DAQ-012-002.2: Operator Responsibilities
Trace Sulfur Dioxide Standard Operating Procedure

Revision 14

Effective Date: October 01, 2020

Disclaimer:

This document, and any revision hereto, is intended solely as a reference guide to assist operators in the setup, calibration, operation and the collection of data related to the North Carolina Division of Air Quality's Sulfur Dioxide (SO_2) Program. This document is intended as a supplement to, and not a substitute for, the education, training and experience required for the efficient operation of ambient air quality monitoring equipment and the collection of scientifically valid data. If an event affecting SO_2 monitoring is outside the purview of this Standard Operating Procedure, contact the Electronics and Calibration Branch and the Raleigh Central Office for guidance.

Approval Sign Off-Sheet

I certify that I have read and approve of the contents of the SO_2 Operator Standard Operating Procedure with an effective date of October 1st, 2020.

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2.0 Scope and Purpose

The U.S. Environmental Protection Agency (EPA) has determined that short-term exposures to Sulfur Dioxide (SO_2) can harm the human respiratory system and make breathing difficult. Vulnerable groups such as people with asthma and children are sensitive to these effects of SO_2. SO_2 can react with other compounds in the atmosphere to form small particles. These particles may penetrate deeply into the lungs and in sufficient quantities can contribute to health problems. High concentrations of SO_2 can also damage foliage and plant life. The Clean Air Act of 1970 set the National Ambient Air Quality Standards (NAAQS), through which concentrations of SO_2 are limited to ensure public safety. This standard was revised in 2010.

High concentrations of SO_2 in the air can lead to the formation of other sulfur oxides. Due to this, SO_2 is used as an indicator of these formations. Sulfur oxide formations can produce acid rain. Fossil fuel combustion at power plants and other industrial facilities are the greatest sources of SO_2 emission. However, smaller sources of SO_2 emissions include industrial processes, natural sources, and vehicles that burn fuel with a high sulfur content. The Division of Air Quality of the Department of Environmental Quality (DEQ) determines the ground level concentration of ambient air sulfur dioxide throughout North Carolina as required by the 1970 Clean Air Act and the subsequent Amendments thereto. In short, the Clean Air Act established ambient air quality as a natural resource that must be protected. The EPA has designated the responsibility to administer and assist in the nationwide program to protect and improve air quality and each state is assigned the direct responsibility for assuring air quality within its borders.

In support of these requirements, the State of North Carolina operates sulfur dioxide monitors across the state for the purpose of monitoring the ambient SO_2 exposure of the general population. In order to collect accurate, meaningful data the monitors must be operated in a consistent manner. The goal of this document is to establish a continuous, verifiable and defensible set of procedures, and a means to record events and activities with regard to the site and the instrument as required by the United States Environmental Protection Agency (US EPA), 40 CFR Parts 50, 53, and 58.

All original records must be legible, complete, accurate, dated, and signed or initialed by the operator and retained as part of the permanent analyzer operational record. This includes both the electronic logbook (e-log) and the site logbook. The operator's name and/or initials presented on the e-log will certify that the activities indicated have been performed in accordance with this Standard Operating Procedure (SOP) and that the information contained on the form is accurate (reference Appendix E for an example of an E-log). All records will be reviewed and verified by the Regional Ambient Monitoring Coordinator and audited by the responsible chemist at the North Carolina Division of Air Quality (NC DAQ) Raleigh Central Office (RCO).

This document includes updates as given in "40 CFR Parts 53 and 58, Revisions to Ambient Air Monitoring Regulations; Final Rule" effective on August 23, 2010 and supplemented by information provided in the update to 40 CFR Part 58 Appendix A, published in March 2016, along with the guidance document "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Quality Monitoring Program", EPA-454/B-17-001, January 2017.

3.0 Equipment Checks

The significant instrumentation and equipment at each NC DAQ sulfur dioxide monitoring site include:

- Thermo Environmental 43i-TLE SO_2 Analyzer - Designated Equivalent Method Number: EQSA-0486-060
  The Model 43i/43i-TLE meets EPA designation requirements when operated as follows:

Range	50 to 1000 ppb
Averaging Time	10 to 300 seconds
Temperature Range	20 to 30 degrees Celsius (°C)
Line Voltage	90 to 110 Vac @50/60 Hertz
	105 to 125 Vac @50/60 Hertz
	210 to 250 Vac @50/60 Hertz
Pressure Compensation	ON or OFF
Temperature Compensation	ON or OFF
Flow Rate	0.5 to 1.0 LPM
	RS-232/RS-485 Interface

- Thermo 146i Dynamic Gas Calibrator
- Certified SO_2 Protocol compressed gas cylinder
- Teledyne Air Generator Model 701
- Teledyne T700U Calibrator
- Dedicated site personal computer (PC)
- Modem and Moxa Serial Server

Note: Reference SOP 2.8.1 Section I: ECB Responsibilities for instruction on using the Thermo Model 43i-TLE SO_2 Analyzers, Thermo Model 146i Dynamic Gas Calibrator, T700U Calibrator, and Teledyne Model 701 Zero Air Generator.

Also included are HoBo back-up temperature sensors (shelter temperature), air conditioners, heaters, and other minor components not specified.

4.0 Site Visits and Checks

Operators are to visit the site at least once every 30 days. Upon arrival at the site, observe the outside of the shelter and probe inlet, looking for vandalism or security breaches. Verify that the probe inlet is in place and that the sample line is not blocked by insects or other debris. *Document all observations and actions on the e-log on the Logbook tab*. More information on locating and opening the E-log can be found in Section 6.0 of this SOP.

If there is any evidence of vandalism the operator should contact the appropriate law enforcement department (generally this is the city police department if the monitor is within city limits or the county sheriff's department if outside city limits) as well as the Regional Office (RO) Ambient Monitoring Coordinator, the RCO, and the Electronics and Calibration Branch (ECB) of DAQ. Unauthorized persons on the monitoring site should not be confronted by the site operator and Police should be contacted. Check the site PC for appropriate date/time and concentration readings. The RO ambient monitoring coordinator and a member of the Projects and Procedures Branch (PPB) of the RCO should review the data generated during any "out-of-control" period to determine if the data should be flagged or invalidated. See Appendix C of this SOP for the schedule of activities required when site Operators visit the site.

4.1 Shelter Temperature

Measure the internal temperature of the building in °C using a National Institute of Standards and Technology (NIST) traceable thermometer. Place the NIST traceable thermometer next to the shelter temperature sensor which should be co-located with the HOBO Temperature data logger (backup). If the NIST traceable thermometer was brought to the site, allow sufficient time for the reading to stabilize. Compare the temperatures for all three and record in the appropriate locations in the e-log. If the shelter temperature sensor is reading greater than ± 2°C of the reference, contact the ECB.

The site thermostat should be adjusted as necessary to maintain the shelter temperature within a 20 to 30°C range. If the temperature cannot be stabilized and controlled within this range, notify the RO Ambient Monitoring Coordinator and the ECB that corrective action is required. *Document in the e-log on the Logbook tab.*

NOTE: All data reported including all calibrations and precision, zero, span (PZS) checks must be invalidated if reported outside of this temperature range.

4.1.1 Hobo Temperature Data

The HOBO temperature data will need to be exported at least once every 30 days from the logger; refer to Raleigh Central Office (RCO) Guidance Documents under the Documents section on NC DAQ's Ambient Monitoring SharePoint page for instructions. The exported temperature data file name should include specific naming parameters such as site, parameter and date. For example, "MQ 20190201to15 ST.xls" would be Millbrook Shelter Temperature between 01 Feb and 15 Feb 2019.
The exported data are considered site files and kept in accordance with section 8.0 Quality Assurance & Data Handling of this SOP. HOBO temperature data may be

imported into Envista Air Resources Manager (ARM) when needed as a backup; refer to RCO Guidance Documents under the Documents section on NC DAQ's Ambient Monitoring SharePoint page for instructions.

NOTE: If the HOBO temperature sensor is reading greater than ± 2° of the reference when checked at the site, contact the ECB.

4.1.2 Standard Deviation of Temperature

The shelter temperature should remain constant and not vary more than ± 2°C standard deviation over 24 hours. The statistician in the RCO keeps track of this statistic. The RO Ambient Monitoring Coordinator will be notified of any shelter temperature issues that arise.

NOTE: All SO_2 data reported during the affected 24 hour period including all calibrations and QA checks must be '2' flagged for an Operational Deviation if reported outside of this temperature standard deviation.

4.2 Electrical Power and Sample Line Check

Observe the analyzer, calibrator, site computer, and data acquisition software for indications of a power failure, and if needed, correct the cause. If there is a loss of power greater than 72 hours, allow an equilibration period of approximately 24 hours for the instrument(s) to stabilize after being powered up. The instrument can remain offline during this time. Visually inspect the sample line tubing, especially at any bends, to ensure that it has not been accidentally kinked, crimped, cut, or to ensure that insects have not nested in the lines. Particulate matter and/or water may also collect in the sample line leading to the instrument. Ensure that the shelter air conditioner is not blowing on the sample line, as this can cause condensation to build up in the line. Ensure that the sample line is being heated and slightly warm to the touch. The ECB is required to replace the sample line every two years and will perform a sample line integrity check during their annual audit (Reference SOP 2.8.1 Section I: ECB Responsibilities for details). *Record all events and observations in the e-log on the logbook tab*.

4.2.1 Residence Time Check

At least every 30 days, check the residence time of the sample line. Enter the sample flow rate into the E-log of the SO_2 analyzer as well as the length of the sample line. The Sample Line length will be provided by the ECB. If the residence time results in a failure in the E-log, all data must be invalidated back to the previous passing residence time check. Contact the ECB in the event of a failed residence time check.

4.3 Time and Date Checks and Adjustments

Record the times from the site computer, analyzer, HOBO Temperature Data Logger, and from NIST on the e-log created for the site visit.

The times for the site computer and the analyzer must be set to EASTERN STANDARD TIME (UTC-5h) for North Carolina. Additionally, they must have the same time and be synched to the NIST time. Time Synchronization on the analyzer and site computer is an automated process that occurs once per day and was programmed during Envidas installation on the site computer.

NOTE: The HOBO data logger time is set to the site computer's time whenever the device is launched. Launching is required after the battery replacement and should be performed at least once every 30 days to synch time with site computer and to export and save the monthly HOBO logger data. Refer to RCO Guidance Documents under the Documents section on NC DAQ's Ambient Monitoring SharePoint page for instructions.

If the times for either the analyzer, HOBO Temperature data logger or site computer are not within 1 minute of NIST time, call the ECB and they will assist with correcting the issue.

Sources for getting NIST time:

1. Call the ECB and ask for the NIST time
2. Call the NIST Colorado time at (303) 499-7111
3. Correct time websites, https://www.time.gov/ or https://nist.time.gov/

4.4 Gas Cylinder and Calibrator Check

Verify that the calibration gas cylinder and calibrator are in certification and document certification dates in the E-log. Calibrator certification is valid for twelve months and the calibration and/or expiration date(s) should be indicated on a sticker on the front panel. Gas cylinders at a concentration of 40 ppm or greater are certified for two years from the original date of the manufacturer's certification. If the cylinder pressure is less than 500 psig, the ECB should be notified that a new cylinder is required. The delivery of a new cylinder or calibrator must be coordinated with the region. The cylinder is not to be used if the pressure is below 200 psig.

Verify that the calibrator has the correct cylinder SO_2 concentration stored in memory.

Cylinder concentration can be accessed on the 146i through the following steps:

1. On the calibrator's Main Menu, press the MENU button to display if on run screen etc.
2. Navigate using the arrow buttons to "Gas Setup" and press ENTER button.
3. Gas A, B, C will display, use arrow keys and select "Gas C" and press ENTER button.
4. The "Tank Conc." displayed should match concentration indicated on the gas cylinder's tag.
5. If the "Tank Conc." needs to be changed, then use the arrows and select "Tank Conc." and press ENTER button.
6. Use the arrow keys to change the value to match the current gas cylinder concentration and save.

Cylinder concentration can be accessed on the T700U through the following steps:

1. On the calibrator's main screen, press the Setup button.
2. Press the Gas button.

3. Press the (Cyl) cylinder button.
4. Select Port 3.
5. If the cylinder concentration needs to be changed, press the Edit button.
6. Enter the correct concentration, and press Enter.

NOTE: Record the cylinder concentration stored in the calibrator in the appropriate location in the E-log.

In lieu of a manual performance check, the daily PZS is performed during the early morning hours (See Section 5.7). Immediately following the installation of a new cylinder or calibrator, the RO must verify that the system is functioning properly. This will be accomplished by observing the results of the PZS performed the morning of the day immediately following the equipment exchange. The operators may, at their discretion, perform a calibration or manual performance check. However, a calibration is no longer required as long as the PZS is within warning limits (See Table 3 of this SOP for limits). The procedures for performing a calibration or manual performance check are provided in Sections 5.5 and 5.7 of this SOP. *Document any calibrator and cylinder information requested in the e-log on the logbook tab*.

4.5 Computer Care

At least once every 30 days, the site computer should be restarted. This will ensure that network updates from the NC Department of Information Technology (DIT) take effect without a prolonged interruption of service. Operators should also contact the ECB if the site computer behaves unusually or if a piece of computer equipment needs to be replaced such as a router, PC tower, computer mouse, etc.

NOTE: NC DIT will have to be contacted if unable to log on to the site computer.

5.0 Common Procedures and Maintenance

5.1 Standard and Service Mode

There are two modes on the analyzer. While sampling in the field, the SO_2 analyzer should always be in its default operating mode, referred to as "Standard mode" within this SOP. When performing any maintenance, the analyzer will need to be switched to Service mode.

To turn Service mode on or off:

- Press the Menu button to go to the Main Menu.
- Use the arrow buttons to toggle to Instrument Controls, and then press Enter. Then toggle to Service Mode.
- When on the Service Mode screen, press Enter to toggle Service mode on or off.

If Service mode was turned on, be sure to always turn Service mode off prior to starting regular sampling. Refer to Figure 1: Thermo Model 43i/43i-TLE Flowchart for a description of the instrument menu.

Note: 12-Minute Rule. Site Activities such as an On-Site Calibration Check and Filter Change requires the SO_2 monitor to be taken out of the Standard mode. This should be performed whenever possible between 12 minutes before the hour and 12 minutes after the hour. The loss of 12 minutes of data in either hour will not result in the invalidation of either hour of SO_2 data. The EPA hourly data reporting requirement is that 75% of an hour or 45 minutes of the 60 minutes in an hour constitutes the minimum number of minutes that can be used to produce a valid hour of SO_2 data.

5.2 Analyzer and Calibrator Operational Checks

On the front panel press the Menu button to get to the Main Menu. The Main Menu contains many submenus (see Figure 1 for the 43i/43i-TLE or Figure 2 for the 146i). Instrument parameters and settings can be found within the submenus according to their function. To select a submenu screen, use the up and down arrow buttons to move the cursor up or down, select the submenu and press ENTER. No values are to be changed without calling the ECB and getting their approval. If the ECB approves changing a value, document the change in the logbook. To exit a screen, press MENU to return to Main Menu and choose another submenu or press RUN to return to the Run Screen.

5.2.1 Alarm Checks (Thermo 43i-TLE Analyzer, Thermo 146i Calibrator or Teledyne T700U Calibrator)

Check for "Alarm" on the displays. If no alarms are present, record the Alarm On check box in the e-log as "no" and continue. If either screen shows an alarm, record the Alarm On check box as "yes" in the e-log for the appropriate instrument/s. View the Alarm menu to determine the cause and enter the alarm description in the Notes section of the e-log. ECB should be notified when an alarm has been detected. Follow the instructions below to view alarms on the instrument.

To view the alarms:

1. Press the MENU button on the front of the instrument.

2. Use the arrow buttons to select the Alarm Submenu.
3. Press the ENTER button.
4. Use the arrow buttons to select the item that is in Alarm Status.
   NOTE: Items that are not in alarm status are labeled “OK”.
5. Press the ENTER button.
6. Determine the cause of the alarm and consult with the ECB prior to performing calibrations or maintenance.
7. Press the MENU button twice to return to the main menu screen.

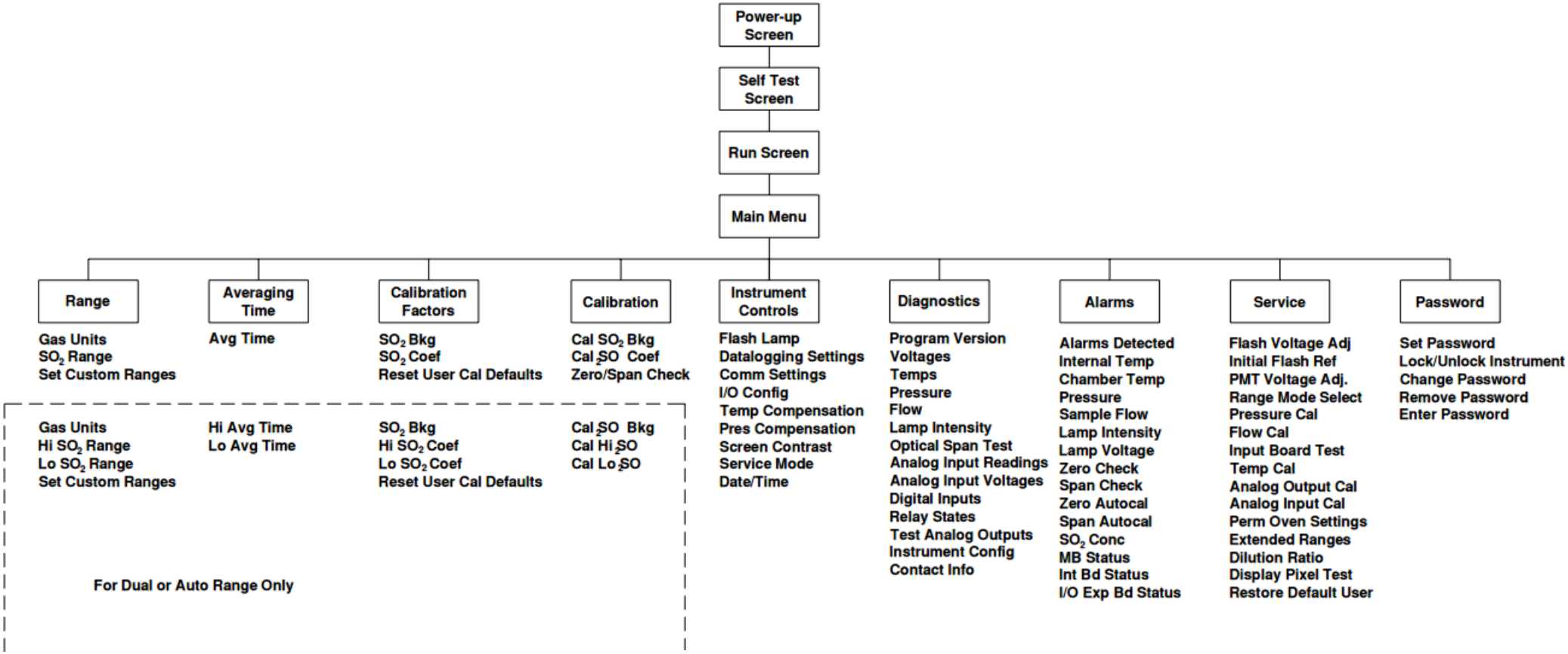


Figure 1: Thermo Model 43i/43i-TLE SO_2 Analyzer Flowchart

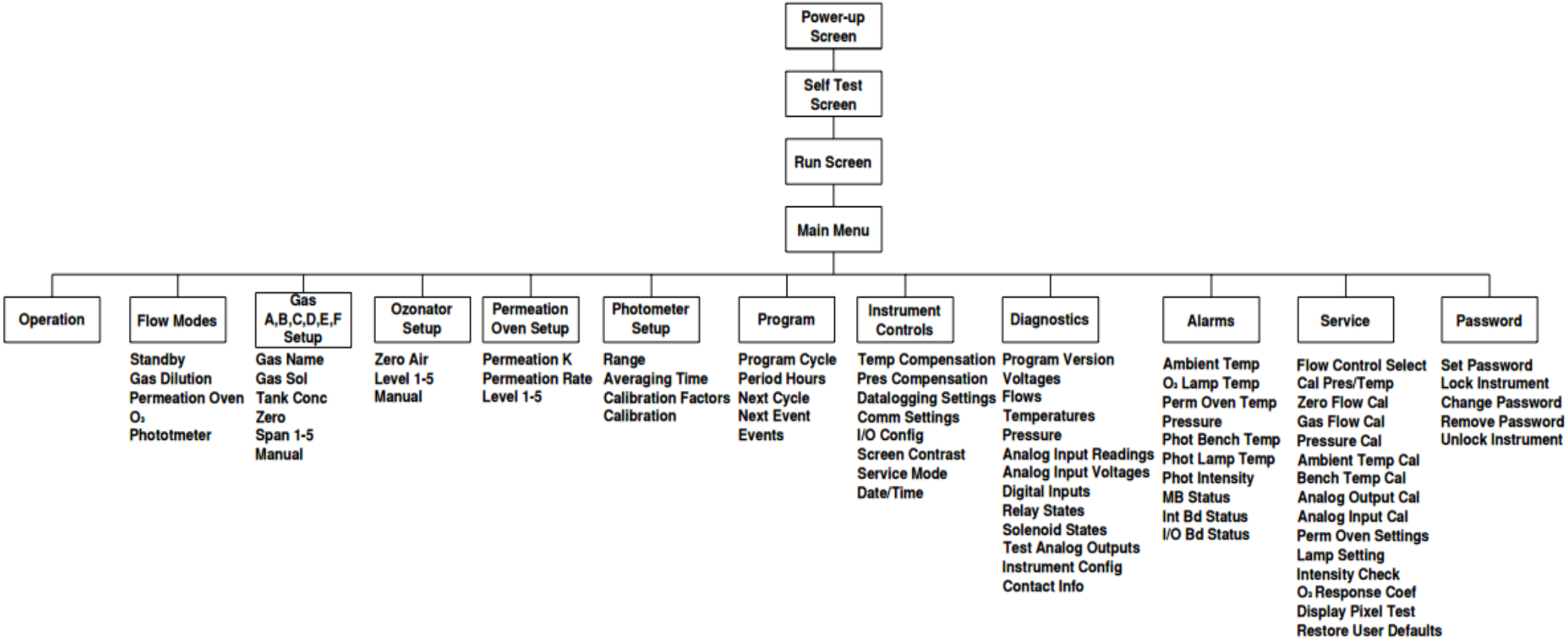


Figure 2: Thermo 146i Calibrator Flowchart

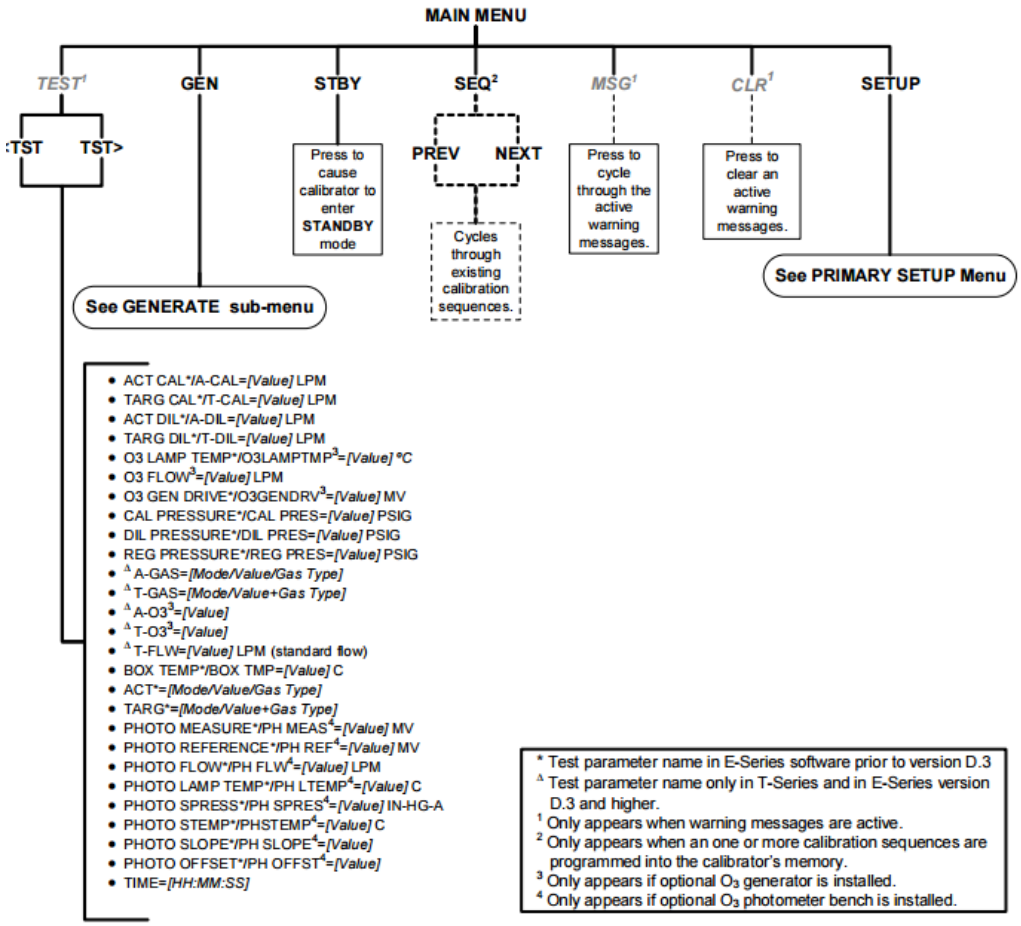


Figure 3: Teledyne T700U Calibrator Flowchart

5.3 Leak Check Procedures

A Leak Check must be performed at least once every 30 days in conjunction with a filter change. A leak check should be performed before and after a filter change.

A) **For the Analyzer SAMPLE port**, perform the following on the analyzer:

1. Mark the SO_2 channel down; refer to RCO Guidance Documents under the Documents section on NC DAQ's Ambient Monitoring SharePoint page for instructions.
2. Disconnect the sample line from the sample inlet port on the rear of the instrument and block the opening with a leak-tight cap. (Do not disconnect the lines going to the filter inlet or the filter outlet.)
3. From the Diagnostics Menu, use the arrow buttons to select "Pressure" and press "Enter". The pressure reading should start to drop.
4. Wait until the pressure drops below 180 millimeters mercury (mm Hg) which should take approximately 3 minutes.

5. Now, using the Diagnostics Menu, toggle back and forth between “Pressure” and “Flow” monitoring both readings. The flow should drop to “zero” liters per minute (LPM), and this may take an additional 1-3 minutes after the pressure has dropped below 180 mm Hg. If the flow does not read exactly 0.000, but displays a value of 0.1 LPM or lower, the flow criteria for the leak check still passes. (Inform the ECB if this situation occurs so that the ECB can make a small adjustment to the flow meter at some convenient future time.)

   NOTE: If the pressure has not dropped below 180 mm Hg in approximately 3 minutes, remove the cap. Check to see that all fittings (leak-tight cap, filter housing, and filter inlet/outlet fittings) are tight and input lines are not cracked or broken, and retest. If either the flow or the pressure is not acceptable, the leak check fails. Contact the ECB for assistance. If the solenoid is changed, keep the solenoid so that it can be tested by the ECB.

6. Remove the cap and Press Run to return to the home screen on the analyzer.

Update the e-log LOGBOOK sheet where appropriate.

B) **For the Analyzer SPAN port** begin the procedure by:

On the analyzer, perform the following steps:

1. Disconnect the calibrator Teflon™ line from the calibration gas inlet port on the rear of the analyzer. Block off the calibration gas inlet port on the back of the analyzer with a leak-tight cap.

2. From the Diagnostics Menu, press “Menu”, use the arrow buttons to select “Pressure”, and press “Enter”. The pressure reading should start to drop.

3. Begin the Zero. In Envidas VIEWER:
   1. Select [Operational]
   2. Select [Phase from Sequence]
   3. Left click "SO2MAN"
   4. In the SO2MAN window,

   Phase = "Zero"

   Change Value For = "01:00:00" [default]
   Click "Start"

   Window will countdown to the top of the minute and start the 'zero span' actuating the span solenoid on the instrument

4. On the Analyzer, wait until the pressure drops below 180 mm Hg which should take approximately 3 minutes.

5. Now, using the Diagnostics Menu on the analyzer, toggle back and forth between “Pressure” and “Flow” monitoring both readings. The flow should drop to “zero” LPM, and this may take an additional 1-3 minutes after the pressure has dropped below 180 mm Hg. If the flow does not read exactly 0.000, but displays a value of

0.1 LPM or lower, the flow criteria for the check still passes. (Inform the ECB if this situation occurs so that the ECB can make a small adjustment to the flow meter at some convenient future time.)

NOTE: If the pressure has not dropped below 180 mm Hg within 3 minutes, immediately remove the cap. Check to see that all fittings (leak-tight cap, filter housing, and filter inlet/outlet fittings) are tight and input lines are not cracked or broken, and retest. Do not cap off the line for more than 5-6 minutes or the system may pressurize. If either the flow or pressure is unacceptable, the leak check fails; contact the ECB for assistance. If the solenoid is changed, keep the solenoid so that it can be tested by the ECB.

6. If the leak check passes, remove the cap, reconnect the calibrator line to the span port and the sample line to the sample inlet. Clear the zero mode by aborting the zero cal.

Remove the cap and document results in the e-log. Press Run to return to the home screen on the analyzer.

5.4 Filter Change Procedure

The particulate filter (5.0-micron 47 mm Teflon) must be replaced at a minimum of every 30 days. The filter is replaced as follows:

1. Mark the SO_2 channel down; refer to RCO Guidance Documents under the Documents section on NC DAQ's Ambient Monitoring SharePoint page for instructions.
2. Perform a leak check of the system. Leak checks are performed on both the Span and Sample ports prior to and after changing the filter (See Section 5.3 of this SOP for instructions). This will ensure the integrity of the system prior to making any changes to the filter.
3. On the back of the analyzer, remove the filter holder (if necessary) and disassemble using the special filter wrenches.
4. Remove the existing filter and discard. Remove any extraneous material from filter housing.
5. Touching only the outer edges, place a new filter in the holder (orientation of filter is not critical). EPA recommends the use of gloves to limit filter contamination and gloves should be used by operators during this process.
6. Reassemble the filter holder and reattach to instrument in same orientation as before removal (i.e., filter inlet/outlet connected to proper lines). Do not over tighten the filter holder for this can tear the filter and/or damage the holder.
7. Perform a post-filter change leak check (See section 5.3 of this SOP for instructions).
8. Record the new filter change date and the leak check results in the e-log.

5.5 Calibration

A calibration **IS** required:

- During initial set-up.
- When the SO_2 analyzer is replaced.
- After two consecutive results from the daily PZS did not pass the warning limit given in Table 3 of this SOP.
- When the analyzer has been without power for more than 3 consecutive days or 72 hours.
- When an SO_2 analyzer undergoes major repairs.
- On a failed Multi-Point Calibration Verification.
- Once every 365 days and once a calendar year regardless of analyzer performance.

A calibration is **NOT** required after the replacement of any of the following components:

- The zero air supply
- The calibrator
- The SO_2 cylinder

This is applicable only when the very next PZS is shown to be within warning limits (see Table 3). If this PZS fails, a calibration is required. It is imperative that the operator be aware of when components are changed so that the results of the next PZS can be reviewed. Therefore, arrangements with the ECB for delivery should be scheduled in advance. If a new monitor is placed into service at a site, allow for an equilibrium period of 24 hours before calibrating.

A calibration consists of 1) setting the "Zero" using a source of zero air, 2) setting the SPAN (SO_2 coefficient) using calibration gas with a concentration of nominally 80% of the analyzer's range (i.e., 85 part per billion [ppb] SO_2), and 3) Performing a multi-point calibration verification (see section 5.6). Zero adjustments affect the span; however, span adjustments do not affect the zero. The procedures to calibrate the analyzer are provided below.

NOTE: The SO_2 channel should still be marked down from the required checks performed previously. If the channel is still enabled, mark down the channel before proceeding.

A) Set Zero Procedure
   1. Open Envidas VIEWER module on the site computer-Icon on desktop.
   2. Enter username & password – this will have been added to your site by ECB personnel beforehand.
   3. In the "Dynamic" tab, select [Tabular] and choose the site to view current data stream.
   4. Under 'Channel' Right click SO_2.
   5. In the options window, move cursor over "Set Channel Flag".
   6. Choose a status (i.e. "To Maintain").

7. In the "Force Status Time" window, Select [Change Status For] and specify a duration (i.e. "Hr" and "2").
8. Click "Force Now".
9. In the "Operational" tab, Select [Phase From Sequence], choose "SO2MAN" (start single phase calibration).
10. Select Phase "Zero" "SO2CAL".
11. Select Change Value For "01:00:00" "SPAN0".
12. Click "Start" - the phase will start at the top of the next minute. A countdown will appear in the dialog box.
    NOTE: Leave the Sequence dialogue box open.
13. Display the minute data and graph; refer to RCO Guidance Documents under the Documents section on NC DAQ's Ambient Monitoring SharePoint page for instructions.

On the Analyzer

The data in Envidas VIEWER should read nominally 0.0 ± 3.0 ppb on the SO_2 channel.

Adjust the *analyzer* zero setting by doing the following:

1. From the Main Menu use the arrow buttons to select Calibration Factors and then select SO_2 Background.
2. Record this value on the e-log as the "SO_2 background" BEFORE CALIBRATION. (If this value is outside of a 0 to 10 ppb range for 43i-TLE, contact the ECB.)
3. Return to the Main Menu, and use the arrow buttons to select Calibration Factors and then select SO_2 Coefficient.
4. Record this value in the e-log as the SO_2 Coefficient BEFORE CALIBRATION. If this value is outside of a 0.800 to 1.200 ppb range, contact the ECB.
5. Return to the Main Menu and "Press" the Menu button on the front of the analyzer and, using the arrow buttons, move the cursor to select Calibration menu.
6. Press the ENTER button to display the Calibration menu.
7. In the Calibration menu select "Cal SO_2 Background" and press the ENTER button.
8. The "Calibrate Zero" screen will appear with the first line of the display showing the current SO_2 reading.
9. With the analyzer producing a stable reading for at least 20 minutes (constant within 0.0 ± 2.0 ppb and not trending up or down) on zero air, press the ENTER button to set the SO_2 reading to zero. The display flashes the message "Saving" and the SO_2 reading is added to the background correction.
10. Return to the Main Menu.
11. From the Main Menu use the arrow buttons to select Calibration Factors and then select SO_2 Background.
12. Record this value on the e-log as the "SO_2 background" AFTER CALIBRATION. (If this value is outside of a 0 to 10 ppb range for 43i-TLE, contact the ECB.)
13. Return to the Main Menu and "Press" the Menu button on the front of the analyzer.
14. Allow the analyzer to stabilize and then record the next five one-minute data concentration values from Envidas on the e-log. The e-log will compute the average

of these five one minute values. If the values are not within ± 1.0 ppb of zero, repeat steps 8 and 9 listed above.

Stopping the zero

In Envidas VIEWER select the RED "Abort" button at the bottom of the dialogue box (Configuration Menu).

B) Set Span Procedure

The span concentrations are preset values as specified in Table 1 of this SOP. The analyzer needs to stabilize for at least 20 minutes prior to recording any concentration values. After the analyzer has stabilized (values not changing by more than ± 3.0 ppb and not continuing to trend up or down), follow the steps below to adjust/calibrate the instrument:

1. Open Envidas VIEWER module on the site computer.
2. In the "Operational" tab select [Phase From Sequence], and then choose "SO2MAN".
3. Select Phase "SPAN".
4. Select Change Value For "01:00:00".
5. Click "Start" - the phase will start at the top of the next minute. A countdown will appear in the dialog box.
   NOTE: Leave the Sequence dialogue box open.
6. Display the minute data and graph; refer to RCO Guidance Documents under the Documents section on NC DAQ's Ambient Monitoring SharePoint page for instructions.
7. Record the concentration value in the e-log. This may be calculated with flows and should be recorded in the e-log if being used. See below for instructions for obtaining flows.

To get the flow readings for the e-log:

On the 146i calibrator

- Press the **Diags** button
- Toggle using arrow keys to **Flows**
- Record the flows in the appropriate boxes in the e-log

On the T700U calibrator

- the flow rates are displayed on the **Home** screen (Cal flow and dil flow)
- Record "Actual" flows on the display in the appropriate boxes in the e-log.

On the analyzer

The values displayed on the analyzer should read within ± 5% of the expected value on the SO_2 channel. Adjust the analyzer span by doing the following:

1. Press the Menu button and use the arrows to select "Calibration". Press Enter.
2. Use the arrows to toggle to Cal SO_2 Coefficient and press Enter.
3. The first line of the display shows the current SO_2 reading, and the third line shows the calibration gas concentration. To adjust the calibration gas concentration, use the left and right arrow buttons to move the cursor to a different digit. Use the up and down arrow buttons to adjust each digit to the true SO_2 Span concentration.
4. Press Enter to calibrate the analyzer to the true 146i/T700U "Output PPB" display SO_2 calibration gas concentration. The screen will flash the message "Saving" and will display the corrected SO_2 reading.
5. Return to the Main Menu, and use the arrow buttons to select Calibration Factors and then select SO_2 Coefficient.
6. Record this value in the e-log as the SO_2 Coefficient AFTER CALIBRATION. If this value is outside of a 0.800 to 1.200 ppb range, contact the ECB.
7. Press Run to return to the "Run screen".
8. Allow the analyzer to stabilize and record the next 5 one-minute concentration values from Envidas REPORTER in the e-log. The e-log will compute the average of these 5 one-minute values. If the values are not within ± 5% of the "True Span concentration", repeat steps 2, 3, and 4 listed above.

To stop the Span gas flow:

In Envidas VIEWER select the RED "Abort" button at the bottom of the dialogue box (Configuration Menu).

NOTE: If the Dialogue box was closed, reopen by:

a. Selecting the "Operational" tab,
b. Selecting "Phase From Sequence"
c. Selecting "SO2MAN" which is currently running.

Table 1: Criteria for Calibrations

	Zero	Span
Concentration (ppb)	0	85
Calibration Criteria (±)	1 ppb	5%

NOTE: Following a calibration, a multi-point calibration verification must occur. (See section 5.6)

5.6 Multi-Point Calibration Verification Procedure

The purpose of this procedure is to "verify" the linearity of the analyzer at multiple concentrations after the completion of a calibration. At an operator's discretion, a multi-point calibration verification can be performed in lieu of a manual performance check (see section 5.7) to support weight of evidence.

A Multi-point Calibration Verification is required:

- After every calibration
- Every 365 days and once a calendar year

To ensure that the adjustments in a calibration were successful, each point should be performed in a multi-point calibration regardless if that same point passed in the calibration. To run a multi-point calibration, follow the steps below:

1. Open Envidas VIEWER module on the site computer.
2. In the "Operational" tab select [Phase From Sequence], and then choose "SO2MAN".
3. Select Zero or the appropriate point needed.
4. Confirm Phase Duration is 1 hour and click "Start".
5. The phase will start at the top of the next minute. A countdown will appear in the dialog box.
   NOTE: Leave the Sequence dialogue box open.
6. Allow the instrument to stabilize for a minimum of 10 minutes to produce a stable reading.
7. Record the 5 one-minute values following the 10-minute stabilization period in the e-log.
8. The e-log will compute the average of these five one-minute values.
9. Abort the completed point by clicking the RED "Abort" button at the bottom of the dialogue box.

Repeat the previous steps for all required points indicated in Table 2 of this SOP.

10. The calibration verification must show that all points are <±2.1% or <±1.5 ppb different of the best-fit straight line (whichever is greater). The Slope must be within 1.0±0.5. The E-log will calculate these values.

Table 2: Criteria for Calibration Verifications

	Zero	Span	Span 2	Span 4
Concentration (ppb)	0	85	45	7
Calibration Criteria (±)	1 ppb	5%	5%	7% (% Diff.)

NOTE: If any of the points ran or the slope that was calculated are outside the specifications of the criteria given in Tables 1, Table 2, or List Item 10 of Section 5.6, the Calibration must be re-run to identify and correct any problems. If a second attempt fails, contact the ECB for guidance.

5.7 Precision, Zero, Span Checks

The purpose of a Precision, Zero, Span or PZS check is to correlate the output of a monitoring system with known traceable concentrations of SO_2, and to periodically confirm that the analyzer's calibration has not drifted outside the acceptable range. The EPA requires that a 1-pt QC check, Zero check and Span check be performed at least once every 14-days. A Precision point is the terminology DAQ uses for a 1-pt QC check. DAQ uses a daily PZS result in lieu of these 14-day calibration checks.

For the PZSs to be successful, the subsequent activities must be followed:

- Continued daily review (by the RO) of the daily PZS results which occur in the early morning hours of each day.
- A three (3) point daily PZS using Zero Air, Span (85 ppb) and appropriate 1-pt QC check (7 ppb) indicated in Table 3 of this SOP.
- The submittal of all valid 1-pt QC, Zero, and Span results from the daily PZS are reported to Air Quality System (AQS) by the RCO.
- Immediate action is required by the operator if one or more points of the PZS listed above are outside of the Warning Limits provided in Table 3 for two consecutive days. This immediate action will be taken on the second of the two consecutive days experiencing an out-of-control situation. If the consecutive days fall on a weekend or extended weekend, then action must take place on the first work day following such a period.
- Immediate action will consist of performing an "investigative" or manual performance check (called SO2MAN in Envidas VIEWER) using the same points provided in Table 3 of this SOP which includes: Zero Air, Span (85 ppb), and 1-pt QC (7 ppb). This manual performance check should ideally be performed at the monitoring site, but may be done so remotely from the RO with ECB assistance if necessary. Refer to RCO Guidance Documents under the Documents section on NC DAQ's Ambient Monitoring SharePoint page for instructions.
- EPA recommends reporting any additional investigative manual precision points run between 80 and 5 ppb, and DAQ shall do so by way of the AQ98 form or via the e-log.
- A calibration IS required if the Manual Performance Check confirms an out-of-control situation.

  NOTE: No checks that affect data will be performed during periods of ambient exceedances.

Table 3: Criteria for PZSs

	Zero	Span	Precision (Span 1)
Concentration (ppb)	0	85	7
Control Limit (±)	<3.1 ppb	<10.1% (% Diff.)	<10.1% (% Diff.)
Warning Limit (±)	>1 ppb	>5% Diff.	>7% (% Diff.)

5.7.1 Manual Performance Check Procedures

An investigative Manual Performance Check must be performed if the daily PZS check results are outside of the warning limits listed in Table 3 for two consecutive days or if the control limit was exceeded during the daily PZS check. In this case the Zero, Span and Precision (Span 1) are performed. The operator may report the Manual Performance Check using the AQ98 form or via the e-log. Should an operator run a Span 6 instead of the Precision (Span 1) point during an investigative check, it would be considered a Systems Test (see section 5.7.2) and would not need to be reported to AQS. Zero and Span points will be submitted to AQS when a Precision point was performed alongside it. Zero and Span points performed without an accompanying Precision point will be considered a Systems Test and will not be used as support for weight of evidence.

NOTE: No adjustments should be made to the analyzer before the manual performance check.

To perform a manual performance check:

1. Mark the SO_2 channel down using Envidas VIEWER icon on Desktop of site PC; refer to RCO Guidance Documents under the Documents section on NC DAQ's Ambient Monitoring SharePoint page for instructions.
2. In the Envidas "VIEWER" module, under the "Operational" tab, select "Phase From Sequence" and choose "SO2MAN"
3. Select Phase "Zero" to run an initial "zero" (then Span followed by any additional spans, i.e. Span 1/Span 2/Span 4/Span 6)
   NOTE: Confirm Phase Duration time of "01:00:00"
4. Click "Start" - the phase will start at the top of the next minute. A countdown will appear in the dialog box.
   NOTE: Leave the Sequence dialogue box open.
5. Open the "Reporter" module in Envidas (username/password)
6. In the "Reports" tab, select "Sites"
7. In the 'Site Report' window select the "Site" from the drop-down menu
8. Select the "SO2" and "146i_gas conc/ T700_ACTCONC" check boxes
9. Choose the report 'Output' type ("Excel" works very well for recording in e-logs)
10. Choose how much data to display in 'Duration' ("Period" works well for displaying cal-check data)
11. Specify the start/stop 'Date and Time'
12. Select "Status" tab, check box "Separated Status\Value".
13. In the "type" tab specify "AVG" data and timebase = "1 Minute" and click "OK"
14. In Envidas VIEWER select the RED "Abort" button at the bottom of the dialogue box (Configuration Menu).
    NOTE: If the Dialogue box was closed, reopen by:
    Selecting the "Operational" tab,
    Selecting "Phase From Sequence"
    Selecting "SO2MAN" which is currently running.

15. Repeat for the remaining points and conclude the procedure by running a final "zero" phase.
16. Record the results from each Phase initiated in the e-log where indicated.
17. The Manual Performance Check must show that all points are <±2.1% or <±1.5 ppb difference of the best-fit straight line (whichever is greater). The Slope must be within 1.0±0.5. The e-log will calculate these values.
18. If the Manual Performance Check is found to be unacceptable, then perform the required calibration.
19. Mark the SO_2 channel back up after the completion of the calibration check; refer to RCO Guidance Documents under the Documents section on NC DAQ's Ambient Monitoring SharePoint page for instructions.

Manual Performance Checks can also be used as a bracketing point before calibrations and extended planned monitor inactivity (such as shutting a site down due to a hurricane). While running a Manual Performance Check is not required in these situations, any data that is outside two valid PZSs (no matter if automated or manual) before a monitor is altered will be considered unverifiable and voided.

Table 4: Criteria for Manual Calibration Checks

	Zero	Span	Span 2	Precision (Span 1)	Span 6
Concentration (ppb)	0	85	45	7	4
Control Limit (±)	<3.1 ppb	5%	5%	<10.1 % (% Diff.)	2 ppb
Warning Limit (±)	>1 ppb	>5% Diff.	>5% Diff.	>7% (% Diff.)	>2 ppb

5.7.2 Systems Test Procedure

In some instances, an operator may want to run a Systems Test to check if a part of the monitoring system equipment is operating as expected. A Systems Test may consist of a Zero, Span, and/or a Span 6. Points ran during a Systems Test do not necessarily need to be ran until stabilized and may be ended as soon as an operator is satisfied that the system is operating normally. A Systems Test will never contain a precision point and cannot be used in support of weight of evidence. A Systems Test is investigative in nature and will not be reported to AQS. Some of the scenarios in which an operator may initiate a Systems Test include but are not limited to:

- After a piece of equipment is swapped out
- After a failed PZS but before a manual performance check is required
- After a filter change

- After a brief power outage

The operator may report the Systems Check using the e-log. If a Systems Test shows that the system is behaving abnormally, the operator should take steps to immediately correct the situation. Should an operator be unable to accomplish this, ECB should be contacted and the RCO Chemist notified.

To perform a Systems Test:

1. Mark the SO_2 channel down using Envidas VIEWER icon on Desktop of site PC; refer to RCO Guidance Documents under the Documents section on NC DAQ's Ambient Monitoring SharePoint page for instructions.
2. In the Envidas "VIEWER" module, under the "Operational" tab, select "Phase From Sequence" and choose "SO2MAN"
3. Select Phase "Zero" to run an initial "zero" (Or Span/Span 6 followed by any additional spans you may want to investigate)
   NOTE: Confirm Phase Duration time of "01:00:00"
4. Click "Start" - the phase will start at the top of the next minute. A countdown will appear in the dialog box.
   NOTE: Leave the Sequence dialogue box open.
5. Open the "Reporter" module in Envidas (username/password)
6. In the "Reports" tab, select "Sites"
7. In the 'Site Report' window select the "Site" from the drop-down menu
8. Select the "SO2" and "146i_gas conc/ T700_ACTCONC" check boxes
9. Choose the report 'Output' type ("Excel" works very well for recording in e-logs)
10. Choose how much data to display in 'Duration' ("Period" works well for displaying cal-check data)
11. Specify the start/stop 'Date and Time'
12. Select "Status" tab, check box "Separated Status\Value".
13. In the "type" tab specify "AVG" data and timebase = "1 Minute" and click "OK"
14. In Envidas VIEWER select the RED "Abort" button at the bottom of the dialogue box (Configuration Menu).
    NOTE: If the Dialogue box was closed, reopen by:
    Selecting the "Operational" tab,
    Selecting "Phase From Sequence"
    Selecting "SO2MAN" which is currently running.
15. Repeat for the remaining points and conclude the procedure by running a final "zero" phase.
16. Record the results from each Phase initiated in the e-log where indicated.
17. If the Systems Test is found to be unacceptable, then immediately correct the situation or contact the ECB and notify the RCO Chemist.
18. Mark the SO_2 channel back up after the completion of the Systems Test; refer to RCO Guidance Documents under the Documents section on NC DAQ's Ambient Monitoring SharePoint page for instructions.

6.0 Logbook Submittal and Data Retrieval

6.1 Logbook Submittal

The SO_2 e-log, or Electronic Logbook, serves as the Transfer Record and Document for evaluating the Success/Failure of the operation of the SO_2 monitoring site and is the essential record for determining the quality of the SO_2 data reported from each site.

1. The **Site Operator** must complete the SO_2 e-log to document the purpose of **Every** site visit, the observations and findings during the site visit, and the evaluation of the performance of the SO_2 monitoring system for each site visit. This includes any and all startups and shutdowns (including severe weather events, temperature extremes, and etc.). The Site Operator must initial and date the last time the E-log was altered.

2. The Site Operator must submit the SO_2 e-log to the RO Ambient Monitoring Coordinator or Designee for review and comment as soon as reasonably possible after the site visit and at a minimum by the end of each month. Additionally, a Site logbook page should be annotated with any site visit; i.e. shutting down for approaching weather, start-ups and shut downs, and etc. Each site visit should provide an E-log and an entry in the Site logbook stating, at a minimum, a purpose for the visit.

3. The **RO Ambient Monitoring Coordinator** or Designee must review site operator monthly submitted SO_2 E-logs for each site in their region and evaluate each E-log for completeness and operator adherence to operating procedures. The RO ambient monitoring coordinator must also consider and compare all SO_2 E-logs submitted for all SO_2 sites in the region and determine if a pattern of operation is negatively impacting the SO_2 sites in that region. Following that review the RO Ambient Monitoring Coordinator must Initial and submit each SO_2 logbook to the RCO Chemist for review.

4. The **PPB Chemist** must review the logbooks submitted by each region from all SO_2 sites for completeness and adherence to operating procedures. The PPB Chemist must also review the logbook submitted from each site and from all regions to determine if there is a procedure or pattern of operation that may be negatively impacting the overall operation of the SO_2 monitoring network and the quality of the SO_2 data reported.

6.2 Data Retrieval and End Processing

Every business day, the RCO statistician initiates a data review for the previous day by providing a raw data report (in a spreadsheet format) to each RO (Reference Section III: Regional Office Polling and Data Review and Section IV: Data Review and Validation QA Plan for Continuous Gaseous and Non-Speciated Particulate Monitors for details on data review). The RCO may request the RO to send additional data that are needed beyond what the RCO requires for verifying any missing data supplied by the RO. These data can be retrieved from the "site analyzer"; refer to RCO Guidance Documents under the Documents section on NC DAQ's Ambient Monitoring SharePoint page for instructions.

7.0 File Management

Site operators must have a PC (or laptop) to generate the e-log files from a Microsoft Excel template file. These e-logs are provided by the RCO and updated periodically. The file naming protocol is provided below. A formalized file naming convention has been established through consensus of the regions and the RCO and should be used by all regions.

7.1 Opening, Naming and Storing the site files

The e-log template file used at the site should be stored on the PC used for field operations by the field technician; see Appendix E of this SOP for an example of the e-log. E-logs can also be found in DAQ's Internet Based Enterprise Application Management system (IBEAM). To access this file, open the e-log template file using Excel. Every time a new e-log is filled out using the template, it must be renamed and saved as a separate and complete workbook (all sheets, i.e., tabs, saved) to preserve the record. Do **NOT** copy over a previously completed e-log.

NOTE: Refer to the Logbook file naming convention "Policy Memorandum" dated January 1, 2011 located in the DAQ IBEAM module (summarized below).

Renaming and Saving the E-log

1. Open the e-log workbook template file using Excel.
2. Left click the "file" toolbar icon. Scroll down to "save as" and left click.
3. Under file name (highlighted in blue) change workbook file name using the following format: Site ID SO_2 Date Activity. For example, BV SO2 20120730 SV.xlsx is a Site Visit at Bayview on July 30, 2012
4. Change save location to operator's choice of folders (example: previously created folder named SO_2).
5. Left click "save".
6. Find the tab needed for the task involved. The first tab selected should be the Logbook. Fill in information as indicated.

8.0 Quality Assurance & Data Handling

All site files, e-logs or other supporting documents generated in the field will be stored on dedicated server space in the RO in a folder named for the official site operation files. These files should be transferred to the Official File on a frequent and regular schedule as established by the Region. This is necessary to prevent the potential loss of such files from the field computer and to maintain a "paper trail" for providing defensible data. This also makes the data easily and readily available for review by the RO Ambient Monitoring Coordinator and transfer to the P: drive for review by the RCO. The files on the site/operator PC can be copied and transferred to the common hard drive via email or flash drive for storage in the official file folder.

The site files should be transferred every three business days and backed up monthly. This serves as a backup system in the event the official PC fails or is removed or the site files are damaged. These files will be retained for a minimum of five years. When the need arises to review a file for data validation or site operations, the official folder is used or a hardcopy is created from this file. For details on data validation procedures, please reference Section III (SOP 2.8.3): Regional Office Polling and Data Review and Section IV (SOP 2.41.4): Data Review and Validation QA Plan for Continuous Gaseous and Non-Speciated Particulate Monitors. The following validation checks shall be completed every month:

1. Providing proper null codes indicating calibrations, audits etc.

2. Providing missing valid data.

3. Documenting any invalid data as to reason with proper null code.

4. Identifying any data that may be associated with exceptional events.

SO_2 exceedances must be evaluated and validated within an appropriate amount of time following the exceedance day. An exceedance is any day in which at least 1 hourly SO_2 value exceeds the NAAQS of 75 ppb.

8.1 SO_2 Monthly Data Validation

Preliminary validation is completed by the RO Operator. The operator must account for and identify the reasons for missing or invalid data within Envista using proper flags and null codes while performing maintenance or shortly thereafter. The operator must review the previous month of data and add any flags or void codes to the Status column as necessary. For each changed status, a comment must be entered with a description of why the status was changed.

The RO Ambient Monitoring Coordinator will perform the second level review of the month of data, adding any additional void codes and comments, and requesting additional information from the operator as necessary. If required, the RO Coordinator can send data back to the RO Operator for additional comments or to correct any codes. When possible the data will be validated within 15 workdays from the end of the collection month.

The RCO Chemist performs the final validation of the one-month period of data. Void codes and comments should all be added, and the RCO Chemist can send the data back to the

previous reviewer. Final validation of the data should be completed within 30 days of the end of the collection month. Once the data has been approved and has had the "final validation" label applied by the RCO Chemist, it is automatically entered into a queue within Envista ARM. The Database Manager will send all approved data to AQS automatically on a regularly scheduled basis.

In some cases, "valid" data that are judged to be out of the ordinary are retained and an informational flag is added in AQS by the RCO. An example would be high concentration values resulting from an exceptional event. EPA has recently begun applying stricter standards for what it will accept as an exceptional event. In any case, where the RO wishes data to be considered "exceptional," the RO should gather sufficient documentation to support the claim in accordance with a policy memorandum from the RCO dated June 29, 2007. Unusually high concentration values that may be the result of an exceptional event must be noted as such on the AQS monthly data summary reports but not deleted. Any exceptional event data will be flagged in AQS by the RCO using the appropriate qualifier code. The fully validated file data are then uploaded into AQS by the RCO.

A list of Null Codes that are routinely used during data validation on the AQS monthly summary report are listed in the following table.

Table 5: Commonly Used EPA-AQS Null Value Codes (partial list)

AE	Shelter Temperature outside Limits
AN	Machine or Equipment Malfunction
AS	Poor Quality Assurance Results
AT	Calibration
AV	Power Failure
AZ	QC (ECB) Audit
BA	Maintenance and Routine Repairs (including filter changes)
BF	Precision/Zero/Span
BJ	Operator Error
BK	Site Computer/Data Logger Down
EC	Exceeds Critical Criteria
QV	Multi-point Calibration Verification

8.2 SO_2 Exceedance Validation

In the event of an SO_2 exceedance at an SO_2 monitoring site, an exceedance report will be filled out. Please see Appendix D of this SOP for an example of the blank exceedance report.

If an exceedance is recorded, DAQ personnel will then retrieve the following data:

1. Most recent calibration data prior to the exceedance.
2. Both PZS checks bracketing the exceedance.
3. Copy of e-log with the date of the most recent filter change and leak check.
4. Hourly SO_2 data from the day of the exceedance.
5. Documentation of any discussion with the facility.

The exceedance report will be completed by the site operator and signed electronically by the RO Air Quality supervisor. The signed report will be submitted to the RCO within ten business days of the exceedance. The RCO chemist will review the form and all accompanying documentation. Once the form and documentation have been reviewed and are free from errors, the RCO chemist will electronically sign the report and store it in the appropriate folder on the shared drive.

9.0 Troubleshooting and Corrective Actions

The table below provides general troubleshooting information and the checks that should be performed. For a more detailed list see Section 6.0 of the Operating Manual.

Problem	**Corrective Action**
Monitor does not respond to any Phase Activation using Envidas Software	Check that Service mode is OFF
Manually activated phases do not initiate and/or terminate properly on the calibrator	Check that the "ADAM" unit is operational and that vent solenoids are being open and closed as needed.
Leak check (Sample or Span) takes longer than 3 minutes to reach 180 mm mercury (Hg)	Suspect internal leak – contact ECB for guidance.
Data Loss	Check all electrical connections, plugs, Uninterrupted Power Supplies (UPS), and confirm channels are reset
Too long residence time (>20 sec)	Perform a Leak test, replace filter, test again and check all lines and connections; Run PZS as appropriate
Zero or Span won't stabilize	Perform a leak test, check flow and pressure readings. -Contact ECB
SO_2 Calibration is outside acceptable limits	Verify Calibrator is providing a flow of at least 0.8 LPM
Poor Linearity	Verify Calibrator accuracy with an independent flow meter
Flow meter fluctuations	check Teflon lines for clogs and capillaries for blockages

10.0 Revision History

Significant Changes include:

- Put SOP into modern format.
- Added to the Notes in Leak Check section to keep a solenoid if changed out.
- Changed Calibration Requirements to state that a monitor has to be calibrated if not in operation for 3 days instead of 2.
- Stated 24 hour equilibrium requirement for new monitors in calibration section
- Made Multi-Point Calibration Verification its own section.
- Stated that all points including zero and span should be ran for a Multi-point calibration verification
- Added in Best Fit Line requirement for Multi-Point Calibration Verifications and Manual Performance Checks.
- Created Troubleshooting and References sections.
- Added Section 4.2.1: Residence Time Check
- Added Section 4.5: Computer Care
- Added 6.1 Logbook Submittal
- Added Glossary and Updated Terminology throughout SOP
- Added that Residence Time must be checked by Operator at least every 30 days
- Added Guidance for Useful Logbook Documentation as an Appendix
- Moved Common Continuous Monitoring Principles Applicable to the SO_2 System from section 3.0 to its own Appendix.
- Added additional information on how Zero and Span points will be reported
- Added that an operator can choose to perform a Multi-Point Calibration Verification in lieu of a Manual Performance Check
- Added section on Systems Test Procedure.
- Removed ability to use a cell phone's clock to check time. Older phones may not necessarily show correct time.
- Document Number changed to modern format

11.0 References

- Quality Assurance Handbook for Air Pollution Measurement Systems: "Volume II: Ambient Air Quality Monitoring Program" EPA-454/B-17-001, U.S. Environmental Protection Agency, January 2017.
- QA Handbook Appendix D Validation Templates, U.S. Environmental Protection Agency, March 2017.
- Code of Federal Regulations: "Title 40: Protection of the Environment", U.S. Government, June 5th 2019.
- Regional Office Polling and Data Review SOP 2.8.3
- Data Review & Validation QA Plan for Continuous Gaseous & Non-Speciated Particulate Monitors SOP 2.41.4

Appendix A: Glossary of Terms

Acceptance criteria – is the pollutant-specific criteria that must be met to collect valid data specified by the United States Environmental Protection Agency in their validation templates, included as Appendix D to the United States Environmental Protection Agency Quality Assurance Handbook.

Calibration – is the act of changing or setting values in a monitor.

- ***Gaseous Monitor Calibration*** – is the act of setting response values stored in a monitor while running a series of challenge concentrations. A calibration for a monitor is accomplished by pressing a button to change the values stored in the monitor for each challenge concentration. For carbon monoxide, a calibration involves running three upscale points to set or reset the coefficients. For all other gaseous monitors the challenge concentrations include zero and at least one span point.
- ***Particulate Matter Calibration*** - For low volume particulate matter monitors a calibration is the changing or resetting of the span and offset using three flow points bracketing the desired flow point. For PM monitors the temperature and pressure calibration is changing or resetting a slope using a one-point measurement. The temperature and pressure calibration must be completed before the flow calibration.

Calibration Criteria – are pollutant-specific limits established by the Division of Air Quality that a calibration must meet to pass and be used to collect valid data. The calibration criteria may be equal to or more stringent than the EPA acceptance criteria.

Control Limits – are limits established by the United States Environmental Protection Agency and published in the Code of Federal Regulations at 40 CFR Part 58 Appendix A. These limits may not be exceeded. They are listed as acceptance criteria in the Environmental Protection Agency validation tables in Appendix D to the United States Environmental Protection Agency Quality Assurance Handbook and North Carolina Division of Air Quality validation tables in the North Carolina Division of Air Quality quality assurance project plans. The precision, zero and span for gaseous monitors or flow rate verification for particulate matter monitors must be within the control limits for the collected data to be valid. Data collected when the precision, zero and span or flow rate verifications are outside of the control limits will be invalidated and replaced with a null code.

Electronics and Calibration Branch Performance Evaluation – is a check performed by the Electronics and Calibration Branch electronics technicians to confirm the correct operation of an instrument. At a minimum, it involves challenging the instrument with a zero and three upscale points. One of the upscale points must be at the detection limit of the instrument. Another upscale point is either at the level of the national ambient air quality standard or at the level of the highest measured values. The Electronics and Calibration Branch electronics technicians must perform an Electronics and Calibration Branch performance evaluation on each instrument at least once every 365 days and at least once every calendar year.

Flowrate Audit - is a measurement of flow, ambient pressure and ambient temperature to ensure correct operation of the monitor, performed by someone other than the operator using a certified flow standard different from that used to calibrate or verify the monitor.

Flowrate Verification – is a measurement of flow, ambient pressure and ambient temperature by the operator to ensure correct operation of the monitor.

Functionality Test – is a test of the monitor, calibrator, cylinder, or zero air supply conducted by an ECB electronics technician, either remotely or on site, to evaluate whether the system is performing as expected. It may include running a zero and span or multiple points. Since functionality tests involving the running of points do not necessarily run the points long enough for them to stabilize and are not necessarily recorded in an e-log, results of functionality tests are not reported to AQS. Functionality tests, alone, cannot be used as weight of evidence to demonstrate that the monitor is functioning properly.

Installation – is when a monitor is both taken to a site and plugged in. A leak check followed by a calibration is required on installation and before data reporting.

Manual Performance Checks – are any performance checks completed by the regional operator to evaluate the instrument and its performance. A manual performance check could be a precision, zero, span or just a zero and a span or just a one-point quality control check. It could be performed remotely or on-site. It includes manual 14-day one-point quality control checks performed at the site.

Moving – for a gaseous monitor, is removing the monitor from the monitoring shelter.

Multi-point Verification – is the check that the operator performs after completing a calibration on a gaseous monitor. It includes running a zero, span and two (for sulfur dioxide) or three intermediate, equally spaced concentrations to verify the linearity of the calibration and assess the overall success of the calibration. A multi-point verification may be used instead of a calibration for carbon monoxide and other pollutants, when allowed by an SOP, for the calibration required once every 365 days or when calibrators and cylinders are replaced.

National Performance Audit Program Performance Evaluation – is a performance check completed by United States Environmental Protection Agency contractors to confirm the correct operation of an instrument. It involves challenging the instrument with a zero and several upscale points.

One-Point Quality Control Check – is a check performed at least once every two weeks on each gaseous monitor. It must fall within the range of 0.5 to 5 parts per million for carbon monoxide and 5 to 80 ppb for all other gaseous pollutants. Any check that meets the requirements of a one-point quality control check must be reported to the Air Quality System.

Precision, zero, span or PZS – is the automated scheduled check that runs each night to measure drift in the zero, span and one-point-quality control check also known as the precision point.

- ***Failed PZS*** – is a check where all of the calibration equipment worked properly to provide the desired gas at the desired concentration but the instrument failed to read the concentration within the EPA-established control limits. [Note that the action or warning limits are stricter than the control limits.] For SO_2 and O_3, the data for a failed PZS are reported to AQS. The data are invalidated back to the last passing PZS. The operator is

required to take corrective action. Valid data cannot be reported until the problem is corrected or the instrument is recalibrated.

- ***Invalid PZS*** – is a check where one or more components of the calibration system (solenoid, zero air generator, gas cylinder, ozone generator, mass flow controllers, etc.) used to produce the challenge concentration failed for some reason. As a result, the system failed to provide the desired gas at the desired concentration. The operator is required to take action within two working days to identify and document the cause of an invalid PZS. The invalid PZS for ozone and sulfur dioxide is reported to the Air Quality System with a null code that describes the reason the PZS failed. Because the PZS is invalid, no data are invalidated as long as the calibration system is fixed and a passed PZS runs within 14 days. If the operator fails to act within the prescribed timeframe, the data may be flagged with a "6" for not following the standard operating procedure.
- ***Passed PZS*** – is a check where all of the calibration equipment worked properly to provide the desired gas at the desired concentration and the instrument successfully measured the concentration within the EPA-established control limits. For sulfur dioxide and ozone the data for a passed PZS are reported to AQS. The operator is only required to take corrective action if the check is outside of the EPA Region 4 recommended warning limits for two consecutive days.
- ***Valid PZS*** – is a check where all of the calibration equipment (solenoid, zero air generator, gas cylinder, ozone generator, mass flow controllers, etc.) used to produce the challenge concentration worked properly to provide the desired gas at the desired concentration. A valid PZS is necessary to have either a passed PZS or a failed PZS. A valid PZS refers only to the status of the equipment used to produce the challenge concentration and not the monitor that measures the challenge concentration.

Shut down – is when the monitor is no longer collecting reportable data.

Start up– is when the monitor is now collecting reportable data.

Systems Test – is a test of the monitor, calibrator, cylinder, zero air supply, or other support equipment conducted by an operator, either remotely or on site, to evaluate whether the system is performing as expected. It may include, but is not limited to, running a zero and span or multiple points. Since systems tests involving the running of points do not necessarily run the points long enough for them to stabilize, results of systems tests are not reported to AQS. Systems tests must be recorded in an elog and, alone, cannot be used as weight of evidence to demonstrate that the monitor is functioning properly.

Warning Limits – are limits recommended by the United States Environmental Protection Agency Region 4 and adopted by the North Carolina Division of Air Quality, which are stricter or tighter than the United States Environmental Protection Agency established control limits. The North Carolina Division of Air Quality has put them into place to minimize data loss. When the precision, zero and span for gaseous monitors or flow rate verification for particulate matter monitors are outside of the warning limits, the operator must take corrective action to identify the cause. If the cause is normal drift, the operator will recalibrate the instrument. If the cause is more serious, the instrument may be replaced or

repaired and then recalibrated. Action must be taken but the data remain valid as long as the precision, zero and span or flow rate verification remains within the control limits. Data may be flagged with a "6" for not following the standard operating procedure if the operator fails to act within the timeframe prescribed by the standard operating procedure.

Weight of evidence – is documentation and verifiable proof that the monitor or calibration system was either working properly or failed in some manner. To demonstrate the system was working properly, the weight of evidence should thoroughly document that whatever occurred at the time had no effect on the data or did not compromise the quality or validity of the data collected. To be acceptable for use as weight of evidence, any points ran must be run by the regional office staff, must be documented in an e-log, and must at a minimum include a precision point, zero point and span point. Whenever points are run to provide weight of evidence that the monitor is functioning properly, they must be reported to AQS.

Appendix B: Common Continuous Monitoring Principles Applicable to the SO_2 System

- Calibration: A calibration is required:
  1) at the initial start-up of a new site;
  2) when the monitor itself is replaced;
  3) when the results of two valid consecutive PZS results fail to meet warning limits;
  4) when the operation is interrupted for more than 3 days without power (such as in the case with hurricanes or shelter repairs); and
  5) If a Multi-Point Calibration Verification fails
  6) Every 365 days and once a calendar year
- A Multi-Point Calibration Verification is required once every 365 days and once a calendar year (even if running smoothly over that time span) per EPA guidance.

  See Section 5.5 of this SOP for details.

- Precision, Zero, Span Check: In lieu of the 14-day manually performed check, the results of the daily PZS results will be used. The NC DAQ PZS includes a zero point, a span point, and the precision point. The precision point for the PZS is called the one-point QC check (1-pt QC), to align terminology with that of the EPA. The PZS occurs in the early morning hours of each day. The daily PZS can also be used for the performance check prior to a cylinder/calibrator change. The daily PZS check on the day following such equipment changes can be used in lieu of a recalibration. The PZS may also be used as the final check when a site is closed and as a performance check after the operation is restored following a power outage lasting for 3 days or less. The operator can, at his/her discretion, perform a manual performance check, multi-point calibration verification, or calibration at any time he/she feels it is necessary to ensure the collection of quality data.

- The clock times of the components at the site are to be verified, and if necessary corrected, during each site visit.

- At each site visit, the site is to be inspected for general maintenance issues such as condition of the shelter and sample lines as well as the residence time.

- Operators are to visit the site at least once every 30 days.

- Residence Time should be checked at least every 30 days.

- No checks that affect data are to be made during periods when the potential for the exceedance of the SO_2 National Ambient Air Quality Standards (NAAQS) exists.

Appendix C: Schedule of Activities

Schedule of Required Activities

Activity	Daily	Every 30 Days	Section Reference
Review data and daily auto-calibration results	x		6.2
Site Visit		x	4.0
Analyzer/Computer date/time check		x	4.3
Verify shelter temperature	x		4.1
Manual Performance Check	(As needed)	(As needed)	5.7.1
Change filter		x	5.4
Perform leak check		x	5.3
Computer Restart		x	4.5
Check Residence Time		x	4.2.1
Calibration & Multi-Point Calibration Verification[A]	(As needed)	(As needed)	5.5

[A] Calibration and Multi-Point Calibration Verification are required at least once every 365 days and once per calendar year per EPA guidance.

Appendix D: SO_2 Exceedance Report

Sulfur Dioxide Monitoring System Exceedance Form

Ver. 2 May 2020

Region: _____ Site: _____

AQS #: #N/A Operator: _____

Maximum 1-Hour Exceedance Details

Date of Exceedance: _____ Hour: _____

Concentration (ppb): _____ Site Wind Direction (degrees): _____

Number of Additional Exceedances: _____ Nearest Airport Wind Direction (degrees): _____

Attach Copies of:

1. Most recent calibration prior to exceedance
2. Logbook from most recent filter and leak check
3. Prior and post exceedance nightly auto calibration checks
4. Raw data printout for the exceedance day
5. Documentation of discussion with facility

Notes: _____

Regional Supervisor Review:

Signature: _____

Date: _____

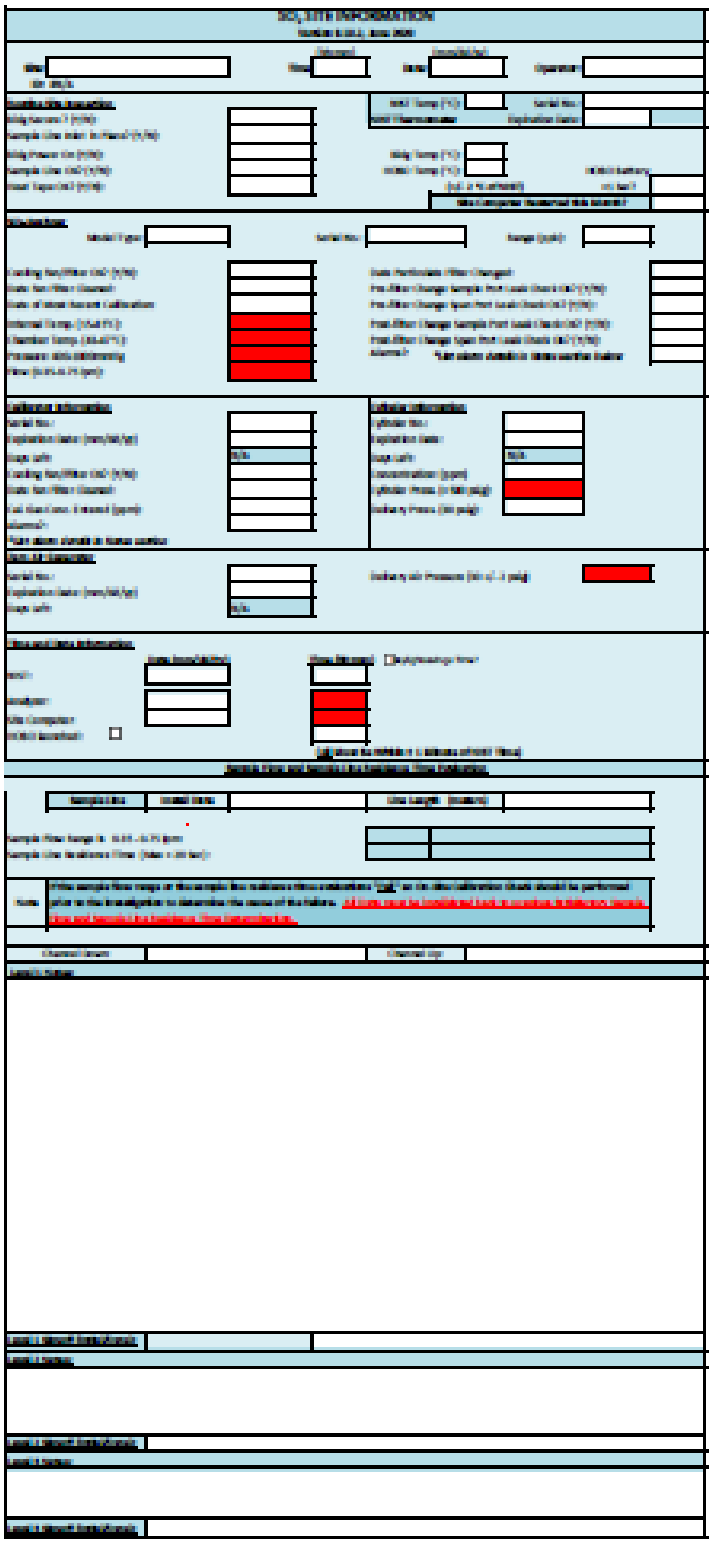
DAQ Central Office Review:

Signature: _____

Date: _____

Regional office should submit form and all documentation to the P: drive within 10 business days of exceedance.
Central office will validate form within 5 business days of receipt.

Appendix E: SO_2 E-log



Appendix F: Guidance for Useful Logbook Documentation

EPA has been providing guidance on record keeping requirements for quality assurance/quality control (QA/QC) programs. In particular, EPA has discussed the role that logbooks play in providing proof that quality assurance project plans (QAPPs) and SOPs are being followed. According to EPA, logbooks should, at a minimum, provide the following to be a useful tool for documenting the operations conducted at a monitoring site:

1. Purpose – Define the purpose of this site visit. Tell why you are there. Is it to replace a filter? Did you note something in the previous data download that is indicating a problem? Are you experiencing data drops and want to see if anything is wrong? In a couple of sentences, tell what you intend to do. Don't say routine maintenance, say instead: "noted fluctuations in flow while reviewing the 5-minute average data". Be specific.

2. Appearance – Tell how you found the site. If the site was secure, say so. If you noted a problem, or a changed condition, then document it in a couple of sentences: "construction has taken place in the vacant lot next to the site since my last visit".

3. Action – Tell what you did. In a few short sentences, describe the actions you took at the site: "cleaned the PM10 head and replaced one of the two gaskets". In particular, you might want to document any site computer updates that were run. Just things like that.

4. Results – Were you successful? Did you accomplish your goals? If so, then say so: "completed the monthly and quarterly maintenance and returned the monitor to "Wait" mode". If not, then say so: "failed as-left leak check, contacted ECB".

5. Response – Is the equipment operating within specifications set in SOP? If so, then great, note that fact in the logbook and you are done. If not, then what did you do? If something is wrong, then reach out for help and document it: "contacted Scott at ECB, he will be here presently with a new FRM."

6. Reviewers should add their comments: "reviewed above, approved operator action." Or: "upon review noted deviation from SOP".

DAQ-12-002.2 rev14 SO2 Operators_Final

Final Audit Report 2020-10-16

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