Alberta Environment

Title: Standard Operating Procedure for Measurement of CO in Ambient Air by Gas Filter Correlation (GFC)		
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1. INTRODUCTION AND SCOPE

To obtain timely data for the purpose of air quality assessment, air quality trend reporting, air quality index reporting and to meet the requirements for inclusion of the data in provincial and national air quality databases, a continuous method of analyzing Carbon Monoxide (CO) concentrations in ambient air is used. This method is capable of measurement updates at a rate of once every five minutes or faster. Readings from instruments of this method enables the calculation of hourly averaged concentrations of CO. Commercially available CO analyzers are used in the method.

This method is applicable to the measurement of CO concentrations in ambient air in the range of 0.05 parts per million (ppm) to 50.0 parts per million (ppm).

This method adheres to the requirements of the current Air Monitoring Directive (AMD) 1989by Alberta Environment In some cases the limits and specifications exceed the requirements of the current AMD and subsequent amendments ?which amendments?. It should be considered that the current and any future amendments or drafts of the AMD will be used as the benchmark for requirements and criteria for ambient air monitoring practices conducted in the Province of Alberta. Information used to write this procedure was also taken from sources identified in the reference section.

2. PRINCIPLE OF THE METHOD

The continuous Carbon Monoxide (CO) Analyzer measures the amount of infrared light absorbed by CO in a sample of ambient air. The quantity of light absorbed is proportional to the concentration of CO in the air sample. A detailed discussion of the analyzer's measurement principle is contained in the Manufacturer's Instruction Manual. This procedure supplements the Manufacturer's Manual with instructions specific to the local requirements for operating the analyzer.

The analyzer determines the concentrations of CO in ambient air by passing non-dispersive single beam infrared (IR) radiation through a rotating gas filter wheel to the sample cell and then the detector. The wheel contains two different entrapped gases: CO and nitrogen. The CO side of the wheel acts to produce a reference beam which cannot be further affected by CO in the sample cell. The nitrogen side of the filter wheel is transparent to the IR radiation and therefore produces a measurement beam which can be absorbed by CO is proportional to the CO concentration. The detector converts the light to electrical energy, and the signal processing electronic system manipulates the electrical information and displays the CO concentration.

3. MEASUREMENT RANGE AND SENSITIVITY

The CO analyzers used in this method are commercially available models. The measurement range is user selectable at ranges between 0 to 1000 parts per million by volume (ppm). The typical range selection used in Alberta is 0 to 50 ppm.

The detection limit of the analyzer is specified by the manufacturer. Generally it is at the 0.05 ppm level.

4. EQUIPMENT AND APPARATUS

The following are available commercial analyzers suitable for used in this method and are currently in use in the AENV network:

- Thermo Environmental Instruments (TEI) Models 48, 48C, 48CTL CO Analyzers

This list does not exclude the use of other equipment that has received the USEPA Reference and Equivalent Method designation.

5. INTERFERENCES

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.

Particulate matter present in the measurement cell or sample lines may interfere with analyzer response. This problem is normally eliminated by using a particle filter of 2.0µm pore size made of inert material, such as Teflon, at the sample inlet of the instrument.

6. PRECISION AND ACCURACY

The measurement precision is generally considered to be the “repeatability of the measurement”. Precision of the data output by the analyzer is established by the manufacturer, but confirmed during daily spans checks and monthly calibrations. See section 9.0 in this document for information on daily calibration checks.

The accuracy of the sensor is generally considered the “deviation from true”. This means how close it is to what it should be. The benchmark of “what it should be” is provided by the Alberta Environment audit team and the use of transfer standards from the National

Institute of Standards and Technology (NIST). As with precision, accuracy is confirmed by the daily spans and monthly calibration checks. Refer to the sections identified above for further information on accuracy relating to calibration and audit procedures.

7. SITE REQUIREMENTS

Site location for CO monitoring should be determined according to the intended application of the monitoring data. Detailed requirements for selection of sites for monitoring ambient CO can be found in "Selecting Sites for Carbon Monoxide Monitoring" EPA-450/3-75-07. Requirements for the immediate surroundings of ambient monitoring sites can be found in Air Monitoring Directive

8. INSTALLATION REQUIREMENTS

All the installation requirements are specified by the manufacturer in the installation procedures of the manual. General requirements listed below must also be followed.

8.1 The ¼ inch diameter connection tubing from the manifold to the analyzer inlet must be made of Teflon or equivalent material for chemical inertness.

8.2 A Teflon particulate filter with a pore size of no larger than 2.0µm must be placed in the sampling line before the air sample enters the detection cells and is recommended to be located as close as possible to the inlet manifold. The holder for such filter must also be made of Aluminum, Teflon, stainless steel or Delrin.

8.3 A data acquisition system (DAS) should be connected to the analyzer to record or download the signal output from the analyzer. For connection to record analog voltage signals, the system should be set to match the voltage range of the analyzer output. Generally this is 1V or 10V full scale.

8.4 Connection of Status line to the logger should be mentioned here as well to monitor any alarm conditions.

8.5 The monitoring station temperature should be controlled within the range of 15 to 30°C. It is important to note that the analyzer will operate properly at any temperature within this range; however, the stability of the station temperature is most important.

9. OPERATIONAL REQUIREMENTS

The following activities must be performed when operating a continuous automated Gas Filter Correlation CO analyzer in Alberta. All operational activities conducted at any ambient monitoring station, must be documented in the station logbook, and/or station checklists. This allows other operators to access a history of the station if the regular technician is not available. The following documentation must be available to the operators on site: operational and maintenance manual(s), and station site documentation.

9.1 Set Up

Range Set – the typical range used for monitoring CO is 0 to 50.0 ppm. This is done as soon as the analyzer is powered up after installation. Refer to the operations manual for instructions on this procedure. Setup configuration recorded and kept with the instrument.

9.2 Daily Requirements

Zero/Span Check – a zero/span cycle is required every day to verify the analyzer's performance. This involves diverting the sample flow of the analyzer so that the analyzer subsequently samples zero air for the zero cycle and air with a known amount of CO for the span cycle. The zero source is typically provided by pulling air through a CO scrubbing canister, and span by diverting the sample flow to pull gas from a cylinder of CO at atmospheric pressure in the appropriate range. This cycle is normally controlled by the DAS in the station, as it also flags the collected data as calibration and not sample data. The DAS is programmed to close contacts that are connected to the zero and span contacts on the analyzer. Refer to the analyzer manual for more information. It is recommended to perform the zero check cycle last to reduce the time required for the instrument to return to ambient readings.

9.3 Analyzer Test Parameters

The analyzer monitors and displays test functions in order for the operator to monitor the performance of specific systems within the analyzer. These test parameters should be monitored on a weekly basis and recorded on a site/instrument checklist (see appendix A).

9.4 Inlet Filter Change

The sample inlet filter is typically replaced when the monthly multipoint calibration is being done. Filters are changed out monthly before each calibration.

9.4 Analyzer Maintenance

Preventative maintenance tasks should be completed on the analyzer on a periodic basis. These tasks are outlined in the operations manual. A strict regiment of these tasks should be adhered to as they are intended to fix a problem before it happens. Any maintenance must be recorded in the station log book and a record kept with the instrument documentation.

9.5 Multipoint Calibration

Multipoint calibrations are conducted on the CO analyzer to verify precision, accuracy and linearity of the instrument. This procedure must be completed after the analyzer has been installed following at least a 24 hour up to 72hrs warm up period, after any repairs or maintenance has taken place which may affect the performance of the instrument and monthly to comply with Alberta Environment regulations. Calibration procedures specific to the CO analyzer are found in section 10 of this document.

9.6 Analyzer Audit

CO analyzers operating in Alberta are required to undergo an on-site audit once per year. This audit involves the Alberta Environment Audit Program staff visiting the site with the NIST traceable standards to verify the accuracy and linearity of the instrument.

10. CALIBRATION

The calibration procedure for CO analyzers is similar to calibration of other continuous ambient air analyzers. This procedure involves generating a known amount of CO, which is introduced to the analyzer to verify its performance. There are certain specifics to the CO calibration that are identified in this section.

10.1 Calibration Equipment – CO analyzers are typically calibrated using the dilution method.

10.2 Referring to the calibration procedure, calculate the slope and intercept of the 4 data points against the calibrator values using linear regression analysis. The acceptance criteria are slope of 1.0±0.1 and intercept of +/- 3% full scale and a coefficient of correlation (CC) >0.998.

10.3 Analyzer is adjusted for zero reading and for a reading of 1:1 at the highest scale point in the calibration. Slope and intercept corrections are not performed.

10.4 A zero/span check cycle is run through the DAS following the calibration to verify the span values and to pick up and zero offset.

11. APPLICABLE DOCUMENTS

- **EM-024a** Thermo Environmental Instruments (TEI) 48 CO Analyzer Operating Manual
- **EM-024b** Thermo Environmental Instruments (TEI) 48C CO Analyzer Operating Manual
- **EM-024c** Thermo Environmental Instruments (TEI) 48i CO Analyzer Operating Manual

12. LITERATURE REFERENCES

- State of California Air Resources Board (CARB) Method Volume II Standard Operating Procedures for Air Quality Monitoring Appendix Y dated April 1996
- Selecting Sites for Carbon Monoxide Monitoring EPA-450/3-75-07

13. REVISION HISTORY

Revision 0 (new document)

Reviewed Dec 29, 2010

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14. APPROVAL

Approved by: **Harry Benders** **Date: June 20, 2008**

Title: **Air Monitoring Team Leader**