

## Advisory Notice

Clearing House

TO: Clearing Member Firms  
Back Office Managers

FROM: Clearing House Department

DATE: February 14, 2005

ADVISORY #: 05-28

SUBJECT: **Averaging Algorithm in the new Average Price System**

In June 2005 CME will implement a replacement to the existing Average Price System (APS). The new system will be a web based application integrated into existing Front End Clearing System and will contain several key enhancements:

- The system will round to the nearest outright minimum fluctuation for the given contract being averaged. The minimum fluctuations for the contracts are found in the contract specifications, the daily CME SPAN files.
  - CME: <http://www.cme.com/clearing/clr/spec/>
  - CBOT: <http://www.cbot.com/cbot/pub/page/0,3181,21,00.html>
- Averaging of cabinet and variable cabinet trades will be allowed in the new system. Specific examples of rounding cabinets will be in a future memo.
- If all trades composing the averaging group are at the same trade price the system will not perform the step to round to the nearest minimum fluctuation. In this case, the average price and the rounded price will be set to the trade price within the group. The resulting residual will then be zero.

Following are the six steps in the algorithm CME will use to calculate average prices for all products. Specific examples will follow the steps.

### ***Step 1: Determining the true average (weighted average price)***

First, each trade price is decimalized if necessary with no loss of precision. The decimalized trade price is multiplied by the trade quantity yielding a quantity weighted price. All quantity weighted prices for the group are summed and then divided by the total quantity of the group. This yields the true average price for the group. For fractional products, the true average will remain in a decimal format.

### ***Step 2: Round the true average to a tick value***

As stated above, if all trades making up the averaging group are at the same price then the system will not perform any contract tick rounding. The system will set the average price equal to the decimal equivalent of the trade prices and will set the rounded price equal to the trade price. This will result in a zero residual.

In all other cases the system will use the true average price to round the average price to the nearest contract tick for an outright trade. The system will round up for buys and down for sells. Again, outright tick fluctuations may be found on the web pages above.

### ***Step 3: Calculate the value of the group at the rounded price***

The value of the group at the rounded price is calculated by multiplying the decimalized rounded price by the contract value factor for the product. The list of contract value factors for CME and CBOT products is attached to this Advisory or they are contained in the daily CME SPAN Files.

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This amount is then rounded to the decimal precision of the settlement currency for the product. For products settled in USD the precision is two; for products settled in JPY the decimal precision is zero. The rounded result is next multiplied by the averaging group quantity yielding the total value at the rounded price.

### ***Step 4: Calculate the value of the component trades***

APS will next compute the value of the component trades. This is calculated by multiplying the trade price and the contract value factor for the product and then rounded to the decimal precision of the settlement currency for the product. This now rounded amount is multiplied by the trade quantity yielding the trade value. The trade values of all the component trades are then summed yielding the total trade value.

### ***Step 5: Calculate the group residual***

To calculate the group residual, the total trade value (Step 4) is subtracted from the total value at the rounded price (Step 3). If averaging sells, this result needs to be further multiplied by -1 since sells were rounded down in Step 2. This result is the total residual value for the group.

In normal circumstances the group residual is a positive number. The Carry Firm to the allocation receives a credit while the Executing Firm gets a debit. However, in certain circumstances the group residual can be calculated to be a negative number. In this case the executing firm will receive a residual that is a credit rather than the expected debit. The carry firm would, in turn, receive a debit. A sample of such a case can be found in Example 7 following.

### ***Step 6: Calculating allocation residuals***

In order to calculate the residual that will be attached to each allocation the total residual value in Step 5 is divided by the averaging group quantity and is not rounded. This result is the residual for each one lot allocation. This value is then multiplied by the allocation quantity and truncated to the precision of the settlement currency for the product. The executing firm retains any difference between the group residual and allocation residuals; these are commonly referred to as "APS Pennies."

If you have any questions regarding the calculation of average prices please contact the CME Clearing House at 312-207-2525.

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### AVERAGING EXAMPLES

#### **Example 1: CME S&P 500 Averaging**

##### **Component Trades:**

- Buy 5 at 1190.00
- Buy 10 at 1190.10
- Buy 5 at 1190.05 (spread)

##### **Step 1: Determining the true average (weighted average price)**

Multiply trade price and quantity:

Quantity		Price		Weighted Price
5	x	1190.00	=	5950
10	x	1190.10	=	11901
5	x	1190.05	=	5950.25
<b>20</b>				<b>23801.25</b>

Divide the total weighted price by the total quantity yielding a weighted average price of 1190.06250000.

##### **Step 2: Round the true average to a tick value**

The outright tick for an S&P is 0.10 and buys round up making 1190.06250000 become 1190.10.

##### **Step 3: Calculate the value of the group at the rounded price.**

Group quantity is again 20 and the rounded price is 1190.10. The contract value factor for S&Ps is 250.00 USD. The USD decimal precision is two decimals.

Contract Value Factor		Rounded Price		Rounded to Precision		Quantity		Value at Rounded Price
\$250.00	x	1190.10	=	\$297,525.00	x	20	=	<b>\$5,950,500.00</b>

##### **Step 4: Calculate the value of the component trades**

Contract Value Factor		Trade Price		Rounded to Precision		Quantity		Trade Value
\$250	x	1190.00	=	\$297,500.00	x	5	=	\$1,487,500.00
\$250	x	1190.10	=	\$297,525.00	x	10	=	\$2,975,250.00
\$250	x	1190.05	=	\$297,513.00	x	5	=	\$1,487,565.00
								<b>\$5,950,315.00</b>

##### **Step 5: Calculate the group residual**

Subtract the total Trade Value from the Total Rounded Value.

	\$5,950,500.00
-	\$5,950,315.00
	<b>\$185.00</b>

##### **Step 6: Calculating allocation residuals**

Divide the total residual by the number of contracts.

Residual		Group Quantity		Residual per Allocation (R.P.A)
\$185.00	÷	20	=	<b>\$9.250</b>

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Quantity		R.P.A		Allocation Residual
1	x	\$9.250	=	\$9.25
9	x	\$9.250	=	\$83.25
10	x	\$9.250	=	\$92.50
<b>Total Allocation Residual</b>				<b>\$185.00</b>
<b>Group Residual</b>				<b>\$185.00</b>
<b>APS Pennies</b>				<b>\$0.00</b>

Quantity		Price		Weighted Price
25	x	111.359375	=	2783.984375
5	x	111.34375	=	556.71875
<b>30</b>				<b>3340.703125</b>

<b>Contract Value Factor</b>		<b>Rounded Price</b>		<b>Rounded to Precision</b>		<b>Quantity</b>		<b>Value at Rounded Price</b>
\$1,000.00	x	111.34375	=	\$111,343.75	x	30	=	<b>\$3,340,312.50</b>

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### Step 5: Calculate the group residual

Subtract the total Trade Value from the Total Rounded Value.

	\$3,340,312.50
-	\$3,340,703.25
	<b>-\$390.75</b>

Sells get multiplied by -1 so the group residual is \$390.75

### Step 6: Calculating allocation residuals

Divide the total residual by the number of contracts.

Residual		Group Quantity		Residual per Allocation (R.P.A)
\$390.75	÷	30	=	<b>\$13.025</b>

These are the residuals assuming the following allocations:

Quantity		R.P.A		Allocation Residual
4	x	\$13.025	=	\$52.10
20	x	\$13.025	=	\$260.50
1	x	\$13.025	=	\$13.02
5	x	\$13.025	=	\$65.12
<b>Total Allocation Residual</b>				<b>\$390.74</b>
<b>Group Residual</b>				<b>\$390.75</b>
<b>APS Pennies</b>				<b>\$0.01</b>

Recall that the allocation residual is truncated rather than rounded.

### Example 3: CME Yen Denominated Nikkei Averaging

#### Component Trades:

- Buy 1 at 11485
- Buy 2 at 11505

#### Step 1: Determining the true average (weighted average price)

Multiply trade price and quantity:

Quantity		Price		Weighted Price
1	x	11485	=	11485
2	x	11505	=	23010
<b>3</b>				<b>34495</b>

Divide the total weighted price by the total quantity yielding an average weighted price of 11498.33333333.

#### Step 2: Round the true average to a tick value

The outright tick for a Yen denominated Nikkei is 5 points. Rounding buys up makes 11498.33333333 become 11500

#### Step 3: Calculate the value of the group at the rounded price.

Group quantity is three and the rounded price is 11500. The contract value factor for Yen denominated Nikkei is 500 JPY. Further, yen has a decimal precision of zero.

Contract Value Factor		Rounded Price		Rounded to Precision		Quantity		Value at Rounded Price
¥500	x	11500	=	¥5,750,000	x	20	=	<b>¥17,250,000</b>

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### Step 4: Calculate the value of the component trades

Contract Value Factor		Trade Price		Rounded to Precision		Quantity		Trade Value
¥500	x	11485	=	¥5742500	x	1	=	¥5,742,500
¥500	x	11505	=	¥5752500	x	2	=	¥11,505,000
								<b>¥17,247,500</b>

### Step 5: Calculate the group residual

Subtract the total trade value from the total rounded value.

	¥17,250,000
-	¥17,247,500
	<b>¥2500</b>

### Step 6: Calculating allocation residuals

Divide the total residual by the number of contracts and do not round.

Residual		Group Quantity		Residual per Allocation (R.P.A)
¥2500	÷	3	=	<b>¥833.333</b>

Here are the residuals per allocation assuming there are three, one lot allocations.

Quantity		R.P.A		Allocation Residual
1	x	¥833.333	=	¥833
1	x	¥833.333	=	¥833
1	x	¥833.333	=	¥833
<b>Total Allocation Residual</b>				<b>¥2499</b>
<b>Group Residual</b>				<b>¥2500</b>
<b>APS Pennies</b>				<b>¥1</b>

The amounts are truncated to the decimal precision of the settlement currency, zero.

### Example 4: CBOT Fed Fund Averaging

#### Component Trades:

- Sell 35 at 97.405
- Sell 3 at 97.400
- Sell 2 at 97.380

### Step 1: Determining the true average (weighted average price)

Multiply trade price and quantity:

Quantity		Price		Weighted Price
35	x	97.405	=	3409.175
3	x	97.400	=	292.2
2	x	97.380	=	194.76
<b>40</b>				<b>3896.135</b>

Divide the total weighted price by the total quantity yielding an average weighted price of 97.40337500.

### Step 2: Round the true average to a tick value

The outright tick for Fed Fund is 0.05 and sells round down. As a result, the average weighted price of 97.40337500 rounds down to 97.400

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### Step 3: Calculate the value of the group at the rounded price.

Group quantity is again 40 and the rounded price is 97.400. The contract value factor for Fed Funds is \$4,167.00. USD decimal precision is two decimals.

Contract Value Factor		Rounded Price		Rounded to Precision		Quantity		Value at Rounded Price
\$4,167.00	x	97.400	=	\$405,865.80	x	40	=	<b>\$16,234,632.00</b>

### Step 4: Calculate the value of the component trades

Contract Value Factor		Trade Price		Rounded to Precision		Quantity		Trade Value
\$4,167.00	x	97.405	=	\$405,886.64	x	35	=	\$14,206,032.40
\$4,167.00	x	97.400	=	\$405,865.80	x	3	=	\$1,217,597.40
\$4,167.00	x	97.380	=	\$405,782.46	x	2	=	\$811,564.92
								<b>\$16,235,194.72</b>

### Step 5: Calculate the group residual

Subtract the total trade value from the total rounded value.

	\$16,234,632.00
-	16,235,194.72
	<b>-\$562.72</b>

Sells get multiplied by -1 so the group residual is \$562.72

### Step 6: Calculating allocation residuals

Divide the total residual by the number of contracts.

Residual		Group Quantity		Residual per Allocation (R.P.A)
\$562.72	÷	40	=	<b>\$14.068</b>

These are the residuals assuming the following allocations:

Quantity		R.P.A		Allocation Residual
7	x	\$14.068	=	\$98.47
20	x	\$14.068	=	\$281.36
10	x	\$14.068	=	\$140.68
3	x	\$14.068	=	\$42.20
<b>Total Allocation Residual</b>				<b>\$562.71</b>
<b>Group Residual</b>				<b>\$562.72</b>
<b>APS Pennies</b>				<b>\$0.01</b>

The allocation residual is truncated rather than rounded.

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### Example 5: CME Eurodollar Averaging

#### Component Trades:

This example will demonstrate contract tick rounding enhancement specifically for quarter tick eligible CME Eurodollar contracts.

- Buy 5 at 97.2025
- Buy 5 at 97.2100
- Buy 5 at 97.2200

#### Step 1: Determining the true average (weighted average price)

Multiply trade price and quantity:

Quantity		Price		Weighted Price
5	x	97.2025	=	486.0125
5	x	97.2100	=	486.05
5	x	97.2200	=	486.1
15				1458.1625

Divide the total weighted price by the total quantity yielding an average weighted price of 97.21083333.

#### Step 2: Round the true average to a tick value

The outright tick for this particular Eurodollar contract is 0.0025 and buys will round up. As a result, the average weighted price of 97.21083333 rounds up to 97.2125.

#### Step 3: Calculate the value of the group at the rounded price.

Group quantity is again 15 and the rounded price is 97.2125. The contract value factor for Eurodollars is \$2,500.00. USD decimal precision is two decimals.

Contract Value Factor		Rounded Price		Rounded to Precision		Quantity		Value at Rounded Price
\$2,500.00	x	97.2125	=	\$243,031.25	x	15	=	\$3,645,468.75

#### Step 4: Calculate the value of the component trades

Contract Value Factor		Trade Price		Rounded to Precision		Quantity		Trade Value
\$2,500.00	x	97.2025	=	\$243,006.25	x	5	=	1215031.25
\$2,500.00	x	97.2100	=	\$243,025.00	x	5	=	1215125
\$2,500.00	x	97.2200	=	\$243,050.00	x	5	=	1215250
								\$3,645,406.25

#### Step 5: Calculate the group residual

Subtract the total trade value from the total rounded value.

	\$3,645,468.75
-	\$3,645,406.25
	\$62.50

#### Step 6: Calculating allocation residuals

Divide the total residual by the number of contracts.

Residual		Group Quantity		Residual per Allocation (R.P.A)
\$62.50	÷	15	=	\$4.166667



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These are the residuals assuming the following allocations:

Quantity		R.P.A		Allocation Residual
7	x	\$4.166666	=	\$29.16
8	x	\$4.166666	=	\$33.33
Total Allocation Residual				\$62.49
Group Residual				\$62.50
APS Pennies				\$0.01

The allocation residual is truncated rather than rounded.

### Example 6: CME Nasdaq 100 Averaging

#### Component Trades:

- Buy 5 at 1532.55 (spread)
- Buy 10 at 1532.55 (spread)
- Buy 10 at 1532.55 (spread)

#### Step 1: Determining the true average (weighted average price)

Multiply trade price and quantity:

Quantity		Price		Weighted Price
5	x	1532.55	=	7662.75
10	x	1532.55	=	15325.5
10	x	1532.55	=	15325.5
25				38313.75

Divide the total weighted price by the total quantity yielding a weighted average price of 1532.55000000.

#### Step 2: Round the true average to a tick value

The outright tick for a Nasdaq 100 is 0.50 and buys would round up. However, the APS detects that all the component trades of the group were executed at 1532.55 the rounded price remains at 1532.55.

#### Step 3: Calculate the value of the group at the rounded price.

Group quantity is again 25 and the rounded price is 1532.55. The contract value factor for the Nasdaq 100 is 100.00 USD. The USD decimal precision is two decimals.

Contract Value Factor		Rounded Price		Rounded to Precision		Quantity		Value at Rounded Price
\$100.00	x	1532.55	=	\$153,255.00	x	25	=	\$3,831,375.00

#### Step 4: Calculate the value of the component trades

Contract Value Factor		Trade Price		Rounded to Precision		Quantity		Trade Value
\$100	x	1532.55	=	\$153,255.00	x	5	=	\$766,275.00
\$100	x	1532.55	=	\$153,255.00	x	10	=	\$1,532,550.00
\$100	x	1532.55	=	\$153,255.00	x	10	=	\$1,532,550.00
								\$3,831,375.00

#### Step 5: Calculate the group residual

Subtract the total trade value from the total rounded value.

	\$3,831,375.00
-	\$3,831,375.00
	\$0.00

#### Step 6: Calculating allocation residuals

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Divide the total residual by the number of contracts.

Residual		Group Quantity		Residual per Allocation (R.P.A)
\$0.00	÷	25	=	\$0.00

Residuals per allocation assuming this allocation:

Quantity		R.P.A		Allocation Residual
25	x	\$0.00	=	\$9.25
Total Allocation Residual				\$0.00
Group Residual				\$0.00
APS Pennies				\$0.00

### Example 7: CBOT 5 Year Note Option Averaging

The following examples is a case where the normal flow of residual, credit to the Carry Firm and debit to the Executing Firm, is inverted. The Executing Firm receives a credit for the residual while the carry firm receives a debit for the residual.

#### Component Trades:

- Sell 3,000 at 2 24/64 (2.375)
- Sell 6,000 at 2 25/64 (2.390625)
- Sell 3,000 at 2 25/64 (2.40625)

#### Step 1: Determining the true average (weighted average price)

Multiply trade price and quantity:

Quantity		Price		Weighted Price
3000	x	2.375	=	7125
6000	x	2.390625	=	14343.75
3000	x	2.40625	=	7218.75
12000				28687.5

Divide the total weighted price by the total quantity yielding an average weighted price of 2.39062500 which is equivalent to a price of 2 25/64.

#### Step 2: Round the true average to a tick value

The outright tick for a 5-Year Note is 1/64 and sells round down. The average weighted price of 2.39062500 is exactly a tick so the rounded price is 2.390625 (2 25/64).

#### Step 3: Calculate the value of the group at the rounded price.

Group quantity is again 12,000 and the rounded price is 2.390625. The contract value factor for 5-Year Notes is 1,000.00 USD and the USD decimal precision is two decimals.

Contract Value Factor		Rounded Price		Rounded to Precision		Quantity		Value at Rounded Price
\$1,000.00	x	2.390625	=	\$2,390.63	x	12000	=	\$28,687,560.00

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### Step 4: Calculate the value of the component trades

Contract Value Factor		Trade Price		Rounded to Precision		Quantity		Trade Value
\$1,000.00	x	2.375	=	\$2,375.00	x	3000	=	\$7,125,000.00
\$1,000.00	x	2.390625	=	\$2,390.63	x	6000	=	\$14,343,780.00
\$1,000.00	x	2.40625	=	\$2,406.25	x	3000	=	7,218,750.00
								<b>\$28,687,530.00</b>

### Step 5: Calculate the group residual

Subtract the total trade value from the total rounded value.

	\$28,687,560.00
-	\$28,687,530.00
	<b>\$30.00</b>

Sells get multiplied by -1 however so the group residual is -\$30.00

### Step 6: Calculating allocation residuals

Divide the total residual by the number of contracts.

Residual		Group Quantity		Residual per Allocation (R.P.A)
-\$30.00	÷	12000	=	<b>-\$0.0025</b>

These are the residuals assuming the following allocations:

Quantity		R.P.A		Allocation Residual
8000	x	-\$0.0025	=	-\$20.00
4000	x	-\$0.0025	=	-\$10.00
<b>Total Allocation Residual</b>				<b>-\$30.00</b>
<b>Group Residual</b>				<b>-\$30.00</b>
<b>APS Pennies</b>				<b>\$0.00</b>

The Executing Firm will receive a credit for the residual while the Carry Firm will receive a debit.