Procedures Manual for Carbon Monoxide Monitoring

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Municipality of Anchorage
Department of Health and Human Services
Environmental Services Division
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Anchorage, Alaska 99501

Procedure Plan Acknowledgement and Approval

Title: ***Procedures Manual for Carbon Monoxide Monitoring***

This manual documents the standard operating procedures of the Anchorage Environmental Quality Program (AEQP), for ambient carbon monoxide monitoring. The Procedures Manual for Carbon Monoxide Monitoring is hereby recommended for approval and commits the Anchorage Environmental Quality Program to follow the elements described within.

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Anchorage Environmental Quality Program
Procedures Manual for Carbon Monoxide Monitoring

1. Purpose: Guide the collection of ambient carbon monoxide (CO) measurements within the quality control and quality assurance guidelines established by the U.S. Environmental Protection Agency (EPA) and the State of Alaska Department of Environmental Conservation (ADEC). Operate and maintain the monitoring system for the course of the monitoring season to meet or exceed those established standards.

- Provide adequate documentation to demonstrate quality control of data for review by the Quality Assurance Officer.
- Meet or exceed EPA standards as established in 40 CFR Part 58 as well as standards described in the ADEC Quality Assurance Procedures & Practices.
- Promote efficient and reliable CO data collection for local air quality analysis and management and national air quality maintenance goals.

2. Background

The Anchorage Environmental Quality Program (AEQP) has been charged with CO data collection using Federal Reference Method (FRM) monitors of ambient conditions at a number of sites within an established non-attainment area for over twenty years. CO data is collected in the six wintertime months only.

CO monitoring started in 1973 using Beckman 866 CO analyzers after a CO saturation study conducted by the Cook Inlet Air Resources Management District established the boundaries of a non-attainment area. AEQP currently has two CO monitoring stations in Anchorage with plans for an additional station in Anchorage and another in Eagle River. CO monitoring stations operate each winter season from October 1 through 31 March.

Responsibility for the collection of data, its quality control and quality assurance has been delegated by EPA to ADEC and thence to AEQP. Both EPA and ADEC oversee, conduct audits and review data generated by AEQP.

3. Monitoring Technology

The EPA has approved the Beckman 866, TECO 48, and TECO 48C as FRM instruments in the *List of Designated Reference and Equivalent Methods*, April 03, 2002, page 3. This document requires that the FRM instrument be run with a range of 0 –50 ppm,[1] within a temperature range of 20 to 30° C and with a time constant of 30 seconds. The TECO 48 and TECO 48C instruments currently employed by AEQP are operated as described in the above cited document, except that AEQP uses an expanded environmental temperature operating range of 15 to 30° C. ADEC allows for this expanded temperature range in recognition that no appreciable loss of accuracy or precision occurs when used within this temperature range. [See ADEC 4.05 *Method for the Determination of Carbon Monoxide (CO) by Non-dispersive Infrared Photometry (NDIR) and Gas Filter Correlation Spectroscopy (GFC)*].

The TECO 48 applies Gas Filter Correlation (GFC) technology for ambient CO measurements. See TECO 48 Instruction Manual for details of operating theory and procedures. Technical support is available from Thermo Electron factory repair technicians @ (909) 349-2373.

[1] In this case and throughout this SOP, ppm means parts per million by volume.

4. Site Selection

ADEC & AEQP are responsible for the selection or de-commissioning of CO sites in the Municipality of Anchorage.

The monitoring network and its design are subject to review by ADEC and, ultimately, the EPA Administrator. Records of operation, quality control and quality assurance reports and procedures are also subject to review or audit.

EPA siting criteria are extensively detailed in 40 CFR 58 Appendix D 2.4

Monitoring sites are classified by their general purpose: 1) An EPA designated & selected site for national purposes is a NAMS, 2) State or Local Monitoring Sites (SLAMS) and 3) locally selected Special Purpose Monitoring (SPM).

The current network configuration includes one SLAMS and one a SPM, both of which are neighborhood scale sites. Site Description Reports are available for each site.

5. Site Setup

Site locations should meet all location, spacing, and setback requirements as described in 40 CFR 58 D, Table 1; and Appendix E, Probe Siting, Table 1 & Table 5. Before selection of a site, permission must be granted by the property owner (preferably a business or institution with long-term potential). Assure that there is space adequate to access and maintain the monitoring equipment and that the site is secure and preferably dedicated to the monitor to prevent tampering or interference caused by activities in a shared location. Power should be reliable and filtered through a quality surge protector. A phone line must be available for regular data retrieval. The owner of leased space must be presented with and sign a Hold Harmless Agreement, which shall include the lease agreement and payment schedule (See Appendix A for example).

5.1 Site Equipment

CO Monitor:

TECO Model 48 or 48C either set on a table or rack mounted and connected to a probe line sampling outside air and meeting the probe siting specifications found in 40 CFR 58 Appendix E, Table 1 & Table 5.

Data Logger:

AEQP presently uses Environmental Systems Corporation (ESC) 8800 series data loggers to receive the output analog data signal for digitizing, storage and subsequent transmission via modem to the central data collection PC. E-DAS Ambient for Windows Ver.5.33 is the software used on this PC for data polling and processing. Any other manufactures' data logger must be compatible with the ESC polling software.

The ESC 8800 data logger is versatile and can be connected to as many as 16 (either voltage or mili-ampere) analog outputs. Each instrument or input is connected to a separate double-input (differential) channel which must be properly initialized.

Procedures for initialization are found in the *ESC 8800 Data Logger Engineering Manual AMB4 Software Version 6*, Section 4.1.

In addition to collecting the output from the TECO48 or 48C, channels may be used for additional monitoring instruments such as room temperature and ambient temperature measurement as well as ambient particulate PM-10 and PM 2.5 continuous monitoring

equipment. This data logger contains an internal clock and calendar. Channel numbers and names must match those loaded into the central office software. Data transmitted includes the site name, ID, parameter and time and date information. Other information carried includes power failures and out of range conditions.

Strip Chart Recorder:

Backup data recorders such as chart recorders as are required by the EPA and are useful in diagnosis and operational checks. A redundant data logger is an acceptable alternative to a strip chart recorder for data backup. However the strip chart recorder is useful as a data archive and as a visual diagnostic tool.

Modem Communications:

AEQP employs Hayes 56k modems. Both the ESC software and the ESC 8800 data logger are configured to set up these modems automatically with each use. AEQP has been successful using telemetry at 9600 baud, which is the fastest possible communication rate for the ESC 8800 data logger. Phone lines should be conventional dedicated line with call-waiting and other special features disabled. Business phone systems using extensions or network features may interfere with modem communications and should not be used.

Probe Line:

The probe line must be made of durable, non-reactive material that can withstand exposure to ultraviolet radiation. Acceptable materials include metal, glass or plastic such as Teflon ® or Decoron ®. For probe lines less than 20 feet, use quarter inch inside diameter Teflon tubing. For greater lengths use half inch inside diameter Decoron. Specific requirements for the probe inlet (e.g. height, distance from walls and obstructions, etc.) are contained in 40 CFR 58 Appendix E, Table 1 and Table 5, and should be reviewed before probe installations.

Calibration Gases:

CO monitoring requires calibration checks every two weeks with dilute CO of known concentrations. AEQP maintains stocks of zero ultra-pure air, precision gas with a CO concentration at about 9 ppm and span gas with approximately 40 ppm (80% of the full-scale instrument reading).

The concentrations of dilute CO must be certified according to EPA requirements. Certification lasts 3 years from the certification date. These criteria are found in *Establishing Traceability of Gas Mixtures to Certain National Bureau of Standards Standard Reference Materials, EPA-600/7-81-01*, page 175. Supplies in excess of 200 psi remaining pressure which extend beyond the certification expiration date can be re-certified by AEQP (See Section 7.8). (See also note in EPA-600/4-77-027, *Quality Assurance Handbook for Air Pollution Measurement Systems Volume II*, Part 1, Section 12.1).

Room Temperature Monitoring:

EPA suggests and ADEC requires monitoring of the room temperature where the CO monitor is located. At each regular site visit, VWR Min/Max recording thermometers should be used to document the range of temperatures experienced since the prior site visit. Excursions outside of the acceptable 15 to 30°C range should be noted.

Supplemental heating should not used at monitoring sites due to risk of fire. The monitor may be tented or enclosed to retain waste heat and maintain the proper temperature environment.

Auxiliary Equipment:

A line voltage surge protector should be used to protect the CO monitor and data logger.
A digital volt meter is necessary for calibrating the data logger analog input and for diagnosing proper instrument and chart recorder function.
Common site tools include wrenches to disconnect the Swage Lock © probe fittings connecting probe lines, particulate filter wrenches, and valve wrenches for the compressed gas bottles.
AEQP maintains a tool case with an assortment of useful tools and supplies.

Site Log Records:

Each monitoring site should include a conventional hardbound log book for recording equipment maintenance and related site activities, and a three-ring binder containing bi-weekly site inspection field logs. Together these documents contain records of all site activities and support quality control and data assurance measures. Record keeping is critical to defensible data collection and these site records are a valuable resource if used properly. These records shall be well maintained by the operator and shall be available for review and marking by the Quality Assurance Officer during quarterly report compilation. These records become part of the permanent site archive file.

6. Parts, Supplies and Inventories

6.1 Recommended spare parts

The TECO CO monitor spare parts inventory should include

- power supply board
- bias power supply board
- pre-amplifier/detector
- filter correlation wheel
- input conditioning board
- microprocessor board
- counter board
- display driver board
- switch board
- bench heater power supply assembly
- five (5) IR sources
- box of fuses
- spare internal sample pump.

The ESC logger is generally repairable only by a qualified electronics repair facility. The Engineering Manual contains proper design and test specifications. The internal lithium ion RAM-battery (type CR2032) should be tested and or replaced at the beginning of each season.

Maintain a couple of spare modems, surge protectors, site lamps, light bulbs, Swage Lock couplings, tees and straight connects, tubing and logbooks, and maintain one extra roll of strip chart paper and a couple of extra pens per monitoring site.

Equipment serial numbers, ownership tag numbers and other pertinent information that is located at each site is listed in the front of the field-form binder.

6.2 Calibration gas stocks

Gas supplies should be tracked in the field form binder at each site and in a master bottle inventory that is maintained by the air quality specialist at the AEQP office. Bottle pressure is recorded in the field form at the time of each use. At a minimum, the master inventory should be updated at the beginning and end of the season or when bottles are added to or removed from the inventory. The master gas bottle inventory shall include the serial number of each bottle, certification and re-certification dates, cylinder pressures, and site location of the bottle. Bottle inventories and replacement gas orders are tracked by the bottle number that begins with "LL" or "JJ". Bottles should be removed from service when the cylinder pressure falls below 200 psi.

Each year, a minimum of three months prior to the beginning of the CO monitoring season, AEQP should ensure that each monitoring site has a set of precision, span and zero gas cylinders with a minimum pressure of 600 psi and certification valid through the end of the next monitoring season (March 31). Calibration gas bottles with less than 600 psi remaining should be refilled and certified by the supplier for three years. Gases which will expire prior to completion of another monitoring season may either be refilled and certified for three years, or recertified in-house for six months as described in Section 7.8.

Calibration gases are certified by the gas supplier under the provisions of EPA Protocol II. Documentation of that certification is provided by the supplier via mail separate from the bottle delivery, but the bottle tag contains the certification date, concentration and bottle number. Hydrostatic tests need to be conducted every five years and the date of the tests is stamped into the bottle casing near the neck.

Gas bottle certifications should be filed in a folder in the AEQP file cabinets under Air Monitoring Gas Supply, each revision of the Gas Bottle Inventory should be printed out and filed with these certification documents. (Having older Gas Bottle Inventories is an aid in resolving questions of ownership.)

7. Field Operation and Quality Control Procedures

7.1 ESC Data logger and strip chart setup

Each year, prior to start-up of the CO data collection network, the backup battery in each site data logger should be checked to insure retention of data in the event of a power failure. The backup battery used in ESC data loggers is a 3v lithium cell, of type CR2032 or equivalent. Any cells that register less than 3.0 volts should be replaced.

Prior to each data collection season, data loggers at each site should be cold-started to wipe clean the logger memory. Before cold staring the logger, record the logger ID (2-digit DCN #), site name, and all channel initialization settings. Cold starting removes all logger identification, passwords and settings and is accomplished by cycling the RAM battery switch off for ten seconds

with the main power switch off. Restore power to the logger, turn on the RAM battery switch, and restore logger ID, site name, time/date, and channel initialization settings as indicated in ESC 8800 Engineering Manual, pages 2-17 to 2-19. Cold starting the logger is necessary to avoid inappropriate retention of prior year data due to a date-wrap anomaly in ESC 8800 data loggers. Seasonal cold starts are not required with 8816 series data loggers.

Verify that all instruments are appropriately connected to the data loggers. Verify proper channel initialization for each device connected to the data logger. Apply zero and full-scale test voltages to the data logger's CO input channel and verify that the logger reports the concentration equivalents of 0 and 50.0 ppm CO. Difference between the concentration reported by the TECO 48/48C and the data logger shall be maintained at less than ±0.05 ppm.

All chart recorders should be set for a voltage range of either 5v or 10v. Check the label on the TECO analog output terminal for the proper full-scale voltage setting. In some instances, a recorder will not allow for use of the full chart range in the 5v setting. In this situation, the 2-volt range setting attenuated to a full-scale reading at 5 volts is appropriate.

7.2 TECO CO Monitor Startup and Calibration

CO monitors shall be tested for proper function at the beginning of the CO sampling season and thereafter during bi-weekly calibration checks. Monitors should be tested for leaks in the sample line and for appropriate IR source intensity and sample-to-reference ratio ranges. The criteria and procedures for these tests are described in sections 7.5 and 7.6 of this SOP covering bi-weekly site checks.

A multi-point calibration should be performed on each CO monitor prior to data collection beginning on October 1st. CO monitors should be turned on and allowed to stabilize for 24 hours prior to performing a multi-point calibration. A minimum of four certified-concentration CO gas mixtures shall be used to perform a multi-point calibration. CO calibration standard gases shall contain purified air (< 0.01 ppm CO) or a certified mixture of CO in pure air or pure nitrogen with an approximate 350 ppm balance of $C0_2$. Calibration gases should consist of one ultra-pure zero standard and four or more concentrations of CO/air or CO/N_2 mixtures ranging in CO concentration from ~9 ppm to ~40 ppm. For calibrations and calibration checks, gases should be introduced into the sample line upstream of the sample particulate filter.

7.3 Probe integrity Check

Probe integrity checks should be performed at a minimum:

- prior to the October 1st beginning of the CO season, and
- following the April 1st end of the data collection season, but prior to seasonal shutdown of the CO monitoring equipment.

To test integrity of the inlet probe, CO span gas should be introduced at low pressure (~3 PSIA) at the sample probe inlet. An atmospheric dump should be installed between the span gas cylinder and the probe to avoid pressurizing the sample line and the measurement chamber.

The probe integrity check procedure requires two people with radio communications. From a stable background reading on the CO monitor, the technician at the monitor should signal to the helper to begin flow of the CO span gas and should note the time that flow is started in minutes and

seconds. The monitor technician should record the time that the monitor takes to register an initial upscale reading greater than 5 ppm. The monitor technician should also record the time that the instrument takes to register a stable CO reading (± 0.2 ppm over 30 seconds). If the instrument does not maintain a stable reading, then a leak test should be performed over the entire length of the sample line and inlet. With sample lines less than 7 meters, a stable reading should be obtained within two minutes of the initial upscale reading. Otherwise, the instrument and sample line should both be checked for the source of instability. The stable reading should also be within ± 1.5 ppm (3% of full-scale instrument range) of the certified span gas concentration. If agreement with the certified span gas concentration differs by more than 1.5 ppm, then the source of the problem needs to be identified and corrected. If agreement differs by more than 15%, then all data back to the previous acceptable probe integrity check should be invalidated.

If the sample line exceeds 10 meters in length, then a leak test should be performed over the entire length of the line as an extra precaution, to test both integrity of the sample line and condition of the sample pump. With the inlet end of the sample line sealed, the sample pump should be able to draw pressure in the line down to 250 mm Hg. Inability to obtain this reduced pressure indicates that a leak is present in the system or that the sample pump requires reconditioning or replacement.

7.4 Seasonal Operation

Carbon monoxide is measured seasonally in Anchorage from 1 October to 1 April. Data is currently collected from the following monitoring sites within the city:

Garden Site- Neighborhood scale SLAMS located at 3000 E 16th Ave.
Turnagain Site- Neighborhood scale SPM Site located at 3201 Turnagain Street.

AEQP plans to install two additional neighborhood scale sites; one in South Anchorage and the other in Eagle River.

7.5 Bi-weekly site checks

Each monitoring site should be visited a minimum of once every fourteen days. Results of instrument checks, calibrations and strip chart transcription checks shall be documented in the field log forms, which are kept at the monitoring site in a three-ring binder. A bound log book is also kept with the instrument and is intended for documentation of instrument maintenance and related site activities.

The air quality specialist should compare data collected by the ESC data logger to data collected via the strip chart recorder. The strip chart comparison check may be performed before or after calibration gas analysis or at separate time altogether; however, the transcription check is useful to determine if the chart recorder and data logger are functioning properly and to determine if adjustments to the strip chart recorder are necessary. Therefore it is advantageous to perform this check prior to the level-one instrument calibration check.

During each site visit the air quality specialist should document in the field log the site location, date, time, current shelter temperature, minimum and maximum shelter temperatures since the last site visit and the name of the specialist performing the inspection. The specialist should also record the instrument serial number and the following instrument readings: instrument operating temperature, chamber temperature (TECO 48C only), barometric pressure, sample-to-reference ratio, and source intensity. Acceptable ranges for each of these parameters are listed in the field

log form. An example copy of the field log is included in Appendix B of this SOP. Source intensity and sample to reference ratios are both reduced with increasing concentrations of CO. Therefore if these two conditions are not acceptable at ambient conditions, they should be re-evaluated with analysis of ultra pure air during the zero calibration check.

During each bi-weekly visit the operator should perform a leak check on the CO monitor and sample line by disconnecting the sample line upstream of the particulate filter, leaving the filter attached to the CO monitor. The operator should cover the inlet of the filter with a finger and note the time in minutes and seconds and then record in the field log the amount of time required for the TECO pressure measurement to reach 250 mm Hg. If this time exceeds 90 sec. or the instrument pump cannot draw the pressure below 250 mm Hg, either a leak has developed in the sample line or the pump requires re-conditioning or replacement. This condition requires prompt remedy. If this condition occurs and results of the precision gas analysis exceeds ± 10% difference from the accepted value, data should be flagged as suspect, but not invalidated. If precision gas analysis exceeds ± 15% difference from the accepted value, data should be invalidated.

7.6 Level-One Instrument Calibration Checks

A level-one instrument calibration check consists of an analysis of certified-concentration precision gas, followed by analysis of ultra-pure zero and CO span gas. Level-two (unofficial or simulated) calibration checks may be useful for instrument diagnosis; however, they are not a regular part of this quality control program.

7.6.1 Performing the Level-One Calibration Check

Prior to analysis of gases, the specialist should "down-channel" the ESC data logger. The specialist should press the login key and type the login ID "BURNH2". The logger will respond with "LOGGED IN." The specialist should press the Set Privilege key and type in the password "H2=ELEC". The logger will respond with "PRIVILEGE PERMITTED!" The specialist should then type in the command "DISABLE AVG ##", where ## is the two digit number for the logger input channel to which the TECO analog input is connected. Typically CO concentration data should be collected on logger channel 01. If a different channel is used for this purpose, a label should be affixed to the front panel of the data logger indicating the appropriate channel.

Prior to analysis of gases, the operator should also record the date, time, and his/her initials on the strip chart paper. The operator should then change the chart speed from 1cm/hr to 1cm/min.

Calibration checks are performed by using precision, zero and span gases with certified CO concentrations to assess instrument precision and zero/span calibrations. After down-channeling the data logger, marking the date and time on the strip chart, and increasing the chart speed, the specialist should first deliver precision gas to the TECO CO instrument at low flow, with an atmospheric dump installed between the gas cylinder and the instrument. The specialist should record the gas cylinder number, bottle pressure, certified concentration, supplier, and certification date in the field log. The gas supply line should be connected to the inlet end of the sample particulate filter so that gas will be delivered to the instrument through the particulate filter. The flow of precision gas will continue until the instrument has maintained a stable reading for two 30-second averaging periods. The CO concentration as

measured by the TECO instrument and the ESC data logger should both be recorded in the field log. Precision gas true value and cylinder number should be recorded on the strip chart adjacent to the resultant peak, along with the associated TECO and ESC concentration readings. A percent difference of 15% or less between the ESC measured value and the certified precision gas concentration shall be acceptable for validation of data collected since the prior valid precision check. No instrument adjustment should be made based on the result of precision gas analysis.

Zero gas and CO span gas should be introduced, analyzed and documented in the same manner as above. Zero gas (ultra pure air with < 0.01 ppm CO) should be analyzed following the precision gas analysis. The instrument zero calibration should be adjusted if the stable ESC reading for zero gas differs from zero by more than ±0.5 ppm (1% of full scale).

Span gas (~ 40 ppm CO) should be analyzed following zero gas analysis and zero calibration adjustment. The analyzer span should be adjusted if the analyzed concentration as reported by the ESC differs from the certified concentration by more than ±1.5 ppm (3% of full scale).

Calibration check results should be documented in both the field log and on the strip chart.

Following the level-one calibration check, the gas delivery line is removed, the sample line is reconnected and data averaging is restored to the appropriate channel of the ESC data logger using the command "ENABLE AVG ##" (i.e. the data logger is "up-channeled"). A mark is placed on the strip chart time axis indicating the current fraction of an hour and the chart trace is advanced to this mark. At this point, the chart speed should be restored to 1 cm/hr. The operator should then record his/her initials, the current date and current time next to the mark on the strip chart.

Note: Care should be taken to verify that the sample line is reconnected, data logger CO-channel averaging is enabled, the chart speed is correct, and that all calibration gas cylinder valves are closed- both regulator valves should read zero.

7.6.2 Control Charting of Calibration Gas Results

In addition to the hard copy field form documentation, results of precision, zero and span gas analyses should be maintained in an Excel file in a table format. This data should be used to generate control charts for each calibration standard used at each site. The control chart should consist of a plot of analyzed concentration over time, with calibration adjustments noted. At the beginning of the season, warning limits should be set at ±10% of analyzed concentration for precision and span gas and ± 1.0 ppm for zero gas. These plots should be used to assess drift in instrument response and instrument stability, and shall be made available during any audit.

7.7 Multipoint Calibration Assessment

Multipoint calibrations are performed a minimum of three times annually on each CO instrument: prior to the 1 October beginning of the CO season; early in the next calendar quarter and after the March 31st end of the CO monitoring season, prior to seasonal shutdown of the CO monitor network. In addition, a multipoint calibration should be performed on a CO monitor following any major repair or re-location of the monitor.

Multipoint calibrations are to be performed using a minimum of five certified CO calibration gas standard within the range of zero to 50 ppm CO. For each CO instrument the certified concentration of the CO standard gases should be plotted versus the measured concentrations to establish the multipoint calibration curve for that instrument. A trend line should be added to the plotted points using a least-squares linear regression (not forced through the zero intercept). The multipoint calibration shall be acceptable if the slope of the regression line is between 0.75 and 1.25, if the Y-intercept is 0 ±1.5 ppm, and the correlation coefficient of the regression line is greater than 0.995.

7.8 Calibration Gas Standards and Certification Periods

Zero gas shall contain less than 0.01 ppm CO. Precision gas shall contain an analyzed CO concentration between 6 and 12 ppm. CO precision/calibration standards should be prepared in nitrogen or ultra pure air. All zero and CO calibration gases should contain a balance of approximately 350 ppm CO_2 and must comply with NIST or ASTM traceability standards.

With the exception of ultra pure air, calibration gas standards shall be certified for a period of three years following analysis by an independent laboratory that uses an EPA-approved procedure. So long as the zero gas contains no evidence of contamination, the certification period of ultra pure air is indefinite. Non-zero calibration gases which have exceeded the initial certification period may be re-certified by demonstration of stability over a period of three weeks or more, provided that the repeated analyses are bracketed by an opening and closing multi-point calibration using traceable gas standards with current certification.

A gas with an expired certification may be re-certified for six months at the original certified concentration if the difference between the mean concentration of the repeated analyses is within ±4% of the original certified concentration. Alternately, if the gas is stable, but the initial concentration and mean analysis result differ by more than ±4%, then the mean of the repeated analyses shall become the new re-certified concentration. Such gases may be re-certified for six months at a new (lower) concentration if one unit of standard deviation of the repeated analyses is equal to or less than ±4% of the mean concentration from the repeated measurements using an instrument operating within a valid multipoint calibration.

7.9 Strip chart verification and calibration

CO concentration data from the monitor is simultaneously recorded by an electronic data logger and a strip chart recorder. The accuracy of both these devices should be evaluated during bi-weekly instrument calibration checks. Chart zero and span calibration adjustment, if necessary, should take place during analysis of the appropriate standard gas. The zero calibration of the chart recorder should be reset any time the chart value differs from the TECO 48/48C value by more than 0.5 ppm (1% of full scale). The span calibration of the chart recorder should be reset any time the chart-reported span value differs from the TECO by more than 1.5 ppm (3% of full scale). Any adjustments to the strip chart recorder should be clearly marked on the strip chart trace at the time of adjustment. Note: the TECO and logger must agree within ±0.05 ppm.

7.10 Strip chart transcription check

As an additional data quality control measure, at the time of each bi-weekly site check, an hourly trace of the historical chart record is visually averaged and compared to the value recorded by the electronic data recorder. The strip chart trace selected for manual averaging and comparison should be selected from a period of elevated CO to achieve a goal of comparing at least 10% of

hourly data ≥ 80% of the exceedance standard of 9.5 ppm (i.e. 10% of all values ≥ 7.6 ppm). Unusual chart trace patterns should also be visually averaged and compared to the logger value to determine if a malfunction has occurred. The visually averaged chart value and ESC value for the chosen hour should be recorded on the chart and in the "Notes" section of the field log form. Variation shall be considered acceptable if the visually averaged chart value is within ±20% difference or 0.5 ppm absolute difference, whichever is greater. Chart time transpired to the nearest documented time on the chart is counted and verified to assess proper and continuous chart advance rate and is documented on the field log form under "Notes:"

7.11 Seasonal System Shutdown

CO measurement in the Municipality of Anchorage network shall be performed each year during the winter CO season from 1 October to 31 March. A closing multipoint calibration and probe integrity check shall be performed at each CO measurement site prior to seasonal shutdown. Acceptance criteria for end-of-season probe integrity checks and multipoint calibrations shall be the same as those provided in Sections 1.2 and 1.3. Should either the closing probe integrity check or multipoint calibration fail acceptance criteria all data collected subsequent to the last acceptable evaluation should be invalidated.

TECO CO analyzers should be turned off following the closing multipoint calibration and probe integrity check. ESC data loggers should remain powered and on during the summer season to avoid depleting the rechargeable gel cell batteries and to overwrite existing CO data. Overwriting old data is an extra precaution against a data anomaly caused by repeated Julian calendar dates within the data buffer, which may occur if the logger is not cold started.

8. Data Collection and Processing

8.1 Data Acquisition Procedures

CO monitor data and other data (e.g. shelter temperature or continuous particulate monitor data) is stored in the ESC 8800 data logger.

Environmental Systems Corporation's Air Monitoring Data Acquisition System software, titled E-DAS Ambient for Windows Ver. 5.33a, resides on both a computer in the AEQP office and in the Local Area Network (AEQP has licenses for both uses). This software is configured to poll the various monitoring site data loggers via telephone modem, download data from any active channels, store the data and allow it to be manipulated and exported. The initial raw data downloads from the data loggers are stored in a file, which cannot be edited; therefore, one always has original data. See SITE INFORMATION, a green binder, kept near the polling computer for copies of all information necessary to load the software for proper operation. This binder contains a printout of all the screens including all of the sites, after they were properly loaded. Syntax or typographical errors result in failure to poll or acquire data.

PC hardware required: IBM or compatible computer with 486 or faster processor, 8 Megabytes of conventional memory plus 1024K of extended memory, a minimum of 400 megabytes of free disk space and a floppy disk drive or connection to a LAN network. A color VGA monitor and graphics adapter, PS-2 mouse, and a Hayes compatible modem with null modem cable are also required.

The polling software is compatible with Windows 98, Windows 2000 and Windows NT, but is adverse to some screen savers; therefore they should not be installed.

Security is provided by password protection in the software and a two-stage password protection in the field data loggers. These passwords are subject to change, see Air Monitoring Data Acquisition System users manual Chapter 3.0- Operators Guide, 3.3- Password entry, and ESC 8800 Data Logger Users Manual Chapter 2.4.2- Levels of Security, and 2.4.3- Initial Login & Privilege.

8.2 Data Processing

With automated polling, downloaded data is stored in a non-editable file named RAW. Data downloaded by either automatic or manual polling includes site name, ID, parameter and dates as well as flagged data, alarms, power failure and out of range conditions. Applying the editing functions within the E-DAS polling software results in the creation of a "validated" data file. Data that is edited, adjusted or manually flagged is automatically marked as edited by the data acquisition software. The software automatically applies flags for hours when the data logger is down-channeled and for power failures, however addition flags can be added, see ESC E-DAS USERS MANUAL.

The working copy of the EDAS data polling software resides on the H drive of the DHHS network. The current systems folder is named AmbientData_2004-05 and contains all stored data, site parameters and polling settings. This systems folder should be copied to an archive directory on the polling computer C drive to keep a historical record of raw data, site instrumentation, and polling settings. At the same time the working directory on the H: should be renamed for the current CO season and the software redirected to the new systems directory within "System Settings."

E-DAS Ambient Software can be used to create data files in EPA-ARS/AQS format for submittal to DEC & EPA-AQS. Prior to creation of data submittal files all hourly data should be reviewed for completeness, reasonableness, validity, and presence of appropriate data flags.

9. Data Acceptance and Data Validation Criteria

9.1 Seasonal and Quarterly QC Criteria

For CO data to be considered valid, the operator of the CO monitor must demonstrate proper instrument calibration as evidenced by acceptable bi-weekly precision checks and acceptable opening and closing multi-point calibrations for the quarterly data collection period. The following calibration criteria must be met for collection of valid CO data.

- A multi-point calibration must be performed prior to and following all reportable data collection.
- The multi-point calibration curve shall be established by measuring monitor response to at least five certified calibration standards (including zero gas) and shall be plotted as certified vs. measured concentration (ppm).
- The lease squares regression curve (not forced through zero) must have:

  Slope (0.75 to 1.25) ; Y-Intercept < 3% full scale range (0 ± 1.5 ppm); and $R^2 > 0.995$
- Prior to data collection a probe integrity check must be performed to demonstrate that no leaks are present in the sample collection system. Probe integrity checks will be considered valid if the measured concentration of the span gas used for the test is < 5%

different from the certified concentration of this gas. Alternately the sample probe inlet may be capped and the internal sample monitor pump may be used to draw pressure in the sample line down to 250 mm Hg. For sample lines greater than 25 ft. in length both procedures are recommended.

9.2 Bi-Weekly Calibration Check Criteria

Regular calibration checks using Zero gas (< 0.01 ppm CO), precision gas (8 to 10 ppm CO), and span gas (35 to 45 ppm CO) shall be conducted throughout the monitoring season at a minimum frequency of once every 14 days.

9.2.1 Flagged Data:

Data shall be flagged as questionable (usable, but with limited data quality) if any of the following conditions occur:

- The measured concentration of span gas differs from the certified concentration by ±15% or more. In such instances all data collected after an acceptable calibration check and prior to re-calibration of the CO monitor should be flagged as qualified data.
- The measured concentration of zero gas differs from zero by ±1 ppm or more (2 % of full scale)
- The measured concentration of precision gas differs from the certified concentration by ±10% or more.
- The temperature of the environmental enclosure containing the monitor falls outside the temperature range of 15 to 30 ºC. If temperature is monitored by a Min/Max recording thermometer, and either extreme is found to be outside this range then all data back to the point that the thermometer was last reset should be flagged for temperature range exceedance. If temperature is measured hourly, then only the hourly data with temperatures outside this range should be flagged.
- Any data that appears to be unlikely within normal operating parameters or for which a measurement interference has been identified (i.e. source of engine exhaust within close proximity to the monitoring probe) should be flagged as qualified.

Whenever data is qualified, an explanation shall accompany the data qualification flag.

9.2.2 Invalid Data:

Data should be invalidated and removed from the data record for any of the following reasons:

- Any failure of seasonal or quarterly QC criteria.
- The measured concentration of span gas differs from the certified concentration by ±25% or more.
- The measured concentration of zero gas differs from zero by ±1.5 ppm or more (3 % of full scale)
- The measured concentration of precision gas differs from the certified concentration by ±15% or more.
- Periods of instrument calibration or maintenance that prevent measurement of an ambient air sample (> 15 min. invalid data per hour should invalidate the whole hour). When properly down-channeled, the data logger will automatically invalidate hourly averages with less than 45 minutes of valid data.

- Any instrument failure or collection error that prevents representative collection or accurate measurement of ambient air from the sampling site. All affected hourly data should be invalidated.

If a clear failure point can be identified, data back to this point should be invalided, otherwise all data back to the last acceptable calibration check prior to the failure or collection error should be invalidated. Full explanation of the data deficiency shall be provided for any period of invalidated data.

10.0 Quality Assurance

Within the Anchorage Environmental Quality Program (AEQP), the Air Quality Specialists, the QA Review Officer and the Program Manager all share responsibility for data quality assurance. The AQ Specialist is responsible for maintaining monitors and the data acquisition system, and for documenting all the proper quality control measures related to the operation of this equipment. The AQ Specialist also has the responsibility for reviewing and editing data, assigning data flags, assembling the data submittal package, and maintaining the quarterly data archives. The QA Review Officer provides an independent review of quality control procedures, QC records, and data records. The QA Review Officer also reviews data packages and electronic files prior to submittal. The Program Manager oversee division of responsibilities and verifies that the required data collection, maintenance and review activities take place as described in this procedure manual.

Upon receiving the data submittal package from the Air Quality Specialist within 20 days from the close of each calendar quarter, the Quality Assurance Officer should file a report with all findings and recommendations to the Project Manager.

10.1 Quality Assurance Procedures

The QA Officer should complete the following review procedure:

- review the precision reports prepared by the Air Quality Specialist in accordance with EPA-454/R-98-004 Aug 1998 QUALITY ASSURANCE HANDBOOK for AIR POLLUTION MEASUREMENT SYSTEMS VOLUME II, Section No.: 2.2.4, and verify the accuracy of this data from the field QC records.
- Review the field logs for practice and procedure compliance with all EPA, ADEC and MOA SOP guidance.
- Review the validated data file for completeness and agreement with the monthly summary data file (Appendix C, example) compiled for review by DEC.
- Determine validity of the data to be submitted by use of the Quality Assurance/ Data Validation Check List (Appendix D, example)
- Calculate percent of data capture per quarter and verify reasonableness of the data captured using the validation check list.
- Document review activities with summary QC sheet initialed by all responsible individuals.

In addition the QA Officer should provide responses to ADEC & EPA audit reports including corrective actions and recommendations.

At the time of the annual ADEC Systems Audit, the QA Officer should review the adequacy of this procedure manual, review the Site Description Reports for accuracy and completeness, and prepare

a quality control checklist report to the Program Manager. All personnel listed in this document with responsibilities for carbon monoxide monitoring or monitoring program management should review and initial this report. A record of deficiencies corrected should be attached or added as an amendment to the original report at the time of correction.

11. Data Submission and Archiving

After the reports described in section 10 above have been completed by the Quality Assurance Officer and he has reviewed the validated electronic file for conformity with the report, the file can be electronically transferred to the Program Manager.

The Program Manager reviews the data files and the QA report and when satisfied transfers the data to ADEC. This transfer is best accomplished via E-mail.

The quarterly data submittal package and QA Report are filed by quarter in the AEQP files.

Terms and Definitions

Atmospheric Dump- A T-shaped tubing connector with one branch open to the atmosphere that is placed in the calibration gas delivery line to prevent pressurization of the gas being analyzed.

Decoron- A brand name for a plastic tubing material that is resistant to ultraviolet light and is well suited for air monitor sampling. This material is manufactured by the Eaton Corporation.

Quality Control- procedures applied to a measurement process to limit the uncertainty in the measurement (e.g., measuring a known quantity via the same process).

Quality Assurance- Independent testing and verification of the measurement process to increase confidence resultant data (e.g., providing an independent review of the process or independent measurement for comparison).

Appendix A – Example: Hold Harmless Agreement

AGREEMENT

__(Host)__ hereby agrees to permit the Municipality of Anchorage to install, operate, and maintain air pollution monitoring equipment within their facility __(Host Physical Address)__ . The Municipality of Anchorage agrees to pay __(Host)__ $ (sum) per year as reimbursement for electrical power consumption and use of their facility. This sum shall be paid in full by the Municipality of Anchorage on or before 15 February of each year.

In return for this permission, the Municipality of Anchorage agrees to indemnify, defend, save and hold harmless __(Host)__ from any claim or lawsuit brought by an employee of the Municipality of Anchorage for alleged injury to the employee arising out of the employee's installation, operation or maintenance of the air pollution samplers at __(Host Address)__, except for any claims or lawsuits arising out of any acts, errors, omissions or alleged negligence of the __(Host)__, their agents, employees or invitees.

This agreement shall become effective on the date of execution by all parties and shall continue until December 31, (three years from data of agreement). Upon mutual consent of the parties, this agreement may be renewed for two (2) additional three (3) year periods. The exercise of any option period shall be by written amendment of the agreement. This agreement may be terminated by either party prior to the expiration, provided that the terminating party notifies the other party in writing of its intent to terminate under this paragraph at least thirty (30) days prior to the effective date of the termination.

_____	_____
Dennis LeBlanc	Individual representing (Host)
Municipal Manager	(Title)
Municipality of Anchorage	(Address)
Date:_____	Date:_____

Appendix B

Example Field Log Form

(for bi-weekly QC site check)

CO System Check – Weekly / Quarterly

AIRS site name_____ Person Performing Inspection_____

Date _____ Shelter Temp (°C)_____ (15 to 30°C Acceptable) Min _____ Max____ Reset Thermometer___

Time (24 Hr)_____ Instrument Operating Temp (°C) _____(8 to 47 °C)

Barometric Press. _____(mmHg) Chamber Temp (°C)_____(40 to 52 °C)

Instrument I.D. (brand, model, S/N) _____

Leak Check/Instrument Check:

Time to drop Press < 250 mm Hg _____(sec.) Did leak check include the particulate filter? No____ Yes____

Did Sample Press drop to < 250 mm Hg in < 1 min. (< 90 sec w/filter)? No____ Yes (Pass)____

If not, leak is present or pump is performing poorly; document appropriate correction.

Sample/Reference Ratio [Main Menu / Diagnostics; Analog: "HA" 4X] _____(Should be btw 1.14 and 1.18)

Source Intensity Check _____ (Should be 10K to 30K for 48; 150K to 300K for 48C)

Precision Check: ESC Reading_____ ppm
Precision Gas True Value_____ ppm TECO Reading _____ ppm % Difference_____ 15% Acceptable

Bottle press._____ Cyl. #_____ Supplier/ Cert. by ☐ Scott Marin / M.J. Monson ☐ Other: _____/_____ Date tested _____

2-Point Calibration: ESC Reading_____ ppm Zero Settings:
Zero Check (0 ± 0.5 ppm): TECO Reading _____ Reset? Yes____ No____ Init____ Final____

Bottle press._____ Cyl. #_____ Supplier/ Cert. by ☐ Scott Marin / M.J. Monson ☐ Other: _____/_____ Date tested _____

Span Check (True Value ± 1.5 ppm): True Value _____ ppm ESC Reading _____ ppm
TECO Reading_____ ppm Span Settings:
Span Gas bottle Press_____ Cyl. #_____ Reset? Yes____ No____ Init_____ Final____

Supplier/ Cert. by ☐ Scott Marin / M.J. Monson ☐ Other: _____/_____ Date tested _____

Chart Recorder:

Mark the exact pen location on the chart with a tic mark. Label mark with time, date, and operator's initials.
Verified correct chart speed and input range? _____

Inspecton Notes:

Multi-Point Calibration (to be done on a Quarterly Basis): Room Temp with NIST Thermometer_____

VWR Min/Max Therrmometer: Current Room Temp simultaneous with NIST =_____ at time_____

Other conditions for recalibration: Span check > 15 % diff., Zero drift > 3 % F.S. (1.5 ppm)
major repairs, physical relocation, power off more than three days, any indication of analyzer inaccuracy.

Gas- **True Value (ppm)**	**Cylinder No.**	**Bottle Pressure (200 PSI Min.)**	**TECO 48 Reading (ppm)**	**Data Logger Reading (ppm)**	**Strip Chart Reading (ppm)**

Calibration Gas Supplier_____ Certified By_____ Date Tested_____

Regression Line:

Slope_____ (0.75 to 1.25) Y- Intercept (0 ± 1.5 ppm) _____ R^2 (> 0.995)_____

Probe Integrity Check: **(**Introduce span gas as close to outdoor sample inlet as possible)

Span gas true value (actual)_____ ppm.

Cylinder No. _____ Supplier / Cert. By _____ Date Tested_____

Initial instrument response time_____(sec.) Time for stable reading: _____(sec.)

Span gas stable response at instrument (indicated): _____ ppm. % Difference from true value = _____ 15% Acceptable

Check Sample Line Filter: Filter OK? _____ Replaced Filter? No _____ Yes_____

Additional Inspection Notes:

Appendix C

Example

Monthly Data Summary Form

Appendix D

Example

Quality Assurance / Validation Check List

Quality Assurance / Data Validation Check List

Quarter __1st__ Year _2004_

Performed by ___Stephen Morris____

Probe Integrity Check
Probe checks are required prior to the beginning of CO monitoring season and near the end of the season (between March 15 and April 7). Probe check should be documented in site logbook and must meet criteria outlined in SOP

	Garden	Seward	Turnagain	Jewel Lake		
Date performed	04/14/04	04/14/04	04/14/04	4/15/04		
Type of check - span gas introduction (S) or pressure drop test (P)	S	S	S	S		
Did probe check meet requirements (± 15%) in SOP? (Y/N)	Y	Y*	Y	Y		
Comments	* Seward Highway probe was found to have a lag time of 5 to 6 minutes between introduction of span gas to the probe inlet and stable reading on the instrument. This is reasonable considering the ~ 100 meter length of the sample line.					

Calibration Gas Certification
Site logbooks should contain documentation of EPA Protocol II certification of all gases used at that site. All gases utilized should have valid (i.e. certification occurred within last 18 ??? months)

	Garden	Seward	Turnagain	Jewel Lake		
Were all gases certified in accordance with EPA Protocol ? (Y/N)	Y	Y	Y	Y		
Any gases with lapsed certification (i.e. > 36 months) (Y/N)	Y *	N	Y*	Y*		
Comments	*Precision gases at Garden,Turnagain, and Jewel lake lapsed expiration date. Span gases at Garden and Turnagain lapsed expritation date. All expired gases were recertified for an additional 6 months by MOA / ADEC on 11/20/03.					

Multi-point Calibrations
At a minimum, multi-point calibrations are to be performed prior to the beginning of the CO monitoring season, mid-season between November 15 and January 15, and near the end of the season (between March 15 and April 7).

	Garden	Seward	Turnagain	Jewel Lake	Garden	Seward
Date initial calibration performed?	01/06/04	01/05/04	01/06/04	01/07/04	01/06/04	01/05/04
Repeated multipoint calibration (ADEC audit)	03/16/04	03/18/04	03/18/04	03/18/04	03/16/04	03/18/04
Repeated multipoint calibration	04/06/04	04/06/04	04/07/04	04/07/04	04/06/04	04/06/04
Do calibrations meet requirements for R^2 and slope? (Y/N)	Y	Y	Y	Y	Y	Y
Comments						

Precision checks
Were acceptable precision checks performed on a fortnightly basis at each site during the quarter? Submit precision check report as per SOP to ADEC for review.

	Garden	Seward	Turnagain	Jewel Lake		
Were precision checks performed on timely basis?	Y	Y	Y	Y		
Have results from precision checks been properly documented and prepared for submission to ADEC?	Y	Y	Y	Y		
Did precision checks meet Q/A criteria in SOP? (Y/N)	Y	Y	Y	Y		
Comments						

Data Capture
Calculate data capture rate for quarter

	Garden	Seward	Turnagain	Jewel Lake		
Number of valid hours of data collected in quarter	2175	2174	2172	2173		
% data capture	99.6	99.5	99.5	99.5		
Comments						

Data Reasonableness Assessment
Have data been reviewed to determine whether values are reasonable?

	Garden	Seward	Turnagain	Jewel Lake		
Maximum hourly average concentration recorded during quarter (ppm)	9.38 on 01/13	8.90 on 01/13	11.33 on 01/04	7.34 on 01/03		
Maximum 8-hour average concentration recorded during quarter (ppm)	6.78 on 01/13	5.77 on 01/13	8.15 on 01/05	4.49 on 01/04		
Average hourly concentration	1.52	1.79	1.35	1.18		
Comments						