

**Section II**

**OPERATOR RESPONSIBILITIES**

**OXIDES OF NITROGEN (NO<sub>y</sub>) QA PLAN**

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## **2.20.2.1 PROCEDURES FOR SITE OPERATION AND CALIBRATION OF THE TEI/TECO MODEL 42S NO<sub>y</sub> ANALYZER**

### **A) Overview**

The Division of Air Quality (DAQ) of the Department of Environment and Natural Resources (DENR) operates NO<sub>y</sub> monitors at various sites across the State of North Carolina to continuously monitor ground level ambient concentrations of NO<sub>y</sub> (NO, NO<sub>2</sub>, NO<sub>y</sub>). This is a major task and thus requires a coordinated effort by both Regional and Headquarters staff to collect quality data and also meet EPA requirements.

The goal of this document is to establish and deploy common site operation and instrument calibration procedures at all six (6) sites for generation of quality data that may be compared and if needed, further extrapolated. It is critical that these procedures be followed to the last details and if questions arise, technical assistance is available from the Electronic and Calibration Branch (919-733-5235) and or the Projects and Procedures Branch (919-733-1487) of the Ambient Monitoring Section in Raleigh, North Carolina.

All original records (calibration logbook and site logbooks) must be legible, complete, dated and signed by the site operator and retained as a part of the permanent analyzer calibration record. The operator's signature on the calibration logbook form certifies that the calibration has been performed in accordance with QA/SOP and that the information contained on the form is accurate. All records will be reviewed and certified by the Regional Chemist and further audited at the Headquarters.

### **B) Continuous Monitoring Principles for the NO<sub>y</sub> System**

- Note any unusual events such as power failures, equipment problems.
- The site is to be inspected for required maintenance such as shelter conditions, condition of plumbing/lines, compressor and silica gel condition, filter changes, leak testing, backup data collection, etc.,
- Note site temperature.
- Verify instrument and cylinder numbers and certification dates. The operator should call Electronic and Calibration Branch (ECB) when the cylinder reaches 500 psing and the cylinder should be replaced before it reaches 200 psing. Note the call to ECB in the logbook.
- An initial adjusted calibration (hereafter referred to as "calibration") must be performed during the site start-up.
- Visit the site at least once every 14 days or less and perform a calibration check (unadjusted calibration). A calibration check is to be performed before any changes are made to the system.

- As a part of calibration check, perform precision check every 14 days (40 CFR 58 App. B)
- A calibration check is required when the span drift on the nightly calibration check is  $> \pm 6\%$  or when the zero drift on the nightly calibration check is greater than or equal to  $\pm 2$  PPB
- Calibration (i. e. adjusted calibration) is required whenever a system's operation is interrupted. (i. e. more than two days without power, physical removal/replacement of system components, or major repairs/maintenance).
- A calibration is required when a calibration check (i. e. unadjusted calibration) fails. Replace the filter and perform calibration.
- With a 146C calibrator and/or gas cylinder change (if not done for a problem), a calibration check should be performed before change out to assess any replacement effects. If the calibration check passes then perform the calibration. If the calibration check fails, perform a thorough investigation of the system to find out the reason(s) for the failure and contact ECB.
- No calibration checks that affect data are to be made during periods of ambient exceedances or between 6:00 AM and 9:00 AM local time.
- A calibration is required at the closure of a site. The instrument should also be calibrated (adjusted calibration) at a minimum of once per year (even when running smoothly over that time span).

### **C) Monitoring Instrumentation, Equipment and Accessories**

TEI/TECO Model 42S NOy Analyzer (check manufacturer manual for operation details)

TEI 146C Dynamic Gas Calibrator (check manufacturer manual for operation details)

Certified NOy Cylinder

Model 111 Zero Supply System (check manufacturer manual for operation details)

ESC Model 8816 Data Loggers (Primary, PDL and Secondary, BUDL)

A Dedicated Site PC

Modem

### **2.20.2.2 Operational Checks and Calibration for NOy Monitoring Sites**

An initial calibration is performed without doing any prior calibration checks. The filter must be clean. Perform all of the following checks and adjustments before calibrating the 42S analyzer. Document all checks and adjustments in the logbook.

#### **A) Site Operational Checks**

Upon arrival at the site, observe the outside of the sampling building and probe, looking for vandalism or security breaches. Check the probe outside for an intact screen any insect nest inside the probe funnel or sample line. Document all actions in the site logbook. If there is any evidence of vandalism, contact the appropriate Law Enforcement Department (generally this one is the City Police, if the site is within city limits and the County Sheriff, if it is outside city limits) and also inform Headquarters.

Conduct the following site operational checks before running calibration. Record all your observations in the logbook. Except for particulate filter changes, phone ECB for guidance if any problems occur while making any adjustments to the front panel controls.

**B) TEI 42S Analyzer Operational Checks**

**1) "Power On" Check:** Verify the instrument "POWER" light is lit and there is an audible sound from the external pump. Observe the vacuum gauge (24 to 28" Hg) and that the "OZONATOR" lamp is lit inside the front panel. If the instrument does not have any power, determine the cause and time of power failure. Invalidate data for the 20-minute period after the power comes back. Correct the cause and verify zero and span. Record all events in logbook. Notify Supervisor and the ECB.

**2) Range Check:** Verify that the range is set at the correct setting of 50 PPB, 100 PPB or 200 PPB for NO, NO<sub>2</sub> and NO<sub>y</sub> by engagement of the "STAT" pushbutton No. 2, 3 and 4 options.

**3) Station Temperature Check:** Measure and record the site temperature in °C. Adjust the site thermostat as necessary to maintain the 20 to 30°C range. If the temperature is outside of the 20 to 30°C range, notify the Regional Chemist and the ECB to correct the problem.

**4) Inspect 5 Micron Teflon Particulate Filters:** Replace before performing calibration. Unscrew the filter holder and replace the old filter with a new one. When changing the filters, touch only its outer edges. Record in logbook. Check for leaks associated with the filter holder. Record in logbook.

**5) Vacuum Check:** Read reaction chamber vacuum gauge (inside panel) and verify 24 to 28" Hg. Record the value. (**Do not adjust**). If these limits are exceeded, check for leaks, determine cause, correct accordingly and record in the instrument logbook and contact ECB

**6) Zero Air Drying Column Replacement:** Change the silica gel in the **Zero Air** drying column every week, if necessary. Return the used silica gel to the ECB for regeneration. Listen for any leaks due to loose fittings on the silica gel canister. Record in logbook.

**7) Run/Test and Ozonator Switches:** Both the Run/Test switch and the Ozonator switch should be set to "Run" for normal operation.

**8) Capillary Replacement:** If there is a problem in obtaining substantial NO, NO<sub>2</sub> and NO<sub>y</sub> span levels, there may be a problem due to the clogged capillaries. There are two capillaries; one for "SAMPLE" and the other one for "OZONE" and these should be cleaned only by the ECB (**ECB function**).

**9) Converter Temperature:** The converter temperature should be set between 325°C to 350°C. If not contact ECB.

**10) PMT Cooler Temperature:** The cooler temperature should be between  $-5^{\circ}\text{C}$  to  $-20^{\circ}\text{C}$ . If not contact ECB.

**11) Reaction Chamber Temperature:** The reaction chamber temperature should be between  $50^{\circ}\text{C}$  to  $55^{\circ}\text{C}$ . If not contact ECB.

**C) Maintenance of Model 111 Zero Air Supply System:** The exact life times of the scrubbing material is hard to predict. It depends on flow, pressure and level of contaminate(s). For most applications the following recommendations should be followed:

Weekly: If optional automatic drain valve is not installed, open stopcock on bottom of the tank and drain water.

Two Weeks: Check the condition of the "Purafil". It should be purple in color. Usually it turns brown when consumed but not always. Replace when the purple color represents less than 20% of the volume. To replace, turn off power and unplug. Wait until reactor cools down. Then remove the cartridge holding the "Purafil". Unscrew cap, dump out the used "Purafil" in a garbage bag and discard it in a trash bin. Replace the cartridge with fresh "Purafil". Screw on cover and replace the cartridge.

Yearly: Replace the charcoal. This procedure is the same as replacing "Purafil" (outlined above).

Pump: When it is observed that the pump is having difficulty keeping the pressure, call ECB for replacement.

**D) Maintenance and Troubleshooting Documentation:** Document any other site related suspected mechanical problems for preventative and routine maintenance in the logbook and notify ECB.

**E) TEI 146C Calibrator Operational Checks and Data Logger Log-in**

**1) Check on Gas Cylinder and 146C Calibrator:** Verify that the gas cylinder and calibrator are in certification and document certification dates in logbook. (If the cylinder pressure is < 200 psi, notify ECB so that arrangements for a new cylinder can be made).

**2) Range Check:** Verify that the range is set at the correct setting of 50 PPB, 100 PPB or 200 PPB for NO, NO<sub>2</sub> and NO<sub>y</sub> by engagement of the "STAT" pushbutton No. 2, 3 and 4 options.

**3) Log-in to 8816 Data Logger:** Sites are equipped with ESC Model 8816 primary and "back-up" data loggers. Both are important tools in reviewing monitor/site operations. To ensure the calibrator and monitor zero/spans are within required ranges, an automatic zero/span check can be performed.

The following sequence is used to log onto PDL and BUDL so that routine checks and calibrations can be performed via 8816 data logger:

- Turn on the screen and printer
- Double click on “Shortcut to Splitscreen”
- PDL and BUDL open
- Highlight PDL and type 2 letter data logger site code (located on the front of 8816 data logger) and AQM (may have to hit ESC several times before typing the site code)
- Select Login (L)
- Enter password ( ) and this will bring up “Home Menu”
- Highlight BUDL and type 2 letter data logger site code (located on the front of 8816 data logger) and AQM (may have to hit ESC several times before typing the site code)
- Select Login (L)
- Enter password ( ) and this will bring up “Home Menu”

#### **4) ESC 8816 Misc. Screen/Menu Items:**

- H: Help Screen
- C: Configure Menu
- D: Real Time Data Display
- R: Report Generation Menu
- G: Graph Generation Menu
- S: Status Menu

#### **5) Configure Menu**

- Configure Channels (enable/Disable Channels)
- Configure Calibrations (Start Span/Zero Air Checks)
- K: Math Constants (used in HSCO Analysis)

#### **6) Real-Time Data Display Menu**

- Provides a number of different ways to view data “Real-Time”
- W/units...W/flag...Base Average...Continuous Average

#### **7) Various Report Generations**

- Type the parameters that you need (NO, NO2 and NOy)
- Make sure that the decimal positioner is marked “Y”
- Go and view “On-Screen”

#### **8) Status Menu**

- Can view “Report Current Cal Status” (tells when all Auto Cals are run)

### **TO MOVE BETWEEN PDL AND BUDL PRESS “ALT” TAB**

#### **9) To Change Time on PDL and BUDL (log out time)**

- Highlight PDL or BUDL
- C: Configuration Menu
- S: Configuration System Parameters
- Highlight Date-Time, <ENTER>
- Type correct date and time
- <ENTER>

#### **F) Calibration**

##### **Disable Channels on Data Logger**

- While disabled, values are collected but flagged as “invalid data”

##### **Procedure**

- Highlight PDL and scroll using arrow keys to select “C” Configuration Menu
- Select “D” Configure Data Channels
- Select “M” Disable/Mark Channel Offline
- Select NO, NO<sub>2</sub>, NO<sub>y</sub> (these are marked down separately)
- ESC, ESC to “Home Menu”
- Select “D” Real Time-Data Display
- Select “B” Display Last Base Avg: This shows the last 1 minute average only w/flag  
D: Disabled
- Highlight BUDL and follow same steps to disable the channel
- ESC, ESC to “Home Menu” on both PDL and BUDL

**On the Model 42S verify that the NO, NO<sub>2</sub> and NO<sub>y</sub> ranges are set to either 50, 100 or 200 PPB by selecting options # 2, 3 and 4 by the “STAT” button and then push the “AUTO” mode**

##### **Run SPAN ZERO Check**

##### **Procedure to set up SPAN ZERO through 8816 PDL**

- Highlight PDL and Select “C” Configuration Menu
- Select “C” Configuration Menu
- Select “1” Start a Single Phase Calibration

- NOCAL <ENTER>
- Select SPAN0 <ENTER>
- <ENTER> Phase Duration
- Select Start Single Cal (NOW) <ENTER>
- ESC, ESC to “Home Menu”

#### **Monitor Actual Values:**

- Select “D” Real Time Display
- Select “B” Display Last Base Avg: Shows the last 1 min average only w/flag  
“D”: Disable and “C”: Calibration
- Can select “C” Continuous Avg Report
- Type in parameters NO, NOy, NO2
- Change # of flags to report from 02 to 03
- Start Continuous Report: This will show the minute averages as they are calculated and keeps all values on screen

#### **Use the following procedure for setting NO, NO2 and NOy Zero:**

##### **Procedure**

Allow the Model 42S microprocessor to stabilize for at least 30 minutes, until the zero channels on the data logger are stable. Press the “CAL” (Calibrate) button and set the value to zero at 0000 on the thumbwheel on the front of the 42S and press <ENTER>. Wait a minimum of 10 minutes for microprocessor to stabilize. The microprocessor will calculate, apply and store the zero background corrections (b0, b1 and b3) for all three channels. Enter 5 minutes of averaged NO, NO2 and NOy data logger data in the log book. The data logger and backup data logger should average the zero (0)  $\pm$  1 PPB for NO, NO2 and NOy. If all three channels are not in this range, contact the ECB.

- Record any adjustments
- Record 5 consistent consecutive values in electronic logbook

The BUDL screen mirrors the activity of the PDL. The instrument control is via the PDL. The BUDL screen is used to view the Real Time Data either as Last Base Avg or through the Continuous Report.

Using “W” command abort the SPAN ZERO. Check after 5 consistent values have been recorded in the logbook.

- ESC, ESC back to “Home Menu”
- C: Configuration Menu
- C: Configure Calibration
- W: Current Calibration

- Purge the instrument with ambient air

### **Check Span 1/Span 2/ Span 3**

#### **Procedure to set up Span 1, 2 and 3 through 8816 PDL**

- Highlight PDL and Select “C” Configuration Menu
- Select “C” Calibration Configuration
- Select NOCAL, <ENTER>
- Select SPAN 1, (SPAN 2, SPAN 3)

**Note: Abort each current SPAN prior to running the next using “W” command**

- Enter Phase Duration
- Select “Start Single Cal” (NOW)
- ESC, ESC to “Home Menu”

#### **Monitor Actual Values:**

- From “Home Menu”
- Select “D” Real Time Data Display
- Select “B” Display Last Base Avg: Shows the last 1 min average only w/flag  
“D”: Disable and “C”: Calibration
- Can Select “C” Continuous Avg Report
- Type parameters NO, NO2, NOy
- Change # of flags from 02 to 03, <ENTER>
- Start Continuous Report: This will show the minute averages as they are calculated and keeps all values on screen
- Abort SPAN 1 using “W” command

**Repeat above steps for SPAN 2 and SPAN 3**

**Adjust the NO/NOy Span using the following procedure:**

**Run and adjust SPAN ZERO. After adjustment abort using “W” command**

#### **Procedure:**

##### **Start SPAN 1**

- Highlight PDL and Select “C” Configuration Menu
- Select “C” Calibration Configuration
- Select NOCAL, <ENTER>

- Select SPAN 1, (SPAN 2, SPAN 3)

**Note: Abort each current SPAN prior to running the next using “W” command**

- Enter Phase Duration
- Select “Start Single Cal” (NOW)

Calculate actual NO/NOy concentrations (Ca) of approximately 90% of full-scale range (approximately 45 PPB, 90 PPB, or 180 PPB) using the equation below. Record the NO and NOy spans in the logbook.

Obtain  $F_{NO+F_{zero}}$  from 146C display by pushing “Run” button.

$$[NO]_{Ca} = [F_{NO}/(F_{NO}+F_{zero})] \times [(NO)_{std}]$$

$$[NOy]_{Ca} = [F_{NO}/(F_{NO}+F_{zero})] \times [(NO)_{std} + (NO2)_{imp}]$$

Where:  $F_{NO}+F_{zero}$  = Calibrated flows in sccm.

$[NO2]_{imp}$  = NO2 impurity in cylinder (on certification sheet)

$[NO)_{std}]$  = Certified NO gas concentration

Note: Multiply liters by 1000 to convert to sccm; multiply PPM by 1000 to convert to PPB

i.e., if  $[NO)_{std} = 5.44$  PPM,  $F_{NO} = 79.99$  sccm and  $F_{zero} = 9797$  sccm (9.797 lpm) then  $[NO] = 0.04405$  PPM (44.05 PPB).

After at least 30-45 minutes, verify that the analyzer data logger has stabilized to obtain a level span trace. Verify that the 42S display shows appropriate NO or NOy concentrations. If not press the “DISP” button until the NO or NOy is displayed. After stabilization, press the “CAL” button, set the value for NO span on the front panel thumbwheel to the calculated NO span. Press the “ENT” button to enter the span concentration. Wait an additional 10 minutes for the microprocessor to stabilize, repeat the entry, if necessary. Change the display to NOy and repeat the same process for the calculated NOy span, including any impurity by pressing “CAL” and “ENT” after thumbwheel entry. Check that NO and NOy displays are reading the calculated NO and NOy spans. If you cannot obtain the appropriate span readings on the data logger and backup data logger, troubleshoot the instrument. If no problem can be detected, the instrument may be malfunctioning. Call the ECB.

The microprocessor will calculate, apply and store an NO span correction (S.F.) and an NOy balance factor (B. F.) which will automatically adjust the analog outputs to reflect the NO and NOy concentrations.

- Record 5 consistent consecutive values in electronic logbook. Abort SPAN 1 using “W” command
- Run SPAN 2 and SPAN 3

**Use the following procedure for the adjustment of the NO<sub>2</sub> SPAN:**

From the **Gas A Dilution** run screen, record the **zero air** and **gas flow** necessary to produce the **Span 1** output, PPM.

After recording the **Span 1** event (including the flows), start the gas phase titration as follows:

**While the Span 1 event is running:**

- Push “Menu” button
- <ENTER>, <ENTER>, <ENTER> until 146C is in “Local”
- On “Home Menu” push “Run”
- Turn “GAS A” on
- Turn SPAN 1 on
- Set bottom line to “OZON” Manual
- From “Main Menu” go to “Ozonator”
- Push <ENTER>
- Go to “Manual”
- Push <ENTER>
- Note Your “GPT” zero air and “GPT” gas flows when you are running the “GPT”. If the flows are not exactly equal to **Span 1** zero air and gas flows that you recorded as noted above, phone ECB for guidance.

Once the GPT is running, use the ↑ ↓ arrows to adjust the O<sub>3</sub> “Level” (percent ozonation) to 20%, allow reading to stabilize. The stabilized NO<sub>y</sub> readings should agree with the original NO<sub>y</sub> span value, if the right amount NO<sub>2</sub> is being converted to NO. Starting from 20% ozonation, slowly increase the O<sub>3</sub> level until the NO readings drop to 10-20% of the span value (e. g. if the NO span is 90 PPB, increase the percent O<sub>3</sub> level slowly until the monitor stabilizes at an NO reading of approximately 9-18 PPB). Usually, an O<sub>3</sub> level set between 20-30% accomplishes the required NO reduction. Once set, the O<sub>3</sub> level will work with other calibrations unless something changes such as a gas cylinder or an ozonator lamp.

**Important:** During the “GPT”, NO reading must not be allowed to decrease by more than 90% of its original full scale span value (45 PPB for a 0-50 PPB range, 90 PPB for a 0-100 PPB range or 180 PPB for the 0-200 PPB range) so that adequate NO is available for the NO/O<sub>3</sub> reaction and enough NO remains for accurate NO<sub>2</sub> Calculations. If the NO reading drops by more than 90% (e.g. below 4.5 for a NO full scale span of 45 PPB), reduce the output of the calibrator until an acceptable NO reading is achieved.

While waiting approximately 45 to 60 minutes for the NO<sub>2</sub> trace to stabilize, verify the display is showing NO<sub>2</sub> concentration, press the “DISP” button to obtain “2”.

After the appropriate time period, look for a stable NO<sub>2</sub> trace of about 10 minutes data logger duration. Calculate the actual concentration of the NO<sub>2</sub> span using the equation below. Wait until the actual concentration is stable on the data logger. If the concentrations measured on the data logger are within ± 5% of the actual concentration, enter 5 minutes averaged NO<sub>2</sub> data logger and backup data logger data into the calibration section of the logbook.

$$[\text{NO}_2]_{\text{Ca}} = [\text{NO}]_{\text{orig}} - [\text{NO}]_{\text{rem}} + [\text{F}_{\text{NO}}/(\text{F}_{\text{NO}}+\text{F}_{\text{zero}})] \times [\text{NO}_2]_{\text{imp}}$$

i. e.  $[\text{NO}_2]_{\text{Ca}} = 180 \text{ PPB} - 20 \text{ PPB} + 0.7 \text{ PPB} = 160.7 \text{ PPB}$

Where:  $[\text{NO}_2]_{\text{Ca}}$  = NO<sub>2</sub> concentration at the output manifold, PPB

$[\text{NO}]_{\text{orig}}$  = Original NO concentration before titration with the O<sub>3</sub>, PPB

$[\text{NO}]_{\text{rem}}$  = No concentration after titration with O<sub>3</sub>, PPB

$[\text{NO}_2]_{\text{imp}}$  = NO<sub>2</sub> impurity in cylinder

NO<sub>2</sub> impurity in cylinder = NO<sub>y</sub> – NO values on the certification sheets

(i. e. 0.7 PPM = 11.7 PPM- 11 PPM or 700 PPB = 11,700 – 11,000 PPB)

$\text{F}_{\text{NO}}$  = No flow rate, sccm

$\text{F}_{\text{zero}}$  = Zero air flow rate, sccm (ozone flow rates included)

$D$  = Dilution ratio  $\text{F}_{\text{NO}}/(\text{F}_{\text{NO}}+\text{F}_{\text{zero}})$

**Note:** NO<sub>2</sub> impurity may be listed as an additional factor in certified protocol NO gas received from the manufacturer. If so, this additional NO<sub>2</sub> must be included when calculating the total NO concentration generated during gas phase titration.

**Note:** To convert liters to sccm, multiply liters by 1000. To convert PPM to PPB multiply by 1000.

If the NO<sub>2</sub> concentration measured on the data loggers is not within ± 5% of the actual concentration,  $[\text{NO}_2]_{\text{Ca}}$ , set the instrument display to read NO<sub>2</sub>, press the “Cal” button, dial in the determined actual concentration of the NO<sub>2</sub> on the thumbwheel and press the “ENT” button. Wait for the microprocessor to stabilize, and enter 5 minutes averaged NO<sub>2</sub> data logger and backup data logger data into the calibration section of the logbook.

If the NO<sub>2</sub> channel is adjusted, recheck the NO and NO<sub>y</sub> span values and readjust, if necessary.

Enter 5 minutes averaged NO<sub>2</sub> data logger and chart data into the calibration logbook.

When the titration finishes, do the following:

- Place 146C back into “Remote”
- Abort NO Span 1

The 146C is now set-up to run the calibration points or the precision check. To cycle through the points press, “Run”, to accept press <ENTER>.

- Once completed and stabilized, document 5 minutes of consistent readings in the logbook
- Calculate the Converter Efficiency as per the procedure outlined in section **2.20.2.3** “Calibration Check Gas Phase Titration (14 days or less Converter Efficiency Calculations)”.

### **Verification of Calibration Points via 146C “Local Mode”**

Generate NO/NOy calibration/precision points (as required).

- Run calibration/precision points SPAN 2 and SPAN 3
- Allow 10-15 minutes for readings to stabilize, record and average the last 5 data values
- Repeat all above (3) steps as necessary for the calibration
- Abort “Span Mode” on the primary data logger using “W”

For each concentration, calculate the NO and NOy concentrations and record the analyzer response (PDL and BUDL). Compare the calculated or “True” values of the NO and NOy calibration/precision points to the corresponding PDL and BUDL values. All calibration points must meet the following criteria:

### **Percent Tolerance Across all Full Scale (FS) Ranges (50, 100, 200)**

<b><u>Point+</u></b>	<b><u>Calibration Tolerance</u></b>
Span (90%)	±3%
Mid (50%)	±3%
Precision (18%)	±10%
Zero (O)	±1 PPB
NO2 Span	±5%

-----  
+Nominal or designated value of each point

If any of the points are greater than the calibration tolerance for the full-scale range, the calibration is unacceptable. If the calibration is unacceptable after two (2) tries, contact ECB. All points on the calibration must meet their respective calibration tolerance. **Adjustments to the 42S should be based on the 42S NOT meeting the tolerance criteria.**

If the calibration is acceptable, proceed to document the operational checks and then “logout”.

## **Abort Calibration on PDL**

### **Procedure**

- Highlight PDL and ESC ESC to Home Menu
- Select “C” Configuration Menu
- Select “C” Configuration Calibration
- Select “A” Abort Calibration Program
- NOCAL, press <ENTER>: This stops the calibration
- ESC, ESC to “Home Menu”

## **Enable Channels on PDL and BUDL**

- Highlight PDL and select “C” Configuration Menu
- Select “D” Configure Data Channels
- Select “E” Enable/Mark Channel Online
- Select NO, NOy, NO2 and press <ENTER>
- Highlight BUDL and follow the above instructions for enabling the 3 channels

**Keep in mind that if the site has a CO monitor, the CO AutoCal needs to be re-set to run at the appropriate time**

## **Setting the CO Autocal**

### **Procedure:**

Change COZAdj Cal Time

- Select PDL and then select “C” Configuration Menu
- Select “C” Configure Calibration
- Select “C” Change Old Cal Program
- Select “COZAdj”
- Highlight time and change XX:46 (Future odd hour)
- Log Out of the PDL and BUDL by ESC, ESC to “Home Menu”
- Select Log Out

### **2.20.2.3 Calibration Check**

Calibration check (every 14 days or less) including converter efficiency calculation determines the ongoing accuracy and stability of site specific NOy monitoring system. As a part of Calibration Check, perform Precision Check every 14 days (40 CFR 58 App. B).

#### A) Site Operational Checks

Upon arrival at the site, observe the outside of the sampling building and probe, looking for vandalism or security breaches. Check the probe outside for an intact screen any insect nest inside the probe funnel or sample line. Document all actions in the site logbook. If there is any evidence of vandalism, contact the appropriate Law Enforcement Department (generally this one is the City Police, if the site is within city limits and the County Sheriff, if it is outside city limits) and also inform Headquarters.

Conduct the following site operational checks before running calibration. Record all your observations in the logbook. Except for particulate filter changes, phone ECB for guidance if any problems occur while making any adjustments to the front panel controls.

#### B) TEI 42S Analyzer Operational Checks

1) **“Power On” Check:** Verify the instrument “POWER” light is lit and there is an audible sound from the external pump. Observe the vacuum gauge (24 to 28” Hg) and that the “OZONATOR” lamp is lit inside the front panel. If the instrument does not have any power, determine the cause and time of power failure. Invalidate data for the 20-minute period after the power comes back. Correct the cause and verify zero and span. Record all events in logbook. Notify Supervisor and the ECB.

2) **Range Check:** Verify that the range is set at the correct setting of 50 PPB, 100 PPB or 200 PPB for NO, NO<sub>2</sub> and NO<sub>y</sub> by engagement of the “STAT” pushbutton No. 2, 3 and 4 options.

3) **Station Temperature Check:** Measure and record the site temperature in °C. Adjust the site thermostats as necessary to maintain the 20 to 30°C range. If the temperature is outside of the 20 to 30°C range, notify the Regional Chemist and the ECB to correct the problem.

4) **Vacuum Check:** Read reaction chamber vacuum gauge (inside panel) and verify 24 to 28” Hg. Record the value. (**Do not adjust**). If these limits are exceeded, check for leaks, determine cause, correct accordingly and record in the instrument logbook.

5) **Zero Air Drying Column Replacement:** Change the silica gel in the **Zero Air** drying column every week, if necessary. Return the used silica gel to the ECB for regeneration. Listen for any leaks due to loose fittings on the silica gel canister. Record in logbook and contact ECB.

6) **Run/Test and Ozonator Switches:** Both the Run/Test switch and the Ozonator switch should be set to “Run” for normal operation.

7) **Capillary Replacement:** If there is a problem in obtaining substantial NO, NO<sub>2</sub> and NO<sub>y</sub> span levels, there may be a problem due to the clogged capillaries. There are two capillaries,

one for "SAMPLE" and the other one for "OZONE" and these should be cleaned only by the ECB (**ECB function**).

**8) Converter Temperature:** The converter temperature should be set between 325<sup>0</sup>C to 350<sup>0</sup>C. If not contact ECB.

**9) PMT Cooler Temperature:** The cooler temperature should be between -5<sup>0</sup>C to -20<sup>0</sup>C. If not contact ECB.

**10) Reaction Chamber Temperature:** The reaction chamber temperature should be between 50<sup>0</sup>C to 55<sup>0</sup>C. If not contact ECB.

**C) Maintenance of Model 111 Zero Air Supply System:** The exact life times of the scrubbing material is hard to predict. It depends on flow, pressure and level of contaminate(s). For most applications the following recommendations should be followed:

Weekly: If optional automatic drain valve is not installed, open stopcock on bottom of the tank and drain water.

Two Weeks: Check the condition of the "Purafil". It should be purple in color. Usually it turns brown when consumed but not always. Replace when the purple color represents less than 20% of the volume. To replace, turn off power and unplug. Wait until reactor cools down. Then remove the cartridge holding the "Purafil". Unscrew cap, dump out the used "Purafil" in a garbage bag and discard it in a trash bin. Replace the cartridge with fresh "Purafil". Screw on cover and replace the cartridge.

Yearly: Replace the charcoal. This procedure is the same as replacing "Purafil" (outlined above).

Pump: When it is observed that the pump is having difficulty keeping the pressure, call ECB for replacement.

**D) Maintenance and Troubleshooting Documentation:** Document any other site related suspected mechanical problems for preventative and routine maintenance in the logbook and notify ECB.

**E) TEI 146C Calibrator Operational Checks and Data Logger Log-in**

**1) Check on Gas Cylinder and 146C Calibrator:** Verify that the gas cylinder and calibrator are in certification and document certification dates in logbook. (If the cylinder pressure is < 200 psi, notify ECB so that arrangements for a new cylinder can be made).

**2) Range Check:** Verify that the range is set at the correct setting of 50 PPB, 100 PPB or 200 PPB for NO, NO<sub>2</sub> and NO<sub>y</sub> by engagement of the "STAT" pushbutton No. 2, 3 and 4 options.

**3) Log-in to 8816 Data Logger:** Sites are equipped with ESC Model 8816 primary and “back-up” data loggers. Both are important tools in reviewing monitor/site operations. To ensure the calibrator and monitor zero/spans are within required ranges, an automatic zero/span check can be performed.

The following sequence is used to log onto PDL and BUDL so that routine checks and calibrations can be performed via 8816 data logger:

- Turn on the screen and printer
- Double click on “Shortcut to Splitscreen”
- PDL and BUDL open
- Highlight PDL and type 2 letter data logger site code (located on the front of 8816 data logger) and AQM (may have to hit ESC several times before typing the site code)
- Select Login (L)
- Enter password ( ) and this will bring up “Home Menu”
- Highlight BUDL and type 2 letter data logger site code (located on the front of 8816 data logger) and AQM (may have to hit ESC several times before typing the site code)
- Select Login (L)
- Enter password ( ) and this will bring up “Home Menu”

**4) ESC 8816 Misc. Screen/Menu Items:**

- H: Help Screen
- C: Configure Menu
- D: Real Time Data Display
- R: Report Generation Menu
- G: Graph Generation Menu
- S: Status Menu

**5) Configure Menu**

- Configure Channels (enable/Disable Channels)
- Configure Calibrations (Start Span/Zero Air Checks)
- K: Math Constants (used in HSCO Analysis)

**6) Real-Time Data Display Menu**

- Provides a number of different ways to view data “Real-Time”
- W/units....W/flag...Base Average...Continuous Average

## 7) Various Report Generations

- Type the parameters that you need (NO, NO2 and NOy)
- Make sure that the decimal positioner is marked “Y”
- Go and view “On-Screen”

## 8) Status Menu

- Can view “Report Current Cal Status” (tells when all Auto Cals are run)

**TO MOVE BETWEEN PDL AND BUDL PRESS “ALT” TAB**

## 9) To Change Time on PDL and BUDL (log out time)

- Highlight PDL or BUDL
- C: Configuration Menu
- S: Configuration System Parameters
- Highlight Date-Time, <ENTER>
- Type correct date and time
- <ENTER>

## F) Calibration Check Procedure

If the monitor is operable, a calibration check must be performed before any component changes, alignments, or calibration (with the exception of the initial calibration). **Make no monitor adjustments before calibration check.**

Hearing protection should be worn while performing any calibration activities.

**Keep in mind that if the site has a CO monitor, the CO monitor’s “AutoCal” needs to set forward in time. Also remember that the CO monitor and NOy monitor share the SAME calibrator.**

## Disable Channels on Data Logger

- While disabled, data are collected but flagged as “invalid data”

### Procedure:

- Highlight PDL and scroll using arrow keys and select “C” Configuration Menu
- Select “D” Configure Data Channel
- Select “M” Disable/Mark Channel offline
- Select NO/NOy/NO2 (these are mark down separately)
- ESC ESC to “Home Menu”

- Select “D” Real Time-Data Display
- Select “B” Display Last Base Avg: This shows the last 1 minute average only w/flag D: Disabled
- Highlight BUDL and follow same steps to disable the channel
- ESC, ESC to “Home Menu” on both PDL and BUDL

**On the Model 42S verify that the NO, NO<sub>2</sub> and NO<sub>y</sub> ranges are set to either 50, 100 or 200 PPB by selecting options # 2, 3 and 4 by the “STAT” button and then push the “AUTO” mode**

**Perform the same above procedure on the BUDL to disable the 3 channels**

- The BUDL screen mirrors all activities of the PDL. The instrument control is via the PDL.

### **Setting the CO Autocal**

#### **Procedure:**

Change COZAdj Cal Time

- Select PDL and then select “C” Configuration Menu
- Select “C” Configure Calibration
- Select “C” Change Old Cal Program
- Select “COZAdj”
- Highlight time and change XX:46 (Future odd hour)
- Log Out of the PDL and BUDL by ESC, ESC to “Home Menu”
- Select Log Out

### **Run SPAN ZERO Check**

**Procedure to set up SPAN ZERO through 8816 PDL**

- Highlight PDL and scroll using arrow keys and select “C” Configuration Menu
- Select “C” Calibration Configuration
- Select “1” Start Single Phase Calibration
- Select NOCAL and <ENTER>
- Select SPANO <ENTER>
- <ENTER> Phase Duration
- Select Start Single Cal (NOW) <ENTER>
- ESC, ESC to “Home Menu”

### **Monitor Actual Values**

- Select “D” Real Time Data Display
- Select “B” Display Last Base Avg: shows the last 1 minute average only w/flag “D”: Disabled and “C” Calibration

### **Can select “C” Continuous Avg Report:**

- Type in parameters NO, NOy, NO2
- Change # of flags to report from 02 to 03 and Enter
- Start Continuous Report: this will show the minute averages as they are calculated and keeps all values on the screen
- Record 5 consistent consecutive values in electronic logbook

The BUDL mirrors all activities of the PDL. The instrument control is via the PDL. The BUDL screen is used to view the Real Time Data either as Last Base Avg or through the Continuous Report.

Using “W” command abort SPAN ZERO. Check after 5 consistent values have been recorded in the logbook

- ESC ESC back to Home Menu
- C: Configuration Menu
- C: Configure Calibration
- W: Current Calibration
- Purge the instrument with ambient air

### **Check Span 1/ Span 2/ Span 3**

#### **Procedure to set up Spans 1, 2 and 3 through 8816 PDL**

- Highlight PDL and select “C” Configuration Menu
- Select “C” Calibration Configuration
- Select NOCAL and <ENTER>
- Select SPAN 1 (SPAN 2, SPAN 3)

**Note: Abort each current SPAN prior to running the next using “W” command**

- Enter Phase Duration
- Select “Start Single Cal” (NOW)
- ESC, ESC to “Home Menu”

### **Monitor Actual Values**

- From “Home Menu”
- Select “D” Real Time Data Display
- Select “B” Display Last Base Avg: shows the last 1 minute average only w/flag “D”: Disabled and “C” Calibration

### **Can select “C” Continuous Avg Report:**

- Type in parameters NO, NOy, NO2
- Change # of flags to report from 02 to 03 and <ENTER>
- Start Continuous Report: this will show the minute averages as they are calculated and keeps all values on the screen
- Record 5 consistent consecutive values in electronic logbook
- Calibration values should continue to be observed and recorded via PDL and BUDL as the Calibrator and Analyzer

Prior to “Aborting Cal” and “Enabling Channels” perform following:

- Calibration check Gas Phase Titration (bi-weekly converter efficiency calculation)

### **Calibration Check Gas Phase Titration (14 Days or Less Converter Efficiency Calculation)**

From the **Gas A Dilution** run screen, record the **zero air** and **gas flow** necessary to produce the **Span 1** output, PPM.

After recording the **Span 1** event (including the flows), start the gas phase titration as follows:

### **While the Span 1 event is running:**

- Push “Menu” button
- <ENTER>, <ENTER>, <ENTER> until 146C is in “Local”
- On “Home Menu” push “Run”
- Turn “GAS A” on
- Turn SPAN 1 on
- Set bottom line to “OZON” Manual
- From “Main Menu” go to “Ozonator”
- Push <ENTER>
- Go to “Manual”
- Push <ENTER>

- Note Your “GPT” zero air and “GPT” gas flows when you are running the “GPT”. If the flows are not exactly equal to **Span 1** zero air and gas flows that you recorded as noted above, phone ECB for guidance.

Once the GPT is running, use the  $\uparrow \downarrow$  arrows to adjust the O<sub>3</sub> “Level” (percent ozonation) to 20%, allow reading to stabilize. The stabilized NO<sub>y</sub> readings should agree with the original NO<sub>y</sub> span value, if the right amount NO<sub>2</sub> is being converted to NO. Starting from 20% ozonation, slowly increase the O<sub>3</sub> level until the NO readings drop to 10-20% of the span value (e. g. if the NO span is 90 PPB, increase the percent O<sub>3</sub> level slowly until the monitor stabilizes at an NO reading of approximately 9-18 PPB). Usually, an O<sub>3</sub> level set between 20-30% accomplishes the required NO reduction. Once set, the O<sub>3</sub> level will work with other calibrations unless something changes such as a gas cylinder or an ozonator lamp.

**Important:** During the “GPT”, NO reading must not be allowed to decrease by more than 90% of its original full scale span value (45 PPB for a 0-50 PPB range, 90 PPB for a 0-100 PPB range or 180 PPB for the 0-200 PPB range) so that adequate NO is available for the NO/ O<sub>3</sub> reaction and enough NO remains for accurate NO<sub>2</sub> Calculations. If the NO reading drops by more than 90% (e.g. below 4.5 for a NO full scale span of 45 PPB), reduce the output of the calibrator until an acceptable NO reading is achieved.

Allow approximately 45 to 60 minutes for the NO<sub>2</sub> trace to stabilize. Verify the display is showing NO<sub>2</sub> concentration, pressing the “DIS” button to obtain “2.”

Calculate and record the resultant NO<sub>2</sub> logbook values using the following equations:

$$[\text{NO}_2]_{\text{Ca}} = [\text{NO}]_{\text{orig}} - [\text{NO}]_{\text{rem}} + [\text{F}_{\text{NO}}/(\text{F}_{\text{NO}}+\text{F}_{\text{zero}})] \times [\text{NO}_2]_{\text{imp}}$$

$$\text{Or } [\text{NO}_2]_{\text{Ca}} = [\text{NO}]_{\text{orig}} - [\text{NO}]_{\text{rem}} + D \times [\text{NO}_2]_{\text{imp}}$$

i. e.  $[\text{NO}_2]_{\text{Ca}} = 180 \text{ PPB} - 20 \text{ PPB} + 0.7 \text{ PPB} = 160.7 \text{ PPB}$

Where:  $[\text{NO}_2]_{\text{Ca}}$  = NO<sub>2</sub> concentration at the output manifold, PPB

$[\text{NO}]_{\text{orig}}$  = Original NO concentration before titration with the O<sub>3</sub>, PPB

$[\text{NO}]_{\text{rem}}$  = No concentration after titration with O<sub>3</sub>, PPB

$[\text{NO}_2]_{\text{imp}}$  = NO<sub>2</sub> impurity in cylinder

NO<sub>2</sub> impurity in cylinder = NO<sub>y</sub> – NO values on the certification sheets

(i. e. 0.7 PPM = 11.7 PPM- 11 PPM or 700 PPB = 11,700 – 11,000 PPB)

$\text{F}_{\text{NO}}$  = No flow rate, sccm

$\text{F}_{\text{zero}}$  = Zero air flow rate, sccm (ozone flow rates included)

$D$  = Dilution ratio  $\text{F}_{\text{NO}}/(\text{F}_{\text{NO}}+\text{F}_{\text{zero}})$

**Note:** NO<sub>2</sub> impurity may be listed as an additional factor in certified protocol NO gas received from the manufacturer. If so, this additional NO<sub>2</sub> must be included when calculating the total NO concentration generated during gas phase titration. **Note:** To convert liters to sccm, multiply liters by 1000. To convert PPM to PPB multiply by 1000.

After the appropriate time period, look for a stable NO<sub>2</sub> trace of about 10 minutes data logger duration.

Enter 5 minutes of averaged NO, NO<sub>2</sub>, NO<sub>y</sub> data logger and backup data logger data into the calibration section of the logbook.

Document each point on the computer printout with the pollutant and calculated concentration of NO, NO<sub>2</sub>, and NO<sub>y</sub>. Complete the NO, NO<sub>2</sub> and NO<sub>y</sub> zero/span/page in the logbook.

Calculate converter efficiency for required 14 days or fewer checks as follows:

$$\text{Percent Converter Efficiency} = \{ [\text{NO}_2]_{\text{conv}} / [\text{NO}_2]_{\text{Ca}} \} \times 100$$

Where  $[\text{NO}_2]_{\text{Ca}}$  = Calculated concentration of NO<sub>2</sub>

$[\text{NO}_2]_{\text{Conv}}$  =  $[\text{NO}_2]_{\text{Ca}} - ([\text{NO}_y]_{\text{orig}} - [\text{NO}_y]_{\text{rem}})$

$[\text{NO}_y]_{\text{orig}}$  = Original concentration of NO<sub>y</sub> prior to addition of O<sub>3</sub>, PPB

$[\text{NO}_y]_{\text{rem}}$  = NO<sub>y</sub> concentration remaining after addition of O<sub>3</sub>, PPB

Record converter efficiency in the logbook. If converter efficiency is less than 96%, recheck calculations, and troubleshoot the instrument. If converter efficiency still remains low, contact ECB.

When the titration finishes, perform the following:

- Place 146C back into “Remote”
- Abort NO Span 1

The 146C is now set-up to run the calibration points or precision check. To cycle through the points press, “Run”, to accept press “<ENTER>”.

### **Verification of Calibration Points via 146C “Local Mode”**

Generate NO/NO<sub>y</sub> calibration/precision points as required. Use primary data logger to activate SPAN 2 and SPAN 3.

- Press “Run” to scroll through the precision points (Span 2 and Span 3)
  - Span 1 = 90% full scale/span
  - Span 2 = 50% full scale/calibration point
  - Span 3 = 18% full scale/precision + calibration point
- When desired calibration point is displayed on the 146C LCD, press “<ENTER>”
- Allow 10-15 minutes for readings to stabilize, record and average the last 5 data values
- Repeat all above (3) steps as necessary for the calibration

- When the calibration is complete, press “Run” to scroll back to Span 1
- Press “<ENTER>” to accept
- Press “Menu” until you bring up the “Main Menu”
- From the “Main Menu” go to “Flow Modes”> “Standby”> press “<ENTER>” to put the 146C “Local Mode” in “Standby”

Stop the span mode on the primary data logger operation, press ESC, enter “C”, the six character code, and “<ENTER>” to “Activate Which Events”/ Answer “02” to “Deactivate Which Event” and press “<ENTER>”. Staple the printout to the appropriate logbook page.

For each concentration, calculate the NO and NOy concentrations and record the analyzer response (PDL and BUDL). Compare the calculated or “True” values of the NO and NOy calibration/precision points to the corresponding PDL and BUDL values. All calibration points must meet the following criteria:

**Percent Tolerance Across all Full Scale (FS) Ranges (50, 100, 200)**

<b><u>Point+</u></b>	<b><u>Calibration Check Tolerance@</u></b>
Span (90%)	±6%
Mid (50%)	±8%
Precision (18%)	±15%
Zero (O)	±2 PPB
NO2 Span	±5%

-----  
+Nominal or designated value of each point  
@% Difference = 100 x (measured-actual)/ actual

If any of the points are greater than the calibration check tolerance for the full scale range, the calibration check is unacceptable and a calibration is required according to procedures in **2.20.2.2**. If the span differs by ±25% or more from the theoretical, invalidate the data collected since the last acceptable check and perform all checks and corrective actions identified in Site Operational Checks (2.20.2.2), follow the Troubleshooting Guide and recalibrate. If the calibration is unacceptable after two (2) tries, contact ECB. All points on the calibration must meet their respective calibration tolerance. **Adjustments to the 42S should be based on the 42S NOT meeting the tolerance criteria.**

If the calibration check is acceptable, proceed to document the operational checks in the section **2.20.2.2** and then “logout”.

If the calibration check is unacceptable, conduct and document the operational checks in the section **2.20.2.2** before proceeding for a calibration.

### **Abort Calibration on PDL and BUDL**

#### **Procedure:**

- Highlight PDL and ESC ESC to Home Menu
- Select C: Configuration Menu
- Select C: Configure Calibration
- Select A: Abort a Calibration Program
- NOCAL press <ENTER>: this stops the calibration
- ESC, ESC to “Home Menu”

### **Enable Channels on PDL and BUDL**

- Highlight PDL and select “C” Configuration Menu
- Select D: Configure Data Channels
- Select E: Enable/Mark Channel Online
- Select NO, NO<sub>2</sub> and NO<sub>y</sub> (do this separately) and press <ENTER>
- Highlight BUDL and follow the above steps for enabling the 3 channels

**Inspect 5 Micron Teflon Particulate Filters:** Replace each month (not to exceed 31 days) or sooner, if moist or excessively dirty. Unscrew the filter holder and replace the old filter with a new one. When changing the filters, touch only its outer edges. Record in logbook. Check for leaks associated with the filter holder. Record in logbook.