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

Electronic Calibration Branch Responsibilities

Standard Operating Procedure Approval

I certify that I have read and approve of the contents of this revision of 2.36.1 with an effective date of April 21, 2016.

Raleigh Central Office Trace Level Carbon Monoxide Lead
Carlton Blakley, Environmental Chemist

Signature: Carlton Blakley Date: April 21, 2016

Electronic and Calibration Branch Lead
Mark Yirka, Electronics Tech III

Signature: Mark Yirka Date: April 28, 2016

Projects and Procedures Branch Supervisor
Joette Steger, Environmental Supervisor

Signature: Joette Steger Date: May 4, 2016

Ambient Monitoring Section Chief
Donnie Redmond, Ambient Monitoring Section Chief

Signature: Date: 5/4/16

U.S. Environmental Protection Agency
Laura Ackerman, Region 4 SESD

Signature: _____ Date: _____

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 10.6.

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

2) Revised EPA audit points.

3) Calibration criteria edited.

4) BUDL and Scheduler procedure removed.

5) Audit Level 2 changed to 0.190 ppm (audit criteria: ± 0.030 ppm difference or ± 15 percent difference, whichever is greater).

6) Audit criteria for Levels 3-10 changed to 15%.

7) Teledyne 701 Zero Air Generator references added, TEI Model 111 Zero Air Generator references removed.

8) T700U calibrator references added.

9) EDAS language removed and AV-Trend language added.

10) SPAN0 calibration procedure added.

11) 48*i* audit frequency and level changes to reflect use Annual Performance Evaluation as described in 40 CFR Part 58 Appendix A Section 3.1.2 for all sites.

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 (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. Certified Primary CO Gas Cylinder Standard
3. Thermo Environmental (TEI) Model 146C (QA/SOP 2.3.4)
4. Teledyne-API T700U Dynamic Gas Calibrator (QA/SOP 2.3.7)
5. Teledyne-API 701 Zero Air Pak (QA/SOP 2.3.5)
6. Computer/ESC 8832 Data Logger/Wireless Modem System/Ethernet
7. Temperature Controlled Monitoring Shelter
8. 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 (5Oct2011, 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)

Model 48*i* TL-CO Monitor testing: The Model 48*i* TLE monitor should be tested thoroughly before deployment at the monitoring site. This testing will involve among other things:

- Pre-calibration electronic adjustment
  1) Data logger analog output adjustment
  2) Setting initial calibration factors, pre-amp board cal, and Sample/Reference (S/R) ratio
- TL-CO operational zero/span test calibration and test calibration check
  1) Operational test calibration Zero/span (all sites)
     a. Zero calibration 0 ppb
     b. SPAN1 – 4000 ppb
     c. SPAN2 – 2000 ppb
     d. SPAN3 – 250 ppb (check SPAN3 – 300 ppb)
  2) Operational test calibration check Zero/span (all sites)
     a. Zero calibration check 0 ppb
     b. SPAN1 – 4000 ppb
     c. SPAN2 – 2000 ppb
     d. SPAN3 – 300 ppb

The procedural details of each of the above are given in the manufacturer's manual "Model 48*i*-Trace Level-Enhanced Instruction Manual, Gas Filter Correlation CO Analyzer, by Thermo Electron Corporation, 5 October, 2011". Further, the ECB staff is expected to follow and fulfill all steps before the monitor is installed at the monitoring site.

Point*	**Calibration Tolerance**	**Concentration**
Span (90%)	± 4%	± 160 ppb
Mid (50%)	± 5%	± 100 ppb
Precision (18%)	± 5%	± 15 ppb
Zero (O)	± 35 ppb	± 35 ppb

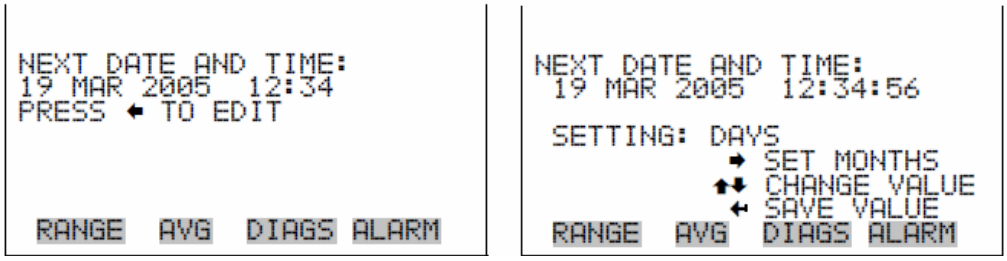
Point*	**Calibration Check Tolerance**	**Concentration**
Span (90%)	± 8%	± 320 ppb
Mid (50%)	± 8%	± 160 ppb
Precision (18%)	± 8%	± 24 ppb
Zero (O)	± 35 ppb	± 35 ppb

---

*Nominal or designated value of each point

Change **Zero/Span Check** time (the Zero/Span Check menu is used to program the instrument to perform fully automated zero adjustments).

- From the 48*i* main menu, move the menu cursor ">" down and select "**CALIBRATION**" <ENTER>, select "**ZERO/SPAN CHECK**" <ENTER>, select "**NEXT TIME**" <ENTER>

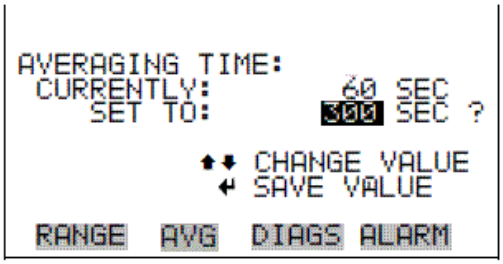


48*i* Next Date/Time Screen

- change time to minimum of 4 hours in advance hour (09, 13, or 17): 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. Press menu button ■ three times to return to main menu.

Change Averaging Times

- From the 48*i* main menu, select "**Averaging Time**" <ENTER>, set to "**300**" using the ↑ ↓ pushbuttons. Press "**SAVE VALUE**" ↵ button (no real changes are made until ↵ is pressed).

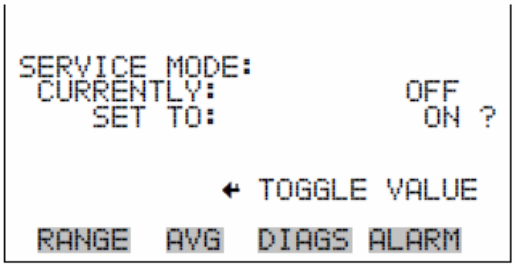


48*i* Averaging Time Screen

- Press the menu button ■ once to return to the main menu.

Edit Service Mode

- From the 48*i* main menu, select **Instrument Controls** > **Service Mode** > **ON**, press ↵ (no real changes are made until ↵ is pressed).

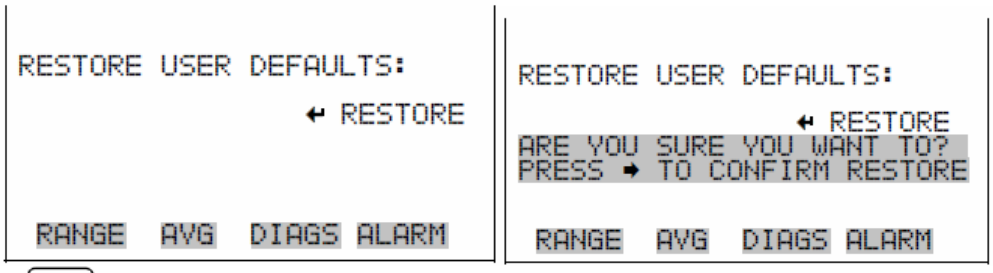


Press menu button ▪ twice to go back to main menu.

Restore User Faults

For SPAN0 calibration, reset the calibration configuration values to the factory defaults:

- From the 48*i* main menu select **Calibration Factors** > **Reset User Cal Defaults**, press **Restore** ↵ button, press right arrow → button to confirm restore



press menu ▪ button twice to return to the main menu

Link to Logger

To begin a direct **Link to Logger** session, log into the AV-Trend system and use the following procedure:

- Click on the AV-Trend icon, enter the username followed by the password, hit "**OK**"
- Select: "**Utilities**"
- Select: "**Link to Logger**"
- From the drop down menu select a site
- Select: "**Connect**"
- Select: "**L**", at LOGIN menu, enter password

Calibrate SPAN0

- Press{**ESC**}{**ESC**} to return to the Home Menu
- Select: "**C**", Configuration Menu
- Select: "**C**", Configure Calibration
- Select: "**1**", Start a Single Phase Calibration, <ENTER>
- Select: "**COTCAL**", <ENTER>
- Select: "**SPAN0**", <ENTER>
- Scroll down and highlight "**Phase Duration**", set to ≥ 2 hour, <ENTER>
- Scroll down and select: "**Start Single Cal** (**NOW**)", <ENTER>

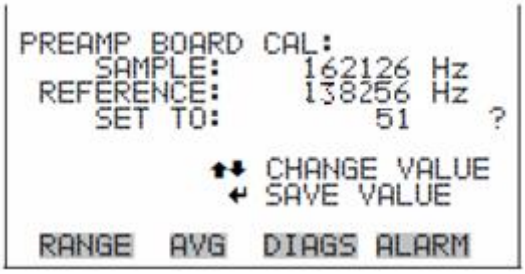
Monitor Actual values

- Press **{ESC} {ESC}** to return to the Home Menu
- Select: "**D**", Real Time Display
- Select: "**C**", Continuous Average Report
- Select: "**Show Channels**", <ENTER>
- Type in parameters: "**COT**", <ENTER>
- Change # of flags to report from "**02**" to "**03**", <ENTER> (the "**<**", "**D**", and "**C**" flags will show)
- Use decimal Positioner?: "**Y**", <ENTER>

- Start continuous report: <ENTER> (this will show the minute averages as they are calculated and keeps all values on screen).

Reset Pre Amp Board Cal

Note: SPAN0 should be running and stable for this adjustment.
From the 48*i* main menu, select **Service > Preamp Board Cal**

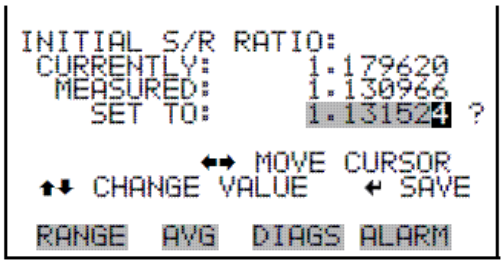


48*i* Preamp Board Cal Screen

SAMPLE: 162126 Hz (-12126) = 150000
REFERENCE: 138256 Hz (+11744) = 150000
SET TO: 51
↑↓ CHANGE VALUE

In this example, at the Preamp Board Cal screen, use ↑↓ until the (Sample + Reference)/2 average value reads as close to 150,000 then press ↵ to save changes (may have to do this several times). Press menu button ■ once to return to the SERVICE menu.

From the 48*i* Service menu, select **Initial S/R Ratio** (SPAN0 must be running ~ 60 minutes)



48*i* Initial S/R Screen

the "**MEASURED**" reading is *entered* into "**SET TO**" reading (adjusts "**CURRENTLY**" reading), **Note:** CO conc = approximately 0 when S/R is correctly adjusted, when finished press menu button ■ once to return to the SERVICE menu.

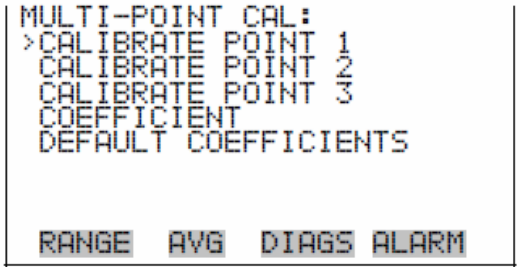
Abort SPAN Zero

- Select: "**C**" Configure Calibration
- Select: "**C**", Configuration Menu
- Select: "**W**", Abort Calibration
- With down arrow ↓ key, select: "**COTCAL**", <ENTER>

Multi-Point Calibration

The 146C/T700U will be used to calibrate POINT 1, POINT 2, and POINT 3. During this time, the span levels required for the calibration will be controlled via the 146C/T700U. **Note:** This procedure should not be performed during the last half of the hour (i.e. after XX:30) in order to prevent interruption in data recovery.

From the 48*i* SERVICE menu, select "**MULTIPOINT CAL**", select "**CALIBRATE POINT 1**" <ENTER>



48i Multi-Point Cal Screen

SPAN1 (CALIBRATE POINT 1)

- Press{**ESC**}{**ESC**} to return to the Home Menu
- Select: "**C**", Configuration Menu
- Select: "**C**", Configure Calibration
- Select: "**1**", Start a Single Phase Calibration, <ENTER>
- Select: "**COTCAL**", <ENTER>
- Select: "**SPAN1**", <ENTER>
- Scroll down and highlight "**Phase Duration**", set to ≥ 1 hour, <ENTER>
- Scroll down and select: "**Start Single Cal** (**NOW**)", <ENTER>

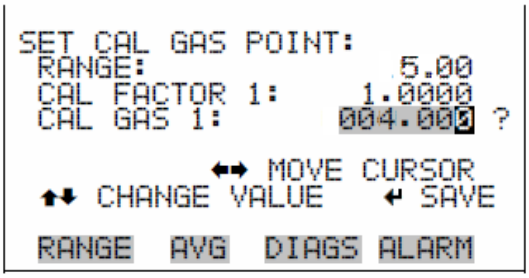
Monitor Actual values

- Press **{ESC} {ESC}** to return to the Home Menu
- Select: "**D**", Real Time Display
- Select: "**C**", Continuous Average Report
- Select: "**Show Channels**", <ENTER>
- Type in parameters: "**COT**", <ENTER>
- Change # of flags to report from "**02**" to "**03**", <ENTER> (the "**<**", "**D**", and "**C**" flags will show)
- Use decimal Positioner?: "**Y**", <ENTER>
- Start continuous report: <ENTER> (this will show the minute averages as they are calculated and keeps all values on screen).

Note: Multiply PPM by 1000 to convert to PPB (data logger reading), ex. CAL GAS 1 (4.00 ppm = 4000 ppb).

Note: When span point has stabilized (~25 min):

- From the SET CAL GAS POINT 1 screen, enter **CAL GAS 1** concentration (**4.000 ppm**, 3 significant CA figures) from 146C/T700U using ← → ↑ ↓ pushbuttons, press ↵ (no real changes are made until ↵ is pressed)



CAL GAS 1 Screen

Abort SPAN1 Calibration

- Select: "**C**" Configure Calibration
- Select: "**C**", Configuration Menu
- Select: "**W**", Abort Calibration
- With down arrow ↓ key, select: "**COTCAL**", <ENTER>

SPAN2 (CALIBRATE POINT 2)
Repeat procedure to calibrate POINT 2 (CAL GAS 2, **2.000 ppm** (3 significant CA figures from 146C/T700U)),

SPAN4 (CALIBRATE POINT 3)
Repeat procedure to calibrate POINT 3 (CAL GAS 3, **0.250 ppm** (3 significant CA figures from 146C/T700U)),

- Press{**ESC**}{**ESC**} to return to the Home Menu
- Select: "**C**", Configuration Menu
- Select: "**C**", Configure Calibration
- Select: "**1**", Start a Single Phase Calibration, <ENTER>
- Select: "**COTCAL**", <ENTER>
- Select: "**SPAN4**", <ENTER>
- Scroll down and highlight "**Phase Duration**", set to ≥ 1 hour, <ENTER>
- Scroll down and select: "**Start Single Cal** (**NOW**)", <ENTER>

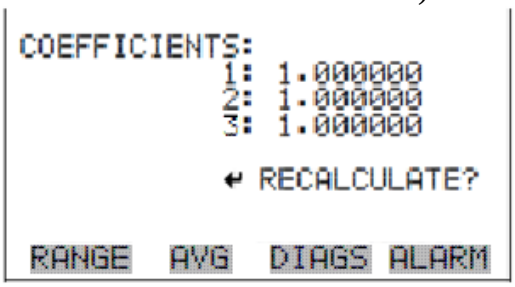
Monitor Actual values

- Press{**ESC**}{**ESC**} to return to the Home Menu
- Select: "**D**", Real Time Display
- Select: "**C**", Continuous Average Report
- Select: "**Show Channels**", <ENTER>
- Type in parameters: "**COT**", <ENTER>
- Change # of flags to report from "**02**" to "**03**", <ENTER> (the "**<**", "**D**", and "**C**" flags will show)
- Use decimal Positioner?: "**Y**", <ENTER>
- Start continuous report: <ENTER> (this will show the minute averages as they are calculated and keeps all values on screen).

Abort SPAN4 Calibration

- Select: "**C**", Configuration Menu
- Select: "**C**", Configure Calibrations
- Select: "**W**", Abort Calibration
- With down arrow ↓ key, select: "**COTCAL**", <ENTER>

From the **Multi-point Cal** screen > select "**COEFFICIENTS**" <ENTER>, press ↵ "**RECALCULATE?**" (to recalculate calibration coefficients).

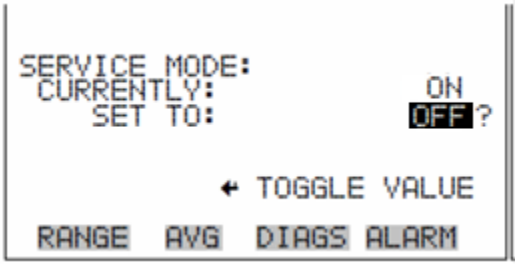


48*i* Calibration Screen

press menu button ▪ three times to return to the main menu

Place 48*i* back in "**Sample Mode**"

- From the 48*i* main menu, select **Instrument Controls** > **Service Mode** > **OFF**, press ↵ (no real changes are made until ↵ is pressed).

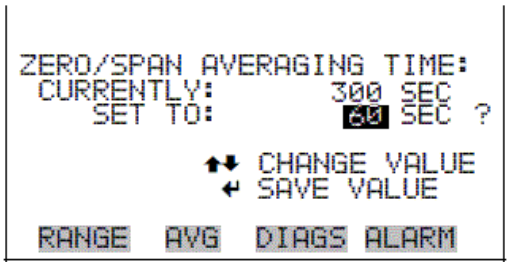


48*i* Service Mode Screen

- Press menu button ▪ once to go back to main menu.

Restore Averaging Times:

- From the 48*i* main menu, move the menu cursor ">" down to "**AVERAGING TIME**", press <ENTER>.
- Change "**SET TO**" to "**60**" sec using the ↑↓ pushbuttons. Press ↵ "**SAVE VALUE**" (no real changes are made until ↵ is pressed).



48*i* Averaging Time Screen

- Press the menu button ▪ once to return to the main menu.

Verification - Zero/Span Points

Span Zero Check Procedure

- Press **{ESC} {ESC}** to return to the Home Menu
- Select: "**C**", Configuration Menu
- Select: "**C**", Configure Calibration
- Select: "**1**", Start a Single Phase Calibration, <ENTER>
- Select: "**COTCAL**", <ENTER>
- Select: "**SPAN0**", <ENTER>
- Scroll down and highlight " **Phase Duration**", set to ≥ 1 hour, <ENTER>
- Scroll down and select: "**Start Single Cal** (**NOW**)", <ENTER>

Monitor Actual values

- Press{**ESC**}{**ESC**} to return to the Home Menu
- Select: "**D**", Real Time Display
- Select: "**C**", Continuous Average Report
- Type in parameter: "**COT**", <ENTER>
- Change # of flags to report from "**02**" to "**03**", <ENTER> (the "**<**", "**D**", and "**C**" flags will show)
- Use decimal Positioner?: "**Y**", <ENTER>
- Start continuous report: <ENTER> (this will show the minute averages as they are calculated and keeps all values on screen).
- Abort SPAN0 "**C**", "**C**", "**W**", "**COTCAL**" <ENTER>

Span Check Procedure

- **{ESC} {ESC}** to return to the Home Menu
- Select: "**C**", Configuration Menu
- Select: "**C**", Configure Calibration
- Select: "**1**", Start a Single Phase Calibration, <ENTER>
- Select: "**COTCAL**", <ENTER>
- Select: "**SPAN1**", <ENTER>
- Scroll down and highlight "**Phase Duration**", set to ≥ 1 hour, <ENTER>
- Scroll down and select: "**Start Single Cal** (**NOW**)", <ENTER>

Monitor Actual values

- Press **{ESC} {ESC}** to return to the Home Menu
- Select: "**D**", Real Time Display
- Select: "**C**", Continuous Average Report
- Type in parameter: "**COT**", <ENTER>
- Change # of flags to report from "**02**" to "**03**", <ENTER> (the "**<**", "**D**", and "**C**" flags will show)
- Use decimal Positioner?: "**Y**", <ENTER>
- Start continuous report: <ENTER> (this will show the minute averages as they are calculated and keeps all values on screen).
- Abort SPAN1 ("**C**", "**C**", "**W**","**COTCAL**" <ENTER>)
- Check SPAN2 (**2000 ppb)** and SPAN3 (**300 ppb**) the same way
- Abort SPAN3 ("**C**", "**C**", "**W**","**COTCAL**" <ENTER>)

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**

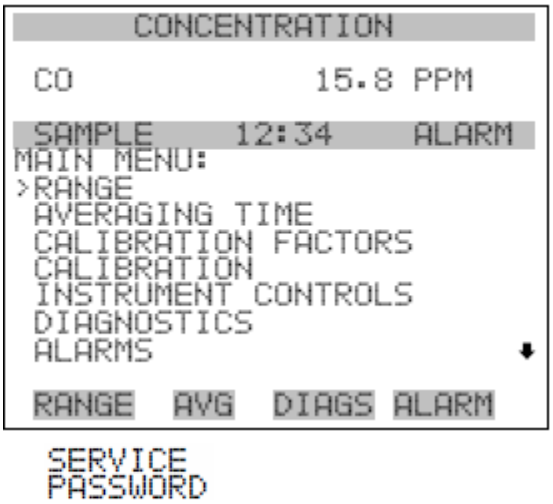
High sensitivity CO analyzers are equipped with a solenoid switching system to draw sample air into a heated internal scrubber that converts all CO to CO_2. The analyzer then measures the light absorption of this CO-free air and uses that light intensity to establish the zero reading. However, any CO 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:



48*i* Main Menu

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

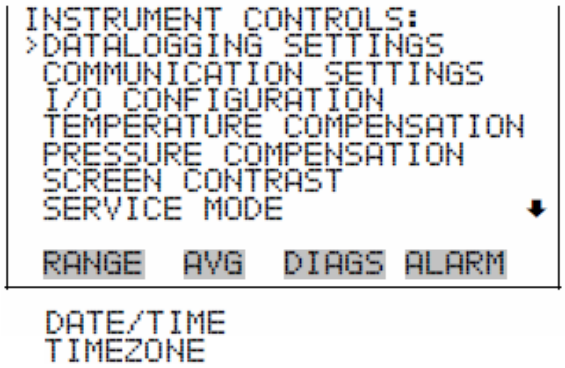
Gas Units	PPM
Range	5

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

Currently	60 sec

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

Next Time	(odd hour) XX: 46
Period HR	4
Total Duration HR	0.4
Zero Duration MIN	20
Span Duration MIN	0
Purge Duration MIN	6
Zero/Span Avg SEC	300
Zero Cal Reset	ON
Span Cal Reset	OFF
Zero/Span Ratio	1



48*i* Instrument Controls Menu

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 > 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

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

Temperature Compensation:

Comp Temp	42.3
Currently	ON

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

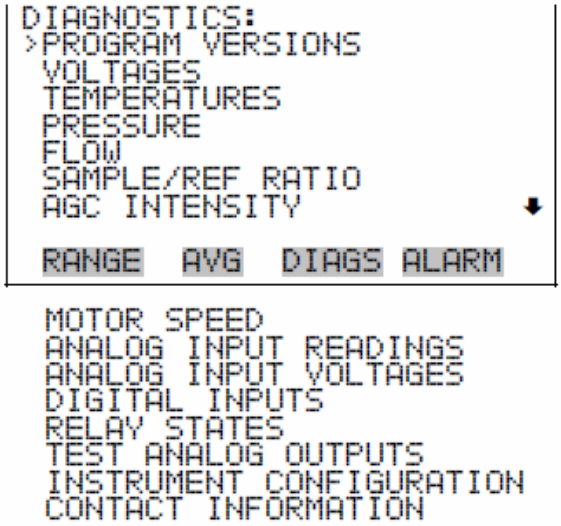
Pressure Compensation

Comp Pres	displays the current optical bench pressure.
Currently	ON

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

Service Mode

Currently	OFF



48*i* Diagnostics Menu

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

Motherboard Voltages:

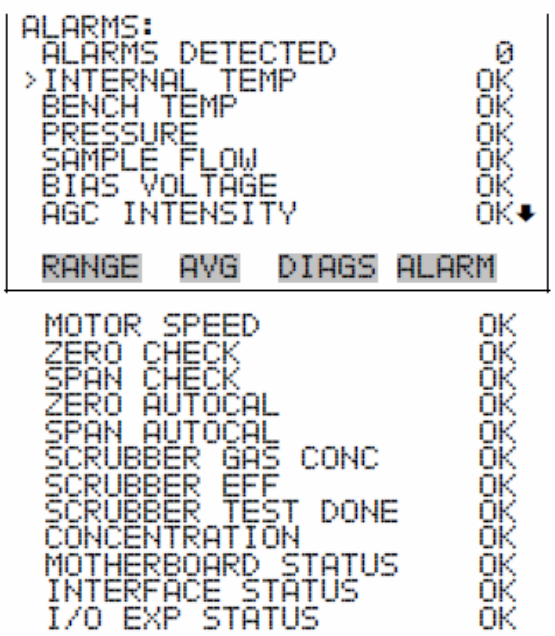
3.3 SUPPLY	3.3 V
5.0 SUPPLY	5.0 V
15.0 SUPPLY	15.0 V
24.0 SUPPLY	24.1 V

-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



48*i* Alarms Menu

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
Sample Flow	.3 LPM	.750 LPM
Bias Voltage	-130 v	-100 v
AGC Intensity	150,000 Hz	300,000 Hz
Motor Speed	100%	
Zero Check	0	10.0
Span Check	0	10.0
Zero AUTOCAL	OK	
Span AUTOCAL	OK	

Scrubber Gas Conc	5	100
Scrubber EFF	95	101
Scrubber TEST DONE	OK	
Concentration	0	1000
Motherboard Status	OK	
Interface Status	OK	
I/O Exp Status	OK	

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; from the 48*i* main menu, select "**CALIBRATION**", select "**ZERO/SPAN CHECK**", select "**ZERO/SPAN AVERAGING TIME**", use the ↑ ↓ pushbuttons to change **SET TO** value to "**300**", press ↵ to save changes.
  c. Set autozero/span check ahead four hours; from the 48*i* main menu, select "**CALIBRATION**", select "**ZERO/SPAN CHECK**". Change "**Next Time**" to minimum of 4 hours in advance odd hour (09, 13 or 17): 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, from the 48*i* main menu, choose **Calibration Factors**

BKG	0.0
COEF	1.000

     Press **Reset user Cal defaults**.
  e. Place 48*i* in Service Mode.
     From the 48*i* main menu**,** select **Instrument Controls** > select **Service Mode**
     Set to "**ON**"
  f. Reset **Pre Amp Board Cal**
     Note: SPAN zero must be running and stable for this adjustment.
     From the 48*i* main menu, select **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 as close to 150,000 then press ↵ to save changes (may have to do this several times).

g. Set Initial S/R Ratio to "Measured".
From the 48*i* main menu, select **Service**, select **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 60 seconds; from the 48*i* main menu, select **CALIBRATION**, select **ZERO/SPAN CHECK**, select **ZERO/SPAN AVERAGING TIME**, use the ↑ ↓ pushbuttons to change **SET TO** value to "**60**", press ↵ to save changes.

i. Remove 48*i* from service mode. From the 48*i* main menu, select **Instrument Controls** > **Service Mode > OFF**, press ↵ (no real changes are made until ↵ is pressed).

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

Sample Route thru Solenoid:

1. From the 48*i* main menu, move menu cursor down, select ***DIAGNOSTICS***, select "***Pressure***" (to display the **Pressure** screen).
2. 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. Press menu button ■ twice to return to the main menu.

Span / Zero Air Route thru Solenoid:

1. From the 48*i* front panel, press ▸ (**RUN**) button until "**ZERO**" appears in the status line.
2. From the 48*i* main menu, move menu cursor down, select ***DIAGNOSTICS***, select "***Pressure***" (to display the **Pressure** screen).
3. 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. Press menu button ▪ twice to return to the main menu.

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. From the 48*i* main menu, move menu cursor down, select ***DIAGNOSTICS***, select "***Pressure***" (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/T700U 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 (0 ppm) events on the data logger and allow the readings to stabilize on the Model 48*i* TLE analyzer.
- Activate the Span 1 (4.000 ppm) event on the data logger and allow the readings to stabilize on the Model 48*i* TLE analyzer.
- 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.

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. Standards in the concentration range of ~200 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. Calibration standards will be replaced every 8 years for 500 ppb to 10 percent CO in air standard (This time 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.

T700U Calibrator

The 48*i* TLE analyzer is calibrated using a T-API T700U Calibrator, which must have flows

certified by ECB and traceable to a primary standard according to the requirements in the QA/SOP 2.3.7 T-API T700U Calibrator. The T-API T700U Dynamic Dilution Calibrator supplies precise levels of sulfur dioxide, sulfate, nitric oxide, and nitrogen dioxide. The gas levels are used to calibrate instruments that perform zero, precision and Level 1 span checks, audits, and multipoint calibration of these gases. For detailed operational procedures and maintenance procedures, consult the Model T700U Instruction Manual ("Operational Manual, Model T700 Dynamic Dilution Calibrator, 6 October 2010" and "Model T700U Calibrator (Addendum to T700 Manual), 6 October 2010, 06876 Rev A").

Teledyne Model 701 Zero Air Generator

The T-API Model 701 Zero Air Generator is a pure air generator system that is capable of continuous delivery of up to 20 standard liters per minute (SLPM), 30 pounds per square inch (PSI) of dry, contaminant-free air. The air is suitable for use as: a zero reference calibration gas, ultra-pure combustion air for flame ionization detector, and service air for pneumatically operated valves. The system is capable of delivering air free from water vapor, particulates, sulfur dioxide (SO2), Hydrogen Sulfide (H2S), Oxides of Nitrogen (NO), Nitrogen Dioxide (NO2), Ozone (O3), and Carbon Monoxide (CO).

Model 701 Zero Air Generator Checks:
- The pollution scrubber/converter media should be replaced yearly by the ECB.
- Verify that the delivery pressure is set to 30 psi. (If the delivery pressure is outside of ± 2 psi range, adjust the pressure using pressure adjust control knob.)
- Check the drain from the air generator.

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 and ECB 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 "CO" Gas Cylinder Standard
- Thermo Environmental (TEI) Model 48*i* TLE Carbon Monoxide Monitor
- Thermo Environmental (TEI) Model 146C Gas Calibrator (QA/SOP 2.3.4)
- T-API T700U Dynamic Gas Calibrator (QA/SOP 2.3.7)
- T-API Model 701 Zero Air Pak (QA/SOP 2.3.5)
- Pretreated Teflon Sampling Line
- Computer/ESC 8832 Data Logger/Wireless Modem System/Ethernet

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.

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/T700U,
  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/T700U,
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 "**Verification of Component Performance A. Equipment Specifications**" (see pg. 25), investigate causes and correct per manufacturer's recommendations until met.
- Conduct operational checks for zero / span solenoid and diagnostics / alarms events.
- Configure the data logger to acquire 48*i diagnostics* "**Flow**" and "**Intensity**".
- The times for the data logger, AV-Trend, and computer must be EASTERN STANDARD TIME. Additionally, they must have the same time and be synched to the NIST time provider in Colorado (± 1 minute). A task can be set up in AV-Trend to ensure that the times are synchronized. This task is accomplished by clicking on the date and time in the lower right corner of the computer screen. Select "**Change date and time settings**". Select "**Internet Time**" tab, and "**Change settings**". Check the box that states "**Synchronize with an Internet time server**". From the Server drop down menu, select "**time.nist.gov**". Press "**Update Now**". Select "**OK**", twice to exit.

  If the data logger time is not within 1 minute of NIST time but it matches the computer time, then there is a problem with the computer time. Either the computer is not synchronizing properly with the NIST time or the clock is drifting too much and needs to be synchronized more often or the computer needs to be replaced.

  If the data logger time is not within 1 minute of NIST time and it does not match the computer time and the computer matches NIST time, then there is a problem with the synchronization of the data logger time with the computer.

  Sources for getting the correct time:
  1. Call the NIST Colorado time @ **(303) 499-7111**.
  2. Correct time from cell phone.
  3. Setting a watch to the correct time website, http://tycho.usno.navy.mil/ , within 24 hours of visiting the site.

- Connect the zero air supply and the CO concentration standard to the Model 146C/T700U 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 Span Zero (0 ppm) event on the data logger and allow the readings to stabilize on the Model 48*i* TLE analyzer. Abort the Span Zero event.
- Activate the Span 1 (4.000 ppm) event and allow the readings to stabilize. Abort the Span 1 event.

- Activate the Span 2 (2.000 ppm) and Span 3 (0.300 ppm) points. Allow the readings to stabilize for 5 minutes for each of the points. Abort the Span 3 event.
- 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.
- Check that the heat tape is working and the insulation is adequate.
- Leave channel down for calibration.

C. Equipment Identification
Fixed Asset System (FAS) numbers for the Model 48*i* TLE Carbon Monoxide Monitor, the Model 146C Gas Calibrator, the Model T700U Gas Calibrator, the Model 701 Zero Air Pak, data logger 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. The 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 701 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 ECB for the site(s).

Annually
Replace Model 701 zero air pack annually with a certified zero air pack or:

Replace CO-CO_2. Shake out the catalyst beads and dispose. No special disposal methods required. Pour in new catalyst to 1/2" from the top of the bores. Tap the cartridge sides gently to settle the beads and top up to the 1/2" level.

Replace the charcoal. Refill the canister with fresh charcoal, up to 3/8" to 1/4" from the top. Rap the sides of the canister gently to settle the charcoal and add more as necessary.

Replace the carulite. The procedure is the same as replacing charcoal.

Replace the NO -NO2 scrubber. This procedure is identical to the charcoal scrubber replacement procedure except that the canister should be refilled with Purafil®.

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 (NCore only).

F. Computer Data Logger System and Modem

1. Site Polling - manually poll the data logger to review data and remove flags if needed.

2. Remote Polling - check to make sure the wireless modem is in working order.

3. Turn off computer screen. **Note: DO NOT** close the AV-Trend 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). 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 (NCore - 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.

146C Calibrator

1. Set autozero/span check ahead four hours; from the 48*i* main menu, press "**CALIBRATION**", select "**ZERO/SPAN CHECK**", select **ZERO/SPAN AVERAGING SECONDS**. Change "**Next Time**" to minimum of 4 hours in advance odd hour (09, 13 or 17): 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. From 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%

   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 146C 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.

T700U Calibrator

1. Set autozero/span check ahead four hours; from the 48*i* main menu, select **CALIBRATION**, select **ZERO/SPAN CHECK**, select **ZERO/SPAN AVERAGING SECONDS**. Change "**Next Time**" to minimum of 4 hours in advance odd hour (09, 13 or 17): 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 T700U set Port 2 Span 1 concentration PPM and appropriate flows to achieve 5.5 ppm.
3. Connect Teflon line to filter holder inlet from T700U output.
4. Place T700U in **STANDBY** mode.
5. Start COT B span 1 on T700U and allow TEI 48*i* to equilibrate.
6. Place 48*i* in **SERVICE** mode.
7. From 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 T700U to **STANDBY**, GAS B Span 1 flow and concentration to 4ppm on the T700U. Remove the 48*i* from *SERVICE* mode.
8. Re-connect the Teflon line to Span in on 48*i* from T700U 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 (Method Detection Limit), Section 2.36.1.11 at the NCore site only.
5. Zero Air Audit (NCore site)

2.36.1.8 Continuously Operating Sites

The monitor should be switched out for preventive maintenance every twelve (12) 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 channel 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 (5Oct2011, 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 (0 ppb) events on the data logger and allow the readings to stabilize on the Model 48*i* TLE analyzer. Abort Span zero.
8. Activate the Span 1 (4.000 ppm) event on the data logger and allow the readings to stabilize on the Model 48*i* TLE analyzer. Abort Span 1.
9. 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. Abort Span 3.
10. Leave channel down for calibration.
11. Ensure that the scheduler has been engaged before leaving the site.
12. MDL (Section 2.36.1.11) will be performed within 30 days of part/monitor change (NCore site only).
13. Document actions on the AQ 109 Form.

Calibrator switching:

1. Down any channel for calibrator being replaced.
2. Shut off the cylinder valve and the outlet valve on the regulator.
3. Turn off the 146C/T700U calibrator power, disconnect necessary wires and tubing.
4. Connect the new 146C/T700U calibrator, power up, and allow to warm up for 1 hour.
5. Purge cylinder regulators ("**Verification of Component Performance B. Equipment Checks**", see pg. 25) 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 (0 ppb) events on the data logger and allow the readings to stabilize on the Model 48*i* TLE analyzer. Abort Span Zero.
9. Activate the Span 1 (4.000 ppm) event on the data logger and allow the readings to stabilize on the Model 48*i* TLE analyzer. Abort Span 1.
10. Activate the Span 2 (2.000 ppm) and Span 3 (0.300 ppm) points. Allow readings to stabilize for each of the points. Abort Span 3.
11. Leave channel down for calibration.
12. Ensure that the poll editor and scheduler has been engaged before leaving the site
13. Document actions on the 109 Form.

Cylinder switching:

1. Down any channel 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/T700U 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 (0 ppb) events on the data logger and allow the readings to stabilize on the Model 48*i* TLE analyzer. Abort Span Zero.
8. Activate the Span 1 (4.000 ppm) event on the data logger and allow the readings to stabilize on the Model 48*i* TLE analyzer. Abort Span 1.
9. Activate the Span 2 (2.000 ppm) and Span 3 (0.300 ppm) points. Allow readings to stabilize for each of the points. Abort Span 3.
10. Leave channel down for calibration.
11. Ensure that the scheduler has been engaged before leaving the site.
12. 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 channel 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.

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. There will be an annual performance evaluation on each of the 48*i* Trace Level monitors in the network at least once per year with an effective date of April 27, 2016.

- One point must be within two to three times the method detection limit of the instruments within the PQAOs network.
- The second point will be less than or equal to the 99th percentile of the data at the site or the network of sites in the PQAO or the next highest audit concentration level.
- The third point can be around the primary NAAQS or the highest 3-year concentration at the site or the network of sites in the PQAO.

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/T700U "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 12 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.

The "audit calibrator" and "field calibrator" will be certified with one dedicated and certified set of flow devices (to be certified annually).

b. Connect the "audit" gas and "audit" certified zero air pak/UHP zero air cylinder to the system to be audited. If a UHP zero air cylinder is used, connect a palladium scrubber to the cylinder.
c. Disable channel on data logger if channel is up. While disabled, values are collected but flagged as invalid data.

Data Logger Login:
- Select the AV-Trend icon, enter the username followed by the password, hit "**OK**"
- Select: "**Utilities**"
- Select: "**Link to Logger**"
- Select the site
- Select: "**Connect**"
- Select: "**L**", to log onto the site data logger (use site password)
- Select: "**C**", configuration menu

Disable channel:
- Press **{ESC} {ESC}** to return to the Home Menu
- Select: "**C**" Configuration Menu
- Select: "**D**" Configure Data Channels
- Select: "**M**" "Disable/Mark Channel Offline"
- Highlight "**COTCAL**" then press, <ENTER>

Change Zero/Span Check time (The Zero/Span Check menu is used to program the instrument to perform fully automated zero adjustments.). From the 48*i* main menu, move the menu cursor ">"

down and select "**CALIBRATION**" <ENTER>, select "**ZERO/SPAN CHECK**" <ENTER>, select "**NEXT TIME**" <ENTER> change starting time to minimum of 4 hours in advance odd hour (13, 17 or 19): 46 using the ← → ↑ ↓ pushbuttons press ↵ (no real changes are made until ↵ is pressed).

ECB activates the certified audit calibrator using: "**SPAN0**" (± .035 ppm), "**SPAN1**" (3.100 ppm, Level 5), "**SPAN2**" (1.000 ppm, Level 4), and "**SPAN3**" (0.190 ppm, Level 2) 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 5 workdays*** of conducting the audit.

- For level 2 audit range: ± 0.030 ppm difference or ± 15 percent difference, whichever is greater.
- For audit levels 3-10: the 10 percent difference acceptance criteria are acceptable.

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* main menu select "**CALIBRATION**", select "**CAL BACKGROUND**" <ENTER>.

d. Enable the channel: Go to the Home Menu (by pressing **{ESC}** several times if needed).
   - Select: "**C**" Configuration Menu
   - Select: "**D**" Configure Data Channels
   - Select: "**E**" "Enable/Mark Channel Online"
   - Use arrow key to select pollutant, highlight "**COTCAL**" <ENTER>

Model 701 Zero Air Audits (NCore only)
Audits for the Model 701 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, NCore only)

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.
2. Check and record previous nightly zero auto-calibration in the MDL spreadsheet.
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 spreadsheet. 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 will also be reported to the DMSSB for entry into the Air Quality System (AQS).
6. Ensure that the scheduler has been engaged for normal operation after the MDL study is completed.

AIR QUALITY SECTION
MAINTENANCE ORDER

Region: _____ Site: _____ Date of Service: _____

Requested By: _____

Action Requested: Repair _____ Supply _____ Maintain _____ Audit _____ Installation _____ Removal _____

Requested Action: _____

Shop Use Only - Action Taken: _____

Removed Cylinders:

Cylinder: Type _____ PPM _____ SN _____ PSI _____ Expires _____

Cylinder: Type _____ PPM _____ SN _____ PSI _____ Expires _____

Cylinder: Type _____ PPM _____ SN _____ PSI _____ Expires _____

Installed Cylinders:

Cylinder: Type _____ PPM _____ SN _____ PSI _____ Expires _____

Cylinder: Type _____ PPM _____ SN _____ PSI _____ Expires _____

Cylinder: Type _____ PPM _____ SN _____ PSI _____ Expires _____

Travel Time: Departed: _____ AM PM Returned: _____ AM PM

Vehicle #: _____ Vehicle #: _____

Logbook(s) Updated: YES NO N/A T Drive Updated: YES NO N/A

Site Temperature	OK _____	Corrected	_____
Probe / Sample Line Connected	OK _____	Corrected	_____
Funnel Clean and In Place	OK _____	Corrected	_____
Building Security	OK _____	Corrected	_____
All Monitoring Systems Operating	OK _____	Corrected	_____

Remarks / Parts Used: _____

Date Signed: _____ Technician(s): _____

MODEL 701 ZERO AIR VERIFICATION and CERTIFICATION

REGIONAL SUPERVISOR		REGIONAL CHEMIST	

STATION #		SITE:		REG:	RARO	QTR:		YR:	
AUDIT CYL TYPE:		UHP	AUDIT CYL SN:			AUDIT CYL EXP. DATE:			N/A
SITE 701 ZAP TBV #		Model 701	701 ZAP TBV SN:		NEXT TBV DATE			TBR DATE	
TBR 701 ZAP TBC #		Model 701	701 ZAP TBC SN:		NEXT TBV DATE			TBR DATE	
AUDITORS:	Mark Yirka / Sahid Thomas				REVIEWED BY:				
					DATE PERFORMED:				

TBC= TO BE CERTIFIED
TBR= TO BE RENEWED (Replaced unit or scrubber chemicals renewed)
TBV= TO BE VERIFIED

701 ZERO AIR VERIFICATION

				DATE	START	END
CALIBRATOR AUDIT FLOW TBV MODEL 701	COT=	2000 SCCM	DATE PERFORMED:			
	SO2T=	2000 SCCM	DATE PERFORMED:			
	NOT / NOYT=	6000 SCCM	DATE PERFORMED:			

				DATE	START	END
CALIBRATOR AUDIT FLOW UHP CYL.	COT=	2000 SCCM	DATE PERFORMED:			
	SO2T=	2000 SCCM	DATE PERFORMED:			
	NOT / NOYT=	6000 SCCM	DATE PERFORMED:			

	Site 701 ZAP To Be Verified 30 Min Run/5 Min Avg				UHP Cylinder Response 30 Min Run/5Min Avg			
POINT	COT ZERO READING (ppb)	SO2T ZERO READING (ppb)	NOT ZERO READING (ppb)	NOYT ZERO READING (ppb)	COT ZERO READING (ppb)	SO2T ZERO READING (ppb)	NOT ZERO READING (ppb)	NOYT ZERO READING (ppb)

Zero Criteria	
Model 48i TLE COT	± 35.000 ppb
Model 43i TLE SO2T	± 2.000 ppb
Model 42i TLE NOT	± 0.200 ppb
Model 42i TLE NOYT	± 0.200 ppb

Absolute Value of Diff.		UNITS	Passed/Fail
Model 48i TLE COT	0.000	ppb	PASSED
Model 43i TLE SO2T	0.000	ppb	PASSED
Model 42i TLE NOT	0.000	ppb	PASSED
Model 42i TLE NOYT	0.000	ppb	PASSED

701 ZERO AIR CERTIFICATION

				DATE	START	END
CALIBRATOR AUDIT FLOW TBC MODEL 701	COT=	2000 SCCM	DATE PERFORMED:			
	SO2T=	2000 SCCM	DATE PERFORMED:			
	NOT / NOYT=	6000 SCCM	DATE PERFORMED:			

				DATE	START	END
CALIBRATOR AUDIT FLOW UHP CYL.	COT=	2000 SCCM	DATE PERFORMED:			
	SO2T=	2000 SCCM	DATE PERFORMED:			
	NOT / NOYT=	6000 SCCM	DATE PERFORMED:			

	Site 701 ZAP To Be Certified 30 Min Run/5 Min Avg				UHP Cylinder Response 30 Min Run/5Min Avg			
POINT	COT ZERO READING (ppb)	SO2T ZERO READING (ppb)	NOT ZERO READING (ppb)	NOYT ZERO READING (ppb)	COT ZERO READING (ppb)	SO2T ZERO READING (ppb)	NOT ZERO READING (ppb)	NOYT ZERO READING (ppb)

Zero Criteria	
Model 48i TLE COT	± 35.000 ppb
Model 43i TLE SO2T	± 2.000 ppb
Model 42i TLE NOT	± 0.200 ppb
Model 42i TLE NOYT	± 0.200 ppb

Absolute Value of Diff.		UNITS	Passed/Fail
Model 48i TLE COT	0.000	ppb	PASSED
Model 43i TLE SO2T	0.000	ppb	PASSED
Model 42i TLE NOT	0.000	ppb	PASSED
Model 42i TLE NOYT	0.000	ppb	PASSED

AUDITOR REMARKS: _____

AUDIT RESULTS: GOOD _____ NOT ACCEPTABLE _____ INDICATE ACTION TAKEN BELOW:
_____ ADDITIONAL OPERATIONAL CHECKS (SPECIFY): _____
_____ PREVENTIVE ACTION (DESCRIBE) _____
REMARKS: _____
EVAL. DATE: _____ EVALUATOR: _____