Thermo Environmental 48*i* Trace Level Carbon Monoxide - QA Plan
Section I

Electronic Calibration Branch Responsibilities

Approval Sign-Off Sheet

I certify that I have read and approve of the contents of the "Thermo Environmental 48*i* Trace Level Carbon Monoxide - QA Plan, Section I, Electronic Calibration Branch (ECB) Responsibilities" with an effective date of October 12, 2011. **Sign, date and return to the Ambient Monitoring Section Chief.**

Joette Steger, PPB Supervisor: _____ 11/16/11

Donnie Redmond, Ambient Monitoring Section Chief: _____ 11/10/2011

Frank Stellitano, ECB Supervisor: _____

Carlton Blakley, Environmental Chemist: _____ 10/12/11

Table of Contents

2.36.1 Trace Level Carbon Monoxide QA Plan: ECB Responsibilities

Note: The following is a list of "significant changes" from Revision 10.1.

1) QA updated per QAP/SOP 2.39 "Standard Operating Procedure (SOP) for Preparing Quality Assurance Plans/SOPs".

2) 48*i* TLE background adjustment procedure.

2.36.1.1 Equipment Selection and Procurement

The Electronics and Calibration Branch (ECB) of the Ambient Monitoring Section of the Division of Air Quality (DAQ) is responsible for the evaluation and procurement of ambient pollution monitoring equipment; installation of monitoring instrumentation, samplers, and support equipment; evaluation of the on-going performance of all state operated air pollution sampling and monitoring systems; and scheduled and unscheduled system maintenance. The ECB maintains a sufficient inventory of monitoring system instrumentation, support equipment, and replacement parts to minimize the loss of ambient air monitoring data for all ambient air monitoring equipment of the Ambient Monitoring Section.

The ECB is also responsible for procuring and maintaining dedicated traceable standards for the certification of all calibrators and the independent accuracy auditing of ambient air quality monitoring systems. These standards provide a direct link to established national standards and are the foundation for the collection of the highest quality ambient air pollution data possible in accordance with current procedures and existing Federal Regulations and Guidelines. The accuracy audits performed by ECB provide an ongoing evaluation of monitoring equipment performance and site operator adherence to approved operating procedures. The ECB maintains permanent records on all standards used in the calibration and auditing of all instrumentation and sampling equipment used in support of DAQ monitoring activities.

The ECB maintains permanent records for each monitor and sampler used to analyze ambient air quality in the state of NC. Each significant component of the ambient air monitoring system (calibrators, analyzers, and zero air supplies) is assigned a dedicated unique logbook. These logbook records include performance evaluations, method detection limits (MDL, Section 2.36.1.11) and the complete repair records for the instrumentation. ECB also maintains monitoring site records detailing the instrumentation and equipment placed at each site. Both of these permanent records are updated continuously.

The ECB is also responsible for evaluating, developing, and recommending changes in equipment and operating parameters to improve the quality of data collected and procedures used in the collection of the data.

2.36.1.2 Ambient Carbon Monoxide Monitoring

The North Carolina Ambient Air Carbon Monoxide Monitoring System must meet or exceed the Reference and Equivalent Method requirements in 40CFR53.1 and 40CFR58. Appendix C. The

NC ambient carbon monoxide monitoring system consists of the following:

1. Thermo Environmental (TEI) Model 48*i* TLE Carbon Monoxide Monitor
2. Thermo Environmental (TEI) Model 146C Gas Calibrator (QA/SOP 2.3.4)
3. Thermo Environmental (TEI) Model 111 Zero Air Pak (QA/SOP 2.3.5)
4. Computer/ESC 8832 Data Logger/Modem System
5. Temperature Controlled Monitoring Shelter
6. Teflon Sampling Line

Note: minor components are not specified but included by reference.

The ECB is responsible for ensuring that all components are compatible with the measurement of ambient levels of atmospheric carbon monoxide. The ECB is responsible for the performance of complete system evaluation prior to the field installation and that the system is fully functional at the completion of the installation. On an ongoing basis as needed the ECB provides equipment and instrumentation maintenance and operational support to maximize the collection of the highest quality ambient air pollution data possible in accordance with accepted and approved procedures.

2.36.1.3 Receipt, Testing and Inventory

The ECB shall conduct operational tests after receipt and unpacking of each instrument. Following the Model 48*i* Trace Level-Enhanced Instruction Manual (Chapter 2) setup procedures, Section 2.36.2.4 of NC QA/SOP and operator's calibration section, the instrument must sample calibration gas at atmospheric pressure. After initial setup and instrument checks, the instrument is either approved or returned to the manufacturer if any damage or problems that cannot be fixed are identified.

Upon approval of the tested unit, the unit shall be added to the fixed asset system. For each monitor, apply an inventory decal and complete an inventory load sheet showing the planned monitor location. Submit the inventory load sheet to the branch supervisor.

2.36.1.4 TEI Model 48*i* TLE Certification (Pre-Site Installation Checks)

Method Detection Limit (MDL)

The method detection limit (MDL) refers to the lowest concentration of a substance that can be reliably determined by a given procedure (Section 2.36.1.11).

Lower Detection Limit (LDL)

The LDL is the minimum pollutant concentration that produces a signal of twice the noise level. To estimate the LDL, zero air is sampled and the noise level of the CO readings is determined according to 40 CFR 53.23(b). The vendor-specified LDL (instrument manual) for the most

sensitive range of high sensitivity CO analyzers should be 0.040 ppm (40 ppb) or lower, over an averaging time of no more than 5 minutes.

Linear Range

The linear range of each high sensitivity CO analyzer should extend from approximately 0.040 ppm to at least 5 ppm. A copy of the linear range will be retained with the instrument logbook/file.

Zero/Span Drift

Zero drift is defined as the change in response to zero pollutant concentration, over 12- and 24-hour periods of continuous unadjusted operation. Span drift is defined as the percent change in response to an upscale pollutant concentration over a 24-hour period of continuous unadjusted operation. Zero and span drift specifications should be obtained from the vendor prior to putting a high sensitivity CO analyzer into service. Such CO analyzers should have 12- and 24-hour zero drift less than 0.100 ppm, and should have a span drift of less than ±1 percent of the full-scale measurement range of the analyzer per 24 hours. Zero tests should be performed with the internal zero engaged. It is suggested that the zero trap of the analyzer be initially and periodically (annually) evaluated for efficiency or if the operator suspects a problem with the zero trap. A suggested means of confirming the functionality of the zero trap is to sample calibration air spiked with 1 to 2 ppm CO during the zero cycle, and review results for the automatic zeroing periods. This approach tests the key components of the zeroing/drying system and should meet the vendor-specified zero drift criterion. Record the zero/span test observations in the instrument logbook/file.

Interferences and Sources of Bias

Preventing interferences or biases is crucial to the accurate measurement of low ambient levels of CO. Record any interferences and sources of bias observations in the instrument logbook/file.

a. **Positive Interferences**

Gas filter correlation (GFC) CO analyzers determine CO concentration by measuring the amount of light that is absorbed at a select wavelength (4.7µm) as it passes through a sample cell containing CO. Any other gas in the air sample that also absorbs at those wavelengths could present an interference that result in an inaccurate determination of CO concentration. Removal of potential interferences must be done selectively such that these interferences are completely removed without affecting the CO concentration. To achieve this goal, high sensitivity CO analyzers are equipped with a permeation tube or Nafion™ drier that selectively removes water vapor from the sample gas without removing CO. Record any positive interference observations in the instrument logbook/file.

b. **Negative Interferences and Biases**

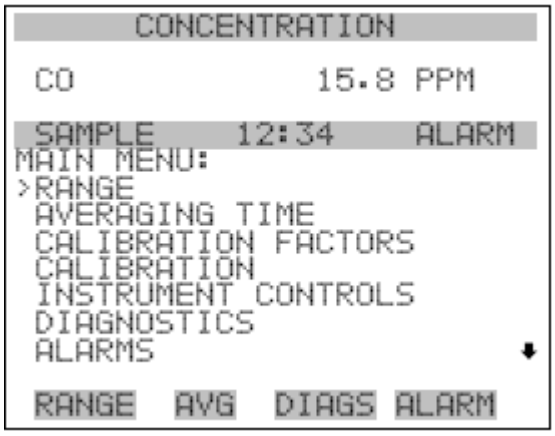
High sensitivity CO analyzers are equipped with a solenoid switching system to draw sample air into a heated internal scrubber that converts all CO to CO_2. The analyzer then measures the light absorption of this CO-free air and uses that light intensity to establish the zero reading. However, any CO that is not converted to CO_2 would remain in the sample gas and decrease the light intensity (i.e., absorb the light) used to establish the zero reading, resulting in an artificially high zero reading and a negative bias when measuring the CO in ambient air. To avoid this situation, it is important that the heated scrubber be maintained at the manufacturer's recommended temperature. Zero air and sample air readings should be within ±0.010 ppm (10 ppb), and scrubber efficiency should be >99%. Record any negative interference or bias observations in the instrument logbook/file.

Detector Stability

The temperature of the detector in a high sensitivity CO analyzer must remain stable in order to allow for ppb sensitivity. Commercial high sensitivity CO analyzers provide a display of the detector temperature. This temperature should be checked periodically for compliance with the vendor's required temperature setting. Bench temperature should be checked both with and without the zero scrubber engaged, to ensure that scrubber effluent does not cause heating of the optical bench. Record the detector temperature checks in the instrument logbook/file.

Verification of Component Performance

The following Test mode parameter ranges are allowed in the TEI 48*i* TLE Analyzer:



Main Menu, choose ***Range***
Range:

Gas Units	PPM
Range	5

Main Menu, choose ***Averaging Time***
Averaging Time:

Currently	60 sec

Main Menu, choose ***Calibration*** > ***Zero/Span Check***
Zero/Span Check:

Schedule	(odd hour) XX: 46
Period	2 hr
Total Duration	.4 hr
Zero Duration	20 min
Span Duration	0 min
Purge	6 min
Zero/Span Avg.	300 sec
Zero Cal Reset	ON
Span Cal Reset	OFF
Zero/Span Ratio	1

Main Menu, choose ***Instrument Controls Menu*** > ***Communication Settings>Baud Rate***
Baud rate:

Baud rate	9600

Main Menu, choose ***Instrument Controls Menu> Communication Settings> Instrument ID***
Instrument ID:

Instrument ID	48

Main Menu, choose ***Instrument Controls Menu*** > ***Communication Settings> Communication Protocol***
Communication Protocol:

Communication Protocol	CLINK

Main Menu, choose ***Instrument Controls Menu*** > ***Communication Settings> RS 232/RS-485***
RS 232/RS-485:

RS 232/RS-485 Selection	RS 232

Main Menu, choose ***Instrument Controls*** > ***I/O Configuration> Output Relay Settings***
Output Relay Settings:

1	NOP	Zero Mode
2	NOP	Purge Mode
3	NOP	UNITS
4	NOP	GEN ALARM
5	NOP	NONE
6	NOP	NONE
7	NOP	NONE

Main Menu, choose ***Instrument Controls*** > ***I/O Configuration> Digital Input Relay Settings***
Digital Input Setting:

1	NOP	Span Mode
2	NOP	NONE
3	NOP	NONE
4	NOP	NONE
5	NOP	NONE
6	NOP	NONE
7	NOP	NONE

Main Menu, choose ***Instrument Controls> Temperature Compensation***
Temperature Compensation:

Comp Temp	42.3
Currently	ON

Main Menu, choose ***Instrument Controls***> ***Pressure Compensation***
Pressure Compensation

Comp Pres	displays the current optical bench pressure.
Currently	ON

Main Menu, choose ***Instrument Controls> Service Mode***
Service Mode

Currently	OFF

Main Menu, choose ***Diagnostics*** > ***Voltages> Motherboard***
Motherboard Voltages:

3.3 SUPPLY	3.3 V
5.0 SUPPLY	5.0 V
15.0 SUPPLY	15.0 V
24.0 SUPPLY	24.1 V
-3.3 SUPPLY	-3.3 V

Main Menu, choose ***Diagnostics*** > ***Interface Board Voltages***
Interface Board Voltages:

3.3 SUPPLY	3:3 V
5.0 SUPPLY	5.0 V
15.0 SUPPLY	15.0 V
24.0 SUPPLY	24.1 V
-15.0 SUPPLY	-15.0 V
18.0 IR SUPPLY	18.0 V
18.0 MOT SUPPLY	18.0 V
Bias SUPPLY	-109.9 V

Main Menu, choose ***Alarms***
Alarms (Choose each parameter to see settings)

Parameter	**Min.**	**Max.**
Internal TEMP	38° C	45° C
Bench TEMP	40° C	59° C
Pressure	250mm Hg	1000 mm Hg
Flow	.3 LPM	.750 LPM
Sample/Ref Ratio	1.14	1.18
Bias Voltage	-130 v	-100 v
AGC Intensity	150,000 Hz	300,000 Hz
Motor Speed	100%	
Span Check	OK	
Zero AUTOCAL	OK	
Span AUTOCAL	OK	
Scrubber Gas Conc	OK	
Scrubber EFF	OK	
Scrubber TEST DONE	OK	
Concentration	OK	
Motherboard Status	OK	
Interface Status	OK	

Main Menu, choose ***Instrument Controls > I/O Configuration >Analog Output Config*** > ***Voltage Channel 1*** > ***RANGE***
Analog Output Config:

Select Range	0-10v
Set Minimum Value	0%
Set Maximum Value	100%
Choose Signal To Output	CO

Note: Adjust the operational parameters as necessary if outside to these ranges. If adjustments are performed the stability of the adjusted parameter(s) must be evaluated and recorded prior to proceeding.

The ECB is responsible for setting the operational parameters of each TEI 48*i* TLE as listed above. Primary Standard operation outside of these settings and limits is non-compliant with the NC QA/SOP for ambient air carbon monoxide monitoring and the data will be invalidated.

Yearly and prior to installation at the monitoring site, the ECB must evaluate the condition and performance of each TEI Model 48*i* TLE. The results of the evaluation, findings, and all adjustments are entered into the carbon monoxide standard specific site logbook, dated, and initialed.

- Perform any scheduled approved preventative maintenance procedures and or system enhancements.

- Visually inspect both cells for contamination and clean if necessary. If cells are dirty investigate causes of contamination and correct per manufacturer's recommendations.
- If the Gas Filter Wheel is changed;
  a. Connect zero air to monitor and equilibrate for 2 hours.
  b. Set Averaging Time to 300 seconds; on the 48*i* **Main Menu**, select "**Averaging Time**" and use the ↑ ↓ pushbuttons to change value, press ↵ to save changes.
  c. Set autozero/span check ahead four hours; on the 48*i* front panel, press "**CAL**" soft key, select "**ZERO/SPAN CHECK**" <ENTER>. Change "**Next Time**" to minimum of 4 hours in advance odd (09 or 13) hour: 46 using the ← → ↑ ↓ pushbuttons press ↵ (no real changes are made until ↵ is pressed). Example, 01:46, 05:46, 09:46, 13:46, 17:46, 21:46.
  d. Reset Calibration Factors to defaults, on the 48*i* front panel **Main Menu**, choose ***Calibration Factors***

     BKG 0.0
     COEF 1.000

     Reset user Cal defaults.
  e. Place 48*i* in Service Mode on.
     From the 48*i* **Main Menu,** choose ***Instrument Controls > Service Mode***
     Set to ***ON***
  f. Reset **Pre Amp Board Cal:**
     From the 48*i* **Main Menu**, choose ***Service > Preamp Calibration***

     SAMPLE: 127807 Hz
     REFERENCE: 148256 Hz
     SET TO: 51
     ↑↓ CHANGE VALUE

     SAMPLE: 162126 Hz (-12126) = 150000
     REFERENCE: 138256 Hz (+11744) = 150000

     In this example, At the Preamp Board Cal screen, use ↑↓ until the (Sample + Reference)/2 average value reads about 150,000 then press ↵ to save changes.
  g. Set Initial S/R Ratio to "Measured".
     48*i* **Main Menu**, choose ***Initial S/R Ratio***

     CURRENTLY: 1.079620
     MEASURED: 1.130966
     SET TO:

     MEASURED reading *entered* into **SET TO**, adjusts **CURRENTLY** reading.
  h. Set Averaging Time to 120 seconds; from the 48*i* **Main Menu**, select **Averaging Time** and use the ↑ ↓ pushbuttons to change value, press ↵ to save changes.
  i. Remove 48*i* from service mode.

- Perform a **Sample Route thru Solenoid**, **Span / Zero Air Route thru Solenoid** and a **Kicker** leak test.

Sample Route thru Solenoid:

1. On the 48*i* front panel, press "***DIAGS***" button.
2. Select "***Pressure***", <ENTER> to display the "**Pressure**" screen.
3. Disconnect the sample input line **at the filter holder inlet** and cap with a cap. It should take less than three minutes from the time the inlet is plugged to the time the pressure reading drops below 250 mmHg. If not, check to see that all fittings are tight and that none of the input lines are cracked or broken. If no leak is found, remove cap and reconnect sample line.

Span / Zero Air Route thru Solenoid:

1. Select "**Main Menu**", press (**RUN**) until "**ZERO**" appears in the status line.
2. On the 48*i* front panel, press "***DIAGS***" soft key.
3. Select "***Pressure***", <ENTER> to display the "**Pressure**" screen.
4. Disconnect the probe line before the "T" fitting and cap it where probe line was removed from with a cap, remove span in line, cap with metal cap nut. It should take less than three minutes from the time the inlet is plugged to the time the pressure reading drops below 250 mmHg. If not, check to see that all fittings are tight and that none of the input lines are cracked or broken. If no leak is found, remove cap and reconnect probe line.

Kicker Leak Check:

Note: Kicker leak check is performed after a filter change.

1. Change schedule on the 48*i* to do an auto zero and let it start.
2. Cap off the filter holder inlet with a plug.
3. On the 48*i* front panel, press "***DIAGS***" soft key.
4. Select "**Pressure**", <ENTER> to display the "**Pressure**" screen.
5. It should take less than three minutes from the time the inlet is plugged to the time the pressure reading drops below 250 mmHg. If not, check to see that all fittings are tight and that none of the inlet lines are cracked or broken. If no leak is found, remove cap and reconnect inlet line. If the leak test fails, investigate causes and correct per manufacturer's recommendations.

- Verify and adjust, if necessary, the Model 48*i* TLE operational parameters. If system fails to achieve required operational parameters investigate causes and correct per manufacturer's recommendations.
- Connect the zero air supply and the CO concentration standard to the Model 146C calibrator and the Model 48*i* TLE analyzer at atmospheric pressure and per manufacturer instructions if necessary. In order to satisfy all EPA requirements for precision and level 1 span checks (see 40 CFR 58, Appendix A), it is recommended that the filter be installed between the sample–span solenoid and the optical bench.
- Activate the Zero (Ø ppm) events on the Primary Data Logger (PDL) and allow the readings to stabilize on the Model 48*i* TLE analyzer.

- From the TEI 48*i* front panel, press "***CAL***" > "***CAL BACKGROUND***", allow the analyzer to sample zero air until a stable reading is obtained. In the **CO Background** screen, press ↵ (may have to do this several times).
- Activate the Span 1 (set dilution to 4.000 ppm) event on the PDL and allow the readings to stabilize on the Model 48*i* TLE analyzer. From the TEI 48*i* front panel, press "***CAL***" > "***Cal COEF***". Adjust Span 1 only using "**SPAN CONC**", enter amount (from 146C) using the ← → ↑ ↓ pushbuttons, press ↵ to save value.
- Activate the Span 2 (set dilution to 2.000 ppm) and Span 3 (set dilution to 0.300 ppm) points. Allow readings to stabilize for 5 minutes for each of the verification points.

2.36.1.5 Calibration Standards and System

Calibration Standards

The ECB shall procure calibration standards for the Ambient Monitoring Section. Primary Carbon Monoxide Standards are used to calibrate and evaluate the ongoing calibration checks and audit performance of the carbon monoxide monitors at each site. The primary CO standards used must be certified, commercially prepared compressed gas standards with a certified accuracy of no worse than ±2 percent. Procedure for the Verification of New Cylinder Concentrations (QA/SOP 2.3.6) will be followed when primary standard calibration gases are purchased / received. Standards in the concentration range of 70 to 195 ppm are suitable choices for dilution to prepare low concentration calibration mixtures.

a. Extreme care must be taken to ensure compatibility for all components. Flow rates and concentration outputs must meet the requirements of the monitor.

b. All primary standard calibration gases must be referenced to a National Bureau of Standards (NBS) carbon monoxide in Air Standard Reference Material (SRM) or an NBS/EPA approved gas manufacturer's Certified Reference Material (CRM). A written statement of certification should be obtained which provides the following:

a. a brief description of the certification procedure,
b. cylinder numbers,
c. cylinder gas concentrations,
d. replicate analysis data,
e. balance gas used,
f. NBS, SRM numbers used as standards, and
g. last analysis date.

A copy of this certification should be available to users and should be kept on file at the ECB.

c. Re-analysis of calibration standards shall be performed every 36 months or when expired for verification of gas stability. (This 36 month period is allowed because CO is very stable as shown by repeated analysis of the same cylinder and in accordance with 40CFR50 App. C.3.1. In actual practice most cylinders may be expended sooner).

d. No cylinder gas should be used below a cylinder pressure of 200 psig as shown by the

cylinder gas regulator.

e. Each CO span gas cylinder shall contain the following minimum traceability information on a label or tag affixed to the cylinder or valve:

a. the concentration of cylinder gas,
b. the last analysis date,
c. the expiration date,
d. the initials of the person performing the analysis,
e. cylinder number, and
f. balance gas.

TEI 146C Calibrator

The 48*i* TLE analyzer is calibrated using a TEI 146C Calibrator, which must have flows certified by ECB and traceable to a primary standard according to the requirements in the QA/SOP 2.3.4 TEI 146C Calibrator. These systems allow for accurate dilution of CO standard gases from high concentration (usually ~200 ppm) to low ambient working standard concentrations (e.g., from 0.040 to 0.500 ppm).

It is highly important when purchasing a mass flow controlled (MFC) calibrator that it meet the 40 CFR 50 requirements of ±2 percent flow accuracy, and that the calibrations of both MFC channels be checked periodically and recorded in the 146C logbook using a NIST traceable flow standard.

TEI Zero Air Source / Generator

Zero air is required for the calibration of high sensitivity CO analyzers. This air must contain no detectable CO (i.e., CO content must be less than the LDL of the CO analyzer) and must be free of particulate matter, which must have flows certified by ECB and traceable to a primary standard according to the requirements in the Zero Air Pak (QA/SOP 2.3.5). Commercially available zero-air generation systems can greatly reduce CO levels in air. However, depending on the required zero airflow rates, it may be difficult to reduce CO levels to **0.040 ppm** or less, unless a palladium (Pd) scrubber is used. A recommended approach to test zero air quality is to compare the readings of the high sensitivity CO analyzer in zero air in sample mode vs. the analyzer output in the "auto zero" mode. This comparison should be done and recorded in logbook at least semi-annually and can only be done with those analyzers that provide a digital recording of the output in the "auto zero" mode.

2.36.1.6 Site Monitor Operation / Verification (Site Installation)

After the regional office has obtained permission to use a site from the site owner, and after DAQ Ambient Monitoring Project and Procedures Supervisor have approved the site, the Electronics and Calibration Branch will install the monitor and its appurtenances. Electrical circuits should be dedicated, properly sized and labeled prior to the installation of the monitor equipment. Inspect the site for integrity and safety.

The ECB Supervisor is responsible for the installation of all State operated ambient air carbon monoxide monitoring sites across the state each year. For seasonal sites, the sites are required to be setup prior to the start date of the EPA approved carbon monoxide monitoring season. Consult the ECB Supervisor for when startup dates are for the instruments being readied for the field

The installation of the carbon monoxide monitoring sites includes:

- Certified Primary Gas cylinder Standard
- Model 48*i* TLE Carbon Monoxide Monitor
- Model 146C Gas Calibrator (QA/SOP 2.3.4)
- Model 111 Zero Air Pak (QA/SOP 2.3.5)
- Pretreated Teflon Sampling Line
- Computer, data logger, and modem system

The monitoring site installation also may include additional items such as the air conditioning unit, the compressor and heater but these components generally remain at the site year round. Following the installation of all components of the carbon monoxide monitoring system, the performance of all components is verified as the final step of the site installation.

Verification of Component Performance

A. Equipment Specifications

The following Test mode parameter ranges are allowed for the TEI 48*i* TLE Analyzer:

Parameter	**Min.**	**Max.**
Internal TEMP	38 °C	45 °C
Bench TEMP	40 °C	59°C
Pressure	250mm Hg	1000 mm Hg
Flow	.3 LPM	.750 LPM
Sample/Ref Ratio	1.14	1.18
Bias Voltage	-130 v	115 v
AGC Intensity	150,000 Hz	300,000 Hz
Motor Speed	100%	

Note: Adjust the operational parameters as necessary if outside to these ranges. If adjustments are performed, the stability of the adjusted parameter (s) must be evaluated prior to proceeding. If the results of the adjustments do not fall within the limits, consult manufacturer until these are met.

The ECB is responsible for setting and recording in logbook the operational parameters of each TEI 48*i* TLE as listed above. Primary Standard operation outside of these settings and limits is non-compliant with the NC QA/SOP for ambient air carbon monoxide monitoring and the data will be invalidated.

B. Equipment Checks

WARNING: Do not plug in the monitor, modem, data logger, and computer until all cables are connected. ELECTRICAL SHOCK AND/OR EQUIPMENT DAMAGE MAY

OCCUR OTHERWISE.

- Connect the TEI Model 48*i* TLE, power up, and allow warming up for 1 hour.
- Perform a leak check as per Instrument Manual, Section 5. If leak check fails, investigate causes and correct per manufacturer's recommendations.
- Bleed cylinder regulator:
  Close line valve, fill regulator by opening cylinder tank valve,
  Close cylinder tank valve,
  Loosen cylinder line fitting at 146C,
  Open line valve – hear gas escape – don't lose all pressure,
  Close line valve,
  Fill regulator by opening cylinder tank valve,
  Close cylinder tank valve,
  Open line valve – hear gas escape – don't lose all pressure,
  Close line valve,
  Fill regulator by opening tank cylinder valve,
  Close cylinder tank valve,
  Open line value – hear gas escape – tighten gas line fitting at 146C,
  Open cylinder valve and line valve fully open,
  Check for leaks,
  Cylinder pressure set to 30 psi,
- Verify and adjust, if necessary, the Model 48*i* TLE operational parameters. If system fails to achieve required operational parameters as listed in Part A above, investigate causes and correct per manufacturer's recommendations until met.
- Conduct operational checks for zero / span solenoid and diagnostics / alarms events.
- Configure PDL to acquire 48*i diagnostics* "**Flow**" and "**Intensity**".
- Set computer, PDL, and BUDL time/date.
  The times for the PDL, BUDL, and computer must be EASTERN STANDARD TIME.
  The BUDL and PDL must have the same NIST time ±1 minute.

  Sources for getting the correct time:
  1. Call the ECB and ask for the NIST time.
  2. Call the NIST Colorado time @ **(303) 499-7111** (long distance).
  3. Correct time loaded into cell phone from NIST source.
  4. Setting a watch to the correct time website, **http://nist.time.gov/**, within 24 hours of visiting the site.

- Setup BUDL Analog output
  In Service mode, set the BUDL analog output to mirror the PDL digital output to within 30ppb.
  Main Menu, choose ***Diagnostics > Test Analog Outputs*** > ***Voltage Channel 1***, select ***SET TO FULL SCALE***, full-scale sets the analog outputs to the full-scale voltage,
  CONNECT METER TO OUTPUT!
  SELECTED OUTPUT: V1

SET TO: 4997
↵ SAVE VALUE ↑↓ INC/DEC

Select ***SET TO ZERO,*** zero sets the analog outputs to 0 volts
CONNECT METER TO OUTPUT!
SELECTED OUTPUT: V1
SET TO: 100
↵ SAVE VALUE ↑↓ INC/DEC

- Connect the zero air supply and the CO concentration standard to the Model 146C calibrator and the Model 48*i* TLE analyzer at atmospheric pressure and per manufacturer instructions if necessary. In order to satisfy all EPA requirements for precision and level 1 span checks (see 40 CFR 58, Appendix A), it is recommended that the filter be installed between the sample–span solenoid and the optical bench.
- Activate the Zero (Ø ppm) events on the Primary Data Logger (PDL) and allow the readings to stabilize on the Model 48*i* TLE analyzer.
- From the TEI 48*i* front panel, press *"**CAL**"* > *"**CAL BACKGROUND***", allow the analyzer to sample zero air until a stable reading is obtained. In the **CO Background** screen, press ↵.
- Activate the Span 1 (set dilution to 4.000 ppm) event on the PDL and allow the readings to stabilize on the Model 48*i* TLE analyzer. From the TEI 48i front panel, press *"**CAL**"* > *"**Cal COEF***". Adjust Span 1 only using "**SPAN CONC**", enter amount (from 146C) using the ← → ↑ ↓ pushbuttons, press ↵.
- Activate the Span 2 (2.000 ppm) and Span 3 (0.300 ppm) points. Allow readings to stabilize for 5 minutes for each of the verification points.
- Verify and adjust, if necessary, the Model 48*i* TLE operational parameters. If system fails to achieve required operational parameters investigate causes and correct per manufacturer's recommendations.
- If system fails to achieve required operational parameters investigate causes and correct per manufacturer's recommendations.
- Check that the heat tape is working and the insulation is adequate.
- Leave supplies (filter material, silica gel, etc.).

C. Equipment Identification
Fixed Asset System (FAS) numbers for the Model 48*i* TLE Carbon Monoxide Monitor, the Model 146C Gas Calibrator, the Model 111 Zero Air Pak, dataloggers and computer will be attached on monitor and documented / logged on the 109 Form and record kept in appropriate ECB file.

D. Teflon Sampling Line
The Teflon sampling line is a 3/8" OD ¼" ID virgin continuous piece of sample tubing that runs from the back of the particulate filter holder on the TEI 48*i* TLE monitor to the inverted funnel on the outside of the monitoring shelter. Care should be taken to ensure that dirty, wet, or incompatible materials in the sample lines do not contaminate the sample.
The inlet line should be wrapped with removable polyurethane insulation and if humidity

problems occur, wrapped with heat tape or similar device to maintain 100° F to 120° F, in order to prevent condensation. The length of the tubing should be held to a minimum. For best results the tubing between the inlet and the analyzer should be less than ten (10) feet. **This sampling line is replaced whenever damage or contamination is observed or every two (2) years. For sites that operate continuously, the probe and funnel will be replaced during even years (i.e., 2006, 2008, etc.). Sample lines should be capped / plugged when not in use.**

E. Zero Air Pak

The Model 111 Zero Air Pak provides dried scrubbed ambient air to the calibrator. The ambient air first passes through two silica gel cartridges to remove moisture. Replacing the silica gel is the responsibility of the regional technicians for the site.

ECB Responsibilities

Annually

Replace Model 111 zero air pack annually with a certified zero air pack or:

Replace the Purafil. Fresh Purafil is purple. It becomes brown when it is used up. Replace when the purple color represents less than 20% of the volume. To replace, shut off the air supply so that the Model 111 pressure drops to 0.0 psig. Remove the cartridge holding Purafil. Slowly unscrew the cap, allowing any remaining pressure to vent, empty out the used Purafil into a zip lock bag and discard. Replace with fresh Purafil. Screw on cover and replace cartridge.

PURAFIL® media is a non-toxic, non-flammable substance. Filtration of contaminants through PURAFIL® media causes molecular changes within the media to occur, and the resulting product is usually not harmful to the environment and does not require special disposal.

Replace the charcoal. The procedure is the same as replacing Purafil, outlined above.

Replace the carulite. The procedure is the same as replacing Purafil, outlined above.

Replace the silica gel. Old silica gel is returned to the ECB for re-drying.

Record the chemical change(s) in the instrument logbook/file. If chemicals are changed in the site zero air pack, the zero air pack must be conditioned 24 hours before use. The performance of the zero air pack must also be confirmed using the procedures in QA/SOP 2.3.5.

F. Computer Data Logger System and Modem

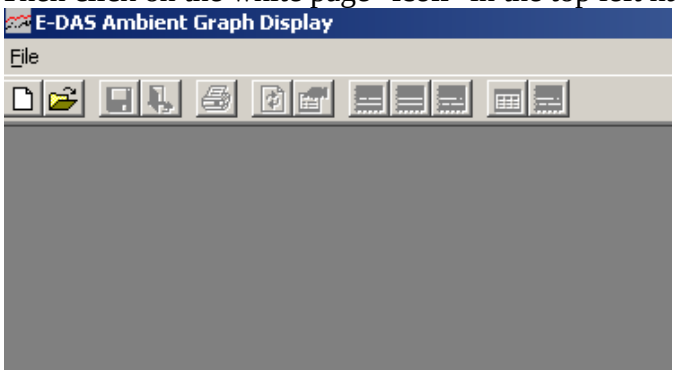
1. Site Polling - manually poll the Primary Data Logger (PDL) and Backup Data Logger (BUDL) to review data and remove flags if needed.
2. Make sure poll editor and scheduler is set to poll the correct site at the next odd hour.

Restart the scheduler by clicking on the Scheduler "**icon**".

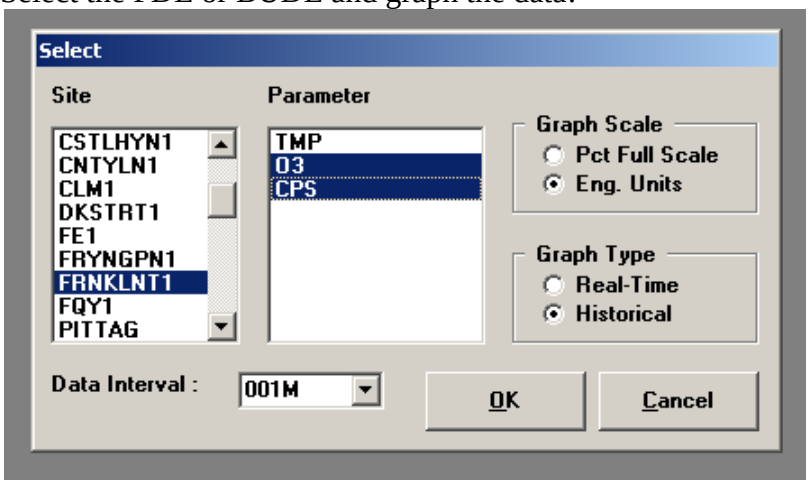
Bring the scheduler back up and verify that it's going to run at the next odd hour.

Check to make sure that the computer is collecting the data from the data logger and storing it on the computer. Check to see IF it has actually happened. Minute data only resides in the data logger for about 3 days, beyond that the minute data is overwritten and is lost FOREVER. It's real easy to see this data, just open up the graph "**icon**".

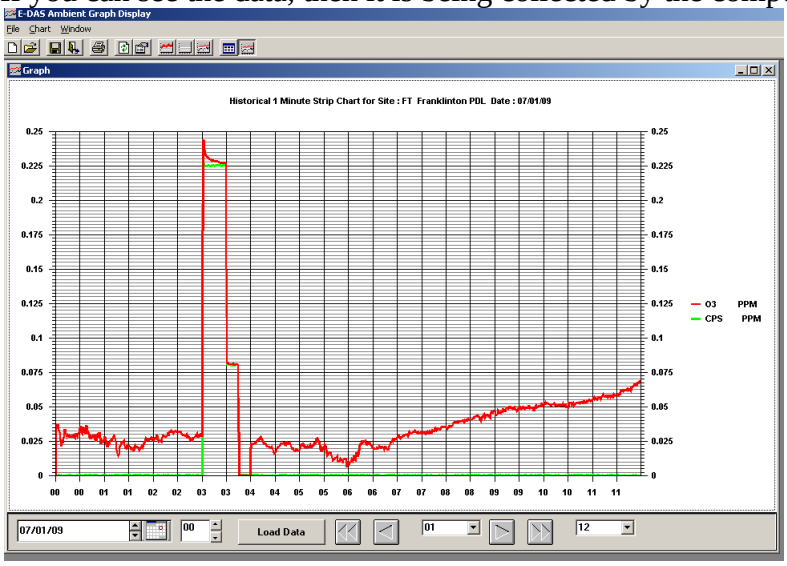
Then click on the white page "**icon**" in the top left hand corner to open the data file area.



Select the PDL or BUDL and graph the data!



If you can see the data, then it is being collected by the computer.



3. Remote Polling - check to make sure the telephone is in working order (dial tone). Call back to the ECB and request a site poll, if necessary.

4. Turn off Computer screen. **Note: DO NOT** close the ESC Digitrend Operating Software, **DO NOT** turn off the computer.

I. Temperature Controlled Monitoring Shelter

The monitor must be installed in a building where the room temperature extremes do not exceed **20°C to 30°C** (68°F to 86°F). Connect all heaters and air conditioning equipment power cords to an 115v AC, 60 Hz grounded receptacle. Check to make sure the equipment is in working order. Remove the air conditioning filter and clean if necessary. Document this activity.

2.36.1.7 Preventive Maintenance

Routine preventive maintenance procedures should be in place to prevent downtime and data loss. Management and field operators should jointly develop their preventive maintenance program. A program designed by persons unfamiliar with analyzer operations may include unnecessary items or omit mandatory ones. Several factors linked to shelter and sampling design can contribute to data loss. CO values can be low if the sample probe and lines are dirty, cracked, or leaky. FEP and PTFE sampling lines should be replaced every two years. Teflon® filters used in the sampling train to remove fine particles should be replaced at least once per month, but may need to be replaced as often as every week, depending on the condition of the filter and the particulate loading around the monitoring site.

Table 1 illustrates items that the ECB will record in their preventive maintenance monitor logbook for TEI48*i* CO monitoring.

Table 1

Item	Schedule
Inspect internal, external tubing; replace if necessary	Annually
Scrubber Efficiency Test	Annually
Replace IR source	Annually
Rebuild or replace pump	Every two years, or as needed
Clean optic bench	As needed
Replace wheel motor	As needed
Replace correlation wheel	As needed

The preventive maintenance plan also includes the task descriptions illustrated below. Record the results of the tasks in the monitor logbook.

1. Because the analyzer pneumatic system requires so much preventive maintenance, the tubing, solenoids, and pump are inspected regularly. Cracked tubing or loose fittings can cause the instrument to analyze room air rather than ambient air and lead to invalid data. A faulty pump can also cause problems with pneumatic systems. When a low flow rate or failed leak test occurs, the pump is failing and should be either repaired or replaced.

2. Check the instrument for vibration. When pumps get old, they sometimes will vibrate more than is normal. If this occurs, it can cause cracks if the tubing is touching another surface.

   Consult the analyzer operations manual for complete details on operation and maintenance.

3. **Scrubber Efficiency Test (Annual)**: The Scrubber Test screen allows the user to initiate a scrubber efficiency test, or to stop a test that is currently in progress. Typically, the efficiency test should run for at least 20 minutes. When the efficiency test is initiated, a timer is started and the efficiency test will automatically shut off. The scrubber test results allow the user to view the current CO reading, the span gas concentration, and the scrubber effectiveness, expressed as a percent efficiency.

   1. Set autozero/span check ahead four hours; on the 48*i* front panel, press "**CAL**" soft key, select "**ZERO/SPAN CHECK**" <ENTER>. Change "**Next Time**" to minimum of 4 hours in advance odd (09 or 13) hour: 46 using the ← → ↑ ↓ pushbuttons press ↵ (no real changes are made until ↵ is pressed). Example, 01:46, 05:46, 09:46, 13:46, 17:46, 21:46.
   2. On the 146C set GAS B Span 1 concentration PPM and appropriate flows to achieve 5.5 ppm.
   3. Connect Teflon line to filter holder inlet from 146C output.
   4. Place 146C in *LOCAL* mode.
   5. Start COT B span 1 on 146C and allow TEI 48*i* to equilibrate.
   6. Place 48*i* in *Service* mode.
   7. In the TEI 48*i* **Main Menu**, choose ***Service> Scrubber Test*** ↵ start
      a. Test phase: SPAN CHK (10 min)
      b. Test phase: SCRUBBER (10 min), end with % EFFICIENCY

SCRUBBER EFFICIENCY:
TEST PHASE: SCRUBBER
TEST GAS CONC: 5.498
CURRENT CONC: 0.000
% EFFICIENCY 0.0%
↵ START

When test is completed, purge 48*i* 10 minutes, set 146C to *REMOTE*, GAS B Span 1 flow and concentration to 4ppm on the 146C. Remove the 48*i* from *SERVICE* mode.

8. Re-connect the Teflon line to Span in on 48*i* from 146 output.

Acceptable efficiency for the scrubber test is 95 – 101%. Contact instrument manufacturer if efficiency test is outside these ranges. **The efficiency test is performed yearly in addition to the Accuracy Audits**. Record the results of the efficiency test on the AQ 109 form and instrument logbook.

4. **MDL,** see Section 2.36.1.11

2.36.1.8 Continuously Operating Sites

The monitor should be switched out for preventive maintenance every twelve (12) months; the calibrators will need to be switched out for recertification every nine (9) months. The cylinder will need to be switched out every 36 months or before it expires. All procedures should be documented on the AQ 109 Form.

Monitor switching:

1. Down any channels for monitors being replaced.
2. Turn off the Model 48*i* TLE power; disconnect necessary wires and tubing.
3. Connect the new TEI Model 48*i* TLE, power up, and allow it to warm up for 1 hour.
4. Perform a leak check as per Instrument Manual (version 27Apr2006), Section 5.
5. Verify and adjust, if necessary, the Model 48*i* TLE operational parameters. If system fails to achieve required operational parameters investigate causes and correct per manufacturer's recommendations.
6. Conduct operational checks for zero / span solenoid and diagnostics / alarms events.
7. Activate the Zero (Ø ppb) events on the PDL and allow the readings to stabilize on the Model 48*i* TLE analyzer.
8. From the TEI 48*i* front panel, press ***"CAL"*** > ***"CAL BACKGROUND***", allow the analyzer to sample zero air until a stable reading is obtained. In the **CO Background Screen,** press ↵ (may have to do this several times).
9. Activate the Span 1 (set dilution to 4.000 ppm) event on the PDL and allow the readings to stabilize on the Model 48*i* TLE analyzer. From the TEI 48*i* front panel, press "***CAL"*** > ***"Cal COEF***". Adjust Span 1 only using "**SPAN CONC**", enter amount (from 146C) using the

← → ↑ ↓ pushbuttons, press ↵ to save changes.

10. Activate the Span 2 (2.000 ppm) and Span 3 (0.300 ppm) points. Allow readings to stabilize for 5 minutes for each of the verification points.
11. Leave channels down for calibration.
12. Ensure that the scheduler has been engaged before leaving the site (Section 2.36.1.6 F.2).
13. MDL (Section 2.36.1.11) will be performed within 30 days of part/monitor change.
14. Document actions on the AQ 109 Form.

Calibrator switching:

1. Down any channels for calibrator being replaced.
2. Shut off the cylinder valve and the outlet valve on the regulator.
3. Turn off the 146C calibrator power, disconnect necessary wires and tubing.
4. Connect the new 146C calibrator, power up, and allow to warm up for 1 hour.
5. Purge cylinder regulators and attached lines (verify pressure is 30 psi).
6. Verify and adjust, if necessary, the Model 48*i* TLE operational parameters. If system fails to achieve required operational parameters investigate causes and correct per manufacturer's recommendations.
7. Conduct operational checks for zero / span solenoid and diagnostics / alarms events.
8. Activate the Zero (Ø ppb) events on the PDL and allow the readings to stabilize on the Model 48*i* TLE analyzer.
9. From the TEI 48*i* front panel, press "**CAL**" > "**CAL BACKGROUND**", allow the analyzer to sample zero air until a stable reading is obtained. In the CO Background screen press ↵ (may have to do this several times).
10. Activate the Span 1 (set dilution to 4.000 ppm) event on the PDL and allow the readings to stabilize on the Model 48*i* TLE analyzer. From the TEI 48*i* front panel, press "**CAL**" > "**Cal COEF**". Adjust Span 1 only using "**SPAN CONC**", enter amount (from 146C) using the ← → ↑ ↓ pushbuttons, press ↵ to save changes.
11. Activate the Span 2 (set dilution to 2.000 ppm) and Span 3 (set dilution to 0.300 ppm) points. Allow readings to stabilize for 5 minutes for each of the points.
12. Leave channels down for calibration.
13. Ensure that the poll editor and scheduler has been engaged before leaving the site (Section 2.36.1.6 F.2).
14. MDL (Section 2.36.1.11) will be performed within 30 days of part/monitor change.
15. Document actions on the 109 Form.

Cylinder switching:

1. Down any channels for cylinder being replaced.
2. Shut off the cylinder valve and the outlet valve on the regulator, remove regulator from the cylinder and the cylinder from the cylinder rack.
3. Place new cylinder in cylinder rack and install the regulator on the cylinder.
4. Purge cylinder regulators and attached lines (adjust pressure to 30 psi).
5. Verify and adjust, if necessary, 146C to match the new cylinder concentration and the Model

48*i* TLE operational parameters. If system fails to achieve required operational parameters investigate causes and correct per manufacturer's recommendations.

6. Conduct operational checks for zero / span solenoid and diagnostics / alarms events.
7. Activate the Zero (Ø ppb) events on the PDL and allow the readings to stabilize on the Model 48*i* TLE analyzer.
8. From the TEI 48*i* front panel, press "**CAL**" > "**CAL BACKGROUND**", allow the analyzer to sample zero air until a stable reading is obtained. In the CO Background screen press ↵ (may have to do this several times).
9. Activate the Span 1 (set dilution to 4.000 ppm) event on the PDL and allow the readings to stabilize on the Model 48*i* TLE analyzer. From the TEI 48*i* front panel, press "**CAL**" > "**Cal COEF**". Adjust Span 1 only using "**SPAN CONC**", enter amount (from 146C) using the ← → ↑ ↓ pushbuttons, press ↵ to save changes.
10. Activate the Span 2 (set dilution to 2.000 ppm) and Span 3 (set dilution to 0.300 ppm) points. Allow readings to stabilize for 5 minutes for each of the points.
11. Up channels.
12. Ensure that the scheduler has been engaged before leaving the site (Section 2.36.1.6 F.2).
13. Document actions on the 109 Form.

2.36.1.9 Site Visits

Whenever the ECB technicians visit a site, they will:

1. Document the time and reason for the visit in the site logbook.
2. Check that the site building temperature is between 20º C and 30º C.
3. Check air conditioner, heater and lines for adequate/proper function.
4. Check that the probe and sample line are connected and secure.
5. Check that the funnel is clean, in place and not damaged. If so replace.
6. Check that the building is secure. Vandalism is reported to the ECB Supervisor.
7. Check that all monitoring systems are operating within normal ranges (unless the reason for the visit is site start-up).
8. Down any channels for monitors being repaired, replaced, or audited during the repair, replacement, or audit.
9. Up any channels after monitors are repaired, replaced, or audited.
10. Ensure that the poll editor and scheduler has been engaged before leaving the site (Section 2.36.1.6 F.2).

2.36.1.10 Accuracy Audits and Reporting

Gaseous Monitor Audits

Accuracy audits for continuous gaseous monitors are performed and reported to the Section Chief by ECB staff using an AQ 121 form. 40 CFR 58 Appendix A requires at least one quarter of the monitors running in a network to be audited each quarter and every monitor to be audited at least once each year.

a. For the continuous CO trace level monitors, the ECB must not perform checks or audits between 6:00 AM and 9:00AM "Local Standard Time". The cylinders and calibrators used for

auditing must be a different one than the calibrator and cylinder used for calibration and one point quality control checks. The 146C "audit calibrator" must be certified one and one half quarters (18 weeks, not to exceed 126 days between consecutive certifications) and the "field calibrator" certifications are good for 9 months. The auditor must not be the same operator as the one who conducts the routine monitoring, calibrations, and analysis. The audit is conducted before making any monitor or data logger adjustments. The monitor must operate in its normal sampling mode, and the audit gas must pass through the existing particulate filter.

b. Disable channels on data loggers if channels are up. While disabled, values are collected but flagged as invalid data.

Disable channels:

- **{ESC}** to Home Menu on PDL
- Select: "**C**" Configuration Menu
- Select: "**D**" Configure Data Channels
- Select: "**M**" "Disable/Mark Channel Offline"
- Use arrow key to select pollutant, <ENTER>
- Highlight "**COT**" then press, <ENTER>
- From Home Menu repeat steps on BUDL

Change Zero/Span Check time (The Zero/Span Check menu is used to program the instrument to perform fully automated zero adjustments.) "**Next Time**", change starting time to minimum of 4 hours in advance odd hour (11 or 15): 46 using the ← → ↑ ↓ pushbuttons press ↵ (no real changes are made until ↵ is pressed).

ECB activates the certified audit calibrator using: "**ZERO**" (± .035 ppm), "**Span 1**" (3.900 ppm), "**Span 2**" (0.750 ppm), and "**Span 3**" (0.100 ppm) calibration points and completes the AQ 121 and AQ 109 report form, reviews the report and forwards the information to the Section Chief of Ambient Monitoring ***within 5 workdays*** of conducting the audit.

When the audit values are more than ± 10 %, call the ECB Supervisor and inform the Section Chief of the situation and print out a copy of the last auto calibration checks. The ECB Supervisor will investigate suspicious audits to determine if there is a problem and if so, where the problem is and how to solve the problem. If the problem is with the ECB equipment, the ECB supervisor generally fixes the audit equipment and repeats the audit. If the problem is with the site equipment, the ECB supervisor takes appropriate action to either repair or replace the site equipment. If the problem is a major site operation problem, the ECB supervisor informs the site operator, the Regional Chemist and the Projects and Procedures Supervisor.

Record "COBKG" on AQ 121 form (**Auditor Remarks**) line:

- From the 48*i* front panel, press "**CAL**" soft key, select "**CAL BACKGROUND**" <ENTER>. **Note: when "COBKG" reaches 7 ppm, refer to page 11 to reset "COBKG" to zero**.

c. Enable the channels**:** Go to the Home Menu (by pressing **{ESC}** several times if

needed), Press "**L**" and **<**ENTER**>** the code when it asks for the password and press <ENTER>.

Enable channels:

- {ESC} to Home Menu on PDL
- Select: "C" Configuration Menu
- Select: "D" Configure Data Channels
- Select: "E" "Enable/Mark Channel Online"
- Use arrow key to select pollutant, <ENTER>
- Highlight "COT" then press, <ENTER>
- Repeat steps on BUDL

Model 111 Zero Air Audits

Audits for the Model 111 Zero Air Pak (QA/SOP 2.3.5) is performed semi-annually and reported to Headquarters' by ECB staff using an AQ 121C form.

2.36.1.11 TEI Model 48*i* Method Detection Limit (MDL)

Method Detection Limit

The method detection limit (MDL) refers to the lowest concentration of a substance that can be reliably determined by a given procedure. The MDL will be done after the following situations:

1. Procurement
2. Within 30 days after site monitor installation
3. Major part/component replacement of the 48*i*
4. Annual monitor audit

The MDL should be established by supplying the analyzer with a test atmosphere containing CO at a concentration that is approximately two and one half (2.5) to five (5) times greater than the estimated noise. The MDL will consist of collecting at least 20 60-second averages spaced at 12 hour intervals over a 5 day period to provide a minimum of ten (10) repetitions over a minimum of a 5 day period. The response should be 0.080 ppm (80 ppb) or lower over an averaging time of no more than 5 minutes.

To perform the MDL test;

1. Ensure that the scheduler has been edited to not interfere with monitor/calibrator during the MDL study (Section 2.36.1.6 F.2).
2. Check and record previous nightly zero auto-calibration in the MDL e-log.
3. Allow 48*i* to finish auto zero before starting.
4. Run zero air through the monitor and establish an acceptable zero.
5. Dilute pollutant gas to the targeted concentration (one to five times the estimated noise per instrument manual) and collect 30 one-minute observations. Repeat this two times per 24-hour period over the course of 5 to 14 days. Average the concentration from the 30 readings and enter them into the MDL e-log. Calculate the standard deviation (S) of the average

readings and compute the MDL. The MDL is then calculated as the standard deviation of the response values times the Student's t-value for the number of test measurements (40 CFR Part 136, Appendix B). The results (raw data and spreadsheets) from the MDL study will be retained with the instrument logbook/file. The results for MDL studies conducted after the monitor is installed at the site will also be reported to the DMSSB for entry into the Air Quality System.

6. Ensure that the scheduler has been engaged for normal operation after the MDL study is completed (Section 2.36.1.6 F.2).

Sign-Off Sheet

I certify that I have read, understand and agree to follow the contents of Revision 10.2 of the "MODEL 48*i* TRACE LEVEL CARBON MONOXIDE (TL-CO) MONITORING SYSTEM, Section I, ELECTRONIC CALIBRATION BRANCH (ECB) RESPONSIBILITIES" QAP/SOP with an effective date of October 12, 2011. **Sign, date and return to the Ambient Monitoring Section Chief.**

ECB Technician: Mark Yuke

ECB Technician: Jody Root 11-7-11

ECB Technician: [signature] 11-7-11

ECB Technician: