STATEWIDE
STANDARD OPERATING PROCEDURE

FOR
TELDYNE API MODEL T300U
CARBON MONOXIDE ANALYZER

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
OFFICE OF AIR MONITORING

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Quality Assurance Manager

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1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to guide the operator in the installation, set-up, calibration and maintenance of the analyzer to conform to the practices used for the API Model T300U Carbon Monoxide (CO) Trace Level Enhanced Analyzer used in the State of Florida Ambient Air Monitoring Program.

Adherence to this manual will enable the site Field Technician to know and follow state- wide quality assurance/quality control (QA/QC) requirements. Site Field Technicians, however, should be knowledgeable of and refer to the references noted in this Standard Operating Procedure (SOP). Other information such as theory of operation, servicing and microprocessor control are covered in the manufacturer's instruction manual and will be referred to as needed. Both the instruction manual and this SOP are to be kept with the instrument or be accessible in electronic format at all times.

These procedures are consistent with the data management requirements specified in the Quality Assurance Project Plan for the Florida Gaseous Ambient Air Monitoring Program, (FDEP QAPP-002). The final data are verified and submitted to the Florida Air Monitoring Verification Program (AirMVP), then uploaded by the Florida Department of Environmental Protection (FDEP) to the US EPA Air Quality System (AQS).

2.0 SCOPE AND APPLICABILITY

The Florida Department of Environmental Protection and Florida Local Air Monitoring Agencies utilize the API Model T300U Trace Level-Enhanced CO analyzers to quantify the ambient air concentrations of CO at NCore and Near Road sites. The API T300U analyzer is designated as an automated reference method for CO measurements, as defined in 40 CFR Part 53. The federal reference method (FRM) for the measurement of CO in the atmosphere is defined in Appendix C to 40 CFR Part 50.

This document is intended to be used as a reference for the set-up, calibration, maintenance and operation of the API T300U analyzer. Additional detailed technical information may be found in the manufacturer's instruction manual. Technicians will refer to the manufacturer's manual for schematics and diagrams.

The proper utilization of this procedure by the technician, in conjunction with the equipment manufacturer's operation manual (and addendums), will conform to the local, state and federal data quality objectives, the State of Florida Quality Assurance Project Plans (QAPPs), the air monitoring regulations published in the Code of Federal Regulations (CFR). The air monitoring data generated as a result of implementing these procedures will be comparable to the National Ambient Air Quality Standards (NAAQS) and reported to the state and federal ambient air monitoring databases.

3.0 SUMMARY OF THE METHOD

The T300 family of analyzers is a microprocessor-controlled analyzer that determines the concentration of carbon monoxide (CO) in a sample gas drawn through the instrument. The family includes the T300, T300E and T300U Gas Filter Correlation Carbon Monoxide Analyzer. It uses a method based on the Beer-Lambert law, an empirical relationship that relates the absorption of light to the properties of the material through which the light is traveling over a defined distance. In this case the light is infrared radiation (IR) traveling through a sample chamber filled with gas bearing a varying concentration of CO.

The T300 series uses Gas Filter Correlation (GFC) to overcome the interfering effects of various other gases (such as water vapor) that also absorb IR. The analyzer passes the IR beam through a spinning wheel made up of two separate chambers: one containing a high concentration of CO known as the reference, and the other containing a neutral gas known as the measure. The concentration of CO in the sample chamber is computed by taking the ratio of the instantaneous measure and reference values and then compensating the ratio for sample temperature and pressure. In the most basic terms, the T300 series uses a high-energy heated element to generate a beam of broad-band IR light with a known intensity (measured during instrument calibration). This beam is directed through a multi-pass cell filled with sample gas. The sample cell uses mirrors at each end to reflect the IR beam back and forth through the sample gas a number of times. The total length that the reflected light travels is directly related to the intended sensitivity of the instrument. The lower the concentrations the instrument is designed to detect, the longer the light path must be in order to create detectable levels of attenuation. Lengthening the absorption path is accomplished partly by making the physical dimension of the reaction cell longer, but primarily by adding extra passes back and forth along the length of the chamber.

The T300U trace level instrument is equipped with a Nafion™ dryer to dry the sample and alleviate any effects from humidity changes in the sample. In addition, the T300U utilizes a temperature-controlled convection-heated oven around the optical bench to reduce instrument noise and temperature related drift.

The Model API T300U outputs the CO concentration to the front panel display, the analog outputs, also makes the data available over the serial or Ethernet connection.

4.0 DEFINITIONS

Technical terms in this SOP are defined as they are introduced so that their meaning is made clear in context. This section explains some general terminology.

Audit – is often used in a generic way to mean check, inspect, examine, or assess, and many SOPs use the term to refer to QC procedures, such as flow checks or leak checks, that are carried out by field operators during the course of normal operations and maintenance.

Calibration – refers to the act of adjusting an instrument after comparison with a standard. When referring to the instrument software, the term "calibration" is used to indicate a procedure that would alter instrument output. A "calibration check" involves only the checking of an instrument against a standard and involves no adjustment of the instrument.

Quality Control (QC) – refers to the operational techniques and activities used to fulfill the requirements for quality.

Quality Assurance (QA) – refers to the planned or systematic activities used to provide confidence that the requirements for quality are fulfilled. An independent audit is an example of a QA activity. QA protocols determine whether the QC procedures are adequate.

Verification – is a review of interim work steps to ensure they are acceptable and to determine whether the system is consistent, adheres to standards, uses reliable techniques, and performs the selected functions in the correct manner. The term is also used to distinguish a calibration check from a calibration adjustment.

Validation – determines whether the system complies with requirements, performs the functions for which it is intended, and meets the organization's goals and user needs. It is a determination of correctness of the data and is usually performed only periodically (e.g., quarterly) or at the end of a project.

Z/S/P Check – a quality control check of the analyzer performed prior to any adjustments, maintenance or calibrations. This QC check consists of checking the ZERO drift, then the SPAN drift, and finally a check of the analyzer's response at the Precision point.

5.0 HEALTH AND SAFETY PRECAUTIONS

To prevent personal injury or damage to the API T300U analyzer, the technician will adhere to the health and safety precautions outlined below. In addition, general safety rules regarding electricity and power tools will be observed.

5.1.Health Precautions

A. Carbon monoxide gas is a poisonous gas. Even low levels of CO can irritate your eyes, nose, throat, and lungs, possibly causing you to cough and experience shortness of breath, tiredness, nausea, and may result in asphyxiation. The technician must vent any calibration span gas to the atmosphere rather than into the shelter or sampling area. If the technician experiences lightheadedness, headache, or dizziness, he or she should leave the area immediately.

B. It is possible (and practical) to purchase multi-blend cylinders containing pollutant gases in addition to CO. If this is done, it is recommended that Safety Data Sheets (SDS) for all cylinder gas components be made available to all staff members who use and handle the cylinders.

C. Always use a third ground wire on all instruments.

D. Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap should be worn while handling any internal component. For more information about appropriate safety precautions, see the "Servicing" chapter in the Model API T300U Instruction Manual.

5.2.Safety Precautions

A. When lifting the instrument, use procedure appropriate to lifting a heavy object, such as, bending at the knees while keeping your back straight and upright. Grasp the instrument at the bottom in the front and at the rear of the unit. Although one person can lift the unit, it is desirable to have two people lifting, one by grasping the bottom in the front and the other by grasping the bottom in the rear. Do not attempt to lift the instrument by the cover or other external fittings.

B. Keep the interior of the analyzer clean.

C. Inspect the system regularly for structural integrity.

D. To prevent problems with leaks, make sure that all sampling lines are reconnected after required checks and before leaving the site.

E. Inspect tubing for cracks and leaks.

F. It is recommended that the analyzer be leak-checked after replacement of any pneumatic parts. If cylinders are used in tandem with Mass Flow Control (MFC) calibrators, their use and transport is a major concern. Gas cylinders may have interior 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 its valve breaks off, the cylinder can become explosive or a projectile.

G. Transportation of cylinders is regulated by the Department of Transportation (DOT). It is strongly recommended that all agencies contact the DOT or the Highway Patrol to learn the most recent regulations concerning the transport of cylinders. Shipping of cylinders is governed by the DOT. Contact the DOT or your local courier about the proper procedures and materials needed to ship high pressure cylinders.

H. Gas cylinders must be properly secured to the interior walls of the shelter with the appropriate straps before use.

6.0 INTERFERENCES

Water Vapor: Studies have shown conclusively that NDIR analyzers have interference from water vapor. Water absorbs very strongly across several bands of IR spectra, which has a quenching effect on the reaction of CO. The TAPI T300/U is equipped with a Nafion™ drier, which effectively scrubs all water and water vapor. No maintenance is required on the dryer.

Carbon Dioxide: Carbon dioxide absorbs in the IR spectrum at 2.7, 5.2, and 8.0 to 12.0 um. This is very close to the regions that CO absorbs within as well. However, since atmospheric CO_2 is much higher in concentration than CO, this UV spectral range must be avoided. To prevent light in this spectral region, the TAPI T300/U analyzer has a band pass filter that blocks these wavelengths.

The instrument manufacturer also recommends that during installation and operation, the operator avoids pressurizing the monitor and does not allow liquids to enter the sample port. In addition, do not expose the instrument to excessive vibration or magnetic interference.

Interferences arising from improper siting can be avoided by exercising care during site selection and installation. Particular attention should be paid to the design criteria for monitoring CO, including general monitoring requirements, spatial scales, and any special site requirements.

7.0 PERSONNEL QUALIFICATIONS

A basic understanding of the principles governing ambient air sampling is necessary. All field operations personnel should be familiar with environmental field measurement techniques. Those who service the analyzer in the field must be very conscientious and attentive to detail to report complete and high-quality environmental data. Installation, operation, maintenance, repair and calibration of the instrument and all support equipment should only be performed by properly trained personnel. The training will be provided by in-house personnel, state or federal agencies when available. The training documentation will be maintained by the state or local agency where the personnel operate. Persons qualified to perform measurements of ambient CO concentrations should be able to:

a. Operate the API T300U analyzer.
b. Calibrate, audit, and troubleshoot the API T300U analyzer.
c. Operate the dilution calibrator and dilution (zero air) system.

Operators are also required to read the manufacturer's instruction manuals supplied with the analyzer and supporting calibration equipment to become familiar with the various controls and components prior to attempting any operation described in this procedure. The manufacturer's manuals contain useful operation, maintenance, and diagnostic information that may not be contained in this SOP.

8.0 EQUIPMENT AND SUPPLIES

The API instruction manuals for the Model T300U contain a regular bill of materials for the standard system hardware provided by API with each instrument purchased and information on the equipment required for instrument maintenance and calibrations. Support equipment for the operation of the API T300U includes the following instruments:

Zero Air System – A system suitable to remove all contaminants, for example, the Thermo Environmental T111 or the T-API T701 zero air unit both of which are currently being used in Florida. Zero Air systems typically consist of a desiccant, Purafil Scrubber, Charcoal Scrubber, pressure adjustment control and a compressor. The zero air system should include a catalyst to remove CO from the zero air generated. The SOP for each Zero Air unit should be referenced for maintenance intervals.

Calibration System – The calibration system must have an accurate mass flow-controlled gas dilution system. The air flow controller should be capable of maintaining constant air flows within ±2% of the required flow rate. For example, calibrators used in Florida include the T-API Models T700/T700U Multi-Gas Dilution Calibrator, Thermo Environmental Instruments Models 146C/146i Dynamic Dilution Calibrator and Environic 6100 series calibrators.

Certified CO Gas Standard(s) – Calibration gas is needed to supply CO to the calibration system. The cylinder(s) must be NIST-traceable with CO gas concentrations that do not require calibration gas flows to fall outside the range of the dilution calibrator.

NOTE: The cylinder should not be used below 200 psi; a higher value is specified by the manufacturer.

Gas Cylinder Pressure Regulator - May have non-reactive internal parts (those coming into contact with the CO standard) as well as a non-reactive diaphragm. Must have sufficient delivery pressure (approximately 20-30 psig). Connecting line from the regulator must be 1/8 " FEP Teflon.

Output Manifold - This is the external manifold between CO analyzer and the dilution calibrator. The manifold receives calibration gases from the calibrator and allows the analyzer to sample these calibration gases at atmospheric pressure. The output manifold must be made of a non-reactive material. The manifold must be vented to ensure conditions in the manifold are at atmospheric pressure and designed so room air does not enter the manifold. A minimum of 10% excess flow must exhaust through the manifold vent when calibration gasses are sampled.

Particulate Filter - A Teflon filter holder is installed at the back of the API T300U analyzer to collect particulates and prevent them from entering the instrument. The filters are usually a 47mm (2 inch) diameter with a 5-micron pore size, as recommended by the manufacturer. These filters are changed at least every 90 days, which will be discussed later in this SOP.

Sample Line Integrity Check (SLIC) tubing assembly – The SLIC tubing assembly is required during all multi-point calibrations/verification checks and consists of a dedicated sample tube with an attached “T” for ventilation. The SLIC must be performed every 90 days, at a minimum.

Logbook – The current year’s hardcopy or electronic logbook containing all forms associated with the operation, maintenance and calibration of the API T300U analyzer.

Data Acquisition System (DAS) – A DAS is necessary for storage of ambient and ancillary data collected by the API T300U. Many of the monitoring agencies in Florida use the Agilaire, LLC 8872, 8832 or 8816 DAS as the primary recorder for all data collection. However, other data acquisition systems that meet the needs of data collection are acceptable.

Before beginning any procedures involving the analyzer calibration process ensure that the appropriate channel(s) on the DAS are marked “down” or offline. Marking a channel “down” or offline causes the DAS to disregard the calibration data and not average it with ambient concentrations throughout the duration of the calibration. The operator will record five - ten, one -minute averages from the DAS after the analyzer stabilizes at each calibration level. The corresponding analyzer channel(s) should be marked “offline” prior to conducting any of the following procedures: Diagnostic checks, QC Checks, multipoint checks and verifications, maintenance, or operational checks. Channels may also be marked “offline” when any analyzers data is deemed suspect.

Instrument Shelter – A shelter is required to protect the analyzer from precipitation and adverse weather conditions, maintain operating temperature within the analyzer's temperature range requirements, and provide security and electrical power. The allowable shelter temperature range for the instrument is 10 - 40°C for EPA equivalency designation.

Wiring, Tubing and Fittings – PTFE, PFA, or FEP Teflon™ or equivalent should be used exclusively throughout the intake system. Examine the tubing and discard if particulate matter collects in the tubing. All fittings and ferrules should be made of Teflon™ or stainless steel. Connection wiring to the DAS should be a shielded two strand wire, RS-232 or CAT 5 or 6 network cables for digital connections.

9.0 INSTALLATION AND START-UP (INCLUDES REMOVAL INSTRUCTIONS)

Operator(s) are required to read the manufacturer's manual for the API T300U and any technical bulletins, for this instrument, published by the manufacturer. In addition, operators must be thoroughly familiar with the various controls and components of the analyzer prior to beginning operation.

9.1. Analyzer Siting and Sampling

All ambient air carbon monoxide analyzers must meet the location and siting criteria referenced in the Code of Federal Regulations (CFR), Part 58, Appendix E, siting criteria. Section 6.2 of Appendix E defines specific spacing requirements for CO monitor inlet probes.

The ambient air inlet probe will be positioned at least 1 meter vertically or horizontally away from any supporting structure or walls and should be 2 to 15 meters above ground level. It will have unrestricted airflow and be located away from obstacles so that the distance from the probe or monitoring path is at least twice the height that the obstacle protrudes above the probe or monitoring path. The probe will have unrestricted airflow in an arc of at least 270 degrees (preferably 360 degrees) around the inlet probe.

In order to collect ambient CO concentrations with the API T300U that complies with the Code of Federal Register, the proper sampling system must be used. The primary components of this system include:

a. Sample train, including connectors, composed of ¼" outside diameter (OD) Teflon or PTFE Tubing, with minimum inside diameter (ID) of ⅛". It is recommended that the length of this tubing be kept to less than 10 feet.
b. Sample inlet funnels composed of PTFE or borosilicate glass such as Pyrex.

It is imperative that all components of the sample train, including the inlets, tubing, and connections, be composed of the inert materials indicated above. For more information, refer to EPA Document "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II.

9.2. Inspecting New/Refurbished 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. Lose circuit boards could cause a short to occur in 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 the manufacturer for instructions on how to proceed.

If you discover that the instrument was damaged during shipping and it becomes necessary to return it to the manufacturer, repack it in the same way it was delivered.

9.3. Analyzer Installation

The API T300U analyzer has a liquid crystal display (LCD) front panel screen with touch control. This allows the user to check functions, switch operating parameters, adjust zero and span settings, and read warning messages. It is extremely important that the user familiarize themselves with the menus available. Inadvertently changing parameters within the analyzer can damage the instrument and possibly invalidate data as well. Please reference the T300U Instruction Manual and read it carefully before adjusting any parameters that are set by the factory.

A. Install a 1- or 5-micron (µm) Teflon particulate filter and filter housing to the "SAMPLE" port at the back of the analyzer. This is the external particulate filter.
B. Connect an appropriate ¼-inch outer diameter (OD) Teflon sample line upstream, after the external particulate filter on the back of the analyzer.
C. Connect the Ethernet cord from the instrument to the Data Acquisition System (DAS) for digital inputs. The data logger must be initialized and calibrated before official data collection begins. Refer to the standard operating procedures for the relevant data logger for specific data logger information.
D. Plug in the power cord and push the front panel power switch to the "on" position. The sample pump should now operate, and the power-up screen will be displayed followed by the Self-Test screen, while the instrument warms up and performs its diagnostic checks.

Although the Operations Manual says it is best to allow at least two (2) hours for the instrument to warm up and stabilize, it is preferable to allow the instrument at least 24 hours to warm up to properly condition the internal scrubbers and system components prior to calibration.

After the electrical and pneumatic connections are made, an initial functional check is in order. Turn on the instrument; the exhaust fan should start immediately. The display will show a splash screen and other information during the initialization process while the CPU loads the operating system, the firmware and the configuration data. The analyzer should automatically switch to Sample Mode after completing the boot-up sequence and start monitoring the gas. However, there is an approximately 1-hour warm-up period before reliable gas measurements can be taken. During the warm-up period, the front panel display may show messages in the parameters (Param) field. Internal temperatures and other conditions may be outside the specified limits during the analyzer's warm-up period. The software will suppress most warning conditions for 30 minutes after power up. If warning messages persist after the 30 minutes warm up period is over, investigate their cause using the troubleshooting guidelines in the Instruction Manual.

The operation of the analyzer is based on a menu-driven software. Main menu selection on the CO analyzer contains lists of submenu items such as operational parameter, functions, and controls. See the manufacturer's manual for more details and pictorials of this section, as necessary.

9.4. Model API T300U Configuration

To configure the instrument's operating parameters or to perform diagnostic testing, press [Setup] on the touch screen to first access the NumaView Primary Setup Menu which includes Range settings, software and password information. From the Primary Setup Menu, select "Setup" to show the Secondary Setup Menu. The communication settings, Variables ("VARS") options, and Diagnostic options are available here. To access either the VARS or DIAG selections, enter the applicable access level password (ex. 818, 929). A menu tree, passwords, and setup variable list can be found in Appendix A of the T300 manual and/or the T300U Addendum.

Configure the analyzer to measure CO in units of parts per million (ppm). Set the analyzer in Single Range Mode from 0 – 30 ppm or 0 – 5 ppm for the Model T300U. The calibration factors are set to 0.0 for the CO Background and 1.000 for the CO Coefficient prior to the initial calibration of the analyzer. The analyzer is designed for any range between 0-100ppm for the appropriate sampling designation. The procedures for configuring the remaining instrument settings for Communication, Input and Output (I/O) configurations, and alarm settings are described in the API T300 Instrument Manual / T300U Addendum. These settings are determined by the technician based on the equipment and configuration of the monitoring station.

9.5. Sample Mode and Auto-Reference Mode

The standard operating mode of the analyzer is the Sample Mode. From this mode, the CO concentration is displayed, and a number of settings and diagnostics can be viewed using the TEST functions. Toggle the <TST and TST> buttons to view the various test parameters.

Tip: Be careful not to accidentally press the CAL button next to the TST buttons (if running Legacy Mode) as this will bring the analyzer to the Calibration Mode where an unintentional adjustment could be made to the analyzer's Offset or Span settings.

The auto-reference mode of the T300U runs automatically and enables the analyzer to make more precise CO concentration calculations by obtaining a more accurate reference measurement to calculate the applied measure/ reference (A-REF) ratio to the concentration. This mode's cycle time is set to manufacturer's recommendations and alteration is not suggested. See T300U Addendum for more details. The technician will also turn [ON] the TEMPERATURE and PRESSURE COMPENSATION setting on the API T300U analyzer. This should be the default setting in the analyzer.

9.6. Initial Calibration

After configuring and installing the analyzer at the air monitoring station, the technician performs an initial calibration according to the calibration procedures in Section 10 of this SOP.

In addition, the technician conducts a Sample Line Integrity Check (SLIC) according to Section 10.9 of this SOP, prior to the start of collecting ambient air quality data.

9.7. Analyzer Removal

This section details the removal of an analyzer that is already installed at a site, such as if the analyzer requires extensive maintenance or replacement. The procedures for reinstalling the analyzer should not be confused with first-time installation procedures. In some instances, the analyzer may need to be removed from the site, such as if it needed total replacement or if a site were to be deactivated. In such an instance, the following procedures should be followed.

NOTE: For removal/restart before and after a severe weather event, a manual z/s/p event must be performed to bracket the carbon monoxide data and also meet the specifications of zero not exceeding ±0.60 ppm and span not exceeding ±15.0% of theoretical value. Otherwise, the data will be invalidated back to the last good z/s/p event.

A. Perform a manual Z/S/P check (Section 12.2) to bracket the data.
B. Using the data logger, down the affected analyzer input channel for the long term. Also, note, in the “Operator Comments” section, the removal of the analyzer on the API T300U Equipment Status Report.
C. Turn off the analyzer and unplug the power cord from the 120 VAC outlet.
D. At the rear of the analyzer, disconnect the ¼-inch sample inlet and exhaust tubing.
E. If the analyzer is to be re-installed at the same location, label all of the wire connections that are connected to the analyzer to ensure proper re-installation.
F. All the pertinent connections to the analyzer should now be disconnected. However, before actually removing the analyzer, inspect the location to ensure that no physical obstructions are present that could cause problems. Clear any obstructions, then remove the analyzer.

9.8. Analyzer Reinstallation

Any analyzer installation or reinstallation requires more than simply placing the analyzer into the desired location and hooking up the correct fittings and wires. Any reinstallation procedure must also incorporate all operational and precision checks required to place the analyzer back into fully certified ambient monitoring condition. The below procedure should be followed to perform this task.

A. Place the new/repaired analyzer into its new operating position.

B. Reconnect the sample inlet tubing to the sample port at the rear of the analyzer. Now connect the ¼-inch exhaust tubing to the exhaust port at the rear of the analyzer.

C. Reconnect the power plug to the power port at the rear of the analyzer and plug the opposite end into a 120 VAC outlet.

D. Reconnect the wiring that was previously labeled and removed in Steps 9.7 above.

E. After the analyzer and all ancillary equipment are connected properly, proceed to Section 9.4 to check instrument settings and conduct the remaining installation procedures.

10.0 INSTRUMENT CALIBRATION

Calibration of the API T300U CO analyzer is achieved by introducing known CO gas concentrations to the analyzer and adjusting the CO Offset and CO Span factors to provide accurate CO measurements. The calibration procedure requires the technician to generate a series of known CO concentrations to the instrument and verify that the unit provides an accurate CO measurement. If the measurement results are not correct, the zero background (offset) and/or span factor are adjusted as necessary.

The calibration procedure is used to document the relationship between the gas concentration measurements made by the analyzer and known concentrations. Florida Department of Environmental Protection Air Monitoring relies upon this documented relationship to establish the legal traceability of the ambient CO measurements subsequently made by the analyzer. All primary records (e.g. records documenting observations, or other relevant information, that cannot be obtained from another more direct or reliable source) must be dated and signed by the operator and retained as part of the permanent analyzer calibration record. The operator's signature on the calibration form certifies that the calibration has been performed in accordance with this SOP and that the information contained on the form, including any pre-printed entry, is accurate. Calibration records must be reviewed and initialed by the agency QA Coordinator, QA staff, or another knowledgeable authority to verify that they are legible and complete. Electronic signatures are acceptable provided that they are secured by a unique password.

The analyzer is required to be calibrated prior to its use in collecting ambient data that may be reported to the AirMVP database. The analyzer must be recalibrated under the following conditions:

1. Every 365 days if automated zero, span, precision checks are performed daily.
2. Every 182 days if manual zero, span, precision checks are performed bi-weekly.
3. Prior to the resumption of ambient data collection following major repairs or service that might affect its calibration.

   a. Detector replacement
   b. Pressure transducer replacement
   c. Bench Temperature replacement
   d. Processor board replacement
   e. Power supply replacement
   f. Disassemble and removal of bench

4. Following a bi-weekly zero response that exceeds ±0.60 ppm or a bi-weekly span or precision QC check response that exceeds 15.0% relative difference for CO trace level.
5. Following any multipoint calibration QC check where any point exceeds ± 2.0% of the calibration curve, best-fit straight line, or 0.03 ppm, whichever is greater. This is the relative difference between the analyzer response and the best fit concentration determined by the linear regression line.
6. Upon indication of analyzer malfunction or change in calibration. This includes exceedance of the control limits during bi-weekly checks.
7. Following physical relocation of the analyzer.
8. Following an interruption in operation of more than 72 consecutive hours.

NOTE: The multipoint calibration QC check refers to the calibration check after an adjustment or calibration of the analyzer, or any other check used to validate the ambient data.

In this procedure, the operator uses a Multi-Gas Calibrator to provide the analyzer with zero air and various concentrations of CO over the analyzer's measurement range. The analyzer's response to each concentration is recorded and, if necessary, the analyzer is adjusted to accurately measure the gas concentrations. Multiple gas concentrations allow the analyzer's linearity to be assessed. Table 10-1 contains the calibration concentrations for the Model T300U trace-level instrument.

Table 10-1 Calibration Check Points

Calibration Point	T-API T300U (ppm) Standard Option 0-30 ppm	T300U (ppm) Trace Level Option
Zero	0	0
Span	24.0	4.5
Upscale 2	15.0	2.4
Upscale 1	8.0	0.5-.6*
Low	4.8*	0.18

* = Precision Point

To ensure the accuracy of the calibration record, the operator must systematically document the calibration process using only approved calibration forms and procedures. All relevant observations or other information must be recorded immediately. The calibration form and equipment status reports must be completed in their entirety, including the heading. Calibration forms may be pre-printed or, have entries on electronic forms made in advance, with any information that is unlikely to change during the time period covered by the logbook. It is the technician's responsibility to ensure that any pre-printed information contained on the calibration form is correct. In the event any of the pre-printed information changes (e.g., temporary use of replacement equipment), the operator should use standard initialed strikethrough(s) to correct the information for hardcopy documents.

The current year calibration records should be kept at the site, or be accessible from the site, in electronic format or at the site in hard copy form.

10.1. Equipment Required for Calibration

A. Zero Air System – An instrument such as the T-API Model T701 or TEI Model 111, or other system which is suitable to remove contaminants to provide pollutant-free dilution air to the analyzer. The SOP for each unit should be referenced for maintenance intervals.

B. Calibration System – The calibration system must have an accurate mass flow-controlled gas dilution system or provide concentrations directly from multiple calibration gas cylinders. The air flow controllers must be capable of maintaining constant air flows within ±2% of the required flow rate.

C. CO Gas Cylinder or Mixed Gas Cylinder – A NIST-traceable gas cylinder for supplying known concentrations of EPA Protocol CO gas to the calibration system.

NOTE: The cylinder(s) should not be used below 200 psi unless a higher value is specified by the manufacturer.

D. Sample Line Integrity Check (SLIC) tubing assembly – This is required prior to multi-point checks for verifying calibrations and consists of a dedicated sample tube with an attached "T" or atmospheric vent for ventilation.

E. NIST-traceable Transfer Standards for time, temperature, barometric pressure, and volumetric flow measurements.

F. The current year's electronic logbook containing a blank copy of the CO calibration form, in hardcopy or electronic format. The Microsoft Excel™ version of this form contains formulas to automatically calculate the statistics and display the results related to each limit or performance criteria.

G. The analyzer's associated data logger system with all necessary interface equipment and peripheral equipment.

10.2. Preparation for Calibrations

Calibrations of a currently operating analyzer must be preceded by the Z/S/P checks described in Section 12.0 of this SOP. The technician must ensure that those checks are completed, and the results documented before proceeding with the analyzer calibration.

NOTE: The technician must be cognizant that the acceptance criteria for the Model T300U CO analyzer are more stringent than the tolerances for the Model T300 since the monitoring objective is for comparison to the NAAQS and the objective for trace-level instruments at NCore and Near Road is to obtain a better understanding of atmospheric chemistry2.

If the analyzer is being installed for the first time at the monitoring site, or reinstalled following removal from the site, the operator must complete the following pre-calibration steps.

A. Ensure that the analyzer and calibration system are wired and plumbed. Also ensure that the data logger has been properly wired, initialized, and calibrated.
B. Ensure that the control settings of the analyzer are set as described in Section 9.0 of this SOP.
C. The regulator on the gas cylinder must be purged prior to use.
D. Check the analyzer, calibrator, and the data logger clocks to ensure that they are all set to within ±2 min of a NIST-traceable standard.

The calibration of a Model API T300U CO analyzer utilizes different zero air and span gas flow rates to produce a calculated theoretical concentration delivered by the calibration system and then compared to the analyzer's response. For each calibration event (zero/span/upscale-2/upscale1/low point), a comparison is made between the calculated theoretical output concentration generated by the calibrator and the best-fit straight line produced by the linear regression of the average analyzer response to the various challenge concentrations.

The calibrator will adjust the zero air and span gas mass flow controllers to deliver the target span gas concentration, or zero air flow rate defined by the field technician. The actual flow for each of the two flow controllers or the output concentration can be seen displayed on the dilution calibrator's front panel.

Record the calibration check information in the appropriate spaces on Calibration Form No. DEP-08-15-B. The Microsoft Excel™ version of this form contains formulas to automatically calculate the statistics and display the results related to each limit or performance criteria. However, if this form is used in hardcopy format, the operator must perform the calculations, manually and record each result.

A. Allow the analyzer to warm up for several hours (preferably overnight) prior to the calibration.
B. Enter the equipment information in the Identification Block of the calibration form and select "Calibration" as the [Procedure] from the dropdown menu on the MS Excel version of Form No. DEP-08-15-B.
C. Enter the CO gas cylinder information from the certification label on the side of the cylinder, in the Standards Block. The values are very important and are used in multiple calculations throughout. Record tank concentrations in parts per million (ppm).
D. "Disable" the CO data logger channel in the site DAS.

Note: The monitoring objective is either for NAAQS compliance or NCORE trace-level monitoring. The selection will determine the precision point and control limits for QC checks.

10.3. Temperature Sensor Check

The temperature sensors measure the instrument's optical bench, wheel, oven, and box temperatures. There are no procedures available on the T300U to adjust or directly compare the temperature sensors. The manufacturer has stated these thermistors are not calibrated and are indicators of proper heater functions. There are procedures described in the T300 manual to troubleshoot for temperature fault warnings and temperature problems by checking resistance of the sensors or associated heating elements. (Section 12.4 of T-API T300 manual). The Bench Temperature Sensor must be checked as part of the initial set-up of the API T300U CO analyzer. At a minimum, the temperature sensor check is performed annually, every 365 days. This procedure is also documented each time an Equipment Status Report form is completed.

After sufficient analyzer warm-up time, the technician observes the analyzer front panel display and confirms the optical bench temperature is controlled at 48 ± 2°C. The temperature sensor check is recorded in the Sensor Calibration / Check of the calibration form, DEP 08-15-D. The form will indicate if the check passes or not in the RESULT column.

10.4. Pressure Sensor Calibration

The pressure sensor located at the sample chamber outlet measures the sample gas pressure and is used to compensate the final CO concentration calculation for changes in pressure. The Pressure Sensor must be checked and calibrated as part of the initial set-up of the API T300U CO analyzer. At a minimum, the pressure sensor calibration is performed annually, every 365 days.

Important: The pressure sensor verification / calibration must be performed when the sensor is measuring ambient atmospheric pressure. This can be accomplished by disconnecting the sample gas pump from the pressure sensor and/or the sample gas-line vent from the rear panel of the analyzer.

The technician compares the analyzer displayed pressure against a NIST-traceable transfer standard and then adjusts the analyzer's settings to calibrate the sensor within ±0.2 inches Hg. Unit conversion may be necessary (1 mm = 0.03937 inches). The calibration check and adjustment, if necessary, is recorded in the Sensor Calibration / Check section of the Sensor Calibration Form, DEP 08-15-D. Follow the step-by-step procedure below.

A. Locate the pressure sensor and/ or sample gas pump in the analyzer and disconnect the attached tubing and allow the sensor to read ambient atmospheric pressure. While in normal Sample Mode, toggle the TST buttons to view the current "PRES" (in Hg) reading. Record this pressure value, for the [Front Panel] entry in the "As Found" row of the sensor calibration form.

B. Record the ambient pressure reading from the NIST-traceable barometer as the [Ref. Standard] in the "As Found" row of the calibration form. Unit conversion may be necessary (1 millimeter = 0.03937 inches).

C. Calculate and record the difference between the [Front Panel] and the [Ref. Standard] in inches Hg, record the RESULT as "PASS" or "CALIBRATE" on the calibration form.

NOTE: If the difference is within ± 0.2 in Hg, it is not necessary to calibrate and the technician can proceed to Section 10.5, below.

A. If adjustment is necessary or desired, access the Pressure Calibration menu by clicking UTILITIES, PRESSURE CAL, Enter “Actual Pressure”, click CALIBRATE.

B. Record the new analyzer pressure for the [Front Panel] entry in the “Post Calibration” row of the calibration form.

C. Record the ambient pressure reading from the NIST-traceable barometer as the [Ref. Standard] in the “Post Calibration” row of the calibration form. Unit conversion may be necessary.

D. Calculate and record the difference between the [Front Panel] and the [Ref. Standard] in inches Hg, record the RESULT as “PASS” or “CALIBRATE” on the calibration form.

E. Re-connect the tubing to the pressure sensor or sample gas pump returning the analyzer to its normal sampling configuration.

10.5. Flow Sensor Calibration

The flow sensor measures the volumetric flow through the pneumatic system. It must be checked and calibrated as part of the initial set-up of the API T300U CO analyzer. At a minimum, the flow sensor calibration is performed annually, every 365 days.

The technician compares the analyzer front panel display against a NIST-traceable volumetric flow meter and then adjusts the analyzer’s settings to calibrate the sensor within ±0.10 LPM (100 cm^3/min). The calibration check and adjustment, if necessary, is recorded in the Sensor Calibration form, DEP 08-15-D.

A. Connect a NIST-traceable volumetric flow standard to the SAMPLE inlet port on the rear of the analyzer. Follow the step-by-step procedure below.

B. Wait at least one (1) minute to allow the flow readings to stabilize on both the reference standard and the analyzer.

C. While in normal Sample Mode, look at the Dashboard to view the current sample flow (cc/m) reading. Record that value, for the [Front Panel] entry in the “As Found” row of the calibration form.

D. Record the volumetric (corrected) flow reading from the NIST-traceable flow meter as the [Ref. Standard] in the “As Found” row of the calibration form.

E. Calculate and record the difference between the [Front Panel] and the [Ref. Standard] in LPM, record the RESULT as “PASS” or “CALIBRATE” on the calibration form.

F. To calibrate (adjust) the flow sensor, The Flow Calibration menu is accessed through Utilities, Diagnostics, Flow Cal. toggle the touch buttons and change the value to the reading on the reference standard, press “Calibrate” to save the calibration setting.

G. Exit out of the Flow Calibration to the normal Sample Mode to view a “real time” sample flow readings on the Dashboard. Record the adjusted analyzer flow measurement for the [Front Panel] entry in the “Post Calibration” row of the calibration form.

H. Record the actual volumetric flow reading from the NIST-traceable flow meter as the [Ref. Standard] in the “Post Calibration” row of the calibration form.

NOTE: If the difference is within ± 0.10 LPM (100 cm³ / min), it is not necessary to calibrate and the technician can proceed to Section 10.6, below.

10.6. Model API T300U Zero Calibration (Adjustment)

Deliver ZERO air to the analyzer while it is in normal Sample Mode and allow it to sample until a stable CO response is obtained. It may be beneficial to view the “STABIL” test parameter during this process to ensure the analyzer has good stability before any adjustment is made. Note: Stability is defined as 5-10 one-minute averages of ±0.2 ppm with no upward or downward trend.

A. First press the CAL button which will put the analyzer into M-P CAL Mode. Next, press the "ZERO" button which will then change to an "ENTER" button option.

B. Press the "ENTER" button to change the Offset and/ or Slope settings of the analyzer so that the analyzer reads zero (0.000 ppm). If no adjustment is desired at this time, the "EXIT" button can be pressed instead to leave the zero calibration unchanged and exit.

C. Using the DAS display, record:1) the average stabilized zero response on the Calibration from, DEP 08-15-B, 2) the dilution air flow, and 3) the calibration gas flow (which should be 0.0 LPM) from the front of the dilution calibrator for the initial zero event of the Calibration Check block.

10.7. Model API T300U Span Calibration (Adjustment)

A. Adjust the dilution (zero air) air flow and the calibration gas flow on the dilution calibrator to provide approximately 80% to 90% of full-scale range. This will be 4.5 ppm for the 0-5 ppm range trace level analyzer.

B. Deliver the Span concentration to the analyzer and allow it to sample until a stable CO response is displayed on the analyzer's front panel display. On Form DEP 08-15-B, record the actual values generated by the dilution calibrator for the Gas and Dilution readings. The spreadsheet will calculate the exact known "Assessment CO concentration.".

C. Follow the step-by-step procedure below to set this known calculated span value into the T300U analyzer. First press the CAL button which will put the analyzer into M-P CAL Mode. Next press the Set Span Target button which brings you to a screen to input the span concentration. Type in the value to the known calculated "Assessment CO concentration", press "ENTER" to save the calibration span setting. Important: This does not yet adjust the analyzer's Span or Offset factor. It only sets or stores the new known calculated CO span concentration value that you will be adjusting the analyzer to in the next step.

D. After the known CO concentration generated by the dilution calibrator is set in the analyzer and stable readings are generated, do this procedure to adjust the analyzer's span after the unit has stabilized. The stability should be less than 0.1 PPM. Once this is achieved, hit the Span button. That will calibrate Span. Note: The stability can take a long time to come down to 0.1 ppm.

E. Using the DAS display, record the average stabilized SPAN response on the Calibration from, DEP 08-15-B, the dilution air flow, and the calibration gas flow from the front of the dilution calibrator for the SPAN event of the CO Calibration Block.

Note: The average data logger response and average analyzer response should agree to within ±2%.

At this point, the Technician can, if needed re-initiate the ZERO event to review any drift caused by the SPAN calibration. If zero drift is greater than ±0.4 ppm, make adjustments to the ZERO calibration and/or the SPAN calibration by repeating sections 10.6, and 10.7, until the analyzer zero response is within ±0.4 ppm and the technician is satisfied that the calibration will achieve the best linearity of the calibration curve.

Once the zero and span adjustments are set, the technician must perform a multipoint calibration check according to the following section, 10.8. A SLIC is also due and will be performed according to the procedures in Section 10.9. The SLIC may be performed before the multipoint calibration check or after the calibration check is complete so as not to interrupt the check for the linearity of the analyzer’s response curve.

10.8. Multipoint Calibration Check

A. Perform an initial ZERO check by delivering zero air to the analyzer.

B. Allow the responses to stabilize until 5-10, one-minute averages are within ±0.2 ppm with no upward or downward trend. Then update the calibrator's calibration gas and dilution air flows recorded on the calibration form for the initial ZERO calibration point in the Calibration Check block.

C. Record the average zero response, from the DAS, on the calibration form for the Observed CO average value.

D. Calculate and record the straight difference between the Assessment CO concentration (0.000 ppm) and the Observed CO response; record the RESULT as "PASS" or "CALIBRATE" on the calibration form.

E. Deliver the SPAN concentration to the analyzer by adjusting the calibrator flows to generate a CO span concentration of approximately 24.0 or 4.5 ppm for the T300U which will be relative to the set range of the analyzer.

F. Allow the responses to stabilize until 5-10, one-minute averages are within ±0.2 ppm with no upward or downward trend. Then update the calibrator's calibration gas and dilution air flows recorded on the calibration form for the SPAN calibration point in the Calibration Check block.

G. Record the average span response, from the DAS, on the calibration form for the Observed CO average value.

H. Calculate and record the relative percent difference (% Diff) between the Assessment CO conc. and the Observed CO response; record the RESULT as "PASS" or "CALIBRATE" on the calibration form.

I. Adjust the calibrator flows to deliver three (3) more concentrations as defined in Table 10- 1, above, repeating steps 10.8.E for each of the remaining calibration check points.

J. The form spreadsheet should record all the appropriate values described below in the Calibration Assessment block on the calibration form, DEP-08-15-B, by entering the data for the multiple calibration points checked as described above. (Assessment CO conc. values in the row labeled [Calibrator Value (X)] and the Observed CO values in the row labeled [Instrument Value (Y)].

K. Calculate and record the slope (m) and intercept (b) using the least squared linear regression method.

L. Apply the slope and intercept to calculate and record each point in the row labeled [Best Fit Concentration].

M. Calculate and record the relative percent difference (%Diff) between the Best Fit Concentration and the Instrument Value (Y); record the RESULT as "PASS" or "CALIBRATE" on the calibration form.

N. Deliver ZERO air until the analyzer reads 0.40 ppm or less; record a 5-minute average value as the [Observed CO], for the Ending Zero point on the calibration form.

O. Return the calibrator to "STANDBY" mode. Allow the analyzer to sample ambient air for several minutes until ambient readings are present.

P. Change the CO channel on the DAS back to ambient mode by enabling the channels and record the time of the Channel On-line in the Primary Recorder Status block of the calibration form.

Q. Complete the calibration form by adding any pertinent comments. Then sign and date the form and submit it to the QA staff for review.

NOTE: All calibration check points must be either ±2% or ±0.03 ppm difference of the Best Fit Straight Line, whichever is greater. If not, the analyzer must be re-calibrated. The Microsoft Excel™ version of this form contains formulas to automatically calculate the Calibration Assessment statistics and display the results related to each limit or performance criteria.

10.9. Sample Line Integrity Check (SLIC)

In this procedure, the Field Technician must determine if contamination of the sample line is adversely affecting ambient CO measurements made by the analyzer. This check is required to be performed during each regularly scheduled analyzer calibration, once per quarter (every 90 days), and whenever visible moisture is observed in the sample line or sample line filter. It may also be performed at any time the Field Technician suspects the sample line has become contaminated. In the event that the sample lines are contaminated, the entire sample line must be cleaned or changed.

The Field Technician performs a SLIC after all maintenance and adjustments to the analyzer are complete. The SLIC procedure must be followed by a QC check, either Z/S/P or a Z/S check, prior to resuming ambient air quality monitoring data collection. Therefore, the SLIC may be performed before the multipoint calibration check so as not to interrupt the check for the linearity of the analyzer's response curve. However, if the SLIC is performed after the multipoint calibration check, the technician must also complete a Z/S check, after the SLIC and prior to resuming ambient air quality monitoring.

Some agencies have safety protocols in place that determine how QA coordinators decide whether to leave the span gas running during the line changes, or to turn off gas generation and/or flow from the calibrator so that only dilution (zero) air is running during the line changes. Consult with your QA coordinator to identify the SLIC approach (Zero/Span/Zero or Span Only) used within your network.

10.9.1. Zero-Span-Zero SLIC Procedure

a. While the analyzer is sampling zero air from the calibrator, disconnect the sample line between the analyzer and multi-gas calibrator and replace it with the SLIC tubing assembly. The SLIC tubing will connect the "Output" fitting of the multigas calibrator and the "Sample" fitting of the analyzer. The vent located on the SLIC line "TEE" can be vented to any external vent that is available.

b. Adjust the calibrator to the same settings used in generating the CO span concentration.

c. Allow the analyzer responses to stabilize and then record 5-10 stable one- minute average readings, as displayed from the data logger on the Data Worksheet under SLIC.

d. Record the average of 5-10 stable one-minute CO response values on the Calibration Form in the Observed CO field, in the SLIC Check Block, SLIC event row.

e. When finished, set the calibrator to supply zero air to the system, and then disconnect the SLIC line from the calibrator, analyzer and vent. Re-install the original sample line in the same configuration as before the SLIC.

f. Adjust the calibrator to the same settings used in generating the CO span concentration.

g. Allow the analyzer responses to stabilize and then record 5-10 stable one- minute average readings, as displayed from the data logger on the Data Worksheet under SPAN.

h. Record the average of 5-10 stable one-minute CO response values on the Calibration Form in the Observed CO field, in the SLIC Check Block, SPAN event row.

i. When finished, set the calibrator to supply zero air to the system, and then calculate the SLIC percent difference.

j. Compare the observed CO response for SLIC to the observed CO response for SPAN and then record the RESULT as "PASS" or "CALIBRATE" on the calibration form.

10.9.2. Span Only SLIC Procedure

a. Disconnect the sample line between the analyzer and multi-gas calibrator and replace it with the SLIC tubing assembly. The SLIC tubing will connect the “Output” fitting of the multi-gas calibrator and the “Sample” fitting of the analyzer. The vent located on the SLIC line “TEE” can be vented to any external vent that is available.
b. Adjust the calibrator to the same settings used in generating the CO span concentration.
c. Allow the analyzer responses to stabilize and then record 5-10 stable one- minute average readings, as displayed from the data logger on the Data Worksheet under SLIC.
d. Record the average of 5-10 stable one-minute CO response values on the Calibration Form in the Observed CO field, in the SLIC Check Block, SLIC event row.
e. When finished, disconnect the SLIC line from the calibrator, analyzer and vent. Re-install the original sample line in the same configuration as before the SLIC.
f. Allow the analyzer responses to stabilize and then record 5-10 stable one- minute average readings, as displayed from the data logger on the Data Worksheet under SPAN.
g. Record the average of 5-10 stable one-minute CO response values on the Calibration Form in the Observed CO field, in the SLIC Check Block, SPAN event row.
h. When finished, set the calibrator to supply zero air to the system, and then calculate the SLIC percent difference.
i. Compare the observed CO response for SLIC to the observed CO response for SPAN and then record the RESULT as “PASS” or “CALIBRATE” on the calibration form.

The equation below will calculate the relative percent difference between the data logger response through its normal sample line and through the clean SLIC line:

$$\% \, Diff = \frac{Response\ (ppb)\,through\ Sample\ Line - Respone\ (ppb)\,through\ SLIC\ Line}{Response\ (ppb)\,through\ SLIC\ Line} \times 100$$

If the calculated difference is ≤±2.0%, the analyzer's sample line is approved for further use without additional effort. If the calculated difference is greater than ±2.0%, the analyzer's sample line must be cleaned or replaced before proceeding with the analyzer calibration or resuming ambient data collection. Replace/recheck the sample line until the calculated results are within ±2.0%. Record the sample line service in the "Comments" section of the Equipment Status Report and on the Analyzer Maintenance Log.

11.0 INSTRUMENT MAINTENANCE

All maintenance of the API T300U falls into two primary categories: scheduled preventive maintenance and unscheduled corrective maintenance. Preventive maintenance is used to reduce the likelihood of future equipment failure, while corrective maintenance activities are used to return malfunctioning equipment to a fully operational or repaired state.

Unscheduled corrective maintenance may occur to correct problems discovered with the analyzer during routine quality control checks, instrument alarms or as a result of changing environmental conditions. The technician will refer to the Model API T300U Instruction Manual for information on troubleshooting, part repair and replacement. Additionally, the operator may contact API Technical Support for diagnostic assistance seeking solutions and corrective actions.

NOTE: Prior to any maintenance activity, the technician must perform a Z/S/P QC

Check as described in Section 12.2, below, and documented on the calibration form, DEP 08-15-B. The bracketing of the ambient data with a Z/S/P check will ensure that the analyzer is producing the highest quality data. If this is not done, it may be necessary to invalidate data going back to the last acceptable z/s/p check.

The field technician will complete an Equipment Status Report and then document the maintenance activities in the Maintenance Log. In addition, the technician shall provide a descriptive comment indicating the purpose for completing maintenance on the Equipment Status Report, explain any conditions that are out of tolerance, and any maintenance checks answered with a comment.

Once the Maintenance Log is complete, the operator will submit it and the Equipment Status Report, to the field technician's supervisor, or other designated QA Staff, for quality control, accuracy and data review. The supervisor will review the Maintenance Log and record [QA Reviewer] and [Review Date] on the form. The supervisor may also add specific comments related to the maintenance activities in the Equipment Status Report [QA Comment] box, then sign and date the Equipment Status Report.

NOTE: The technician must "disable" the channels affected on the data logger before performing maintenance and "enable" the channels to ambient mode when completed.

The remainder of this section describes the scheduled preventative maintenance that is performed periodically, in order to ensure both accurate and uninterrupted performance.

11.1. Replace External Particulate Filter

As per the initial set-up of the API T300U CO analyzer in Section 9.0 of this SOP, then a quarterly requirement thereafter, the sample line is configured with a Teflon filter to prescreen particles larger than 5 microns (µm). This filter is located in the filter housing, between the sample line and the analyzer, to protect the instrument.

from particle contamination. The external particulate filter will be replaced every 90 days, on a quarterly basis or sooner, if necessary.

Note: While visiting the site it is "best practice" to look at the filter through the clear glass lid of the filter housing on the back side of the unit. If it looks exceptionally dirty, the operator may change it at their discretion.

A. Disconnect the sample line from the back of the analyzer leaving the analyzer running to draw shelter air during this procedure.

B. Open the filter holder by grasping each end of the device and twisting; remove and discard the filter element.

C. Install a new 1 or 5 µm filter such that it lies flat against, and completely covers, the perforated surface at the output end of the holder.

D. Reconnect the sample train and then condition the filter membrane by running a span concentration of CO gas through the filter for several minutes to ensure accurate sampling results.

E. Record the Particulate Filter Maintenance as completed in the Maintenance Log (DEP 08-15-C.

11.2. Perform Leak Test & Pump Check-Out

The technician will inspect the pneumatic system for external leaks and verify that the pressure reading falls below 10 in-Hg during the test annually (at a minimum) or after any maintenance to the pneumatic system.

A. With the instrument running, disconnect the sample line and plug in the analyzer inlet port (SAMPLE port).

B. From the normal Sample Mode screen, scroll through the TST buttons to view the Sample Pressure reading.

C. After several minutes, the pressure reading should fall to < 10 in-Hg. In addition, scroll to the Sample Gas Flow test function and it should fall to < 10 cc/min. If both of these criteria are met, it indicates there are no large leaks and that the pump is in good condition.

D. Replace the pump diaphragm as needed.

E. Record the Leak Test as "Pass" or "Fail" in the Maintenance Log (DEP 08-15-D).

NOTE: If the Sample Flow is not less than 10 cc/min, check that all fittings are tight and that no input lines are cracked or broken. If the pressure does not fall below 10 in-Hg, inspect the pump diaphragm condition and the flow control assembly for blockage or leaks.

11.3. Clean/Replace Sample Lines

In order to ensure that accurate samples are being transmitted from the sampling inlet/manifold to the analyzer, and ensure sample line integrity, it is essential that the sample lines be kept clear of any obstructions and free of possible contaminants. Therefore, the sample lines are cleaned or replaced annually, or if a contaminant is detected during a span check or SLIC.

A. Detach all the lines and filter holder from the inlet to the back of the analyzer, including the sample inlet tube that penetrates into the manifold.

B. Replace the sample lines going to the calibrator and analyzer, and then re-install the sample line filter assembly.

C. Record the sample line maintenance as completed in the Maintenance Log (DEP 08-15-C).

D. Turn off the power to the analyzer and vacuum pump.

12.0 QUALITY ASSURANCE & QUALITY CONTROL

Quality assurance is a system of management and operational activities designed to ensure that the data produced by the operation of the analyzer will be of the type and quality needed and expected by the data user. Quality control defines the procedures implemented to assure that acceptable precision, bias, completeness, representativeness, and comparability are obtained and maintained in the generated data set. Quality control procedures, when properly executed, provide data that meet or exceed the minimally acceptable quality criteria established to assist management in making confident decisions. It is the policy of the Florida PQAO to implement a QA program and QC procedures to assure that data of known and acceptable precision, bias, completeness, comparability, and representativeness are collected from all monitoring projects. The following procedures and their associated intervals are used to manage the quality of data generated by the analyzer.

Table 12-1 QA/QC Acceptance Criteria

Parameter	NAAQS (T300U) Acceptance Criteria	NCore (T300U) Acceptance Criteria	Frequency
One Point QC Check for Precision	Control within ± 10.1% (percent difference) Warning identified at > 7.0%	Control within ± 15.1% (percent difference) Warning identified at > 12.0%	minimum every 14 days
Zero/Span QC Check	Zero drift within ± 0.61 ppm Span drift within ± 10.1 %	Zero drift within ± 0.61 ppm Span drift within ± 15.1 %	minimum every 14 days
Sample Line Integrity Check	Within ± 2%	Within ± 2%	Upon installation, adjustment, or repair, and minimally every 90 days
Multipoint Calibration QC Check	Zero drift within ± 0.21ppm, All points within ± 2.0% of calibration range best-fit straight line.	Zero drift within ± 0.41ppm, All points within ± 2.0% of calibration range best-fit straight line; low point within ±0.03 ppm.	Upon initial installation, maintenance, repair; every 182-days if biweekly Z/S/P or 365 days if daily Z/S/P checks are performed.
Temperature Sensor - Check the analyzer bench temperature sensor against a NIST traceable standard	Within ± 2°C	Within ± 2°C	Annually, every 365-days
Pressure Sensor - Check the analyzer pressure sensor at Zero and Span against a NIST traceable standard	Within ± 2 mmHg	Within ± 2 mmHg	Annually, every 365-days
Flow Sensor – Check the analyzer flow sensor at Zero and Span against a NIST-traceable standard	Within ± 0.2 LPM	Within ± 0.1 LPM	Annually, every 365-days
Performance Audit	Within ± 15.0% of audit levels 3-10; within ± 0.03 ppm of audit levels 1&2.	Within ± 15.0% of audit levels 3-10; within ± 0.03 ppm of audit levels 1&2.	Annually, every 365-days

12.1. Equipment Status Report

An Equipment Status Report should be completed routinely and at least once per month. It is used to document the shelter environmental conditions and diagnostic parameters of the analyzer. Once complete, the operator will sign, date, and submit the form to QA Staff for review and document retention in the agency Document Management System.

12.2. Routine QC Checks

Routine Z/S/P checks must be performed at least every 14 days (bi-weekly). More frequent checks are permitted for diagnostic purposes or confirming instrument repairs.

All precision data is to be documented and reported to the AirMVP database. This specifically includes the "unadjusted" zero, span, and precision QC checks performed prior to any calibration or maintenance of the analyzer. These checks must also be performed under the following conditions (unless prevented by analyzer malfunction):

A. Immediately prior to a calibration of the analyzer unless prevented by its malfunction.

NOTE: No checks are required prior to the calibration performed following the analyzer's initial installation (or re-installation) at the monitoring site.

B. Immediately prior to an intentional analyzer shutdown (e.g. hurricane, end of site operations etc.) likely to last longer than four (4) hours, unless prevented by its malfunction.

C. Immediately prior to performing any maintenance or repair procedures on the analyzer.

D. Prior to any other operation which is likely to affect the response of the analyzer (e.g., sample line cleaning or drying, sample filter replacement (Quarterly Requirement), voltage adjustment), unless prevented by its malfunction.

To perform the routine manual Z/S/P checks, the operator will follow the Multipoint Check procedures in Section 10.8, above, for the initial zero and then only the span and precision calibration check points. It is not necessary to perform a SLIC, therefore, the operator will skip Section 10.9.

Table 12-1 is a summary of the Measurement Quality Objectives for CO, as reported by the Florida Ambient Air Monitoring Network. The Acceptance Criteria defines the QC limits for the Model T300U analyzers. A One Point QC Check for Precision is performed as part of a Z/S/P QC check and the Calibration QC Check is a multipoint verification that any adjustments to the instrument response are acceptable.

QC checks at the Span and Precision points which result in the percent difference greater than the Control Limit of 15% for Trace Level, require corrective actions that may include calibrating the analyzer according to Section 10.0 of this SOP. QC checks which result in the percent difference greater than the Warning Limit of 12% for Trace Level, which require the technician to investigate the poor performance.

Once the routine QC check is complete, the operator will deliver zero air to the analyzer and only observe 1 or 2 minutes before returning the instrument to sample ambient air. All Z/S/P checks are documented on the Calibration form (DEP 08-15-B). When complete, the operator will sign, date, and submit the calibration form to QA Staff for review and document retention in the agency Document Management System.

13.0 DATA ACQUISITION AND RECORDS MANAGEMENT

The Model API T300U can be interfaced with analog connection, serial or via network Ethernet cables. The Florida Ambient Air Monitoring Network is configured to use digital connections from the API T300U through the data acquisition system to the main data storage in the main office. The Florida Statewide Data Handling and data Validation SOP covers the data handling for the state of Florida.

14.0 REFERENCES

Quality Assurance Project Plan for the State of Florida Ambient Air Quality Monitoring Program, FL-Gaseous QAPP, Revision No. 2, April 2022, Florida Department of Environmental Protection, Tallahassee, FL

Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II (EPA- 454/B-17-001, January 2017).

Teledyne-API Operation Manual, T300/ T300M Carbon Monoxide Analyzer, Part number 06864, 14 February 2012.

Teledyne-API Manual Addendum, T300U CO Analyzer with Auto-Reference, Part number 06867D, 21 August 2018.

15.0 APPENDIX

15.1. Appendix A Forms

15.1.1. DEP 08-15-A Equipment Status Report (Electronic)

Form No. DEP 08-15-A		Teledyne API T300U Equipment Status Report			Effective: May 2023	
Identification Block						
Date Performed:		Site Name:		Site AQS #:		Procedure:
Analyzer Mfr:		Analyzer Model:	T300U	Analyzer Serial #:		Date Calibrated:
Calibrator Mfr:		Calibrator Model:		Calibrator Serial #:		Date Certified:
Primary Recorder Mfr:		Primary Recorder Model:		Primary Recorder Serial #:		Date Verified:
Standards Block						
Time Standard Mfr:		Model:		ID/Serial #:		Date Certified:

Analyzer Checks			
Parameter	Limits	Units	Value
Range	0-5 (Trace) 0-30 (Std.)	PPM	
Stability	<1.0 w/ Zero air	PPM	
CO Measure	2500 - 4800	MV	
CO Reference	2500 - 4800	MV	
M/R Ratio	1.1 - 1.3 w/ Zero air	n/a	
A Zero M/R Ratio	1.1-1.3	n/a	
Pressure	-2" Ambient Absolute	In-Hg-A	
Sample Flow	1800 ± 20%	cm³ / min	
Bench Temp	48 ± 2	°C	
Wheel Temp	62 ± 2	°C	
Oven Temp	46 ± 1	°C	
Photo Drive	250 - 4750	mV	
CO Slope	1.0 ± 0.3	n/a	
CO Offset	0 ± 0.3	PPM	

Shelter Checks		
MIN Temp (°C)	≥ 10°C	
MAX Temp (°C)	≤ 40°C	

Concurrency Checks					
Concurrency	NIST	Instrument	Difference	Limits	RESULT
Time Display				± 2 minutes	
Concurrency	NIST	Data Logger	Difference	Limits	RESULT
Time Display				± 2 minutes	
Concurrency	Instrument	Data Logger	Difference	Limits	RESULT
Time Display				± 2 minutes	
Concentration Display				± 0.2 ppm	

Operator Comments:			
Performed by:		Date:	

QA Comments:			
Verified by:		Date:	

Instructions:

This Equipment Status Report is formatted as an electronic spreadsheet used specifically for the Model T300U CO analyzer. It is completed for all instrument operational checks, internal performance audits, and calibrations. The information contained in each activity report may be aggregated as a running instrument operational log.

1. Enter the activity date [Date Performed] and site/equipment information in the Identification Block at the top of the form.
2. Enter the [Procedure] to be from the drop-down menu.
3. Enter the equipment information and [Certification Dates] in the Identification Block and Standards Block.
4. In the Concurrency Checks block, enter time (hh:mm) from the transfer standard and analyzer display, and then indicate "PASS" for time difference within ± 2 minutes, or "CALIBRATE" for a difference out of tolerance.
5. In the Concurrency Checks block, enter the time and concentrations displayed on the analyzer and the DAS. Calculate and record the difference and then record the RESULT as "PASS" for checks within the limits or "CALIBRATE" for checks exceeding the limits.
6. In the Analyzer Checks block, record the observed values from the instrument's diagnostic displays.
7. In the Shelter Checks block, record the "YES" or "NO" for shelter temperature minimums and maximums.
8. Enter operator/technician comments in the comment box.

The operator should provide a descriptive comment indicating the purpose for completing an Equipment Status Report, explain any conditions that are out of tolerance, and any maintenance checks answered with a "NO", "N/A" or similar non-affirmative answer. Once the form is complete, the operator will submit it to the field technician's supervisor for quality control, accuracy and data review. The supervisor may add comments in the [QA Comment] box, then sign and date the report/log.

15.1.2. DEP 08-15-B Calibration Form (Electronic)

Form No. DEP 08-15-B **Teledyne API Model T300U CO Analyzer QC Check and Calibration Log** **Effective: September 2023**

Identification Block

Date Performed:		Site Name:		AQS #:		Procedure:	
Analyzer Mfr:		Model:		Serial #:		Date Calibrated:	
Data Logger Mfr:		Model:		Serial #:		Date Calibrated:	
Calibrator Mfr:		Model:		Serial #:		Date Certified:	
Zero Air System Mfr:		Model:		Serial #:		Date Serviced:	
Monitoring Objective:	NCORE	Nightly Checks:	Yes				

Standards Block

Gas Cylinder Serial #:		Concentration (ppm):		Pressure (psi):		Expiration Date:	
Time Standard Mfg:		Model:		ID/Serial #:		Date Certified:	

Analyzer Checks

CO Measure	2500-4800mV	
CO Reference	2500-4800mV	
M/R Ratio with Zero Air	1.1-1.3	
A Zero M/R Ration	1.1-1.3	
Pressure	28-32inHg	
Sample Flow	1440-2160ccm	
Bench Temp	46-50°C	
Wheel Temp	60-64°C	
Oven Temp	45-47°C	
Photo Drive	250-2750mV	

QC Checks

Time			
NIST	Instrument	Difference	Limits
			± 2 minutes
NIST	Data Logger	Difference	
			± 2 minutes
Instrument	Data Logger	Difference	
			± 2 minutes
Concentration			
Instrument	Data Logger	Difference	Limits
			± 0.5 ppb

Primary Recorder Status

	Time
Channel Off-line:	
Channel On-line:	

Calibration Factors

Slope:		Post Adjustment:	
Offset:		Post Adjustment:	

Pre-Maintenance Z/S/P

Calibration Point	Gas (cc/min)	Dilution (cc/min)	Calculated CO	Observed CO	% or ppm Diff.	Limits	RESULT
Zero	0		n/a	n/a	n/a	±0.41 ppm	n/a
Span (≥80% scale) (4.5)			n/a	n/a	n/a	± 15.1%	n/a
Precision (0.5)			n/a	n/a	n/a	± 15.1%	n/a

Calibration Check

Calibration Point	Gas (cc/min)	Dilution (cc/min)	Calculated CO	Observed CO	% or ppm Diff	Limits	RESULT
Initial Zero	0		n/a	n/a	n/a	± 0.41 ppm	n/a
Span (≥80% scale) (4.5)			n/a	n/a	n/a	See Linearity Results	
Upscale 1 (2.4)			n/a	n/a	n/a	See Linearity Results	
Upscale 2 (.18)			n/a	n/a	n/a	See Linearity Results	
Precision (0.5)			n/a	n/a	n/a	See Linearity Results	
Final Zero	0		n/a	n/a	n/a	See Linearity Results	

Gas Flow Conversion: 1000 cc/min = 1 LPM

SLIC Check

Calibration Point	Gas (cc/min)	Dilution (cc/min)	Calc. CO	Observed CO	% Diff	Limits	RESULT
SLIC			n/a	n/a	n/a	±2%	n/a
Span (≥80% scale) (4.5)			n/a	n/a			

Post-Maintenance Z/S/P

Calibration Point	Gas (cc/min)	Dilution (cc/min)	Calculated CO	Observed CO	% or ppb Diff.	Limits	RESULT
Zero	0		n/a	n/a	n/a	±0.41 ppm	n/a
Span (≥80% scale) (4.5)			n/a	n/a	n/a	± 15.1%	n/a
Precision (0.5)			n/a	n/a	n/a	± 15.1%	n/a

Linearity Check

	Zero	Low Point	Precision	Upscale	Span
Calibrator Value (X)	-	-	-	-	-
Instrument Value (Y)	-	-	-	-	-
Best Fit Concentration	-	-	-	-	-
% Diff of Best fit Conc. vs. Y values (±2.0%)	-	n/a	n/a	n/a	n/a

Slope (m)	Intcpt (I)
-	-

Operator Comments:

Performed by: Date:

QA Comments:

Verified by: Date:

Instructions:

Identification Block…

Date Performed…	Enter date maintenance and or checks were completed.
Site Name…	Enter site name.
Site AQS #...	Enter site AQS number.
Procedure…	Select the appropriate procedure from the dropdown list.
Analyzer Mfr…	Enter the manufacturer of the SO2 analyzer being used.
Serial Number…	Enter the serial number of the SO2 analyzer being used.
Date Calibrated…	Enter the date the SO2 analyzer was calibrated.
Data Logger Mfr…	Enter the manufacturer of the data logger.
Model…	Enter the model of the data logger.
Serial #...	Enter the serial number of the data logger.
Date Calibrated…	Enter the date the data logger was calibrated.
Calibrator Mfr…	Enter the calibrator manufacturer.
Calibrator Model…	Enter the calibrator model.
Serial #...	Enter the serial number of the calibrator.
Date Certified…	Enter the date the calibrator was last certified.
Zero Air System Mfr…	Enter the manufacturer of the zero air system.
Model…	Enter the model of the zero air system.
Serial #...	Enter the serial number of the zero air system.
Date Serviced…	Enter the date the zero air system was serviced.
Nightly Checks…	Enter yes from the list if nightly checks are being run, and no if they are not.

Standards Block...

Gas Cylinder SN…	Enter the serial number of the gas cylinder.
Concentration…	Enter the concentration of SO2 in the tank.
Pressure…	Enter the pressure of the tank.
Expiration Date…	Enter the date the tank expires.

Data Logger Status…

Channel Off-Line…	Enter the time the channel was downed.
Channel On-Line…	Enter the time the channel was returned to normal.

Calibration Factors…

Background…	Enter the background of the analyzer.
Coefficient…	Enter the coefficient of the analyzer.
Post adjustment…	Enter the post adjustment background and coefficient if any changes were made.

Pre-Maintenance Z/S/P…

Zero Dilution…	Enter the calibrator dilution concentration used during the bracketing pre-maintenance z/s/p check.
Span Gas/Dil…	Enter the calibrator cal gas and dilution concentrations used during the bracketing pre-maintenance z/s/p check.
Precision Gas/Dil…	Enter the calibrator cal gas and dilution concentrations used during the bracketing pre-maintenance z/s/p check.

Calibration Check…

Initial Zero Dilution	Enter the calibrator dilution concentration used during the initial zero.
Span Gas/Dil…	Enter the calibrator cal gas and dilution concentrations used during the sp
Upscale Gas/Dil…	Enter the calibrator cal gas and dilution concentrations used during the upscale point.
Precision Gas/Dil…	Enter the calibrator cal gas and dilution concentrations used during the precision point.
Low Point Gas/Dil..	Enter the calibrator cal gas and dilution concentrations used during the low point.
Final Zero Dilution	Enter the calibrator dilution gas used during the final zero check.

SLIC Check…

SLIC Gas/Dilution..	Enter the calibrator cal gas and dilution concentrations while using the SLIC line.
SPAN Gas/Dilution	Enter the calibrator cal gas and dilution concentrations while the sample line is being used.

Post Maintenance Z/S/P...

Zero Dilution…	Enter the calibrator dilution concentration used during the post maintenan z/s/p check.
Span Gas/Dil…	Enter the calibrator cal gas and dilution concentrations used during the post maintenance z/s/p check.
Precision Gas/Dil…	Enter the calibrator cal gas and dilution concentrations used during the post maintenance z/s/p check.

Operator Comments…

Enter comments in this section.

QA Comments…

This section is reserved for QA personnel comments.

The technician should provide a descriptive comment indicating the purpose for performing the calibration(s) and any adjustments performed. Once the form is complete, the operator will submit it to the QA officer for verification and data validation review. The QA officer may add comments in the [QA Comment] box, then sign and date the report/log.

15.1.3. DEP 08-15-C Maintenance Log (Electronic)

Form No. DEP 08-15-C | **Teledyne API T300U Maintenance Schedule** | **EFFECTIVE DATE May 2023**

Identification Block					
Year:		Site Name:		AQS #:	
Instrument Mfr.:		Model:		Serial #:	

Minimum Maintenance Frequency:		Monthly	Quarterly		Annual							As Needed			
Date	Operator	Inspect Filter	Sample Line Filter Change	Sample Line Integrity Check	Multi-point Calibration / Verification	Clean Instrument Interior	Leak Check	Replace/Clean Sample Line	Temperature Sensor Check	Pressure Sensor Calibration	Flow Sensor Calibration	Replace Pump Diaphragm	Examine/Clean Pneumatic Lines	QA Verification	QA Date
ENTER DATE LAST PERFORMED:														LEAVE BLANK	
	Due Dates:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				
	Warnings:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				

Operators Comments:

QA Comments:

Instructions:

Identification Block

Year….	Year that maintenance form will be used
Site Name …	Written site name
AQS # …	AQS number attributed to site
Instrument Mfr .	Analyzer's manufacturer
Model …	Analyzer's model number
Serial # …	Analyzer's serial number
Data Logger Mfi	Data logger's manufacturer
Model …	Data logger's model number
Serial # …	Data logger's serial number
Date …	Date maintenance was performed
Operator ….	First initial and last name of operator who performed the maintenance
Maintenane Liste	Maintenance is listed on the top row. For each maintenance select an appropriate dropdown
	"performed" or similar response is used if maintenance was performed for any reason
	"not performed" if maintenance was scheduled but could not be performed
	"not due" if maintenance is not past due and was not performed
QA Verification	First initial and last name of personnel who verified the maintenance was performed
QA Date …	Date QA Verification was performed

The technician should provide a descriptive comment indicating the purpose for performing the calibration(s) and any adjustments performed. Once the form is complete, the operator will submit it to the QA officer for verification and data validation review. The QA officer may add comments in the [QA Comment] box, then sign and date the report/log.

15.1.4. DEP 08-15-D Annual Pressure /Temperature Verification (Electronic)

Form No. DEP 08-15-D **Teledyne API T300U Sensor Calibration Form** **Effective: May 2023**

Identification Block							
Date Performed:		Site Name:		AQS #:			
Instrument Mfr.		Model:		Serial #:		Date Calibrated / Verf.:	
Calibrator Mfr.		Model:		Serial #:		Date Certified:	
Primary Recorder Mfr.		Model:		Serial #:		Date Verified:	

Standards Block							
Flow Standard Mfg:		Model:		ID/Serial #:		Date Certified:	
Temp. Standard Mfg:		Model:		ID/Serial #:		Date Certified:	
BP Standard Mfg:		Model:		ID/Serial #:		Date Certified:	

Sensor Calibration / Check					
Bench Temperature	Front Panel	Analyzer Specification	**Difference**	**Limits**	**RESULT**
As Found (°C)		48.0	N/A	± 2°C	N/A
Sample Pressure	Front Panel	Ref. Standard	**Difference**	**Limits**	**RESULT**
As Found (in Hg)			N/A	± 0.2 in Hg	N/A
Post Calibration (in Hg)		N/A	N/A	± 0.2 in Hg	N/A
Flow	Front Panel	Ref. Standard	**Difference**	**Limits**	**RESULT**
As Found (cm³ / min.)			N/A	± 100 cm³ / min.	N/A
Post Calibration (cm³ / min.)		N/A	N/A	± 100 cm³ / min.	N/A
	Front Panel Flow	**Limit**	Front Panel Pressure	**Limit**	**RESULT**
Leak Test		< 10 cm³ / min.		< 10 mmHg	

Operator Comments:

Performed by:		Date:	

QA Comments:

Verified by:		Date:	

Instructions:

This calibration form is formatted as an electronic spreadsheet used for the Model T300U CO analyzer. It is used for the annual calibration or verification of the temperature, pressure, and flow sensors in the analyzer.

1. Enter the activity date [Date Performed] and site/equipment information in the Identification Block at the top of the form.
2. Enter the equipment information for the transfer standards in the Standards Block.
3. In the Sensor Calibration / Check block, record the instrument's front panel reading of the internal temperature, pressure and flow values, "As Found" on the analyzer's display.
4. Record the "Reference Standard" values and then calculate the differences and indicate the RESULT as "PASS" or "Calibrate."
5. If the difference is out of tolerance and the RESULT indicates "Calibrate", take corrective actions and record the "Post Calibration" values.

The technician should provide a descriptive comment indicating the purpose for performing the calibration(s) and any adjustments performed. Once the form is complete, the operator will submit it to the QA officer for verification and data validation review. The QA officer may add comments in the [QA Comment] box, then sign and date the report/log.

16.0 GLOSSARY

10BaseT An Ethernet standard that uses twisted ("T") pairs of copper wires to transmit at 10 megabits per second (Mbps).

100BaseT Same as 10BaseT except ten times faster (100 Mbps).

ASSY Assembly.

CD Corona Discharge, a frequently luminous discharge, at the surface of a conductor or between two conductors of the same transmission line, accompanied by ionization of the surrounding atmosphere and often by a power loss.

O3 Ozone.

cm3 Metric abbreviation for cubic centimeter (replaces the obsolete abbreviation "cc")

CPU Central Processing Unit.

DFU Dry Filter Unit.

DHCP Dynamic Host Configuration Protocol. A protocol used by LAN or Internet servers to automatically set up the interface protocols between themselves and any other addressable device connected to the network.

DIAG Diagnostics, the diagnostic settings of the analyzer.

DOM Disk On Module, a 44-pin IDE flash drive with up to 128MB storage capacity for instrument's firmware, configuration settings and data.

DTE Data Terminal Equipment.

Ethernet A standardized (IEEE 802.3) computer networking technology for local area networks (LANs), facilitating communication and sharing resources.

I2C bus A clocked, bi-directional, serial bus for communication between individual analyzer components.

PM Preventive maintenance.

PM Schd Preventive maintenance schedule.

IP Internet Protocol.

IZS Internal Zero Span.

LAN Local Area Network.

LCD Liquid Crystal Display.

LED Light Emitting Diode.

LPM Liters per Minute.

MFC Mass Flow Controller.

M/R Measure/Reference.

RS-232 Specification and standard describing a serial communication method between DTE (Data Terminal Equipment) and DCE (Data Circuit-terminating Equipment) devices, using a maximum cable-length of 50 feet.

RS-485 Specification and standard describing a binary serial communication method among multiple devices at a data rate faster than RS-232 with a much longer distance between the host and the furthest device.

SLPM Standard Liters Per Minute of a gas at standard temperature and pressure.

STP Standard Temperature and Pressure.

TCP/IP Transfer Control Protocol / Internet Protocol, the standard communications protocol for Ethernet devices.

TS A transfer standard, defined as a transportable device or apparatus which, together with associated operational procedures, is capable of accurately reproducing pollutant concentration standards or of producing accurate assays of pollutant concentrations which are quantitatively related to an authoritative master standard.

USB Universal Serial Bus: a standard connection method to establish communication between peripheral devices and a host controller, such as a mouse and/or keyboard and a personal computer or laptop.

VARS Variables, the variable settings of the instrument.