirations. Unless specifically referenced in this Interpretation, all other futures and options contracts, will continue to use the Pro Rata Allocation Algorithm. This Implied Order Algorithm for Eurodollar futures, Euroyen futures and One Month LIBOR futures contracts operates as follows:

- A "1st Generation Implied In" order for a calendar spread may be derived on the Globex system from actual orders in the individual contracts or legs of the calendar spread. E.g., a buy order for 15 contracts at 95.05 in a nearby Eurodollar futures contract and a sell order for 10 contracts at 95.00 in a deferred Eurodollar futures

contracts creates a 1st-Generation Implied In order to buy 10 calendar spreads at 0.05.

- A "1st-Generation Implied Out" order for an individual contract may be derived on the Globex system from (1) actual orders in a calendar spread that includes that individual contract; and (2) actual orders in the other individual contract that comprises the calendar spread. E.g., a buy order for 5 contracts at 95.15 in a nearby Eurodollar futures contract and a sell order for 10 calendar spreads, that include that nearby contract and a deferred contract, at 0.05 creates an Implied Out order to buy 5 contracts in the deferred leg of calendar spread at 95.10.
- A "2nd-Generation Implied In" order for a calendar spread may be derived on the Globex system from (1) actual orders in one individual contract of the calendar spread; and (2) 1st-Generation Implied Out orders in the other individual contract that comprises the calendar spread.
- A "2nd-Generation Implied Out" order for an individual contract may be derived on the Globex system from (1) actual orders in a calendar spread that includes that individual contract; and (2) 1st-Generation Implied Out orders in the other individual contract that comprises the calendar spread.
- Implied In orders for calendar spreads and Implied Out orders for an individual contract based on orders for calendar spread and another individual contract shall be for a quantity representing the smaller of the two orders from which the Implied order is derived.
- The Globex system will create 2nd-Generation Implied In and Out orders, for matching purposes only, if there are insufficient quantities of actual and 1st-Generation Implied In and Out orders to satisfy arriving orders. This may result in a match with 2nd-Generation Implied orders at more favorable prices than had previously been available. Second-Generation Implied orders will not be disseminated to the marketplace.
- A "1st-Generation Implied In" order for a butterfly spread may be derived on the Globex system from (1) actual orders in the three individual contracts or legs of the butterfly spread, e.g. a buy order for 10 contracts at 95.15 in the first of the three contract months, a sell order for 20 contracts at 95.00 in the second of the three contract months, and a buy order for 10 contracts at 94.95 in the last of the three contract months create a 1st-Generation Implied In order to buy 10 butterfly spreads at 0.10; (2) actual orders in two calendar spreads, e.g., a buy order for 10 calendar spreads between the first two of the three contract months at 0.15 and a sell order for 10 calendar spreads between the last two of the three contract months at 0.05 create a 1st-Generation Implied In order to buy 10 butterfly spreads at 0.10; or (3) actual orders in two individual contracts and a calendar spread, e.g. a buy order for 10 contracts at 95.15 in the first of the three contract months, a sell order for 10 contracts at 95.00 in the second of the three contract months and an actual sell order for 10 calendar spreads between the last two of the three contract months at 0.05 create a 1st-Generation Implied In order for 10 butterfly spreads at 0.10.
- A "1st-Generation Implied Out" order for an individual contract from a butterfly spread may be created from an actual order for a butterfly spread with (1) an actual order for a calendar spread and an actual order for an individual contract, e.g. a buy order for 10 butterfly spreads at 0.10, a buy order for 10 calendar spreads between the last two of the three contract months at 0.05, and a buy order for 10 contracts in the second of the three contract months at 95.00 create a 1st-Generation Implied Out buy order for 10 contracts in the nearby month at 95.15; or (2) actual orders for two of the three individual contract months, e.g. a buy order for 10 butterfly spreads at 0.10, a buy order for 20 contracts in the second of the three contract months at 95.00 and a sell order for 10 contract in the last of the three contract months at 94.95 create 1st-Generation Implied Out buy order for 10 contracts in the nearby month at 95.15. A "1st-Generation Implied Out" order for a calendar spread from a butterfly spread may be created from an actual order for a butterfly spread with (1) an actual order for a calendar spread, e.g. a buy order for 10 butterfly spreads at 0.10, a buy order for 10 calendar spreads between the last two of the three contract months at 0.05 create a 1st-Generation Implied Out buy order for 10 calendar spreads between the first two of the three contract months at 0.15; or (2) actual orders for two of the three individual contract months, e.g. a buy order for 10 butterfly spreads at 0.10, a buy order for 10 contracts in the second of the three contract months at 95.00 and a sell order for 10 contract in the last of the three contract months at 94.95 create 1st-Generation Implied Out buy order for 10 calendar spreads between the first two of the three contract months at 0.15.
- Note that an Implied Out order for the second of the three contract months from a butterfly spread is for two contracts. These two contracts may have different implied prices, e.g. a buy order for 1 butterfly spread at 0.15, a sell order for 1 contract in the first of the three contract months at 95.15 and a sell order for 1 contract in the last of the three contract months at 94.95 creates implied orders in the second of the three contract months to sell 1 contract at 95.00 and 1 contract at 94.95. Regardless of whether the implied prices for the two contracts are identical, the trade can only occur if both contracts can be matched opposing orders. In the event an opposing order exists for one of the two contracts in the second leg of butterfly spread, an Implied Out order for the remainder may be created.
- A "2nd-Generation Implied In" order for a butterfly spread may be derived on the Globex system from a combination of actual orders in the individual contracts and 1st-Generation Implied Out orders from calendar spreads for the remaining leg(s) in the butterfly spread.
- A "2nd-Generation Implied out" order for an individual contract from a butterfly spread may be derived on the Globex system from an actual order for a butterfly spread and a combination of actual and implied orders in the individual contracts and/or calendar spreads.
- The Globex system will disseminate 1st-Generation Implied In orders for butterfly spreads and 1st-Generation Implied Out orders for the first and the last of the three contract months from a butterfly spread order. 1st-Generation Implied Out orders for the second of the three contract months from a butterfly spread order are not disseminated due to the fact that such orders can only be filled if both contracts for each spread can be matched to opposing orders. 2nd-Generation Implied orders are created for matching purpose only and are

also not disseminated.

- Implied In and Implied Out orders created by the Implied Order Algorithm shall be processed per the Pro Rata Allocation Algorithm described above, except that
  1. Implied orders shall not be granted Time Priority or considered the TOP order;
  2. In the event that contracts remain to be allocated after the Initial Allocation, as described in the Pro Rata Allocation Algorithm above, and two or more orders have identical quantities and are the largest orders, allocations shall be made to Implied orders only after allocation to actual orders is complete. Allocations to Implied orders shall be made on the basis of maturity of the contract(s) where nearby contracts receive priority over deferred contracts.
- Market orders, that are entered into the Globex System where the Implied Order Algorithm is effective, shall be converted into limit orders and filled at the best available price from actual orders or 1st Generation Implied orders. If the quantity of the market order exceeds the quantity of opposite actual and 1st Generation Implied orders, Globex will create, and allocate the remaining contracts to, 2nd Generation Implied orders. Allocations to Implied orders shall be made on the basis of maturity of the contract(s) where nearby contracts receive priority over deferred contracts. Any part of such market order that is not filled at the limit price or better shall remain as a resting order at such limit price until filled or cancelled.
- Stop limit orders, that are entered into the Globex System where the Implied Order Algorithm is effective, are activated and placed into the order book when the order's specified stop price is traded, at which time the order may be executed at the specified limit price or better. Such stop limit orders are initially allocated to actual and 1st Generation Implied orders. If the quantity of the stop limit order exceeds the quantity of opposite actual and 1st Generation Implied orders, Globex will create, and allocate the remaining contracts to, 2nd Generation Implied orders. Allocations to Implied orders shall be made on the basis of maturity of the contract(s) where nearby contracts receive priority over deferred contracts. Any part of such stop limit order that is not filled at the limit price or better shall remain as a resting order at such limit price until filled or cancelled.

Agricultural Futures Contracts: Unless specifically referenced in this Interpretation, all other futures and options contracts will continue to use the Pro Rata Allocation Algorithm. This Implied Order Algorithm for Agricultural futures contracts operates as follows:

- A "1st Generation Implied In" order for a calendar spread may be derived on the Globex system from actual orders in the individual contracts or legs of the calendar spread. E.g., a buy order for 15 contracts at 85.05 in a nearby Live Cattle futures contract and a sell order for 10 contracts at 85.00 in a deferred Live Cattle futures contract creates a 1st Generation Implied In order to buy 10 calendar spreads at 0.05.
- A "1st Generation Implied Out" order for an individual contract may be derived on the Globex system from (1) actual orders in a calendar spread that includes that individual contract; and (2) actual orders in the other individual contract that comprises the calendar spread. E.g., a buy order for 5 contracts at 85.15 in a nearby Live Cattle futures contract and a sell order for 10 calendar spreads, that include that nearby contract and a deferred contract, at 0.05 creates an Implied Out order to buy 5 contracts in the deferred leg of calendar spread at 85.10.
- A "2nd Generation Implied In" order for a calendar spread may be derived on the Globex system from (1) actual orders in one individual contract of the calendar spread; and (2) 1st Generation Implied Out orders in the other individual contract that comprises the calendar spread.
- A "2nd Generation Implied Out" order for an individual contract may be derived on the Globex system from (1) actual orders in a calendar spread that includes that individual contract; and (2) 1st Generation Implied Out orders in the other individual contract that comprises the calendar spread.
- Implied In orders for calendar spreads and Implied Out orders for an individual contract based on orders for calendar spread and another individual contract shall be for a quantity representing the smaller of the two orders from which the Implied order is derived.
- All implied orders will be derived by the Globex system subject to the applicable daily price limits for that particular product and contract month.
- The Globex system will create 2nd Generation Implied In and Out orders, for matching purposes only, if there are insufficient quantities of actual and 1st Generation Implied In and Out orders to satisfy arriving orders. This may result in a match with 2nd Generation Implied orders at more favorable prices than had previously been available. Second Generation Implied orders will not be disseminated to the marketplace.
- Implied In and Implied Out orders created by the Implied Order Algorithm shall be processed per the LMM Allocation Algorithm (Option B) described below, except that
  1. Implied orders shall not be granted Time Priority or considered the TOP order;
  2. In the event that contracts remain to be allocated after the Initial Allocation, as described in the Pro Rata Allocation Algorithm above, and two or more orders have identical quantities and are the largest orders, allocations shall be made to Implied orders only after allocation to actual orders is complete. Allocations to Implied orders shall be made on the basis of maturity of the contract(s) where nearby contracts receive priority over deferred contracts.
- Market orders, that are entered into the Globex System where the Implied Order Algorithm is effective, shall be converted into limit orders and filled at the best available price from actual orders or 1st Generation Implied orders. If the quantity of the market order exceeds the quantity of opposite actual and 1st Generation Implied orders, Globex will create, and allocate the remaining contracts to, 2nd Generation Implied orders. Allocations to Implied orders shall be made on the basis of maturity of the contract(s) where nearby contracts receive priority over deferred contracts. Any part of such market order that is not filled at the limit price or better shall

remain as a resting order at such limit price until filled or cancelled.

- Stop limit orders, that are entered into the Globex System where the Implied Order Algorithm is effective, are activated and placed into the order book when the order's specified stop price is traded, at which time the order may be executed at the specified limit price or better. Such stop limit orders are initially allocated to actual and 1st Generation Implied orders. If the quantity of the stop limit order exceeds the quantity of opposite actual and 1st Generation Implied orders, Globex will create, and allocate the remaining contracts to, 2nd Generation Implied orders. Allocations to Implied orders shall be made on the basis of maturity of the contract(s) where nearby contracts receive priority over deferred contracts. Any part of such stop limit order that is not filled at the limit price or better shall remain as a resting order at such limit price until filled or cancelled.

Housing and Eurozone HICP Futures Contracts: Unless specifically referenced in this Interpretation, all other futures and options contracts will continue to use the Pro Rata Allocation Algorithm. This Implied Order Algorithm for housing and HICP futures contracts operates as follows:

- A "1st Generation Implied In" order for a calendar spread may be derived on the Globex system from actual orders in the individual contracts or legs of the calendar spread. E.g., a buy order for 15 contracts at 85.05 in a nearby housing futures contract and a sell order for 10 contracts at 85.00 in a deferred housing futures contract creates a 1st Generation Implied In order to buy 10 calendar spreads at 0.06.
- A "1st Generation Implied Out" order for an individual contract may be derived on the Globex system from (1) actual orders in a calendar spread that includes that individual contract; and (2) actual orders in the other individual contract that comprises the calendar spread. E.g., a buy order for 5 contracts at 85.15 in a nearby housing futures contract and a sell order for 10 calendar spreads, that include that nearby contract and a deferred contract, at 0.05 creates an Implied Out order to buy 5 contracts in the deferred leg of calendar spread at 85.10.
- A "2nd Generation Implied In" order for a calendar spread may be derived on the Globex system from (1) actual orders in one individual contract of the calendar spread; and (2) 1st Generation Implied Out orders in the other individual contract that comprises the calendar spread.
- A "2nd Generation Implied Out" order for an individual contract may be derived on the Globex system from (1) actual orders in a calendar spread that includes that individual contract; and (2) 1st Generation Implied Out orders in the other individual contract that comprises the calendar spread.
- Implied In orders for calendar spreads and Implied Out orders for an individual contract based on orders for calendar spread and another individual contract shall be for a quantity representing the smaller of the two orders from which the Implied order is derived.
- The Globex system will create 2nd Generation Implied In and Out orders, for matching purposes only, if there are insufficient quantities of actual and 1st Generation Implied In and Out orders to satisfy arriving orders. This may result in a match with 2nd Generation Implied orders at more favorable prices than had previously been available. Second Generation Implied orders will not be disseminated to the marketplace.
- Implied In and Implied Out orders created by the Implied Order Algorithm shall be processed per the LMM Allocation Algorithm (Option B) described below, except that
  1. Implied orders shall not be granted Time Priority or considered the TOP order;
  2. In the event that contracts remain to be allocated after the Initial Allocation, as described in the Pro Rata Allocation Algorithm above, and two or more orders have identical quantities and are the largest orders, allocations shall be made to Implied orders only after allocation to actual orders is complete. Allocations to Implied orders shall be made on the basis of maturity of the contract(s) where nearby contracts receive priority over deferred contracts.
- Market orders, that are entered into the Globex System where the Implied Order Algorithm is effective, shall be converted into limit orders and filled at the best available price from actual orders or 1st Generation Implied orders. If the quantity of the market order exceeds the quantity of opposite actual and 1st Generation Implied orders, Globex will create, and allocate the remaining contracts to, 2nd Generation Implied orders. Allocations to Implied orders shall be made on the basis of maturity of the contract(s) where nearby contracts receive priority over deferred contracts. Any part of such market order that is not filled at the limit price or better shall remain as a resting order at such limit price until filled or cancelled.
- Stop limit orders, that are entered into the Globex System where the Implied Order Algorithm is effective, are activated and placed into the order book when the order's specified stop price is traded, at which time the order may be executed at the specified limit price or better. Such stop limit orders are initially allocated to actual and 1st Generation Implied orders. If the quantity of the stop limit order exceeds the quantity of opposite actual and 1st Generation Implied orders, Globex will create, and allocate the remaining contracts to, 2nd Generation Implied orders. Allocations to Implied orders shall be made on the basis of maturity of the contract(s) where nearby contracts receive priority over deferred contracts. Any part of such stop limit order that is not filled at the limit price or better shall remain as a resting order at such limit price until filled or cancelled.

#### Lead Market Maker (LMM) Allocation Algorithms

The Exchange may designate, per the provisions of Rule 581, Globex Lead Market Maker Program, multiple Lead Market Makers (LMMs) in specified futures and option markets traded on the Globex Electronic Trading System. The Exchange has determined to use either LMM Allocation Algorithm (Option A) or LMM Allocation Algorithm (Option B) as described below to match orders in specified markets. No markets are currently subject to LMM Allocation Algorithm (Option A). Weather futures, agricultural futures, futures on Standard and Poor's Depository Receipts ("SPDR"), NASDAQ-100 Tracking Stock ("QQQQ"), Russell 2000 iShares ("IWM"), and Housing futures shall be subject to LMM Allocation Algorithm (Option B). All other futures and options contracts, unless specifically referenced in this Interpretation, will continue to use the normal matching algorithm based on price and time priority.

1. The LMM Allocation Algorithm (Option A) operates as follows:
  - After the opening, Time Priority is assigned to the first order at a price that betters the market when the order is received. Only one buy order and one sell order can have Time Priority at any given time. Orders with Time Priority are matched first regardless of whether it was entered by an LMM or non-LMM.
  - An order will lose Time Priority when an order at a better price is entered. Example: An order to buy 50 contracts is entered at 105. This order is the first order in at this price level. Another order comes in and betters the market, buy 25 contracts at 106. The order at the 106 level has Time Priority now. The market sells off and the bid of 25 contracts at 106 is hit. The bid for 50 contracts at 105 does not regain its Time Priority and will be allocated according to the LMM Allocation Algorithm along with all the other 105 bids.
  - After the Time Priority order is filled, the LMM Allocation Algorithm is applied to the remainder of the resting orders at that price level. The LMM Algorithm will attempt to allocate a specified minimum proportion of the trade to the LMM provided that the LMM's bid or offer matches the best available bid or offer. Any contracts still to be allocated after the "LMM Allocation" are allocated based upon the time of order entry.
  - If the allocation to the LMM results in a fraction, the LMM Algorithm will "Round Down" to the nearest integral contract multiple.
  - In the event that the Exchange designates a single LMM in a specified market, the LMM's allocated proportion shall be 40%. In the event that the Exchange designates two (2) LMMs in a specified market, each LMM shall be allocated 20%. In the event that the Exchange designates three (3) LMMs in a specified market, each LMM shall be allocated 15%.
2. The LMM Allocation Algorithm (Option B) operates in a manner similar to Option A as described above, except that LMMs will be allocated a specified minimum proportion of the trade provided that the LMM's bid or offer matches the best available bid or offer regardless of whether the LMM had achieved Time Priority.

#### Best Price Priority Allocation Algorithm

The Exchange has determined to use a Best Price Priority Allocation Algorithm to match orders in foreign exchange (currency and currency cross rate and E-mini) futures calendar spreads (intra-currency futures spreads) entered in the Globex Electronic Trading System. Unless specifically referenced in this Interpretation, all other futures and options contracts, including currency options, will continue to use the normal matching algorithm based on price and time priority. Foreign exchange futures calendar spread contracts were chosen to use a Best Price Priority Allocation Algorithm because they, like Eurodollar futures contracts, usually trade in a narrow price range, and price levels are represented by size, particularly during the rollover period. The Best Price Priority Allocation Algorithm operates as follows:

- After the opening, Price Priority is assigned to all orders at the price that betters the market when orders are received. All buy orders and all sell orders at the best price have Price Priority at any given time. Orders with Price Priority at the best price are matched according to an Allocation Algorithm in proportion to all orders bid or offered at that best price as follows. Example: Suppose the best bid of a June/September calendar spread is 14 and a total of 1,210 contracts are bid at that price by four different orders as follows: 1,000 contracts by Order 1; 100 contracts by Order 2; 100 contracts by Order 3; and 10 contracts by Order 4, then when a sell order hits the 14 bid by selling 500 contracts, the Globex system will allocate 414 contracts ( $1,000/1,210 * 500$  plus 1 remainder) to Order 1; 41 contracts each ( $100/1,210 * 500$ ) to Orders 2 and 3; and 4 contracts ( $10/1,210 * 500$ ) to Order 4.
- All orders at the best price will lose Price Priority when an order (or orders) at a better price is (are) entered. Example: An order to buy 50 contracts is entered at 12. This order is the first order in at this price level. Another order comes in and betters the market, buy 25 contracts at 13. The buy order at the 13 level has Price Priority now. The market sells off and the bid for 25 contracts at 13 is hit. The bid for 50 contracts at 12 regains its Price Priority because it is now the best price and this order will be allocated according to size along with all the other 12 bids.
- If the "Initial Allocation" results in a fraction, the Algorithm will "Round Down" or drop the fractional amount. Any contracts still to be allocated after the "Initial Allocation" has run are added to the largest order. If two or more orders have identical quantities and are the largest orders, the Algorithm will perform an "Electronic Coin Flip" and assign the remainder to the order that wins.

Use of the Best Price Priority Allocation Algorithm for foreign exchange futures calendar spreads will be effective on Sunday, May 10, 2002, for the Globex trade date of Monday, May 20, 2002.

#### User Defined Futures & Options Spreads on CME Globex

For combination trades of options and futures contracts on Globex, the following additional matching mechanisms apply. For each such combination, the quantity of each option contract shall be an integer, while the quantity of futures position can be a fraction. Hereafter, the quantity of each futures contract per combination shall be referred to as the "delta" with respect to the futures expiration. Each delta shall be no smaller than 0.01 and no larger than (i) 1.00, if there is only one option in the combination, or (ii) 40.00, if there are two or more distinct option contracts in the combination. For each futures contract, the price at which the futures transaction shall be consummated shall be defined within the combination, and is subject to the futures price increment conventions defined by the respective Exchange Rules. Two combinations with identical futures and options quantities and buy/sell, long/short configurations are distinct if the futures prices are not identical, and shall be treated as different combinations.

Order matching shall proceed in accordance with the same trade allocation rule as described previously in this interpretation to Rule 580, with the following provisions for assigning the futures positions. For each futures contract specified in the combination,

1. the total number of futures positions to be assigned shall be the number of combinations traded multiplied by



- the respective delta. This number of futures position shall be assigned to the incoming order.
- each of the resting limit orders, against which the incoming order are matched to, shall be assigned a futures position of the allocated numbers of combinations times the delta, rounding down to the nearest integer. e.g., if an order is allocated 15 combinations, and the delta is 0.45, 6 futures contracts shall be allocated.
  - the total number of futures position assigned to the resting limit orders following the preceding step will be equal to or fewer than the total number of futures positions to be assigned to the incoming order. The difference, if any, shall be assigned one futures contract per resting order in the following priority until the difference is reduced to zero: the resting order with the highest magnitude of rounding down in step 2 shall be first to receive an additional futures position, followed by the order with the second highest magnitude of rounding down in step 2, etc. If two orders have the same magnitude of rounding down, the oldest order shall receive the additional futures position.

For example, a trade of 60 contracts with a delta of 0.45 is matched between an incoming order and 4 resting limit orders with quantities of 20, 15, 15, 10. Total number of futures position to be assigned is  $60 \times 0.45 = 27$  contracts. The four resting orders shall receive the following assignment of futures position:

Resting Order	Matched Quantity	Quantity X delta	Initial Futures Allocation	Magnitude of Rounding	Additional Allocation	Total Futures Allocation
1	20	9.00	9	0.00	0	9
2	15	6.75	6	0.75	1	7
3	15	6.75	6	0.75	1	7
4	10	4.50	4	0.50	0	4
Incoming Order	60	27.00				27

#### INTERPRETATION OF RULE 582-GLOBEX SWITCH TRADE MATCHING ALGORITHM

Bids or offers may be entered for all available contract expirations on behalf of an account during each trading session. If both bids and offers for the same contract expiration are entered on behalf of an account, the trade matching algorithm will net the offsetting bids and offers and recognize the net order.

Orders can be entered into Globex during the pre-open period. A notification of receipt of such order shall be sent by Globex indicating that the order has been accepted. Globex will disregard any price associated with the order and substitute the price as determined for the specific expiration. Since all the outstanding orders for the same expiration carry the same price at the conclusion of order entry period, all trades for the same expiration will be consummated at the same price.

While the outcome of the trade matching process is a calendar spread, it is not necessary to enter matching buy and sell orders.

The following example demonstrates the outcome of the trade matching process. For illustrative purposes, assume that there are 4 separate accounts and 10 available contract expirations. The following table shows the outstanding orders for each account for each contract expiration. A positive number in the following table represents a bid and a negative number represents an offer. For example, for account 1, there is a bid for 98 contracts for expiration 1, a bid for 68 contracts for expiration 2, ... an offer of 125 contracts for expiration 5, ..., and no outstanding order for expiration 10.

Table: Summary of outstanding bids and offers

Expiration	Account 1	Account 2	Account 3	Account 4
1	98	-118	6	-38
2	68	65	-6	-74
3	60	39	-83	39
4	18	36	69	-46
5	-125	-83	98	28
6	68	-124	-13	-114
7	-123	24	-64	-104
8	49	-13	77	-74
9	-122	-64	116	-63
10	0	10	111	-28

The trade matching algorithm will determine the distribution of contracts bought and sold such that the total number of contracts matched is maximized, and, for each account, the total number of contracts bought equals to the total number of contracts sold. The following table shows an admissible allocation that maximizes the objective. For example, Account 1 bought 64, 6, 13, 40 and 2 contracts of expiration 1, 3, 6, 7 and 9 respectively, and sold 125 contracts of expiration 5.

Table: Summary of contracts bought and sold

Expiration	Account 1	Account 2	Account 3	Account 4
1	64	-70	6	0
2	0	26	-6	-20
3	6	39	-83	38
4	0	36	0	-36
5	-125	-4	98	28

Expiration	Account 1	Account 2	Account 3	Account 4
6	13	0	-13	0
7	40	21	-61	0
8	0	0	0	0
9	2	-61	59	0
10	0	10	0	-10

If there are multiple admissible distributions of positions yielding the same total number of contracts matched, the algorithm will choose among the admissible distribution the one with the least total sum of squares of positions to achieve widest distribution of positions. For example, the sum of squares of the positions for account 1 is  $642 + 62 + 1252 + 132 + 402 + 22$ . The total sum of squares of positions shall be the sum of squares of the positions for all accounts under the distribution.

The algorithm shall not recognize any time priority for purposes of filling orders.

#### INTERPRETATION OF RULE 584.—CME GLOBEX OPTIONS VOLATILITY QUOTE TRADING

**CME GLOBEX OPTIONS VOLATILITY TRADING MATCH.**—Once a trade occurs in an outright option or combination quoted in volatility terms, this matched transaction will be assigned: (1) a

price in premium terms for each option in the trade and (2) a delta neutral hedge quantity assignment of futures contracts, if applicable, according to the following procedures:

The exchange will determine the option price in premium terms by inserting the following variables into the appropriate standard option pricing model:

- (a) matched implied volatility,
- (b) underlying futures price from CME Globex (see details below),
- (c) time to expiration in years (equals number of calendar days from option's trade date to option's expiration date divided by 365 days),
- (d) option strike price,
- (e) current interest rate (see details below),
- (f) whether a put or a call option,
- (g) option style, either European or American to determine the appropriate standard option pricing model as detailed in Appendix A.

The resulting premium price will be rounded to the appropriate minimum tick interval of the option according to the individual options' Price Increments rules. Where, the interest rate used will be the rate implied by the prior day's settlement price of the nearest to expiration CME Group serial or quarterly Three Month Eurodollar futures contract month ( $100.00 - 3\text{-Month Eurodollar futures price} - \text{interest rate}$ ).

Where, the underlying futures price used will be based on the following tiered hierarchy:

**Tier 1:**—Most recent midpoint of the nearest to expiration March quarterly cycle ("front month") futures contract bid and ask spread on CME Globex is used as the basis for determining the underlying futures prices for all listed contract months.

If the calculated midpoint is not on a tick, CME Globex will round to either the bid side or ask side whichever has the smallest quantity of contracts bid or offered.

If the volatility quoted option being matched has an underlying futures contract other than the front month futures contract, then CME Globex will adjust the calculated price for the front month futures contract by the appropriate previous day's settlement price spread differential to imply an appropriate underlying futures price.

Normally, under Tier 1, the underlying futures price is based on the front month future bid/ask spread. However, during the expiration week of the front month future, CME Globex compares the bid/ask spreads of the front month future and the next quarterly contract month and uses the instrument with the tightest bid/ask spread for the volatility to premium price conversion. However, if the next quarterly contract month bid/ask spread is used (tighter bid/ask spread), then CME Globex will imply the underlying futures price for the front month future from the next quarterly contract month midpoint, adjusted by the appropriate spread differential from the respective previous day's settlement prices.

**Tier 2:**—Previous settlement price (when no most recent bid/ask midpoint in the nearest to expiration March quarterly cycle futures contract is available).

When the outright option includes futures in a delta neutral ratio to the options, the delta will be calculated for European-style options from the standard Black option pricing model, and for the American-style options from the standard Whaley option pricing model. See Appendix A for details of these standard options pricing models.

The quantity (" $Q_{fut}$ ") of futures contracts to be allocated in the delta neutral hedge equals the product of the net delta in the options combination (" $\Delta$ ") as determined by the applicable options pricing model, and the quantity of trades (" $Q_{opt}$ ") triggered by the incoming options order. This resulting product is rounded to the nearest integer to determine the quantity of futures contracts allocated.

$$Q_{fut} = \Delta * Q_{opt}$$

In the event an incoming options order trading in volatility terms is matched by CME Globex to more than one resting order, the resulting allocation of futures contracts shall be as follows:

The incoming order is matched via the best price and FIFO matching algorithm to two or more resting orders. The quantity of each such allocation of futures contracts equals the quantity of that portion of the matched options trade times the net delta, rounded down to the nearest integer. The sum total of the futures contracts allocated to the resting options orders after this allocation may be less than the allocation of futures contracts originally defined for the incoming options order. This difference shall be allocated one futures contract at a

time to the resting order portion that is the most under-allocated (i.e., highest remainder given the product of the net delta and option order quantity), based on the extent of rounding down in the calculation above. If there is a tie in the amounts by which two or more resting orders are the most under-allocated, then the residual futures contract shall be allocated to the oldest resting order (first order entered) that is matched to the incoming options order.

If the incoming options order is for a quantity larger than can be matched with resting orders at the same options volatility price, then the remaining quantity of the incoming options order becomes a resting limit order for the unmatched, remaining quantity at the same volatility price.

The price of futures contracts allocated by CME Globex shall be as determined in step 1 above. The following section provides a numerical example of CME Globex allocations of futures contracts, given a volatility quoted option match. Match of Multiple Counterparties and Futures Contract Hedge Assignments

The following example is for a European-style option:

- a. Assume the Ask side order enters the market and sweeps the Bid side quantity in resting orders.

1,7000 Call / Currency Option			
BID		ASK	
QTY	Volatility	Volatility	QTY
40	1220	1220	100 (incoming order)
30	1220		
20	1220		
10	1220		

- b. The Black option pricing model outputs a computed net delta of 0.51.

- c. The Bid side breakdown for assigned futures contracts is as follows:

Bid Side QTY	Delta	Delta x QTY	Rounding Down	Residual	Total Assigned Futures Contracts
40	0.51	20.4	20	1 <sup>2</sup>	21
30	0.51	15.3	15	0	15
20	0.51	10.2	10	0	10
10	0.51	5.1	5	0	5
Subtotals			50	1	51
100 matched to incoming order	0.51	Totals 51	51	Na	51

<sup>2</sup> Remainder amount rounded down for this order = 0.40, which is the highest amount of all orders. Therefore, this order is the most under-allocated and is allocated the residual futures contract.

### Appendix A: Option Pricing Models

For the purposes of providing conversions of volatility to premium option prices and options deltas under Rule 584, CME Globex will use the following option pricing models for European and American style options.

#### Black Option Pricing Model for European Style Options

##### CME Assumptions

Applicable interest rate will be based on the nearest to expiration Eurodollar Time Deposit (ED) future contract month

Price of the underlying futures contract from CME Globex as determined by the methodology detailed in this Interpretation

$$\text{Time to expiration in years is } \frac{\# \text{ of days}}{365}$$

Abbreviations used in the formula

- C = call premium
- P = put premium
- U = price of the underlying contract (future)
- E = expiration (strike) price
- t = time to expiration in years
- v = annual volatility expressed as a decimal
- r = interest rate assumption expressed in decimal
- e = base of the natural logarithm
- ln = natural logarithm
- N = normal standard distribution
- h = calculated variable (see formula below)

Equations:

$$C = Ue^{-rt}N(h) - Ee^{-rt}N(h - v\sqrt{t})$$

$$P = -Ue^{-rt}N(-h) + Ee^{-rt}N(v\sqrt{t}-h)$$

$$\text{Where } h = \frac{\ln\left(\frac{U}{E}\right) + \frac{v^2}{2}t}{v\sqrt{t}}$$

$$\text{Call delta} = e^{-rt}N(h)$$

$$\text{Put delta} = -e^{-rt}N(-h)$$

John Natenberg, S. (1994). *Option Volatility and Pricing*. New York: McGraw-Hill

#### Whaley Option Pricing Model for American-Style Options

The following model is based on the Barone-Adesi-Whaley model as described in the *Journal of Finance*, Vol. 42 No. 2, pages 301-320. The model uses analytic approximation techniques to solve for the price of the American-style option. The model estimates a value for  $S^*$  which is the underlying price above which the option should be exercised. The value of  $S^*$  is then used to determine the value of the option. For call options, the model estimates  $S^*$  by satisfying the following equation:

$(LHS - RHS) / K < 0.00001$  (Please see notes 1-4 at the end of this section.)

Where

$$LHS = S^* - K$$

$$RHS = c(S, T) + \{[1 - e^{-b(T-t)}]N(d_1(S^*))\} * (S^* / q_2)$$

$$d_1 = \{\ln(S^* / K) + (b + \sigma^2 / 2)T\} / \sigma \sqrt{T}$$

$$d_2 = d_1 - \sigma \sqrt{T}$$

$$q_2 = \{(N - 1) + \sqrt{(N - 1)^2 + 4M / k}\} / 2$$

$$M = 2 * f / \sigma^2$$

$$N = 2 * b / \sigma^2$$

$$k = 1 - e^{-ct}$$

$N(\cdot)$  is the cumulative univariate normal distribution.

$n(\cdot)$  is the univariate normal density function.

$\sigma$  = volatility (e.g. 10% per annum = 0.10)

$T$  = time until expiration in years (e.g. 90 days = 0.247)

$r$  = interest rate (e.g. 8% per annum = 0.08)

$b$  = cost of carry, assumed to be zero for the purposes of this calculation

$K$  = strike price

$S$  = underlying price

After each iteration, the estimate of  $S^*$  is adjusted by:

$$S_{i+1}^* = \{K + RHS - b_i S_i^*\} / (1 - b_i)$$

where

$$b_i = e^{-b(T-t)}N(d_1(S^*))\{1 - 1/q_2\} + [1 - e^{-b(T-t)}n(d_1(S^*)) / \sigma \sqrt{T}] / q_2$$

Once the correct value of  $S^*$  is found, the value of the call and the call's delta are found by solving:

$$C(S, T) = c(S, T) + A_2 (S / S^*)^2$$

Where

$$A_2 = (S^* / q_2) \{1 - e^{-b(T-t)}N(d_1(S^*))\}$$

$$A_1 = \Delta_c + A_2 * q_2 * (S / S^*)^2 - f / S$$

$c(S, T)$  = the price of a European style call option.

$\Delta_c$  = the delta of the European style call option.

For put options, the model estimates  $S^*$  by satisfying:

$(LHS - RHS) / K < 0.00001$

where

$$LHS = K - S^*$$

$$RHS = p(S, T) - \{[1 - e^{-b(T-t)}]N(d_1(S^*))\} * (S^* / q_2)$$

$$d_1 = \{\ln(S^* / K) + (b + \sigma^2 / 2)T\} / \sigma \sqrt{T}$$

$$d_2 = d_1 + \sigma \sqrt{T}$$

$$q_1 = \{(N - 1) - \sqrt{(N - 1)^2 + 4M / k}\} / 2$$

$$M = 2 * f / \sigma^2$$

$$N = 2 * b / \sigma^2$$

$$k = 1 - e^{-ct}$$

$N(\cdot)$  is the cumulative univariate normal distribution.

$n(\cdot)$  is the univariate normal density function.

$\sigma$  = volatility (e.g. 10% per annum = 0.10)  
 $T$  = time until expiration in years (e.g. 90 days = 0.247)  $r$  = interest rate (e.g. 3% per annum = 0.03)  
 $b$  = cost of carry, assumed to be zero for the purposes of this calculation  
 $K$  = strike price  
 $S$  = underlying price

After each iteration, the estimate of  $S^*$  is adjusted by:

$$S_{i+1}^* = \{K - RHS + b_i S_i^*\} / (1 + b_i)$$

where

$$b_i = e^{(b - r)T} N[d_1(S_i^*)] (1 - 1/q_2) - [1 + e^{(b - r)T} N[d_1(S_i^*)] / \sigma \sqrt{T}] / q_2$$

Once the correct value of  $S^*$  is found, the value of the put and the put's delta are found by solving:

$$P(S, T) = p(S, T) + A_2 (S / S^*)^2$$

where

$$A_2 = -(S^* / q_2) (1 - e^{(b - r)T} N[d_1(S^*)])$$

$$\Delta = \Delta_1 + A_2 \cdot 2 \cdot q_2 \cdot (S / S^*)^2 / S$$

$p(S, T)$  = the price of a European-style put option.

$\Delta_2$  = the delta of the European-style put option.

Note 1. — CME Group's Falcon engine goes slightly further in its precision to 0.000001 (one more decimal place).

Note 2. CME Group's Falcon engine also has a maximum number of iterations that it will perform on the equation discussed in Note 1 to fall within the tolerance level. If after 10,000 iterations the Falcon engine calculation is not within a tolerance of 0.000001, it will fall back to the European model instead.

Note 3. CME Group's Falcon engine does not implement any notion of a carrying cost or foreign interest rate. The  $b$  variable is always equal to zero in the equations. If for some reason the Falcon engine does start to use  $b$ , it is worth noting that if  $b$  is ever greater than or equal to the interest rate  $r$ , the Falcon engine automatically falls back to the European model.

Note 4. CME Group's Falcon engine uses the Black Option Pricing Model (see Appendix A) in place of the Merton Model referred to in the abstract of Giovanni Barone-Adesi and Robert E. Whaley's article in the June 1987 *Journal of Finance* (Volume XLII, No. 2).

#### INTERPRETATION OF RULE 585 — GLOBEX CALL MARKET TRADING ALGORITHM

Trade Allocation Algorithm pertinent to Globex Call Markets

The Exchange may designate the trade allocation algorithms applicable to a designated set of contracts trading pursuant to Rule 585 — Globex Call Market Trading Algorithm, including without limitation any of the algorithms set forth in Rule 580 — Globex Trade Algorithms.

Pursuant to the provisions of Rule 581 — Globex Lead Market Maker Program and Rule 585, the Exchange may designate multiple Lead Market Makers (LMMs) for a Globex Call Market for a designated set of contracts. Each LMM shall be assigned an allocation proportion for the purpose of trade matching. Trade allocation in a Call Market with LMMs operates as follows:

1. If one or more LMM's bids or offers match the best available bid or offer, against which an opposing executable order exist, the LMM's orders shall be eligible for allocation along with the orders at the best bid or offer.
2. For each LMM with orders eligible for allocation, the total allocation for the LMM shall be the smaller of its allocation proportion times the size of the opposing order, rounded down to the nearest integral contract multiple, or the aggregate order size at the same price level from the LMM. If the order with time priority has a quantity of a minimum of fifty (50), it will be designated as the TOP order. If there is a TOP order, it shall also receive an allocation of the smaller of 25% times the original quantity of the opposing order, rounded down to the nearest integer, or the size of the TOP order.
3. Following the allocation of trades to the LMM(s) and the TOP order, if it exists, the remainder of the trade shall be allocated to all remaining bids or offers at the best price on a pro rata basis. The pro rata allocation for each order shall be rounded down to the nearest integral contract multiple, with the residual quantity allocated to the largest order. If two or more orders have identical quantities and are the largest orders, the residuals shall be equally allocated between the largest orders, subject to rounding down to the nearest integral contract multiple. Any remaining unallocated contracts shall be allocated on the basis of time priority.

The Exchange retains the right to grant specific allocation proportion(s) to the LMM(s). The aggregate allocation proportion of all LMM(s), however, shall not exceed 50%. If no LMM has been designated, trade allocation shall be executed on pro rata basis, resembling step 3 of trade allocation with LMMs.

New combinations of futures and option contracts, as defined in Rule 585.1.b, can be defined by any market participants on demand. For each such combination, the quantity of each option contract shall be an integer, while the quantity of futures position can be a fraction. Hereafter, the quantity of each futures contract per combination shall be referred to as the "delta" with respect to the futures expiration. Each delta shall be no smaller than 0.01 and no larger than (i) 1.00, if there is only one option in the combination, or (ii) 40.00, if there are two or more distinct option contracts in the combination. For each futures contract, the price at which the futures transaction shall be consummated shall be defined within the combination, and is subject to the futures price increment conventions defined by the respective Exchange Rules. Two combinations with identical futures and options quantities and buy/sell, long/short configurations are distinct if the futures prices are not identical, and shall be treated as different combinations.

Order matching shall proceed in accordance with the same trade allocation rule as described previously in this interpretation to Rule 585, with the following provisions for assigning the futures positions. For each futures contract specified in the combination,

1. the total number of futures positions to be assigned shall be the number of combinations traded multiplied by the respective delta. This number of futures position shall be assigned to the incoming order.

2. each of the resting limit orders, against which the incoming order are matched to, shall be assigned a futures position of the allocated numbers of combinations times the delta, rounding down to the nearest integer; e.g. if an order is allocated 15 combinations, and the delta is 0.45, 6 futures contracts shall be allocated.
3. the total number of futures position assigned to the resting limit orders following the preceding step will be equal to or fewer than the total number of futures positions to be assigned to the incoming order. The difference, if any, shall be assigned one futures contract per resting order in the following priority until the difference is reduced to zero: the resting order with the highest magnitude of rounding down in step 2 shall be first to receive an additional futures position, followed by the order with the second highest magnitude of rounding down in step 2, etc. If two orders have the same magnitude of rounding down, the oldest order shall receive the additional futures position.

For example, a trade of 60 contracts with a delta of 0.45 is matched between an incoming order and 4 resting limit orders with quantities of 20, 15, 15, 10. Total number of futures position to be assigned is  $60 \times 0.45 = 27$  contracts. The four resting orders shall receive the following assignment of futures position:

Resting Order	Matched Quantity	Quantity X delta	Initial Futures Allocation	Magnitude of Rounding	Additional Allocation	Total Futures Allocation
1	20	9.00	9	0.00	0	9
2	15	6.75	6	0.75	1	7
3	15	6.75	6	0.75	1	7
4	10	4.50	4	0.50	0	4
Incoming Order	60	27.00				27

In the case of a Request for Cross (RFC) entered pursuant to Rule 539.C.4., matching will depend upon whether the RFC price at the time of entry, relative to other orders in the market, improves both the current bid and offer prices, matches the bid or offer price, or is outside of the bid or offer price.

RFC Price Improves Current Bid and Offer Prices in the Market

If the RFC price represents strict improvement on both the current bid and offer prices at the time of the entry of the RFC, 100% of the buy and sell orders represented in the RFC shall be matched against each other at the RFC price immediately upon submission of the RFC.

RFC Price Matches or is Outside the Current Bid or Offer Price in the Market

All Products Excluding Equity Options

If the RFC price matches or is outside the bid or offer price in the market at the time the RFC order is entered, 1) the applicable side of the RFC order will immediately match against orders in the market at a price better than or equal to the RFC price in accordance with the allocation algorithm described above, 2) immediately thereafter, 60% of the smaller quantity remaining on one side of the RFC order will be matched against the opposite side of the RFC order at the RFC price, 3) any remaining unmatched portion of the RFC bid and offer will then be available for matching against other incoming orders for an additional five (5) seconds, 4) any match eligible quantity remaining on the RFC order will then be matched at the RFC price, and 5) any remaining unmatched balance on one side of the RFC will either be cancelled or will remain in the order book depending on the order instructions entered via the RFC.

Equity Options

If the RFC price matches or is outside the bid or offer price in the market at the time the RFC order is entered, 1) the applicable side of the RFC order will immediately match against orders in the market at a price better than or equal to the RFC price in accordance with the allocation algorithm described above, 2) immediately thereafter, 100% of the smaller quantity remaining on one side of the RFC order will be matched against the opposite side of the RFC order at the RFC price, and 3) any remaining unmatched balance on one side of the RFC will either be cancelled or will remain in the order book depending on the order instructions entered via the RFC.

**CBOT and NYMEX Amendments:**

**580. GLOBEX TRADE MATCHING ALGORITHMS**

The Globex platform employs multiple predefined sets of matching algorithms used to match trades on the platform. Information concerning the matching algorithm applicable to a particular product is set forth in the CME Globex Price Banding document available on cmegroup.com at [www.cmegroup.com/globex/files/PriceBanding.pdf](http://www.cmegroup.com/globex/files/PriceBanding.pdf). Information on the operation of the matching algorithms is available on cmegroup.com at [www.cmegroup.com/globex/introduction](http://www.cmegroup.com/globex/introduction).