

**Thermo Environmental 48C Carbon Monoxide QA Plan  
Section I**

**Electronic Calibration Branch Responsibilities**

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## **2.9.1 SAMPLE EQUIPMENT**

### **2.9.1.1 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 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.

### **2.9.1.2 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 48C Carbon Monoxide Monitor
2. Thermo Environmental (TEI) Model 146C Gas Calibrator (see Section 2.3.4.1)
3. Teflon Sampling Line
  
4. Model 1001 Zero Air Supply

5. Computer/ESC 8816 Data Logger/Modem System
6. Nighthawk CO Alarm
7. Temperature Controlled Monitoring Shelter

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 possible in accordance with accepted and approved procedures.

### **2.9.1.3 Receipt, Testing and Inventory**

The ECB shall conduct operational tests after receipt and unpacking of each instrument. Following the new factory manual setup procedures and Section 2.9.1.4 and operators 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 or discovered.

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 unit supervisor.

### **2.9.1.4 TEI Model 48C Certification (Pre-Site Installation Checks)**

The alarm limits allowed in the TEI 48C Analyzer MAIN MENU, diagnostics:

<b><u>Parameter</u></b>	<b><u>Min.</u></b>	<b><u>Max.</u></b>
Supply Voltages	± 0.5v	
Alarm Bias	-100v	-130v
Battery	2.0v	3.5v
Internal Temperature	8° C	47° C
Chamber Temperature	40° C	52° C
Pressure	250-mmHg	1000-mmHg
Flow	.350 LPM	1.50 LPM
Sample/Reference Ratio	1.14	1.18 (when zero air is being sampled)
Automatic Gain Control (AGC) Int	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.

The ECB is responsible for setting the operational parameters of each TEI 48C 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 48C. The results of the evaluation, findings, and all adjustments are entered into the carbon monoxide standard specific logbook, dated, and initialed.

- Perform any scheduled approved preventative maintenance procedures and or system enhancements.
- Check Background PPM every two years. If Background PPM > 4.0 ppm adjust S/R ratio. With zero air established go to **Service** mode, choose **S/R Ratio**, adjust **INIT ZERO** value to **CURRENT** value, press **ENTER** to save changes.
- Visually inspect both cells for contamination and clean if necessary. If cells are dirty investigate causes of contamination and correct per manufacturer's recommendations.
- Connect the TEI Model 48C, power up, and allow warming up for 1 hour.
- Perform a leak test. If the leak test fails investigate causes and correct per manufacturer's recommendations.
- Verify and adjust Analog to Digital (A-D) Zero on the Model 48C operational parameters to the dataloggers. 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 48C 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, B), 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 48C analyzer.
- Activate Span 1 (set dilution to 42 ppm) event on the PDL and allow the readings to stabilize on the Model 48C analyzer.
- Activate Span 2 (set dilution to 18 ppm) event on the PDL and the low-level precision point, Span 3 (set dilution to 9 ppm). Allow readings to stabilize for 5 minutes for each of the verification points.
- If system fails to achieve required operational parameters investigate causes and correct per manufacturer's recommendations.

#### **2.9.1.5 CALIBRATION STANDARDS AND SYSTEM**

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 audits) performance of the carbon monoxide monitors at each site.

The 48C analyzer is calibrated using a TEI 146C Calibrator, which must have flows certified by ECB and traceable to a primary standard.

- 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. 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 in the Ambient Monitoring Unit files.

- 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.

#### **2.9.1.6 Site Monitor Operation / Verification (Site Installation)**

After the regional office has obtained permission to use a site from the site owner, and after the site has been approved by DAQ Ambient Monitoring Project and Procedures Supervisor, 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.

The ECB is responsible for the installation all State operated ambient air carbon monoxide monitoring sites across the state each year. The sites are required to be setup prior to the October 1 start date of the EPA approved carbon monoxide monitoring season. The season ends March 31<sup>st</sup>.

The installation of the carbon monoxide monitoring sites includes the Certified Primary Gas cylinder Standard, the Model 48C Carbon Monoxide Monitor, the Model 146C Gas Calibrator, the Zero Air Supply, the Pretreated Teflon Sampling Line, and the computer, data logger, and modem system.

The monitoring site installation also may include additional items such as the air conditioning unit 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.

#### **A. Equipment Specifications**

The alarm limits allowed in the TEI 48C Analyzer MAIN MENU, diagnostics:

<b><u>Parameter</u></b>	<b><u>Min.</u></b>	<b><u>Max.</u></b>
Supply Voltages	± 0.5v	
Alarm Bias	-100v	-130v
Battery	2.0v	3.5v
Internal Temperature	8° C	47° C
Chamber Temperature	40° C	52° C
Pressure	250-mmHg	1000-mmHg
Flow	.350 LPM	1.50 LPM
Sample/Reference Ratio	1.14	1.18 (when zero air is being sampled)
Automatic Gain Control (AGC) Int	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.

The ECB is responsible for setting the operational parameters of each TEI 48C 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.**

Install the monitor, calibrator, computer, data loggers, and modem at the site by placing the units on a stable, level surface.

- Check the building for problems (leaks, infestations, etc.).
- Connect the zero air supply, CO concentration standard, the Model 146C calibrator and the Model 48C analyzer. In order to satisfy all EPA requirements for precision and level 1 span checks (see 40 CFR 58, Appendix A, B), it is recommended that the filter be installed between the sample–span solenoid and the optical bench and allow warming up for 1 hour.
- Perform leak check(s)
  - a) **Sample Route thru Solenoid:** In order to test for the presence of external leaks around the fittings, plug the "**Probe**" inlet fitting with a cap. From the 48C **MAIN MENU** select **Diagnostics, Pressure** to check pressure. Pressure in millimeters Hg will be displayed. This should be approximately ambient pressure. The flow on the Model 48C should gradually decrease to zero if no leak is present. The pressure on the LED (Light Emitting Diode) display should drop to below 250 mmHg. If the pump diaphragm is in good condition and the capillary is not blocked, it should take less than 90 seconds from the time the inlet is plugged to the time the reading below 250 mmHg is obtained. If this takes longer than 90 seconds, check the integrity of the pump diaphragm and check for blocking of the capillary. If no leak is found, remove cap on probe inlet fitting.
  - b) **Cal/Span Gas Route thru Solenoid:** Activate solenoid by logging in using the datalogger and activating a zero. From the 48C **MAIN MENU** select **Diagnostics, Pressure** to check pressure. Pressure in millimeters Hg will be displayed. This should be approximately ambient pressure. Plug the "**Span**" gas inlet fitting with a cap. The flow on the Model 48C should gradually decrease to zero if no leak is present. The pressure on the LED (Light Emitting Diode) display should drop to below 250 mmHg. If the pump diaphragm is in good condition and the capillary is not blocked, it should take less than 90 seconds from the time the inlet is plugged to the time the reading below 250 mmHg is obtained. If this takes longer than 90 seconds, check the integrity of the pump diaphragm and check for blocking of the capillary. If no leak is found, remove cap on span inlet fitting.
- Conduct operational checks for solenoids and events.
- Bleed cylinder regulators and attached lines to purge out any residual air; crack gas line, open the main cylinder valve all the way counter-clockwise, set the regulator pressure at 35 psi, close the main cylinder valve all the way, fully open the needle valve. Repeat several times. Reconnect gas line.
  
- Adjust and verify the Analog to Digital (A-D) Zero on the Model 48C operational parameters to the dataloggers. If system fails to achieve required operational parameters investigate causes and correct per manufacturer's recommendations.
- Activate the Zero (Ø ppm) events on the Primary Data Logger (PDL) and allow the readings

to stabilize on the Model 48C analyzer.

- Activate Span 1 (set dilution to 42 ppm) event on the PDL and allow the readings to stabilize on the Model 48C analyzer.
- Activate Span 2 (set dilution to 18 ppm) event on the PDL and the low-level precision point, Span 3 (set dilution to 9 ppm). Allow readings to stabilize for 5 minutes for each of the verification points.
- 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**

The Model 48C Carbon Monoxide Monitor, the Model 146C Gas Calibrator, the Model 1001 Zero Air Supply, dataloggers and computer identification numbers will be documented / logged on the 109 Form.

### **D. Teflon Sampling Line**

The Teflon sampling line is a 3/8" OD 1/4" ID virgin continuous piece of sample tubing that runs from the back of the particulate filter holder on the TEI 48C 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 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. The probe and funnel will be changed every 2 years at site set-up. When the sampling line is replaced, do a leak test. Sample lines should be capped when not in use.

### **E. Zero Air Supply**

The Model 1001 Zero Air Supply provides dried scrubbed pollutant – free ambient air for zeroing and diluent to the calibrator. The ambient air first passes through two silica gel cartridges to remove moisture and pollutants. The Zero Air Supply provides dried scrubbed ambient air to the calibrator. Replacing the silica gel is the responsibility of the regional technicians for the site.

### **F. Computer Data Logger System and Modem**

- a. Site Polling - manually poll the PDL and Backup Data Logger (BUDL) to review data and remove flags if needed.
- b. Make sure poll editor and scheduler is set to poll the correct site at the next odd hour.
- c. Remote Polling - check to make sure the telephone is in working order (dial tone). Call back to the ECB shop and request a site poll, if necessary.
- d. Turn off Computer screen. **Note: DO NOT** close the ESC Digitrend Operating Software, **DO NOT** turn off the computer.

## **G. 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) with a two (2) degree of variance. 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.

### **2.9.1.7 Routine Maintenance**

#### **TEI 48C Analyzer**

Periodic maintenance procedures should be performed when necessary to ensure proper operation of the 48C. Maintenance includes preventive, routine, and corrective tasks. ECB is expected to be entirely responsible for the corrective maintenance issues and to assist with preventative and routine maintenance that may fall outside the regions' comfort levels or capabilities.

Step-by-step procedures for all maintenance activities should be followed as presented by the manufacturer in the instrument's operation manual (Chapter 5, "Preventive Maintenance" and Chapter 7, "Servicing", 5/24/2004 version). Always down / disable the PDL and BUDL data channels.

Items requiring maintenance by ECB are:

- Cleaning the optics (checked on a regular calendar basis and replaced if necessary)
- IR source replacement (checked on a regular calendar basis and replaced if necessary)
- Replacing the printed circuit boards (performed when operational problem is traced to a particular component)
- Leak Checks (performed after filter changes or when sample flow drops below 0.35 lpm as determined during bi-weekly QC checks)

#### **TEI 146C Calibrator**

Periodic maintenance and/or adjustment for the Model 146C is required to ensure proper operation. Refer to the "146C Calibrator" QA Section/Operation guidelines for details and the instrument manual (Chapter 4, "Preventive Maintenance" and Chapter 7, "Servicing", 11/20/98 version). Except for mass flow controller re-certification, which occurs every 9 months, the following maintenance activities are performed only when the calibrator malfunctions as determined by the site operator. Items requiring ECB maintenance are:

- Leak Checking
  - Solenoid Replacement
  - Circuit Board Replacement
  - Mass Flow Controller Replacement
  - Replacement of DVM
- 
- Internal Adjustments
  - Certification of Mass Flow Controllers (see section 2.3.3.5 of 146C Calibrator QA Manual)

### **Zero Air Pack and Compressor Checks**

Periodic maintenance and/or adjustment for the Zero Air Pack is required to ensure proper operation. The ECB shall re-certify the zero air system once per year by:

- Replacing the silica gel with re-generated material (dark blue or purple color).
- Verifying that the pressure gauge on the Zero Air Supply is reading 20 psi  $\pm$  2 psi.
- Verifying that the outlet pressure on the air compressor is reading between 30 and 40 psi. (If pressures are outside of the specifications, check and tighten all fitting and/or rebuild the compressor by replacing the pump diaphragms.)
- Draining any water from the compressor.

**After conducting any maintenance** up the PDL and BUDL channels (enable/mark channels online), document the work done in the site logbook (and instrument logbook if appropriate), and flag the data.

#### **2.9.1.8 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 20° C and 30° C.
3. Check that the probe and sample line are connected and secure.
4. Check that the funnel is clean, in place and not damaged. If so replace.
5. Check that the building is secure. Vandalism is reported to the ECB Supervisor.
6. Check that all monitoring systems are operating within normal ranges (unless the reason for the visit is site start-up).
7. Down any channels for monitors being repaired, replaced, or audited during the repair, replacement, or audit.
8. Up any channels after monitors are repaired, replaced, or audited during the repair, replacement, or audit.
9. Ensure that the scheduler has been engaged before leaving the site.

#### **2.9.1.9 Accuracy Audits and Reporting**

Accuracy audits for continuous gaseous monitors are performed and reported to Headquarters' 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 monitors CO, the ECB must not perform checks or audits between 6:00 AM and 9:00AM "Local Standard Time". The calibrators used for auditing must be different than the calibrator used for calibration and spanning. The audit calibrator must be calibrated quarterly (not to exceed 92 days between consecutive calibrations).

The auditor must not be the same operator 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. ECB activates the audit calibrator using: "**ZERO**" ppm, "**Level 1**" (1.5 - 4 ppm), "**Level 2**" (5 - 15 ppm) and "**Level 3**" (20 - 50 ppm) audit 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 15 workdays* of conducting the audit.

c. When the audit values are more than  $\pm 10\%$  ppm, call the ECB Supervisor and inform him 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.