

South Coast Air Quality Management District
Science and Technology Advancement

Monitoring and Analysis Division
Atmospheric Measurements Branch



STANDARD OPERATING PROCEDURE

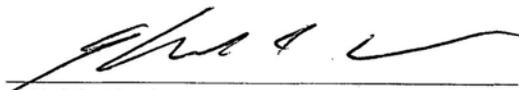
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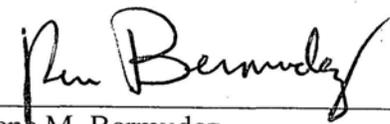
Operations of Thermo
49i Ozone Analyzer

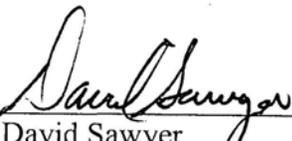
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PREPARATION, REVIEWS AND APPROVALS
Standard Operating Procedure for Thermo 49i Ozone Analyzer

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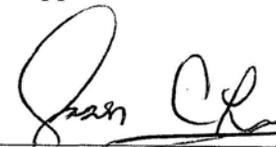
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Standard Operating Procedure for Thermo 49i Ozone Analyzer

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Standard Operating Procedure for Thermo 49i Ozone Analyzer

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N/A	- N/A

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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 49i Ozone Analyzer

- ☞ 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 49i Ozone Instruction Manual
- "SOP for General Air Monitoring Station Operations"

1.4. General Description

The Thermo Electron Corporation Model 49i is a UV photometric ozone analyzer and is designated by the United States Environmental Protection Agency (USEPA) as an Equivalent Method for the measurement of ambient concentrations of ozone.

1.5. Principal of Operation

The Model 49i operates on the principle that ozone (O₃) molecules absorb UV light at a wavelength of 254 nm. The degree to which the UV light is absorbed is directly related to the ozone concentration as described by the Beer-Lambert Law:

$$\frac{I}{I_0} = e^{-KLC}$$

Where:

K = molecular absorption coefficient, 308 cm⁻¹ (at 0°C and 1atm)

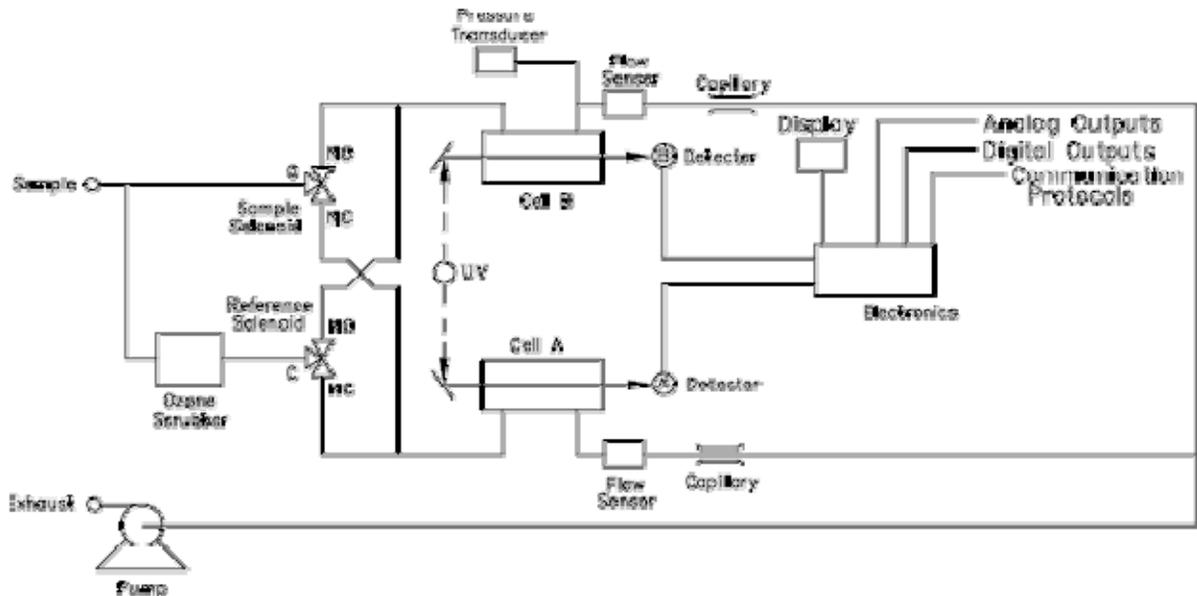
L = length of cell, 38 cm

I = UV light intensity of sample with ozone (sample gas)

I_o = UV light intensity of sample without ozone (reference gas)

The sample is drawn into the Model 49i through the *sample* bulkhead and is split into two gas streams, as shown in Figure 1-1. One gas stream flows through an ozone scrubber to become the reference gas (I_o). The reference gas then flows to the reference solenoid valve. The sample gas (I) flows directly to the sample solenoid valve. The solenoid valves alternate the reference and sample gas streams between cells A and B every 10 seconds. When cell A contains reference gas, cell B contains sample gas and vice versa.

The UV light intensities of each cell are measured by detectors A and B. When the solenoid valves switch the reference and sample gas streams to opposite cells, the light intensities are ignored for several seconds to allow the cells to be flushed. The Model 49i calculates the ozone concentration for each cell and outputs the average concentration to the front panel display, the analog outputs, and also makes the data available over the serial or Ethernet connection.



Model 49i 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 49i Ozone Instruction Manual pg 2-3)
- Pneumatic Connections:
Verify correct tubing and connection installation, check for clearance and damaged tubing, verify correct inlet/outlet (exhaust) connections (Figure 2)
(Thermo 49i Ozone Instruction Manual pg 2-5)
- Initial Startup:
Verify Initial startup procedure corresponds with factory firmware and calibration
(Thermo 49i Ozone Instruction Manual pg 2-9)
- Initial Calibration:
Verify multi-point calibration; verify documentation of calibration in Station Logbook, Instrument Logbook & Monthly Maintenance Sheet
(Thermo 49i Ozone 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 performed more frequently but should be performed 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

Ozone Validation Template			
Requirement	Frequency	Acceptance Criteria	Information /Action
CRITICAL CRITERIA-Ozone			
One Point QC Check Single analyzer	1/2 weeks	$\leq \pm 7\%$ (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 $\leq \pm 2\%$ of full scale Span drift $\leq \pm 7\%$	

- ☞ *One Point QC Check - Daily - Required every 2 Weeks*
 $\pm 07\%$ = Out of Tolerance - Disable - Report
 $\pm 05\%$ = 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 patterns 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 49i O3 Instruments

- Check O3 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 49i O3 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 with ESC (± 5 min)
- Replace Inline Filter
- Complete maintenance check sheet (Values Obtained from Main Menu > Diagnostics >)
 1. Check for Variances in Voltages (Interface, I/O & Motherboard) & Record Any In Comments
 2. Check & Record Bench Temperature (25 – 40°C)
 3. Check & Record Bench Lamp Temperature (50 – 60°C)
 4. Check & Record Pressure (710 – 780 mmHg)
 5. Check & Record Flows Cell A & B (0.4 – 1.0 Lpm)
 6. Check & Record Intensities Cell A & B (>90,000 Hz)
- Record Verification of Alarms (Record in Station Logbook, Instrument Logbook & Monthly Maintenance Sheet & Notify Senior if unable to resolve, Fill out Downtime log if necessary)
- Check Calibration Factors – O3 BKGN & O3 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 49i O3 Instruments*

- **Perform Analog Output Test for Zero & Full Scale**
(Thermo 49i Instruction Manual pg 3-69)
- **Zero Span Check for O3**

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 & Adjustment Zero Span for procedure on Manual Zero adjustment)

3.7. *Semi Annual Tasks: Thermo 49i O3 Instruments*

3.7.1. Station Operations:

- Clean Manifold, Probe Inlet & Instrument tubing/lines
- Verify Following Task Completion and Documentation of the following

3.7.2. Support Group:

- Multi-Point Calibration:
(Thermo 49i Ozone Instruction Manual pg 4-1)
- Optical Bench Cleaning:
(Thermo 49i Ozone Instruction Manual pg 5-2)
- Analog Output Calibration:
(Thermo 49i Ozone Instruction Manual pg 3-92 & 7-14)

3.8. *Annual Tasks: Thermo 49i O3 Instruments*

3.8.1. Station Operations:

- Verify the Following Task Completion and Documentation of the following

3.8.2. Support Group:

- Complete Leak Test & Pump Diagnostic (Thermo 49i Ozone Instruction Manual pg 5-7)
- Calibrate Flows A & B (Thermo 49i Ozone Instruction Manual pg 3-89)
- Calibrate Pressure (Thermo 49i Ozone Instruction Manual pg 3-87)
- Calibrate Temperature (Thermo 49i Ozone Instruction Manual pg 3-91)

4. Trouble Shooting:

4.1. General

Before starting any troubleshooting procedure, refer to Thermo 49i Ozone 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 & Chessell connection, check for proper grounding

(Inform Senior AQIS of the Following Conditions)

If Alarm - Bench Temp

Then Check Fan Filter: Clean or Replace Foam Filter
Check Fan Operation: Replace fan if not operating properly.
(Thermo 49i Ozone Instruction Manual page 7-11)

If Cell A and B frequency low or zero

Then Clean cells (Optical Bench Cleaning)
(Thermo 49i Ozone Instruction Manual page 5-2 & 6-2)

If Alarm – Low Flow A & or Low Flow B

Then Check sample capillary (0.015 inch ID) for blockage
(Thermo 49i Ozone Instruction Manual page 5-5)

If Alarm – Pressure: High Pressure Indication

Then Check the pump for a tear in the diaphragm, repair/replace pump
(Thermo 49i Ozone Instruction Manual page 5-5, 5-6 & 7-10)

4.2. Detailed Maintenance Procedures

4.2.1. Zero/Span Check: General

The zero and span check procedure is performed at the air monitoring site. When completing this procedure the operator will comply with instruction from the manufacturer's operation manual.
(Thermo 49i Ozone Instruction Manual page 3-22)

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.

4.2.2. Zero Span Calibration

(Thermo 49i Ozone Instruction Manual page 3-22)

The Calibrate Zero screen is used to perform a zero calibration. Be sure the analyzer samples zero air until the readings stabilize.

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

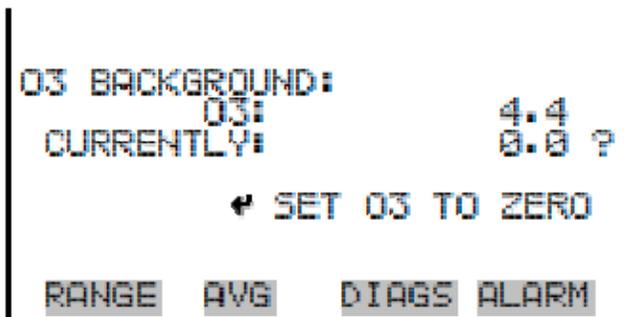


Figure 3 Soft Key Panel

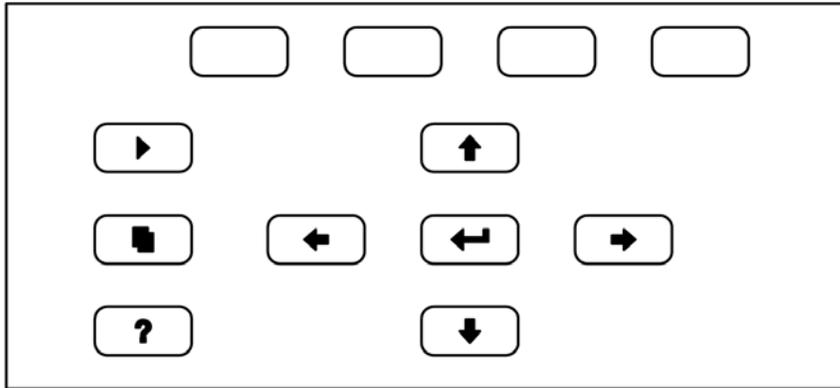


Table 1 Soft Key Functions

 = 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 O ₃ 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 patterns 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	Station Operator
Bi-Annually	Clean Manifold, Probe Inlet, & Instrument tubing/lines	Station Operator
	Multi-Point Calibration, Optical Bench Cleaning, Analog Output Calibration	Repair/Calibration Technician
Annually	Complete Leak Test & Pump Diagnostic, Flows Calibration, Pressure Calibration, Temperature Calibration	Repair/Calibration Technician

Appendix A: Thermo 49i Ozone Maintenance Sheet

South Coast Air Quality Management District
 Monthly Maintenance Report
 Thermo 49i Ozone (O3)

See SOP for Maintenance Sheet Instructions

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

DATE:					
TIME:					
Change Filter					
Bench Temp (25-40°C)					
Bench Lamp T (50-60°C)					
Pressure (710 - 780mmHg)					
Flow Cell A (0.4-1.0Lpm)					
Flow Cell B (0.4-1.0Lpm)					
Intensities Cell A (>90,000 Hz)					
Intensities Cell B (>90,000 Hz)					
Alarm					
O3 BKGND: (Zero)					
O3 COEF: (Span)					

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

DATE:	TELEMETRY	CHESSEL								
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ZERO	SPAN									
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Comments:

Calibration Date: _____ Reviewed BY: _____