STANDARD OPERATING PROCEDURES

THERMO ENVIRONMENTAL INSTRUMENTS

42CY NO_y TRACE LEVEL

REACTIVE NITROGEN COMPOUNDS INSTRUMENT

Version 1.1

Section 1.1 Acknowledgments

This Standard Operating Procedure (SOP) for Trace Level Reactive Nitrogen Compounds is the product of EPA's Office of Air Quality, Planning and Standards. The following individuals are acknowledged for their contributions.

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3.0 PROCEDURES

3.1 Scope and Applicability

Reactive nitrogen compounds (NO_y) have been identified as precursors for both ozone and fine particulate matter ($PM_{2.5}$). Measurements of NO_y constitute a valuable adjunct to current NO and NO_2 monitoring because the individual species comprising NO_y include not only NO and NO_2 but also other organic nitroxyl compounds that have recently been shown to play a significant role in the photochemical O_3 formation process.

NO_y consists of all oxides of nitrogen in which the oxidation state of the N atom is +2 or greater, ie, the sum of all reactive nitrogen oxides including NO_x ($NO + NO_2$) and other nitrogen oxides referred to as NO_z. The major components of NO_z include nitrous acids [nitric acid (HNO_3), and nitrous acid (HONO)], organic nitrates [peroxyl acetyl nitrate (PAN), methyl peroxyl acetyl nitrate (MPAN), and peroxyl propionyl nitrate, (PPN)], and particulate nitrates.

$$NO + NO_2 + NO_z = NO_y$$

The Thermo Environmental Instruments (TECO) model 42CY is an instrument for the determination of trace levels of NO_y by its chemiluminescent reaction with O_3. This SOP will detail the operation, calibration, preventive maintenance, cautions and health warnings.

3.2 Summary of Method

The analytical principle is based on the chemiluminescent reaction of NO with an excess of O_3. This reaction produces a characteristic near infrared luminescence with an intensity that is linearly proportional to the concentration of NO present. Specifically,

$$NO + O_3 \rightarrow NO_2 + O_2 + h_v$$

where:

h_v = emitted photon energy

The reaction results in electronically excited NO_2 molecules which revert to their ground state, resulting in an emission of light or chemiluminescence.

To determine the concentration of NO, the sample gas is blended with O_3 in a reaction chamber causing the reaction to occur. The chemiluminescence that results from the reaction is monitored by an optically filtered high-sensitivity photomultiplier. The optical filter and photomultiplier respond to light in a narrow-wavelength band unique to the NO and O_3 reaction. The electronic signal produced in the photomultiplier is proportional to the NO concentration.

To measure NO_y, sample air is passed through a probe-mounted chemical reduction converter and the nitroxyl compounds present are reduced to NO. The sample is then blended with O_3 and the chemiluminescent response is proportional to the concentration of NO_y entering the converter. The chemical reduction converter uses heated molybdenum to convert non-NO NO_y species to NO. Specifically,

$$NO_{2/Z} + Mo \rightarrow NO + MoO_3$$

where:

Mo = heated molybdenum reductant

The concentration of $NO_2 + NO_z$ is calculated as the difference between a measured NO_y value and a measured NO value representing approximately the same point in time. This procedure is similar to the current methodology used to measure NO_x, however, the converter temperature is higher in order to enhance conversion of NO_z species. In addition, the converter has been moved to the sample inlet to avoid line losses of "sticky" NO_y species such as HNO_3.

A diagram of the 42CY instrument is presented in Figure 3-1. For the 42CY, ambient sample is first drawn through a short Teflon sample line and split into two parallel flow channels using a ½ inch PFT Teflon tee. Channel 1 passes through a Teflon filter and then directly to the monitor. Channel 2 first passes through a catalytic converter before going through a Teflon filter to the monitor. Flow from each channel is alternately fed to the reaction chamber to detect the NO. The converter is operated outside of the analyzer, close to the ambient sampling point. This allows for a short flow path upstream of the converter and minimizes the loss of species such as HNO_3. In addition to alternating flows from Channel 1 and Channel 2 to the reactor, the analyzer also alternates a flow of internal zero air, produced by pre-reacting the sample flow with a high concentration of ozone before reaching the chemiluminescent detector. The signal from this zero air stream is used to correct for analyzer drift, and allows the analyzer to achieve very low detection limits (0.05 ppb) compared with standard NO_x analyzers.

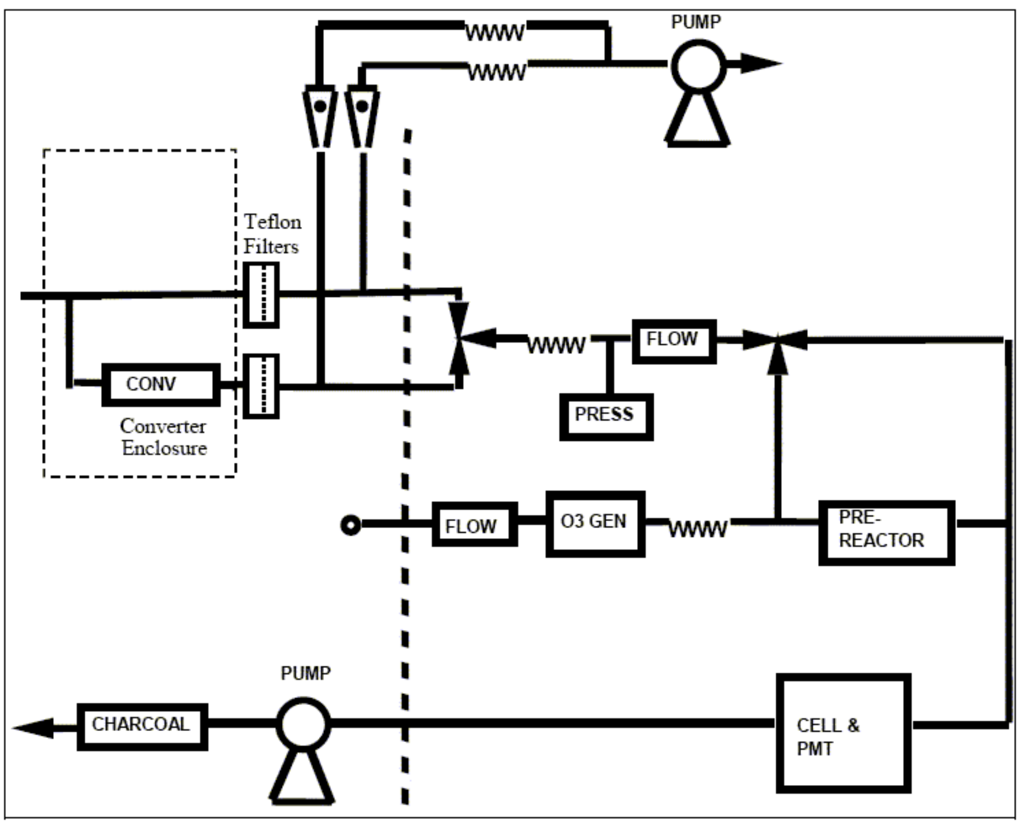

Figure 3-1. Simplified Flow Diagram of 42CY NO_y Monitor

3.3 Definitions

Here are some key terms for this method.

Table 3-1, Definitions of Key Terms

Term	Definition
NO_y	Total reactive nitrogen including NO, NO_2, HNO_3, and other reactive organic nitrogen compounds.
NO_z	Reactive nitrogen compounds other than NO and NO_2.
DAS	Data acquisition system. Used for automatic collection and recording of Carbon Monoxide concentrations.
Interferences	Physical or chemical entities that cause NO_y measurements to be higher (positive) or lower (negative) than they would be without the entity. (See Section 3.6).

3.4 Health and Safety Warnings

To prevent personal injury, please heed these warnings concerning the 42CY.

1. Nitrogen oxides are a poisonous gas. Vent any nitrogen oxide or calibration span gas to the atmosphere rather than into the shelter or other sampling area. If this is impossible, limit exposure to nitrogen oxide by getting fresh air every 5 to 10 minutes. If the operator experiences light headedness, headache or dizziness, leave the area immediately.
2. Always use a third ground wire on all instruments.
3. Always unplug the analyzer when servicing or replacing parts.
4. If it is mandatory to work inside an analyzer while it is in operation, use extreme caution to avoid contact with high voltages. The analyzer has a 110 volt Volts Alternating Current (VAC) power supply. Refer to the manufacturer's instruction manual and know the precise locations of the VAC components before working on the instrument.
5. Avoid electrical contact with jewelry. Remove rings, watches, bracelets, and necklaces to prevent electrical bums.

3.5 Cautions

To prevent damage to the 42CY, all cautions should immediately precede the applicable step in this SOP. The following precautions should be taken:

1. Keep the interior of the analyzer clean.
2. Inspect the system regularly for structural integrity.
3. To prevent major problems with leaks, make sure that all sampling lines are reconnected after required checks and before leaving the site.
4. Inspect tubing for cracks and leaks.
5. It is recommended that the analyzer be leak checked after replacement of any pneumatic parts.
6. If cylinders are used in tandem with Mass Flow Control (MFC) calibrators, use and transport is a major concern. Gas cylinders can sometimes contain pressures as high as 2000 pounds per square inch (psi). Handling of cylinders must be done in a safe manner. If a cylinder is accidentally dropped and valve breaks off, the cylinder can become explosive or a projectile.
7. Transportation of cylinders is regulated by the Department of Transportation (DOT). It is strongly recommended that all agencies contact the DOT or Highway Patrol to learn the most recent regulations concerning transport of cylinders.
8. Low levels of nitrogen oxides in the air can irritate your eyes, nose, throat, and lungs, possibly causing you to cough and experience shortness of breath, tiredness, and nausea. Exposure to low levels can also result in fluid build-up in the lungs 1 or 2 days after exposure. Breathing high levels of

nitrogen oxides can cause rapid burning, spasms, and swelling of tissues in the throat and upper respiratory tract, reduced oxygenation of body tissues, a build-up of fluid in your lungs, and death.

9. It is possible (and practical) to blend other compounds with NO. If this is the case, it is recommended that MSDS for all compounds be made available to all staff that use and handle the cylinders or permeation tubes.
10. Shipping of cylinders is governed by the DOT. Contact the DOT or your local courier about the proper procedures and materials needed to ship high-pressure cylinders.

3.6 Interferences

Ammonia: Depending on the converter temperature, the converter may convert a small amount of ammonia (NH_3) to NO, resulting in increased NO readings. However, under normal circumstances NH_3 concentrations are low compared to NO and this positive interference is negligible. Nonetheless, care should be taken when siting the monitor to be sure that it is not located near significant NH_3 sources which could cause elevated NH_3 concentrations (e.g., concentrated animal feeding operations).

3.7 Personal Qualifications

The person(s) chosen to operate the 42CY should have a minimum of qualifications. The understanding of basic chemistry and electronics are a must. The understanding of digital circuitry is helpful, but not required. Also, courses in data processing and validation are also welcome.

3.8 Equipment and Supplies

Monitoring Apparatus: The design of the 42CY is similar to the 42C with several major variations. A diagram of the 42CY instrument is presented in Figure 3-1. The four main components are:

- *Remote Inlet and Converter:* This component consists of a weather resistant enclosure that houses the molybdenum converter and supports the sample inlet.
- *Pneumatic System:* Consists of sample inlet lines, sample bypass pump, particulate filters, reaction chamber, flowmeters, and vacuum pump, all used to bring ambient air samples to the analyzer.
- *Analytical System*: This portion of the instrument consists of the ozone generator, pre-reaction chamber, reaction chamber, and photomultiplier tube.
- *Electronic Hardware:* The part of the analyzer that generally requires little or no maintenance. If the 42CY is operated above the manufacturer's recommended temperature limit, however, individual integrated chips can fail and cause problems with data storage or retrieval.

Other apparatus and equipment includes the following.

Instrument Shelter: A shelter is required to protect the analyzer from precipitation and adverse weather conditions, maintain operating temperature within the analyzer's temperature range requirements, and provide security and electrical power. The recommended shelter temperature range is 20-30^{o}C.

Spare Parts and Incidental Supplies:. See the 42CY operating manual, Chapter 5, for specific maintenance and replacement requirements.

Calibration System: A system that creates concentrations of nitrogen oxide of known quality is necessary for establishing traceability. The calibration system must also include a high precision ozone generator in order to generate concentrations of nitrogen dioxide by gas phase titration with nitrogen oxide. This is described in detail in the “Calibration of Trace Gas Instruments SOP.” Please reference this document.

DAS: A data acquisition system is necessary for storage of ambient and ancillary data collected by the 42CY. The 42CY requires a minimum of two analog outputs, one each for NO and NO_y outputs. A third output is also needed if the monitor is to be run in auto-ranging mode to capture the range information. Note, a digital DAS is preferred because diagnostic information can also be collected which will greatly help troubleshooting and validation of data. This is detailed in the "Data Acquisition and Management SOP."

Wiring, Tubing and Fittings*:* PFT Teflon™ should be used exclusively throughout the intake system. Examine the tubing and discard if particulate matter is collects in the tubing. All fittings and ferrules should be made of Teflon™ or stainless steel. Connection wiring to the DAS should be shielded two strand wire or RS-232 cables for digital connections.

Reagents and Standard: The 42CY does not require any reagents since the instrument uses photometry to analyze for NO_y. All standards for the NO_y method can be obtained in compressed cylinders and must be NIST traceable. Please see the "Calibration of Trace Gas Analyzers" SOP.

3.9 Procedure

3.9.1 Sample Collection: Ambient air is drawn through a sample inlet located on the remote inlet/converter. The sampling point should be located 3 to 5 meters above ground level, at least 1 meter from all obstructions, and at least 10 meters from obstructions over a range of at least 180 degrees. These requirements necessitate mounting the catalytic converter outside the shelter. The sample bypass lines from the converter to the instrument should not exceed 10 meters in length.

3.9.2 Sample Handling and Preservation: NO_y samples receive no special preparation prior to analysis. Therefore this SOP does not need a section on Sample Handling and Preservation.

3.9.3 Instrument Operation, Startup and Maintenance

This section discusses startup, operation and maintenance of the 42C-NOY. The 42CY series instrument has a digital front panel screen with control buttons below. This allows the user to check functions, switch operating parameters, adjust zero and span and read warnings messages. **It is extremely important that the user familiarize themselves with the menus available. Inadvertently changing parameters within the analyzer can damage the instrument and possibly invalidate data as well. Please reference the 42CY owner's manual and read it carefully before adjusting any parameters that are set by the factory.**

3.9.3.1 Installation and Start up

1. Before the instrument is operated, inspect the instrument for any damage. If damage is observed to the shipping box or the instrument, contact your shipping personnel.
2. Remove the instrument from its shipping container and set on a table or bench that allows easy access to both the front and read or the instrument.
3. Carefully remove the instrument cover and remove any packing material.
4. Check for possible internal damage.
5. Check that all connectors and printed circuit boards are firmly attached.
6. Once you have performed your inspection, replace the cover.
7. Remove the remote inlet enclosure and place on a bench that allows easy access.
8. Open the enclosure and check for internal damage.
9. Using ¼ inch PFT Teflon™ tubing, plumb the inlet as shown in Figure 3-2.
10. Mount the enclosure at the desired sampling location being sure to meet the requirements detailed in 3.9.1, above.

11. Determine the distance from the point where the sample tubing exits the converter enclosure to the point where the tubing will enter the monitoring station, including ample length to account for any curves or obstructions. Cut the two plastic conduits to this length.
12. Run the two sample lines, calibration line, and thermocouple wire through one conduit, and the converter power cable through the second.
13. Connect the two sample lines, calibration line, thermocouple wire, and power cable inside the converter enclosure as shown in Figure 3-2, and secure the conduits to the converter enclosure.
14. Run the tubing, thermocouple wire, and power cable in to the monitoring station.
15. Mount the 42CY in its rack being sure that the 42CY has enough clearance so that it gets proper ventilation.
16. Connect the sample lines to the bypass pump, filters, and analyzer as shown in Figure 3-1.
17. Connect the Dryrite™ air dryer to the dry air bulkhead.
18. Connect the intake of the vacuum pump to the exhaust bulkhead.
19. Connect the charcoal container to the outlet of the vacuum pump.
20. Connect the converter power cable and thermocouple wire to the back of the 42CY.
21. Connect the power cable and plug the instrument, vacuum pump, and bypass pump into a grounded power strip that has surge protection. It is also advisable to purchase an Uninterrupted Power Supply (UPS). An UPS will protect the 42CY from power surges and keep the unit operating until an operator can shut it down.
22. Connect the output of the analog to a DAS via shielded two wire cable. Please see EPA SOP on "Data Management" for details.
23. Connect the digital RS-232 port to an appropriate cable and connect it to the DAS. Please see EPA SOP on "Data Management" for further details.
24. Press the power rocker switch to "ON."
25. After an adequate warm-up period, run through the menu and record factory/start-up settings. Compare to recommended limits located in the manual and listed on the daily worksheet.

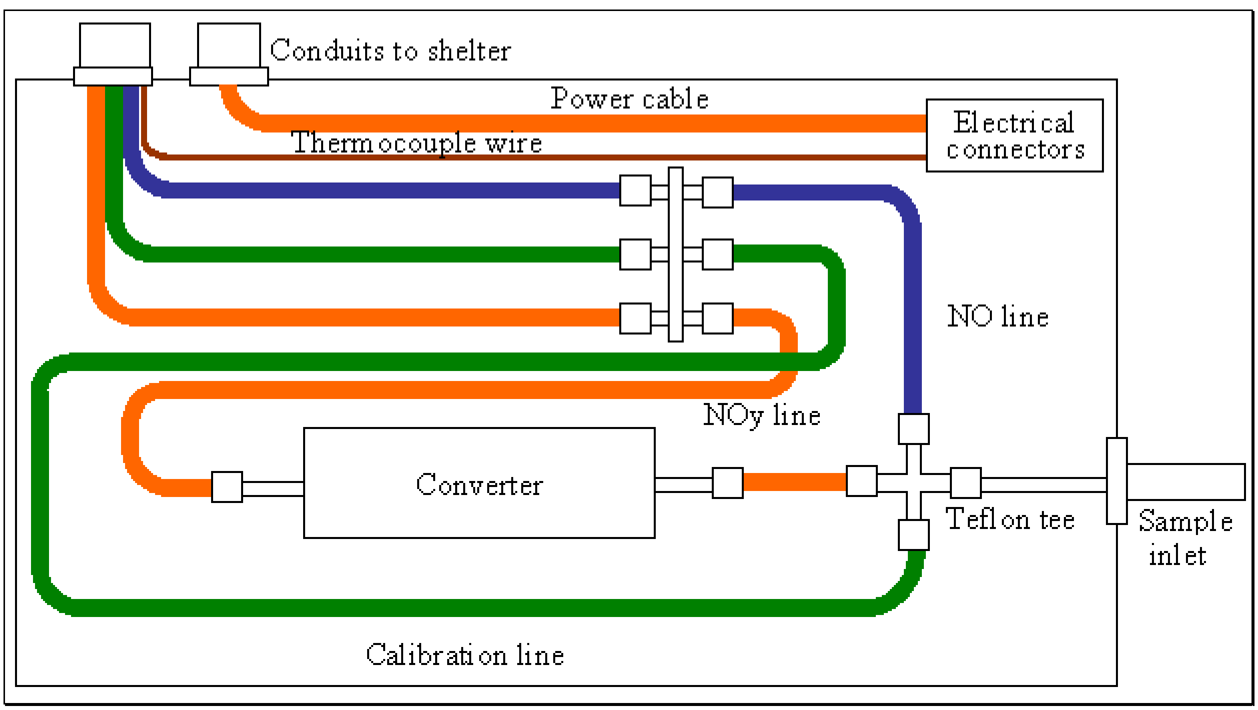

Figure 3-2. Schematic of plumbing and wiring for 42CY External Converter

3.9.3.2 Operation and Range Setting

1. The exhaust fan will start and the Power-Up and Self-Test screens will be displayed. These screens are displayed each time the instrument is turned on, and will continue to be displayed till the instrument has completed its warm up and self-checks. You should allow 30 minutes for the instrument to stabilize.
2. After the warm-up period the Run screen, the normal operating screen, is displayed. This screen is where the NO and NO_y concentration is displayed. The display for the model that EPA is using currently mis-reports the data. The data reported as NO_x is actually NO_y. The data reported as NO_2 is actually NO2 + NO_z. Future versions should correct this, and are expected to report NO, NO_y and "DIFF" which would represent NO2 + NO_z.
3. In the bottom right hand corner the word "**LOCAL**" or "**REMOTE**" will be displayed. The analyzer must be in local mode to adjust the configuration using the keys on the front panel. Press the **ENTER** button until the analyzer is in local mode.
4. From the Run screen, the Main Menu, which contains a list of submenus, can be displayed by pressing the **MENU** pushbutton.
5. Instrument parameters and features are divided into the submenus according to their function. Use the **UP/DOWN ARROW** pushbuttons to move the cursor to each submenu. **Note:** When the Main Menu is entered directly from the Run screen, the **LEFT ARROW** pushbutton may be used to jump to the most recently displayed submenu screen.
6. To set the range for the instrument, press the **DOWN ARROW** pushbutton till the cursor is on "Range." Press the **ENTER** pushbutton to display the Range Menu.
7. In the upper right corner of the display, the word single, dual, or auto is displayed to indicate the active mode. For a detailed explanation about the single, dual, or autorange mode, see Chapter 3 (page 3-7) of the manual. This SOP addresses setting the range for a single range.
8. Press the **ENTER** pushbutton for the Gas Units screen. Use the **DOWN ARROW** pushbutton to select "PPB" and press **ENTER**. Press **MENU** to return to the Range Menu.
9. Use the **DOWN ARROW** pushbutton to display the Range screen and press **ENTER**.
10. Use the **UP/DOWN ARROW** pushbuttons to scroll through the preset ranges. Select "100.0" and press **ENTER**. Press **MENU** to return to the Range Menu. Note, a higher range may be required in areas with higher NO_y concentrations.
11. Press **RUN** to return to the Run screen.
12. To set the averaging time, press the **MENU** button to return to the Main Menu. Press the **DOWN ARROW** pushbutton till the cursor is on Averaging Time.
13. Press **ENTER** for the averaging time screen. Use the **DOWN ARROW** pushbutton to select the desired averaging time and press **ENTER**. Press **RUN** to return to the Range Menu.
14. To set the correct time and date on the instrument, press **MENU** to return to the Main Menu. Press the **DOWN ARROW** pushbutton till the cursor is on Instrument Controls. Press **ENTER** to display the Instrument Controls screen.
15. Use the **UP/DOWN ARROW** pushbuttons to scroll through the choices. Select "Time" and press **ENTER**.
16. Use the **UP/DOWN ARROW** pushbuttons to increase/decrease the hours and minutes; use the **LEFT/RIGHT ARROW** pushbuttons to move the cursor left and right. Set the appropriate time and press **ENTER**. Press **MENU** to return to the Instrument Controls screen.
17. Select "Date" and press **ENTER**.
18. Use the **UP/DOWN ARROW** pushbuttons to increase/decrease the month, day, and year; use the **LEFT/RIGHT ARROW** pushbuttons to move the cursor left and right. Set the appropriate date and press **ENTER**. Press **RUN** to return to the Run screen.
19. The instrument is now set with the appropriate time, date and full scale range.
20. It is recommended that you allow the 42CY 24 hours before you attempt function checks or calibration.

21. If the DAS system that you have does not have the RS-232 capabilities, then proceed to the next section, Diagnostic Checks/Manual Checks. If you have connected the 42CY to a computer or DAS, review the Diagnostic Check from your computer screen.

3.9.3.3 Diagnostic Checks/Manual Checks

To determine whether the 42CY is working properly, the field operators should perform the Diagnostic Checks every time they visit the monitoring station. It is good practice for the operator to check these Diagnostic Checks either by the computer or manually. Below are instructions on how to perform this manually. Please note that the 42CY has set upper and lower ranges for some of these Diagnostic checks. Please reference the owner's manual for these ranges.

1. To display the Diagnostics menu, from the Run screen press the **MENU** pushbutton to display the Main Menu. Use the **UP/DOWN ARROW** pushbuttons to move the cursor to "Diagnostics." Press **ENTER** for the Diagnostics screen.

2. Use the **UP/DOWN ARROW** pushbuttons to toggle through the function check tree. The following table illustrates the functions that should be recorded. Please see Chapter 3 (page 3-36) 42CY manual for more details. A manual checklist on maintenance is attached in Appendix A of this SOP.

3. On the Program Number screen, the version numbers of the program installed are displayed. Prior to contacting the factory with any questions regarding the instrument, note the program numbers.

Table 3-2 Diagnostic Checks

Check	Explanation
Voltages	The current DC power supply and PMT power supply voltages
Temperatures	The current internal instrument and chamber temperatures
Pressure	The current chamber pressure
Flow	The current ozonator and sample flow rate
Test Analog Outputs	Enable analog outputs to be set to zero and full scale to adjust analog outputs to agree with the front panel display

Reference the owners manual or the worksheet in Appendix A of this SOP for acceptable limits. Once the Diagnostic checks have been established and recorded for the 42CY, it is time to calibrate the instrument. Please refer to section 3.9.4 of this SOP.

3.9.3.4 Preventive Maintenance

Preventive maintenance should prevent down-time and data loss. Table 3.3 lists the preventive maintenance items that are listed in the 42CY manual, section 5.

Table 3-3 Preventive Maintenance Schedule the TECO 42CY

Item	Schedule
Replace ozonator air feed drying column	As needed
Inspect and replace sample filters	Weekly

Inspect and replace capillaries	Quarterly
Digital to analog converter test	As needed
Inspect and clean cooler fins	Semi-annually
Inspect and clean fan filters	Semi-annually

3.9.3.5 Instrument Troubleshooting

The 42CY manual has an excellent troubleshooting guide in Chapter 6. Please reference the manual for details on troubleshooting the 42CY analyzer.

3.9.4 Calibration and Standardization

The calibration of the 42CY is performed by comparing the output of the instrument against standardized gases of known quality. Generation of these gases is detailed in the "Calibration of Trace Gas Analyzers" SOP. This section will detail how to adjust the 42CY to the standardized gases. Once the calibration has been performed, compare the response of your DAS to the calculated "source" value. If this is outside of +/-10%, then adjust the instrument response as detailed in the next sections.

3.9.4.1 Adjustment to Zero Air

In order to adjust the output of the 42CY to zero air, perform the following:

1. Connect the calibration line to a source of zero air. Supply a sufficient amount of zero air to supply the analyzer and to ensure that a small amount of excess zero air exits from the sample inlet.
2. Allow the analyzer to sample zero air for at least 15 minutes or until stable NO, NO_y, and NO_2+NO_z readings are obtained.
3. From the Main Menu, choose Calibration. From the calibration menu, choose Calibrate Zero.
4. The Calibrate Zero screen displays the NO, NO_y, and Prereactor readings.
5. Press **ENTER** to set the NO, NO_y, and Prereactor readings to zero.
6. The message "Savings Parameters(s)" is briefly displayed to indicate that the background readings have been set to zero.
7. Press **MENU** to return to the Calibration menu.
8. Press **RUN** to return to the Run screen.

3.9.4.2 Adjustment to Calibration Gas

In order to adjust the output of the 42CY to NIST traceable calibration gas, perform the following:

1. Switch the calibration unit to generate a known concentration of NO corresponding to approximately 80% of full scale.
2. Supply a sufficient amount of calibration air to supply the analyzer and to ensure that a small amount of excess calibration air exits from the sample inlet.
3. Allow the instrument to sample calibration gas for a minimum of 15 minutes, or until stable NO, NO_y, and NO_2+NO_z readings are obtained.
4. From the Main Menu select the Calibration menu; select the "Calibrate NO" screen.
5. On the bottom line, there will be individual digits with which the span value can be set. In order to change the span value, use the **UP/DOWN ARROW** pushbuttons to increase/decrease each digit; use the **LEFT/RIGHT ARROW** pushbuttons to move the cursor left and right.
6. Change the span value to reflect the known concentration of NO in the calibration gas being sampled.

7. Press **ENTER** to calibrate the NO reading to the NO calibration gas.
8. This operation changes the calculation equation and adjusts the NO span coefficient of the instrument.
9. Press **MENU** to return to the Calibration menu.
10. Select "Calibrate NO_y".
11. Change the span value to reflect the known concentration of NO plus any known NO_2 impurity in the calibration gas being sampled.
12. Press **ENTER** to calibrate the NO_y reading to the NO calibration gas.
13. This operation changes the calculation equation and adjusts the NO_y span coefficient of the instrument.
14. Press **MENU** to return to the Calibration menu.
15. Adjust the calibrator to add a known concentration of ozone to the calibration gas corresponding to approximately 60% of full scale. The ozone will react with the NO in the calibration gas to form NO_2.
16. Supply a sufficient amount of calibration air to supply the analyzer and to ensure that a small amount of excess calibration air exits from the sample inlet.
17. Allow the instrument to sample calibration gas for a minimum of 15 minutes, or until stable NO, NO_y, and NO_2+NO_z readings are obtained.
18. Select "Calibrate NO2" from the Calibration menu.
19. Change the span value to reflect the known concentration of ozone added to the calibration gas plus any known NO_2 impurity in the calibration gas being sampled.
20. Press **ENTER** to calibrate the NO_2 reading to the NO calibration gas.
21. This operation changes the calculation equation and adjusts the NO_2 span coefficient of the instrument.
22. Press **RUN** to return to the Run screen.

3.10 Data Analysis and Calculations

Data analysis for this analyzer is detailed in "Data Acquisition and Management" SOP.

4.0 QUALITY CONTROL AND QUALITY ASSURANCE

The following section has brief definitions of the QA/QC indicators. Table 4-1 has the Measurement Quality Objectives (MQOs) of the 42CY. Please note that this section details primarily with the data quality indicators. Quality Control for continuous electronic instruments, such as the 42CY consists of performing the diagnostic checks, maintenance and calibrations. These procedures are detailed in sections 3.9.3 and 3.9.4: Instrument Operation, Startup and Maintenance and Calibration and Standardization. Appendix A has an example of a Quality Control and Maintenance Record developed by the EPA for this instrument.

4.1 Precision

Precision is defined as the measure of agreement among individual measurements of the same property taken under the same conditions. For NO_y, this refers to testing the NO_y analyzer in the field at concentrations between 0.2 and 100 ppb (note, higher test levels may be required in areas with higher NO_y concentrations). The test must be performed, at a minimum, once every two weeks. Calculations for Precision can be found in Reference 4.

4.2 Bias

Bias is defined as the degree of agreement between a measured value and the true, expected, or accepted value. Quantitative comparisons are made between the measured value and the true, standard value during audits. Generally, three upscale points and a zero point are compared. Two audit types commonly used for NO_y, direct comparison and blind, are discussed below. The SOP should discuss plans for each type of audit.

- **Direct Comparison Audits:** An independent audit system is brought to the monitoring location and produces gas concentrations that are assayed by the monitoring station's NO_y analyzer. In most cases, a person outside of the agency or part of an independent QA group within the agency performs the audit. The responses of the on-site analyzer are then compared against the calculated concentration from the independent audit system and a linear regression is generated

- **Blind Audits:** In blind audits (also called performance evaluation audits); agency staff are sent an audit device, such as the National Performance Evaluation Program (NPEP). The agency staff does not know the NO_y concentrations produced by the audit equipment. Responses of the on-site analyzer are then compared against those of the generator and a linear regression is calculated.

4.3 Representativeness

Representativeness refers to whether the data collected accurately reflect the conditions being measured. It is the data quality indicator most difficult to quantify. Unless the samples are truly representative, the other indicators are meaningless. Since the NCORE Level I and II siting criteria are urban and regional, the TL-NO_y criteria are the same. Please reference the National Monitoring Strategy[5] for a discussion of NCORE Level II NO_y monitoring scale.

4.4 Completeness

Completeness is defined as the amount of data collected compared to a pre-specified target amount. The EPA does not have a minimum completeness requirement for NO_y sampling. However, for NO_x, EPA requires a minimum completeness of 75% (40 CFR 50, App.H.3). Typical completeness with the 42CY values can approach 90-93%.

4.5 Comparability

Comparability is defined as the process of collecting data under conditions that are consistent with those used for other data sets of the same pollutant. The 42CY meets the MQOs for a Trace Level NO_y instrument. Please see Table 4-1.

4.6 Method Detection Limit

The method detection limit (MDL) or detectability refers to the lowest concentration of a substance that can be determined by a given procedure. The 42CY must be able to detect a minimum value of 50 ppt of NO_y.

Table 4-1 Measurement Quality Assurance Objectives

Requirement	Frequency	Acceptance Criteria	Reference	Information or Action
Bias	NCORE, once per year	Slope: 1.00 +/- 0.15 Intercept: +/- 3% of full scale Regression: <0.9950	40 CFR Pt.58	Use of NIST generated gas concentrations with Mass Flow Calibration unit that is NIST traceable
Precision	1 every 2 weeks	Concentration: 0.2 -600 ppb, Coefficient of Variance less than 15%.	40 CFR Pt.58 Appendix A	If CV is greater than 15%, institute Quality Control measures
Completeness	Quarterly, Annually	NCORE, 75%	National Monitoring Strategy.	If under 75%, institute Quality Control Measures
Representativeness	N/A	Neighborhood, Urban or Regional Scale	40 CFR 58	N/A
Comparability	N/A	Must be a Trace Level instrument. See Sections 3.1 and 3.2 of this document.	National Monitoring Strategy.	N/A
Method Detection Limit	NA	50 ppt	National Monitoring Strategy	Testing is performed at the factory.

5.0 REFERENCES

1. Merck Index, twelfth edition 1996, page 296
2. Seinfeld, John H., Atmospheric Chemistry and Physics of Air Pollution, 1986, page 54
3. Code of Federal Regulations, Title 40, Part 53.23c
4. Code of Federal Regulation, Title 40, Part 58, Appendix A
5. The National Air Monitoring Strategy, Final Draft, 4/29/04, http://www.epa.gov/ttn/amtic/monstratdoc.html
6. Model 42CY Instruction Manual, Thermo Environmental Instruments

Appendix A
Environmental Protection Agency
Monthly Quality Control and Maintenance Records
Thermo 42C Trace Level NO/NOy Analyzer

Site Name/Location: ______________________________
Technician: ______________________________
Date/Time: ______________________________
Instrument: ______________________________
Serial Number: ______________________________
Range: ______________________________

Date Time									Parameters Acceptance Range
PMT voltage									
+5 volt supply									5 +/- 0.5
+15 volt supply									15 +/- 1.5
Internal temp									15-45 C
Chamber temp									47-51 C
Cooler temp									-20 - -1 C
Converter temp									300 - 350 C
Chamber pressure									200 - 400 mm Hg
Ozonator flow									0.05 - 0.15 lpm
Sample flow									0.1-2 lpm
Other Tests									