South Coast Air Quality Management District
Science and Technology Advancement

Monitoring and Analysis Division
Atmospheric Measurements Branch

STANDARD OPERATING PROCEDURE

FOR

Operation of Thermo 43*i* SO2 Analyzer

SOP00057
Version 1.0
April 6, 2010

PREPARATION, REVIEWS AND APPROVALS

Standard Operating Procedure for Thermo 43*i* SO2 Analyzer

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Standard Operating Procedure for Thermo 43*i* SO2 Analyzer

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1 General

1.1 Purpose

The purpose of this Standard Operating Procedure (SOP) is to provide a set of written instructions that document routine maintenance and operation procedures for measurement of the Thermo Electron Corporation Model 43*i* SO2 Analyzer

1 The AQIS Operator is ultimately responsible for the Air Monitoring Site data quality. If a critical failure is being reported or the analyzer is over the "Validation Tolerance" the **AQIS Operator shall "Disable" the onsite Datalogger immediately**. Consultation with the Senior AQIS can be made after the fact.

1.2 Safety

Air Monitoring Stations have a great many reasons for safety concerns. Please see "Station Safety Manual", SOP's for Specific Instrumentation and Manufacture's Instrument Manuals and Recommendations.

1.3 References

- Thermo 43i SO2 Manual
- "SOP for General Air Monitoring Station Operations"

1.4 General Description

The Thermo Electron Corporation Model 43*i* is designated by the United States Environmental Protection Agency (USEPA) as an Equivalent Method for SO2

The Model 43*i* meets EPA designation requirements when operated as follows:

Range	50 to 1000 ppb
Averaging Time	10 to 300 seconds
Temperature Range	20 to 30 °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

.

1.5 Principal of Operation

The Model 43*i* operates on the principle that SO2 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. Specifically,

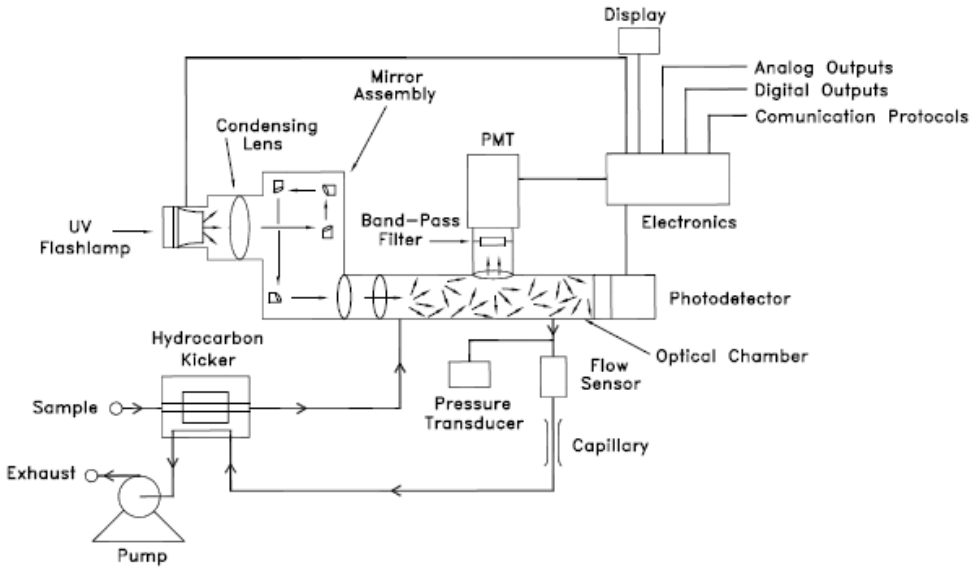
$$SO_2 + h\upsilon_1 \rightarrow SO_2^* \rightarrow SO_2 + h\upsilon_2$$

The sample is drawn into the Model 43*i* through the *sample* bulkhead, as shown in the Model 43*i* Flow Schematic. The sample flows through a hydrocarbon "kicker", which removes hydrocarbons from the sample by forcing the hydrocarbon molecules to permeate through the tube wall. The SO2 molecules pass through the hydrocarbon "kicker" unaffected.

The sample flows into the fluorescence chamber, where pulsating UV light excites the SO2 molecules. The condensing lens focuses the pulsating UV light into the mirror assembly. The mirror assembly contains four selective mirrors that reflect only the wavelengths which excite SO2 molecules.

As the excited SO2 molecules decay to lower energy states, they emit UV light that is proportional to the SO2 concentration. The bandpass filter allows only the wavelengths emitted by the excited SO2 molecules to reach the photomultiplier tube (PMT). The PMT detects the UV light emission from the decaying SO2 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 lamp intensity.

As the sample leaves the optical chamber, it passes through a flow sensor, a capillary, and the "shell" side of the hydrocarbon kicker. The Model 43*i* outputs the SO2 concentration to the front panel display, the analog outputs, and also makes the data available over the serial or Ethernet connection.



Model 43*i* Flow Schematic

2 Siting and Installation:

2.1 Initial Setup and Installation: Station Operations

- Verify Correct Instrument Installation
- Verify Receipt of Current Instrument Manual
- Verify Receipt of all Instrument Log Books
- Verify Receipt of Instrument Specific Maintenance Sheet

2.2 Physical Instrument Inspection: Station Operations

Verify the Following

- Sufficient space in front of and behind the instrument for service and maintenance routines
- Electrical Connections:
  Verify Clean and professional installation, check for loose wires and connections and proper clearance for instrument inspection and maintenance (Figure 2)
  (Thermo 43*i* SO2 Instruction Manual pg 3-9 & 3-10)
- Pneumatic Connections:
  Verify correct tubing and connection installation, check for clearance and damaged tubing, verify correct inlet/outlet (exhaust) connections (Figure 2)
  (Thermo 43*i* SO2 Instruction Manual pg 2-5)
- Initial Startup:
  Verify Intial startup procedure corresponds with factory firmware and calibration
  (Thermo 43*i* SO2 Instruction Manual pg 3-6 & 3-78)
- Initial Calibration:
  Verify multi-point calibration; verify documentation of calibration in Station Logbook, Instrument Logbook & Monthly Maintenance Sheet
  (Thermo 43*i* SO2 Instruction Manual pg 4-1)

3 Routine Servicing

3.1 General Information

Perform the following checks at the intervals specified in the service schedule. The checks may be preformed more frequently but should be preformed at least at the prescribed intervals. Be sure to document all results of maintenance and downtime on the monthly maintenance sheet and downtime log. The Downtime Log, Monthly Maintenance sheet and Maintenance Summary Table are included as attachments.

3.2 Data Validation

SO_2 Validation Template

Requirement	Frequency	Acceptance Criteria	Information /Action
CRITICAL CRITERIA- SO_2			
One Point QC Check Single analyzer	1/ 2 weeks	≤ ±10% (percent difference)	0.01 - 0.10 ppm Relative to routine concentrations 40 CFR Part 58 App A Sec 3.2
Zero/span check	1/ 2 weeks	Zero drift ≤ ± 3% of full scale Span drift ≤ ± 10 %	

☞ One Point QC Check – *Daily - Required every 2 Weeks*

±10 % = Out of Tolerance – Disable – Report

±07 % = Out of Tolerance Warning – Report

AQIS Operator shall record the current Span readings from the Chessell Video Recorder on the PC/SPAN maintenance sheet. Verify that the readings are within the Acceptance Criteria Range.

Data Validation can be an issue if the Data is outside this range. Perform a visual inspection of all instruments to ensure that they are not damaged and are functioning correctly.

Review the Chessell Video Recorder data for the preceding week to ensure that data appears to follow normal patters and check appropriate box to indicate whether traces are normal on maintenance sheets.

3.3 AM Work Orders

The AQIS Operator shall in the course of duties utilize as explained in the "SOP for General Air Monitoring Station Operations" the "AM Work Order" Procedure.

If a critical failure is being reported or the analyzer is over the "Validation Tolerance" the **AQIS Operator shall "Disable" the on-site Datalogger immediately**. Consultation with the Senior AQIS can be made after the fact.

3.4 Daily Tasks: Station Operations Thermo 43i SO2 Instruments*

- Check SO2 Instrument Status on Chessell
- Check that "Sample" mode is On
- Check for Alarms (Record in Station Logbook, Instrument Logbook & Monthly Maintenance Sheet if any & Notify Senior if unable to resolve; Fill out Downtime log if necessary
- Record any problems or changes in Station Logbook, Instrument Logbook & Monthly Maintenance Sheet

*on the day that the operator services the station

3.5 Weekly Tasks: Station Operations Thermo 43i SO2 Instruments

- *All Checks to be run with Zero Air through gas calibrator for a minimum of 15 minutes: Record downtime in downtime log.*
  - Record & Check Time: Align with ESC (± 5 min)
  - Replace Inline Filter
    - Complete maintenance check sheet (Values Obtained from Main Menu > Diagnostics > …..) (Figure 3 & Table 1)
      1. Check & Record PMT Supply (-700 – -1100 Volts)
      2. Check for Variances in Voltages (Interface, I/O & Motherboard)
         & Record Any In Comments
      3. Check & Record Internal Temperature (8– 47°C)
      4. Check & Record Chamber Temperature (43 – 47°C)
      5. Check & Record Pressure (400 – 1000 mmHg)
      6. Check & Record Sample Flow (0 – 1.0 Lpm)
      7. Check & Record Lamp Intensity (20 – 100%)
    - Alarm Check
    - Check Calibration Factors – SO2 BKGN & SO2 COEF (Obtained from Main Menu > Calibration factors) with those recorded in the Instrument Logbook & record on monthly maintenance sheet

3.6 Monthly Task: Station Operations Thermo 43i SO2 Instruments

- **Perform Analog Output Test for Zero & Full Scale**
  (Thermo 49*i* Instruction Manual pg 3-87 & 3-88)
- **Zero Span Check for SO2**

Parameters	Response
> or < than +/- 10 PPB	Invalid Data Call in work order
-10 to -5 PPB or 5 to 10 PPB	Perform Manual Zero Adjustment
-5 to 0 PPB or 0 to 5 PPB	No Adjustment Needed

(See Detailed Maintenance Procedure & Adjustment Zero Span for procedure on Manual Zero adjustment)

3.7 Semi Annual Tasks: Thermo 43i SO2 Instruments

3.7.1 Station Operations:

- Clean Manifold, Probe Inlet & Instrument tubing/lines
  - Clean Fan & Fan Filter (See Detailed Maintenance Procedure Cleaning or Replacing Fan Filter: Figure 1)
- Verify Following Task Completion and Documentation of the following

3.7.2 Support Group:

- Multi-Point Calibration: (Thermo 43*i* SO2 Instruction Manual pg 4-1)
- Analog Output Calibration: (Thermo 43*i* SO2 Instruction Manual pg 3-115)

*3.8 Annual Tasks: Thermo 43*i *SO2 Instruments*

3.8.1 Station Operations:

- Verify the Following Task Completion and Documentation of the following

3.8.2 Support Group:

- Lamp Voltage Check (Thermo 43*i* SO2 Instruction Manual pg 5-5)
- Complete Leak Test & Pump Diagnostic (Rebuilding) (Thermo 43*i* SO2 Instruction Manual pg 5-6)
- Flow Calibration (Thermo 43*i* SO2 Instruction Manual pg 3-111)
- Pressure Calibration
  (Thermo 43*i* SO2 Instruction Manual pg 3-1081)
- Temperature Calibration
  (Thermo 43*i* SO2 Instruction Manual pg 3-114)

4 Documentation:

4.1 Station & Instrument Logbooks

The AQIS Operator shall maintain as explained in the “SOP for General Air Monitoring Station Operations” the Station and Instrument Logbooks.

4.2 Monthly Downtime Log

Complete the Monthly Downtime Log as per instructions in the “SOP for General Air Monitoring Station Operations” Section.4.5 and submit as described.

4.3 Maintenance Sheets

Complete and submit the Thermo 43i SO2 Monthly Maintenance sheet to the Senior AQIS for review. Once reviewed, the Senior AQIS submits the maintenance sheet to Data Validation for review

5 Trouble Shooting:

5.1 General

Before starting any troubleshooting procedure, refer to Thermo 43*i* SO2 Instruction Manual pg 5-1 & 6-1 for more specific information.

Check for Leaks at all obvious connections
Check all electrical connections, specifically those at the ESC & Chessel connection, check for proper grounding

5.2 Detailed Maintenance Procedures

5.2.1 Zero/Span Check: General

The zero and span check procedure is preformed at the air monitoring site. When completing this procedure the operator will comply with instruction from the manufacturer's operation manual. (Thermo 43*i* SO2 Instruction Manual page 3-24 & 4-5)

To complete the procedure the operator may examine the nightly span/precision values to verify zero values or the operator use the gas dilution system to zero/span the criteria pollutant analyzers. During the procedure verify the analyzer is in normal operation mode.

The following is a *general description* of the instrument zeroing procedure. Instrument specific procedures are included in the attached appendix.

- Initiate the flow of zero air through the analyzer until it stabilizes; approximately 15 minutes
- Compare the values from the Chessell or ESC data logger to the table and determine if adjustments are required
- If adjustments are required note the old calibration factors both in the logbook and on the maintenance sheet.
- While running zero air, place the instrument in the calibration mode and run for at least 15 additional minutes.
- Press the "zero mode" function
- Press the "enter button"
- The instrument should now have a new "zero" or "intercept "value"
- Record these new values both in the log book and on the maintenance sheet.

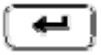
Please be sure to note any additional information regarding erratic instrument behavior.

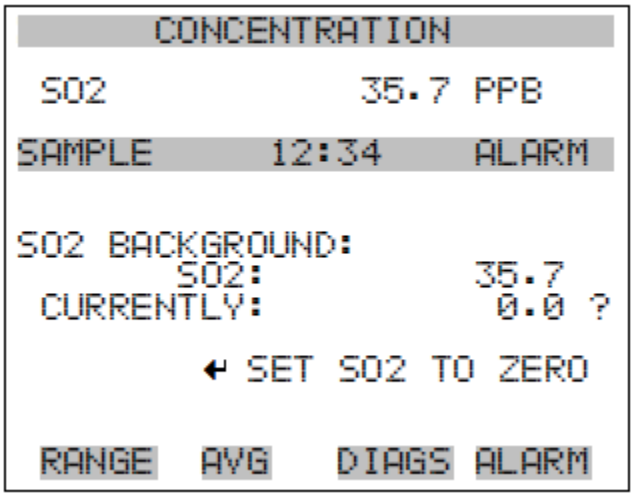
5.2.2 Zero Span Calibration

(Thermo 43*i* SO2 Instruction Manual page 3-24 & 4-5)

The Calibrate SO2 Background screen is used to adjust the SO2 background, or perform a “zero calibration”. Before performing a zero calibration, ensure the analyzer samples zero air for at least 15 minutes.

It is important to note the averaging time when calibrating. The longer the averaging time, the more precise the calibration will be. For the most precise calibration, use the 300-second averaging time. For more information about calibration, see Chapter 4, “Calibration”.

- In the Main Menu, choose Calibration > Calibrate Zero.
- Press  to set the new reading to zero.



Zero Calibration Screen

5.2.3 Cleaning or Replacing Fan Filter:

- Remove Fan Guard
- Wash Filter & Allow to Air Dry Before Reinstallation
- Replace Filter if Damaged

Figure 1 Fan Assembly

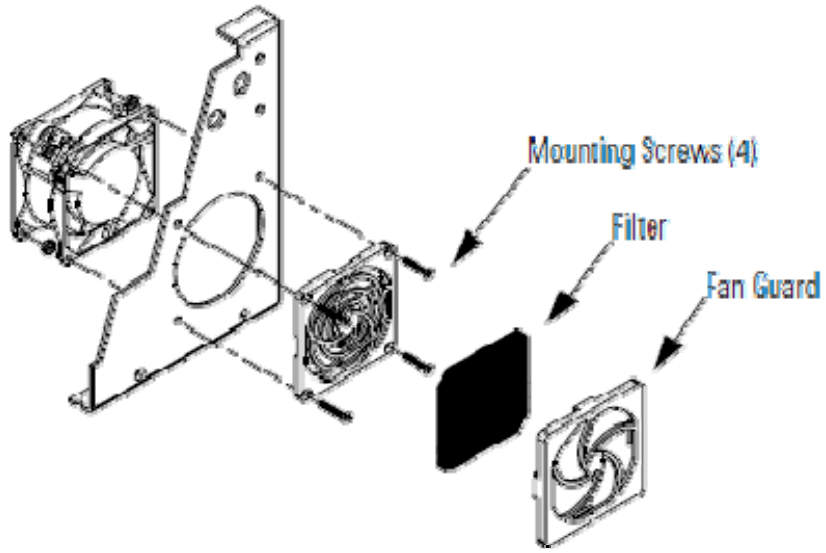


Figure 2 Back Panel

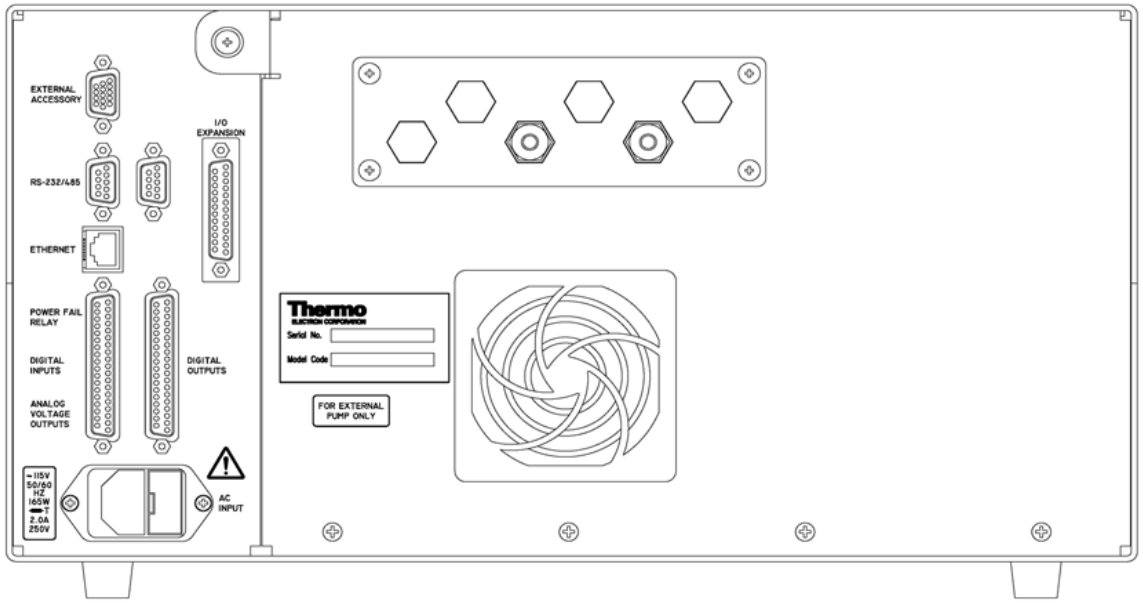


Figure 3 Soft Keys Panel

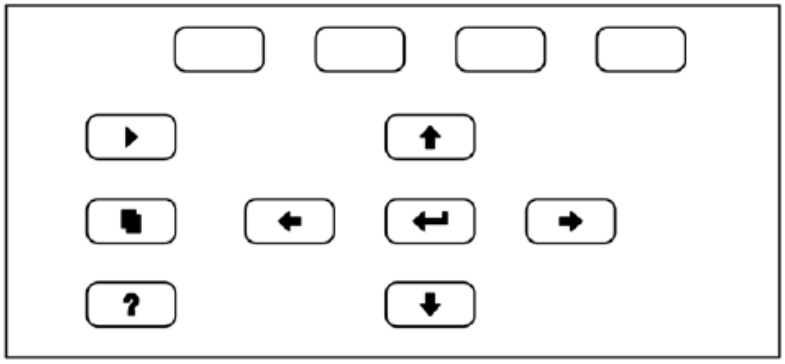


Table 1: Soft Key Functions

[ ] = Soft Keys	The [ ] soft keys are used to provide shortcuts that allow the user to jump to user-selectable menu screens. For more information on processing soft keys, see "Soft Keys" below.
[▸] = Run	The [▸] is used to display the Run screen. The Run screen normally displays the SO_2 concentration.
[▪] = Menu	The [▪] is used to display the Main Menu when in the Run screen, or back up one level in the menu system. For more information about the Main Menu, see "Main Menu" later in this chapter.
[?] = Help	The [?] is context-sensitive, that is, it provides additional information about the screen that is being displayed. Press [?] for a brief explanation about the current screen or menu. Help messages are displayed using lower case letters to easily distinguish them from the operating screens. To exit a help screen, press [▪] or [?] to return to the previous screen, or [▸] to return to the Run screen.
[↑] [↓] = Up, Down [←] [→] = Left, Right	The four arrow pushbuttons ([↑], [↓], [←], and [→]) move the cursor up, down, left, and right or change values and states in specific screens.
[↵] = Enter	The [↵] is used to select a menu item, accept/set/save a change, and/or toggle on/off functions.

Table 2 Maintenance Interval

Maintenance Summary Table

Interval	Maintenance	Responsibility
Daily	Review all data collected from the previous day for all sites by viewing data remotely or Chessell strip-chart. Data should be compared to the previous day for consistency. Perform a visual inspection of all instruments to ensure that they are not damaged and are functioning correctly.	Station Operator
Weekly	Complete all weekly maintenance sheet tasks. Record the current readings from the Chessell strip-chart recorder and data logger in the appropriate columns on the PC/SPAN maintenance sheet. Perform a visual inspection of all instruments to ensure that they are not damaged and are functioning correctly. Review the Chessell strip-chart data for the preceding week to ensure that data appears to follow normal patters and check appropriate box to indicate whether traces are normal on maintenance sheets. Notify Senior if otherwise.	Station Operator
Monthly	Perform Analog Output Test for Zero & Full Scale, Zero Span Check	Station Operator
Semi-Annually	Clean Manifold, Probe Inlet, & Instrument tubing/lines, Clean Fan & Fan Filter	Station Operator
	Multi-Point Calibration, Analog Output Calibration	Repair/Calibration Technician
Annually	Lamp Voltage Check, Complete Leak Test & Pump Diagnostic, Flow Calibration, Pressure Calibration, Temperature Calibration	Repair/Calibration Technician

Appendix A: Thermo 43i SO2 Maintenance Sheet

South Coast Air Quality Management District
Monthly Maintenance Report
Thermo 43i SO2 Analyzer

See SOP for Maintenance Sheet Instructions

Location:	Month & Year:
Station #	Technician:
Instrument Serial #	AQMD Property #

DATE:					
TIME:					
Change Filter					
PMT Supply (-700 - -1100 V)					
Internal Temp (8 - 47°C					
Chamber Temp (43 - 47°C)					
Pressure (400-1000mmHg)					
Sample Flow (0-1.0 Lpm)					
Lamp Intensity (20-100%)					
Alarm					
SO2 BKG (Zero)					
SO2 COEFF (Span)					

Monthly: Perform Analog Output Test (± 1% Full Scale)

DATE:	TELEMETRY		CHESSEL	
	ZERO	SPAN	ZERO	SPAN

Comments:

Calibration Date: _____ Reviewed BY _____

Thermo 43I SO2 maint sheet.xls

South Coast Air Quality Management District
Science and Technology Advancement

Monitoring and Analysis Division
Atmospheric Measurements Branch

STANDARD OPERATING PROCEDURE

FOR

Calibration of Thermo 43i SO_2 Analyzer

SOP00111
Version 1.0
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PREPARATION, REVIEWS AND APPROVALS

Calibration of Thermo 43i SO_2 Analyzer

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Quality Assurance Manager

REVISION HISTORY

Calibration of Thermo 43i SO_2 Analyzer

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1.0 GENERAL INFORMATION

1.1 Purpose

The purpose of this Standard Operating Procedure (SOP) is to provide for the proper calibration of the Thermo Model 43i and Trace Level Enhanced SO_2 Analyzer through dynamic calibration. This is necessary to establish accurate data reporting and traceability with National Institute of Standards and Technology (NIST) protocols. The required frequency of calibration is once every six months. A calibration will also be needed after most instrument servicing or after relocation. Typically this procedure is performed by an Air Quality Instrument Specialist II.

1.2 General Description and Principle of Operation

This SOP covers the calibration procedures for the Thermo Scientific, Pulsed Fluorescence SO_2 Analyzer Model 43i (Thermo 43i). This document is intended to supplement the manufacturers operating manual and should not be used as a substitute. Read the procedures outlined in this document and examine the user's manual before attempting to calibrate a Thermo 43i unit. Calibration of the Thermo 43i is required every six months.

The Thermo 43i Trace Level-Enhanced analyzer operates on the principle that 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. Specifically,

$$SO_2 + h\upsilon_1 \rightarrow SO_2^* \rightarrow SO_2 + h\upsilon_2$$

The sample is drawn into the Thermo 43i through the sample bulkhead, as shown in Figure 1. The sample first flows through a hydrocarbon "kicker," which removes hydrocarbons from the sample; the SO_2 molecules pass through the hydrocarbon "kicker" unaffected.

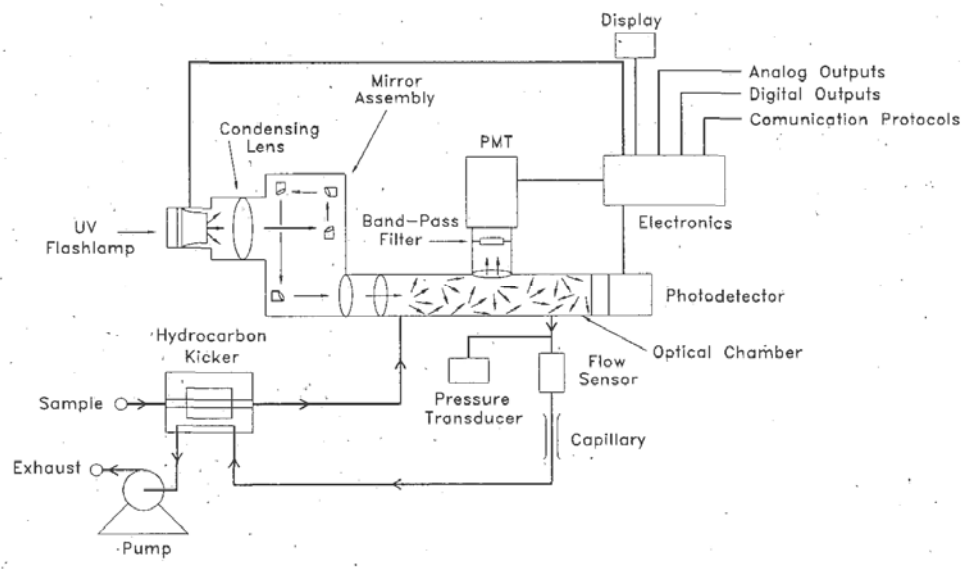


Figure 1.
Model 43i Flow Schematic

Figure 2.
Thermo Model 43i SO_2 Trace Level Analyzer

The 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 containing 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 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 fluctuation in the UV light. The Thermo 43i outputs the SO_2 concentration to the front panel display and the analog outputs, and also makes the data available over the serial or Ethernet connection.

1.3 Safety

The instruction manual for the Thermo 43i identifies several safety precautions related to potential equipment damage, including the following:

- Some internal components can be damaged by small amounts of static electricity. A properly ground antistatic wrist strap must be worn while handling any internal component. Follow procedures in the manufacturer's instruction manual for capillary inspection and replacement, fan filter inspection and cleaning, and pump rebuilding.
- The mirrors in the optical bench should **NOT** be cleaned. Cleaning can damage the mirrors.
- Do not clean the outside instrument case with solvents or other cleaning products. Use only a damp cloth and take care not to damage the labels on the case.
- Always use appropriate care when using/transporting compressed gas cylinders.

2.0 APPARATUS AND EQUIPMENT

Equipment needed for calibrating the Thermo 43i includes the following:

- Gas Calibration Dilution System (GCDS) – certified within past 6 months with an NIST traceable standard
- Certified Cylinder of EPA Protocol SO2
- Teflon Tubing, Two six foot lengths.
- Pure Air Generator
- ESC Data Logger that displays current SO2 concentration
- Instrument Calibration Card (Figure 3)
- SO_2 Calibration Spreadsheet (Figure 5)
- Laptop Computer

3.0 CALIBRATION PROCESS

3.1 Preparation

There are a number of conditions which should be met prior to a calibration or a zero/span check for the Thermo 43i.

1. The instrument should have at least 30 minutes to warm up and stabilize (preferably overnight).
2. All operational adjustments to the instrument should be completed prior to calibration.
3. All parts of the gas flow system, such as sample lines, and particulate filters, which are used in normal monitoring should also be used during calibration.
4. It is recommended that the recording devices and outputs used during normal monitoring be calibrated prior to the instrument calibration and that they be used during the calibration or the zero/span check.

3.2 Equipment Equilibration

Turn on the GCDS and allow it and the gas cylinder to equilibrate at the calibration location for at least 2-3 hours, ideally overnight, before beginning calibration.

3.3 Instrument Check

Before starting a calibration, check the Thermo 43i for the following:

1. Time/clock should agree with the time on the ESC data logger. If it is off, adjust the time on the Thermo 43i analyzer.
2. Instrument sampling Range should be 500 ppb.
3. Thermo 43i Sample Flow should be approximately 0.5 LPM.
4. Inline sample inlet filter housing should be tight and leak-free. Housing should be tightened using the two green “plastic” wrenches provided with the instrument. housing should not be tightened by hand alone.

5. Make sure that the Teflon in-line filter is reasonably clean. If it has been 3 days or more since it was last changed, change it to prevent absorption of SO_2 by trapped materials on the filter.
6. Check the SO_2 trace of the Thermo 43i on the Chessell Video Data Logger for stable operation over the past two weeks. Investigate any problem of instability before starting a calibration.
7. Evaluate the maintenance sheet for the Thermo 43i for consistency in diagnostics readings over the past 2-3 weeks. Investigate any irregularity.

3.4 Calibration Set-up

1. Connect the thin wall Teflon tubing from the T-connection at the back of the Pure Air Generator to the Diluent connection at the back of the GCDS. Open the valve at the T-connection. Be sure that air continues to be provided to Port 1 of the Air Monitoring Station (AMS) gas calibrator. A typical calibration setup is pictured in Figure 3

2. Remove the connection from the output at the back of the AMS gas calibrator and connect it to the output at the back of the GCDS. This connection goes to the ambient air sample inlet at the top of the AMS. If the hose is not long enough, use thick wall Teflon tubing to make the connection.

3. Ensure there is a good, leak-free connection between the Certified Calibration Gas cylinder and one of the ports at the back of the GCDS.

4. Open both the valves on the pressure regulator on the calibration gas cylinder and set the regulator at 25-30 psi. Be sure to properly flush the regulator thoroughly to avoid contaminating the cylinder.

5. Lower the flow rate on the rotameter for the AMS air sample manifold residence pump from 3 LPM to 1 LPM.

6. Set up the ESC data logger and the Chessell video data logger to display the SO_2 channel to monitor the Thermo 43i reaction to the various SO_2 concentrations.

7. Annotate Chessel to reflect calibration work.

8. Set up the AMS gas calibration system for low flow. This puts the station into calibration mode and essentially puts the station data stream off line. This is preferable to using the “00” command on the data logger as this takes the entire station off line including particulate and MET.

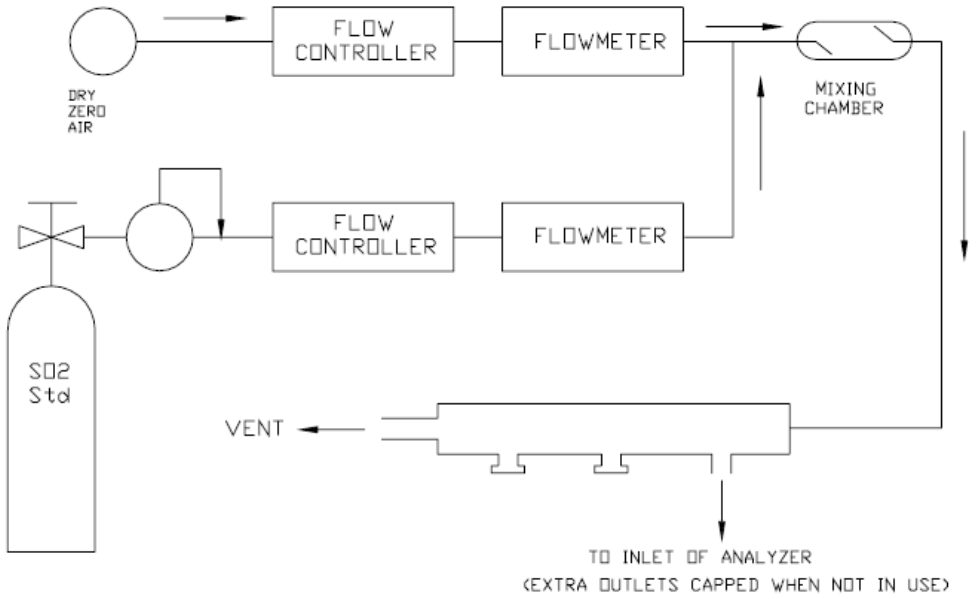


Figure 3.
Cylinder Gas Calibration Set-up

3.5 SO_2 "As-Is" Multi-Point Calibration Check

1. Setup the GCDS to dilute SO_2 using certified SO_2 concentration value in the Superblend gas cylinder. That value can be found on the tag attached to the cylinder.

2. Generate 0 ppm of SO_2 (zero air) and let it run for 15 minutes to allow for all instruments to stabilize and produce a reliable reading on the ESC data logger. Record that reading on the SCAQMD calibration form (attached) in the appropriate location.

3. Using the GCDS generate SO2 dilutions in five evenly spaced points similar to the following: 0.450 ppm, 0.350 ppm, 0.250 ppm, 0.150 ppm and 0.050 ppm. At each concentration point, allow 15 minutes for stabilization, then record the ESC reading on the calibration form.

4. After entering the last reading, the calibration form will generate a slope, intercept, correlation, deviation and change from last calibration. Ideally, values should be close to the following: slope should be 1, intercept 0, correlation 1 and deviation and change from last cal should be 0%.

5. The maximum allowable deviation is 2% with a correlation no less than 0.99990.

6. In the event the deviation exceeds 10% there may be grounds for data invalidation. In this case enter findings in the station downtime log and notify Data Validation Group.

7. If the 2% threshold is met, the instrument calibration is considered acceptable and

final and will not have to be calibrated for another 6 months unless the instrument is moved, repaired or exceeds 7% on the nightly Span/PC checks.

8. If the 2% threshold is exceeded, a calibration adjustment will need to be done.

3.6 SO_2 Calibration/Adjustment

1. Generate 0 ppm of SO_2 (zero air) and let it run for 15 minutes to allow for all instruments to stabilize and produce a reliable reading on the ESC data logger.

2. Once the reading is stable, press the  pushbutton to access the Main Menu on the Thermo 43i.

3. Scroll down the menu using the down arrow pushbutton  until the cursor is at "Calibration". Press the <Enter> pushbutton.

4. Scroll down the menu using the <Down> arrow pushbutton  until the cursor is at "Cal SO_2 Background". Press the <Enter> pushbutton.

   The next screen appears:

   SO2 BACKGROUND:
   SO2: 12.5
   CURRENTLY: 0.0 ?
   SET SO2 TO ZERO
   RANGE AVG DIAGS ALARM

5. Press the <Enter> pushbutton to set the Zero/Background for the unit.

6. The display flashes the message "Saving", and the SO_2 reading on the ESC should be close to .0000.

7. Return to the Main Menu by pressing the  pushbutton.

8. Generate 0.400 ppm of SO_2 and let it run for 15 minutes to allow for all instruments to stabilize and produce a reliable reading on the ESC data logger.

9. Once the reading is stable, press the  pushbutton to access the Main Menu on the Thermo 43i.

10. Scroll down the menu using the <Down> arrow pushbutton until the cursor is at "Calibration".

11. Press the <Enter> pushbutton.

12. Scroll down the menu using the <Down> arrow pushbutton until the cursor is at
13. "Cal SO_2 Coefficient". Press the <Enter> pushbutton.

    The next screen appears :

    CALIBRATE SO2:
    SO2: 412
    SPAN CONC: 400
    □□ MOVE CURSOR
    □□ CHANGE VALUE SAVE
    RANGE AVG DIAGS ALARM

14. Use the <Left> and <Right> pushbuttons to move the cursor to the SO2 CONC option.

15. Use the <Up> and <Down> pushbuttons to change the SO2 CONC value to 400 if it is not already set to that value.

16. Press the <Enter> pushbutton to set the Span/Coefficient for the unit.

17. The display flashes the message "Saving", and the SO_2 reading on the ESC should be close to .4000.

18. Return to the Main Menu by pressing the pushbutton.

3.7 SO_2 Final Multi-Point Calibration Check

1. Repeat the steps for an "As-Is" Multi-Point Calibration (Section 3.5) as performed prior to the Calibration/Adjustment. The results should be much closer to ideal values as specified in that section.

2. Record all new values on the approved calibration spreadsheet (Figure 4). Additionally all "as is" and "final" results should be recorded in the station instrument logbook along with the Calibration Dilution System model number, SCAQMD property number and last calibration date.

3. Fill out a calibration card (Figure 5) for the Thermo 43i and place it on or near the instrument rack.

4. All calibration data should be archived in the following location on the "E-drive" E:\ASTD\AMCALIB\Station Calibration Files

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

TECO 43i SO2 CALIBRATION REPORT

As-Is _____
Final _____ Date _____

Station No. _____ Location _____ Code _____ Control # _____

Range _____ Span Val. _____ Zero Val. _____ Samp. Flow _____ LPM

Env Cont # _____ Cert Date _____ By _____ Total Flow _____ LPM

Gas Cyl # _____ Cert Date _____ By _____ SO2 Conc _____ ppm

Previous Calibration _____ Previous % Deviation _____

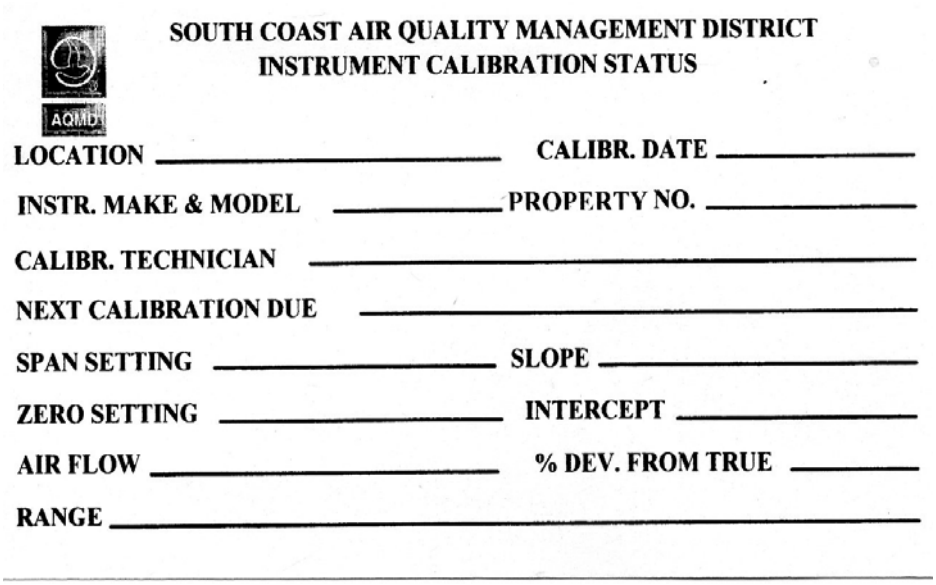
Run No.	True Concentration	Instrument Net Reading
Zero		
1		
2		
3		
4		
5		

SLOPE
INTERCEPT
CORRELATION
DEVIATION %
% CHANGE _____

By _____

Remarks: _____

Figure 4.
SO_2 Calibration Spreadsheet



SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
INSTRUMENT CALIBRATION STATUS

AQMD

LOCATION _____ **CALIBR. DATE** _____

INSTR. MAKE & MODEL _____ **PROPERTY NO.** _____

CALIBR. TECHNICIAN _____

NEXT CALIBRATION DUE _____

SPAN SETTING _____ **SLOPE** _____

ZERO SETTING _____ **INTERCEPT** _____

AIR FLOW _____ **% DEV. FROM TRUE** _____

RANGE _____

Figure 5.
Instrument Calibration Card

Notes:

If the "final" calibration check still fails to produce a good result, instrument troubleshooting should be pursued.

All "as is" and "final" results should be recorded in the station instrument logbook along with the Calibration Dilution System model number, AQMD property number and last calibration date.

3.8 Breakdown of Calibration setup

After the Final Calibration is completed, generate 0 ppm/zero air for at least 5 minutes to purge the system of any residual calibration gas.

Return the AMS setup back to the normal configuration.

Do an outgoing check including:

- Air sample inlet tubing connected to the Output at the back of the AMS gas calibrator,
- Valve at the back of the Aadco Pure Air Generator is closed (righty-tighty),
- Flow on the Residence pump rotameter is back to 3.0 LPM,
- AMS gas calibrator is back to its normal display with the timer set for the next Span/PC event.

4.0 Quality Control

As mentioned in section 3.2, all "as is" result data that exceeds the 10% threshold limit should be reported to Data Validation for possible invalidation. In addition the calibration technician should make a detailed entry in the station downtime log.

- All "as is" and "final" calibration results should be entered into the instrument logbook.
- An Ozone calibration card should be filled out and posted near the station instrument.
- A copy of the Ozone Calibration Spreadsheet (Figure 4) should be filed in the following directory:

E:\ASTD\AM CALIB\Station Calibration Files

5.0 REFERENCES

1. Thermo 43i Analyzer Operator's Manual

2. EPA QA Handbook for Air Pollution Measurement Systems