*The powerful and flexible
trading and risk management tool from
the Chicago Board Options Exchange*

# THE CBOE VOLATILITY INDEX® – VIX®

**CBOE**®

# THE CBOE VOLATILITY INDEX® - VIX®

In 1993, the Chicago Board Options Exchange® (CBOE®) introduced the CBOE Volatility Index®, VIX®, which was originally designed to measure the market's expectation of 30-day volatility implied by at-the-money S&P 100® Index (OEX®) option prices. VIX soon became the premier benchmark for U.S. stock market volatility. It is regularly featured in the *Wall Street Journal*, *Barron's* and other leading financial publications, as well as business news shows on *CNBC, Bloomberg TV* and *CNN/Money*, where VIX is often referred to as the "fear index."

Ten years later in 2003, CBOE together with Goldman Sachs, updated the VIX to reflect a new way to measure expected volatility, one that continues to be widely used by financial theorists, risk managers and volatility traders alike. The new VIX is based on the S&P 500® Index (SPX℠), the core index for U.S. equities, and estimates expected volatility by averaging the weighted prices of SPX puts and calls over a wide range of strike prices. By supplying a script for replicating volatility exposure with a portfolio of SPX options, this new methodology transformed VIX from an abstract concept into a practical standard for trading and hedging volatility.

## VOLATILITY AS A TRADABLE ASSET – VIX FUTURES & OPTIONS

On March 24, 2004, CBOE introduced the first exchange-traded VIX futures contract on its new, all-electronic CBOE Futures Exchange℠ (CFE®). Two years later in February 2006, CBOE launched VIX options, the most successful new product in Exchange history. In less than five years, the combined trading activity in VIX options and futures has grown to more than 100,000 contracts per day.

The negative correlation of volatility to stock market returns is well documented and suggests a diversification benefit to including volatility in an investment portfolio. VIX futures and options are designed to deliver pure volatility exposure in a single, efficient package. CBOE/CFE provides a continuous, liquid and transparent market for VIX products that are available to all investors from the smallest retail trader to the largest institutional money managers and hedge funds.

## BEYOND VIX

In addition to VIX, CBOE calculates several other volatility indexes including the CBOE Nasdaq-100® Volatility Index (VXN℠), CBOE DJIA® Volatility Index (VXD℠), CBOE Russell 2000® Volatility Index (RVX℠) and CBOE S&P 500® 3-Month Volatility Index (VXV℠). Currently, VXD and RVX futures are listed on CFE; RVX options trade on CBOE.

In 2008, CBOE pioneered the use of the VIX methodology to estimate expected volatility of certain commodities and foreign currencies. The CBOE Crude Oil Volatility Index (OVX℠), CBOE Gold Volatility Index (GVZ℠) and CBOE EuroCurrency Volatility Index

(EVZ[SM]) use exchange-traded fund options based on the United States Oil Fund, LP (USO), SPDR Gold Shares (GLD) and CurrencyShares Euro Trust (FXE), respectively.

## HISTORICAL PRICES FOR VIX AND OTHER VOLATILITY INDEXES

Perhaps one of the most valuable features of VIX is the existence of more than 20 years of historical prices. This extensive data set provides investors with a useful perspective of how option prices have behaved in response to a variety of market conditions. Price history for the original CBOE Volatility Index (Ticker – "VXO") based on OEX options is available from 1986 to the present. CBOE has created a similar historical record for the new VIX dating back to 1990 so that investors can compare the new VIX with VXO, which reflects information about the volatility "skew" or "smile." Historical prices for VIX, VXO and CBOE's other volatility indexes may be found on the CBOE website at http://www.cboe.com/micro/IndexSites.aspx under *CBOE Volatility Indexes*.

*CBOE would like to thank Sandy Rattray and Devesh Shah for their significant contributions to the development of the New VIX calculation.*

## THE VIX CALCULATION STEP-BY-STEP

Stock indexes, such as the S&P 500, are calculated using the prices of their component stocks. Each index employs rules that govern the selection of component securities and a formula to calculate index values.

VIX is a volatility index comprised of *options* rather than stocks, with the price of each option reflecting the market's expectation of future volatility. Like conventional indexes, VIX employs rules for selecting component options and a formula to calculate index values.

The generalized formula used in the VIX calculation[§] is:

$$\sigma^2 = \frac{2}{T} \sum_i \frac{\Delta K_i}{K_i^2} e^{RT} Q(K_i) \quad - \quad \frac{1}{T} \left[ \frac{F}{K_0} - 1 \right]^2 \qquad (1)$$

### WHERE...

$\sigma$ is $\quad\quad\quad \dfrac{VIX}{100} \Rightarrow VIX = \sigma \times 100$

T $\quad\quad\quad$ Time to expiration

F $\quad\quad\quad$ Forward index level derived from index option prices

$K_0$ $\quad\quad\quad$ First strike below the forward index level, F

$K_i$ $\quad\quad\quad$ Strike price of $i^{th}$ out-of-the-money option; a call if $K_i > K_0$ and a put if $K_i < K_0$; both put and call if $K_i = K_0$.

$\Delta K_i$ $\quad\quad\quad$ Interval between strike prices – half the difference between the strike on either side of $K_i$:

$$\Delta K_i = \frac{K_{i+1} - K_{i-1}}{2}$$

$\quad\quad\quad$ (*Note*: $\Delta K$ for the lowest strike is simply the difference between the lowest strike and the next higher strike. Likewise, $\Delta K$ for the highest strike is the difference between the highest strike and the next lower strike.)

R $\quad\quad\quad$ Risk-free interest rate to expiration

$Q(K_i)$ $\quad\quad\quad$ The midpoint of the bid-ask spread for each option with strike $K_i$.

[§] Please see "*More than you ever wanted to know about volatility swaps*" by Kresimir Demeterfi, Emanuel Derman, Michael Kamal and Joseph Zou, Goldman Sachs Quantitative Strategies Research Notes, March 1999.

## GETTING STARTED

VIX measures 30-day expected volatility of the S&P 500 Index. The components of VIX are near- and next-term put and call options, usually in the first and second SPX contract months. "Near-term" options must have at least one week to expiration; a requirement intended to minimize pricing anomalies that might occur close to expiration. When the near-term options have less than a week to expiration, VIX "rolls" to the second and third SPX contract months. For example, on the second Friday in June, VIX would be calculated using SPX options expiring in June and July. On the following Monday, July would replace June as the "near-term" and August would replace July as the "next-term."

In this hypothetical example, the near-term and next-term options have 9 days and 37 days to expiration, respectively, and reflect prices observed at the open of trading – 8:30 a.m. Chicago time. For the purpose of calculating time to expiration, SPX options are deemed to "expire" at the open of trading on SPX settlement day - the third Friday of the month[1].

The VIX calculation measures time to expiration, *T*, in calendar days and divides each day into minutes in order to replicate the precision that is commonly used by professional option and volatility traders. The time to expiration is given by the following expression:

$$T = \{M_{Current\ day} + M_{Settlement\ day} + M_{Other\ days}\}/ \text{Minutes in a year}$$

### WHERE...

$M_{Current\ day}$ = minutes remaining until midnight of the current day
$M_{Settlement\ day}$ = minutes from midnight until 8:30 a.m. on SPX settlement day
$M_{Other\ days}$ = total minutes in the days between current day and settlement day

Using 8:30 a.m. as the time of the calculation, *T* for the near-term and next-term options, $T_1$ and $T_2$, respectively, is:

$$T_1 = \{930 + 510 + 11{,}520) / 525{,}600 = \textbf{0.0246575}$$
$$T_2 = \{930 + 510 + 51{,}840) / 525{,}600 = \textbf{0.1013699}$$

The risk-free interest rate, *R*, is the bond-equivalent yield of the U.S. T-bill maturing closest to the expiration dates of relevant SPX options. As such, the VIX calculation may use different risk-free interest rates for near- and next-term options. In this example, however, assume that R = 0.38% for both sets of options.

Since many of the interim calculations are repetitive, only representative samples appear below. The complete set of SPX option data and calculations may be found in *Appendix 1*.

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[1] Technically, the expiration date for SPX options is the "Saturday following the third Friday of the expiration month." In this example, however, expiration is deemed to take place at the determination of the exercise settlement value of the SPX, which is based on the opening prices of SPX component securities.

**STEP 1** – *Select the options to be used in the VIX calculation*

The selected options are out-of-the-money SPX calls and out-of-the-money SPX puts centered around an at-the-money strike price, $K_0$. Only SPX options quoted with <u>non-zero bid prices</u> are used in the VIX calculation.

One important note: as volatility rises and falls, the strike price range of options with non-zero bids tends to expand and contract. As a result, the number of options used in the VIX calculation may vary from month-to-month, day-to-day and possibly, even minute-to-minute.

For **each** contract month:

- Determine the forward SPX level, *F*, by identifying the strike price at which the absolute difference between the call and put prices is smallest. The call and put prices in the following table reflect the average of each option's bid / ask quotation. As shown below, the difference between the call and put prices is smallest at the **920** strike for both the near- and next-term options.

| Near-Term Options | | | | Next-Term Options | | | |
|---|---|---|---|---|---|---|---|
| Strike Price | Call | Put | Absolute Difference | Strike Price | Call | Put | Absolute Difference |
| . | . | . | . | . | . | . | . |
| 900 | 48.95 | 27.25 | 21.70 | 900 | 73.6 | 52.8 | 20.80 |
| 905 | 46.15 | 29.75 | 16.40 | 905 | 70.35 | 54.7 | 15.65 |
| 910 | 42.55 | 31.70 | 10.85 | 910 | 67.35 | 56.75 | 10.60 |
| 915 | 40.05 | 33.55 | 6.50 | 915 | 64.75 | 58.9 | 5.85 |
| *920* | *37.15* | *36.65* | *0.50* | *920* | *61.55* | *60.55* | *1.00* |
| 925 | 33.30 | 37.70 | 4.40 | 925 | 58.95 | 63.05 | 4.10 |
| 930 | 32.45 | 40.15 | 7.70 | 930 | 55.75 | 65.4 | 9.65 |
| 935 | 28.75 | 42.70 | 13.95 | 935 | 53.05 | 67.35 | 14.30 |
| 940 | 27.50 | 45.30 | 17.80 | 940 | 50.15 | 69.8 | 19.65 |
| . | . | . | . | . | . | . | . |

Using the 920 call and put in each contract month and the formula,

$$F = \text{Strike Price} + e^{RT} \times (\text{Call Price} - \text{Put Price}),$$

the forward index prices, $F_1$ and $F_2$, for the near- and next-term options, respectively, are:

$$F_1 = 920 + e^{(0.0038 \times 0.0246575)} \times (37.15 - 36.65) = \mathbf{920.50005}$$
$$F_2 = 920 + e^{(0.0038 \times 0.1013699)} \times (61.55 - 60.55) = \mathbf{921.00039}$$

- Next, determine $\mathbf{K_0}$ - the strike price immediately below the forward index level, F - for the near- and next-term options. In this example, $\mathbf{K_{0,1} = 920}$ and $\mathbf{K_{0,2} = 920.}$

- Select out-of-the-money put options with strike prices < $K_0$. Start with the put strike immediately lower than $K_0$ and move to successively lower strike prices. Exclude any put option that has a bid price equal to zero (i.e., no bid). As shown below, once two puts with consecutive strike prices are found to have zero bid prices, no puts with lower strikes are considered for inclusion.

| Put Strike | Bid | Ask | Include? |
|---|---|---|---|
| 200 | 0.00 | 0.05 | *Not considered* |
| 250 | 0.00 | 0.05 | *following two* |
| 300 | 0.00 | 0.05 | *zero bids* |
| 350 | 0.00 | 0.05 | No |
| 375 | 0.00 | 0.10 | No |
| 400 | 0.05 | 0.20 | Yes |
| 425 | 0.05 | 0.20 | Yes |
| 450 | 0.05 | 0.20 | Yes |
| . | . | . | . |

Next, select out-of-the-money call options with strike prices > $K_0$. Start with the call strike immediately higher than $K_0$ and move to successively higher strike prices, excluding call options that have a bid price of zero. As with the puts, once two consecutive call options are found to have zero bid prices, no calls with higher strikes are considered. (Note that the 1250 call option is not included despite having a non-zero bid price.)

| Call Strike | Bid | Ask | Include? |
|---|---|---|---|
| . | . | . | . |
| 1215 | 0.05 | 0.50 | Yes |
| 1220 | 0.05 | 1.00 | Yes |
| 1225 | 0.00 | 1.00 | No |
| 1230 | 0.00 | 1.00 | No |
| 1235 | 0.00 | 0.75 | |
| 1240 | 0.00 | 0.50 | |
| 1245 | 0.00 | 0.15 | *Not considered* |
| *1250* | *0.05* | *0.10* | *following two* |
| 1255 | 0.00 | 1.00 | *zero bids* |
| . | . | . | |

Finally, select **both** the put and call with strike price $K_0$. Notice that two options are selected at $K_0$, while a single option, either a put or a call, is used for every other strike price.

The following table contains the options used to calculate the VIX in this example. VIX uses the average of quoted bid and ask, or mid-quote, prices for each option selected. The $K_0$ put and call prices are averaged to produce a single value. The price used for the 920

strike in the near-term is, therefore, $(37.15 + 36.65)/2 = 36.90$; and the price used in the next-term is $(61.55 + 60.55)/2 = 61.05$.

| Near-term Strike | Option Type | Mid-quote Price | | Next-term Strike | Option Type | Mid-quote Price |
|---|---|---|---|---|---|---|
| 400 | Put | 0.125 | | 200 | Put | 0.325 |
| 425 | Put | 0.125 | | 300 | Put | 0.30 |
| 450 | Put | 0.125 | | 350 | Put | 0.50 |
| . | . | . | | . | . | . |
| 910 | Put | 31.70 | | 910 | Put | 56.75 |
| 915 | Put | 33.55 | | 915 | Put | 58.90 |
| *920* | *Put/Call Average* | *36.90* | | *920* | *Put/Call Average* | *61.05* |
| 925 | Call | 33.30 | | 925 | Call | 58.95 |
| 930 | Call | 32.45 | | 930 | Call | 55.75 |
| . | . | . | | . | . | . |
| 1210 | Call | 0.275 | | 1150 | Call | 0.825 |
| 1215 | Call | 0.275 | | 1155 | Call | 0.725 |
| 1220 | Call | 0.525 | | 1160 | Call | 0.60 |

**STEP 2** – *Calculate volatility for both near-term and next-term options*

Applying the VIX formula (1) to the near-term and next-term options with time to expiration of $T_1$ and $T_2$, respectively, yields:

$$\sigma^2{}_1 = \frac{2}{T_1} \sum_i \frac{\Delta K_i}{K_i^2} e^{RT_1} Q(K_i) - \frac{1}{T_1}\left[\frac{F_1}{K_0} - 1\right]^2$$

$$\sigma^2{}_2 = \frac{2}{T_2} \sum_i \frac{\Delta K_i}{K_i^2} e^{RT_2} Q(K_i) - \frac{1}{T_2}\left[\frac{F_2}{K_0} - 1\right]^2$$

VIX is an amalgam of the information reflected in the prices of all of the selected options. The contribution of a single option to the VIX value is proportional to $\Delta K$ and the price of that option, and inversely proportional to the square of the option's strike price.

Generally, $\Delta K_i$ is half the difference between the strike prices on either side of $K_i$. For example, the $\Delta K$ for the next-term 300 Put is 75: $\Delta K_{300\ Put} = (350 - 200)/2$. At the upper and lower edges of any given strip of options, $\Delta K_i$ is simply the difference between $K_i$ and the adjacent strike price. In this example, the 400 Put is the lowest strike in the strip of near-term options and 425 is the adjacent strike. Therefore, $\Delta K_{400\ Put} = 25$ (i.e., $425 - 400$).

The contribution of the near-term 400 Put is given by:

$$\frac{\Delta K_{400\,Put}}{K_{400\,Put}^2}\,e^{RT_1}\,Q(400\,Put)$$

$$\frac{\Delta K_{400\,Put}}{K_{400\,Put}^2}\,e^{RT_1}\,Q(400\,Put)=\frac{25}{400^2}\,e^{.0038\,(0.0246575)}\,(0.125)=0.0000195$$

A similar calculation is performed for each option. The resulting values for the near-term options are then summed and multiplied by $2/T_1$. Likewise, the resulting values for the next-term options are summed and multiplied by $2/T_2$. The table below summarizes the results for each strip of options.

| Near-term Strike | Option Type | Mid-quote Price | Contribution by Strike | | Next-term Strike | Option Type | Mid-quote Price | Contribution by Strike |
|---|---|---|---|---|---|---|---|---|
| 400 | Put | 0.125 | 0.0000195 | | 200 | Put | 0.325 | 0.0008128 |
| 425 | Put | 0.125 | 0.0000173 | | 300 | Put | 0.300 | 0.0002501 |
| 450 | Put | 0.125 | 0.0000139 | | 350 | Put | 0.500 | 0.0001531 |
| . | . | . | . | | . | . | . | . |
| 910 | Put | 31.70 | 0.0001914 | | 910 | Put | 56.75 | 0.0003428 |
| 915 | Put | 33.55 | 0.0002004 | | 915 | Put | 58.90 | 0.0003519 |
| *920* | *Put/Call Average* | *36.90* | *0.0002180* | | *920* | *Put/Call Average* | *61.05* | *0.0003608* |
| 925 | Call | 33.30 | 0.0001946 | | 925 | Call | 58.95 | 0.0003446 |
| 930 | Call | 32.45 | 0.0001876 | | 930 | Call | 55.75 | 0.0003224 |
| . | . | . | . | | . | . | . | . |
| 1210 | Call | 0.275 | 0.0000009 | | 1150 | Call | 0.825 | 0.0000031 |
| 1215 | Call | 0.275 | 0.0000009 | | 1155 | Call | 0.725 | 0.0000027 |
| 1220 | Call | 0.525 | 0.0000018 | | 1160 | Call | 0.600 | 0.0000022 |
| $\frac{2}{T}\sum_i \frac{\Delta K_i}{K_i^2}\,e^{RT}\,Q(K_i)$ | | | 0.4727799 | | | | | 0.3668297 |

Next, calculate $\dfrac{1}{T}\left[\dfrac{F}{K_0}-1\right]^2$ for the near-term ($T_1$) and next-term ($T_2$):

$$\frac{1}{T_1}\left[\frac{F_1}{K_0}-1\right]^2=\frac{1}{0.0246575}\left[\frac{920.50005}{920}-1\right]^2=0.0000120$$

$$\frac{1}{T_2}\left[\frac{F_2}{K_0}-1\right]^2=\frac{1}{0.1013699}\left[\frac{921.00039}{920}-1\right]^2=0.0000117$$

Now calculate $\sigma^2_1$ and $\sigma^2_2$:

$$\sigma^2_1 = \frac{2}{T_1}\sum_i \frac{\Delta K_i}{K_i^2}e^{RT_1}Q(K_i) - \frac{1}{T_1}\left[\frac{F_1}{K_0}-1\right]^2 = 0.4727799 - 0.0000120 = \textbf{0.4727679}$$

$$\sigma^2_2 = \frac{2}{T_2}\sum_i \frac{\Delta K_i}{K_i^2}e^{RT_2}Q(K_i) - \frac{1}{T_2}\left[\frac{F_2}{K_0}-1\right]^2 = 0.3668297 - 0.0000117 = \textbf{0.3668180}$$

**STEP 3** – *Calculate the 30-day weighted average of $\sigma^2_1$ and $\sigma^2_2$. Then take the square root of that value and multiply by 100 to get VIX.*

$$VIX = 100 \times \sqrt{\left\{T_1\sigma_1^2\left[\frac{N_{T_2}-N_{30}}{N_{T_2}-N_{T_1}}\right] + T_2\sigma_2^2\left[\frac{N_{30}-N_{T_1}}{N_{T_2}-N_{T_1}}\right]\right\} \times \frac{N_{365}}{N_{30}}}$$

When the near-term options have less than 30 days to expiration and the next-term options have more than 30 days to expiration, the resulting VIX value reflects an interpolation of $\sigma^2_1$ and $\sigma^2_2$ ;i.e., each individual weight is less than or equal to 1 and the sum of the weights equals 1.

At the time of the VIX "roll," both the near-term and next-term options have more than 30 days to expiration. The same formula is used to calculate the 30-day weighted average, but the result is an extrapolation of $\sigma^2_1$ and $\sigma^2_2$ ;i.e., the sum of the weights is still 1, but the near-term weight is greater than 1 and the next-term weight is negative (e.g., 1.25 and – 0.25).

Returning to the example…

$N_{T1}$ = number of minutes to settlement of the near-term options (12,960)
$N_{T2}$ = number of minutes to settlement of the next-term options (53,280)
$N_{30}$ = number of minutes in 30 days (30 × 1,440 = 43,200)
$N_{365}$ = number of minutes in a 365-day year (365 ×1,440 = 525,600)

$$VIX = 100 \times \sqrt{\left\{0.0246575 \times 0.4727679 \times\left[\frac{53,280-43,200}{53,280-12,960}\right] + 0.1013699 \times 0.3668180 \times\left[\frac{43,200-12,960}{53,280-12,960}\right]\right\} \times \frac{525,600}{43,200}}$$

$$\boxed{VIX = 100 \times 0.612179986 = 61.22}$$

## NOTES ON CALCULATING OTHER CBOE VOLATILITY INDEXES

### BROAD-BASED VOLATILITY INDEXES

CBOE calculates volatility indexes on three other broad-based indexes representing different segments of the U.S. stock market:

- CBOE DJIA Volatility Index (VXD) based on options on the Dow Jones Industrial Average (DJX);
- CBOE Nasdaq-100 Volatility Index (VXN) based on Nasdaq-100 Index (NDX) options; and
- CBOE Russell 2000 Volatility Index (RVX) based on Russell 2000 Index (RUT) options.

For each of these indexes, the selection of component options and calculation are identical to the method detailed in the previous example.

The CBOE S&P 500 3-Month Volatility Index (VXV) measures the market's expectation of 3-month volatility implied by SPX options that bracket a 93-day maturity. Comparing VIX and VXV provides investors with information about the SPX volatility term structure in the four near-term contract months.

### COMMODITY & CURRENCY VOLATILITY INDEXES

CBOE began calculating two commodity volatility indexes and one currency volatility index in 2008:

- CBOE Crude Oil Volatility Index (OVX) based on United States Oil Fund, LP (USO) options;
- CBOE Gold Volatility Index (GVZ) based on the, SPDR Gold Shares (GLD) options; and
- CBOE EuroCurrency Volatility Index (EVZ) based on CurrencyShares Euro Trust (FXE) options

Each of these non-equity volatility indexes are calculated using exchange traded fund, or "ETF", options that trade like options on individual stocks - they may be exercised prior to their expiration date; exercise results in the delivery of ETF shares rather than cash; and they settle at the close of trading rather than at the open.

For each of the non-equity volatility indexes, the method of selecting component options and the formula are identical to that used for VIX and other broad-based volatility indexes.

However, there is a slight difference in the methodology that accounts for the fact that USO, GLD and FXE options expire at the close rather than at the open. As before, the time to expiration is given by the following expression:

$$T = \{M_{\text{Current day}} + M_{\text{Settlement day}} + M_{\text{Other days}}\}/ \text{Minutes in a year}$$

## Where...

$M_{\text{Current day}}$ = minutes remaining until midnight of the current day
$M_{\text{Other days}}$ = total minutes in the days between current day and settlement day

But now, adjusting for p.m. settlement…

$M_{\text{Settlement day}}$ = minutes from midnight until **3:00 p.m.** on expiration day
= 900 minutes

As with the previous example, assuming near- and next-term options with 9 and 37 days to expiration and 8:30 a.m. as the time of the calculation, T for the near-term and next-term options, $T_1$ and $T_2$, respectively, is:

$$T_1 = \{930 + 900 + 11{,}520) / 525{,}600 = \mathbf{0.0253995}$$
$$T_2 = \{930 + 900 + 51{,}840) / 525{,}600 = \mathbf{0.1021118}$$

*Special Note:* All CBOE Volatility Indexes – VIX, VXD, VXN, RVX, VXV, OVX, GVZ and EVZ – are calculated using option price quotes from CBOE exclusively.

Option Series included in the VIX calculation are **highlighted**.

| | Near-Term Options | | | | | Next-Term Options | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Strike** | **Calls** | | **Puts** | | **Strike** | **Calls** | | **Puts** | |
| | **Bid** | **Ask** | **Bid** | **Ask** | | **Bid** | **Ask** | **Bid** | **Ask** |
| 200 | 717.60 | 722.80 | 0.00 | 0.05 | **200** | 716.40 | 721.40 | 0.05 | 0.60 |
| 250 | 667.60 | 672.90 | 0.00 | 0.05 | **300** | 616.60 | 621.60 | 0.20 | 0.40 |
| 300 | 617.90 | 622.90 | 0.00 | 0.05 | **350** | 566.80 | 571.80 | 0.15 | 0.85 |
| 350 | 567.90 | 572.90 | 0.00 | 0.05 | **375** | 541.70 | 547.40 | 0.20 | 0.50 |
| 375 | 542.90 | 547.90 | 0.00 | 0.10 | **400** | 517.10 | 522.10 | 0.20 | 0.85 |
| **400** | 517.70 | 523.20 | 0.05 | 0.20 | 425 | 492.30 | 497.30 | 0.00 | 1.00 |
| **425** | 493.50 | 498.70 | 0.05 | 0.20 | **450** | 467.30 | 472.80 | 0.20 | 1.20 |
| **450** | 468.00 | 473.00 | 0.05 | 0.20 | **475** | 442.90 | 447.90 | 0.50 | 1.50 |
| **470** | 448.00 | 453.00 | 0.05 | 0.25 | **500** | 418.10 | 423.60 | 1.35 | 2.00 |
| **475** | 443.00 | 448.00 | 0.05 | 0.25 | **525** | 393.90 | 398.90 | 1.25 | 2.50 |
| **480** | 438.00 | 443.00 | 0.05 | 0.30 | **550** | 369.60 | 374.60 | 1.55 | 2.75 |
| **490** | 428.00 | 433.00 | 0.05 | 0.80 | **575** | 345.20 | 350.90 | 2.10 | 4.30 |
| **500** | 418.00 | 423.00 | 0.05 | 0.30 | **600** | 321.70 | 327.20 | 3.40 | 5.40 |
| **510** | 407.80 | 413.30 | 0.05 | 0.40 | **610** | 312.20 | 317.70 | 3.50 | 5.70 |
| **520** | 397.80 | 403.30 | 0.05 | 0.75 | **615** | 307.20 | 312.20 | 3.90 | 6.10 |
| **525** | 392.80 | 398.30 | 0.05 | 0.80 | **620** | 302.70 | 308.20 | 4.00 | 6.40 |
| **530** | 388.60 | 393.80 | 0.05 | 0.80 | **625** | 297.80 | 302.80 | 4.20 | 6.90 |
| **540** | 378.10 | 383.10 | 0.05 | 0.75 | **630** | 292.80 | 298.50 | 4.60 | 6.90 |
| **550** | 368.10 | 373.10 | 0.10 | 0.20 | **635** | 288.10 | 293.80 | 4.70 | 7.30 |
| **560** | 357.90 | 363.40 | 0.05 | 0.70 | **640** | 283.50 | 289.10 | 5.10 | 7.50 |
| **570** | 347.90 | 353.40 | 0.05 | 0.75 | **650** | 274.10 | 279.60 | 5.80 | 8.10 |
| **575** | 343.20 | 348.20 | 0.05 | 0.40 | **660** | 265.00 | 270.00 | 6.30 | 9.00 |
| **580** | 338.20 | 343.20 | 0.05 | 0.80 | **670** | 256.00 | 261.50 | 7.20 | 9.70 |
| **585** | 333.00 | 338.70 | 0.10 | 0.75 | **675** | 251.40 | 256.20 | 7.50 | 9.80 |
| **590** | 328.00 | 333.50 | 0.05 | 0.75 | **680** | 246.40 | 251.60 | 8.10 | 10.40 |
| **595** | 323.50 | 329.00 | 0.05 | 0.45 | **690** | 237.70 | 243.20 | 8.80 | 11.40 |
| **600** | 318.30 | 323.30 | 0.25 | 0.50 | **700** | 228.70 | 233.70 | 9.40 | 12.40 |
| **605** | 313.10 | 318.80 | 0.10 | 0.80 | **710** | 219.30 | 224.90 | 10.00 | 13.60 |
| **610** | 308.10 | 313.60 | 0.10 | 0.80 | **720** | 210.40 | 216.00 | 11.00 | 14.70 |
| **615** | 303.40 | 308.40 | 0.10 | 0.85 | **725** | 206.40 | 211.20 | 11.70 | 15.90 |
| **620** | 298.20 | 303.70 | 0.10 | 0.85 | **730** | 201.80 | 206.80 | 12.10 | 16.20 |
| **625** | 293.70 | 299.20 | 0.40 | 0.90 | **740** | 192.90 | 198.50 | 13.20 | 17.60 |
| **630** | 288.50 | 293.50 | 0.10 | 0.90 | **750** | 184.70 | 189.90 | 15.00 | 18.80 |
| **635** | 283.30 | 288.80 | 0.10 | 0.95 | **760** | 176.00 | 181.40 | 16.20 | 19.90 |
| **640** | 278.60 | 283.60 | 0.30 | 1.05 | **770** | 167.40 | 172.50 | 17.90 | 22.00 |
| **645** | 273.40 | 278.90 | 0.10 | 1.10 | **775** | 163.20 | 168.40 | 18.30 | 22.90 |
| **650** | 268.50 | 274.20 | 0.50 | 1.10 | **780** | 159.00 | 164.20 | 19.20 | 24.00 |
| **655** | 263.80 | 268.80 | 0.20 | 1.25 | **790** | 150.90 | 156.10 | 20.80 | 26.00 |
| **660** | 258.60 | 264.10 | 0.30 | 1.30 | **800** | 142.80 | 146.00 | 22.70 | 28.00 |
| **665** | 253.70 | 259.40 | 0.20 | 1.30 | **805** | 138.80 | 144.00 | 23.70 | 28.90 |
| **670** | 249.00 | 254.00 | 0.40 | 1.45 | **810** | 134.90 | 140.00 | 25.00 | 29.70 |
| **675** | 244.10 | 249.10 | 0.50 | 1.50 | **815** | 130.90 | 136.10 | 25.90 | 30.50 |
| **680** | 239.20 | 244.20 | 0.55 | 1.55 | **820** | 127.10 | 132.20 | 26.90 | 31.90 |
| **690** | 229.40 | 234.40 | 0.70 | 1.85 | **825** | 123.20 | 128.40 | 27.80 | 33.30 |
| **700** | 219.40 | 225.10 | 1.30 | 1.70 | **830** | 119.40 | 124.60 | 29.30 | 34.50 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **710** | 209.90 | 214.90 | 1.10 | 2.40 | **835** | 115.60 | 120.80 | 30.30 | 35.40 |
| **720** | 200.00 | 205.70 | 1.10 | 3.00 | **840** | 111.90 | 117.10 | 31.80 | 36.90 |
| **725** | 195.20 | 200.90 | 2.00 | 3.00 | **845** | 108.20 | 113.40 | 32.90 | 38.00 |
| **730** | 190.60 | 195.60 | 1.40 | 3.50 | **850** | 107.00 | 109.70 | 34.10 | 39.60 |
| **740** | 180.80 | 186.50 | 1.80 | 4.00 | **855** | 101.30 | 106.30 | 35.90 | 39.00 |
| **750** | 171.30 | 177.00 | 3.20 | 3.90 | **860** | 97.40 | 103.00 | 37.40 | 42.50 |
| **760** | 162.10 | 167.10 | 2.85 | 5.00 | **865** | 94.80 | 99.50 | 38.60 | 43.70 |
| **770** | 152.80 | 157.80 | 4.00 | 5.60 | **870** | 91.30 | 96.00 | 40.00 | 45.10 |
| **775** | 148.20 | 153.20 | 3.90 | 5.90 | **875** | 87.90 | 92.60 | 41.70 | 47.10 |
| **780** | 143.60 | 148.60 | 4.10 | 6.70 | **880** | 83.60 | 88.90 | 43.30 | 48.70 |
| **790** | 134.60 | 140.10 | 4.90 | 7.50 | **885** | 80.30 | 85.80 | 44.80 | 50.30 |
| **800** | 125.60 | 131.10 | 6.10 | 7.50 | **890** | 77.50 | 83.00 | 47.00 | 52.10 |
| **805** | 121.00 | 126.00 | 6.40 | 9.10 | **895** | 74.00 | 79.50 | 48.60 | 53.80 |
| **810** | 116.50 | 121.50 | 7.10 | 9.50 | **900** | 70.80 | 76.40 | 50.20 | 55.40 |
| **815** | 112.20 | 117.20 | 7.50 | 10.30 | **905** | 67.60 | 73.10 | 52.20 | 57.20 |
| **820** | 107.60 | 113.20 | 8.20 | 10.80 | **910** | 64.60 | 70.10 | 54.00 | 59.50 |
| **825** | 103.70 | 108.90 | 8.90 | 11.50 | **915** | 62.40 | 67.10 | 56.30 | 61.50 |
| **830** | 99.10 | 104.30 | 9.00 | 13.00 | **920** | 59.10 | 64.00 | 57.80 | 63.30 |
| **835** | 95.30 | 100.30 | 9.80 | 13.70 | **925** | 56.20 | 61.70 | 60.30 | 65.80 |
| **840** | 90.90 | 95.90 | 10.60 | 14.30 | **930** | 53.00 | 58.50 | 62.90 | 67.90 |
| **845** | 86.70 | 91.90 | 11.50 | 15.20 | **935** | 50.30 | 55.80 | 64.60 | 70.10 |
| **850** | 82.60 | 88.00 | 13.50 | 16.00 | **940** | 47.60 | 52.70 | 67.00 | 72.60 |
| **855** | 78.70 | 83.90 | 13.50 | 17.50 | **945** | 45.70 | 50.40 | 69.50 | 75.00 |
| **860** | 74.90 | 79.90 | 14.50 | 18.70 | **950** | 44.80 | 47.70 | 72.20 | 76.60 |
| **865** | 70.90 | 76.10 | 15.50 | 19.90 | **955** | 40.40 | 45.30 | 74.70 | 79.70 |
| **870** | 67.20 | 72.30 | 17.10 | 20.90 | **960** | 38.10 | 43.20 | 77.30 | 82.30 |
| **875** | 63.80 | 68.60 | 18.20 | 22.20 | **965** | 35.60 | 40.70 | 79.80 | 85.30 |
| **880** | 59.80 | 65.30 | 19.20 | 24.00 | **970** | 33.40 | 38.90 | 82.60 | 87.90 |
| **885** | 56.60 | 61.60 | 20.30 | 25.40 | **975** | 32.40 | 36.10 | 85.70 | 90.70 |
| **890** | 53.70 | 58.40 | 22.10 | 26.80 | **980** | 28.90 | 34.00 | 88.60 | 93.40 |
| **895** | 50.30 | 55.00 | 23.90 | 29.00 | **985** | 27.00 | 32.00 | 91.60 | 96.80 |
| **900** | 46.20 | 51.70 | 25.50 | 29.00 | **990** | 25.40 | 30.30 | 94.70 | 99.80 |
| **905** | 43.40 | 48.90 | 27.20 | 32.30 | **995** | 23.20 | 28.60 | 97.80 | 103.00 |
| **910** | 40.00 | 45.10 | 29.20 | 34.20 | **1000** | 23.00 | 26.40 | 101.00 | 106.20 |
| **915** | 37.30 | 42.80 | 30.80 | 36.30 | **1005** | 20.00 | 24.70 | 104.30 | 109.50 |
| **920** | 35.20 | 39.10 | 35.20 | 38.10 | **1010** | 18.40 | 23.30 | 107.70 | 112.90 |
| **925** | 31.40 | 35.20 | 35.10 | 40.30 | **1015** | 17.10 | 21.20 | 111.10 | 116.30 |
| **930** | 31.00 | 33.90 | 37.40 | 42.90 | **1020** | 18.00 | 19.80 | 114.60 | 119.80 |
| **935** | 26.00 | 31.50 | 40.30 | 45.10 | **1025** | 14.40 | 18.20 | 118.20 | 123.40 |
| **940** | 26.00 | 29.00 | 42.50 | 48.10 | **1030** | 13.10 | 16.90 | 121.90 | 127.10 |
| **945** | 21.60 | 26.40 | 45.30 | 50.60 | **1035** | 11.80 | 15.80 | 125.60 | 130.60 |
| **950** | 21.60 | 24.40 | 47.60 | 53.10 | **1040** | 10.70 | 14.70 | 128.80 | 134.30 |
| **955** | 17.20 | 22.50 | 51.30 | 56.50 | **1045** | 9.30 | 13.60 | 133.10 | 138.60 |
| **960** | 15.50 | 19.60 | 54.40 | 59.40 | **1050** | 10.80 | 12.00 | 137.30 | 142.30 |
| **965** | 13.90 | 18.00 | 57.50 | 62.50 | **1055** | 8.10 | 10.60 | 140.90 | 146.60 |
| **970** | 12.00 | 16.40 | 60.80 | 66.00 | **1060** | 8.20 | 9.80 | 145.20 | 150.70 |
| **975** | 12.50 | 14.80 | 64.30 | 69.50 | **1065** | 6.50 | 9.00 | 148.90 | 154.40 |
| **980** | 9.30 | 13.10 | 67.80 | 73.00 | **1070** | 5.60 | 8.10 | 153.40 | 158.60 |
| **985** | 8.00 | 11.90 | 71.50 | 76.70 | **1075** | 5.10 | 7.60 | 157.40 | 162.90 |
| **990** | 7.40 | 9.90 | 75.10 | 80.50 | **1080** | 4.40 | 6.80 | 162.40 | 167.40 |
| **995** | 6.40 | 8.70 | 79.20 | 84.20 | **1085** | 3.80 | 6.20 | 166.40 | 172.10 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1000 | 6.50 | 7.50 | 82.50 | 88.00 | 1090 | 3.30 | 5.50 | 171.30 | 176.30 |
| 1005 | 4.40 | 6.80 | 86.90 | 92.50 | 1095 | 2.90 | 4.90 | 175.80 | 180.80 |
| 1010 | 3.60 | 6.00 | 91.10 | 96.50 | 1100 | 3.30 | 4.50 | 180.10 | 185.60 |
| 1015 | 3.10 | 5.10 | 95.40 | 101.10 | 1105 | 2.00 | 4.10 | 184.20 | 189.70 |
| 1020 | 3.50 | 4.60 | 99.80 | 105.40 | 1110 | 2.00 | 3.60 | 189.30 | 194.80 |
| 1025 | 2.00 | 4.10 | 104.70 | 109.70 | 1115 | 1.65 | 3.30 | 194.20 | 199.20 |
| 1030 | 1.60 | 3.50 | 108.50 | 114.00 | 1120 | 1.45 | 3.00 | 198.90 | 203.90 |
| 1035 | 1.20 | 3.10 | 113.60 | 119.10 | 1125 | 2.00 | 2.40 | 202.90 | 208.40 |
| 1040 | 1.25 | 2.50 | 118.50 | 123.50 | 1130 | 0.90 | 2.20 | 208.40 | 213.40 |
| 1045 | 0.85 | 2.10 | 123.20 | 128.20 | 1135 | 0.70 | 1.90 | 212.70 | 218.40 |
| 1050 | 1.30 | 1.80 | 127.70 | 133.20 | 1140 | 1.00 | 1.75 | 218.00 | 223.00 |
| 1055 | 0.40 | 1.65 | 132.50 | 138.00 | 1145 | 0.50 | 1.50 | 222.80 | 227.80 |
| 1060 | 0.90 | 1.40 | 137.60 | 142.60 | 1150 | 0.35 | 1.30 | 227.40 | 232.90 |
| 1065 | 0.20 | 1.25 | 142.20 | 147.70 | 1155 | 0.25 | 1.20 | 232.30 | 237.80 |
| 1070 | 0.15 | 1.15 | 147.30 | 152.30 | 1160 | 0.10 | 1.10 | 236.70 | 242.20 |
| 1075 | 0.50 | 1.00 | 152.20 | 157.20 | 1165 | 0.00 | 1.00 | 241.60 | 247.10 |
| 1080 | 0.40 | 0.95 | 156.90 | 162.40 | 1170 | 0.00 | 0.90 | 247.00 | 252.50 |
| 1085 | 0.20 | 0.90 | 161.80 | 167.30 | 1175 | 0.30 | 0.85 | 251.90 | 257.40 |
| 1090 | 0.30 | 0.85 | 167.00 | 172.00 | 1180 | 0.00 | 0.85 | 257.10 | 262.10 |
| 1095 | 0.20 | 0.75 | 171.70 | 177.20 | 1185 | 0.00 | 0.80 | 261.30 | 266.50 |
| 1100 | 0.30 | 0.45 | 176.90 | 181.90 | 1190 | 0.00 | 0.50 | 267.00 | 272.00 |
| 1105 | 0.20 | 0.75 | 181.60 | 187.10 | 1190 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1110 | 0.20 | 0.35 | 186.80 | 191.80 | 1195 | 0.00 | 0.75 | 271.20 | 276.40 |
| 1115 | 0.05 | 0.80 | 191.80 | 196.80 | 1200 | 0.30 | 0.60 | 276.90 | 281.90 |
| 1120 | 0.05 | 0.50 | 196.80 | 201.80 | 1205 | 0.00 | 0.75 | 281.60 | 287.10 |
| 1125 | 0.15 | 0.50 | 201.50 | 207.00 | 1210 | 0.00 | 0.60 | 286.80 | 291.80 |
| 1130 | 0.05 | 0.90 | 206.70 | 211.70 | 1215 | 0.00 | 0.85 | 291.80 | 296.80 |
| 1135 | 0.05 | 0.90 | 211.70 | 216.70 | 1220 | 0.00 | 0.75 | 296.80 | 301.80 |
| 1140 | 0.05 | 0.70 | 216.70 | 221.70 | 1225 | 0.00 | 0.80 | 301.50 | 307.00 |
| 1145 | 0.05 | 0.95 | 221.70 | 226.70 | 1230 | 0.00 | 0.80 | 306.70 | 311.70 |
| 1150 | 0.05 | 0.35 | 226.70 | 231.70 | 1235 | 0.00 | 0.80 | 311.70 | 316.70 |
| 1155 | 0.05 | 0.95 | 231.70 | 236.70 | 1240 | 0.10 | 0.75 | 316.70 | 321.70 |
| 1160 | 0.05 | 0.50 | 236.70 | 241.70 | 1245 | 0.00 | 0.75 | 321.70 | 326.70 |
| 1165 | 0.05 | 0.35 | 241.70 | 246.70 | 1250 | 0.00 | 1.00 | 326.70 | 331.20 |
| 1170 | 0.05 | 0.45 | 246.40 | 251.90 | 1255 | 0.00 | 0.75 | 331.40 | 336.90 |
| 1175 | 0.05 | 0.15 | 251.40 | 256.90 | 1260 | 0.00 | 0.70 | 335.90 | 341.10 |
| 1180 | 0.05 | 0.80 | 256.40 | 261.90 | 1265 | 0.00 | 0.70 | 341.60 | 346.60 |
| 1185 | 0.05 | 0.25 | 260.90 | 266.10 | 1270 | 0.00 | 0.70 | 346.60 | 351.60 |
| 1190 | 0.05 | 0.50 | 266.60 | 271.60 | 1275 | 0.05 | 0.20 | 351.60 | 356.60 |
| 1195 | 0.05 | 1.00 | 271.60 | 276.60 | 1280 | 0.00 | 0.75 | 356.60 | 361.60 |
| 1200 | 0.05 | 0.15 | 276.60 | 281.60 | 1290 | 0.00 | 0.75 | 366.60 | 371.60 |
| 1205 | 0.05 | 1.00 | 281.60 | 286.60 | 1300 | 0.05 | 0.45 | 375.70 | 381.00 |
| 1210 | 0.05 | 0.50 | 286.60 | 291.60 | 1315 | 0.00 | 0.50 | 390.70 | 395.90 |
| 1215 | 0.05 | 0.50 | 291.60 | 296.60 | 1320 | 0.00 | 0.75 | 396.50 | 401.50 |
| 1220 | 0.05 | 1.00 | 296.60 | 301.60 | 1325 | 0.00 | 0.50 | 399.90 | 405.90 |
| 1225 | 0.00 | 1.00 | 301.60 | 306.60 | 1335 | 0.00 | 0.75 | 411.50 | 416.50 |
| 1230 | 0.00 | 1.00 | 306.60 | 311.60 | 1340 | 0.00 | 0.75 | 416.50 | 421.50 |
| 1235 | 0.00 | 0.75 | 311.60 | 316.60 | 1345 | 0.00 | 0.75 | 421.50 | 426.50 |
| 1240 | 0.00 | 0.50 | 316.60 | 321.60 | 1350 | 0.00 | 0.50 | 425.60 | 430.80 |
| 1245 | 0.00 | 0.15 | 321.60 | 326.60 | 1360 | 0.00 | 0.75 | 435.70 | 440.90 |
| 1250 | 0.05 | 0.10 | 326.60 | 331.60 | 1375 | 0.00 | 0.55 | 451.40 | 456.40 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1255 | 0.00 | 1.00 | 331.60 | 336.60 | 1380 | 0.00 | 0.75 | 456.40 | 461.40 |
| 1260 | 0.00 | 1.00 | 336.60 | 341.60 | 1395 | 0.00 | 0.50 | 471.40 | 476.40 |
| 1265 | 0.00 | 1.00 | 341.60 | 346.60 | 1400 | 0.00 | 0.50 | 475.50 | 480.70 |
| 1270 | 0.00 | 0.30 | 346.60 | 351.60 | 1420 | 0.00 | 0.75 | 496.30 | 501.30 |
| 1275 | 0.00 | 0.10 | 351.60 | 356.60 | 1425 | 0.00 | 0.75 | 501.30 | 506.30 |
| 1280 | 0.00 | 0.15 | 356.60 | 361.60 | 1440 | 0.00 | 0.75 | 516.30 | 521.30 |
| 1285 | 0.00 | 0.15 | 361.60 | 366.60 | 1450 | 0.00 | 0.50 | 525.30 | 530.60 |
| 1290 | 0.00 | 0.15 | 366.60 | 371.60 | 1475 | 0.00 | 0.75 | 551.20 | 556.20 |
| 1295 | 0.00 | 0.15 | 371.60 | 376.60 | 1480 | 0.00 | 0.75 | 556.20 | 561.20 |
| 1300 | 0.00 | 0.10 | 376.60 | 381.60 | 1500 | 0.00 | 0.50 | 575.20 | 580.50 |
| 1305 | 0.00 | 0.10 | 381.60 | 386.60 | 1525 | 0.00 | 0.75 | 601.10 | 606.10 |
| 1310 | 0.00 | 0.10 | 386.60 | 391.60 | 1550 | 0.00 | 0.50 | 625.10 | 630.90 |
| 1315 | 0.00 | 0.10 | 391.60 | 396.60 | 1575 | 0.00 | 0.75 | 650.80 | 656.30 |
| 1320 | 0.00 | 0.10 | 396.10 | 401.80 | 1600 | 0.00 | 0.50 | 675.00 | 680.20 |
| 1325 | 0.00 | 0.10 | 401.30 | 406.80 | 1625 | 0.00 | 0.75 | 700.70 | 706.20 |
| 1330 | 0.00 | 0.10 | 406.30 | 411.80 | 1650 | 0.00 | 0.50 | 724.10 | 730.10 |
| 1335 | 0.00 | 0.10 | 411.30 | 416.80 | 1680 | 0.00 | 0.75 | 755.60 | 761.10 |
| 1340 | 0.00 | 0.10 | 416.30 | 421.80 | 1690 | 0.00 | 0.75 | 765.80 | 770.80 |
| 1345 | 0.00 | 0.10 | 421.30 | 426.80 | 1700 | 0.00 | 0.50 | 775.80 | 780.80 |
| 1350 | 0.00 | 0.05 | 425.80 | 431.00 | 1735 | 0.00 | 0.75 | 810.50 | 816.00 |
| 1355 | 0.00 | 0.10 | 430.80 | 436.00 | 1750 | 0.00 | 0.75 | 825.70 | 830.70 |
| 1360 | 0.00 | 0.10 | 435.80 | 441.00 | 1775 | 0.00 | 0.20 | 850.70 | 855.70 |
| 1365 | 0.00 | 0.10 | 441.50 | 446.50 | 1800 | 0.00 | 0.75 | 875.60 | 880.60 |
| 1370 | 0.00 | 0.10 | 446.50 | 451.50 | 1850 | 0.00 | 0.75 | 925.50 | 930.50 |
| 1375 | 0.00 | 0.10 | 451.50 | 456.50 | 1900 | 0.00 | 0.20 | 974.70 | 979.90 |
| 1380 | 0.00 | 0.10 | 456.50 | 461.50 | 1950 | 0.00 | 0.75 | 1025.10 | 1030.60 |
| 1385 | 0.00 | 0.10 | 461.50 | 466.50 | 2000 | 0.00 | 0.20 | 1074.80 | 1079.80 |
| 1390 | 0.00 | 0.10 | 466.50 | 471.50 | | | | | |
| 1395 | 0.00 | 0.10 | 471.50 | 476.50 | | | | | |
| 1400 | 0.00 | 0.05 | 476.50 | 481.50 | | | | | |
| 1405 | 0.00 | 0.10 | 481.50 | 486.50 | | | | | |
| 1410 | 0.00 | 0.10 | 486.50 | 491.50 | | | | | |
| 1415 | 0.00 | 0.10 | 491.50 | 496.50 | | | | | |
| 1420 | 0.00 | 0.10 | 496.50 | 501.50 | | | | | |
| 1425 | 0.00 | 0.10 | 501.50 | 506.50 | | | | | |
| 1430 | 0.00 | 0.10 | 506.50 | 511.50 | | | | | |
| 1435 | 0.00 | 0.10 | 511.50 | 516.50 | | | | | |
| 1440 | 0.00 | 0.10 | 516.50 | 521.50 | | | | | |
| 1445 | 0.00 | 0.10 | 521.50 | 526.50 | | | | | |
| 1450 | 0.00 | 0.10 | 526.50 | 531.50 | | | | | |
| 1460 | 0.00 | 0.10 | 536.50 | 541.50 | | | | | |
| 1470 | 0.00 | 0.10 | 546.50 | 551.50 | | | | | |
| 1475 | 0.00 | 0.10 | 551.50 | 556.50 | | | | | |
| 1480 | 0.00 | 0.10 | 556.50 | 561.50 | | | | | |
| 1490 | 0.00 | 1.00 | 566.50 | 571.50 | | | | | |
| 1500 | 0.00 | 0.05 | 576.50 | 581.50 | | | | | |
| 1650 | 0.00 | 1.00 | 726.40 | 731.40 | | | | | |
| 1700 | 0.00 | 1.00 | 776.10 | 781.60 | | | | | |

## INDIVIDUAL OPTION CONTRIBUTIONS – $K_0 = 920$

| Near term Strike | Option Type | Mid-quote Price | Delta-K | Contribution by Strike | Next term Strike | Option Type | Mid-quote Price | Delta-K | Contribution by Strike |
|---|---|---|---|---|---|---|---|---|---|
| 400 | Put | 0.125 | 25.0 | 0.0000195 | 200 | Put | 0.325 | 100 | 0.0008128 |
| 425 | Put | 0.125 | 25.0 | 0.0000173 | 300 | Put | 0.300 | 75.0 | 0.0002501 |
| 450 | Put | 0.125 | 22.5 | 0.0000139 | 350 | Put | 0.500 | 37.5 | 0.0001531 |
| 470 | Put | 0.150 | 12.5 | 0.0000085 | 375 | Put | 0.350 | 25.0 | 0.0000622 |
| 475 | Put | 0.150 | 5.0 | 0.0000033 | 400 | Put | 0.525 | 37.5 | 0.0001231 |
| 480 | Put | 0.175 | 7.5 | 0.0000057 | 450 | Put | 0.700 | 37.5 | 0.0001297 |
| 490 | Put | 0.425 | 10.0 | 0.0000177 | 475 | Put | 1.000 | 25.0 | 0.0001108 |
| 500 | Put | 0.175 | 10.0 | 0.0000070 | 500 | Put | 1.675 | 25.0 | 0.0001676 |
| 510 | Put | 0.225 | 10.0 | 0.0000087 | 525 | Put | 1.875 | 25.0 | 0.0001701 |
| 520 | Put | 0.400 | 7.5 | 0.0000111 | 550 | Put | 2.150 | 25.0 | 0.0001778 |
| 525 | Put | 0.425 | 5.0 | 0.0000077 | 575 | Put | 3.200 | 25.0 | 0.0002421 |
| 530 | Put | 0.425 | 7.5 | 0.0000113 | 600 | Put | 4.400 | 17.5 | 0.0002140 |
| 540 | Put | 0.400 | 10.0 | 0.0000137 | 610 | Put | 4.600 | 7.5 | 0.0000928 |
| 550 | Put | 0.150 | 10.0 | 0.0000050 | 615 | Put | 5.000 | 5.0 | 0.0000661 |
| 560 | Put | 0.375 | 10.0 | 0.0000120 | 620 | Put | 5.200 | 5.0 | 0.0000677 |
| 570 | Put | 0.400 | 7.5 | 0.0000092 | 625 | Put | 5.550 | 5.0 | 0.0000711 |
| 575 | Put | 0.225 | 5.0 | 0.0000034 | 630 | Put | 5.750 | 5.0 | 0.0000725 |
| 580 | Put | 0.425 | 5.0 | 0.0000063 | 635 | Put | 6.000 | 5.0 | 0.0000744 |
| 585 | Put | 0.425 | 5.0 | 0.0000062 | 640 | Put | 6.300 | 7.5 | 0.0001154 |
| 590 | Put | 0.400 | 5.0 | 0.0000057 | 650 | Put | 6.950 | 10.0 | 0.0001646 |
| 595 | Put | 0.250 | 5.0 | 0.0000035 | 660 | Put | 7.650 | 10.0 | 0.0001757 |
| 600 | Put | 0.375 | 5.0 | 0.0000052 | 670 | Put | 8.450 | 7.5 | 0.0001412 |
| 605 | Put | 0.450 | 5.0 | 0.0000061 | 675 | Put | 8.650 | 5.0 | 0.0000950 |
| 610 | Put | 0.450 | 5.0 | 0.0000060 | 680 | Put | 9.250 | 7.5 | 0.0001501 |
| 615 | Put | 0.475 | 5.0 | 0.0000063 | 690 | Put | 10.100 | 10.0 | 0.0002122 |
| 620 | Put | 0.475 | 5.0 | 0.0000062 | 700 | Put | 10.900 | 10.0 | 0.0002225 |
| 625 | Put | 0.650 | 5.0 | 0.0000083 | 710 | Put | 11.800 | 10.0 | 0.0002342 |
| 630 | Put | 0.500 | 5.0 | 0.0000063 | 720 | Put | 12.850 | 7.5 | 0.0001860 |
| 635 | Put | 0.525 | 5.0 | 0.0000065 | 725 | Put | 13.800 | 5.0 | 0.0001313 |
| 640 | Put | 0.675 | 5.0 | 0.0000082 | 730 | Put | 14.150 | 7.5 | 0.0001992 |
| 645 | Put | 0.600 | 5.0 | 0.0000072 | 740 | Put | 15.400 | 10.0 | 0.0002813 |
| 650 | Put | 0.800 | 5.0 | 0.0000095 | 750 | Put | 16.900 | 10.0 | 0.0003006 |
| 655 | Put | 0.725 | 5.0 | 0.0000085 | 760 | Put | 18.050 | 10.0 | 0.0003126 |
| 660 | Put | 0.800 | 5.0 | 0.0000092 | 770 | Put | 19.950 | 7.5 | 0.0002525 |
| 665 | Put | 0.750 | 5.0 | 0.0000085 | 775 | Put | 20.600 | 5.0 | 0.0001716 |
| 670 | Put | 0.925 | 5.0 | 0.0000103 | 780 | Put | 21.600 | 7.5 | 0.0002664 |
| 675 | Put | 1.000 | 5.0 | 0.0000110 | 790 | Put | 23.400 | 10.0 | 0.0003751 |
| 680 | Put | 1.050 | 7.5 | 0.0000170 | 800 | Put | 25.350 | 7.5 | 0.0002972 |
| 690 | Put | 1.275 | 10.0 | 0.0000268 | 805 | Put | 26.300 | 5.0 | 0.0002030 |
| 700 | Put | 1.500 | 10.0 | 0.0000306 | 810 | Put | 27.350 | 5.0 | 0.0002085 |
| 710 | Put | 1.750 | 10.0 | 0.0000347 | 815 | Put | 28.200 | 5.0 | 0.0002124 |
| 720 | Put | 2.050 | 7.5 | 0.0000297 | 820 | Put | 29.400 | 5.0 | 0.0002187 |
| 725 | Put | 2.500 | 5.0 | 0.0000238 | 825 | Put | 30.550 | 5.0 | 0.0002245 |
| 730 | Put | 2.450 | 7.5 | 0.0000345 | 830 | Put | 31.900 | 5.0 | 0.0002316 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 740 | Put | 2.900 | 10.0 | 0.0000530 | 835 | Put | 32.850 | 5.0 | 0.0002357 |
| 750 | Put | 3.550 | 10.0 | 0.0000631 | 840 | Put | 34.350 | 5.0 | 0.0002435 |
| 760 | Put | 3.925 | 10.0 | 0.0000680 | 845 | Put | 35.450 | 5.0 | 0.0002483 |
| 770 | Put | 4.800 | 7.5 | 0.0000607 | 850 | Put | 36.850 | 5.0 | 0.0002551 |
| 775 | Put | 4.900 | 5.0 | 0.0000408 | 855 | Put | 37.450 | 5.0 | 0.0002562 |
| 780 | Put | 5.400 | 7.5 | 0.0000666 | 860 | Put | 39.950 | 5.0 | 0.0002702 |
| 790 | Put | 6.200 | 10.0 | 0.0000994 | 865 | Put | 41.150 | 5.0 | 0.0002751 |
| 800 | Put | 6.800 | 7.5 | 0.0000797 | 870 | Put | 42.550 | 5.0 | 0.0002812 |
| 805 | Put | 7.750 | 5.0 | 0.0000598 | 875 | Put | 44.400 | 5.0 | 0.0002901 |
| 810 | Put | 8.300 | 5.0 | 0.0000633 | 880 | Put | 46.000 | 5.0 | 0.0002971 |
| 815 | Put | 8.900 | 5.0 | 0.0000670 | 885 | Put | 47.550 | 5.0 | 0.0003037 |
| 820 | Put | 9.500 | 5.0 | 0.0000706 | 890 | Put | 49.550 | 5.0 | 0.0003129 |
| 825 | Put | 10.200 | 5.0 | 0.0000749 | 895 | Put | 51.200 | 5.0 | 0.0003197 |
| 830 | Put | 11.000 | 5.0 | 0.0000798 | 900 | Put | 52.800 | 5.0 | 0.0003261 |
| 835 | Put | 11.750 | 5.0 | 0.0000843 | 905 | Put | 54.700 | 5.0 | 0.0003341 |
| 840 | Put | 12.450 | 5.0 | 0.0000882 | 910 | Put | 56.750 | 5.0 | 0.0003428 |
| 845 | Put | 13.350 | 5.0 | 0.0000935 | 915 | Put | 58.900 | 5.0 | 0.0003519 |
| 850 | Put | 14.750 | 5.0 | 0.0001021 | **920** | *Put/Call Average* | **61.050** | **5.0** | **0.0003608** |
| 855 | Put | 15.500 | 5.0 | 0.0001060 | | | | | |
| 860 | Put | 16.600 | 5.0 | 0.0001122 | 925 | Call | 58.950 | 5.0 | 0.0003446 |
| 865 | Put | 17.700 | 5.0 | 0.0001183 | 930 | Call | 55.750 | 5.0 | 0.0003224 |
| 870 | Put | 19.000 | 5.0 | 0.0001255 | 935 | Call | 53.050 | 5.0 | 0.0003035 |
| 875 | Put | 20.200 | 5.0 | 0.0001319 | 940 | Call | 50.150 | 5.0 | 0.0002839 |
| 880 | Put | 21.600 | 5.0 | 0.0001395 | 945 | Call | 48.050 | 5.0 | 0.0002691 |
| 885 | Put | 22.850 | 5.0 | 0.0001459 | 950 | Call | 46.250 | 5.0 | 0.0002563 |
| 890 | Put | 24.450 | 5.0 | 0.0001544 | 955 | Call | 42.850 | 5.0 | 0.0002350 |
| 895 | Put | 26.450 | 5.0 | 0.0001651 | 960 | Call | 40.650 | 5.0 | 0.0002206 |
| 900 | Put | 27.250 | 5.0 | 0.0001682 | 965 | Call | 38.150 | 5.0 | 0.0002049 |
| 905 | Put | 29.750 | 5.0 | 0.0001816 | 970 | Call | 36.150 | 5.0 | 0.0001922 |
| 910 | Put | 31.700 | 5.0 | 0.0001914 | 975 | Call | 34.250 | 5.0 | 0.0001802 |
| 915 | Put | 33.550 | 5.0 | 0.0002004 | 980 | Call | 31.450 | 5.0 | 0.0001638 |
| **920** | *Put/Call Average* | **36.900** | **5.0** | **0.0002180** | 985 | Call | 29.500 | 5.0 | 0.0001521 |
| | | | | | 990 | Call | 27.850 | 5.0 | 0.0001421 |
| 925 | Call | 33.300 | 5.0 | 0.0001946 | 995 | Call | 25.900 | 5.0 | 0.0001309 |
| 930 | Call | 32.450 | 5.0 | 0.0001876 | 1000 | Call | 24.700 | 5.0 | 0.0001235 |
| 935 | Call | 28.750 | 5.0 | 0.0001644 | 1005 | Call | 22.350 | 5.0 | 0.0001107 |
| 940 | Call | 27.500 | 5.0 | 0.0001556 | 1010 | Call | 20.850 | 5.0 | 0.0001022 |
| 945 | Call | 24.000 | 5.0 | 0.0001344 | 1015 | Call | 19.150 | 5.0 | 0.0000930 |
| 950 | Call | 23.000 | 5.0 | 0.0001274 | 1020 | Call | 18.900 | 5.0 | 0.0000909 |
| 955 | Call | 19.850 | 5.0 | 0.0001088 | 1025 | Call | 16.300 | 5.0 | 0.0000776 |
| 960 | Call | 17.550 | 5.0 | 0.0000952 | 1030 | Call | 15.000 | 5.0 | 0.0000707 |
| 965 | Call | 15.950 | 5.0 | 0.0000856 | 1035 | Call | 13.800 | 5.0 | 0.0000644 |
| 970 | Call | 14.200 | 5.0 | 0.0000755 | 1040 | Call | 12.700 | 5.0 | 0.0000587 |
| 975 | Call | 13.650 | 5.0 | 0.0000718 | 1045 | Call | 11.450 | 5.0 | 0.0000524 |
| 980 | Call | 11.200 | 5.0 | 0.0000583 | 1050 | Call | 11.400 | 5.0 | 0.0000517 |
| 985 | Call | 9.950 | 5.0 | 0.0000513 | 1055 | Call | 9.350 | 5.0 | 0.0000420 |
| 990 | Call | 8.650 | 5.0 | 0.0000441 | 1060 | Call | 9.000 | 5.0 | 0.0000401 |
| 995 | Call | 7.550 | 5.0 | 0.0000381 | 1065 | Call | 7.750 | 5.0 | 0.0000342 |
| 1000 | Call | 7.000 | 5.0 | 0.0000350 | 1070 | Call | 6.850 | 5.0 | 0.0000299 |
| 1005 | Call | 5.600 | 5.0 | 0.0000277 | 1075 | Call | 6.350 | 5.0 | 0.0000275 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1010 | Call | 4.800 | 5.0 | 0.0000235 | 1080 | Call | 5.600 | 5.0 | 0.0000240 |
| 1015 | Call | 4.100 | 5.0 | 0.0000199 | 1085 | Call | 5.000 | 5.0 | 0.0000212 |
| 1020 | Call | 4.050 | 5.0 | 0.0000195 | 1090 | Call | 4.400 | 5.0 | 0.0000185 |
| 1025 | Call | 3.050 | 5.0 | 0.0000145 | 1095 | Call | 3.900 | 5.0 | 0.0000163 |
| 1030 | Call | 2.550 | 5.0 | 0.0000120 | 1100 | Call | 3.900 | 5.0 | 0.0000161 |
| 1035 | Call | 2.150 | 5.0 | 0.0000100 | 1105 | Call | 3.050 | 5.0 | 0.0000125 |
| 1040 | Call | 1.875 | 5.0 | 0.0000087 | 1110 | Call | 2.800 | 5.0 | 0.0000114 |
| 1045 | Call | 1.475 | 5.0 | 0.0000068 | 1115 | Call | 2.475 | 5.0 | 0.0000100 |
| 1050 | Call | 1.550 | 5.0 | 0.0000070 | 1120 | Call | 2.225 | 5.0 | 0.0000089 |
| 1055 | Call | 1.025 | 5.0 | 0.0000046 | 1125 | Call | 2.200 | 5.0 | 0.0000087 |
| 1060 | Call | 1.150 | 5.0 | 0.0000051 | 1130 | Call | 1.550 | 5.0 | 0.0000061 |
| 1065 | Call | 0.725 | 5.0 | 0.0000032 | 1135 | Call | 1.300 | 5.0 | 0.0000050 |
| 1070 | Call | 0.650 | 5.0 | 0.0000028 | 1140 | Call | 1.375 | 5.0 | 0.0000053 |
| 1075 | Call | 0.750 | 5.0 | 0.0000032 | 1145 | Call | 1.000 | 5.0 | 0.0000038 |
| 1080 | Call | 0.675 | 5.0 | 0.0000029 | 1150 | Call | 0.825 | 5.0 | 0.0000031 |
| 1085 | Call | 0.550 | 5.0 | 0.0000023 | 1155 | Call | 0.725 | 5.0 | 0.0000027 |
| 1090 | Call | 0.575 | 5.0 | 0.0000024 | 1160 | Call | 0.600 | 5.0 | 0.0000022 |
| 1095 | Call | 0.475 | 5.0 | 0.0000020 | | | | | |
| 1100 | Call | 0.375 | 5.0 | 0.0000015 | | | | | |
| 1105 | Call | 0.475 | 5.0 | 0.0000019 | | | | | |
| 1110 | Call | 0.275 | 5.0 | 0.0000011 | | | | | |
| 1115 | Call | 0.425 | 5.0 | 0.0000017 | | | | | |
| 1120 | Call | 0.275 | 5.0 | 0.0000011 | | | | | |
| 1125 | Call | 0.325 | 5.0 | 0.0000013 | | | | | |
| 1130 | Call | 0.475 | 5.0 | 0.0000019 | | | | | |
| 1135 | Call | 0.475 | 5.0 | 0.0000018 | | | | | |
| 1140 | Call | 0.375 | 5.0 | 0.0000014 | | | | | |
| 1145 | Call | 0.500 | 5.0 | 0.0000019 | | | | | |
| 1150 | Call | 0.200 | 5.0 | 0.0000008 | | | | | |
| 1155 | Call | 0.500 | 5.0 | 0.0000019 | | | | | |
| 1160 | Call | 0.275 | 5.0 | 0.0000010 | | | | | |
| 1165 | Call | 0.200 | 5.0 | 0.0000007 | | | | | |
| 1170 | Call | 0.250 | 5.0 | 0.0000009 | | | | | |
| 1175 | Call | 0.100 | 5.0 | 0.0000004 | | | | | |
| 1180 | Call | 0.425 | 5.0 | 0.0000015 | | | | | |
| 1185 | Call | 0.150 | 5.0 | 0.0000005 | | | | | |
| 1190 | Call | 0.275 | 5.0 | 0.0000010 | | | | | |
| 1195 | Call | 0.525 | 5.0 | 0.0000018 | | | | | |
| 1200 | Call | 0.100 | 5.0 | 0.0000003 | | | | | |
| 1205 | Call | 0.525 | 5.0 | 0.0000018 | | | | | |
| 1210 | Call | 0.275 | 5.0 | 0.0000009 | | | | | |
| 1215 | Call | 0.275 | 5.0 | 0.0000009 | | | | | |
| 1220 | Call | 0.525 | 5.0 | 0.0000018 | | | | | |

**Sum of Individual Contributions** 0.0058288

$$\frac{2}{T}\sum_i \frac{\Delta K_i}{K_i^2}e^{RT}Q(K_i)$$ 0.47277799

**Sum of Individual Contributions** 0.0185927

$$\frac{2}{T}\sum_i \frac{\Delta K_i}{K_i^2}e^{RT}Q(K_i)$$ 0.3668297