# Standard Operation Procedures for Trace Level CO

In Use By

## Polk County Air Quality
## Ambient Air Monitoring Personnel

## For Calendar Year 2017

## Revised: December 7, 2016

## Section: 22
## Revision: 11

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**POLK COUNTY AIR QUALITY DIVISION**

**STANDARD OPERATING PROCEDURE MANUAL FOR THE THERMO-SCIENTIFIC 48*i* TRACE LEVEL CO**

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# 22.0 STANDARD OPERATING PROCEDURE FOR TRACE LEVEL CARBON MONOXIDE MONITORING USING THE THERMO SCIENTIFIC 48*i* TRACE LEVEL MONITOR

## 22.1 Purpose

To establish a standard operating procedure (SOP) manual for the Polk County Air Quality Division personnel concerning the setup, operation, bi-weekly zero, precision and span checks, calibrations, audits and maintenance of trace level carbon monoxide (TL-CO) monitors maintained and operated by Polk County staff. This SOP is intended for individuals responsible for collecting ambient air monitoring data supported by the Polk County Air Quality Division.

## 22.2 Scope

These procedures are to be used by Polk County Air Quality Division personnel. The objective of this SOP is to familiarize the station operator with procedures used in the collection of air monitoring data. The accuracy of data obtained from any instrument depends upon the instrument's performance and the operator's skill. It is important that the station operator become familiar with both this SOP as well as the manufacturer's instruction manual in order to achieve a high level of data quality. This SOP is to be used as an outline and is not intended to replace the equipment manufacturer's manual or procedures. This SOP describes the proper procedures for the setup, operation, zero, precision and span checks, calibrations, audits and maintenance of trace level carbon monoxide equipment operated by Polk County Air Quality personnel.

## 22.3 References

**22.3.1 Model 48*i* Trace Level-Enhanced (TLE), Gas Filter Correlation CO Analyzer. Thermo Scientific. Part 102948-00. December 20, 2007.**

**22.3.2 Model 146*i* Dynamic Gas Calibrator. Thermo Scientific. Part Number 102482-00, January 30, 2008.**

**22.3.3 Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II – Ambient Air Specific Methods. EPA-454/B-13-003, May 2013.**

**22.3.4 Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II – Ambient Air Specific Methods., Appendix D EPA-454/B-13-003, July 2014.**

**22.3.5 40 Code of Federal Regulations (CFR) Part 58, Appendix A. Quality Assurance Requirements for State and Local Air Monitoring Stations (Slams).**

**22.3.4 40 Code of Federal Regulations (CFR) Part 58, Appendix D. Network Design for State and Local Air Monitoring Stations (SLAMS), National Air Monitoring Stations (NAMS), and Photochemical Assessment Monitoring Stations (PAMS).**

**22.3.5 40 Code of Federal Regulations (CFR) Part 58, Appendix E. Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring.**

**22.3.6 40 Code of Federal Regulations (CFR) Part 53.20. Procedures for Testing Performance Characteristics of Automated Methods for $SO_2$, CO, $O_3$, and $NO_2$.**

**22.3.7 40 Code of Federal Regulations (CFR) Part 136, Appendix B. Definition and Procedure for the Determination of method Detection Limit.**

**22.3.8 Technical Assistance Document (TAD) for Precursor Gas Measurements in NCore – Version 3. EPA – Contract No. 68-D-02-061, Work Assignment 3-02 August, 2005.**

**22.3.9 Standard Operating Procedures Thermo Scientific Model 48*i*-TLE Trace Level CO Instrument – Version 1.10. EPA July, 2005.**

## 22.4 Introduction

The U.S. Environmental Protection Agency (EPA) has determined carbon monoxide (CO), a colorless, tasteless, highly poisonous, and odorless gas that can be lethal in high concentrations, a health and environmental concern. CO originates from the partial oxidation of hydrocarbon fuels, coal, and coke. CO affects the oxygen carrying capacity of the blood. CO can diffuse through the alveolar walls of the lungs and compete with oxygen for one of the four iron sites in the hemoglobin molecule. The affinity of the iron site for CO is approximately 210 times greater than oxygen. Low levels of CO can cause a number of symptoms including a headache, mental dullness, dizziness, weakness, nausea, vomiting and loss of muscular control. In extreme cases, collapse, unconsciousness and death can occur. For this reason, The Clean Air Act of 1970 set the National Ambient Air Quality Standards (NAAQS), through which concentrations of carbon monoxide are limited to ensure public safety.

Polk County Air Quality Division uses the Thermo Scientific Model 48*i* Trace level-Enhanced (48*i*-TLE) Gas Filter Correlation (GFC) CO Analyzer. The Model 48*i*-TLE is based on the principle that carbon monoxide absorbs infrared radiation at a wavelength of 4.6 microns. Because infrared absorption is a non-linear measurement technique, it is necessary for the instrument electronics to transform the basic analyzer signal into a linear output. The Model 48*i* -TLE uses an exact calibration curve to accurately linearize the instrument output over any range up to a concentration of 1,000 ppm.

The sample is drawn into the Model 48*i*-TLE through the sample bulkhead. The sample flows through the optical bench. Radiation from an infrared source is chopped and then passed through a gas filter alternating between CO and $N_2$. The radiation then passes through a narrow bandpass interference filter and enters the optical bench where absorption by the sample gas occurs. The infrared radiation exits the optical bench and falls on an infrared detector.

The CO gas filter acts to produce a reference beam which cannot be further attenuated by CO in the sample cell. The $N_2$ side of the filter wheel is transparent to the infrared radiation and therefore produces a measure beam, which can be absorbed by the CO in the cell. The chopped detector signal is modulated by the alternation between the two gas filters with amplitude related to the concentration of CO in the sample cell. Other gases do not cause modulation of the detector signal since they absorb the reference and measure beams equally. Thus the GFC system responds specifically to CO.

The Model 48i-TLE has a purge port specifically designed to prevent ambient levels of CO from interfering with analysis. A source of zero air is connected to the purge outlet which ensures that the housing of the filter wheel is exposed to pure air, free of CO. A capillary is placed before the wheel to allow air to enter. The target air flow is 10 psi, whereas the operating range is 8-15 psi. With this in place, ambient air cannot get in as a result to positive pressure. At the bottom of the housing there is a little tiny hole that allows the air to continually escape.

## 22.5 Health and Safety Warning/Precautions

Only properly trained personnel should perform 48*i*-TLE testing, installation, operation, maintenance and calibration procedures. As with all monitoring equipment, precautions should be taken when working around electricity, power tools and above ground elevations.

Cylinder gases are used in tandem with Mass Flow Control (MFC) calibrators for the 48*i*-TLE. Gas cylinders can sometimes contain pressures as high as 2000 pounds per square inch (psi). Handling of cylinders must be done in a safe manner. If a cylinder is accidentally dropped and valve breaks off, the cylinder can become explosive or a projectile.

Transportation of cylinders is regulated by the Department of Transportation (DOT). It is strongly recommended that all agencies contact the DOT or Highway Patrol to learn the most recent regulations concerning transport of cylinders. It is possible to blend other compounds with CO cylinder gas. In this case, it is recommended that MSDS for all compounds be made available to all staff that use and handle the cylinders or permeation tubes.

## 22.6 Sampler Setup

### 22.6.1 Site Selection

In selecting a location to measure for trace level carbon monoxide (TL-CO), it is important for the test site to be predominately in an urban area which can be shown to have at least moderate concentrations of various pollutants. The site shall be clearly identified and shall be justified as an appropriate test site with suitable supporting evidence such as maps, population density data, vehicular traffic data, emission inventories, pollutant measurements from previous years, concurrent pollutant measurements, and meteorological data.

For detailed information concerning site selection for Trace Level CO monitoring, refer to Table 22-4 in this SOP or to the 40 CFR 58, Appendix D or the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Section 6.2, Monitoring Site Location.

#### 22.6.1.1 The Monitoring Station

The structure housing the monitoring equipment may consist of a trailer, a room in a building, or a shelter designed specifically for air monitoring purposes. A clean, dry, secure and temperature controlled space is required so that the sampling equipment can operate properly.

Careful thought and planning is required in locating a monitoring station. The individual responsible for the installation must consider:

- Proximity to the nearest power source. A 120 VAC source is required for operation of the CO monitoring instruments.
- The space where the equipment is housed must maintain a temperature range of 20-30ºC. This usually requires the need for an air conditioner and a heater controlled by a thermostat.
- The accessibility of the equipment to the operator. The operator must be able to safely access the equipment during regular business hours.
- The security of the equipment. Monitoring instruments are expensive. They must be placed in a location where security can be assured.
- Contracts for rental of space or power. Contracts need to be signed with the owner of the property where the instruments are to be located.
- Local building codes. In most cases, the contractor installing the power, structure, concrete, etc. know the local building codes.

#### 22.6.1.2 Probe Placement

Once the location of the station has been identified, the individual responsible for the installation must be familiar with the criteria for locating the probe. The location of the sample probe is critical and individuals performing the installation must follow these specific guidelines:

- The sample inlet should be located between 3-15 meters above ground level

- The distance of the probe inlet must be at least 20 meters from nearby obstructions (buildings and trees)
- The vertical and horizontal distance of the probe inlet must be at least one meter from the ground and support structure
- The probe should be positioned with at least 270 degrees of unrestricted airflow

For more detailed information concerning site selection for carbon monoxide monitoring, refer to Table 22-4 in this SOP or to the 40 CFR 58, Appendix E or the Quality Assurance Handbook for Air Pollution Measurement Systems , Volume II, Section 7.2, entitled "Sampling Probes and Manifolds."

### 22.6.2 Inspecting New Equipment

When shipment of the monitor is received, verify that the package contents are complete as ordered. Inspect the instrument for external physical damage due to shipping, such as scratched or dented panel surfaces and broken knobs or connectors.

Remove the instrument cover and all interior foam packing and save (in case future shipments of the instrumentation are needed). Make note of how the foam packing was installed.

Inspect the interior of the instrument for damage, such as broken components or loose circuit boards. Make sure that all of the circuit boards are completely secured. Loose boards could short out the motherboard. If no damage is evident, the monitor is ready for calibration, installation and operation. If any damage due to shipping is observed contact Thermo Scientific at 1-866-282-0430 for instructions on how to proceed.

### 22.6.3 Equipment Installation

Installation of a 48*i*-TLE monitor consists of connecting the sample tubing to the sample gas inlet fitting and connecting the primary power and the data logger device. The sampler inlet line connection should be made with ¼ -inch outer diameter Teflon tubing.

The entrance of the sampling system must ensure that rain or condensation cannot enter the system. An inverted funnel and sample line must be placed outside the trailer or enclosure to prevent water from entering the sample line.

Because the analyzer is an optical instrument, it is possible that particulate in the gas sample could interfere with the TL-CO readings, even though, the sampling/referencing cyclic operation of the instrument is designed to eliminate such interference. In order to avoid frequent cleaning of the optics and flow handling components, a 0.5-micron Teflon filter must be installed between the ambient sample line and the sample port of the analyzer prior to operation of the analyzer. A Teflon filter will not degrade the TL-CO concentration. However, if particulate matter builds up on the filter, the particulate matter will destroy some of the TL-CO in the sample.

Since the instrument's exhaust consists of ambient air with some CO removed, a three-way solenoid is used to ensure that the exhaust cannot re-enter the sample system. The three-way solenoid is also used to switch between zero and span during nightly checks.

Install the monitor's electrical connections as indicated in the operating manual.

The power backup, data acquisition equipment, and any monitoring equipment, calibration equipment, or other ancillary equipment should be installed according to information supplied in the appropriate operating manuals.

### 22.6.4 Programming Equipment

When the instrument is first turned on, the exhaust fan will start and the Power-Up and Self-Test screens will be displayed. These screens will be displayed until the instrument has completed its warm up and self-checks. Allow 90 minutes for the instrument to stabilize.

After the warm-up period the Run Screen, or Normal Operating Screen, is displayed. The Run Screen displays the TL-CO concentration. Press the **MENU** button to access the Main Menu, which contains a list of submenus. Instrument parameters and features are divided into the submenus according to their function. Use the ↑ or ↓ buttons to move the cursor to each submenu.

#### 22.6.4.1 Range and Units

The Gas Units Screen defines how the CO concentration reading is expressed. From the Range Menu, select **GAS UNITS** to display the Gas Units screen. Use the ↓ button to select "PPM" and press **ENTER**. Press **MENU** twice to return to the Run Screen.

The Range Screen defines the concentration range of the analog outputs. The Polk County Air Quality Department will use the range of 0 – 5 ppm for the analyzer. To set the range for the instrument, press the **MENU** button to access the Main Menu. Press the ↓ button until the cursor is on "Range." Press **ENTER** to display the CO Range Menu, and select **RANGE**. Use the ↑ or ↓ buttons to scroll through the preset ranges. Select "5.00" and press **ENTER**. Press **MENU** to return to the Range Menu.

#### 22.6.4.2 Averaging Time

The averaging time defines a time period (1 to 300 seconds) during which CO measurements are taken. The average concentration of the readings is calculated for that time period. Polk County Air Quality Department will use the setting of 300 seconds as the averaging time for the collection of data. An averaging time of 60 seconds will be used during calibrations, audits, zero/precision/span checks, and internal zero checks.

From the Main Menu, use the ↓ button to scroll to **AVERAGING TIME** and press **ENTER**. From the Averaging Time Screen, use the ↑ or ↓ buttons to scroll through the preset ranges. Press **ENTER** to select the desired averaging time. Press **RUN** to return to the Run Screen.

#### 22.6.4.3 Temperature Compensation

Temperature Compensation provides compensation for any changes to the instrument's output signal due to variations in internal instrument temperature. When the temperature compensation is off, the first line of the display shows the factory standard temperature of 25ºC. Polk County Air Quality will run the TL-CO analyzer with the temperature compensation set to **ON**.

From the Main Menu, use the ↓ button to scroll to **INSTRUMENT CONTROLS** and press **ENTER**. From the Instrument Controls Screen, use the ↓ button to scroll to **TEMPERATURE COMPENSATION**, and press **ENTER**. Press **ENTER** to toggle the temperature compensation on or off. Press **RUN** to return to the Run Screen.

#### 22.6.4.4 Pressure Compensation

Pressure Compensation provides compensation for any changes to the instrument's output signal due to variation of reaction chamber pressure. When the pressure compensation is off, the first line display shows the factory standard pressure of 760 mmHg. Polk County Air Quality will run the TL-CO analyzer with the pressure compensation set to **ON**.

From the Main Menu, use the ↓ button to scroll to **INSTRUMENT CONTROLS** and press **ENTER**. From the Instrument Controls Screen, use the ↓ button to scroll to **PRESSURE COMPENSATION**, and press **ENTER**. Press **ENTER** to toggle the pressure compensation on or off. Press **RUN** to return to the Run Screen.

#### 22.6.4.5 Baud Rate

The Baud Rate Screen is used to set the RS-232 interface baud rate. The Polk County Air Quality Department will use a baud rate of 9600.

From the Main Menu, use the ↓ button to scroll to **INSTRUMENT CONTROLS** and press **ENTER**. From the Instrument Controls Screen, use the ↓ button to scroll to **COMMUNICATION SETTINGS** and press **ENTER**. From the Communication Settings Screen, use the ↓ button to scroll to **SERIAL SETTINGS** and press **ENTER**. From the Serial Settings Screen, use the ↓ button to scroll to **BAUD RATE**, and press **ENTER**. Use the **↑ or ↓** buttons to scroll through the preset rates. Press **ENTER** to select the desired baud rate. Press **RUN** to return to the Run Screen.

#### 22.6.4.6 Clock Set

To set the correct time and date on the instrument, press **MENU** to return to the Main Menu. Use the ↓ button to scroll to **INSTRUMENT CONTROLS** and press **ENTER.** Use the ↓ buttons to scroll to **DATE/TIME** and press **ENTER**. The date and time should be set to the data logger time. Press **ENTER** to enable editing. Use the → button to select: year, month, day, hour, minutes, or seconds. Use the ↑ or ↓ buttons to increase/decrease the desired value. Set the appropriate date and time and press **ENTER**. Press **RUN** to return to the Run Screen. The instrument is now set with the appropriate time, date, full scale range and units.

**NOTE**: **It is recommended that you allow the 48*i*-TLE 24-hours before you attempt checks or calibration.**

## 22.7 Standards

The CO concentration standard comes in an individual certified cylinder. There are two separate cylinders; one for audits and one for the calibrations and zero/precision/span checks. The CO cylinders have been assayed in a dilution method of a carbon monoxide in and inert nitrogen gas mixture at 50-250 ppm. The cylinder must be traceable to a National Institute of Standards and Technology (NIST) CO in $N_2$ Standard Reference Material. Procedures for certifying the CO cylinder (working standard) against a NIST traceable CO standard is given in EPA Publication NO. EPA-454/R-05-003, "Technical Assistance Document for High Sensitivity Carbon Monoxide Measurements." The cylinder should be recertified on a regular basis as determined by the local quality control program.

The gas certification process is quite rigorous. However, it is still possible to receive a cylinder gas out of specification. Polk County Air Quality will verify that a new cylinder gas is within specification before it is put into use. Prior to removing an old cylinder, perform a zero/precision/span check, making sure that relevant

criteria are met. Change to the new cylinder, and update the Thermo 146*i* with the new stock gas concentration. Adjust the 146*i* to produce a target concentration equivalent to the precision level last used with the old cylinder. If the instrument reading is within 4% of the expected value, proceed to calibrate the analyzer with the new stock cylinder. If it is not within 4%, investigate and resolve the disparity prior to using the new cylinder. Record all information on the Gas Comparison Spreadsheet, Form 1, Appendix A.

Operators will be required to replace the CO cylinder when the cylinder pressure drops below 200 PSI. This will involve removing the regulator on the depleted cylinder and installing the regulator on a replacement cylinder.

Precautions must be taken to remove "dead" pockets of contaminants which are created within the regulator whenever it is removed from the cylinder. This problem can be minimized by carefully evacuating the regulator (also known as purging) after it is connected to the cylinder. Better results will be achieved by alternately pressurizing and depressurizing the regulator once it has been attached to the cylinder.

Contamination with even a small amount of moisture from back diffusion can cause the CO concentration to become unstable. The lower the cylinder concentration, the more susceptible it is to any contamination from "abuse" in the field. The best way to ensure low concentration cylinders are not contaminated by back diffusion is to make sure whenever the cylinder valve is open, there is gas flow out of the cylinder.

Polk County addresses this issue by:

- The cylinder utilized is only used for this site and is not removed until expiration of the certificate.
- The gas dilution system is fixed at this site and is not used at any other site so is not moved unless for maintenance or re-certification.
- The regulator will continuously be kept pressurized with cylinder gas.

## 22.8 Qualification, Certification and Recertification

Gas dilution in the Model 146*i* Dynamic Gas Calibrator is achieved by utilizing two or more mass flow controllers. One is a high flow controller (typically 20 slm full scale) to govern the diluting zero air. The other controller is for low flow (typically 100 sccm) and governs the flow of the gas to be diluted. See Polk County Air Quality SOP Section 26 for calibration instructions of the 146*i* Mass Flow Controllers.

## 22.9 Calibration

### 22.9.1 Multipoint Calibrations

The Thermo Scientific Model 48*i*-TLE analyzers are calibrated whenever the following occurs: installation of a new monitor, replacement of broken parts, when a zero/precision/span check fails by more than 10%, after 6 months has expired since the last calibration, or yearly if a daily automated zero and span checks are being performed, or at the operator's discretion. The calibration check is a quality control procedure used to verify that the air monitoring system is operating properly. The check involves comparing the response of the station analyzer to CO concentrations generated by the station gas calibration system. The calibration levels shall be:

- Zero
- Level 1 – 4.000-5.000 ppm
- Level 2 – 2.000-2.500 ppm

- Level 3 – 1.000-1.500 ppm
- Level 4 – 0.500-0.600 ppm

Using linear regression, a calibration relationship is determined using the indicated values of the analyzer and the actual values of the transfer standard. Acceptance criteria can be found in Table 22-4 of this SOP from the Measurement Quality Acceptance Tables from the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Appendix D. EPA-454/B-13-003, July 2014. The calibration data is saved for use as a point of reference for subsequent calibrations.

On the Main Screen (or Standby Screen) of the 146*i* Calibrator, press the MENU button to access the Main Menu Screen. Scroll to **OPERATION** and press **ENTER**. Use the ← and → buttons to select desired **GAS** and press **ENTER**. Use the ↓ button to scroll down to **SPAN**. Use the ← and → buttons to scroll to **ZERO** and press **ENTER** to put the 146*i* Calibrator in zero air mode. With the zero air flowing, verify that the Calibrator and data logger reads 0.000 ppm ± 0.040 ppm. Allow the analyzer to sample zero gas until a stable reading is obtained on the CO channel.

Press the front panel **MENU** button on the 48*i*-TLE site analyzer to display the Main Menu. Use the arrow keys to select **CALIBRATION** and press **ENTER** to display the Calibration Menu.

Select **CAL BACKGROUND** and press **ENTER**. Press **ENTER** to set the CO reading to zero. Press the **MENU** button to return to the Calibration Menu. Record all information on the Calibration Field Sheet, Form 2, Appendix A.

**Note: This procedure is for calibrating zero with an external zero air source. Polk County also performs an hourly zero calibration internally, in order to read electrical noise in the instrument. Every hour the background coefficient is reset from its internal check, not using an external zero source, but an internal scrubber. Therefore, an external zero air calibration will be null and void as soon as the next hour is reached. The internal zero supersedes the external zero allowing the two to help the operator determine how well the internal scrubber is performing.**

Adjust the flow rate from the CO standard to generate and CO concentration of approximately 80-90% the upper range limit (URL) of 5.000 ppm (i.e. 4.000 - 4.500 ppm). Allow the site analyzer and data logger to obtain stable readings on the CO channel.

Press the front panel **MENU** button on the 48*i*-TLE site analyzer to display the Main Menu. Use the arrow keys to select **CALIBRATION** and press **ENTER**. Scroll to **CAL COEF** and press **ENTER**. In the **CALIBRATE CO** screen, use the ← and → buttons to move the cursor left and right. Use the ↓ or ↑ buttons to increment and decrement the digit to the expected CO concentration and press **ENTER**.

After the zero and 80-90% URL points have been set, determine at least 2 approximately evenly spaced points between zero and the 80-90% URL without further adjustment to the analyzer. SPAN 1 - 4 have been programmed for calibrations. SPAN 4 is set to 4.500 ppm, SPAN 3 is set to 2.250 ppm, SPAN 2 is set to 1.200 ppm, and SPAN 1 is set to 0.550 ppm.

Perform the calibration check by a direct comparison between the 146*i* Calibrator and data logger. Allow the site analyzer and data logger to obtain stable readings on the CO channel and record readings.

Repeat for SPAN 4 - 1, respectively. Record all information on the Calibration Field Sheet, Form 2, Appendix A.

Generate the regression analysis calculations by least squares the slope, intercept, and correlation coefficient of the site analyzer response versus the calibration standard concentrations, Form 3, Appendix A.

### 22.9.2 Automated Hourly Zero Calibrations

The Thermo Scientific 48*i*-TLE analyzer is programmed to do an automated zero check and calibration once every hour. The 48*i*-TLE is designed to test for such a low level of CO, that drift is expected. Zero drift is internally adjusted by the 48*i*-TLE analyzer hourly, in order to reduce error in data collection.

When the 48*i*-TLE goes into auto zero-mode, a solenoid valve dictates the direction of the sampled ambient air. Instead of going directly to the bench to be measured, the ambient air is routed to the CO scrubber where the CO is removed. This purified air is then used to calibrate the instrument to zero, and the background coefficient is adjusted accordingly. **Note: This procedure will nullify any external zero calibration performed as soon as the internal resets the background coefficient.**

#### 22.9.2.1 Calibration Program in 48*i*-TLE

From the Main Menu, use the ↓ button to scroll to **CALIBRATION** and press **ENTER**. From the Calibration Menu, use the ↓ button to scroll to **ZERO/SPAN CHECK** and press **ENTER**.

##### 22.9.2.1.1 Next Time

The Next Time screen is used to view and set the next zero/span check date and time. Once the initial check is performed, the date and time of the next check is calculated and displayed.

From the Zero/Span Check Menu, use the ↓ button to scroll to **NEXT TIME** and press **ENTER**. Use the → button to select: year, month, day, hour, minutes, or seconds. Use the ↑ or ↓ buttons to increase/decrease the desired value. Set the appropriate date and time and press **ENTER**.

**NOTE: At each site visit, the internal clock on the site analyzers and transfer standard should be synced to the time on the data logger.**

##### 22.9.2.1.2 Period Hours

The period Hours screen defined the period or interval between zero/precision/span checks. Periods between 0 and 999 hours are acceptable. To turn the check off, set the period to 0.

From the Zero/Span Check Menu, use the ↓ button to scroll to **PERIOD HR** and press **ENTER**. Use the ← and → buttons to move the cursor left or right, and the ↑ and ↓ buttons to increment or decrement to the desired numeric value. Polk County Air Quality will use a sample period of 1-hour.

#### 22.9.2.1.3 Zero Duration

The Zero Duration Minutes Screen defines how long the zero level is sampled by the instrument. Durations between 0 and 60 minutes are acceptable.

To set the zero duration, use the ← and → buttons to move the cursor left or right, and the ↑ and ↓ buttons to increment or decrement to the desired numeric value. Polk County Air Quality will sample zero air for 5 minutes.

#### 22.9.2.1.4 Span Duration

The Span Duration Minutes Screen defines how long the span level is sampled by the instrument. Durations between 0 and 60 minutes are acceptable. Span gas is not sampled during the hourly zero auto-calibrations, so the Span Duration will be set to zero.

#### 22.9.2.1.5 Averaging Time

The Averaging Time screen allows the user to adjust the zero/span averaging time. This averaging time is used by the analyzer only when performing an automatic check. The analyzer's averaging time is used for all other functions.

From the Zero/Span Check Menu, use the ↓ button to scroll to **AVERAGE TIME** and press **ENTER**. Use the ↑ and ↓ buttons to scroll to **60 SEC** and press **ENTER**.

### 22.9.2.2 Communication Settings for Automated Hourly Zero Checks

During the automated hourly zero calibration, in order for the data to be flagged with a "C", a calibration program must be setup digital inputs must be assigned in the Agilaire AirVision software. See Polk County Air Quality AirVision SOP Section 18 for specific instructions.

## 22.10 Quality Control

### 22.10.1 Station Inspection

Before entering the station, the perimeter should be inspected for damage. Extreme weather conditions, neglect of station maintenance, or vandalism may have resulted in damage to the site since the operator's last visit. Check that the sample probe is intact and has not been damaged.

Once the operator enters the monitoring station:

- Check for any obvious analyzer malfunctions. For example, check to see that the equipment is running, the pumps are operating and the instrument is cycling properly.
- Note any unusual odors or noise. An unusual odor may indicate a point source of a pollutant or a strange new noise can indicate a malfunction in the equipment. These observations should be recorded in the station log book and may prove to be invaluable if the data is challenged.

The station operator is responsible for making several observations during the station inspection. Any of the above described observations must be thoroughly detailed in the station log book.

Once the initial inspection is made, the operator must proceed with a routine inspection and performs a zero/precision/span check on the TL-CO analyzer.

### 22.10.2 Station Log Book

A station log book must be maintained at each monitoring site and should accurately reflect site operations. The log book will be identified with the station name, station number, date, time, operator, instrument identification, parameter, scale and units. All entries shall include the date, time, quality control checks, and maintenance on equipment, audits, equipment changes and missing or invalid data. Additional information should include: maintenance performed on the station, abnormal traffic patterns, nearby construction, or sample line cleaning.

Should the data be challenged, the information recorded in the log book is invaluable. A written record of observations concerning abnormal operations or localized occurrences is critical if a violation of ambient air standards were recorded during this period. Completed log books will be maintained by Polk County Air Quality and will be archived for future reference.

### 22.10.3 Bi-Weekly Zero, Precision and Span Checks

The zero, precision and span check is a quality control procedure used to verify that the air monitoring system is operating properly. The check involves comparing the response of the station analyzer to CO concentrations generated by the station transfer standard. The deviation between the "indicated" value of the analyzer and the "actual" or "true" value of the transfer standard is then determined.

Zero air and CO concentrations of 0.550 ppm (precision), and 4.500 ppm (span) are generated by the Calibrator. Each concentration is measured by the Calibrator and the station analyzer. Following the precision and span checks, the deviation from the true TL-CO value is determined.

The following critical criteria require recalibration of the field analyzer and invalidation of the data unless there is compelling reason and justification not to do so: if the precision difference or span drift is outside $\pm$10%.

The zero drift criteria of $\geq$ 0.040 ppm will be used as an action level which may require recalibration of the field analyzer and invalidation of data. However, since the TL-CO performs an hourly internal zero auto-calibration, only the corresponding hour would be subject to any given zero drift result.

The zero/precision/span check must be performed once every fourteen days and is always performed in the same manner. Failure to perform and document zero/precision/span data within the required frequency and concentration may result in the invalidation of data. The operator is required to submit the completed field sheet form to the Quality Assurance Officer for review. For more detailed procedures on, Zero, Precision and Span Checks refer to Section 22.14.4 Zero, Precision and Span Checks.

### 22.10.4 Data Acquisition and Telemetry

Data acquisition involves retrieval of the ambient air quality data from the data logger. The station operator has the primary responsibility for distinguishing valid measurements from indications caused by malfunctioning instruments or source interferences. The telemetry system can be used by a station operator to scan data transmitted from the monitoring station to a central location. This enables the operator to "call" the monitor site and examine the data recorded at the monitoring station (i.e. TL-CO concentrations and station temperature). The station operator should be familiar with daily concentration variations (i.e. the times daily maximum concentrations occur). By recognizing abnormal data, the operator is alerted that the instruments may not be operating properly and a station visit may be

necessary. However, monitoring a station by telemetry is not to be substituted for the site visit. See Polk County Air Quality SOP Section 18 for instructions on data acquisition.

## 22.11 Equipment, Maintenance and Trouble Isolation

The equipment used to calibrate, audit, perform zero/precision/span checks and monitor trace level carbon monoxide concentrations in the network is a Thermo Scientific Model 48*i* Trace Level Carbon Monoxide Monitor (48*i*-TLE), Thermo Scientific Models 146*i* Dynamic Gas Calibration System, and a Teledyne Instruments Zero Air Module Model 701H.

The Thermo Scientific Model 48*i*-TLE Enhanced Trace Level CO analyzer (Figure 22-1) is an improved version of the standard Model 48*i* Ambient CO analyzer (U.S. EPA Designation Method RFCA-0981-054). The primary modifications to the Model 48*i*-TLE analyzer that improve its sensitivity over the Model 48*i* include the use of higher reflectance gold-coated mirrors, incorporation of a baseline auto-zeroing function, and the implementation of ± 1C control of optical bench temperature. The recommended operating temperature for the instrument ranges from 20°C to 30°C, but the Model 48*i*-TLE CO analyzer can be operated over the range of 5°C to 45°C. The Model 48*i*-TLE CO analyzer has an LDL of 0.02 ppm. Data can be provided in analog or digital formats.

**Figure 22-1: Thermo Scientific Model 48*i*-TLE CO Analyzer**


### 22.11.1 Preventative Maintenance

Each instrument must be periodically examined and serviced to anticipate and prevent instrument failure. Scheduled maintenance on the instruments will prevent costly repairs and loss of data. The routine maintenance required on the analyzers by the station operator is minimal and outlined in the manufacturer's instruction manual. By keeping track of the instrument responses from week to week, the operator can observe trends, which would alert the operator of a potential problem, and to correct the situation before the instrument fails. Table 22-1 displays a preventative maintenance schedule for the operator at the end of these procedures.

#### 22.11.1.1 Analyzer Leak Check

A system leak check should be performed on a yearly basis, or as needed for trouble shooting purposes. To perform a system leak check on the analyzer, disconnect the sample line from the **SAMPLE INLET** on the back panel, and plug the fitting.

Press the **MENU** button to display the Main Menu. Use the ↓ buttons to scroll to **DIAGNOSTICS** and press **ENTER**. From the Diagnostic Menu, use the ↓ buttons to scroll to **SAMPLE FLOW** and press **ENTER**. The flow reading should slowly drop to zero. Press the **MENU** button to return to the Diagnostics Menu. Use the ↓ buttons to scroll to **PRESSURE** and press **ENTER**. The pressure reading should drop below 250 mmHg. If the flow and pressure do not drop to their desired limits, there is a leak in the system. Check to see that all fittings are tight, and none of the input lines are cracked or broken.

#### 22.11.1.2 Solenoid Valve Leak Check

A solenoid valve leak check should be performed on a yearly basis, or as needed for trouble shooting purposes. To perform a solenoid valve leak check on the analyzer, plug the S**PAN INLET** and **SPAN OUTLET** fittings on the back panel.

Press the **MENU** button to display the Main Menu. Use the ↓ buttons to scroll to **DIAGNOSTICS** and press **ENTER**. From the Diagnostic Menu, use the ↓ buttons to scroll to **PRESSURE** and press **ENTER**. The pressure reading should drop below 250 mmHg. If the pressure does not drop to its desired limit, there is a leak in the system. Check to see that all fittings are tight and none of the input lines is cracked or broken.

Repeat this procedure for the valve associated with the zero line.

#### 22.11.1.3 Sample Line Leak Check

A comprehensive leak check should be performed on a yearly basis, and anytime new sample line is installed. Unscrew the sample line from the back of the analyzer, and connect the vacuum pressure gauge. The sample line must be capped off on the top side of the roof before proceeding.

Turn vacuum pump on and wait for the pump to remove all air from the sample line. The vacuum gauge will indicate a steady reading of approximately 21 in Hg vacuum when the lines have been evacuated. The vacuum reading must be at least 15 in Hg for the leak check to take place.

Close the valve that is located between the vacuum gauge and the pump. Once the valve is closed record the reading from the gauge and start a timer. Shut the pump off and wait 1 minute. Record the reading from the vacuum gauge.

The acceptable leak rate for the sample lines is 0.5 in Hg for the 1 minute check. If the leak check fails, make sure all lines are connected securely to the vacuum gauge and the line is capped off at the roof, and repeat the check. If a second leak check fails, look for the leak and/or replace sample line if needed.

### 22.11.1.4 Particulate Filter Changes

A 0.5 micron Teflon filter housed in a Teflon filter holder is located on the outside of the analyzer and is connected to the sample line. The filter should be checked every two weeks and changed when noticeably dirty. Slow response of the analyzer during the zero/precision/span check is an indication of a dirty filter or contaminants in the sample line. To replace the used filter, loosen the two halves of the filter holder and replace the dirty filter with a new filter.

### 22.11.1.5 Cleaning the Fan and Filters

Under normal use, the fan filters on the rear panel should be cleaned every six months. If the instrument is operated in excessively dirty surroundings, it may be necessary to clean the fan filters more frequently.

### 22.11.1.6 CO Scrubber Efficiency Test

The converter efficiency of the CO scrubber should be tested quarterly. Polk County Air Quality personnel will perform this test as part of the quarterly audit procedures. If the converter efficiency falls below 95%, replace the CO Scrubber. This test is performed while the 48*i*-TLE is being challenged with Audit Level 4 gas in the range of 0.900-2.999 ppm.

On the Main Screen (or Standby Screen) of the 146*i* Calibrator, press the MENU button to access the Main Menu Screen. Scroll to **OPERATION** and press **ENTER**. Use the ← and → buttons to select **CO GAS** and press **ENTER**. Use the ↓ button to scroll down to **SPAN**. Use the ← and → buttons to scroll to **SPAN 4** and press **ENTER**. **SPAN 4** has been programmed to produce the audit range of 0.900-2.999 ppm. Perform the span check using a cylinder containing 50 to 250 ppm CO in $N_2$. The flow can be read on the 146*i* Calibrator display screen by pressing **RUN** button. This screen reports the actual gas and zero-air flows and the corresponding target flows.

Once the 48*i*-TLE site analyzer has stabilized at this level, put the analyzer in Zero Mode. On the 48*i*-TLE, press the **RUN** button to put the site analyzer in **ZERO** mode. If the CO scrubber is working efficiently, the contaminated sample should be fully converted to purified air. Allow the 48*i*-TLE to stabilize at zero. Record five readings taken at 1-minute intervals and calculate the average of these five readings on the Scrubber Efficiency Field Sheet, Form 4, Appendix A. Use the following equation to calculate the converter efficiency of the CO scrubber:

$$\%Difference = \frac{C_{Original} - C_{Final}}{C_{Original}} \times 100$$

Where:

$C_{Original}$ = CO audit concentration of 0.900-2.999 ppm

$C_{Final}$ = CO concentration in zero mode, ppm

### 22.11.1.7 Replacing the Sample Lines

It is the operator's responsibility to maintain the sample lines. The sample lines must be replaced if the operator suspects a loss in CO concentrations due to contamination in the line, or every two years.

**Table 22-1: Preventive Maintenance Schedule for the 48*i*-TLE**

| Item | Schedule |
|---|---|
| Sample particulate filter inspection | 1/2 Weeks |
| Diagnostics Check | 1/2 Weeks |
| Perform Level I zero/span checks | daily |
| Leak check and pump check | 1/year |
| Clean inside of chassis | as needed |
| Rebuild or replace pump | as needed |
| Replace IR source | as needed |
| Replace wheel motor | as needed |
| Replace gases in correlation wheel | as needed |

### 22.11.2 Trouble Isolation

The instruments in Polk County Air Quality's air monitoring network are very reliable. However, after a period of continuous use, problems may occur. Leaks in the system and built up dirt on the optics are typical. After time, the operator should be able to quickly distinguish the symptoms and causes of equipment failure. Table 22-2 displays a list of common problems and possible solutions to be used as a troubleshooting guide.

It is suggested that each station operator consult the Model 48*i* Trace Level CO Analyzer Instruction Manual**,** and compile personal notes on troubleshooting as they gain experience with the Thermo Scientific. The operator is encouraged to contact Thermo Scientific technical support at 1-866-282-0430 when attempting any repairs.

**Table 22-2: Instrument Troubleshooting for the 48*i*-TLE**

| Problem | Possible Cause | Possible Solution |
|---|---|---|
| Noisy Output | Defective DC Power Supply | Replace Power Supply |
| | Dirty Optics | Clean Optics Bench |
| Highly Positive Zero Drift | Defective Bandpass Filter | Replace Filter |
| No Response to Span Gas | IR Source is Defective | Replace IR Source |
| | IR Power Supply Defective | Replace IR Power Supply |
| Differential Signal at Zero | IR Source is Defective | Replace IR Source |
| | IR Power Supply is Defective | Replace IR Power Supply |
| | CO Leak from Correlation Wheel | Replace Wheel |
| Zero Output at Ambient Levels | Pump Failure | Check Pump |
| | IR Source Failure | Replace IR Source |
| | IR Power Supply Defective | Replace Power Supply |
| No Flow Through Analyzer | Pump Failure | Replace/Rebuild Pump Head |
| Reference Signal at Zero | N2 Leak From Correlation Wheel | Replace Wheel |

### 22.11.3 Environmental Control for Monitoring Equipment

Instrument vibration should be reduced as much as possible. Use shock-absorbing feet for the monitor. Any pumps must be fitted with rubber feet to reduce vibration. All pumps connected to the analyzer should be connected using tubing that will prevent the transfer of vibrations back to the instrument and/or the instrument rack.

All instruments should be shielded from natural or artificial light.

Ensure constant voltage to surge protection devices and equipment.

Regulate the housing temperature between 20-30°C. The operator's manual indicates that in non-condensing environments or when a water drop-out is present the instrument may be safely operated over the rage of 5-45°C. Hourly temperature readings are collected by the polling computer during daily polling. Polk County will make every effort to operate the monitor in the 20-30°C range. Data will be investigated to determine the validity of the data for hourly concentrations where the shelter temperatures fall outside the range of (20-30°C).

## 22.12 Quality Assurance

The audit schedule for SLAMS monitoring, is that each analyzer must be audited at least once a year. Polk County should audit 25 percent of the analyzers per quarter. Since Polk County operates only one TL-CO analyzer, it should be audited at least once a year as specified in Table 22-4 of this SOP or in the "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II – Ambient Air Specific Methods." However, it is Polk County Air Quality Division's policy to audit the TL-CO analyzer once per quarter.

### 22.12.1 Direct Comparison Audit

Once during each calendar quarter, the designated Quality Assurance Officer, utilizing the procedures and calculations specified in 40 CFR 58, Appendix A, "Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)," will audit the TL-CO analyzer using a direct comparison between the analyzer's current indicated value and the audit standard's current known concentration.

An audit is an independent assessment of the accuracy of data generated by an ambient air analyzer. Independence is achieved by having the audit performed by an operator other than the one conducting the routine field measurements and by using audit standards, reference materials, and equipment different from those routinely used in monitoring. Proper implementation of an auditing program will ensure the integrity of the data and assess the accuracy of the data.

An audit consists of challenging the 48*i*-TLE continuous analyzer with known concentrations of CO within the measurement range of the analyzer. The 146*i* Dynamic Gas Calibrators can be programmed to generate the desired CO audit concentrations, see Polk County Air Quality SOP Section 26.

Generate at least three of the following SLAMS audit concentrations: 0.020-0.059 ppm, 0.060-0.199 ppm, 0.200-0.899 ppm, 0.900-2.999 ppm, 3.000-7.999 ppm, 8.000-15.999 ppm, 16.000-30.999 ppm, 31.000-39.999 ppm, 40.000-50.000 ppm, and 50.000-60.000 ppm. One point should be within two to three times the method detection limit of the instruments. The second point should be less than or equal to the $99^{th}$ percentile of the data at the site. The third point should be around the primary NAAQS concentration or the highest 3-year concentration at the site.

Allow each audit concentration to stabilize for a minimum of 5 minutes. Record the site analyzers response from the data logger display. Readings should be taken only after a stable response is exhibited by the site analyzer. The results are recorded on the Quarterly Audit Field Sheet, Form 5, Appendix A.

The audit fails if any of the following acceptance criteria are not met:

- For EPA Audit Levels 1 and 2, the acceptance criteria is ± 0.030 ppm, or ±15%, whichever is greater
- The percent difference is outside ±15% for EPA Audit Levels 3-10.

If there is no reason to believe the results are incorrect or not representative of the analyzers performance, the cause for the audit failure must be investigated and corrected. In addition, if the absolute value of the zero reading is greater than 0.040 ppm during an audit, the results must also be investigated. An investigation initiated by audit results that are outside the above limits may require the invalidation of data. Record all information in the site log.

**NOTE: For more detailed information concerning audit performances for CO monitoring, refer to the "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II" or 40 CFR 58**.

### 22.12.2 Federal Audits

Agency staff is sent an audit device, such as for the National Performance Audit Program (NPAP). The agency staff does not know the CO concentrations produced by the audit equipment. Responses of the on-site analyzer are then compared against those of the generator and a linear regression is calculated.

The Polk County Air Quality Department will participate in the USEPA performance audit program for TL-CO and in all other EPA audit programs, which may arise in the future. According to the May 2013 Redbook, The audit fails if any of the following acceptance criteria are not met:

- For EPA Audit Levels 1 and 2, the acceptance criteria is ± 0.030 ppm, or ±15%, whichever is greater
- The percent difference is outside ±15% for EPA Audit Levels 3-10.

If there is no reason to believe the results are incorrect or not representative of the analyzers performance, the cause for the audit failure must be investigated and corrected. An investigation initiated by audit results that are outside the above limits may require the invalidation of data. Record all information in the site log.

## 22.13 Data Quality Assessment

EPA recommends that measurement quality objectives for bias and precision be based on upper confidence limits at the monitoring site level, to provide a higher probability of reaching appropriate conclusions (e.g., in comparisons to NAAQS). The intent of this recommendation is to move agencies to a performance-based quality system, allowing organizations that show tight control of precision and bias to reduce the frequency of certain QC checks, and to focus their quality system efforts where most needed.

For each calendar quarter and year, Polk County Air Quality will prepare data precision, accuracy and completeness reports for the Iowa Department of Natural Resources (Iowa DNR) and EPA-Region 7 in accordance with the current Letter of Agreement (LOA).

### 22.13.1 Precision

Precision is defined as the measure of agreement among individual measurements of the same property taken under the same conditions. Precision is assessed from checks that are performed at least once every two weeks (see Section 22.14). Calculations to assess precision are given below and should be used to assess precision on a quarterly basis. It is recommended that high sensitivity CO analyzers have a 95 percent probability limit for precision of ±10 percent or less.

The precision will be evaluated and reported employing the frequencies, procedures and calculations in 40 CFR Part 58, Appendix A, "Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)".

### 22.13.2 Accuracy

The Polk County Air Quality Program participates in the USEPA performance audit program for CO and in all other EPA audit programs, which may arise in the future. Using results from the performance audits and the calculations specified in 40 CFR 58, Appendix A, "Quality Assurance Requirements for State and Local Air Monitoring Stations". The accuracy will be evaluated and reported.

### 22.13.3 Data Completeness

The completeness of the data will be determined for each monitoring instrument and expressed as a percentage. Percent valid data will be a gauge of the amount of valid data obtained from the monitoring instrument, compared to the amount expected under ideal conditions (24 hours per day, 365 days per year). Exceptions will be made for analyzers with a seasonal sampling period, which were not installed at the beginning, or which were discontinued prior to the end of any reporting period for calculation purposes.

## 22.14 Procedures of Bi-Weekly Checks

New station operators will be provided with on-site training by an experienced operator before they operate a station on their own. The following procedures are intended to assist the operator in performing and documenting monitoring procedures. Monitoring personnel must become familiar with the Operating and Maintenance Manuals for Thermo Scientific Model 48*i* Trace Level, CO Analyzer, Instruction Manual.

### 22.14.1 Maintenance Mode for Agilaire Model 8832 Data Loggers

During any maintenance, zero/precision/span checks, calibrations, audits, or site visit the data logger must be placed into maintenance mode. This mode flags hourly data with an (M), indicating the analyzer is in the process of being checked by the technician. Scroll down to **LOGIN/SET USER LEVEL (or just press L)** and press **ENTER**. Login to the data logger using the appropriate password and press **ENTER**. Use the arrow keys to scroll to **CONFIGURATION MENU (C)** and press **ENTER**. Use the arrow keys to select **CONFIGURE (DATA) CHANNEL (D)** and press **ENTER**. Use the arrow keys to select **PUT CHANNEL IN MAINTENANCE MODE (I)** and press **ENTER**. Select the correct pollutant channel and press **ENTER**. Press the escape button (Esc) twice, then scroll to **REAL-TIME DISPLAY MENU (D).** Then select **DISPLAY READINGS WITH FLAGS (F)** to confirm there is an M flag next to the appropriate channels for maintenance. Repeat procedures for all appropriate channels. Proceed with maintenance, weekly precision/span check, calibration, or audit of the analyzer. Figure 22-2 displays and data logger Model 8832.

### 22.14.2 Maintenance and Diagnostics Check

Begin by checking and recording the monitor readings on the data logger. Check and record any alarms on the analyzer. If alarms are present, check field sheet for out-of-control limits and perform any necessary maintenance. Check and record all diagnostics on the Verification Field Sheet, Form 6, Appendix A. Table 22-3 displays a list of diagnostic checks and their explanations.

Check and record the calibration factors on the 48i-TLE. Press **MENU** and scroll to **CALIBRATION FACTORS** and press **ENTER**. Record the BKG and COEF coefficients.

**Figure 22-2: The Agilaire Model 8832 Data Logger**


Write down any maintenance that was performed on the instrument or additional comments that may affect the air monitoring system. Examples include:

- replacement of UV lamps, pumps or tubing
- repairs or maintenance made to or around the shelter
- abnormal localized occurrences nearby
- suggestions for improvements to the system
- supplies that are needed
- checks or audits that were performed

**Table 22-3: Diagnostic Checks**

| Check | Explanation |
|---|---|
| Voltages | The DC power supply voltages |
| Temperatures | The internal instrument and chamber temperatures |
| Pressure | The optical chamber pressure |
| Flow | The sample flow rate |
| Sample/Reference Ratio | The ratio of the intensities of the light source through the sample (CO) side and reference ($N_2$) side of the correlation wheel |
| AGC intensity | The intensity of the reference channel Automatic Gain Control circuit |
| Motor Speed | The status of the chopper motor |

### 22.14.3 Zero, Precision and Span Checks

Use the 146*i* to perform the zero/precision/span checks by diluting the cylinder gas to the desired precision/span levels. The zero/precision/span check must be performed through the sample line filter used in daily sampling. The ranges are as follows:

- Precision: 0.550 ppm
- Span: 4.500 ppm

The zero air must be free of contaminants that could cause a detectable response on the TL-CO analyzer. Polk County Air Quality Division uses the Teledyne 701H air generator with charcoal, Purafil®, and hydrocarbon scrubbers for the source of zero air. For more information on zero air scrubbers, see Polk County Air Quality SOP Section 25 for instructions for the Zero Air Module Model 701/701H.

The external zero air generator is connected to the zero air port on the back of the 146*i* Calibrator. The 146*i* Calibrator output port is connected to the 48*i*-TLE site analyzer's sample/zero port.

#### 22.14.3.1 Span Checks

On the Main Screen (or Standby Screen) of the 146*i* Calibrator, press the **MENU** button to access the Main Menu Screen. Scroll to **OPERATION** and press **ENTER**. Use the ← and → buttons to select **CO GAS**. Use the ↓ button to scroll down to **SPAN**. Use the ← and → buttons to scroll to **SPAN 4** and press **ENTER**. **SPAN 4** has been programmed to produce the span check in the range of 4.000-5.000 ppm. Perform the span check using a cylinder containing 150 to 250 ppm CO in $N_2$. The flow can be read on the 146*i* Calibrator display screen by pressing the Diagnostics Quick button. Scroll to Flow and select Enter. This screen reports the actual gas and zero-air flows and the corresponding target flows.

Allow the site analyzer to run for 15 minutes or until stable, then record the CO flow, zero actual and gas actual readings from the TL-CO channels on the Verification Field Sheet, Form 6, Appendix A.

**NOTE**: **Polk County Air Quality uses the Agilaire Model 8832 data loggers for data recording. The values indicated on the data logger are the values that are being transmitted to, and recorded by, the central computer. Therefore, it is important that data logger readings be recorded on the field sheet.**

Determine the analyzer's % difference by using the following equation to determine the percent difference between the data logger and the transfer standard:

$$\%Difference = \frac{C_M - C_{146}}{C_{146}} \times 100$$

Where:

$C_M$ = data logger concentration, ppm

$C_{146}$ = Calibrator concentration, ppm

Refer to Section 22.10.3 for acceptable control limits.

For control limits and recommended corrective actions, refer to Table 22-4 in this SOP or to the Measurement Quality Objective Tables from the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Appendix D. EPA-454/B-13-003, July 2014. If a calibration is necessary, it must be performed after the zero/precision/span checks are finished.

### 22.14.3.2 Precision Check

At this point the span readings have been recorded, perform the precision level check. On the Main Screen (or Standby Screen) of the 146*i* Calibrator, press the **MENU** button to access the Main Menu Screen. Scroll to **OPERATION** and press **ENTER**. Use the ↓ button to scroll down to **SPAN**. Use the ← and → buttons on the 146*i* to scroll to **SPAN 1** and press **ENTER**. **SPAN 1** has been programmed to produce the precision level of 0.550 ppm.

Allow the site analyzer to stabilize for a minimum of 15 minutes and record all data logger readings from the TL-CO channels on the Verification Field Sheet, Form 6, Appendix A.

### 22.14.3.3 Zero Air Check

At this point the precision reading has been recorded, perform the zero check. On the Main Screen (or Standby Screen) of the 146*i* Calibrator, press the **MENU** button to access the Main Menu Screen. Scroll to **OPERATION** and press **ENTER**. Use the ↓ button to scroll down to **SPAN**. Use the ← and → buttons on the Calibrator to scroll to **ZERO** and press **ENTER** to put the 146*i* Calibrator in zero air mode. With the zero air flowing, verify that the Calibrator and data logger reads 0.000 ppm ± 0.040 ppm. Allow the site analyzer to stabilize for a minimum of 15 minutes and record all data logger readings from the TL-CO channels on the Verification Field Sheet, Form 6, Appendix A.

**NOTE: If a problem is recognized while performing maintenance, diagnostic, zero air, weekly precision or span checks which has or could affect data, a corrective action form is to be filled out describing the problem identified and the action taken to correct the problem, Form 7, Appendix A. All forms and documentation must be submitted to the Quality Assurance Officer**.

### 22.14.3.4 Invalidate Data and Recalibrate

The following critical criteria require recalibration of the field analyzer and invalidation of the data unless there is compelling reason and justification not to do so: if the precision check or span drift results are greater than $\pm$ 10%. The zero drift criteria of $\geq$ 0.040 ppm will be used as an action level which may require recalibration of the field analyzer and invalidation of data. See Section 22.9 for calibration procedures.

**NOTE: In order to minimize data loss, Polk County personal will recalibrate the instrument when the results of bi-weekly checks reach recalibration thresholds, unless there is compelling reason and justification not to do so. Recalibration criteria refer to thresholds that typically require recalibrating the analyzer, but do not require the invalidation of data. Recalibration criteria should be set to levels that are as tight as practically possible, and based on historical performance data. They may change after reviewing typical differences from control charts.**

### 22.14.4 Standby Mode

Once all checks have been completed, put the 146*i* Calibrator back in Standby Mode. On the 146i press the quick button (OPER) and use the ← → arrows to change the gas to off and press Enter. Then press the quick button (MODE). Scroll to Standby and press enter. Then press the run button to get to the standby screen.

On the Data Logger press the escape button (Esc) until the main menu is reached. Take the data logger out of maintenance mode by using the arrow keys to scroll to **CONFIGURATION MENU (C)** and press **ENTER**. Use the arrow keys to select **CONFIGURE DATA CHANNELS (D)** and press **ENTER**. Use the arrow keys to select **TAKE CHANNEL OUT OF MAINTENANCE (O)** and press **ENTER**. Repeat procedures to take all channels out of maintenance mode. Press the (Esc) button until the main menu is reached. Use the arrow keys to select **LOG OUT** and press **ENTER**. Record all information on tasks performed in the site log.

## 22.15 Automated Zero and Span Checks

An external 24-hour automated zero/precision/span check is conducted utilizing the auto function of the Thermo Scientific 146*i* Multi Gas Calibrator in conjunction with the 48*i*-TLE analyzer. The data is flagged for this period with a "C" on the data logger.

A three-way solenoid valve is used to dictate whether the air flow to the site analyzer is ambient air from the sample inlet, or CO gas generated by the transfer standard during automated checks. During regular sampling, the valve is open to allow ambient air to enter and be sampled by the site analyzer. The valve connected to the calibrator is closed so that only ambient air will be sampled during that time. During the automated zero/precision/span checks, the valves are closed to restrict the flow of ambient air. The valve connected to the calibrator is opened so that only the challenge gas will be sampled by the site analyzer.

The automated zero, precision and span checks are used to determine if the 48*i*-TLE is operating properly, and if drift in instrument response has occurred. For these checks, the challenge gas should be sampled through as much of the sampling inlet system as practical to mimic the actual sampling of ambient air. The results of the zero/precision/span checks should be plotted on control charts to graphically illustrate the trends in the response of the analyzer to the challenge gases.

Polk County Air Quality Division will analyze "drift" as a direct comparison of the current indicated concentration collected from the site analyzer to the actual concentration collected from the Transfer Standard. Polk County Air Quality Division will strive to obtain a zero drift $\leq$ 0.040 ppm, a span drift $\leq$ 10% of the span level, and a % difference for precision $\leq$ 10%. If the daily automated precision check results are outside ± 10%, the instrument will be recalibrated and the data will be invalidated to the last acceptable check, unless there is a compelling reason and justification not to do so.

There are several components to a successful automated zero/precision/span checks:

- A zero air generator that gives an output of at least 20 psig. The generator is equipped with dual scrubbers of charcoal and Purafil® to remove any water vapor or contaminants that may result in scrubbing. See Polk County Air Quality SOP Section 25 for instructions for the Teledyne 701H Zero Air Generator.
- A Calibration Program setup in the 146*i* Calibrator

- Digital input communication setup in the AirVision Software for the Agilaire Model 8832 data logger
- A Calibration Program setup in the AirVision Software for the Agilaire Model 8832 data logger

### 22.15.1 Calibration Program in the 146*i* Calibrator

A calibration program must be set up in the 146*i* Calibrator before the calibration will occur. From the Main Menu, use the ↓ button to scroll to **PROGRAM** and press **ENTER**. From the Program Menu, use the ↓ button to scroll to **PROGRAM CYCLE** and press **ENTER**.

#### 22.15.1.1 Program Cycle

The Program Cycle screen is used to turn the program mode on or off. The Program Cycle must be enabled for a programmed event to occur. From the Program Cycle Status Screen, press **ENTER** enable the program cycle.

#### 22.15.1.2 Period Hours

The Period Hours screen defined the period or interval between zero/precision/span checks. Periods between 0 and 999 hours are acceptable. To turn the check off, set the period to 0.

From the Program Menu, use the ↓ button to scroll to **PERIOD HOURS** and press **ENTER**. Use the ← and → buttons to move the cursor left or right, and the ↑ and ↓ buttons to increment or decrement to the desired numeric value. **Polk County Air Quality will use a sample period of 24-hours.**

#### 22.15.1.3 Next Cycle

The Next Cycle screen is used to view and set the next zero/precision/span check date and time. Once the initial check is performed, the date and time of the next check is calculated and displayed.

From the Program Menu, use the ↓ button to scroll to **NEXT CYCLE** and press **ENTER**. Use the → button to select: year, month, day, hour, minutes, or seconds. Use the ↑ or ↓ buttons to increase/decrease the desired value. Set the appropriate date and time and press **ENTER**. **Polk County Air Quality will set the cycle to occur daily at 22:07.**

#### 22.15.1.4 Events

The Events Menu is used to configure events that are part of the program cycle. The number of events and total time of enabled events are displayed. The target values on the right side of the display, is an abbreviated line that describes the settings for that specific event, and should show the desired values based on the displayed operation parameters on the left side. Specific parameters include:

- Gas: A-F, Zero
- Span level for the gas: 1-5, Zero
- Ozonator and permeation levels: 1-5, Off
- Photometer mode: I=internal, E=external, C=control
- Event duration time in minutes

From the Program Menu, use the ↓ button to scroll to **EVENTS** and press **ENTER.** Use the ↓ button to scroll to Event 1 and press **ENTER**. Event 1 will be used for the zero check. Use the ← and → buttons to scroll to **ENABLED** and press **ENTER** to enable the event. To set the zero duration, use the ↓ button to scroll to **DURATION** and press **ENTER**. Use the ← and → buttons to move the cursor left or right, and the ↑ and ↓ buttons to increment or decrement to the desired numeric value. Polk County Air Quality will sample zero air for 17 minutes. Use the ↓ button to scroll to **GAS** and press **ENTER**. Use the ← and → buttons to select **CO** and press **ENTER**. Use the ↓ button to scroll to the forth line and use the ← and → buttons select **ZERO** and press **ENTER**.

From the Events Menu, use the ↓ button to scroll to **EVENT 2** and press **ENTER.** Use the ↓ Event 2 will be used for the precision check. Use the ↓ button to scroll to **ENABLED** and press **ENTER** to enable the event. To set the precision duration, use the ↓ button to scroll to **DURATION** and press **ENTER.** Use the ← and → buttons to move the cursor left or right, and the ↑ and ↓ buttons to increment or decrement to the desired numeric value. Polk County Air Quality will sample precision gas for 17 minutes. Use the ↓ button to scroll to **GAS** and press **ENTER**. Use the ← and → buttons to select **CO** and press **ENTER**. Use the ↓ button to scroll **SPAN 1** and press **ENTER**. Span 1 has been programmed to sample gas at the precision level of 0.550 ppm. See Polk County Air Quality SOP Section 26 for instructions on programming the precision and span concentrations in the 146*i* for the Dynamic Gas Calibrators.

From the Events Menu, use the ↓ button to scroll to **EVENT 3** and press **ENTER.** Use the ↓ Event 3 will be used for the span check. Use the ↓ button to scroll to **ENABLED** and press **ENTER** to enable the event. To set the span duration, use the ↓ button to scroll to **DURATION** and press **ENTER.** Use the ← and → buttons to move the cursor left or right, and the ↑ and ↓ buttons to increment or decrement to the desired numeric value. Polk County Air Quality will sample span gas for 17 minutes. Use the ↓ button to scroll to **GAS** and press **ENTER**. Use the ← and → buttons to select **CO** and press **ENTER**. Use the ↓ button to scroll select **SPAN 4** and press **ENTER**. Span 4 has been programmed to sample gas at the span level of 4.500 ppm. See Polk County Air Quality SOP Section 26 for instructions on programming the precision and span concentrations in the 146*i* for the Dynamic Gas Calibrators.

### 22.15.2 Calibration Communication Settings in Agilaire AirVision Software

The Model 146*i* communicates with the 8832 ESC data logger via of Modbus through the Ethernet. For an instrument-controlled calibration, the digital inputs must be assigned in AirVision, in order for the instrument to communicate with the logger when a calibration is occurring and when there is a change from one calibration phase to another. See Polk County Air Quality AirVision SOP Section 18 for instructions on programming digital inputs in AirVision software.

### 22.15.3 Calibration Program in Agilaire AirVision Software

A Calibration Program must be set up in AirVision in order for the software to recognize that the instrument is in calibration mode and flags the data with a "C". An Instrument-Controlled Calibration program will be used. An instrument-controlled calibration is initiated by the calibration program set up in the Thermo 146*i* Calibrator, refer to Section 22.15.1. The data logger senses the zero, precision, and span phases through its digital input lines. For each phase, a specific pattern of input control line status is defined. The data logger monitors input control line status and when the specified pattern is met, the corresponding calibration phase is initiated. There is no predefined duration for individual phases programmed into the AirVision calibration program; each phase will continue until the input line pattern

is no longer met. The duration of each phase is determined by the calibration program in the Thermo 146*i* Calibrator. **Polk County uses a 17-minute duration for each desired phase.** At the end of each phase, the concentrations are written into the calibration report. See Polk County Air Quality AirVision SOP Section 18 for instructions on setting up a calibration program in AirVision software.

The specific pattern of input control line status currently in us for TL-CO:

- Zero Phase: 28 = on, 29 = off, 30 = off
- Precision Phase: 28 = on, 29 = on, 30= off
- Span Phase: 28 = on, 29 = on, 30 = on

**NOTE: When reading the status inputs from the Model 8832 data logger, the following patterns will be observed:**

- Zero Phase: 28&29=0&30=0
- Precision Phase: 28,29&30=0
- Span Phase: 28&29&30

## Table 22-4 Measurement Quality Objectives

**CO Validation Template**

| 1) Requirement (CO) | 2) Frequency | 3) Acceptance Criteria | Information /Action |
|---|---|---|---|
| **CRITICAL CRITERIA-CO** | | | |
| ***One Point QC Check Single analyzer*** | ***1/ 2 weeks*** | ≤ ±10% (percent difference) | 1 and 2) 40 CFR Part 58 App A Sec 3.2<br>3) Recommendation based on DQO in 40 CFR Part 58 App A Sec 2.3.1. QC Check Conc range 1 - 10 ppm relative to routine concentrations |
| Zero/span check | 1/ 2 weeks | Zero drift ≤ ± 0.4 ppm (24 hr)<br>≤ ± 0.6 ppm (>24hr-14 day)<br>Span drift ≤ ± 10 % | 1 and 2) QA Handbook Volume 2 Section 12.3<br>3) Recommendation |
| **OPERATIONAL CRITERIA-CO** | | | |
| Shelter Temperature range | Daily<br>(hourly values) | 20 to 30° C. (Hourly avg)<br>or<br>per manufacturers specifications if designated to a wider temperature range | 1, 2 and 3) QA Handbook Volume 2 Section 7.2.2<br><br>Generally the 20-30 ° C range will apply but the most restrictive operable range of the instruments in the shelter may also be used as guidance. FRM/FEM list found on AMTIC provides temp. range for given instrument. FRM/FEM monitor testing is required at 20-30 ° C range per 40 CFR Part 53.32 |
| Shelter Temperature Control | Daily (hourly values) | ≤ ± 2° C SD over 24 hours | 1, 2 and 3) QA Handbook Volume 2 Section 7.2.2 |
| Shelter Temperature Device Check | 1/6 mo | ± 2°C of standard | 1, 2 and 3) QA Handbook Volume 2 Section 7.2.2 |
| ***Annual Performance Evaluation Single Analyzer*** | ***Every site 1/year 25 % of sites quarterly*** | Percent difference of audit levels 3-10 ≤ ±15%<br>Audit levels 1&2 ± 0.03 ppm difference or ±15% | 1 and 2) 40 CFR Part 58 App A sec 3.2.2<br>3) Recommendation- 3-audit concentrations not including zero. AMTIC guidance 2/17/2011<br>http://www.epa.gov/ttn/amtic/coreldoc.html |
| ***Federal Audits (NPAP)*** | 1/year at selected sites 20% of sites audited | Audit levels 1&2 ± 0.03 ppm difference all other levels percent difference ± 15% | 1) 40 CFR Part 58 App A sec 2.4<br>2) NPAP adequacy requirements on AMTIC<br>3) NPAP QAPP/SOP |
| ***Verification/Calibration*** | Upon receipt/adjustment/repair/ installation/moving<br>1/6 months if manual zero/span performed biweekly<br>1/year if continuous zero/span performed daily | All points within ± 2 % of calibration range of best-fit straight line | 1) 40 CFR Part 50 Appendix C Section 4<br>2 and 3) Recommendation<br><br>See details about CO2 sensitive instruments Multi-point calibration (0 and 4 upscale points) |
| ***Gaseous Standards*** | All gas cylinders | NIST Traceable<br>(e.g., EPA Protocol Gas) | 1) 40 CFR Part 50 Appendix C Section 4.3.1<br>2) NA Green book<br>3) 40 CFR Part 50 Appendix C Section 4.3.1 See details about CO2 sensitive instruments<br>Gas producer used must participate in EPA Ambient Air Protocol Gas Verification Program<br>40 CFR Part 58 App A sec 2.6.1 |
| ***Zero Air/Zero Air Check*** | 1/year | ***< 0.1 ppm CO*** | 1) 40 CFR Part 50 App C Section 4.3.2 |

| 1) Requirement (CO) | 2) Frequency | 3) Acceptance Criteria | Information /Action |
|---|---|---|---|
| | | | 2) Recommendation<br>3) 40 CFR Part 50 App C Section 4.3.2 |
| Gas Dilution Systems | 1/year or after failure of 1 point QC check or performance evaluation | Accuracy ± 2 % | 1,2 and 3) Recommendation based on SO2 requirement in 40 CFR Part 50 App A-1 Sec 4.1.2 |
| **Detection (FEM/FRMs)** | | | |
| *Noise* | 1/year | *0.2 ppm (standard range)*<br>*0.1 ppm (lower range)* | 1) 40 CFR Part 53.23 (b) (definition & procedure)<br>2) Recommendation- info obtained from LDL<br>3) 40 CFR Part 53.20 Table B-1 |
| *Lower detectable level* | 1/year | *0.4 ppm(standard range)*<br>*0.2 ppm (lower range)* | 1) 40 CFR Part 53.23 (c) (definition & procedure)<br>2) Recommendation<br>3) 40 CFR Part 53.20 Table B-1 |
| **SYSTEMATIC CRITERIA-CO** | | | |
| *Sampler/Monitor* | NA | *Meets requirements listed in FRM/FEM designation* | 1) 40 CFR Part 58 App C Section 2.1<br>2) NA<br>3) 40 CFR Part 53 & FRM/FEM method list |
| *Standard Reporting Units* | *All data* | *ppm (final units in AQS)* | 1, 2 and 3) ) 40 CFR Part 50.8 (a) |
| *Rounding convention for data reported to AQS* | *All data* | *1 decimal place* | 1, 2 and 3) 40 CFR Part 50.8 (d) (for averaging values for comparison to NAAQS not for reporting individual hourly values.) |
| *Completeness* | *8-hour standard* | *75% of hourly averages for the 8-hour period* | 1) 40 CFR Part 50.8(c)<br>2) 40 CFR Part 50.8(a-2)<br>3) 40 CFR Part 50.8(c) |
| Sample Residence Time Verification | 1/year | < 20 seconds | 1,2, and 3) Recommendation. CO not a reactive gas but suggest following same methods other gaseous criteria pollutants. |
| Sample Probe, Inlet, Sampling train | All Sites | Borosilicate glass (e.g., Pyrex®) or Teflon® | 1,2, and 3) Recommendation. CO not a reactive gas but suggest following same methods other gaseous criteria pollutants. FEP and PFA have been accepted as a equivalent material to Teflon. Replacement/cleaning is suggested as 1/year and more frequent if pollutant load dictate. |
| Siting | 1/year | *Meets siting criteria or waiver documented* | 1) 40 CFR Part 58 App E, sections 2-6<br>2) Recommendation<br>3) 40 CFR Part 58 App E, sections 2-6 |
| *Precision(using 1-point QC checks)* | *Calculated annually and as appropriate for design value estimates* | *90% CL CV ≤ 10%* | 1) 40 CFR part 58 App A sec 3.2.1<br>2) 40 CFR Part 58 App A sec 4 (b)<br>3) 40 CFR Part 58 App A sec 4.1.2 |
| *Bias (using 1-point QC checks)* | *Calculated annually and as appropriate for design value estimates* | *95% CL ≤ ± 10%* | 1) 40 CFR Part 58 App A sec 3.2.1<br>2) 40 CFR Part 58 App A sec 4 (b)<br>3) 40 CFR Part 58 App A sec 4.1.3 |
| *Annual PE Primary QA Organization (PQAO) Evaluation* | 1/year | *95% of audit percent differences fall within the one point QC check 95% probability intervals at PQAO level of aggregation* | 1) 40 CFR Part 58 App A Section 3.2.2<br>2) Recommendation<br>3) 40 CFR Part 58 App A sec 4.1.4 & 4.1.5 |

**Note: Polk County Air Quality's SOP may specify more stringent requirements or non critical criteria or more frequent QA procedures than required by the EPA. The operational and systematic criteria listed in the MQO Table are the Federal minimum criteria only.**

## APPENDIX A-Critical Forms and Field Sheets

# Form 1 – Gas Comparison Spreadsheet

| | |
|---|---|
| Date | 12/20/16 |
| Time | 1PM |
| Site | Carpenter |
| Pollutant | CO |
| Operator | JM |

**Gases**

| | | |
|---|---|---|
| Standard Cylinder Conc. | 243.00 | PPM |
| Serial Number | CC114981 | |
| Expiration Date | 08/01/21 | |
| Canidate Cylinder Conc. | 241.60 | PPM |
| Serial Number | CC18867 | |
| Expiration Date | 07/25/24 | |

**Instruments**

| | | |
|---|---|---|
| Gas Calibrator | Thermo 146i | 1030945144 |
| Last Verification | 7/11/2016 | |
| Monitor | Thermo 48i | 1153210046 |
| Last Calibrated | 12/5/2016 | |

**ZERO TEST**

| | *AIR* | *GAS* | *Known Value* | *Instrument Response* |
|---|---|---|---|---|
| **Verification** | **Zero Air Actual MFC** | **Gas Pollutant Actual MFC** | **CO** | **CO** |
| | **SCCM** | **SCCM** | **PPM** | **PPM** |
| **Standard Zero** | 7994 | 0 | 0.0 | 0.02 |
| **Canidate Zero** | 7994 | 0 | 0.0 | 0.00 |

**VERIFICATION**

| | *AIR* | *GAS* | *Known Value* | *Instrument Response* | *% Difference* | *Pass* |
|---|---|---|---|---|---|---|
| **Verification** | **Zero Air Actual MFC** | **Gas Pollutant Actual MFC** | **CO** | **CO** | **CO** | **CO** |
| | **SCCM** | **SCCM** | **PPM** | **PPM** | **PPM** | **PPM** |
| **Standard Precision .450** | 15470 | 28.69 | 0.450 | 0.46 | | |
| **Candidate Precision .450** | 15470 | 28.85 | 0.450 | 0.45 | 2.9 | TRUE |
| **Standard Span 4.500** | 4017 | 75.91 | 4.500 | 4.54 | | |
| **Candidate Span 4.500** | 4017 | 76.33 | 4.500 | 4.46 | 1.8 | TRUE |

| **Average Percent Diffenece** | **Is Average Percent Diffence ±4% ?** |
|---|---|
| 2.3 | TRUE |

| **Is Candidate Gas OK ?** |
|---|
| TRUE |

## Form 2 – Calibration Field Sheet

Trace Level Carbon Monoxide Calibration Sheet **Site:**_____

**Date:** _____
**Time:** _____
**Tech:**_____
**Analyzer Ser #:**_____
**Data of last calibration:**_____
**Calibrator Ser #:**_____
**Date of last calibration:** _____

**Date of last audit:**_____
**Date of last verification:** _____
**Zero air Ser #:** _____
**Last annual maintenance:** _____
**Gas cylinder ser #:** _____

**Gas expiration date:** _____
**Cylinder>200 psig? (Y or N)**
**Psig reading:** _____

**Cylinder Concentration:** _____
**Zero Coefficient Reading:** _____

**Precision Coefficient Reading:**_____
**Station Observations Made: (Y or N)**
**Data logger recording shelter temp?**
**(Y or N) Reading:**_____
**Changed Filter? (Y or N)**
**Sample Line Checked? (Y or N)**

**Date/Days Elapsed:**_____
**Ambient:**_____

| Checks | Value | Alarm? (Y or N) | If Yes, Suggested Corrective Actions |
|---|---|---|---|
| BIAS Voltage: (-130 to -100 Volts) | | | Refer to Instruction Manual. |
| Internal Temp: (38-43°C) | | | Refer to Instruction Manual. |
| Bench Temp: (40-59°C) | | | Refer to Instruction Manual. |
| Pressure: (250-1000 mmHg) | | | Replace pressure transducer |
| Flow: (0.3-1.5 LPM) | | | Replace Pump |
| S/R Ration (1.00-1.18) | | | Replace to Instruction Manual. |
| AGC Intensity: (150,000-300,000) | | | Replace/clean correlation wheel<br>Replace IR source |
| Motor Speed: (100%) | | | Replace motor |

| | Zero Actual sccm | Gas Actual sccm | ESC Reading 'Monitor' | 146 C Calibrator 'Assessment' | CALCULATIONS |
|---|---|---|---|---|---|
| **Reading** | | | | | **% Difference**<br>% Difference Drift = (Data Logger Reading – Transfer Standard Reading) x 100 / Transfer Standard Reading |
| | | | | | **DRIFT**<br>**Zero Drift = Current Data Logger Reading – Calibrator Reading** |
| **Unadjusted Zero** | | | | | |
| **External Zero<br>Span 0** | | | | | |
| **Level 4<br>Span 1 (.500-.600 ppm)<br>Set Point: .550 ppm** | | | | | |
| **Level 3<br>Span 2 (1.000-1.500)<br>Set Point: 1.200 ppm** | | | | | |
| **Level 2<br>Span 3 (2.000-2.500)<br>Set Point: 2.250 ppm** | | | | | |
| **Level 1<br>Span 4 (4.000-5.000)<br>Set Point: 4.500 ppm** | | | | | |

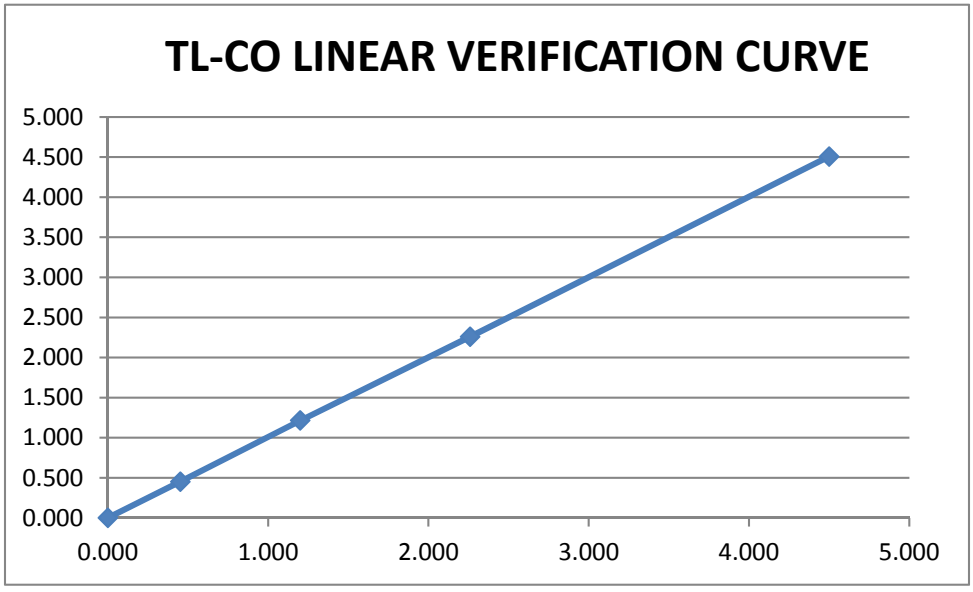
The following critical criteria require recalibration of the field analyzer and invalidation of the data unless there is compelling reason and justification not to do so: if the precision or span check results in a percent difference ± 10%. The zero drift of ± 0.040 ppm is considered an action level for investigation that may lead to the invalidation of data. See SOP for calibration procedures.

**Form 3 – Calibration Linear Regression**

# Trace Level Carbon Monoxide Multi-Point Calibration Spreadsheet

| | |
|---|---|
| **Analyzer:** | **TECO Model 48I CO Trace** |
| **Serial No.:** | **904034721** |
| **Site:** | **Carpenter** |
| **Operator:** | **RP** |
| **Full Scale: ppm** | **5** |
| **2% of Full Scale: ppm** | **0.1** |
| **Date:** | **July 18, 2012** |
| **Zero Set Pt Prior:** | **0.175** |
| **Span Set Pt Prior:** | **1.036** |
| **Zero Set Pt Post:** | **0.175** |
| **Span Set Pt Post:** | **1.036** |
| **Zero/Span Adjust Made?:** | **no** |
| **Cal. Gas Serial #** | **cc275898** |
| **Gas Expiration Date** | **3/11/2013** |

| Known Conc. | Measured Conc. | rpd | slope | intercept | rsq | forecast | distance to least squares line | acceptable distance | Pass/ Fail |
|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 0.002 | n/a | 1.0006 | 0.0042 | 1.0000 | 0.0042 | 0.0022 | 0.100 | pass |
| 0.452 | 0.453 | 0.2% | | | | 0.4565 | 0.0035 | 0.100 | pass |
| 1.200 | 1.216 | 1.3% | | | | 1.2049 | 0.0111 | 0.100 | pass |
| 2.260 | 2.260 | 0.0% | | | | 2.2655 | 0.0055 | 0.100 | pass |
| 4.500 | 4.507 | 0.2% | | | | 4.5068 | 0.0002 | 0.100 | pass |



**Form 4 – Converter Efficiency Field Sheet**

# SCRUBBER EFFICIENCY TEST

| | |
|---|---|
| Date | |
| Quarter | |
| Auditor | |

| | ***Instrument Response*** |
|---|---|
| **Pollutant** | **CO** |
| **Level** | **ppm** |
| 3 - (1.5-2.99) | 2.000 |

| **CO SCRUBBER EFFICIENCY TEST** | |
|---|---|
| **CO** | **ZERO READING** |
| **MINUTE** | **ppm** |
| 1 | 0.002 |
| 2 | 0.009 |
| 3 | 0.012 |
| 4 | 0.022 |
| 5 | 0.001 |
| **AVERAGE** | **0.009** |

| **SCRUBBER EFFICIENCY** | **Is Converter Efficiency 1 ±0.05 ?** |
|---|---|
| 99.54% | TRUE |

## Form 5 – Trace CO Audit Sheet

Trace Level Carbon Monoxide Audit Field Sheet **Site:**_____

**Date:** _____
**Time:** _____
**Tech:**_____
**Analyzer Ser #:**_____
**Data of last calibration:**_____
**Calibrator Ser #:**_____
**Date of last calibration:** _____
**Date of last audit:**_____
**Date of last verification:** _____
**Zero air Ser #:** _____
**Last annual maintenance:** _____
**Gas cylinder ser #:** _____
**Gas expiration date:** _____
**Cylinder>200 psig? (Y or N)**
**Psig reading:** _____
**Cylinder concentration:** _____
**Zero Coefficient Reading:** _____
**Precision Coefficient Reading:**_____
Station Observations Made: (Y or N)
**Data logger recording shelter temp?**
**(Y or N) Reading:**_____
**Changed Filter? (Y or N)**
**Sample Line Checked? (Y or N)**
**Date/Days Elapsed:**_____
**Ambient:**_____

| Checks | Value | Alarm? (Y or N) | If Yes, Suggested Corrective Actions |
|---|---|---|---|
| BIAS Voltage: (-130 to -100 Volts) | | | Refer to Instruction Manual. |
| Internal Temp: (38-43°C) | | | Refer to Instruction Manual. |
| Bench Temp: (40-59°C) | | | Refer to Instruction Manual. |
| Pressure: (250-1000 mmHg) | | | Replace pressure transducer |
| Flow: (0.3-1.5 LPM) | | | Replace Pump |
| S/R Ration (1.00-1.18) | | | Replace to Instruction Manual. |
| AGC Intensity: (150,000-300,000) | | | Replace/clean correlation wheel<br>Replace IR source |
| Motor Speed: (100%) | | | Replace motor |

| | Zero Actual sccm | Gas Actual sccm | ESC Reading 'Monitor' | 146 C Calibrator Concentration 'Assessment' | CALCULATIONS |
|---|---|---|---|---|---|
| **Reading** | | | | | |
| | | | | | **DRIFT**<br>**Zero Drift = Current Data Logger Reading – Calibrator Reading** |
| **1) Unadjusted Zero** | | | | | |
| **2) External Zero**<br>**Span 0** | | | | | |
| | | | | | **% DIFFERENCE**<br>**(Data Logger Reading – Transfer Standard Reading) x 100**<br>**Transfer Standard Reading** |
| **3) Level 2**<br>**Range 0.06-0.199 ppm** | | | | | |
| **4) Level 3**<br>**Range 0.2 - 0.899ppm** | | | | | |
| **5) Level 4**<br>**Range 0.9-2.99 ppm** | | | | | |

**If the difference is outside 0.030 ppm or ±15% for audit levels 1-2, or if the difference is outside ± 15% for audit levels 3-10, and there is reason to believe the results are incorrect or not representative of the analyzers performance, the cause for the error must be investigated and corrected. An investigation initiated by audit results outside the above limits may require the invalidation of data.**

## Form 6 – Verification Field Sheet

Trace Level Carbon Monoxide Field Sheet

**Site:**_____
**Date:** _____
**Time:** _____
**Tech:**_____
**Analyzer Ser #:**_____
**Data of last calibration:**_____
**Calibrator Ser #:**_____
**Date of last calibration:** _____

**Date of last audit:**_____
**Date of last verification:** _____
**Zero air Ser #:** _____
**Last annual maintenance:** _____
**Gas cylinder ser #:** _____

**Gas expiration date:** _____
**Cylinder>200 psig? (Y or N)**
**Psig reading:** _____
**Cylinder Concentration:** _____
**Zero Coefficient Reading:** _____
**Precision Coefficient Reading:**_____

**Station Observations Made: (Y or N)**
**Data logger recording shelter temp?**
**(Y or N) Reading:**_____
**Changed Filter? (Y or N)**
**Sample Line Checked? (Y or N)**
**Date/Days Elapsed:**_____
**Ambient:**_____

| Checks | Value | Alarm? (Y or N) | If Yes, Suggested Corrective Actions |
|---|---|---|---|
| BIAS Voltage: (-130 to -100 Volts) | | | Refer to Instruction Manual. |
| Internal Temp: (38-43°C) | | | Refer to Instruction Manual. |
| Bench Temp: (40-59°C) | | | Refer to Instruction Manual. |
| Pressure: (250-1000 mmHg) | | | Replace pressure transducer |
| Flow: (0.3-1.5 LPM) | | | Replace Pump |
| S/R Ration (1.00-1.18) | | | Replace to Instruction Manual. |
| AGC Intensity: (150,000-300,000) | | | Replace/clean correlation wheel<br>Replace IR source |
| Motor Speed: (100%) | | | Replace motor |

| | Zero Actual sccm | Gas Actual sccm | ESC Reading 'Monitor' | 146 C Calibrator 'Assessment' | CALCULATIONS |
|---|---|---|---|---|---|
| **Reading** | | | | | |
| | | | | | **DRIFT**<br>**Zero Drift = Current Data Logger Reading – Calibrator Reading** |
| **1) Unadjusted Zero** | | | | | |
| **2) External Zero**<br>**Span 0** | | | | | |
| | | | | | **% DIFFERENCE**<br>**(Data Logger Reading – Transfer Standard Reading) x 100**<br>**Transfer Standard Reading** |
| **3) Precision Level**<br>**Span 1 (.500-.600 ppm)**<br>**Set Point: .550 ppm** | | | | | |
| **5) Span Level**<br>**Span 4 (4.000-5.000)**<br>**Set Point: 4.500 ppm** | | | | | |

The following critical criteria require recalibration of the field analyzer and invalidation of the data unless there is compelling reason and justification not to do so: if the precision or span check results in a percent difference ± 10%. The zero drift of ± 0.040 ppm is considered an action level for investigation that may lead to the invalidation of data. See SOP for calibration procedures.

**Form 7 – Corrective Action Form**

## Polk County Corrective Action Form

To: _____ Polk Co. Air Quality _____
(position)

From: _____

Copies of completed form to: AQ Supervisor, File

Urgency: ☐ Emergency (immediate action needed) ☐ Urgent (24 Hr.)

☐ Routine (7 days) ☐ Next scheduled visit ☐ Information only

**Problem Identification:**

Site: _____
System: _____
Date: _____

Description of Problem: _____

Recommended Action: _____

Signature of Initiator: _____ Date: _____

**Problem Resolution:**

Date of Corrective Action: _____

Summary of Corrective Action: _____

Result of Corrective Action: _____

Signature of resolver: _____ Date: _____

Signature of QA Officer: _____ Date: _____