South Coast Air Quality Management District
Science and Technology Advancement

Monitoring and Analysis Division
Atmospheric Measurements Branch

STANDARD OPERATING PROCEDURE

FOR

Operations of Thermo 42*i* NO/NOX/NO2 Analyzer

SOP00075
Version 1.0
April 02, 2010

PREPARATION, REVIEWS AND APPROVALS

Standard Operating Procedure for Thermo 42*i* NO/NOX/NO2 Analyzer

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REVISION HISTORY

Standard Operating Procedure for Thermo 42*i* NO/NOX/NO2 Analyzer

Version	Date
1.0	January 07, 2010

REVISION CHANGES FROM PREVIOUS VERSION

Standard Operating Procedure for Thermo 42*i* NO/NOX/NO2 Analyzer

Section	Revisions
N/A	- N/A

TABLE OF CONTENTS

Standard Operating Procedure for Thermo 42*i* NO/NOX/NO2 Analyzer

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 42*i* NO/NOX/NO2 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 42i NO/NOx NITROGEN OXIDES ANALYZER, Instruction Manual
- "SOP for General Air Monitoring Station Operations"

1.4 General Description

The Thermo Electron Corporation Model 42*i* is designated by the United States Environmental Protection Agency (USEPA) as an Equivalent Method for the measurement of ambient concentrations of nitrogen dioxide

The Model 42*i* meets EPA designation requirements when operated as follows:

Range	50 to 1000 ppb
Averaging Time	10 to 300 seconds
Temperature Range	15 to 35 °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 42*i* operates on the principle that nitric oxide (NO) and ozone (O3) react to produce a characteristic luminescence with an intensity linearly proportional to the NO concentration. Infrared light emission results when electronically excited NO2 molecules decay to lower energy states.

Specifically,

$$NO + O3 \longrightarrow NO2 + O2 + h\nu$$

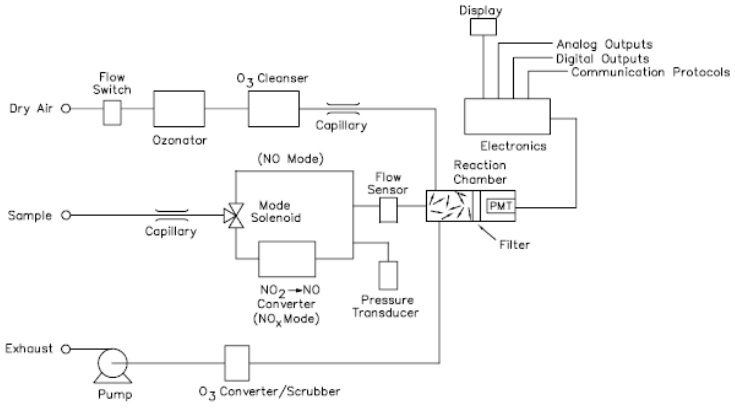
Nitrogen dioxide (NO2) must first be transformed into NO before it can be measured using the chemiluminescent reaction. NO2 is converted to NO by a molybdenum NO2-to-NO converter heated to about 325 °C (the optional stainless steel converter is heated to 625 °C).

The ambient air sample is drawn into the Model 42*i* through the *sample* bulkhead, as shown in the Flow Schematic. The sample flows through a capillary, and then to the mode solenoid valve. The solenoid valve routes the sample either straight to the reaction chamber (NO mode) or through the NO2-to-NO converter and then to the reaction chamber (NOX mode). A flow sensor prior to the reaction chamber measures the sample flow.

Dry air enters the Model 42*i* through the *dry air* bulkhead, passes through a flow switch, and then through a silent discharge ozonator. The ozonator generates the ozone needed for the chemiluminescent reaction. At the reaction chamber, the ozone reacts with the NO in the sample to produce excited NO2 molecules. A photomultiplier tube (PMT) housed in a thermoelectric cooler detects the luminescence generated during this reaction. From the reaction chamber, the exhaust travels through the ozone (O3) converter to the pump, and is released through the vent.

The NO and NOX concentrations calculated in the NO and NOX modes are stored in memory. The difference between the concentrations is used to calculate the NO2 concentration. The Model 42*i* outputs NO, NO2, and NOX concentrations to the front panel display, the analog outputs, and also makes the data available over the serial or Ethernet connection.

- Model 42*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 42*i* NO/NOX/NO2 Instruction Manual pg 2-5 thru 2-8 and 3-9 thru 3-12)
- Pneumatic Connections:
  Verify correct tubing and connection installation, check for clearance and damaged tubing, verify correct inlet/outlet (exhaust) connections (Figure 2)
  (Thermo 42*i* NO/NOX/NO2 Instruction Manual pg 2-3)
- Initial Startup:
  Verify Intial startup procedure corresponds with factory firmware and calibration
  (Thermo 42*i* NO/NOX/NO2 Instruction Manual pg 2-9, 3-6 & 3-58)
- Initial Calibration:
  Verify multi-point calibration; verify documentation of calibration in Station Logbook, Instrument Logbook & Monthly Maintenance Sheet
  (Thermo 42*i* NO/NOX/NO2 Instruction Manual Chapter 4)

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

NO_2 Validation Template

Requirement	Frequency	Acceptance Criteria	Information /Action
CRITICAL CRITERIA- NO_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 42*i *NO/NOX/NO2 Instruments*

- Check NO/NOX/NO2 Instrument Status on Chessel
  - 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 42*i *NO/NOX/NO2 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 > …..) (Figures 3 & 4 & 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 (47 – 51°C)
    5. Check & Record Pressure (50 – 300 mmHg)
    6. Check & Record Flow (0 – 1.0 Lpm)
    7. Check & Record Ozonator Flow (OK)
  - Check Alarms (Alarms Detected – None) (Obtained from Main Menu > Alarm)
  - Check Calibration Factors – NO/NOX BKGN & NO/NO2/NOX COEF (Obtained from Main Menu > Calibration factors) with those recorded in the Instrument Logbook & recorded on monthly maintenance sheet

*3.6 Monthly Task: Station Operations Thermo 42*i *NO/NOX/NO2 Instruments*

- **Perform Analog Output Test for Zero & Full Scale**
  (Thermo 42*i* Instruction Manual pg 3-62)
- **Zero Span Check for NO/NOX/NO2**

Parameters	Response
> or < than +/- 10 PPB	Invalid Data Call in work order
-15 to -5 PPB or 5 to 15 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 42*i *NO/NOX/NO2 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 42*i* NO/NOX/NO2 Instruction Manual Chapter 4)
- Analog Output Calibration: (Thermo 42*i* NO/NOX/NO2 Instruction Manual pg 3-83 & 7-29)

*3.8 Annual Tasks: Thermo 42*i *NO/NOX/NO2 Instruments*

3.8.1 Station Operations:

- Verify the Following Task Completion and Documentation of the following

3.8.2 Support Group:

- Flow Calibration: (Thermo 42*i* NO/NOX/NO2 Instruction Manual pg 3-77)
- Pressure Calibration: (Thermo 42*i* NO/NOX/NO2 Instruction Manual pg 3-75)
- Temperature Calibration: (Thermo 42*i* NO/NOX/NO2 Instruction Manual pg 3-81)

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 API 200E NO/NOx 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 42*i* NO/NOX/NO2 Instruction Manual Chapter 5 & 6 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 42*i* NO/NOX/NO2 Instruction Manual page 3-22 & 4-10)

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.

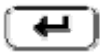
Please be sure to note any additional information regarding erratic instrument behavior.

5.2.2 Zero Span Calibration

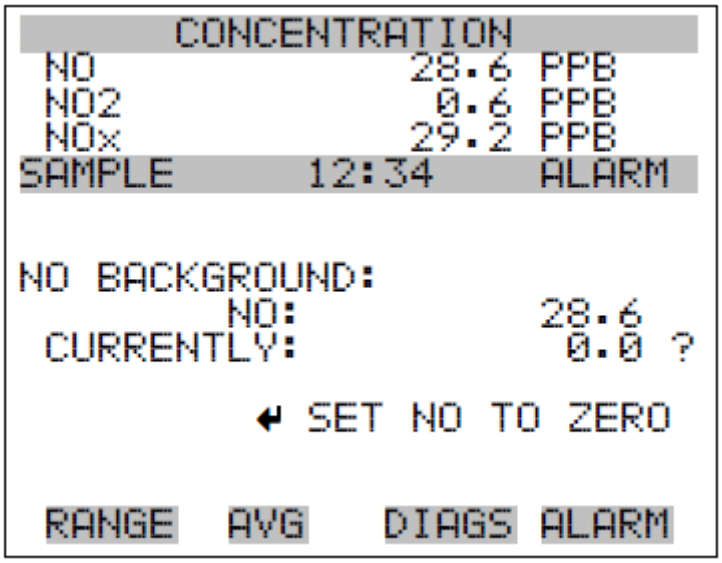
(Thermo 42*i* NO/NOX/NO2 Instruction Manual page 3-22 & 4-10)

The Calibrate NO and NOX 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

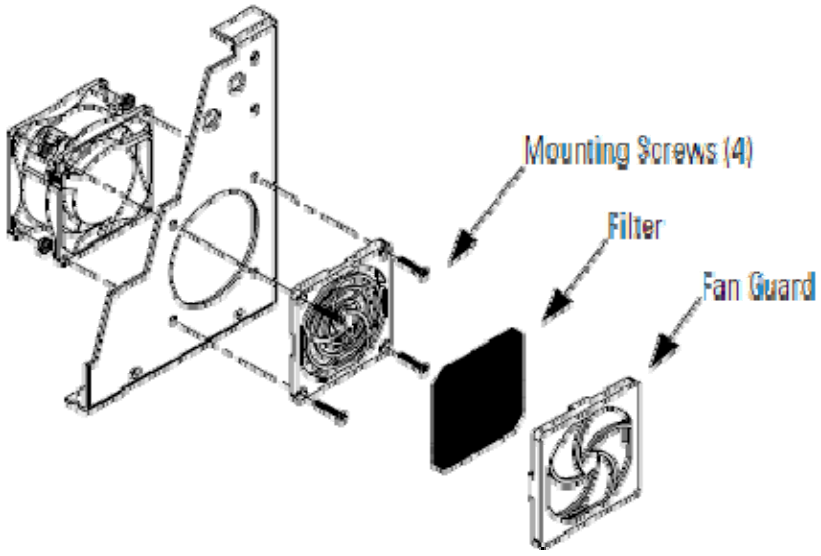


Figure 2 **Back Panel**

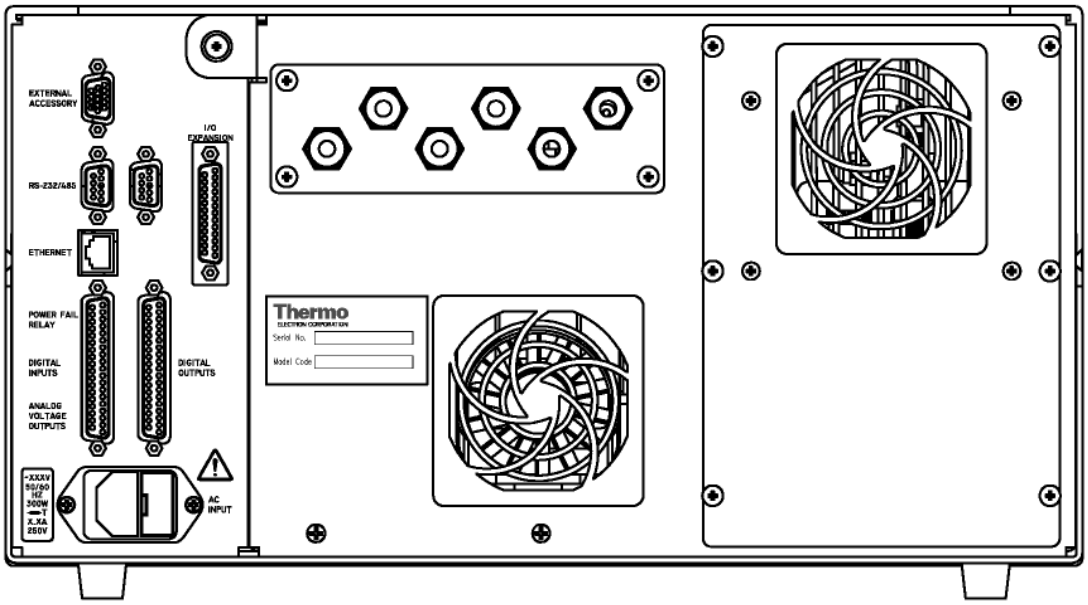


Figure 3 **Front Pane**

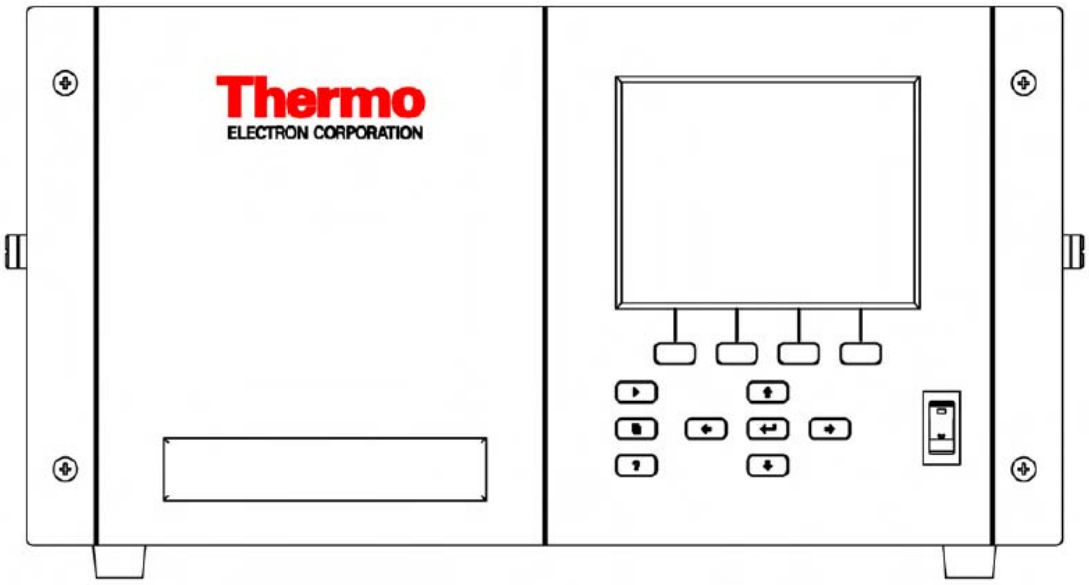
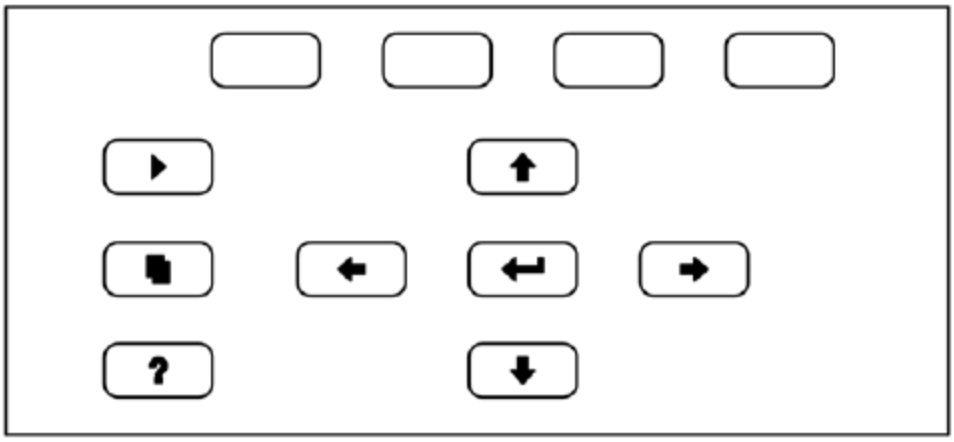


Figure 4 **Soft Keys Panel**



6 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	Flow Calibration, Pressure Calibration, and Temperature Calibration	Repair/Calibration Technician

Appendix A: Thermo 42i NO/NOx Maintenance Sheet

South Coast Air Quality Management District
Monthly Maintenance Report
Thermo 42i NO/NO2/NOX 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 (47 - 51°C)					
Pressure (50-300mmHg)					
Sample Flow (0-1.0 Lpm)					
Ozonator Flow (OK)					
Alarm					
NO BKGN (Zero)					
NOX BKGN (Zero)					
NO COEF (Span)					
NO2 COEF (Span)					
NOX COEF (Span)					

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

DATE:

Comments:

	TELEMETRY		CHESSEL	
	ZERO	SPAN	ZERO	SPAN
NO				
NOX				

Calibration Date: _____ Reviewed BY _____

Thermo 42i NONOX maint sheet.xls

South Coast Air Quality Management District
Science and Technology Advancement

Monitoring and Analysis Division
Atmospheric Measurements Branch

STANDARD OPERATING PROCEDURE

FOR
Thermo 43i
NO/NOX Instrument Calibrations

SOP00056
Version 1.0
April 2, 2010

PREPARATION, REVIEWS AND APPROVALS

Thermo 43i NO/NOX Calibrations

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REVISION HISTORY

NO/NOX 43i Instrument Calibrations

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1.0	April 2, 2010

REVISION CHANGES FROM PREVIOUS VERSION

Calibration of Thermo 43i NO/NOX Analyzer

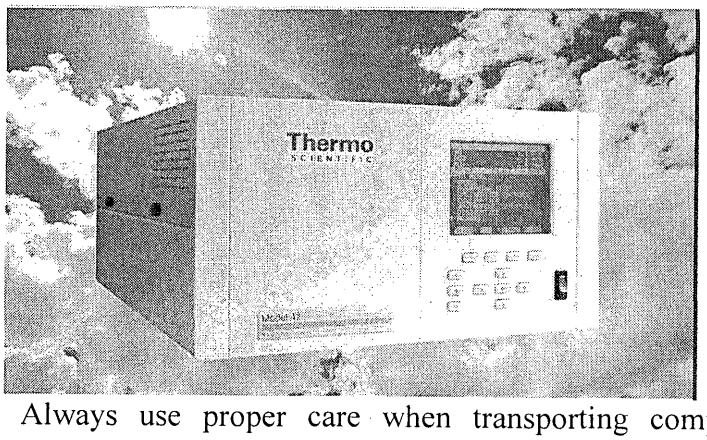
Section	Revisions
N/A	N/A

TABLE OF CONTENTS

1 General

1.1. **Purpose**: The purpose of this procedure is to provide for the proper calibration of the Thermo 42i NO/NOX Analyzer through dynamic calibration. This is necessary to establish accurate data reporting and traceability with NIST protocols. The recommended frequency of calibration is once every three months or up to six months if the instrument has demonstrated sufficient stability. A calibration is also needed after most instrument service or after a relocation.

1.2. **Description**: Calibration determines the relationship between the observed and the true values of the variable being measured. This relationship is derived from the instrument's response to successive samples of different known concentrations. These samples may be introduced in an order of decreasing concentration to minimize response times. Five reference points and a zero point are used to define this relationship. The certified values of the NO standards must be traceable to NIST-SRMs.



1.3. **Safety**: Always use proper care when transporting compressed gas cylinders as per AQMD district policy.

2 Apparatus and Equipment:

1. A recently certified gas dilution system such as an Environics 100 gas calibrator
2. Two small crescent wrenches or open end wrenches
3. Two six foot lengths of Teflon tubing (1/4")
4. 1/8" fifteen feet Teflon tubing for superblend
5. Selection of 1/4 Swage loc fittings
6. Copy of the approved NOX calibration spreadsheet
7. Laptop computer or other device capable of running an Excel spreadsheet.

3 **Reagents and Consumable Materials**:

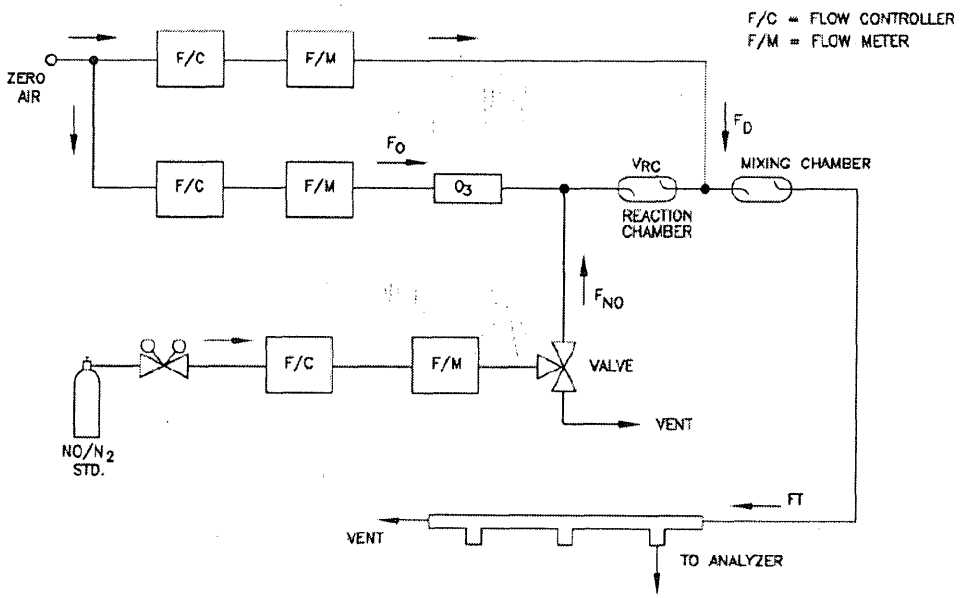
1. EPA protocol super blend gas with NO/NOX concentrations ~ 75 PPM
2. Zero Air source for diluant at least 10 L/M flow minimum.

4 **Calibration Procedure**:

1. Assemble all equpment required for calibration activities.
2. Ensure transfer standard dilution system is calibrated under the conditions of use against a reliable standard, such as a primary standard piston prover.
3. All volumetric flow rates should be corrected to 25 °C and 760 mmHg.
4. Precautions should be taken to remove O2 and other contaminants from the NO pressure regulator and delivery system prior to the start of calibration to avoid any conversion of NO to NO2. Failure to do so can cause significant errors in calibration. This problem can be minimized by:

    a. Carefully evacuating the regulator after the regulator has been connected to the cylinder and before opening the cylinder valve.
    b. Thoroughly flushing the regulator and delivery system with NO after opening the cylinder valve.
    c. Not removing the regulator from the cylinder between calibrations unless absolutely necessary. Thoroughly flush cylinder if removed.

5. Turn on the gas dilution system and allow it and the gas cylinder to equilibrate at the calibration location for at least 2-3 hours, ideally overnight, before beginning calibration.
6. Connect calibration equipment to inlet of station manifold. (See Figure 1)
7. Take station "off line" on telemetry system using the station data logger or putting station in "cal mode" using station Gas dilution system. Using the latter is preferable as it does not remove particulate and MET from the data stream.
8. Annotate that calibration has begun on station Chessel or other data recording devices. Refer to the Chessel Operators manual for specific instructions.
9. Adjust the residence time rotameter down to 1 LPM.
10. Assess whether total flow generated by calibration dilution system exceeds demand on manifold. It should be greater.
11. Inspect station instrumentation for proper operation.
    a. If warning flags are evident, instrument troubleshooting should be initiated.



Gas Phase Titration/Calibration Setup (42i Manual)
Figure 1

4.1 As Is Calibration Check

1. Initiate calibration flows to challenge instrument.
    a. Dilutions should be run at zero and 5 different levels from 80% of scale or upper range limit (URL) to zero.
    b. Flows should be run for about 15 minutes and evaluated for stability.
    c. All resulting values should be read from the official data logging stream and entered into the NOX calibration spreadsheet. (Figure 4)
    d. The spreadsheet calculates slope, Intercept, correlation, and percent deviation.
2. If percent deviation is greater than 2%, a recalibration should be performed. If less than 2%, an "as is" equals "final" calibration can be declared but only if greater than zero. Always recalibrate NOX instruments if the slope is less than 1.0 or greater than 1.02.

4.2 Perform Converter Efficiency Test

1. Initiate a dilution blend equal to 90% of scale.
2. Sample this NO concentration until the NO and NOx responses have stabilized and record the NO concentration on the calibration spreadsheet.
3. Adjust the O3 generator in the GPT system to generate sufficient O3 to produce a decrease in the NO concentration equivalent to about 80% of the URL of the NO2 range.
4. When the analyzer responses stabilize, record the resultant NO concentrations on the calibration spreadsheet. Do this for four additional O3 concentrations to generate NO2 levels evenly spaced between 0 and 80% of URL of the NO2 range. The calibration spreadsheet calculates the converter efficiency. This test should be considered a failure if the level drops below 97%.

Note: The quantity of NO2 converted to NO is calculated using the following equation:

$$[NO]CONV = [NO2]OUT - ([NOX]ORIG - [NOX]REM)$$

Converter efficiency is calculated using the following formula where "b" is the slope:

$$\text{Converter efficiency} = 100 \times b \Rightarrow 97\%$$

Note: If percent deviation is greater than 10% or if the converter efficiency drops below 97% ther e may be reason to invalidate data. All results should be entered in the downtime log and Data Validation should be notified

Notes:

- The AQMD Instrument Calibration Status card (Figure 5) should be posted at the station, on the side of the instrument rack.

- The AQMD CO Calibration Report Worksheet should be stored in the E drive (E:\ASTD\AM calib\station calibration files).

4.3 **Final Calibration** (If Necessary)

- Instrument recalibration adjustment

a. A "final calibration" consists of the following and should be performed upon initial setup or whenever instrument is found to be >2% out of true. The actual procedure for making adjustments to the instrument involves this sequence of steps:

1. Setting the NO and NOx background zero (Figure 2)
2. Adjusting NO/NOx dilution to ~ 80% URL using the calibration transfer standard dilution system.
3. Adjusting the NO/NOX span settings to match the transfer standard dilution. (Figure 3)
4. Initiate calibration flows to challenge instrument as was done during the "as is" calibration check. (Section 4.1)Three dilution levels plus zero are sufficient to assess result.

Use the following procedure from the 42i manual to set the NO/NOX background:

Note The NO channel should be calibrated first and then calibrate the NO_x channel. ▲

For detailed information about the menu parameters and the icons used in these procedures, see the "Operation" chapter.

1. Determine the GPT flow conditions required to meet the dynamic parameter specifications as indicated in "Dynamic Parameter Specifications for Gas Titrator" earlier in this chapter.

2. Adjust the GPT diluent air and O_3 generator air flows to obtain the flows determined in "Dynamic Parameter Specifications for Gas Phase Titrator" earlier in this chapter. The total GPT airflow must exceed the total demand of the analyzer. The Model 42*i* requires approximately 700 cc/min of sample flow, and a total GPT airflow of at least 1.5 liters/min is recommended.

   a. Allow the analyzer to sample zero air until the NO, NO_x, and NO_2 responses stabilize.

   b. After the responses have stabilized, from the Main Menu, choose Calibration > **Cal NO Background**.

   c. Press [↵] to set the NO reading to zero.

   d. Press [■] to return to the Calibration menu and repeat this procedure to set the NO_x background to zero.

   e. Record the stable zero air responses as Z_{NO}, Z_{NOX}, and Z_{NO2} (recorder response, percent scale).

Background Adjustment Procedure
Figure 2

Use the following procedure from the 42i operator's manual to adjust the instrument span calibration coefficients:

1. Allow the analyzer to sample the NO calibration gas until the NO, NO2, and NOx readings have stabilized.

2. When the responses stabilize, from the Main Menu, choose Calibration > **Cal NO Coefficient**.

   The NO line of the Calibrate NO screen displays the current NO concentration. The SPAN CONC line of the display is where you enter the NO calibration gas concentration.

   Use [←] [→] to move the cursor left and right and use [↑] [↓] to increment and decrement the numeric character at the cursor.

3. Press [↵] to calculate and save the new NO coefficient based on the entered span concentration.

   The NO recorder response will equal:

$$\text{Recorder Response (\% scale)} = \frac{[NO]_{OUT}}{URL} \times 100 + Z_{NO}$$

   Where:

   URL = Nominal upper range limit of the NO channel, ppm

4. Record the $[NO]_{OUT}$ concentration and the analyzer NO response as indicated by the recorder response.

Span Adjustment Procedure
Figure 3

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

THERMO 42i NO-NOX CALIBRATION REPORT

As-Is X
Final

Date 1/7/2010

Station No. 33165 Location Mira Loma V. B. Code MLVB

Property # 16770 Range 1.0 ppm NO Zero 2.9 NOX Zero 3.9
NO Span 1.468 NOX Span 1.000

Sample flow 711 LPM

Previous Calibration: 10/16/2009 NO % Dev.: -0.10 Nox % Dev.: -0.10

Env Cont # 5006 Cert Date 9/4/2009 By TC Total Flow 8.0 LPM

Gas Cyl # FF13039 Cert Date 9/21/2009 By SM NO Conc 74.6 ppm

RUN#	TRUE NO/NOX	NET NO PPM	NET NOX PPM
ZERO	0.000	0.000	0.002
1	0.800	0.763	0.764
2	0.600	0.573	0.573
3	0.400	0.382	0.383
4	0.200	0.192	0.195
5	0.100	0.097	0.100

	NO	NOX
SLOPE	0.953	0.950
INTERCEPT	0.001	0.004
CORRELATION	1.00000	0.99999
DEVIATION %	-4.7	-5.0
% CHANGE	4.6	4.9

O_3 OFF		O_3 ON		Δ NO	Δ NOx
NET NO	NET NOx	NET NO	NET NOx		
0.903	0.905	0.111	0.904	0.792	0.001
		0.340	0.904	0.563	0.001
		0.560	0.900	0.343	0.005
		0.674	0.904	0.229	0.001
		0.788	0.902	0.115	0.003
			Σ =	2.042	0.011

CONVERTER EFFICIENCY = 99.5

By TC

REMARKS: _____

Calibration Worksheet
Figure 4

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
INSTRUMENT CALIBRATION STATUS

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.
AQMD Instrument Calibration Card

5 Calculations:

a. All data should be recorded in the approved "NOX calibration worksheet." (Figure 4.) The spreadsheet automatically calculates slope, intercept, correlation coefficients, and converter efficiency. Converter efficiency calculations are explained in section 5.2.
b. Results of all "as is" and "final" calibration work should be recorded in the instrument logbook. In addition the Instrument Calibration Card should be filled out and posted in a conspicuous place near the instrumentation.

6 References:

- Thermo Model 42i Instruction Manual
- EPA Quality Assurance Guidance Document 2.3