STATEWIDE
STANDARD OPERATING PROCEDURE

FOR

THERMO SCIENTIFIC MODEL 43IQ and 43IQ-TRACE
LEVEL-ENHANCED SULFUR DIOXIDE ANALYZER

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
OFFICE OF AIR MONITORING

Prepared by: Florida PQAO Date: March 2023

Approved by: Daisy Anderson Digitally signed by Daisy Anderson Date: 2023.04.17 08:38:11 -04'00' Date: April 17, 2023
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EPA Region IV Approval Officer

REVISION HISTORY

Revision No.	Date	Responsible Person	Description of Change
0	March 2023	SOP Committee	Initial Draft

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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 Thermo Fisher Scientific Model 43IQ Sulfur dioxide (SO_2) Analyzer (43IQ) and the Model 43IQ Trace Level-Enhanced Sulfur dioxide (SO_2) Analyzer (43IQ-TLE) 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 always accessible in electronic format.

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 Validation 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 Thermo Fisher Scientific Model 43IQ SO_2 analyzer to monitor for compliance with the National Ambient Air Quality Standard (NAAQS) for SO_2. The network also contains Thermo Fisher Scientific Model 43IQ Trace Level-Enhanced SO_2 analyzers to quantify the ambient air concentrations of SO_2 at NCore sites. The 43IQ/43IQ-TLE analyzer is designated as an automated reference method (Number R EQSA-0486-060) for SO_2 measurements, as defined in 40 CFR Part 53. The federal reference method (FRM) for the measurement of SO_2 in the atmosphere is defined in Appendix A-1 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 43IQ/43IQ-TLE 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 by 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 FRM for the measurement of SO_2 in the atmosphere, Appendix A-1 to 40 CFR Part 50, is based on the intensity of the characteristic fluorescence released by SO_2 in an ambient air sample contained in a measurement cell of the analyzer when the air sample is irradiated by ultraviolet (UV) light passed through the cell.

The 43IQ/43IQ-TLE operates on the principle that sulfur dioxide (SO_2) molecules absorb ultraviolet (UV) light and become excited at one wavelength, then decay to a lower energy state emitting UV light at a different wavelength. The sample is drawn into the 43IQ/43IQ-TLE through the SAMPLE bulkhead, and through a hydrocarbon "kicker," which removes hydrocarbons from the sample by forcing the hydrocarbon molecules to permeate through the tube wall. The SO_2 molecules pass through the "kicker" unaffected. The ambient air sample then flows into the fluorescence chamber, where pulsating UV light excites the SO_2 molecules. The condensing lens focuses the pulsating UV light into the mirror assembly. The mirror assembly contains eight selective mirrors that reflect only the wavelengths which excite SO_2 molecules.

As the excited SO_2 molecules decay to lower energy states they emit UV light that is proportional to the SO_2 concentration. The bandpass filter allows only the wavelengths emitted by the excited SO_2 molecules to reach the photomultiplier tube (PMT). The PMT detects the UV light emission from the decaying SO_2 molecules. The photodetector, located at the back of the fluorescence chamber, continuously monitors the pulsating UV light source and is connected to a circuit that compensates for fluctuations in the UV light.

As the sample leaves the optical chamber, it passes through a flow sensor, a capillary, and the "shell" side of the hydrocarbon kicker. The sample then flows to the pump and is exhausted out the EXHAUST bulkhead of the analyzer.

The Model 43IQ/43IQ-TLE outputs the SO_2 concentration to the front panel display, to the analog outputs, and to the serial or Ethernet connection.

4.0 DEFINITIONS AND CONVERSION FACTORS

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 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.

Control Limit (CL) – the relative percent difference between the theoretical value and the instrument response value which is considered out-of-tolerance, results in invalid data, and requires corrective action.

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.

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.

Warning Limit (WL) – the relative percent difference between the theoretical value and the instrument response value which is less than, but approaching, out-of-tolerance conditions requiring further investigation and possible corrective actions.

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 43IQ/43IQ-TLE 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. Sulfur dioxide gas is a poisonous gas. Even low levels of SO_2 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 SO_2. If this is done, it is recommended that Material Safety Data Sheets (MSDS) 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 43IQ/43IQ-TLE 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 persons 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 transport of cylinders. Cylinder shipping 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

As per Appendix A-1 of 40 CFR 50, the FRM for measuring SO_2 (ultraviolet fluorescence method), aromatic hydrocarbons such as xylene and naphthalene can fluoresce and act as strong positive interferences. These gases are removed by the permeation type scrubber (hydrocarbon "kicker") in the 43IQ/43IQ-TLE analyzer.

Nitrogen oxide (NO) in high concentrations can also fluoresce and cause positive interference. Optical filtering is employed to improve the rejection of interference from high NO. The 43IQ/43IQ-TLE analyzer utilizes a mirror assembly and light baffle to mitigate interference.

Ozone can absorb UV light given off by the SO_2 molecule and cause a measurement offset. This effect can be reduced by minimizing the measurement path length between the area where SO_2 fluorescence occurs and the photomultiplier tube detector (e.g., <5 cm). The 43IQ/43IQ-TLE analyzer hydrocarbon scrubber, optical filter and appropriate distancing of the measurement path length are used to reduce interference.

Although the 43IQ/43IQ-TLE is designed to minimize potential interferences, poor siting, inadequate electrical power, bad electrical grounding, poor control of the sample air relative humidity (RH) in humid environments, oscillations in the temperature of the environmental enclosure and significant vibrations are known sources of interference. The 43IQ/43IQ-TLE is supplied with a three-wire grounded power cord. Under no circumstances should this grounding system be defeated.

The instrument manufacturer also recommends that during installation and operation, the operator avoid pressurizing the monitor and do 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 SO_2, 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 SO_2 concentrations should be able to:

a) Operate the 43IQ/43IQ-TLE analyzer;

b) Calibrate, audit, and troubleshoot the 43IQ/43IQ-TLE analyzer; and

c) Operate the dilution calibrator and dilution (zero air) system.

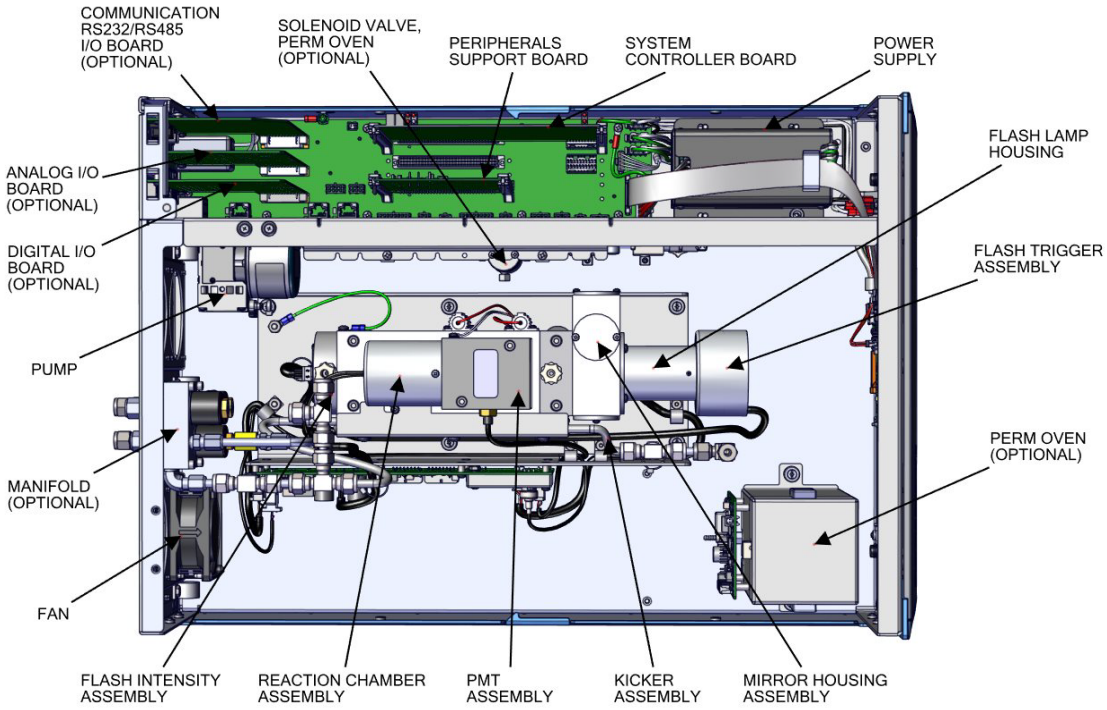
d) Safely handle and use gas bottles and regulators

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 Thermo Scientific instruction manuals for the Model 43IQ and Model 43IQ-TLE contain a regular bill of materials for the standard system hardware provided by Thermo Scientific with each instrument purchased and information on the equipment required for instrument maintenance and calibrations. A diagram of the 43IQ/43IQ-TLE instrument is presented in Figure 8-1, below, showing the component layout in the analyzer.

Figure 8-1. 43IQ/43IQ-TLE Component Layout



Support equipment for the operation of the 43IQ/43IQ-TLE 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 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 or Thermo Environmental Instruments Models 146C/146i Dynamic Dilution Calibrator.

Certified SO_2 Gas Standard(s) – Calibration gas is needed to supply SO_2 to the calibration system. The cylinder(s) must be NIST-traceable with SO_2 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 - Must have non-reactive internal parts (those in contact with the SO_2 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 and should be less than 24" in length.

Output Manifold - This is the external manifold between SO_2 analyzer and the dilution calibrator. The manifold receives calibration gasses from the calibrator and allows the analyzer to sample these calibration gasses 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 TE 43IQ analyzer to collect particulates 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 every 30-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.

Logbook – The current year’s hardcopy or electronic logbook containing all forms associated with the operation, maintenance and calibration of the 43IQ/43IQ-TLE analyzer.

Data Acquisition System (DAS) – A DAS is necessary for storage of ambient and ancillary data collected by the 43IQ/43IQ-TLE. Many of the monitoring agencies in Florida use the Agilaire, LLC 8872, or 8832 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 off-line 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, one-minute averages from the DAS after the analyzer stabilizes at each calibration

level. The corresponding analyzer channel(s) should be marked "off-line" prior to conducting any of the following procedures: Diagnostic checks, QC Checks, multi-point checks and verifications, maintenance, or operational checks. Channels may also be marked "off-line" when any analyzers data is deemed suspect.

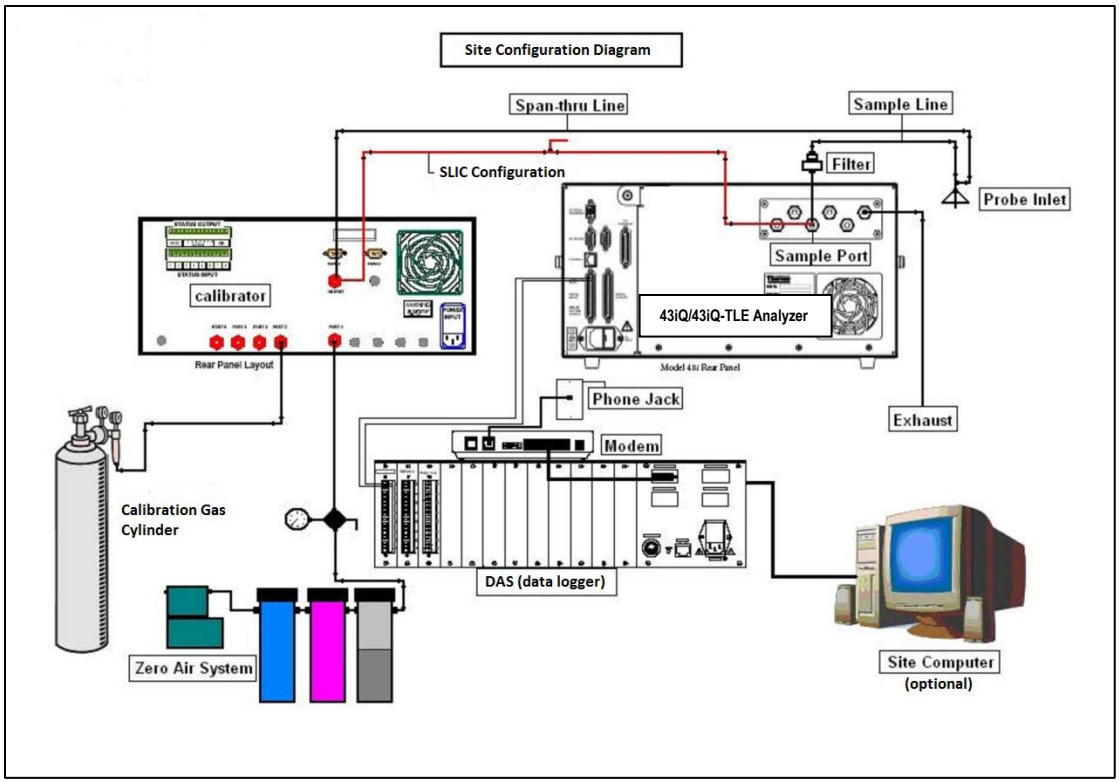
Instrument Shelter – A shelter is required to protect the analyzer from precipitation and adverse weather conditions, maintain operating temperature within the analyzer's temperature range requirements, and provide security and electrical power. The allowable shelter temperature range for the instrument is 0-45°C according to the Automated Equivalent Method; EQSA-0486-060.

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

9.0 INSTALLATION, START-UP, AND REMOVAL INSTRUCTIONS

Operator(s) are required to read the manufacturer's manual for the 43IQ/43IQ-TLE 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. Figure 9-1 illustrates a typical site configuration for the Model 43IQ or 43IQ-TLE analyzer.

Figure 9-1. Example Site Configuration



9.1 Analyzer Siting and Sampling System

All ambient air sulfur dioxide analyzers must meet the location and siting criteria referenced in the Code of Federal Regulations (CFR), Part 58, Appendix E, siting criteria which include specific spacing requirements for SO_2 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 (preferable 360 degrees) around the inlet probe.

To collect ambient SO_2 concentrations with the 43IQ/43IQ-TLE that complies with the CFR, 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, January 2017, Section 7.

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 the circuit boards are completely secured. Loose boards could short out the motherboard. If no damage is evident, the monitor is ready for calibration, installation and operation. If any damage due to shipping is observed contact 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 Installation and Start-up

The front panel of the 43IQ/43IQ-TLE analyzer has an LCD touch screen with USB port, LED alarm lights, and power switch below. This allows the user to check functions, switch operating parameters, adjust zero and span, and read warnings 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 43IQ/43IQ-TLE Instruction Manual (1Sep2021) and read it carefully before adjusting any parameters that are set by the factory.

Although the Operations Manual says to allow 90-120 minutes 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.

1. Install a 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.
2. Connect an appropriate ¼-inch outer diameter (OD) Teflon sample line upstream, after the external particulate filter on the back of the analyzer.
3. 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.
4. 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.

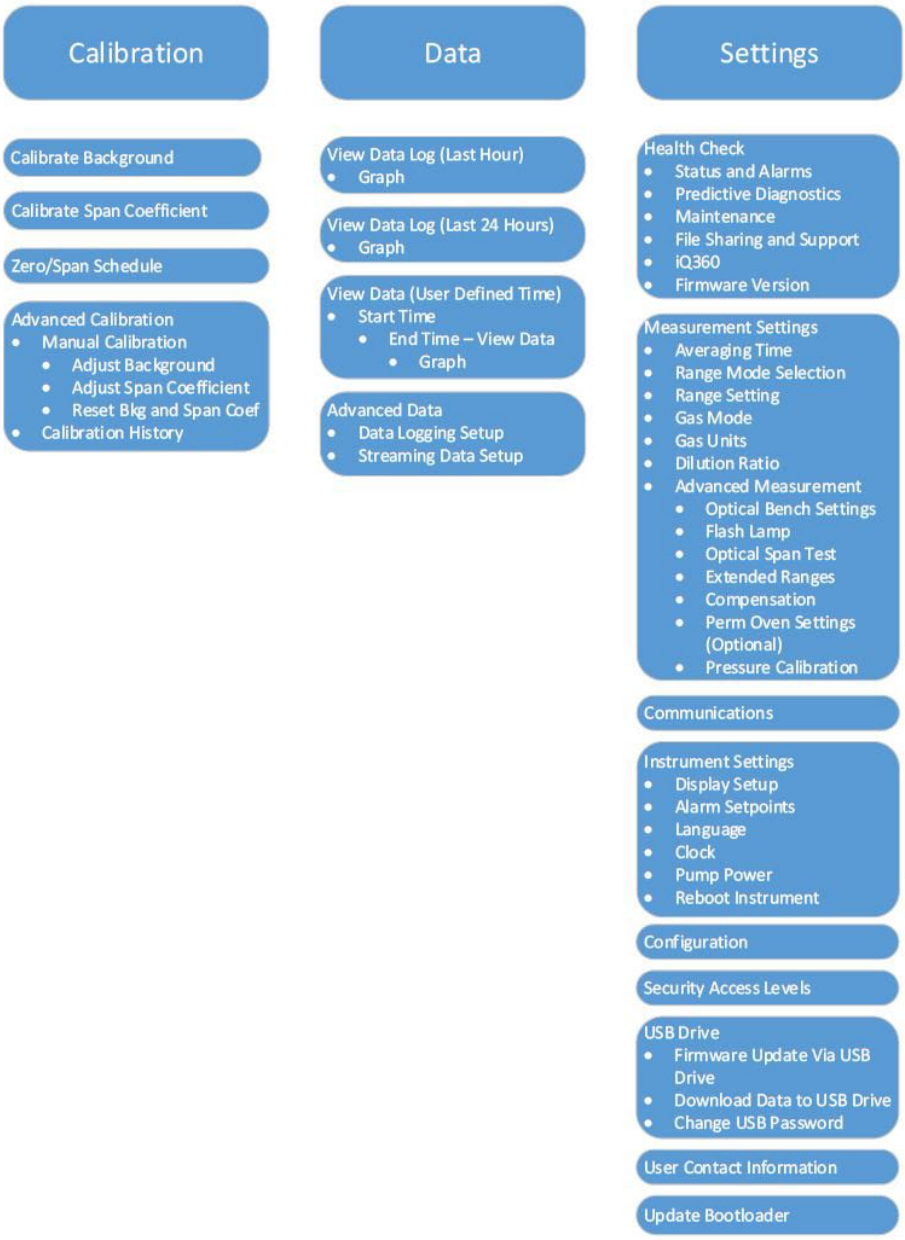
Figure 9-2. Home Screen Display (single range mode)

After the electrical and pneumatic connections are made, an initial functional check is in order. Turn on the instrument and plug in external pump. 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 mode "warm up" is displayed on the gas mode button in

the title bar, and the concentration calculation is turned off. 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 Chapter 6 of the Instruction Manual.

Figure 9-2 shows the front panel of the instrument during normal operation. The operation of the analyzer is based on menu-driven software. Main menu selections on the SO_2 analyzer contain lists of submenu items such as operational parameters, functions, and controls. See the manufacturer's manual for more details and pictorials of this section, as necessary.

Figure 9-3. Main Menus and Keypads



9.4 Model 43IQ/43IQ-TLE Configuration

To configure the instrument's operating parameters, select the Settings menu from the main display.

Configure the analyzer to measure SO_2 in units of parts per billion (ppb). Set the analyzer in Single Range Mode from 0 – 500 ppb for sites where the monitoring objective is for compliance with NAAQS or 0 – 100 ppb for sites where the monitoring objective is for NCore. The averaging time is set to ten (10) seconds and the calibration factors are set to

0.0 for the SO_2 Background and 1.000 for the SO_2 Coefficient prior to the initial calibration of the analyzer.

1. From the Home Screen, select *SETTINGS*, *MEASUREMENT SETTINGS,* then select *RANGE MODE SELECTION*.
2. Select *SINGLE RANGE* to save the selection, then return to the *MEASUREMENT SETTINGS menu.*
3. From the *MEASUREMENT SETTINGS* menu, select *GAS UNITS*, and select "ppm." Then, return to the *MEASUREMENT SETTINGS* menu.
4. Select the *RANGE SETTING* submenu to define the concentration range, changing the value to display [500] or [100] ppb. Then, return to the *MEASUREMENT SETTINGS* menu.
5. From the *MEASUREMENT SETTINGS* menu, select *AVERAGING TIME*. Change the value to [10] seconds. Then, return to the Home Screen.
6. From the *CALIBRATION* menu, select *ADVANCED CALIBRATION* to view the *BKG* and *COEF* factors. If these are not preset to 0.0 and 1.000 respectively, then scroll and select *ADJUST BACKGROUND* to change the factor to [0.0] and/or select *ADJUST SPAN COEFFICIENT* to change the factor to 1.000.
7. Return to the Home Screen and then select the *SETTINGS* menu, then *INSTRUMENT SETTINGS* menu, select *CLOCK* to set the current date and time on the analyzer clock.
8. Change the month, day, year, and time to within ±1 minute of a NIST-traceable time standard. Then, return to the Home Screen.

9.5 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.

9.6 Additional Menu Settings

The procedures for configuring the remaining instrument settings for Communication, Input and Output (I/O) configurations, and alarm settings are described in the Thermo 43IQ/43IQ-TLE Instrument Manual. These settings are determined by the technician based on the equipment and configuration of the monitoring station. The technician will also turn [ON] the *TEMPERATURE COMPENSATION* and the *PRESSURE COMPENSATION* settings on the Thermo 43IQ/43IQ-TLE analyzer to account for local variations.

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 SO^2 data and also meet the specifications of zero not exceeding ±5.0 ppb and span not exceeding ±10.0% of theoretical value. Otherwise, the data will be invalidated back to the last good z/s/p event.

1. Perform a manual Z/S/P check (Section 12.2) to bracket the data.
2. 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 Thermo 43IQ/43IQ-TLE Equipment Status Report, Form DEP 07-07-A.
3. Turn off the analyzer and unplug the power cord from the 120 VAC outlet.
4. At the rear of the analyzer, disconnect the ¼-inch sample inlet and exhaust tubing.
5. If the analyzer is to be re-installed at the same location, label all the wire connections that are connected to the analyzer to ensure proper re-installation.
6. 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.

1. Place the new/repaired analyzer into its new operating position.
2. 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.
3. Reconnect the power plug to the power port at the rear of the analyzer and plug the opposite end into a 120V AC outlet.

4. Reconnect the wiring that was previously labeled and removed in Step 9.7.5 above.
5. After the analyzer and all ancillary equipment are connected properly, proceed to Section 9.3 to check instrument settings and conduct the remaining installation procedures.
6. Complete a full calibration check of the instrument as described in Section 10 and SLIC according to Section 10.9 of this SOP, prior to the start of collecting ambient air quality data.

10.0 INSTRUMENT CALIBRATION

Calibration of the 43IQ/43IQ-TLE SO_2 analyzer is achieved by introducing known SO_2 gas concentrations to the analyzer and adjusting the *SO_2 Background* and *SO_2 Coefficient* factors to provide accurate SO_2 measurements. The calibration procedure requires the technician to generate a series of known SO_2 concentrations to the instrument and verifying that the unit provides an accurate SO_2 measurement. If the measurement results are not correct, the zero background 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 DEP relies upon this documented relationship to establish the legal traceability of the ambient SO_2 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 undergo a multi-point verification/calibration under the following conditions:

1. Upon receipt/adjustment/repair/installation/moving locations.

2. Following a bi-weekly zero response that exceeds ±5.0 ppb or a bi-weekly span response that exceeds ±10.0% relative difference for SO_2.

3. Following any multipoint calibration QC check where any point(s) exceed < ± 2.1 % or < ± 1.5 ppb difference of best-fit straight line whichever is greater and Slope 1 ± .05. This is the relative difference between the analyzer response and the best fit concentration determined by the linear regression line.

4. Upon any indication of analyzer malfunction or change in calibration. This includes exceedance of the control limits during bi-weekly checks.

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 (e.g., Thermo Scientific Model 146i) to provide the analyzer with zero air and various concentrations of SO_2 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 43IQ and the Model 43IQ-TLE, trace-level instrument.

TABLE 10-1: Calibration Check Points

Calibration Point	Model 43IQ/43IQ-TLE (ppb) @ NAAQS	Model 43IQ-TLE (ppb) @ NCore
Zero	0	0
Span	400	80
Upscale	200	50
Precision	75	20
Low	45	7

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

In addition to the equipment and supplies listed in Section 8.0, above, the technician may need a hand-held calculator or equivalent calculation device (e.g., computer software) for computations if not using the Microsoft Excel™ electronic version of the calibration form. The electronic form contains formulas to automatically calculate the statistics and display the results related to each limit or performance criteria.

10.2 Preparation for Calibrations

Annual calibrations and semi-annual calibration checks of the 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 SO_2 analyzers located at sites where the monitoring objective is for comparison to the NAAQS, the acceptance criteria are more stringent than for Model 43IQ-TLE SO_2 analyzers sited at NCore sites where the objective for trace-level instruments is to obtain a better understanding of atmospheric chemistry.

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 as shown in Figure 9-1. 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 43IQ/43IQ-TLE SO_2 analyzer utilizes 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/precision/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. Once the zero air and span gas flow rates have stabilized, use the formula, Equation 10-1, below to determine the calculated theoretical output concentration being delivered to the analyzer.

Equation 10-1: Calibration Gas Output Concentration

$$SO_2\ output\ = \frac{Fg}{F_T} \times Cg \qquad \text{(EQ 10-1)}$$

Where

Fg = SO_2 gas flow (L/min)
F_T = Total Air flow (L/min)
Cg = SO_2 gas concentration in cylinder (ppb)

Record the calibration check information in the appropriate spaces on DEP Form 07-07-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.

1. Allow the analyzer to warm up for several hours (preferably overnight) prior to the calibration.
2. Enter the equipment information in the *Identification Block* on DEP Form 07-07-D, Sensor Calibration form and on DEP Form 07-07-B, Calibration form.
3. Enter the [Flow] configuration as "0.5" or "1.0" from the dropdown menu on the MS Excel version of DEP Form 07-07-D, Sensor Calibration form.
4. Select "*Calibration*" as the [Procedure] from the dropdown menu on the MS Excel version of DEP Form 07-07-B, Calibration form.
5. Select the [Monitoring Objective] from the dropdown menu on the MS Excel version of Form DEP 07-07-B.

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.

6. Enter the equipment information in the S*tandards Block* on DEP Form 07-07-D, Sensor Calibration form and on DEP Form 07-07-B, Calibration form.
7. Enter the SO_2 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 DEP Form 07-07-B. Record tank concentrations in parts per million (ppm).
8. "Disable" the SO_2 data logger channel in the site DAS and record the time [Off-Line] on the calibration form.

10.3 Model 43IQ/43IQ-TLE Zero Calibration

1. Deliver ZERO air to the analyzer and allow it to sample until a stable SO_2 response is displayed on the primary data recorder, DAS.

Note: Stability is defined as 5-10 one-minute averages all within ±1 ppb with no upward or downward trend.

2. To ensure that the zero measured at atmospheric pressure is 0.5 LPM as reported zero air flow in the analyzer and the actual zero air flow should be 0.8 LPM or greater with the excess out the atmospheric bypass, go from the Home Screen, select *SETTINGS,* then, *HEALTH CHECK,* then *STATUS and ALARMS,* then *FLOW and PRESSURE;* the reported sample flow must be less than the actual zero air flow

3. From the Home Screen, select *CALIBRATION*, then select *CALIBRATE BACKGROUND*.
4. Allow the analyzer to sample ZERO air until a stable reading is obtained, then adjust the instrument's zero-offset and set the SO_2 reading to zero.
5. Using the continuous one minute readings from the DAS display, record the average stabilized ZERO response on the Calibration form, DEP 07-07-B, the dilution (zero) air flow, and the calibration gas flow, which should be 0.0 LPM, from the front of the dilution calibrator for the initial zero of the *SO_2 Calibration Block*.

Note: The average analyzer response, as displayed on the DAS, shall be within ±3.0 ppb of zero, 0.0 ppb. Otherwise, further zero adjustment, according to the procedures in the instrument's operational manual, is necessary.

10.4 Model 43IQ/43IQ-TLE Span Calibration

1. Adjust the ZERO air flow and the calibration gas flow on the dilution calibrator to provide approximately 80% to 90% of full-scale range; 400 ppb for the Model 43IQ analyzer or 80 ppb for the Model 43IQ-TLE analyzer.
2. To ensure that the span gas is measured at atmospheric pressure, the flow must be 0.5 LPM or more with the excess flow out the atmospheric bypass.
3. Deliver SPAN concentration to the analyzer and allow it to sample until a stable SO_2 response is displayed on the DAS.
4. From the Home Screen, select *CALIBRATION*, then select *CALIBRATE SPAN COEFFICIENT*.
5. Allow the analyzer to sample SPAN concentration until a stable reading is obtained.
6. Adjust the displayed value to match the actual concentration being delivered by the calibrator, and then adjust the instrument's span-factor and set the SO_2 reading to match the true span concentration.
7. Using the DAS display, record the average stabilized SPAN response on the Calibration from, DEP 07-07-B, the dilution air flow, and the calibration gas flow from the front of the dilution calibrator for the SPAN event of the *SO_2 Calibration Block*.

Note: The average analyzer response, as displayed on the DAS, should agree to within ±2.0 ppb of the SPAN concentration.

At this point, the Technician will re-initiate the ZERO event to review any drift caused by the SPAN calibration. Although the acceptable level of zero drift within 24 hours of calibrating the zero offset is ± 3.0 ppb, the zero response is typically within ± 1.0 ppb during this review However, if zero drift is greater than ±3.0 ppb, adjust the ZERO calibration and/or the SPAN calibration by repeating sections 10.6, and 10.7, until the

analyzer zero response is within ±3.0 ppb 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 and SLIC according to the procedures in Section 10.9.

Note: 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.

10.5 Multipoint Calibration Check

A Multipoint Calibration Check is performed to verify that the adjustments to the analyzer's *SO_2 Background* and *SO_2 Coefficient* factors held to produce a linear calibration curve. All analyzer responses are taken from the DAS and recorded on the calibration form, DEP-07-07-B.

1. Perform an initial ZERO QC check by delivering ZERO air to the analyzer.
2. Allow the responses to stabilize until 5-10, one-minute averages are within ±2 ppb 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*.
3. Record the average zero response, from the DAS, on the calibration from for the *Observed SO_2* average value.
4. Calculate and record the straight difference between the calibrated zero (*Calc. SO_2*) and the *Observed SO_2* response; record the RESULT as "*PASS*" or "*CALIBRATE*" on the calibration form.

Note: The straight difference for a zero calibration check must be within ± 1.5 ppb.

5. Deliver the SPAN concentration to the analyzer by adjusting the calibrator flows to generate a SO_2 span concentration of approximately 400 ppb for the 43IQ or 80 ppb for the 43IQ-TLE at NCore.
6. Allow the responses to stabilize until 5-10, one-minute averages are within ±2 ppb 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*.
7. Record the average span response, from the DAS, on the calibration from for the *Observed SO_2* average value.
8. Calculated and record the relative percent difference (%Diff) between the *Calculated SO_2* and the *Observed SO_2* response; record "n/a" in the [RESULT] field.

9. Adjust the calibrator flows to deliver three (3) more concentrations as defined in Table 10-1, above, repeating steps 10.8.5 through 10.8.8 for each of the remaining calibration check points.
10. Record the *Calibration Assessment* on the calibration form, DEP-07-07-B, by entering the *Calculated SO_2* values in the row labeled [Calibrator Value (X)] and the *Observed SO_2* values in the row labeled [Instrument Value (Y)].
11. Calculate and record the slope (m) and intercept (b) using the least squares linear regression method.
12. Apply the slope and intercept to calculate and record each point in the row labeled [Best Fit Concentration].
13. 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.

NOTE: All calibration check points must be within ±2% of the Best Fit Linear Regression Line. 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.

14. Deliver ZERO air until the analyzer displays 0.5 ppb or less; record the dilution air flow and a 5-minute average as the [Observed SO_2] value for the *Ending Zero* point on the calibration form.
15. Return the calibrator to "STANDBY" mode. Allow the analyzer to sample ambient air for 5 minutes.
16. Change the SO_2 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.
17. Complete both calibration forms, DEP 07-07-B and DEP 07-07-D, by adding any pertinent *Operator Comments*. Then sign and date the form and submit them to the QA staff for review.

10.6 Sample Line Integrity Check (SLIC)

In this procedure, the Field Technician must determine if contamination of the sample line is adversely affecting ambient SO_2 measurements made by the analyzer. This check is required to be performed during each regularly scheduled analyzer calibration, once per quarter, 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. If the sample lines are contaminated, the entire sample line must be cleaned or changed.

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.

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 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 SO_2 span concentration in step 10.8.5.

    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 SO_2 response values on the Calibration Form in the Observed SO_2 field, of the 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 SO_2 span concentration in step 10.8.5.

    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 SO_2 response values on the Calibration Form in the Observed SO_2 field, of the 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 SO_2 response for SLIC to the observed SO_2 response for SPAN and then record the RESULT as "*PASS*" or "*CALIBRATE*" on the calibration form.

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 SO_2 span concentration in step 10.8.5.

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 SO_2 response values on the Calibration Form in the Observed SO_2 field, of the 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) Adjust the calibrator to the same settings used in generating the SO_2 span concentration in step 10.8.5.

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 SO_2 response values on the Calibration Form in the Observed SO_2 field, of the 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 SO_2 response for SLIC to the observed SO_2 response for SPAN and then record the RESULT as "PASS" or "CALIBRATE" on the calibration form.

Equation 10-2 below calculates the relative percent difference between the data logger response through its normal sample line and through the clean SLIC line:

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

(EQ 10-2)

If the calculated difference is ≤±2.0%, the analyzer's sample line is approved for further use without additional maintenance. 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 (DEP Form 07-07-C).

11.0 INSTRUMENT MAINTENANCE

All maintenance of the TEI 43IQ/43IQ-TLE 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 routing quality control checks, instrument alarms or as a result of changing environmental conditions. The technician will refer to the Model 43IQ/43IQ-TLE Instruction Manual (Chapters 6, Troubleshooting and/or Chapter 7, Servicing) for information on troubleshooting, part repair and replacement. Additionally, the operator may contact Thermo Fisher Scientific 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 12.1, below, and documented on the calibration form, DEP 07-07-B. Bracketing the ambient data with a Z/S/P check will ensure that the analyzer is producing the highest quality data and that the maintenance activities did not leave the analyzer in an unacceptable condition. 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, DEP 07-07-A and then document the maintenance activities in the Maintenance Log, Form DEP 07-07-C. 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 "NO", indicating the scheduled maintenance as not completed.

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, to ensure both accurate and uninterrupted performance.

Table 11-1: Preventive Maintenance Schedule

Section	Item	Schedule
11.1	Replace External Sample Line Particulate Filter	Monthly
11.2	Clean Analyzer Fan Filter & Guard	Quarterly
11.3	Perform Leak Test and Pump Check-Out	Semi-Annual
11.4	Clean or Replace Sample Lines	Annually
11.5	Inspect and Clean Capillary	Annually
11.6	Lamp Voltage Check	Every three years

11.1 Replace External Particulate Filter

As per the initial set-up of the 43IQ/43IQ-TLE SO_2 analyzer in Section 9.0 of this SOP, 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 30-days; on a monthly basis or sooner, if necessary.

1. Disconnect the sample line from the back of the analyzer leaving the analyzer running to draw shelter air during this procedure.
2. Open the filter holder by grasping each end of the device and twisting; remove and discard the filter element.
3. Install a new 5 µm filter such that it lies flat against, and completely covers, the perforated surface at the output end of the holder.
4. Reconnect the sample train and then condition the filter membrane by running at least a SPAN concentration of SO_2 gas through the filter for several minutes to ensure accurate sampling results.
5. Record the Particulate Filter Maintenance as completed in the Maintenance Log (DEP 07-07-C).

11.2 Clean Fan Filter & Fan Guard

Lint and dirt can accumulate inside the analyzer even under the cleanest conditions. If left unchecked, dirt can eventually degrade analyzer performance and possibly cause instrument failure. For this reason, the analyzer must be cleaned quarterly.

1. Turn off the power to the analyzer and vacuum pump.
2. Remove the fan guard from the fan and remove the filter.
3. Flush the filter with warm water and let dry or blow the filter clean with compressed air.
4. Re-install the filter and fan guard.
5. Record the Fan Maintenance as completed in the Maintenance Log (DEP 07-07-C).

11.3 Perform Leak Test & Pump Check-Out

Every 180 days, the technician will inspect the pneumatic system for external leaks and verify that the pressure reading falls below 180 mmHg during the test.

1. With the instrument running, disconnect the sample line and plug the analyzer inlet (SAMPLE fitting).
2. Wait 2-minutes and then from the Home Screen, select *SETTINGS*, and then press *HEALTH CHECK*, then *STATUS AND ALARMS* to display the current instrument status menu.
3. Scroll to FLOW and select to display the Sample Flow screen. The flow reading should indicate zero flow.
4. Return to the Status and Alarms menu and then scoll to Pressure and select. The pressure reading should be less than 180 mmHg.

NOTE: If the Sample Flow is not zero, check that all fittings are tight and that no input lines are cracked or broken. If the pressure does not fall below 180 mmHg, inspect the pump diaphragm condition and the capillaries for blockage.

5. Record the Leak Test as completed in the Maintenance Log (DEP 07-07-C).

11.4 Clean/Replace Sample Lines

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. During the annual sample line change, the residence time within the entire sampling system needs to be calculated to be less than 20 second, preferably less than 10 seconds.

1. Detach all the sample lines and filter holder from the inlet to the back of the analyzer, including the sample inlet tube that penetrates into the manifold.
2. Remove the filter membrane from the external filter holder using the same method listed in Section 11.1, above.
3. Replace the sample lines going to the calibrator and analyzer, and then re-install the sample line filter assembly.
4. Using the procedure in Section 11.1 above, replace the sample filter membrane in the sample filter holder.
5. Record the sample line maintenance as completed in the Maintenance Log (DEP 07-07-C).

11.5 Clean/Replace Capillaries

The flow reducing capillaries control the flow rate through the pneumatic system of the 43IQ/43IQ-TLE and should operate with little or no need for servicing throughout the life

of the instrument. However, in cases when the sample flow is diminished below 30% of the design option; 0.5 LPM in a standard analyzer or 1.0 LPM in a higher flow option, the capillaries may be clogged and need servicing or replacement. The following procedure can be used in such a case.

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

NOTE: Internal components can be damaged by small amounts of static electricity. The technician should wear a properly grounded antistatic wrist strap while handling any internal component, or continually discharge built-up static electricity while performing this maintenance task.

2. Remove the instrument cover and remove the sample flow capillary from the inlet elbow fitting on the pump head.
3. Clean the capillary with a wire smaller than 0.018-inch diameter or replace.
4. Check the O-rings for cuts or abrasions and replace if present.
5. Remove the purge capillary from the capillary holder on the rear panel and clean with a wire smaller than 0.006-inch diameter or replace.
6. Check the O-rings for cuts or abrasions and replace if present.
7. Replace the capillaries in their holders, making sure the O-ring is around each one before inserting it into the fitting.
8. Tighten the fitting caps over the capillaries enough to ensure a tight seal.
9. Perform a leak test according to step 11.3, above.
10. Record the Capillary Maintenance as completed in the Maintenance Log (DEP 07-07-C).

11.6 Lamp Voltage Check

Although the instrument has a lamp voltage control circuit which corrects for degradation of the lamp after several years of use. The operator can check the lamp voltage in *MEASUREMENT SETTINGS, then ADVANCED MEASUREMENT SETTINGS,* then *Optical Bench Settings,* then *DETECTOR GAIN SETTINGS* which displays the current Lamp Voltage and Lamp Intensity.

Another method is to go to *SETTINGS*, then *HEALTH CHECK*, then *STATUS AND ALARMS*, then *SO2 BENCH* screen. The upper and lower limits will show for the current Lamp Voltage and Lamp Intensity. Consult with the manual regarding the Lamp Voltage Adjustment procedure under Maintenance.

12.0 QUALITY ASSURANCE AND 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 (43i) Acceptance Criteria	NCore (43i-TLE) Acceptance Criteria	Frequency
One Point QC Check for Precision	Control within ± 10.1% (percent difference) or 1.5 ppb whichever is greater Warning identified at > 7.1%	Control within ± 15.1% (percent difference) or 3.0 ppb whichever is greater Warning identified at > 12.1%	minimum every 14 days
Zero/Span QC Check	Zero drift within ± 5.1 ppb Span drift within ± 10.1 %	Zero drift within ± 5.1 ppb Span drift within ± 15.1 %	minimum every 14 days
Sample Line Integrity Check	Within ± 2.1%	Within ± 2.1%	Upon installation, adjustment, or repair, and; minimally every 90 days
Multipoint Verification/Calibration QC Check	Zero drift within ± 1.5 ppb, All points within ± 2.1% of calibration range best-fit straight line.	Zero drift within ± 3.0 ppb, All points within ± 2.1% of calibration range best-fit straight line.	Upon initial installation, adjustment, repair; every 182-days if manual biweekly Zero/span performed or 365 days if continuous Zero/Span checks are performed on a determined "daily" schedule
Performance Audit	Within ± 15.1% of audit levels 3-10; within ± 1.5 ppb of audit levels 1&2.	Within ± 15.1% of audit levels 3-10; within ± 1.5 ppb of audit levels 1&2.	Annually, every 365 days

12.1 Equipment Status Report

An Equipment Status Report (DEP 07-07-A) is completed prior to any Z/S/P or Multipoint QC check, instrument maintenance, or calibration. It is used to document the diagnostic parameters of the analyzer, "As Found", and provide commentary on any subsequent procedures performed on the instrument that day. 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.

To complete the Equipment Status Report (ESR):

1. Enter the equipment information in the *Identification Block*, paying special attention to enter the [Parameter] as "SO_2" for standard analyzers and "SO_2TL" for trace-level analyzers.
2. Enter the instrument information in the *Standards Block*.
3. Indicate "YES" or "NO" for any [Analyzer Alarms] on the instrument's display.
4. Enter the local standard time [LST] from the NIST-traceable time standard.
5. Enter the time displayed on the analyzer and then indicate the results of the [Time Check] as "PASS", or "CALIBRATE" if the absolute difference between the time standard and instrument display is greater than 2 minutes.
6. In the *QC Check Block*, complete the Concurrency checks between the instrument display and the DAS recorder by calculating the absolute difference for [Time Display] and [Concentration Display], and then enter the [RESULT].

NOTE: If any System Checks or QC Checks result in the need for "CALIBRATION" (adjustments), the technician will affirm calibrations in the Operator Comments Block.

7. Enter the values for each *Equipment Status* parameter in the *Analyzer Checklist Block*.
8. In the *Maintenance Checklist Block*, indicate if the external particulate filter was replaced by entering "YES", "NO", OR "NOT DUE".
9. Indicate whether the sample probe lines were checked and free of contaminants by entering "YES" or "NO". If "NO" is the response, explain the corrective actions taken in the *Operator Comments Block*.
10. Complete the ESR form by adding any pertinent *Operator Comments*. Then sign and date the form and submit it to the QA staff for review.

12.2 Routine QC Checks

Routine manual (operator-observed) 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. However, if the DAS/calibrator is configured for automated nightly (daily) Z/S/P checks, then the routine manual QC checks may be performed every 30 days (monthly), coinciding with sample line filter changes.

All precision data is to be documented and reported to the FAMAS 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 shut-down (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 of the "major" maintenance procedures for analyzer described in the manufacturer's manual and/or addendum, unless prevented by its malfunction.

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, 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 SO2, as reported by the Florida Ambient Air Monitoring Network. The ***Acceptance Criteria*** define the QC limits for the Model 43IQ and Model 43IQ-TLE 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 10.0 % for NAAQS comparison or 15% for NCore, 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 7.0% for NAAQS comparison or 12% for NCore, require the technician to investigate the poor performance which may include taking corrective actions.

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 07-07-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 43IQ/43IQ-TLE 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 43IQ/43IQ-TLE 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, FDEP QAPP-002, Revision 1, April 2016, Florida Department of Environmental Protection, Tallahassee, FL.

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

Thermo Scientific Model 43IQ Instruction Manual, Gas Filter Correlation SO2 Analyzer, PART NUMBER 117568-00, September 1, 2021.

15.0 APPENDICES

APPENDIX A - **Forms**

1. DEP Form 07-07-A - Equipment Status Report
2. DEP Form 07-07-B - Calibration Form
3. DEP Form 07-07-C - Maintenance Log
4. DEP Form 07-07-D – Sensor Calibration Form

DEP 07-07-A Equipment Status Report (electronic)

Form No. DEP 07-07-A **TEI 43IQ/43IQ-TLE Equipment Status Report** **EFFECTIVE DATE: March 2023**

Identification Block						
Date Performed:		Site Name:		AQS #:		Parameter:
Instrument Mfr:		Model:	43iQ-TLE	Serial #:		Date Calibrated:
Primary Recorder Mfr:		Model:		Serial #:		Date Calibrated:
Calibrator Mfr:		Model:		Serial #:		Date Certified:
Remote Access:		Flow Rate:	0.5 LPM			

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

Shelter Temperature	20-30 °C	

Analyzer Checks				
Parameter	Range	Value		
Internal Temperature (°C)	8-47 °C			
Chamber Temperature (°C)	43-47 °C			
Chamber Pressure (mmHG)	400-1000 mmHG			
Flow (0.5 LPM)	.35 - .65			
Flow (1.0 LPM)	.7 - 1.3			
Lamp Intensity (%)	>20			
Lamp Voltage (V)	500-1200			
Background (ppb)	N/A		Post Adjustment	
Coefficient (ppb)	N/A		Post Adjustment	

QC Checks							
Concurrency	NIST	Instrument	Data Logger	Difference (NIST vs Instrument)	Difference (NIST vs Data Logger)	Difference (Instrument vs Data Logger)	Limits
Time Display							± 2 minutes
Concentration Display	N/A			N/A	N/A		± 0.5 ppb

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 43IQ and Model 43IQ-TLE SO2 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 [Parameter] as "SO2" for the standard analyzer or "SO2TL" for the trace-level analyzer.
3. Enter the [Calibration/Certification Dates].
4. Enter the equipment information and [Certification Dates] in the *Standards Block*.
5. In the *Analyzer Checks Block*, record the observed values from the instrument's diagnostic displays.

6. In the *QC 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.
7. In the *Maintenance Checklist* B*lock*, record the "YES" if completed, "NOT DUE", or "NO" if not completed. If "NO" is entered, explain in the *Operator Comments Block*.
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.

DEP 07-07-B Calibration Form (electronic)

Form No. DEP 07-07-B **TEI Model 43IQ SO_2 Analyzer Calibration Log** **EFFECTIVE DATE: March 2023**

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

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

Analyzer Checks		
Internal Temperature (°C)	8 - 47°C	
Chamber Temperature (°C)	43-47°C	
Chamber Pressure (mmHG)	400-1000 mmHG	
Flow (0.5 LPM)	.35-.65	
Flow (1.0 LPM)	.7-1.3	
Lamp Intensity (%)	>20	
Lamp Voltage (V)	500-1200	
Background (ppb)	N/A	
Coefficient (ppb)	N/A	

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			
Background:		Post Adjustment:	N/A
Coefficient:		Post Adjustment:	N/A

Pre-Maintenance Z/S/P							
Calibration Point	**Gas (cc/min)**	**Dilution (cc/min)**	**Calculated SO_2**	**Observed SO_2**	**% or ppb Diff.**	**Limits**	**RESULT**
Zero	0		n/a	n/a	n/a	±5.0 ppb	n/a
Span (≥80% scale) (400)			n/a	n/a	n/a	± 15.0%	n/a
Precision (75)			n/a	n/a	n/a	± 15.0%	n/a

Multipoint Check							
Calibration Point	**Gas (cc/min)**	**Dilution (cc/min)**	**Calculated SO_2**	**Observed SO_2**	**% or ppb Diff**	**Limits**	**RESULT**
Initial Zero	0		n/a	n/a	n/a	± 1.5 ppb	n/a
Span (≥80% scale) (400)			n/a	n/a	n/a	See Linearity Results	
Upscale (200)			n/a	n/a	n/a	See Linearity Results	
Precision (75)			n/a	n/a	n/a	See Linearity Results	
Low Point (45)			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. SO_2**	**Observed SO_2**	**% Diff**	**Limits**	**RESULT**
SLIC			n/a	n/a	n/a	±2%	n/a
Span (≥80% scale)			n/a	n/a			

Post-Maintenance Z/S/P							
Calibration Point	**Gas (cc/min)**	**Dilution (cc/min)**	**Calculated SO_2**	**Observed SO_2**	**% or ppb Diff.**	**Limits**	**RESULT**
Zero	0		n/a	n/a	n/a	±5.0 ppb	n/a
Span (≥80% scale) (400)			n/a	n/a	n/a	± 15.0%	n/a
Precision (75)			n/a	n/a	n/a	± 15.0%	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**
ppb Difference (±1.5ppb)	**n/a**	**n/a**	-	-	-

Slope (m)	Intcpt (I)
-	-

Operator Comments:

Performed by: Date:

QA Comments:

Verified by: Date:

Instructions:

This calibration form is formatted as an electronic spreadsheet used for the Model 43IQ or Model 43IQ-TLE SO2 analyzer. Once the operator selects the [Monitoring Objective] and the [Procedure] from the cell dropdown menus, the electronic version of this form will determine the corresponding limits to apply.

1. Enter the activity date [Date Performed] and site/equipment information in the *Identification Block* at the top of the form.
2. Select the [Procedure] and the [Monitoring Objective] from the cell dropdown menus.
3. Enter the calibration gas information in the *Standards Block*.
4. Record, in the *Primary Recorder Status Block*, the times the DAS is taken "off-line" prior to the procedure and again when it is placed back "on-line" to record the ambient air quality measurements.
5. Record the *Analyzer Coefficients* for [Background] and [Span].
6. In the *SLIC Check Block*, record the Gas and Dilution Air Flows while generating a SPAN concentration level, and then calculate the SO_2 concentrations based on the calibration gas cylinder concentration.
7. Enter the average Observed SO_2 values with the SLIC configuration, first, and then again under normal ambient air sampling line configuration.
8. Calculate and record the relative percent difference between instrument SLIC and SPAN responses. Record the RESULT as "PASS" or "Calibrate".
9. In the *Calibration Check Block*, record the Gas and Dilution Air Flows while generating each calibration check point. Calculate the SO_2 concentrations based on the calibration gas cylinder concentration, and record the Observed SO_2 response from the analyzer for each QC check point.
10. Calculate and record the relative percent difference, and then record the RESULT as "PASS" or "Calibrate".
11. If the [Procedure] is a "Calibration" check, then the technician will record the known concentrations and analyzer responses in the *Calibration Assessment Block*, and then calculate and record the linear regression slope and intercept.
12. Apply the linear regression equation to determine the Best Fit Concentration, and then calculate the relative percent differences for each calibration check point. Record the RESULT as "PASS" or "Calibrate".

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.

DEP 07-07-C Maintenance Log (electronic)

Form No. DEP 07-07-C

TEI Model 43IQ/43IQ-TLE SO2 Maintenance Log

EFFECTIVE DATE: March 2023

Identification Block							
Year:		Site Name:		AQS #:		Auto QC Checks:	
Analyzer Mfr:		Analyzer Model:		Analyzer S/N:			

Maintenance Activity Checklist		Sample Line Filter Inspection	Sample Line Filter Change	Instrument Ext./Int. Cleaned	Sample-Line Integrity Check (SLIC)	Leak Test	Inspect Capillaries	Sample/Calibrator Lines Changed or Cleaned	Zero Air System Serviced	Multipoint Calibration	Flow Sensor Calibration	Pressure Sensor Calibration	Temperature Sensor Calibration		
Frequency:		Monthly	Quarterly	Quarterly	Quarterly	Bi-annually	Annually	Annually	Annually	Bi-Annually	Annually	Annually	Annually		
Date Last Completed:															
Maintenance Due Date:															
Maintenance Date	Operator													QA Reviewer	Review Date
	Maintenance Due Date:														
	Maintenance Due Date:														
	Maintenance Due Date:														
	Maintenance Due Date:														
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	Maintenance Due Date:														
	Maintenance Due Date:														
	Maintenance Due Date:														

Operator Comments:

QA Comments:

Instructions:

This Maintenance Log is formatted as an electronic spreadsheet for the Model 43IQ and Model 43IQ-TLE SO_2 analyzer. It is completed for all scheduled or unscheduled maintenance activities.

1. Enter the 4-digit calendar [Year], site information and [Parameter] as "SO2" or "SO2TL".
2. Enter the equipment information and certification/installation dates.
3. For each *Maintenance Activity*, the technician will enter the [Maintenance Date] (mm/dd/yyyy) the maintenance was performed and their first initial, last name in the [Operator] field.
4. Using the cell dropdown list, select a response {YES, NO, NOT DUE, N/A} under each maintenance activity item.

The [Maintenance Due Date] is 30, 60, 90, or 365 days from the [Maintenance Date] entered by the technician (date performed). The due date is automatically entered when using the electronic spreadsheet version for DEP Form 07-06-C.

The technician should provide any descriptive comments regarding maintenance activity items answered with a "NO on the corresponding Equipment Status Report (DEP 07-06-A) for that day, to explain why the maintenance item was not performed. Once the form is complete, the technician will submit it to the field technician's supervisor for quality control; accuracy and data review.

DEP 07-07-D Sensor Calibration Form (electronic)

Form No. DEP 07-07-D	43IQ/43IQ-TLE Sensor Calibration Form	EFFECTIVE DATE: March 2023

Identification Block			
Date Performed:	Site Name:	AQS #:	
Analyzer Mfr:	Model:	Serial #:	Date Calibrated:
Data Logger Mfr:	Model:	Serial #:	Date Calibrated:
Calibrator Mfr:	Model:	Serial #:	Date Certified:

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					
Internal Temperature	Front Panel	Ref. Standard	Difference	Limits	RESULT
As Found (degrees C)			N/A	± 2°C	N/A
Post Calibration (°C)		N/A	N/A	± 2°C	N/A
Span Pressure	Front Panel	Ref. Standard	Difference	Limits	RESULT
As Found (mm Hg)			N/A	± 2 mm Hg	N/A
Post Calibration (mm Hg)		N/A	N/A	± 2 mm Hg	N/A
Flow	Front Panel	Ref. Standard	Difference	Limits	RESULT
As Found (LPM)			N/A	±0.01 LPM	N/A
Post Calibration (LPM)		N/A	N/A	±0.01 LPM	N/A

Operator Comments:

Performed by: Date:

QA Comments:

Verified by: Date:

Instructions:

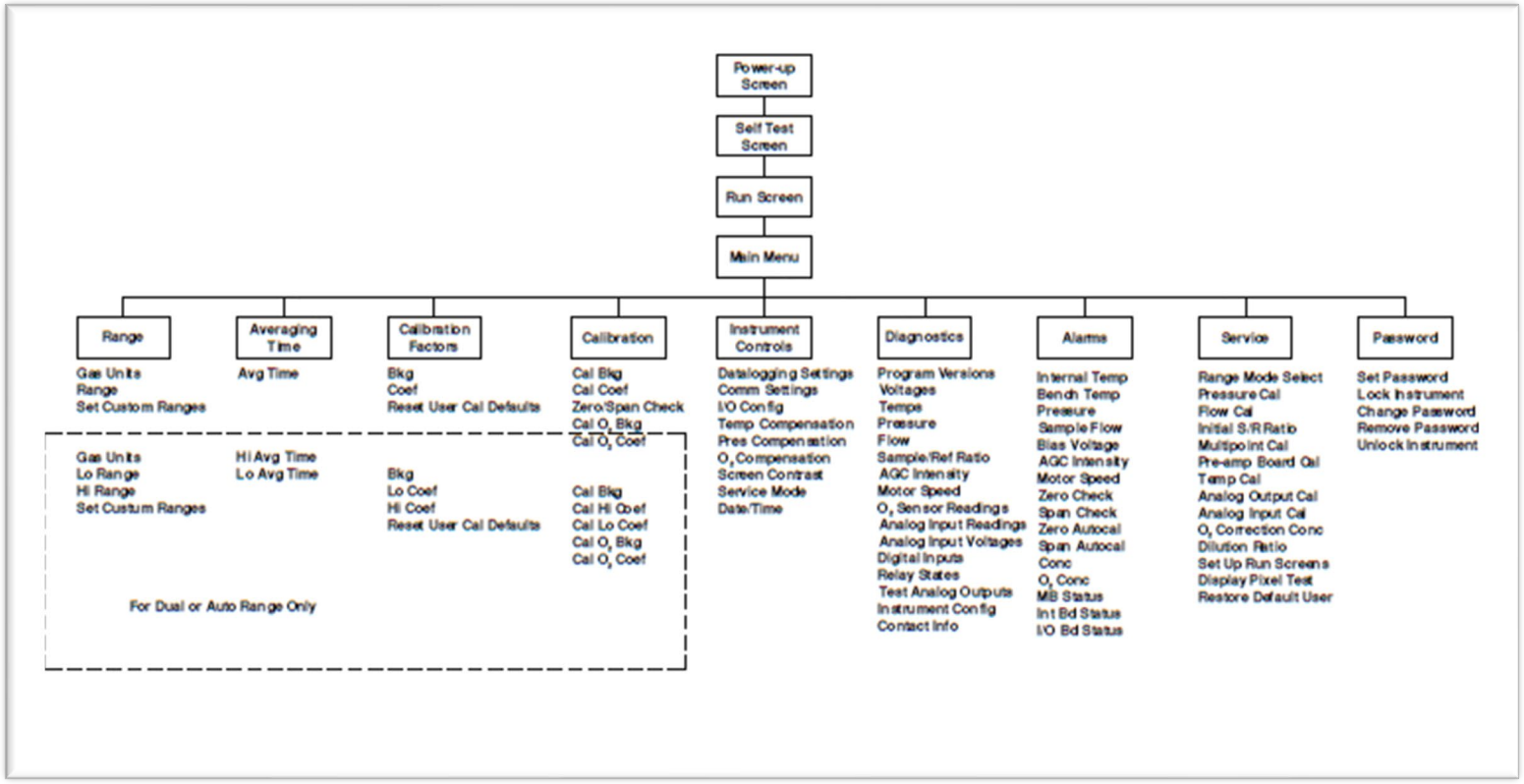
This calibration form is formatted as an electronic spreadsheet used for the Model 43IQ or Model 43IQ-TLE SO_2 analyzer. It is used for the annual calibration or verification of the temperature, pressure, and flow sensors in the analyzer.

1. Enter the activity date [Date Performed] and site/equipment information in the *Identification Block* at the top of the form.
2. Select the [Flow (LPM)] from the cell dropdown menus to record the analyzers configured flow rate.
3. Enter the equipment information for the transfer standards in the *Standards Block*.
4. In the Sensor Calibration Block, record the instrument's internal temperature, pressure and flow values, "As Found" on the analyzer's display.
5. Record the "Reference Standard" values and then calculate the differences and indicate the RESULT as "PASS" or "Calibrate".
6. 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.

APPENDIX B - **Diagrams**

Model 43IQ/43IQ-TLE – Basic Menu Tree



16.0 GLOSSARY

AQS	-	Air Quality System
CFR	-	Code of Federal Regulations
cm^3/min	-	cubic centimeters per minute
CPU	-	Central Processing Unit
DAS	-	Data Acquisition System
DEP	-	Florida Department of Environmental Protection
DFU	-	Dry Filter Unit
DOT	-	U.S. Department of Transportation
EPA	-	U. S. Environmental Protection Agency
ESR	-	Equipment Status Report
FAMAS	-	Florida Air Monitoring and Assessment System
FEM	-	Federal Equivalent Method
FEP	-	Fluorinated Ethylene Propylene
GFC	-	Gas Filter Correlation
LED	-	Light Emitting Diode
LPM	-	liters per minute
MFC	-	Mass Flow Control
MSDS	-	Material Safety Data Sheets
NAAQS	-	National Ambient Air Quality Standards
NCore	-	National Core Network
NDIR	-	Non-Dispersive Infrared Photometry
NIST	-	National Institute of Standards and Technology
OD	-	Outside Diameter
PFA	-	Perfluoroalkoxy
PMT	-	Photomultiplier
PQAO	-	Primary Quality Assurance Organization
psig	-	Pounds per square inch gage, pressure relative to atmospheric pressure

PTFE	-	Polytetrafluoroethylene
QA	-	Quality Assurance
QAPP	-	Quality Assurance Project Plan
QC	-	Quality Control
RH	-	Relative Humidity
SLIC	-	Sample Line Integrity Check
SO_2	-	Sulfur Dioxide
SOP	-	Standard Operating Procedure
TLE	-	Trace Level Enhanced
UV	-	Ultraviolet
VAC	-	Volts Alternating Current
Z/S/P	-	Zero/Span/Precision