1.0 Title Page

Standard Operating Procedures

TELEDYNE-ADVANCED POLLUTION INSTRUMENTATION MODEL 200EU ULTRA SENSITIVE $NO/NO_2/NO_y$ ANALYZER WITH MODEL 501Y CONVERTER

NOTICE: This Standard Operating Procedure is written for use with the above named analyzer or system at the EPA/OAQPS/AAMG Burdens Creek ambient air monitoring site located in Research Triangle Park, North Carolina.

Approvals:

______________________ Author	________________ Date
______________________ OAQPS QA Manager	________________ Date
______________________ OAQPS Project Manager	________________ Date
______________________ OAQPS QA Coordinator	________________ Date

Annual Review by:					
Date of Review:					

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STANDARD OPERATING PROCEDURES FOR TELEDYNE-ADVANCED POLLUTION INSTRUMENTATION MODEL 200EU ULTRA SENSITIVE NO/NO_2/NO_y ANALYZER

3.0 Scope, Definitions, Method Description, Analytical Principle, Interferences and Quality Objectives

3.1 Scope

The U.S. Environmental Protect Agency (EPA) utilizes the Teledyne-Advanced Pollution Instrumentation (T-API) Model 200EU/501Y (M200EU/510Y) analyzer to quantify NO_y concentrations in the ambient air at the Burdens Creek site in Research Triangle Park, NC. This instrument is not an EPA designated equivalency method. The analyzer is operated, calibrated and maintained in accordance with the manufacturer's Instruction Manual.

The M200EU/501Y is a low level NO/NO_y analyzer (0-0.20 ppm range), which operates in virtually the same manner as the Model M200E, with the exception of the 501Y module. This 501Y module contains a molybdenum catalytic converter. The module is mounted outside the shelter on a 10-meter height tower so that catalytic reaction to convert NO_y species to NO occurs very close to the point where ambient air is sampled. This configuration allows the immediate conversion of approximately 30 nitroxyl compounds (collectively known as NO_y) to NO. The NO_y compounds are too unstable to be measured when taken in through the entire length of the typical ambient air sampling inlet system.

3.2 Definitions

Definitions of key terms used in this method are listed in Table 1.

Table 1. Definitions of Key Terms

Term	**Definition**
NO_y	Total reactive nitrogen including NO, NO_2, HNO_3, and several reactive organic nitrogen compounds, for example n-propyl nitrate.
NO_z	Reactive nitrogen compounds other than NO and NO_2.
DAS	Data acquisition system. Used for automatic collection and recording of pollutant gas 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.
Span Gas	Span gas is defined as a gas specifically mixed to match the chemical composition of the type of gas being measured at near full scale of the desired measurement range. Typically, this is 80 % of the measurement range of the application of the instrument.
Zero Gas	Zero gas or zero calibration gas is defined as a gas that is similar in chemical composition to the measured medium but without the gas to be measured by the analyzer.

3.3 Method Description

The M200EU monitor is a close derivative of the Model 200E NO_x analyzer. The differences are as follows:

- The M200EU is more sensitive at low NO_x levels than a standard M200E. The instrument has user-selectable full scale ranges of 0-0.005 ppm to 0-2.00 ppm of NO_y.
- The reaction cell is gold-plated. In addition, there is a pre-reactor, which provides for removal of any hydrocarbon interferents in the sample stream.
- The M200EU sample flow is about 1000 mL/min.
- The M200EU is equipped with a high performance pump, capable of producing a reaction cell pressure of less than 5 inches of mercury.

The Teledyne-API Model 200EU/501Y system is composed of three (3) modules:

- The T-API M200EU (without a molybdenum converter)
- A Bypass pump chassis containing:
    - Bypass pump
    - Flow controller
    - Sample filtration
    - Molybdenum converter/temperature controlled
    - Pneumatic provisions for passage of calibration gases
- The T-API M501Y molybdenum converter (mounted outside the shelter at the top of a 10-M height tower).

The M200EU has operating ranges from 0 to 0.005 ppm up to 0 to 2.00 ppm with a lower detectable limit of 50 ppt (parts per trillion). The analyzer may be safely operated in the temperature range of 5 ^{o}C to 35 ^{o}C. The T-API specifications for the M200EU/501Y are illustrated in Table 2.

Table 2. T-API M200EU/501Y NOy Analyzer Specifications

Performance Parameters	**T-API M200EU/501Y NOy Analyzer Specifications**
Precision	0.5% of Reading
Bias	Not Available
Method Detection Limit	Not Available
Lower Detectable Limit	50 ppt (0.050 ppb)
Linearity	1% Full Scale
Zero Drift	<0.0001 ppm/24-hours; <0.0002 ppm/7 Days
Span Drift	<0.5% Full Scale/7 Days or 0.0005 ppt/7 Days, Whichever is Greater

3.4 Analytical Principle

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

$$NO + O_3 \rightarrow NO_2^* \rightarrow NO_2 + O_2 + h\nu$$

Where: NO = Nitric Oxide
O_3 = Ozone
NO_2* = Nitrogen Dioxide in an excited state
NO_2 = Nitrogen Dioxide
O_2 = diatomic oxygen
hν = 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, as illustrated in Figure 1.

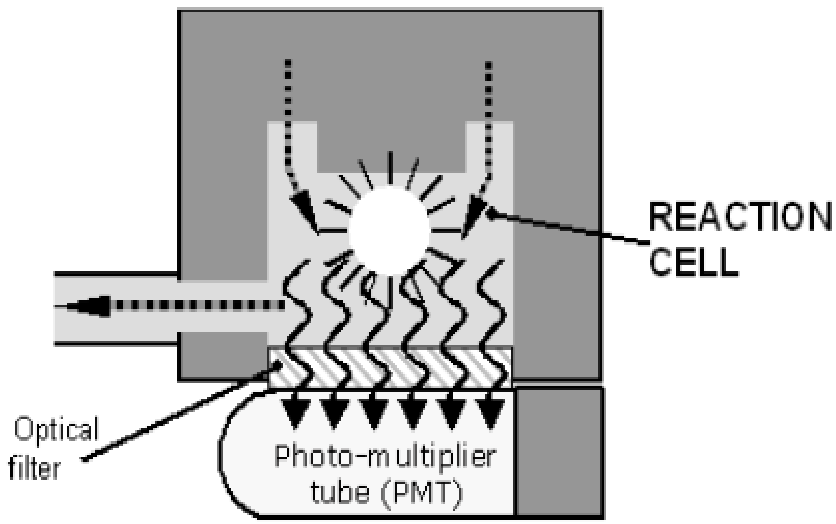


Figure 1. Reaction Cell Where NO Reacts With O_3 to Generate Excited State NO_2* Which Decays and Emits Light Which is Detected by the Photomultiplier Tube

To determine the concentration of NO, the ambient air sample (that bypasses the probe-mounted molybdenum converter) is blended with excess O_3 in a reaction chamber. The chemiluminescent emission that results from the reaction is detected by an optically-filtered, high-sensitivity photomultiplier tube. The optical filter and photomultiplier respond to light in a narrow-wavelength band unique to the NO and O_3 reaction.

To measure NO_y, the ambient sample air is passed through the probe-mounted chemical reduction converter and the nitroxyl compounds present are reduced to NO. This sample is then blended with O_3, chemiluminescence occurs, and the detected light response is proportional to the concentration of NO_y. Figure 2 illustrates the internal configuration of the T-API M200EU low-sensitivity NO_y analyzer.

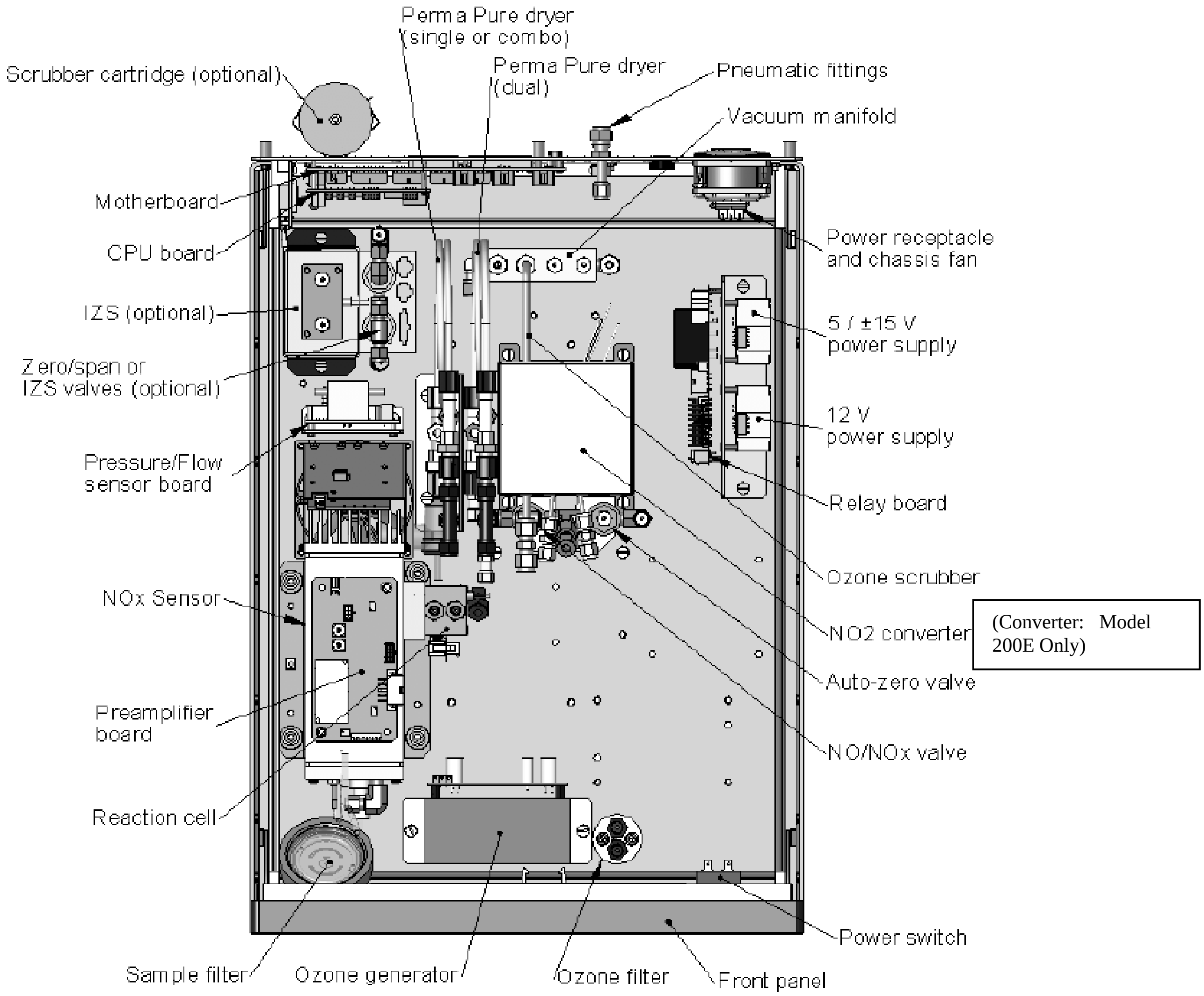


Figure 2. Internal Configuration of the T-API M200EU (With NO_2 Converter)

3.5 Interferences

The chemiluminescence method for detecting NO_y is subject to interference from a number of sources including certain hydrocarbons, water vapor (H_2O), and ammonia (NH_3). The T-API M300EU has been designed to reject most of these interferences when used under normal ambient air conditions. Hydrocarbons are removed by a pre-reactor; water vapor is removed by a Perma-Pure dryer. However, depending on its temperature, the converter may convert a small amount of NH_3 to NO, resulting in increased NO readings. However, under normal ambient air circumstances, NH_3 concentrations are much lower than NO levels and the 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 (e.g., concentrated animal feeding operations) which could produce elevated NH_3 concentrations. [The T-API M 200EU can be modified with a special sample gas conditioning option to remove ammonia and water vapor.]

3.6 Data Quality Objectives and Measurement Quality Objectives

3.6.1 Data Quality Objectives

The Burdens Creek site provides the EPA/OAQPS Ambient Air Monitoring Group with the ability to test new monitoring and data acquisition/data transfer technologies and to train monitoring organizations in these technologies. Data are gathered at the Burdens Creek site in a manner similar to state, local, and tribal monitoring organizations in order to assist or guide others and to test two data acquisition systems' ability to transfer data to information management programs like AIRNow and the AQS system. NO_y will be measured year-round on a range setting of 0 to 0.20 ppm (0 to 200 ppb) and reported at a minimum frequency of one-hour averages.

The decision rule for determining the quality of the Burdens Creek NO_y data is based on whether or not the data meet the measurement quality objectives of precision and bias which will be estimated from the quality control zero, span, and precision checks that are made automatically, beginning at midnight, on a daily basis and the zero, span, and precision checks that are made manually at least every two weeks.

The Burdens Creek site will use the Data Quality Objectives (DQOs) developed by EPA and documented in 40 CFR Part 58, Appendix A. The goal for acceptable measurement uncertainty for the NO_y methods is defined for precision as an upper 90 percent confidence limit for the coefficient of variation (CV) of 10 percent and for bias as an upper 95 percent confidence limit for the absolute bias of 10 percent (CV). Thus, the Burdens Creek site data set will be assumed to have met the DQO if the Measurement Quality Objectives of 10% or better for precision and 10% or better for bias are consistently met over the months and years of site operation.

3.6.2 Measurement Quality Objectives

Measurement Quality Objectives (MQOs) are identified to control and assess various phases of a data collection activity and provide information to estimate how well the challenges established by the DQO process were met. Through the implementation of MQOs and achieving the acceptance limits for those MQOs, the assumption can be made that the DQOs will be met. Standardization of operation against a specific set of MQOs will yield consistency of data among the various NCore sites included in the monitoring network to allow evaluation of treads nationwide. Although the EPA Burdens Creek site is not an official NCore site, but rather is an instructional and testing site for NCore operations, it will be operated according to DQOs and MQOs that are expected to mirror those of actual NCore sites. MQOs can be defined in terms of the following data quality indicators (DQIs):

- **Precision-** A measurement of mutual agreement among individual measurements of the same property usually under prescribed similar conditions. This is the random component of error. Precision is estimated by various statistical techniques using some derivation of the standard deviation.

- **Bias-** The systematic or persistent distortion of a measurement process which causes errors in one direction. Bias is determined by estimating the positive and negative deviation from the true value as a percentage of the true value.
- **Representativeness-** A measure of the degree which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.
- **Detectability (Method Detection Limit) -** The determination of the low range critical value of a characteristic that a method specific procedure can reliably discern (40CFR136, Appendix B).
- **Completeness-** A measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct, normal conditions.
- **Comparability-** A measure of confidence with which one data set can be compared to another.

Table 3 identifies the MQOs established for the Burdens Creek monitoring site.

Table 3. MQOs for the high-sensitivity NOy NCore and Burdens Creek Monitors

MQO Indicator	Acceptable Range	Criteria	Minimum Frequency Required/Recommended
Precision	± 10 %	0.005-0.020 ppm	Bi-weekly/Daily
Bias	± 10 %		Calculated Annually
Representativeness	Determined		As Part of DQOs
Detectability (MDL)	50 ppt (parts per trillion)		Once per Year
Completeness	75 %	Goal is 90%	Once per Year
Other			
Converter Efficiency	> 96%		During Multi-point Calibration and Every Two Weeks
Traceable Standards	± 1 % versus NIST standards	In range of 9-13 ppm	Per Manufacturer's Requirements
Zero Air	<0.10 ppb NO_x		Annual Zero Air Purity Check
Gas Phase Titration (GPT) Capability	Slope: 1.00 ± 0.02 Intercept: ± 1.0 ppb R^2: 0.9950	Multi-point Calibration (At Least 4 Points Incl. Zero)	Upon Receipt, After Repair/Adjustment, or Once Every 3 Months
Independent/Federal Audit	<10 %	Mean Absolute Difference <10%	Annual

4.0 Personnel Qualifications, Health and Safety Warnings, and Cautions

4.1 Personnel Qualifications

The person(s) chosen to operate the T-API Model 200EU Ultra Sensitive NO/NO2/NOy analyzer should have several qualifications. An understanding of basic chemistry and electronics is a must. An understanding of digital circuitry is helpful, but not required. Coursework and experience in data processing and validation are also helpful.

4.2 Health and Safety Warnings

To prevent personal injury, the following safety point should be followed while working with the M200EU NO_y analyzer.

4.2.1 Nitrogen oxide gases are poisonous. 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 by getting fresh air every 5 to 10 minutes. If the operator experiences lightheadedness, headache, or dizziness, he or she should leave the area immediately.
4.2.2 Always use a third ground wire on all instruments.
4.2.3 Always unplug the analyzer when servicing or replacing parts.
4.2.4 If it is necessary to work within the interior of the analyzer while it is in operation, use extreme caution to avoid contact with high voltages. The analyzer has a 110 volt alternating current (VAC) power supply. Refer to the manufacturer's instruction manual and know the precise locations of these components before working on the instrument.
4.2.5 Avoid electrical contact with jewelry. Remove rings, watches, bracelets, and necklaces to prevent electrical burns.

4.3 Cautions

To prevent damage to yourself or the NO_y analyzer, the following cautions should be observed at appropriate points in this SOP.

4.3.1 Keep the interior of the analyzer clean.
4.3.2 Inspect the system regularly for structural integrity.
4.3.3 To prevent problems with leaks, make sure that all sampling lines are reconnected after required checks and before leaving the site.
4.3.4 Inspect tubing for cracks and leaks.
4.3.5 It is recommended that the analyzer be leak-checked after replacement of any pneumatic parts.
4.3.6 If cylinders are used in tandem with Mass Flow Control (MFC) calibrators, their use and transport is a major concern. Gas cylinders may have interior 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 its valve breaks off, the cylinder can become explosive or a projectile.

4.3.7 Transportation of cylinders is regulated by the Department of Transportation (DOT). It is strongly recommended that all agencies contact the DOT or the Highway Patrol to learn the most recent regulations concerning transport of cylinders. 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.

4.3.8 Even low levels of nitrogen oxides 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 a day or two 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. It is possible (and practical) to purchase multiblend cylinders containing pollutant gases in addition to NO. If this is done, it is recommended that Material Safety Data Sheets (MSDS) for all cylinder gas components be made available to all staff members who use and handle the cylinders.

5.0 NOy Analyzer Siting, Equipment and Supplies, and Installation

5.1 NOy Analyzer Siting Recommendations

All ambient air oxides of nitrogen analyzers must meet the location and siting criteria referenced in the *Code of Federal Regulations (CFR), Part 58, Appendix E, Sections 2.0-2.6 for NO_2 siting criteria*. The siting and location criteria for NO_x analyzers and therefore NO_y analyzers are thus very similar.

The Burdens Creek monitoring site is configured to meet the following recommendations for NO_y monitoring.

- The probe inlet and molybdenum-based catalytic converter unit will be placed at least 10 meters above ground in order to minimize loss of HNO_3 (and other oxidized nitrogen species collectively known as NO_z) within the sampling system. The probe will be positioned at least 1 meter vertically or horizontally away from any supporting structure or walls and must be well away from dusty or dirty areas.
- The ambient air inlet probe will have unrestricted airflow and be located away from obstacles so that the distance from the probe or monitoring path is at least twice the height that the obstacle protrudes above the probe or monitoring path. The probe will have unrestricted airflow in an arc of at least 270 degrees (preferable 360 degrees) around the inlet probe.
- Trees provide surfaces for SO_2, O_3, NO_2 or NO_y adsorption or reactions and can obstruct wind flow. To reduce these possible interferences, the Burdens Creek NO_y sampling probe will be 20 meters or more from the drip line of any trees.

5.2 Equipment and Supplies

The design of the M200EU NO_y analyzer is similar to the Teledyne-API Model 200EU with one major variation – the addition of a catalytic converter that is external to the instrument at the site's ambient air entry point. Its 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.
- **A Bypass pump chassis containing:**
  - Bypass pump
  - Flow controller
  - Sample filtration
  - Molybdenum converter temperature control
  - Pneumatic provisions for routing calibration gases.
- **Analytical System:** This portion of the instrument consists of the ozone generator, pre-reaction chamber, reaction chamber, and photomultiplier tube.
- **Electronic Hardware:** This hardware consists of components to convert photomultiplier tube currents to concentration units (ppm or micrograms per cubic meter) and provide for electronic data storage and retrieval. This part of the analyzer generally requires little or no maintenance. However, if the NO_y analyzer is operated above the manufacturer's recommended temperature limit, individual integrated chips may fail and cause disruption of data storage and retrieval.

Other apparatus and equipment includes the following.

5.2.1 Instrument Shelter: A shelter is required to protect the analyzer from precipitation and adverse weather conditions, maintain operating temperature at a fixed point within the acceptable range of 20 to 30 ^{o}C, and provide security and electrical power.

5.2.2 Spare Parts and Incidental Supplies: Refer to the NO_y analyzer's Instruction Manual, Chapter 7, for specific maintenance and replacement requirements.

5.2.3 Calibration System: A system that creates concentrations of nitrogen oxide of known quality is necessary to establish a NIST-traceable calibration. The calibration system must also include a high precision ozone source in order to generate known concentrations of nitrogen dioxide by gas phase titration.

5.2.4 Data Acquisition System (DAS): A DAS is necessary for storage of ambient and ancillary data collected by the NO_y analyzer. The NO_y analyzer requires a minimum of two analog outputs, one for NO and one for NO_y. 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. The Burdens Creek site uses the ENVIDAS digital DAS.].

5.2.5 Wiring, Tubing and Fittings: PFA Teflon™ tubing should be used exclusively throughout the ambient air sample intake system. Examine the tubing interior and replace the tube if particulate matter is present. 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.

5.2.6 Reagents and Standards: The NO_y analyzer does not require any reagents since the instrument uses photometry to analyze for NO_y. Standards for the NO_y method can be obtained in compressed gas cylinders. Their contests must be NIST-traceable by US EPA Protocol Gas production and verification methods.

5.3 NOy Analyzer Installation and Sample Routing

In operation, ambient air is pulled into the externally mounted molybdenum converter unit located at the entrance of the probe assembly, approximately 10 meters above the ground. This configuration minimizes transit time delay between the sample inlet port and the molybdenum converter. This enables effective conversion of labile components of NO_y to NO. NO_y consists of all oxides of nitrogen in which the oxidation state of the N atom is +2 or greater. The sum of all reactive nitrogen oxides (nitroxyl compounds) includes NO_x (the combination of NO and NO_2) and "other reactive" compounds referred to as NO_z. NO_y is therefore represented as:

$$NO_y = NO_x + NO_z$$

The converter reduces all the NO_y species to NO by the following reaction:

$$3\ NO_y + Mo \xrightarrow{350\ ^{o}C} 3\ NO + MoO_3$$

Where:

NO_y = all reactive oxides of nitrogen species
Mo = heated molybdenum reducing catalyst
NO= Nitric Oxide, and
MnO_3 = Molybdenum Oxide

Two separate sample lines are used to convey the ambient air sample: one routes the air through the converter and the other line bypasses the converter. One line is for NO_y samples and the other is for NO samples. The lines are then connected to the M501Y Bypass Pump Module and Model 200EU NO_y analyzer as illustrated in Figure 3.

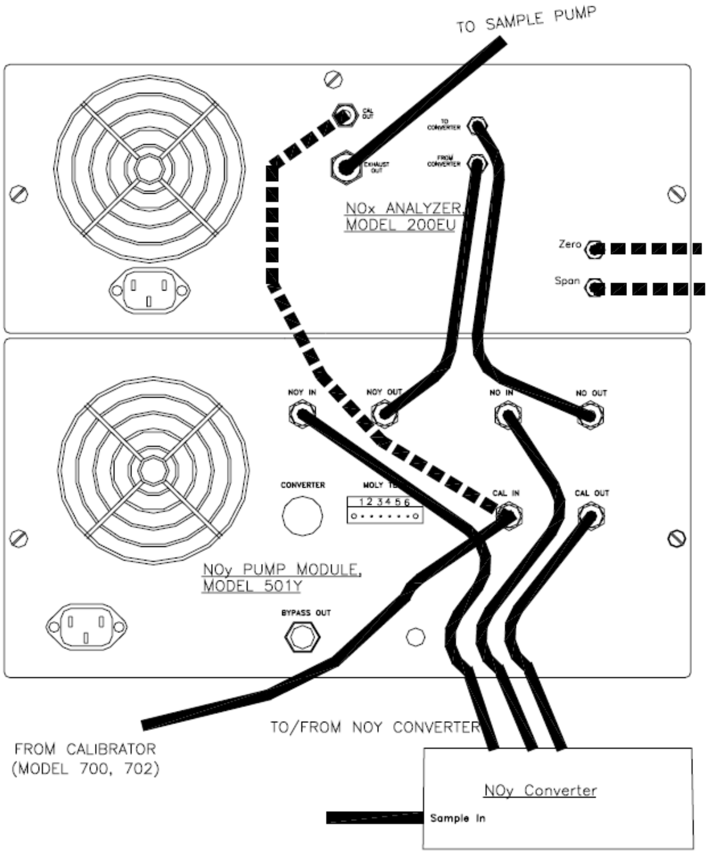


Figure 3. M501Y Pump Module Connections from NO_y Converter to the NO_y Pump Module and the M200EU NO_y Analyzer

6.0 Operation of NOy Analyzer System: Routine Checks

6.1 Daily or Weekly NO_y Systems Review

Some or all of the following checks are conducted at the time of the periodic (bi-weekly) visit to the Burdens Creek monitoring site.

- Once inside the monitoring shelter, verify that the inside shelter temperature is between 20-30 ^{o}C. Visually check all of the front panels of the analyzers for alarms or fault indicators. If faults, examine cause of fault, repair if possible, and document in site logbook.
- Confirm that data acquisition systems are operational (Refer to Section 6.2)
- Confirm proper NO_y analyzer operating parameters (Refer to Section 7.14)
- Check sample line filters and replace as necessary
- Perform manual unadjusted calibration, if appropriate (Refer to Section 8.0)
- Perform adjusted calibration if warranted (Refer to Section 9.0)

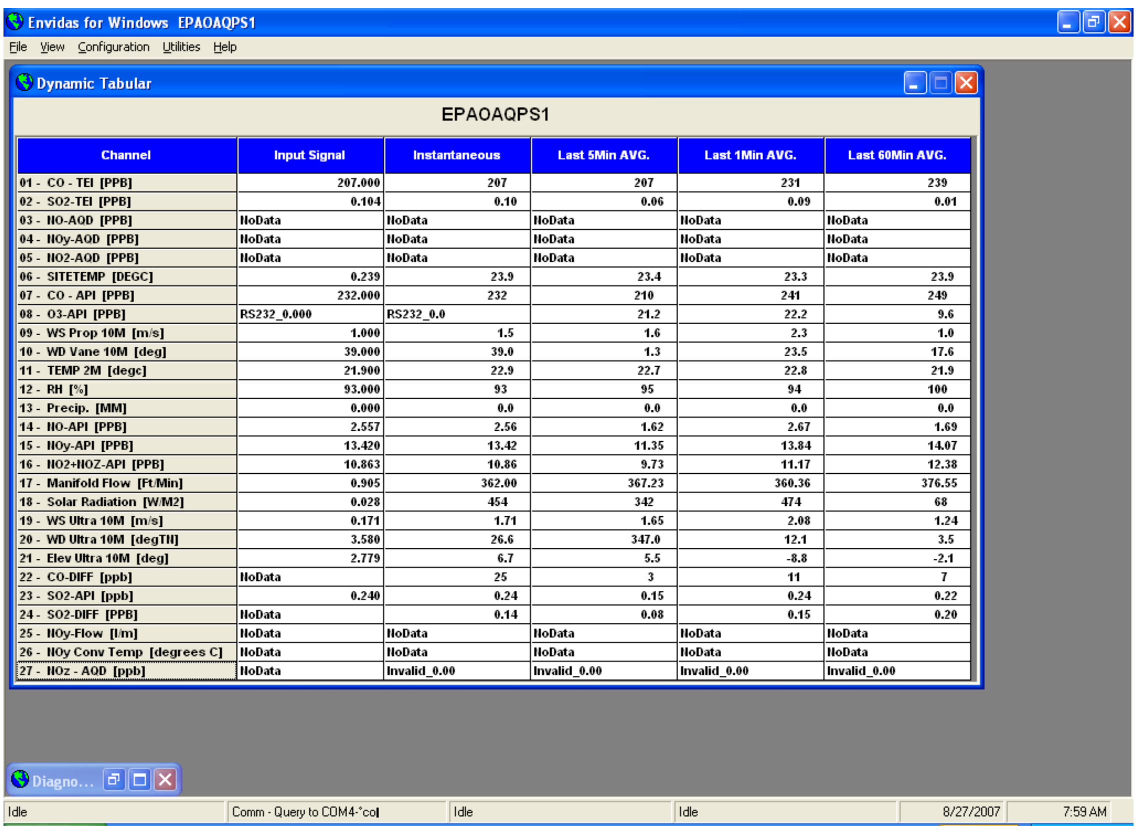
- Inspect the compressed gas cylinders and verify proper pressure. Pressure should be >300 psig. Also certify that the expiration date for the NIST-traceable gas cylinder is not exceeded. The cylinder gas concentration of NO used at the Burdens Creek site is between 9 and 10 ppm; NO_x concentration is less than 0.0005 ppm. The balance gas is nitrogen. If needed at this time, record cylinder concentration information on the Unadjusted/As Found Zero and Span Verification Form and the Multi-point Calibration Form (refer to Figure 11 and Figure 12, respectively).

6.2 Confirmation of Data Acquisition System Operation and NOy Display

The Burdens Creek NCore site has two data acquisition systems housed in two separate computers: (1) The ENVIDAS for Windows system which is connected through the RS232 ports of the analyzers; and (2) The ESC 8832 E-DAS system which receives the analog output from the analyzers. Proceed with checks of these systems as follows.

6.2.1 Working with the ENVIDAS computer, maximize the Dynamic Tabular Screen which remains in the "minimized" position during routine monitoring.

6.2.2 Review the Dynamic Tabular Screen active channels for consistent data over the previous monitoring period, as illustrated in Figure 4.



Envidas for Windows EPAOAQPS1

File View Configuration Utilities Help

Dynamic Tabular

EPAOAQPS1

Channel	Input Signal	Instantaneous	Last 5Min AVG.	Last 1Min AVG.	Last 60Min AVG.
01 - CO - TEI [PPB]	207.000	207	207	231	239
02 - SO2-TEI [PPB]	0.104	0.10	0.06	0.09	0.01
03 - NO-AQD [PPB]	NoData	NoData	NoData	NoData	NoData
04 - NOy-AQD [PPB]	NoData	NoData	NoData	NoData	NoData
05 - NO2-AQD [PPB]	NoData	NoData	NoData	NoData	NoData
06 - SITETEMP [DEGC]	0.239	23.9	23.4	23.3	23.9
07 - CO - API [PPB]	232.000	232	210	241	249
08 - O3-API [PPB]	RS232_0.000	RS232_0.0	21.2	22.2	9.6
09 - WS Prop 10M [m/s]	1.000	1.5	1.6	2.3	1.0
10 - WD Vane 10M [deg]	39.000	39.0	1.3	23.5	17.6
11 - TEMP 2M [degc]	21.900	22.9	22.7	22.8	21.9
12 - RH [%]	93.000	93	95	94	100
13 - Precip. [MM]	0.000	0.0	0.0	0.0	0.0
14 - NO-API [PPB]	2.557	2.56	1.62	2.67	1.69
15 - NOy-API [PPB]	13.420	13.42	11.35	13.84	14.07
16 - NO2+NOZ-API [PPB]	10.863	10.86	9.73	11.17	12.38
17 - Manifold Flow [Ft/Min]	0.905	362.00	367.23	360.36	376.55
18 - Solar Radiation [W/M2]	0.028	454	342	474	68
19 - WS Ultra 10M [m/s]	0.171	1.71	1.65	2.08	1.24
20 - WD Ultra 10M [degTN]	3.580	26.6	347.0	12.1	3.5
21 - Elev Ultra 10M [deg]	2.779	6.7	5.5	-8.8	-2.1
22 - CO-DIFF [ppb]	NoData	25	3	11	7
23 - SO2-API [ppb]	0.240	0.24	0.15	0.24	0.22
24 - SO2-DIFF [PPB]	NoData	0.14	0.08	0.15	0.20
25 - NOy-Flow [l/m]	NoData	NoData	NoData	NoData	NoData
26 - NOy Conv Temp [degrees C]	NoData	NoData	NoData	NoData	NoData
27 - NOz - AQD [ppb]	NoData	Invalid_0.00	Invalid_0.00	Invalid_0.00	Invalid_0.00

Diagno...

Idle | Comm - Query to COM4-°col | Idle | Idle | 8/27/2007 | 7:59 AM

Figure 4. ENVIDAS for Windows Dynamic Tabular Screen

6.2.3 After reviewing the Dynamic Tabular screen, record any problems identified in the station logbook. Leave the screen in maximized position.

6.2.4 Log into the ESC 8832 data system. Verify that the Digi-Trend Scheduler program is operating. Initiate <STOP SCHEDULER>. Go to the ESC icon on desktop and activate. Type in operator's initials as <USER NAME>. No password is required.

6.2.5 Hit <OLL> and Version <Symbol>. Go to <UTILITIES>, link to logger.

6.2.6 Hit <ENTER> or <L>. Enter password. The Main Screen for the ESC Digi-Trend software should appear, as illustrated in Figure 5.

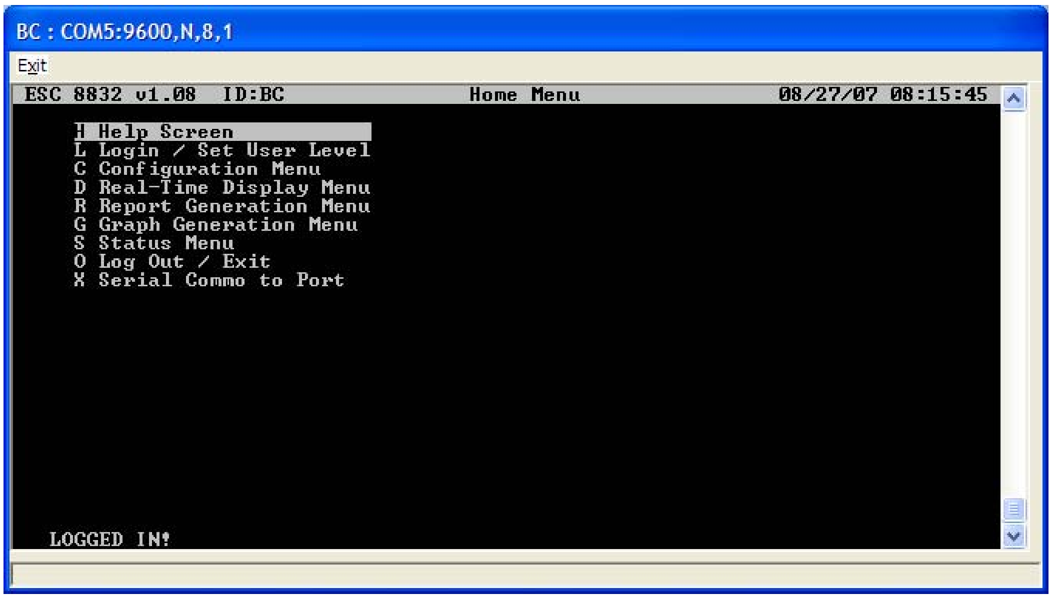


Figure 5. Main Screen for ESC 8832 Digi-Trend Software

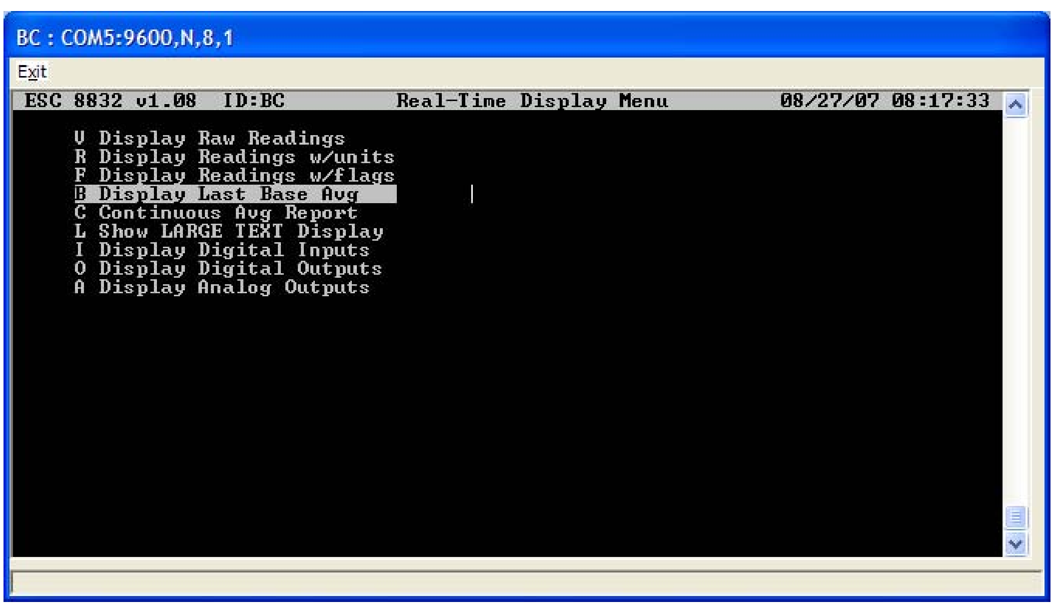


Figure 6. ESC 8832 Digi-Trend Display of Last Base Average

6.2.7 Go to <REAL TIME DISPLAY> menu (D), hit <ENTER> and highlight <DISPLAY LAST BASE AVERAGE>, as illustrated in Figure 6.

6.2.8 The screen should now display all the last averages for NO_y and other monitored pollutants, as illustrated in Figure 7.

6.2.9 Review data and observe any flags. Investigate flags; make notes in site log.

[Note: Refer to the ESC 8832 Manual, Chapter 5, for interpretation of flags.]

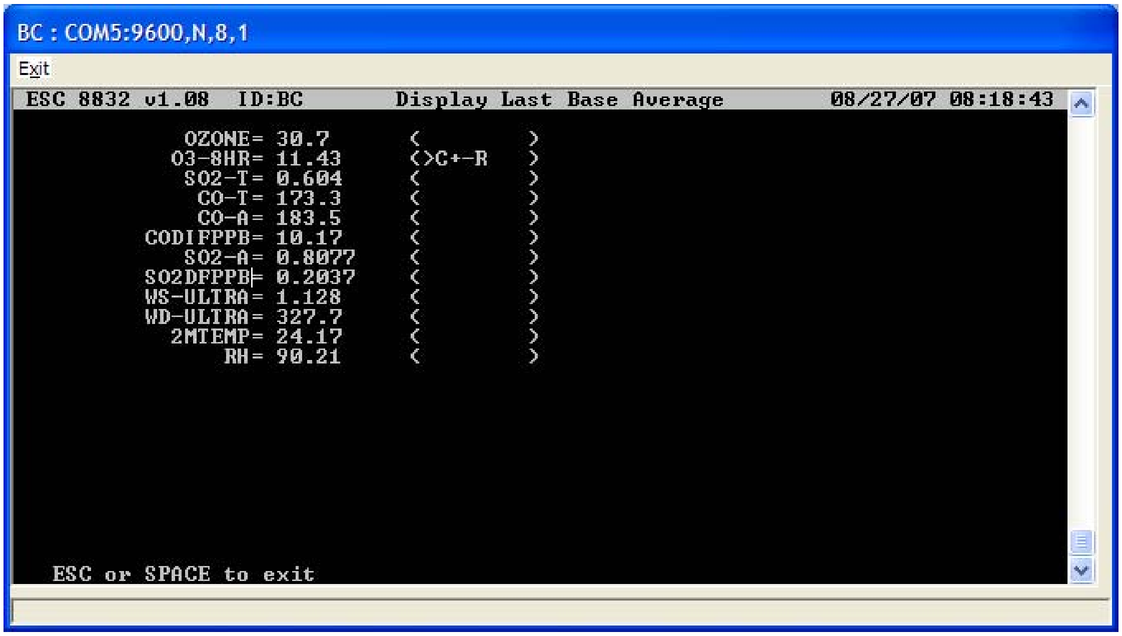


Figure 7. ESC 8832 Digi-Trend Display of Last Base Average Analyte Concentration and Flags

6.2.10 Review NO and NO_y values as displayed by the ESC data system and compare to those displayed by the ENVIDAS data system. Values should compare within ± 0.5 ppb. Note findings in Station Logbook.

6.2.11 Disable the ESC and ENVIDAS data system displays. Return them to normal data acquisition mode and display.

7.0 200EU NOy Analyzer Initial Setup

[Note: The following activities (Steps 7.1 through 7.17) are performed during initial setup of the 200E NO_y analyzer. If the analyzer is operational and taking ambient data, then proceed to Section 8.0. The information is presented here to remind the operator of these activities which should be performed periodically in order to ensure accurate and reliable data.]

7.1 For safety, disconnect electrical power from the M200EU NO_y analyzer. Carefully remove the top cover of the analyzer and check for any internal damage.

Inspect the interior of the instrument to make sure all circuit boards and other components are in good shape and properly seated. Use a light spray of compressed air and a small brush to remove dust should any be present.

7.2 Check the connectors of the various internal wiring harnesses and pneumatic hoses to make sure they are firmly and properly seated.

7.3 Verify that the T-API M200EU analyzer and the T-API M501Y Bypass Pump Chassis are in close proximity to each other. Verify that the electrical/pneumatic cable fittings to the rear of the Bypass Pump Chassis are connected. Use the tags on each tube to match up the correct tube with the rear panel bulkhead fitting. Verify that the 7-pin power and signal cable are connected to the rear of the Bypass Pump Chassis.

7.4 Verify that the exhaust of the analyzer is connected to the external vacuum pump.

7.5 Verify that the zero/span valves are connected to appropriate gas cylinders and that the calibration gas cylinder indicates at least 300 psig pressure. If not replace the cylinder, purge the regulator and lines, and update the NO and NO_x concentrations for later use in calibrations, span and precision checks and in cross-checks of analyzer response based on old and new cylinder concentrations.

[<u>Caution:</u> Maximum pressure of any gas at the sample inlet should not exceed 1.5 inches of mercury above ambient pressure and ideally should equal ambient atmospheric pressure. Also, the exhaust from the external pump needs to be vented outside the immediate area or shelter surrounding the instrument using a maximum length of 10 meters of ¼" O.D. PTFE Teflon tubing. Only Teflon can withstand the high ozone concentrations exiting the analyzer.]

7.6 Verify that the ¼" O.D. exhaust line is connected to the exhaust port of the analyzer and to the inlet port of the pump.

7.7 Verify that the power cord to the analyzer is plugged into a power outlet capable of carrying at least 10 Amp current at 110 volts. To avoid damage to the analyzer, make sure that the AC power voltage matches the voltage indicated on the rear panel serial number label and that the frequency is between 47 and 63 Hz.

7.8 Verify that the analog output connections are secure and the serial cable is connected to the COM1 serial port on the rear panel. The other end of the serial cable is connected to the computer.

7.9 After the electrical and pneumatic connections have been verified, check that the Bypass Pump Module power supply is on and the "Red" LED is illuminated. The power indicator light and display should be glowing on the Bypass Pump Module and, in addition, the bypass pump can be heard operating. If the pump of the bypass module has just been activated, the M501Y requires about 30 minutes for the converter to come up to operating temperature ($350 \pm 7\ ^oC$). Once the Bypass Pump Module is "On," the front panel display will display the temperature of the converter. While the converter is coming up to temperature, the M200EU should be powered-up also (activate the power switch on front panel and observe an illuminated "Green" LED) if not already done so. The "No Fault"red LEDs on the front of the M200EU should be illuminated. The exhaust and PMT cooler fans should be operating. It will also take about 30 minutes for the internal ozone generator of the M200EU to start up and achieve stability.

[Note: During this time the instrument will not respond to calibration gases.]

The display on the M200EU should immediately display a single, horizontal dash in the upper left corner of the display. This will last approximately 30 seconds while the CPU loads the operating system. Once the CPU has completed this activity, it will begin loading the analyzer firmware and configuration data. During this process, a string of messages will appear on the analyzer's front panel display, as illustrated in Figure 8.

7.10 The M200EU requires approximately 30 minutes to warm-up before reliable data can be gathered or calibration of the instrument can be performed. During this period, various portions of the instrument's front panel will display various readings, as identified in Table 4.

Table 4. Warm-up Readings Displayed on 200EU NOy Analyzer Front Panel

Name	Color	Behavior	Significance
Concentration Field	N/A	Switches between NO_x, NO and NO_y	This is normal operation.
Mode Field	N/A	Displays blinking "SAMPLE"	Instrument is in sample mode but is still in process of warming up (hold-off period is active).
STATUS LEDs			
Sample	Green	On	Unit is operating in sample mode; front panel display is continuously updated.
Cal	Yellow	Off	The instrument's calibration is not enabled.
Fault	Red	Blinking	The analyzer is warming up and out of specification for a fault-free reading.

7.11 During warm-up, various warning messages may appear on the instrument screen. This is due because internal temperatures and other parameters may be outside of specified limits during warm-up. The software will suppress most warning conditions for 30 minutes after power up. Refer to the M200E Instruction Manual, Table 3-6, for example of error warning messages that might appear during warm-up. If warning messages persist after 30 minutes, investigate their cause using the troubleshooting guidelines in Chapter 1 of the Model 200E Instruction Manual.

7.12 After the M501Y converter has warmed up for at least 30 minutes, the display on the Bypass Pump Chassis should read 350 ^{o}C, indicating that the converter is up to temperature. At this time, open the box of the M501Y and observe the 47-mm filters. Verify that they are free of particulate matter. If dirty, replace with clean filters.

7.13 After the 30-minute warm-up for the M200EU, the analyzer will be in the "Sample Mode."

7.14 In this step, checks are conducted to see that all parameters of the M200EU are operating within the proper ranges. Appendices A and C of the Model 200E Instruction Manual include a list of test functions viewable from the analyzer's front panel as well as the expected, acceptable values. These functions may also be used and as useful tools for documenting proper operation as well as for diagnosing performance problems with the analyzer during normal operations. To view the current values for the test functions, press one of the **<TST TST>** key. The various test functions which are viewable are illustrated in Figure 9.

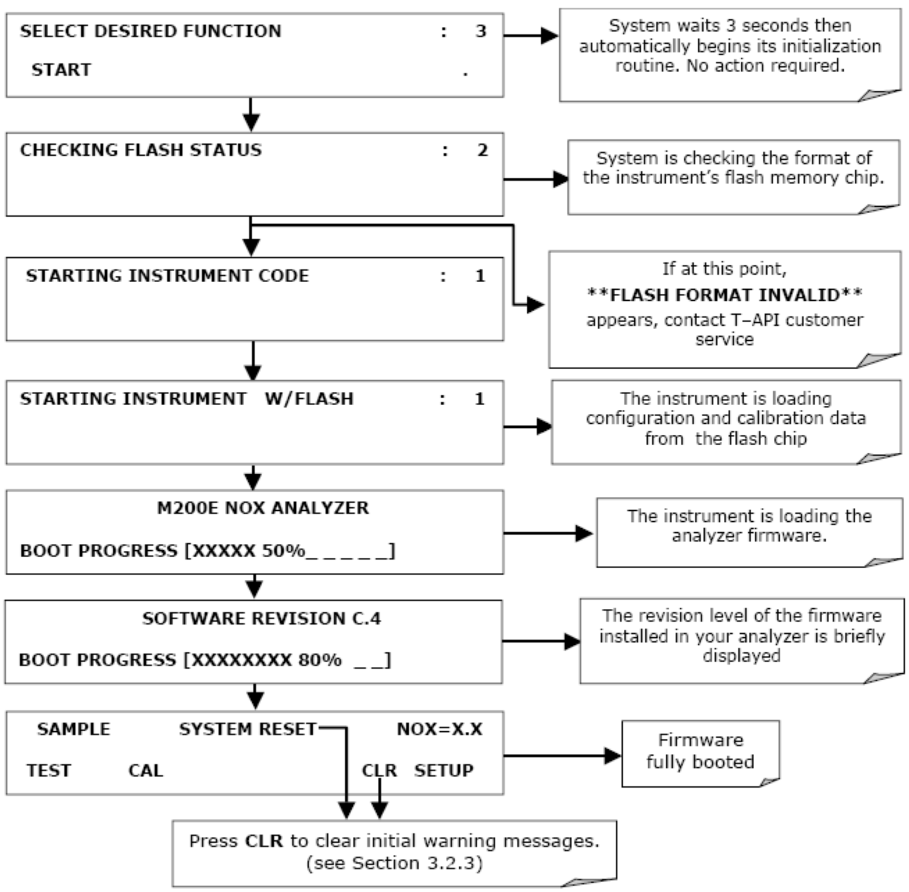


Figure 8. M200EU NOy Analyzer Front Panel Display During Startup Sequence

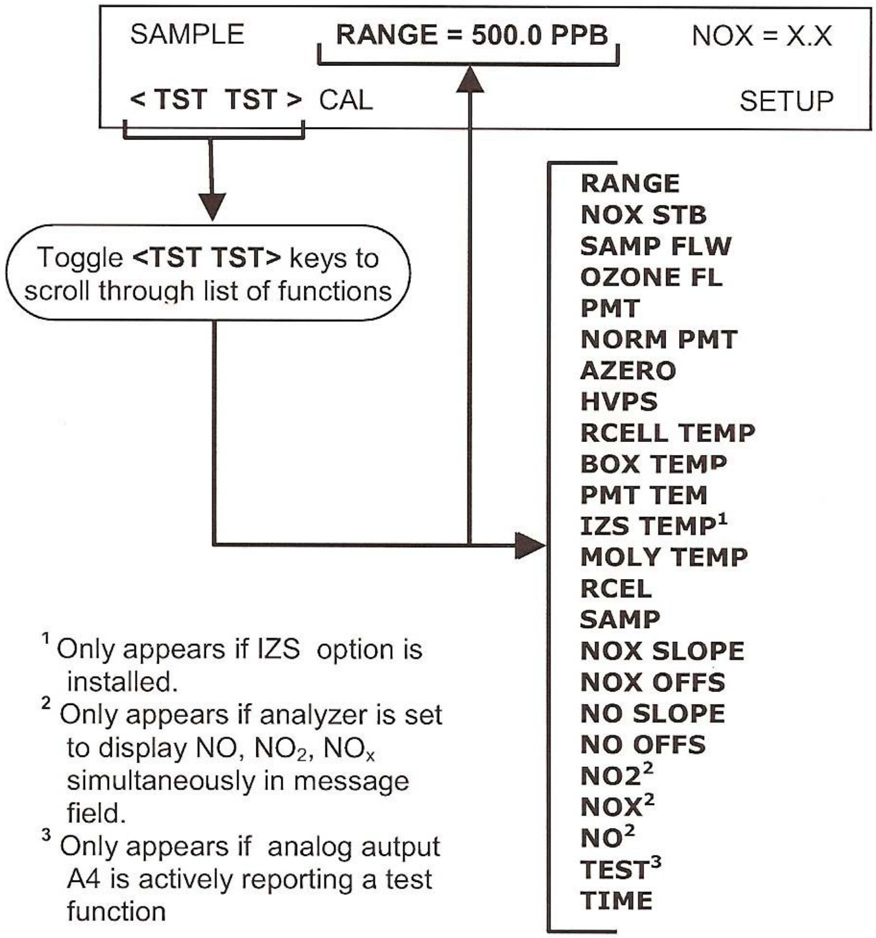


Figure 9. Viewable Test Functions Accessible From Front Panel of M200EU NOy Analyzer

7.15 View the values displayed on the front panel of the M200EU as you press one of the <TST TST> keys. Record the information on the Burdens Creek Site M200EU Test Measurement Record, as illustrated in Figure 10. Keep this record at the site for comparison to results of subsequent tests.

7.16 If there are problems and disagreements with the expected or acceptable values recorded in Figure 10, maintenance and leak checks of the NO_y analyzer may be indicated. Consult the Operator's Manual for additional information on leak check procedures. Perform a leak check of the entire analyzer system in accordance with the instrument's manufacturer's recommendations and EPA requirements. Inspect the analyzer system and sample line for dirt, debris and moisture. Change and/or clean if necessary. Suggestions for maintenance and leak checks are given in Section 7.17.

7.17 **[Note: The following activities (Steps 7.17.1 through 7.17.6) are performed during initial setup of the M200 EU NO_y analyzer. If the analyzer has been challenged with zero and span gas as identified in Section 8.0 (Unadjusted/As**

Found Zero and Span Determination and Verification of NO_y Sampling Data Prior to Calibration) and passed % error limitations, then proceed directly to Section 8.0 for manual multi-point calibration. The information is presented here to remind the operator of these activities which should be performed periodically in order to ensure accurate and reliable data.]

7.17.1 Replace the sampling train in-line particulate filter with new clean 5.0 μM Teflon® filters, if needed. The NO_y analyzer has two (2) inline filters that need to be changed in the NO and NO_y sampling trains.

7.17.2 Perform a leak check of the entire analyzer system in accordance with the instrument's manufacturer's recommendations and EPA requirements. Inspect the analyzer system and sample line for dirt, debris and moisture. Change and/or clean if necessary.

7.17.3 Confirm and record that the analog output to the DAS agrees with the front panel of the instrument. Perform adjustments, if necessary, in accordance to the manufacturer's instructions.

7.17.4 Perform any further maintenance on the instrument in accordance with the instrument manufacturer's recommendations.

7.17.5 Record all test readings, pass/fail of leak check, and flows in the site logbook.

Teledyne-Advanced Pollution Instrumentation
Model 200EU Ultra Sensitive
$NO/NO_2/NO_x$ Analyzer with Model 501 Converter

Burdens Creek Site

M200EU Test Measurements Record

Parameter	**Recorded Value**			**Acceptable Value**
Date of Test →				
Range				0-0.200 ppm
NO_x STAB				< 1 ppb with Zero Air
Sample Flow				1000 ± 50 cm^3/min.
Ozone Flow				80 ± 15 cm^3/min.
PMT				-20 to 150 mV
Norm PMT				800 mV
Pre-React				
HVPS				400 to 900 Volts
RCell Temp				50 ± 1 ^oC
Box Temp				Ambient ± 5 ^oC
PMT Temp				7 ± 2 ^oC
MF Temp				50 ± 1 ^oC
O_3 KL Temp				
RCell Press				< 10 in. Hg Absolute
Samp Press				Ambient ± 1 in. Hg Absolute
NO_x Slope				1.0 ± 0.3
NO_x Offset				50 to 150
NO Slope				1.0 ± 0.3
NO Offset				50 to 150
Time of Day				± 5 Minutes
Others				
Moly Temp				350 ± 5 ^oC
Shelter Temp				20-30 ^oC
Operator's Name	**Comments and Notes**			

Figure 10. Burdens Creek Site M200EU NOy Test Measurement Record

8.0 Conduct Manual Unadjusted/As Found Zero and Span Determination and Verification of NO_y Sampling Data Prior To Calibration

[Note: Unlike most NO/NO_x analyzers, the M200EU with the NO_y option does not have a sample inlet port on the rear panel of the 200EU. The sample port is located on the "external converter" (i.e., molybdenum converter) at the inlet of the probe. This means that the zero/span gases always are routed through a connection in front of the converter at the entrance to the probe assembly. The calibration gases must be delivered under a small positive pressure (2-5 psig above atmospheric pressure) to overcome internal resistance within the ¼ inch O.D. Teflon tubing leading from within the shelter to the top of the 10-meter height tower. Also, excess calibration gas is vented through the sample inlet and there must be no additional venting of the zero and span gas to the atmosphere. Calibration gases must be provided for both the bypass system and the M200EU analyzer. Flow requirements are 1.1 L/min for NO bypass, 1.1 L/min for NO_y bypass and 1 L/min for the M200EU analyzer. Calibration gas flow must be in sufficient excess (~4 L/min) to flood the area and prevent ambient air from entering the sampling port at the top of the tower.]

Use the following steps to conduct a manual unadjusted zero and span procedures. Study and consult the Operator's Manual for full details

8.1 Go to the ENVIDAS with the Dynamic Tabular Screen open. Go to <Configuration>, then <Set-up>. Enter user name and password, press O.K.

8.2 Go to <Channels>, click on <NO-API>. Go to <State> on screen and scroll to <Off Scan>. Then hit <Save>.

8.3 Return to <Channels>, click on <NO_y-API>. Go to <State> on screen and scroll to <Off Scan>. Then hit <Save>.

8.4 Return to <Channels>, click on <NO_2 + NO_z-API>. Go to <State> on screen and scroll to <Off Scan>. Then hit <Save>.

8.5 Return to Dynamic Tabular Screen to verify that the changes have been made.

8.6 From the Dynamic Tabular Screen, go to <View>, then to <Dynamic Data>, then to <I/O Dynamic>.

8.7 Go to <NO Calibration> symbol and highlight "Dot" to switch ambient solenoid to normally closed position and commence flowing of calibration gas to the tower-mounted converter.

8.8 Go to the Environics Series 9100 calibrator and press <Concentration Mode> (i.e., F1). The screen now displays the "Target Gas" concentration. Observe that "Total Flow" is greater than 5 L/min. Enter 0.0 for "NO-Target Gas."

8.9 Hit <Start> (i.e., F1). The zero gas will now flow from the NO_y Pump Module up to the probe and down to the analyzer.

8.10 Wait 15 minutes or until a stable reading occurs. Observe and record the gas concentrations for the zero gas (as displayed on the ESC Series 9100 and the ENVIDAS) on the "Unadjusted/As Found Zero and Span Verification Form," Figure 11.

8.11 Go to the Environics Series 9100 Calibrator and using the Up/Down Arrows, enter target gas concentration of 0.180 ppm (i.e., 90% of full scale value of 0.200 ppm).

8.12 Hit <Update> (F1).

8.13 Wait 15 minutes or until a stable reading is obtained. Observe and record the gas concentrations for the span gas, as presented on the ESC Series 9100 and the ENVIDAS, on the "Unadjusted/As Found Zero and Span Verification Form," Figure 11.

8.14 Repeat Steps 8.8 through 8.13 for the NO_y channel.

8.15 Calculate per cent error using the following equations:

$$\% \text{ error} = \frac{(\text{NO output ppb} - \text{NO input ppb})}{(\text{NO input ppb})} \times 100$$

and

$$\% \text{ error} = \frac{(NO_y \text{ output ppb} - NO_y \text{ input ppb})}{(NO_y \text{ input ppb})} \times 100$$

[Note: Data are valid if percent error is ≤ ± 15%. If the percent error exceeds ±15% of the generated values, then find the problem, fix it, and perform a multi-point calibration to verify linearity of system.]

8.16 Record monitor response values on the Unadjusted/As Found Zero and Span Verification Form, Figure 11.

8.17 Go back on ENVIDAS to the "I/O Panel," turn-off NO solenoid by clicking on <Red Dot>.

8.18 Go to <Channels>, click on <NO-API>. Go to <State> on screen and scroll to <On Scan>. Then hit <Save>.

8.19 Return to <Channels>, click on <NO_y-API>. Go to <State> on screen and scroll to <On Scan>. Then hit <Save>.

8.20 Return to <Channels>, click on <NO_2 + NO_z-API>. Go to <State> on screen and scroll to <On Scan>. Then hit <Save>.

**Teledyne-Advance Pollution Instrumentation
Model 200EU Ultra Sensitive
NO/NO_2/NO_y Analyzer with Model 501 Converter**

Burdens Creek Site
Unadjusted/As Found Zero and Span Verification Form

GENERAL INFORMATION

- Date: ____
- Site: ____
- Analyst: ____
- Analyzer Model and S/N:____
- Analyzer Range:____
- Sampler Location:____
- Calibration Operator: ____
- Project No.: ____

CALIBRATION GAS INFORMATION

- Gas Cylinder S/N:____
- Gas Cylinder Pressure:____
- Gas Pollutant and Concentration:_______NO_______NO_2_______NO_x _______Other
- Certification Date: ____
- Zero Air Supply Model & S/N: ____
- Span Gas Pollutant Concentration:______NO_______NO_2________NO_x______Other

FIELD INFORMATION

- Ambient Temperature: ____
- Ambient Pressure: ____
- Wind Speed/Wind Direction: ____
- Rain: Yes___________No______________
- Analyzer Leak Check: ___________Pass__________Fail

Point #	**Zero Gas (ppm)**		**Span Gas (ppm)**		**% Error**
Data System ➔	**ENVIDAS**	**ESC Series 9100**	**ENVIDAS**	**ESC Series 9100**	**(± 15%)**
Reading➔	NO= NO_2= NO_y=	NO= NO_2= NO_y=	NO= NO_2= NO_y=	NO= NO_2= NO_y=	

Figure 11. Unadjusted/As Found Zero and Span Verification Form

9.0 Manual Multi-Point Zero and Span Calibration Procedures for the M200EU NOy Analyzer

[Note: The calibration of the M200EU NO_y Analyzer can be checked or adjusted using gas introduced through the calibration port on the Bypass Pump Module. The zero gas and calibration gas is routed to a "TEE" near the sample inlet port located at the inlet of the remote molybdenum converter assembly on the sample probe tower outside the shelter.]

Conduct the manual multi-point zero and span calibration procedure as follows.

9.1 Go to the ENVIDAS with the Dynamic Data Screen open. Go to <Configuration>, then <Set-up>. Enter user name and password, press O.K.
9.2 Go to <Channels>, click on <NO-API>. Go to <State> on screen and scroll to <Off Scan>. Then hit <Save>.
9.3 Return to <Channels>, click on <NO_y-API>. Go to <State> on screen and scroll to <Off Scan>. Then hit <Save>.
9.4 Return to <Channels>, click on <NO_2 + NO_z-API>. Go to <State> on screen and scroll to <Off Scan>. Then hit <Save>.
9.5 Go to the Dynamic Tabular Screen, go to "I/O" and highlight <NO Cal Sol>.
9.6 Go to the Environics Series 9100 and press <Concentration Mode> (i.e., F1). The screen now displays the "Target Gas" concentration. Observe that "Total Flow" is greater than 5 L/min. Enter 0.0 for "NO-Target Gas."
9.7 Hit <Start> (i.e., F1). The zero gas will now flow from the NO_y Pump Module up to the probe and down to the analyzer.
9.8 Wait 15 minutes or until a stable reading is obtained.
9.9 On the M200EU, hit <Cal>, then <Zero> twice which will zero all channels.
9.10 Record zero reading on the Multipoint Calibration Data Sheet, Figure 12.
9.11 Go to the Environics Series 9100 and scroll to <NO Target> and enter span value of "0.180 ppm."
9.12 Hit <UPDATE> F1 and wait 15 minutes or until a constant reading is obtained.
9.13 Go to the M200EU, hit <CONC>, hit NO_x button, hit <ENTER>.
9.14 Change to NO, observe 0.180 ppm, hit <ENTER>.

[Note: If the monitor does not display exactly 0.18 ppm, one can use the toggles under the number to adjust the value to 0.18 ppm.]

9.15 Hitting <ENTER>, the M200EU sets all values to 0.18 ppm and adjust slope of curve. Enter span gas value and monitor response on the Multipoint Calibration Data Sheet, Figure 12.
9.16 Go to the Dynamic Tabular Screen and record observed values on Multipoint Calibration Data Sheet found in Appendix C.

9.17 Repeat **Steps 9.11** through **9.14** for span points 0.12 ppm, 0.080 ppm, 0.04 ppm and 0 ppm. Do not make adjustments to the analyzer response to these calibration gas standards. The only concentration adjustment is made to the 0.18 ppm standard.

9.18 Record all data on the Multipoint Calibration Data Sheet found in Appendix C.

9.19 On the Multipoint Calibration Data Sheet, calculate the NO and NO_y values (subtracting the mean zero) for each of the 4 points completed and the % error.

[<u>Note:</u> If the % errors of the points, and especially for the final point, (0.04 ppm) are more than ± 5.0%, the system should be checked and the calibration may need to be repeated.]

9.20 Calculate the NO and NO_y regression data using the input ppm as the 'X' variable and the output ppm as the 'Y' variable. Though the <u>actual</u> zero values are <u>not</u> to be used in calculating the regression values, a zero value of 0.000 is to be entered as the last integer in the 'x' and 'y' columns. Record the 'm' (slope, 1.0 ± 0.02 or less), 'b' (y intercept, ± 1.0 ppb or less) and 'r' (correlation coefficient, 0.9950 or greater). Enter the NO and NO_y regression values on the calibration form.

Teledyne-Advance Pollution Instrumentation
Model 200EU Ultra Sensitive
NO/NO_2/NOy Analyzer with Model 501 Converter

Burdens Creek Site
Multi-point Calibration Form

GENERAL INFORMATION

- Date: ______________________________
- Site: ______________________________
- Analyzer Model and S/N:______________________________
- Analyzer Range:______________________________
- Sampler Location:______________________________
- Calibration Operator: ______________________________
- Project No.: ______________________________

CALIBRATION GAS INFORMATION

- Gas Cylinder Serial Number:______________________________
- Gas Cylinder Pressure:______________________________
- Gas Pollutant and Concentration:_______NO_______NO_2_______NO_x_______Other
- Certification Date/Expiration Date______________________________
- Zero Air Supply Model & Serial Number: ______________________________
- Span Gas Pollutant Concentration:_______NO_______NO_2_______NO_x_______Other

FIELD INFORMATION

- Ambient Temperature: ______________________________
- Ambient Pressure: ______________________________
- Wind Speed/Wind Direction: ______________________________
- Rain: Yes__________No____________
- Analyzer Leak Check: __________Pass__________Fail

Table 1. As Found Conditions

NO Point	NO	NOy	NO2 + NOz
180 ppb			
120			
80			
40			
0			

Table 2. Multipoint Calibration

NO Point	NO	NOy	NO2 + NOz
180 ppb			
120			
80			
40			
0			

Table 3. Gas Phase Titration Results

NO Point	NO	NOy	NO2 + NOz
160 ppb			
120			
80			
40			
0			

FLOWS
Dilution Flow____
Span Flow____

RELATIONSHIPS

NO Regression y = mx + b
Slope (m) =____
Y Intercept (b) = ______________________________________
Correlation Coefficient (cc) = _____________________________

NO_y Regression y = mx + b
Slope (m) =____
Y Intercept (b) = ______________________________________
Correlation Coefficient (cc) = _____________________________

Comments and Maintenance Activities

Figure 12. Multi-Point Calibration Data Sheet for NOy Analyzer

10.0 Converter Efficiency Determination by Gas Phase Titration (GPT)

[Note: The converter efficiency test can be performed during the multi-point calibration].

10.1 Go to the Environics calibrator, go to NO and enter 0.18 ppm.
10.2 Hit <UPDATE> F1. Wait 15 minutes or until a constant reading is obtained. Record value in Station Logbook and on Multi-point Calibration Form, Figure 12.
10.3 Go to the calibrator. Move cursor to <OZONE> and change to 0.16 ppm.

[Note: The O_3 reacts with the NO to form NO_2 which flows to the probe at the inlet of the converter. In the gas stream we now have:

- **0.02 ppm NO**
- **0.16 ppm of NO_2 and NO_z**
- **0.18 ppm of NO_y]**

10.4 Wait 15 minutes or until stable readings are evident.
10.5 Go to M200EU, press <CAL>, then <CONC>, then <CONV>, then hit <SET>. Record present converter efficiency.
10.6 Change the CE to 1.000.
10.7 Hit **<EXIT>** three times**.**
10.8 Go to Dynamic Tabular Screen of the ENVIDAS data system and observe readings for NO, NO_2 + NO_x and NO_y. They should be the same as displayed on the front panel of the M200EU analyzer.
10.9 Calculate converter Efficiency (CE by the following equation:

Converter Efficiency (CE) = Measured NO_2/Actual NO_2

Where: Actual $NO_2 = NO_I - NO_{GPT}$

If CE is less than 0.96 then molybdenum converter must be repaired or replaced

10.10 Go to M200EU, press <CAL>, then <CONC>, then <CONV>, then hit <SET>. Enter the new CE into the M200EU analyzer. Hit <ENTER>.
10.11 Repeat for points at 0.12, 0.08, 0.04, and zero ppb ozone. Do not adjust the CE for these points.

11.0 Quality Control Checks and Quality Assurance

11.1 Introduction

The purpose of performing quality control checks being performed is to verify the quality of the data being collected. The quality control checks performed allow the precision and validity of the ambient air monitors to be quantified. This is done by testing the monitor's response to known inputs in order to assess the measurement error. The Burdens Creek site will use the Data Quality Objectives (DQOs) developed by EPA and documented in 40 CFR Part 58, Appendix A.

The goal for acceptable measurement uncertainty for the NO_y methods is defined for precision as an upper 90 percent confidence limit for the coefficient of variation (CV) of 10 percent and for bias as an upper 95 percent confidence limit for the absolute bias of 10 percent (CV). Thus, the Burdens Creek site data set will be assumed to have met the DQO if the Measurement Quality Objectives of 10% or better for precision and 10% or better for bias are consistently met over the months and years of site operation.

Table 5 documents the Measurement Quality Objectives (MQOs) associated with the Model 200EU NO_y analyzer. This section details primarily with the data quality indicators. Quality control for continuous electronic instruments, such as the Model 200EU consists of performing the diagnostic checks, maintenance and calibrations.

Table 5. Measurement Quality Assurance Objectives

Requirement	**Frequency**	**Acceptance Criteria**	**Reference**	**Action**
Bias	NCORE, once per year	Slope: 1.00 ± 0.02 Intercept: ± 1.0 ppb Regression: <0.9950	40 CFR Pt.58	Use of NIST-traceable generated gas concentrations with Mass Flow Calibration unit that is NIST traceable
Precision	Quarterly Daily Zero/Span	Multi-point Concentration: 0-0.180 ppm, Coefficient of Variance less than 10%. 1-Point Check at Conc. Near Typical NO_y Levels at NCore Station	40 CFR Pt.58 Appendix A	If CV is greater than 10%, Institute Quality Control Measures If CV is greater than 10%, Institute Multi-point Calibration
Completeness	Quarterly, Annually	NCORE, 75%	National Monitoring Strategy.	If under 75%, institute Quality Control Measures
Representa-tiveness	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 (MDL)	NA	50 ppt	National Monitoring Strategy	MDL determined at Burdens Creek site or EPA lab.
Converter Efficiency (CE)	Every 2 weeks	1-Point Check at Conc. Near 0.18 ppm NO_y;CE ≥ 96%.	National Monitoring Strategy	Replace Converter and Determine New Efficiency

11.2 Maintenance and Leak Check

11.2.1 Follow the procedures outlined in the Operator's Instruction Manual for maintenance and leak check of the NO_y analyzer.
11.2.2 Record all test readings, pass/fail of leak check, and flows in the log entry.

11.3 Procedures in the Event of a QC or QA Audit Check Failure

11.3.1 In the event of an audit failure, investigative/corrective actions **must** be performed **as soon as possible**.
11.3.2 Data must be verified **before** any corrective action is taken.
A manual set of zero/upscale points **should** be introduced **manually** from the certified calibration source and gas standard through the sampling train/convertor to the analyzer. The instrument's internal solenoids **must not** be used. A Standard zero must also be run at the end of the challenged points. The data channel should be flagged down manually for these proceedings. Enter the results in the logbook entry.
11.3.3 Once data has been verified, investigative/corrective action may be taken to repair the instrument. A leak check **should** also be performed on the entire sampling train. The corrective actions are to be also noted in the log entry.
11.3.4 Once repairs have been made a follow-up set of zero/Level 1 points and a Standard zero must again be introduced **manually** from the certified calibration source and gas standard through the sampling train/probe to insure that the instrument is now functioning properly.
11.3.5 If the **manual** follow-up set of points is ≤ ± 15.0% data will again be valid. However, if the **manual** follow-up points are > ± 15.0%, and if the internal/instrument zero is > ± 1.0%, then a new complete multi-point calibration must be followed. Enter all events into the logbook.
11.4.6 Once the above procedures have been successfully completed, the instrument's data channel(s) can be put back online.

12.0 Preventive Maintenance and Troubleshooting

Long-term operation of continuous gas analyzers requires a preventive maintenance program to avoid instrument down-time and data loss. Despite active preventive maintenance, occasional problems may arise with the high sensitivity NO_y analyzer. This section briefly describes several key items which should assist with maintaining 75% data capture by implementing a rigorous preventive maintenance and troubleshooting program. The Model 200EU Instruction Manual also provides guidance on important functions for a preventive maintenance program.

12.1 Preventive Maintenance

NO_y values can be erroneous if the sample inlet and lines become dirty, cracked, or leaky. PFA lines should be inspected at least quarterly and replaced as needed, but at least every two years. Teflon filters used in the sampling train to remove fine particles may need to be replaced as often as every week, depending on the condition of the filter and the particulate loading around the monitoring site. The NO_y inlet should be inspected every time the NO_y filter is changed. Routine preventive maintenance procedures and schedule are illustrated in Table 6.

Table 6. Preventive Maintenance Schedule for Teledyne-API Model 200EU

Item	Schedule
Maintain Air Dryer	As Needed
Replace Particle Filter	Bi-weekly or monthly depending on ambient particulate loading
Perform Pneumatic System Leak Check	At Least Quarterly
Inspect Internal, External Tubing; Replace If Necessary	Inlet, Weekly; Other, Quarterly
Clean Optical Bench	As Needed
Replace PMT	As Needed
Monitor NO_2 Conversion Efficiency with GPT	At Least Every 2 weeks
Monitor NPN Conversion Efficiency	At Least Every 6 months

12.2 Troubleshooting

When troubleshooting, an operator must constantly be aware of environmental factors that may affect the instrument. Environmental factors can also cause:

- Variable shelter temperature (fluctuations greater than several degrees C)
- Excessive vibration from other equipment
- Voltage instability; fluctuations in the 110 VAC line voltage
- Air conditioning system blowing on instrument
- Frequent opening of the door of the shelter
- Leaks

Table 7 summarizes common problems seen with precursor NO_y analyzers, possible causes, and possible solutions.

Table 7. Instrument Troubleshooting for Teledyne-API Model 200EU

Problem	Possible Cause	Possible Solution
Noisy Output	Defective DC Power Supply	Replace Power Supply
	Dirty Reaction Cell	Clean Cell
	PMT Failure	Replace PMT
High Positive Zero Drift	Defective Band pass Filter	Replace Filter
	PMT Failure	Replace PMT
High Pre reactor Zero Reading	Moisture in PMT Housing	Allow PMT Housing to Warm Up; Purge with Dry Gas
No Response to Span Gas	PMT Failure	Replace PMT
	Voltage Failure	Replace High Voltage Source
	No O_3 Supply	Clean or Replace O_3 Generator
Low or Declining Response to Span Gas	O_3 Source Failing	Clean or Replace O_3 Generator
	Dirty Reaction Cell Window	Clean Window
Zero Output at Ambient Levels	Pump Failure	Check Pump
	PMT Failure	Replace PMT
Low NO_2 or n-propyl nitrate Conversion Efficiency	Aging or Dirty Converter	Replace Converter
No Flow Through Analyzer	Pump Failure	Replace/Rebuild Pump Head

13.0 References

1. Code of Federal Regulations, Title 40, Part 53.23c
2. Code of Federal Regulation, Title 40, Part 58, Appendix A
3. The National Air Monitoring Strategy, Final Draft, 4/29/04, http://www.epa.gov/ttn/amtic/monstratdoc.html
4. Model 200E Nitrogen Oxides Analyzer Instruction Manual, Teledyne-Advanced Pollution Instrumentation (T-API), 9480 Carroll Park Drive, San Diego, CA 92121-5201, January 9, 2007 (PN 04410)
5. Model 200EU Ultra Sensitive $NO/NO_2/NO_y$ Analyzer Instruction Manual, Teledyne-Advanced Pollution Instrumentation (T-API), 9480 Carroll Park Drive, San Diego, CA 92121-5201, January 9, 2007 (Addendum to M200E Manual PN 04410)