2B Technologies, Inc.

An InDevR Company

Technical Note No. 015

Recommended Calibration Procedure for 2B Tech Ozone Monitors™

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1. Enter the instrument menu and make a note of the calibration parameters, Z and S, that are in use in the instrument. These parameters may useful for correcting recent data obtained with the instrument. Also, it is useful to compare the new calibration parameters to the old ones in order to diagnose any problem with the instrument. Now set the calibration parameters to Z = 0 and S = 1.00. Set the averaging time to 10 seconds.

2. Attach the inlet of the ozone monitor to a calibrated source of ozone. This can be the Model 306 Ozone Calibration Source™ or an ozone calibrator provided by another company. If you are not using a Model 306 Ozone Calibration Source™, which has an internal overflow tee, it may be necessary to use an external overflow tee so that excess calibration gas is vented and not forced into the ozone monitor.

Note: Do not set the 2B Tech Ozone Monitor on top of a Thermo Electron Corp. (also now Thermo Fisher Scientific) ozone calibrator such as the Model 49i. The Thermo instrument outputs electrical interference that strongly affects measurements by 2B Tech Ozone Monitors.

3. Measure the instrument offset (zero) by collecting data points with the ozone calibrator set to zero ozone or by using an external ozone scrubber. Allow sufficient time for the ozone source to reach zero concentration. It may take a few minutes for the measurement to stabilize as the external ozone scrubber or ozone scrubber internal to the ozone calibrator equilibrates with ambient conditions. Average a minimum of 10 data points after the reading has stabilized. Note that individual measurements may fluctuate by ± 2 ppb or so for an instrument that meets the precision specification. It is useful at this time to calculate the standard deviation of the data. If the standard deviation of 10 consecutive measurements is consistently greater than 1.0 ppb for a Model 205 or 1.5 ppb for a Model 202 Ozone Monitor™, the instrument is noisier than it is capable of being. Noise will affect the precision but not the accuracy of the measurement. However, if you are using averaging greater than 10 seconds, the noise will be greatly reduced by the averaging process. In theory, the noise is reduced by a factor of $\sqrt{(N-1)}$ where N is the number of 10-s measurements. For 1-minute, 5-minute

and 1-hour averaging, the statistical noise is calculated to be reduced by factors of 2.2, 5.4 and 18.9, respectively.

The new Z calibration parameter is the negative of the average instrument offset. For example, if you average 10 points and obtain a value of -2.3 ppb, the new Z cal factor is 2.3, which rounds to 2. If you measure a value of 5.7, ppb, the new Z cal factor is -5.7, which rounds to -6.

4. Measure the output of at least one ozone concentration by setting the Ozone Calibration Source™ or other ozone calibrator to that concentration. We recommend 300 ppb if you are only using one concentration to determine the span. At 2B Technologies, we use nominal values of 50, 100, 150, 200, 250 and 300 ppb. However, 2B Tech Ozone Monitors™ are extremely linear, so one concentration should be adequate. For each concentration, should wait until the concentration measurement is stable, and then average a minimum of 10 measurements. The standard deviation of the measurements should not be much larger than what you obtained at zero concentration. A higher standard deviation is likely due to fluctuations in your ozone source. If the source is noisy, you will need to average more data points in order to improve the estimate of the mean concentration.

If you use only one ozone concentration, the S calibration parameter may be calculated from the average measurement M of the true concentration C as:

$$S = \frac{C}{M + Z}$$

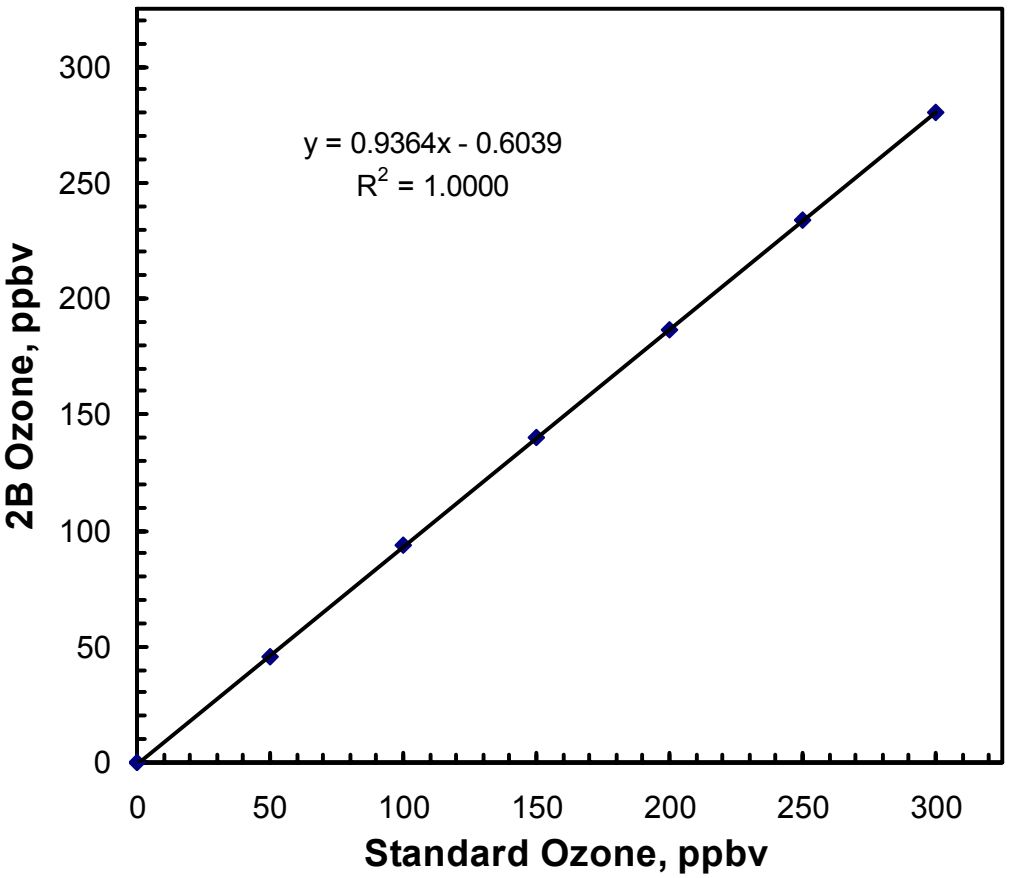
where Z is the cal factor you determined above. For example, if Z is +3 and an average ozone concentration of 289 ppb is measured when providing the ozone monitor with a true concentration of 300 ppb, the S parameter is calculated to be 1.03.

If you use more than one ozone concentration in the calibration, plot the data with true concentration on the x axis and measured concentration on the y axis in a program such as Microsoft Excel. Now fit the data with a linear regression, making sure that the program provides you with the equation of the least squares line. The calibration parameter S will be given by

S = 1/slope

where “slope” is the slope of the least squares line.

The following is an example of calibration data obtained with multiple ozone concentrations.



In this example, the calibration parameter S would be 1/0.9364 = 1.068, which rounds to 1.07. The y intercept of this plot, b in the equation y = mx + b, which is -0.6 in the example above, should be within ±2 ppb of the offset measured with the Ozone Calibration Source set to zero. If not, there may be a problem with the instrument. Usually, this is an indication of contamination in the ozone monitor flow path.

5. Enter the calibration parameters into the instrument menu. As a check, it is a good idea to then measure zero and one other ozone concentration to make sure that your calibration is accurate.

If Z is outside the range -9 to +9 ppb or S is outside the range 0.99 to 1.09 ppb, the instrument probably needs to be cleaned or repaired.