**Standard Operating Procedure for NOx and CO calibrations at Rabbit Mountain**

***NO and NOx Calibration***

1. On the Thermo 146i calibrator, go to the main menu, then choose flow modes, then gas setup. Make sure that the gases and gas concentrations are the same in this menu as they are in the calibration gas cylinder you are using. If you have questions about this, see page 3-21 in the manual.
2. If you are just installing the calibration gas, make sure you purge the regulator thoroughly before beginning the calibration.
3. Select OPER, then set the following settings to calibrate NO at five points between zero and 300 ppb (see page 3-8 of the manual for more information):
   * NO
   * Set SPAN 1, 2, 3, 4, 5 or set ZERO (this sets the NO concentration)
   * Set OZONE to OFF
   * Set PHOT to OFF
4. After you save each of the settings by pressing the enter key, the calibrator will start producing the concentrations you want. You can select run to go back to the run screen to make sure it has done this.
5. Wait for the NOx analyzer to stabilize (probably 5-10 minutes), and then you are ready to record the concentration reported by the NOx analyzer, or to calibrate the NOx analyzer.
   * If you need to calibrate the NOx analyzer, select the main menu on the analyzer, then select Calibration. It is best to first calibrate at zero ppb, then at 300 ppb. You only need to calibrate NO and NOx (to zero ppb and 300 ppb), not NO2.
6. If it is the beginning of the measurement season, adjust the calibration at zero and 300 ppb, then do a 5 point calibration and record the results in the Excel QC report. If it is the end of the season, make sure to do the 5 point calibration and record the results before you make any changes to the analyzer.

***CO Calibration***

1. The easiest and fastest way to do the CO calibration is to do it at the same time as NOx. Since the calibrator only reports the concentration of one gas (NOx, in this case), you need to calculate the CO concentration based on the ratio of NOx to CO this way:
   * ( [COcyl] / [NOxcyl] ) X [NOxdil] = [COdil], where

[COcyl] and [NOxcyl] are the concentrations of CO and NOx in the cal gas cylinder and [NOxdil] and [COdil] are the concentrations of NOx coming out of the calibrator after dilution.

1. Change the CO calibration and record the 5 pt CO calibration the same way you do for NOx. Make sure you give CO plenty of time to equilibrate before you calibrate it or record its values. 10-15 minutes at least.

***NO2 Gas Phase Titration Calibration***

1. The last step is to check the ability of the NOx analyzer to measure NO2. The calibration gas cylinder only has NO in it, not NO2. So when you calibrate with that gas, NO = NOx, since NO2 is zero. NO and ozone react together to make NO2, so to calibrate for NO2 we add NO from the cal gas and the calibrator generates ozone. The two mix together and some of the NO is converted to NO2. Do this this way:
2. Select OPER, then set the following settings to calibrate NO at five points between zero and 300 ppb (see page 3-8 of the manual for more information):
   * NO
   * Set SPAN 1, 2, 3, 4, 5 or set ZERO (this sets the NO concentration. Set it to anywhere greater than 200 ppb)
   * Set OZONE to OZONE3 (ozone generator at 35%)
   * Set PHOT to OFF
3. This will allow the calibrator to generate ozone and NO. This takes a long time to equilibrate. Maybe 15 minutes.
4. You only need to do this GPT calibration at one point (instead of 5)
5. When we do the GPT calibration for NO2, what we want is (1) for the NOx concentration to equal the amount of NO we added, and (2) for the NO concentration to be quite a bit lower than the amount of NO we added, since some of the NO should have been converted to NO2. Thus, the NO concentration will be lower, but the NOx concentration will be the same (since NO + NO2 = NOx).
6. Record this value in the QC report. You shouldn’t have to calibrate this. If the NOx concentration is more than 5% different from what the calibrator is generating, you have one of two problems:
   * The calibration gas regulator still has oxygen in it and it turning some of the NO to NO2 before it reaches the calibrator. This would mean that your NO and NOx calibration got messed up.
   * If it isn’t that, then the NO2 converter in the Nox analyzer is probably bad and needs to be replaced.

What I would do if this happens is purge the cal gas regulator with a lot of cal gas, preferably by vacuuming it down, then pressurizing it, then vacuuming it, then pressurizing, maybe 5 or 10 times. Then I would recalibrate NO and NOx, and then try the GPT calibration check again.