

MODEL 42*i*-Y TRACE LEVEL REACTIVE OXIDES OF
NITROGEN (NO_y) MONITORING SYSTEM
Section II

OPERATOR RESPONSIBILITIES

Standard Operating Procedure Approval

I certify that I have read and approve of the contents of this revision of 2.38.2 with an effective date of February 10, 2016.

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2.38.2 Trace Level NOy Monitoring Site Operation Procedure

Note: The following is a list of "significant changes" from Revision 5.4.

- 1) Calibration (adjusted calibration) is required every 91 days for the Model 42i-Y TLNO_y monitor (NCore site only).
- 2) Calibration requirements added to Calibration section.
- 3) Zero Calibration Check criteria changed to ± 0.5 ppb.
- 4) Scheduler and Back-Up Data Logger (BUDL) references removed.
- 5) Remote Calibration Check procedure added.
- 6) Non-NCore calibration requirement added.
- 7) EDAS language removed and AvTrend language added.
- 8) Teledyne Model 701 Zero Air Pak added to ambient monitoring system.
- 9) Auxiliary pump capillary replacement removed.

2.38.2.1 Site Operation for Trace Level High Sensitivity Nitrogen Oxide (TLNOy) Monitors

The goals of the United States-Environmental Protection Agency's (US-EPA) National Ambient Air Monitoring Strategy (NAAMS) include improvement of scientific and technical competency of the nation's air monitoring networks and increased value in protecting public health and the environment. Monitoring data are used to characterize air quality and associated health and eco-system impacts, develop emission strategies to reduce impacts, and account for progress over time. In that regard substantial improvements in ambient air quality have been achieved over the last two decades and as a result ambient concentrations of several of the criteria pollutants (such as Pb, CO, SO₂, NO₂, etc.) are now well below the applicable National Ambient Air Quality Standards (NAAQS).

While the obvious problems of widespread elevated concentrations have been largely solved for some of the criteria pollutants, problems related to particulate matter (PM), ozone (O₃) and toxic air pollutants still remain. Further it now has become clear that even very low air pollution levels can be associated with adverse environmental and human health effects. As a result, new approaches in air monitoring are required to measure these low levels and to incorporate these measurements with other related data into compressive assessments of human and environmental health.

One of the major areas of investment in the NAAMS is the use of highly sensitive commercial air pollutant monitors for the characterization of the precursor gases such as CO, SO₂, and total reactive oxides of nitrogen (NO_y) in a new National Core (NCore) monitoring network. These high sensitivity monitors (such as CO, SO₂ and NO_y) are fundamentally the same as those designated as Federal Reference and Equivalent methods, but with modifications to improve sensitivity and accuracy or reduce interferences. The use of such precursor gas analyzers in the NCore network will not only allow determination of compliance with the NAAQS, but will also provide measurements at much lower detection limits than achievable by current monitors. This capability of more accurate measurements at low concentrations will also support long-term epidemiological studies, reduce uncertainties in data for modeling of air pollution episodes, and support source apportionment and observational analysis.

NCore is both a repackaging and an enhancement of existing networks with emphasis on the term "Core" reflects a multi-faceted national network that can be complemented by more specific efforts, such as intensive field campaigns to understand atmospheric processes, or personal and indoor measurements to assess human exposure effects.

The precursor gases CO, SO₂ and NO_y play an important role in the formation of atmospheric ozone, air toxics and particulate matter on both local and regional scales. Measurements of ambient nitrogen oxides differ from measurement of CO and SO₂ in that the target air pollutant is not a single chemical but a group of chemicals of different properties. Nitrogen oxides released from emission sources are primarily nitric oxide (NO) with lesser amounts of nitrogen dioxide (NO₂), which collectively are termed as NO_x (i.e. NO_x = NO + NO₂). These primary emitted species are converted by atmospheric processes to numerous other inorganic and organic nitrogen oxides, which are collectively called NO_z. The total of all reactive gaseous nitrogen species present in ambient air is called NO_y (i.e. NO_y = NO_x + NO_z).

The objectives of this document are to establish and deploy common site operations and instrument calibration procedures for the generation of quality NO_y data that may be compared and if needed, further extrapolated. Therefore, it is critical that the Site Operator strictly follow these protocols and procedures to the last details. Technical assistance is also available from the Electronics and Calibration Branch (ECB), Telephone Number 919-715-1761.

All original records (electronic logbook, site logbook, etc.) must be legible, complete, dated and initialed by the Site Operator and retained as a part of the permanent analyzer record. The Operator's initial on the logbook form certifies that the procedures have been performed in accordance with QA/SOP and that the information contained on the form is accurate. All records are to be reviewed and certified by the Regional Chemist and further audited at the Central Office.

A. Continuous Monitoring Principles for the Model 42i-Y NO_y Monitoring System- Site Operator Responsibilities

- Note any unusual events at the site such as power failure, equipment problems, Site building problems, etc.
- The site is to be inspected for required maintenance such as shelter conditions, condition of plumbing/lines, compressor and silica gel condition, filter changes, etc.
- Note site temperature.
- Verify instrument and cylinder numbers and certification dates. The site operator should call Electronics and Calibration Branch (ECB) when the cylinder pressure reaches 500 psig and the cylinder should be replaced before it reaches 200 psig. Note the call to ECB in the electronic logbook.
- Verify that the 146C has the correct cylinder concentration stored in memory.
- An initial adjusted calibration (hereafter referred to, as "adjusted calibration" must be performed during the site start-up.
- Calibration (adjusted calibration) is required whenever a system's operation is interrupted: more than two days without power, physical removal/replacement of system's components (monitor, calibrator, NO cylinder, NO₂ – to NO Converter, sample line) or major repairs/maintenance.
- Calibration (adjusted calibration) is required whenever a system's operation is offline more than two days.
- A calibration (adjusted calibration) is required when a calibration check (i.e. unadjusted calibration) fails. Replace the filter and perform calibration.
- **NCore** - The monitor should be calibrated (adjusted calibration) at a minimum of once per quarter (91 days), even when properly operating over that time period.
- **Non NCore** - The monitor should be calibrated (adjusted calibration) at a minimum of once per year, even when properly operating over that time period.
- **All Sites** - visit the site at least once every 14 days or less and perform a calibration check (unadjusted calibration). A calibration check is to be performed before any changes are made to the monitoring system.
- As a part of calibration check, perform a precision check including the titration every 14 days (40 CFR 58 Appendix A).
- A calibration is required when the span drift on the nightly autocal is $> \pm 6\%$ or when the zero drift on the nightly autocal is greater than or equal to ± 0.5 PPB for two consecutive days.
- If a failed nightly autocal is caused by a data logger issue or a power failure, a calibration check should be conducted and if it passes then there is no need for an adjusted calibration.
- With a 146C calibrator and/or NO gas cylinder change (if not done for a problem), a calibration check should be performed before change out to assess any replacement effects. However, if calibration check fails, perform a thorough investigation of the system to find out reason(s) for the failure and then contact ECB. If calibration check passes then perform the calibration.

- No calibrations or calibration checks that effects the data are to be made during periods of ambient exceedances or between 6:00 AM and 9:00 AM local time.

B. Monitoring Instrumentation, Equipment and Accessories

- Thermo Electron (TEI) Model 42i-Y NOy analyzer
- Thermo Electron (TEI) Model 146C Gas Calibrator
- Thermo Electron (TEI) Model 111 Zero-Air Supply System
- Teledyne (TAPI) Model 701 Zero-Air Supply System
- ESC Model 8832 Data logger
- Dedicated Site PC
- Wireless Modem / Ethernet
- Air Compressor

Thermo Environmental Model 42i-Y NOy Analyzer System

In general the NOy analyzer system consists of the following components:

- Pneumatic System: This portion of the analyzer consists of a sample inlet incorporating a heated converter, sample inlet line, particulate matter filter, gas phase titration calibration unit, ozone generator, pre-reactor, flow meter, and pump, all used to bring ambient air samples to the analyzer inlet.
- Analytical System: This portion of the analyzer consists of the reaction chamber, photomultiplier, and bandpass filters.
- Electronic Hardware: This portion of the analyzer consists of the electronic components that control the analyzer and process the signals.

Maintenance and Trouble Shooting Documentation

Document any other site related suspected mechanical problems for preventive and routine maintenance in the logbook and notify ECB.

Model 111 Zero-Air Supply Systems

The TEI Model 111 Zero Air Supply Systems are currently being used as a constant supply of clean air. Carbon monoxide (CO), SO₂, and NOy are scrubbed from the ambient air using "Purafil" (oxidizes NO to NO₂), charcoal (removes NO₂ and SO₂) and "Carulite" (removes CO). Water vapor is removed using "Silica Gel". The silica gel is changed/replaced as needed (indicated by its color change to pink) while other materials are replaced annually. The delivery pressure should be set to 30 psig. A capillary "bleed" is installed to allow a constant low flow of air through the scrubbing media.

Teledyne Model 701 Zero Air Generator

The main function of the Teledyne Model 701 Zero Air Generator is to supply pollutant-free air (zero-air) for the analyzer zeroing and to provide clean diluent air for use with the 146C calibrators. Because the goal of the NOy analyzer is to detect/quantify NOy concentrations at levels very close to zero, determining the response to the clean air (and

hence the baseline of the NOy analyzer) is vital for collecting defensible data in the NCore program. In its operation ambient air is drawn into the system, which removes water vapor, SO₂, NO, NO₂, O₃, CO and hydrocarbons. In reality, zero-air should contain a concentration of NOy that is less than the Lower Detectable Level (LDL) for the analyzer or approximately 0.1 PPB.

The Teledyne Model 701 Zero Air Generator is a pure air generator system that is capable of continuous delivery of up to 20 standard liters per minute (SLPM), 30 pounds per square inch (PSI) of dry, contaminant-free air. The air is suitable for use as: a zero reference calibration gas, ultra-pure combustion air for flame ionization detector, and service air for pneumatically operated valves. The system is capable of delivering air free from water vapor, particulates, sulfur dioxide (SO₂), Hydrogen Sulfide (H₂S), Oxides of Nitrogen (NO), Nitrogen Dioxide (NO₂), Ozone (O₃), and Carbon Monoxide (CO) and hydrocarbons.

2.38.2.2 Calibration

- An initial adjusted calibration (hereafter referred to, as "adjusted calibration") must be performed during the site start-up.
- Calibration (adjusted calibration) is required whenever a system's operation is interrupted: more than two days without power or offline, physical removal / replacement of system's components (monitor, calibrator, NO cylinder, NO – to NO₂ converter, sample line) or major repairs/maintenance.
- A calibration (adjusted calibration) is required when a calibration check (i.e. unadjusted calibration) fails for two consecutive days. Replace the filter and perform calibration.
- **NCore**-The monitor should be calibrated (adjusted calibration) at a minimum of once per quarter (91 days), even when properly operating over that time period.
- **Non NCore**-The monitor should be calibrated (adjusted calibration) at a minimum of once per year, even when properly operating over that time period.

2.38.2.2.1 Operational Checks

An initial calibration is performed without doing any prior calibration checks. The filter must be clean. Perform all of the following checks and adjustments before calibrating the 42i-Y NOy analyzer. All checks and adjustments will be documented in the electronic logbook.

Site Operational Checks

Upon arrival at the site, observe the outside of the sampling building and probe, looking for any vandalism or security breaches. Document all actions in the site logbook. If there is any evidence of vandalism, take pictures, contact the appropriate Law Enforcement Department (generally this one is City Police, if the site is within city limits and the County Sheriff, if it is outside city limits), the Central Office Supervisor and ECB for any necessary repairs.

Power On and Sample Line Check: observe the analyzer, calibrator, computer, and data logger for indications of power failure, and if needed, correct the cause. Verify the instrument "LCD" panel is lit and there is an audible sound from the external pump.

If the analyzer or calibrator lost power, allow an equilibration period of at least an hour for the instrument(s) to stabilize. Visually inspect the tubing, especially at any bends, to ensure that it has not been accidentally kinked, crimped, cut, or insects are nested in the lines. Particulate matter may also load the sample line ahead of the inlet filter. Such restrictions can usually be determined by disconnecting the inlet line of the sample pump. If pump performance is significantly improved and the inlet filter itself is not loaded with particulate matter, the sample line may require replacement. Record all events in the comments section of the e-log. Notify supervisor and call the ECB for instructions on length of stabilization period and recycling the data logger if necessary.

The operator will inspect the outside portion of the probe to ensure the probe is in the right place that the candy cane support has not been damaged, and that there is nothing on the end of the filter holder obstructing the flow. The operator will check indoor portion of the probe to insure that the line does not have any low spots where moisture might accumulate, that there is no condensation in the line, and that there are no dark spots or places where particles have been collecting inside the line. Visually inspect the tubing, especially at any bends, to ensure that it has not been accidentally kinked, crimped, cut, or insects are nested in the lines.

Check on Gas Cylinder and 146C Calibrator: verify the gas cylinder and calibrator are in certification (calibrator certification sticker on front panel) and document certification dates in logbook. (If the cylinder pressure is less than 500 psig arrange with ECB when the Region will do a calibration check before delivery of the cylinder. Calibrate after the new cylinder is installed per **2.38.2.2 Calibration**. Verify that the 146C has the correct cylinder concentration stored in memory.

146C Calibrator

- Main Menu
- Gas A, <ENTER>
- Tank Conc., <ENTER>

Model 111 Zero Air Pak and Compressor Checks

The Model 111 Zero Air Supply has been designed with ease of maintenance as an important criterion. Components and sub-assemblies have been selected for high performance, excellent stability, and long life. The exact lifetimes of the scrubbing material is hard to predict. It is dependent upon flow, pressure, and level of contaminate. For most applications the following recommendation should be followed by the Electronics and Calibration Branch (ECB):

Annually

ECB will replace site Model 111 zero air pack with a certified zero air pack annually or:

Replace the Purafil. Fresh Purafil is purple. It becomes brown when it is used up. Replace when the purple color represents less than 20% of the volume. To replace, shut off the air supply so that the Model 111 pressure drops to 0.0 psig. Remove the cartridge holding Purafil. Slowly unscrew the cap, allowing any remaining pressure to vent, empty out the used Purafil into a zip lock bag and discard. Replace with fresh Purafil. Screw on cover and replace cartridge.

PURAFIL[®] media is a non-toxic, non-flammable substance. Filtration of contaminants through PURAFIL[®] media causes molecular changes within the media to occur, and the resulting product is usually not harmful to the environment and does not require special disposal.

Replace the charcoal. The procedure is the same as replacing Purafil, outlined above.

Replace the carulite. The procedure is the same as replacing Purafil, outlined above.

Replace the silica gel. Old silica gel is returned to the ECB for drying and reuse.

Record any chemical change(s) in the e-log.

Verify and record that the outlet pressure on the air compressor is reading between 40 and 50 psi. Verify and record that the ZAP is reading 30 psi. If either pressure reading is outside of these ranges, contact the ECB and record corrective action. Also, check and drain any water from the compressor (do this at every site visit).

Model 701 Zero Air Generator Checks:

- The pollution scrubber/converter media should be replaced yearly by the ECB.
- Verify that the delivery pressure is set to 30 ± 2 psi. (If the delivery pressure is outside of ± 2 psi range, adjust the pressure using pressure adjust control knob.)
- Check the drain from the air generator.

Record all events in the electronic e-log.

TEI 146C Dynamic Gas Calibrator Operational Checks

Check the TEI 146C Run Screen

- a. Press the <MENU> button on the front of the instrument. (Make sure the 146C is in "**Remote**" mode, the 146C has to be in the REMOTE MODE in order to activate the internal span solenoid inside the 42i-Y TLE)

Check for "**Alarm**" on the displays. If no alarms are present, record the "Alarm On" checks in the logbook as "**no**" and continue. If either screen shows an alarm, record the "Alarm On" check as "**yes**" in the logbook for the appropriate instrument(s).

NOTE: Items that are not in alarm status are labeled "OK"

View the Alarm menu to determine the cause:

- b. Use the ↑ or ↓ menu pushbuttons to select the **Alarm Submenu**, <ENTER>
- c. Use the ↑ or ↓ menu pushbuttons to select the item that is in Alarm Status.
- d. Determine the cause of the alarm. Consult with the ECB prior to performing calibrations or maintenance.
- e. Press the <MENU> button twice to return to the main menu screen.

The following Alarm Limit is used in the NOy operation with the TEI 146C Calibrators:

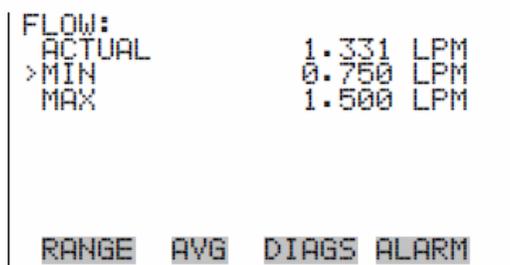
<u>Parameter</u>	<u>Min.</u>	<u>Max.</u>
Internal Temperature	18.5°C	47°C

Thermo Environmental Model 42i-Y NOy Analyzer Operational Checks

- Verify the analyzer "POWER" light is lit and there is audible sound from the external pump. Observe the chamber pressure (200 to 450 mm Hg). If the analyzer does not have any power, determine the cause and time of failure. Invalidate data for a 20-minute period after the power comes back. Correct the cause and verify zero and span. Record all events in the electronic logbook and notify Supervisor and the ECB.
- Verify that the NOYT concentration range is set at correct setting i.e. 200 PPB for NOT, NO2T and NOYT by using: **Main Menu**, choose *Range*
- Verify reactor chamber pressure is between 200 and 450 mmHg. **Main Menu**, choose *Diagnostics > Pressure*
- NO sample and NOy sample flow readings should be between 0.75 to 2.0 LPM. **Main Menu**, choose *Diagnostics > Flow*

If sample flow is low or if there is an alarm, verify low sample flow:

From the 42i Y Main Menu, select **Alarms > Flow** (check "ACTUAL")

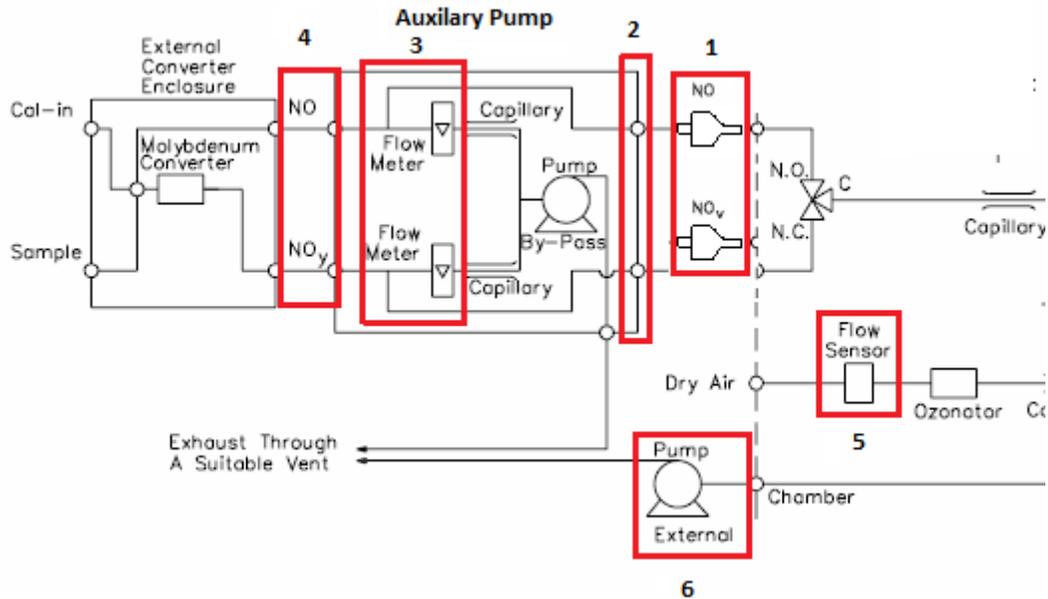


42i Y Alarm Flow Screen

Alarm – Low Sample Flow

1. If using sample particulate filter, make sure it is not blocked. Disconnect sample particulate filter going into monitor, if flow increases, replace the filter.
2. Clog in sample line. If monitor reading has reduced/low flow, disconnect sample line going into filter and bypass the auxiliary pump, if flow increases (leak or clogged sample line upstream), contact ECB.
3. Check auxiliary pump if any of the rotameter(s) indicates reduced/zero sample flow, leak or clogged sample line from external converter assembly, contact ECB.

4. Disconnect sample lines (NO/NOy In) going into auxiliary pump, if flow increases (leak or clogged sample line upstream), contact ECB.
5. Flow sensor out of calibration, if reading has reduced/zero flow, contact ECB.
6. Ruptured vacuum pump diaphragm, if monitor reading has reduced/zero flow, contact ECB.



- The PMT cooler temperature should be between -1°C to -20°C . If not contact ECB. **Main Menu**, choose *Diagnostics* > *Temperatures* > *Cooler*
- The reaction chamber temperature should be between 47°C to 51°C . If not contact ECB. **Main Menu**, choose *Diagnostics* > *Temperatures* > *Chamber*
- Inspect 5 Micron Teflon Particulate Filters: Replace before performing calibration. Unscrew the filter holder and replace the old filter with a new one.

2.38.2.2.2 Filter Conditioning

Condition the Teflon particulate matter filter before performing a calibration. To replace the filter, unscrew the filter holder and replace the old filter with a new one. When changing the filters, touch only its outer edges. Check for leaks associated with the filter holder (run Zero and SPAN1). Record changes in the e-log.

- Select the AV-Trend icon, enter the username followed by the password, hit "OK"
- Select: "Utilities"
- Select: "Link to Logger"
- From the drop down menu, select the site
- Select: "Connect"
- Select: "L", LOGIN Menu, enter password <ENTER>

Disable Channels on Data Logger

- Press {ESC}{ESC} to return to the Home Menu
- Select: "C", Configuration Menu
- Select: "D", Configure Data Channels
- Select: "M", Disable/Mark Channel Offline
- Select: "NOT", <ENTER>
- Select: "M", Disable/Mark Channel Offline
- Select: "NO2T", <ENTER>
- Select: "M", Disable/Mark Channel Offline
- Select: "NOYT,"<ENTER>

To condition a filter:

- Press {ESC}{ESC} to return to the Home Menu
- Select: "C", Configuration menu
- Select: "C", Configure Calibration Menu
- Select: "1", Start Single Phase Cal, press <ENTER>
- Select: "Level 1", <ENTER>
- Scroll down and highlight "**Phase Duration**", enter "**20 Minutes**", <ENTER>
- Scroll Down to "**Start Single Cal (NOW)**", <ENTER>
- Run Zero and SPAN1, if they pass it is then this is considered a leak check. Record Zero / SPAN1 results in the e-log (Filter tab).

Maintenance and Trouble Shooting Documentation

Document any other site related suspected mechanical problems for preventive and routine maintenance in the logbook and notify ECB.

Setting computer, data logger time/date.

The times for the data logger, computer, and AV-Trend must be EASTERN STANDARD TIME. Also, must be synched to the NIST time provider in Colorado (\pm 1 minute). This task is accomplished by clicking on the date and time in the lower right corner of the computer screen. Select "**Change date and time settings**". Select "**Internet Time**" tab, and "**Change settings**". Check the box that states "**Synchronize with an Internet time server**". From the Server drop down menu, select "**time.nist.gov**". Press "**Update Now**". Select "**OK**" twice to exit. Then create a task scheduler in AV-Trend to sync the data logger and computer time.

If the data logger time is not within 1 minute of NIST time but it matches the computer time, then there is a problem with the computer time. Either the computer is not synchronizing properly with the NIST time or the clock is drifting too much and needs to be synchronized more often or the computer needs to be replaced. Call the ECB and they will help identify the issue and tell you what to do to correct it.

If the data logger time is not within 1 minute of NIST time and it does not match the computer time and the computer matches NIST time, then there is a problem with the synchronization of the data logger time with the computer. Call the ECB and they will

give you instructions on how to synchronize the data logger to the computer.

Data logger time:

- Press {ESC}{ESC} to return to the Home Menu
- Select: "C", Configuration menu
- Select: "S", Configuration Systems Parameters menu
- Select: "Logger Time", <ENTER>
- Type in correct time in the format of: **HH:MM:SS** <ENTER>

Sources for getting the correct time:

1. Call the ECB and ask for the NIST time.
2. Call the NIST Colorado time @ (303) 499-7111.
3. Correct time loaded into cell phone.
4. Correct time website, <http://tycho.usno.navy.mil/>

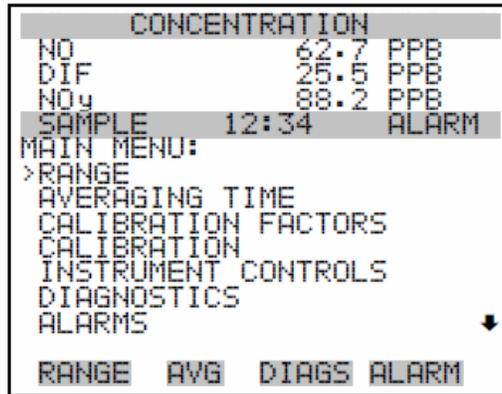
Note: Record pre Calibration Factors BKG's and COEF's (Pre Cal, Logbook tab):
42i Y Main Menu, choose *Calibration Factors* <ENTER> **NO BKG, NOy BKG, NO COEF, DIF COEF & NOy COEF**, press menu button 2X to return to the main menu.

2.38.2.2.4 Zero Calibration

- Press {ESC}{ESC} to return to the Home Menu
- Select: "C", Configuration Menu
- Select: "C", Configure Calibrations
- Select: "1", Start Single Phase Cal, <ENTER>
- Select: "NOTCAL", <ENTER>
- Select: "SPAN0", <ENTER>
- Scroll down and highlight "Phase Duration", set to ≥ 1 hour, <ENTER>
- Scroll down and select: "Start Single Cal (NOW)", <ENTER>

Monitor Actual Values

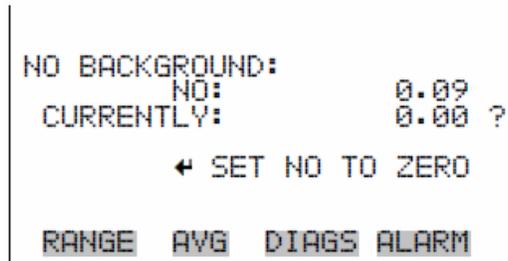
- Press {ESC}{ESC} to return to the Home Menu
- Select: "D", Real Time Display Menu
- Select: "C", Continuous Average Report
- Type in parameters "NOT", and "NOYT" <ENTER>
- Change # of flags to report from "02" to "03", <ENTER> (the "<", "D", and "C" flags will show)
- Use decimal Positioner?: "Y", <ENTER>
- Start continuous report: <ENTER> (this will show the minute averages as they are calculated and keeps all values on screen).



SERVICE
PASSWORD

42i Main Menu Screen

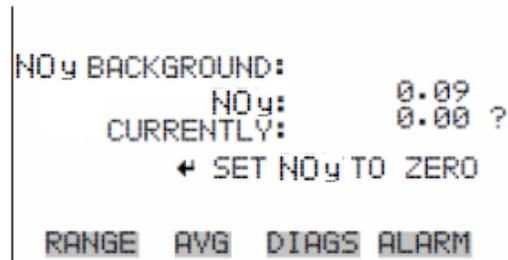
- From the 42i main menu, move the menu cursor ">" down to "CALIBRATION" <ENTER>, select "CAL PREREACTOR ZERO" <ENTER>, select "CAL NO BACKGROUND" <ENTER>



42i NO Background Screen

set "NO Background" to "ZERO" by pressing ↓ <ENTER>. Press menu button  1X to return to CALIBRATION menu.

- From the CALIBRATION menu, select "CAL PREREACTOR ZERO" <ENTER>, select "CAL NOy BACKGROUND" <ENTER>



42i NOy Background Screen

set "NOy Background" to "ZERO" by pressing ↓ <ENTER>, you may need to press ↓ <ENTER> a second time if the first is not stabilizing, if all three channels are still not in

range contact the ECB). The microprocessor will calculate, apply and store the pre-reactor and zero "CALIBRATION FACTORS" for all three channels.

- Record 5 consistent 1-minute NOT and NOYT values in the electronic logbook. The data logger should average to zero (O) \pm 1 PPB or may be even less for NOT and NOYT. Press menu button  1X to return to CALIBRATION menu.

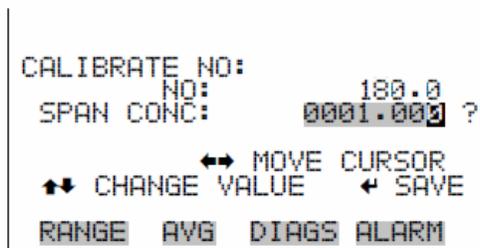
Abort SPAN0

- Press {ESC}{ESC} to return to the Home Menu
- Select: "C", Configuration Menu
- Select: "C", Configure Calibrations
- Select: "W", Abort calibration
- Select: "NOTCAL" <ENTER>

2.38.2.2.5 Multi-Point Calibration

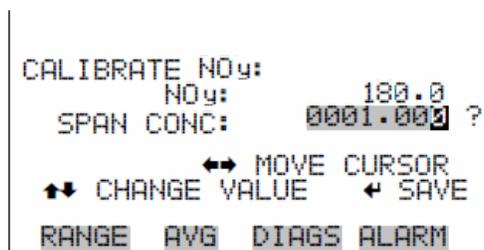
Span1 Calibration

- Press {ESC}{ESC} to return to the Home Menu
- Select: "C", Configuration Menu
- Select: "C", Configure Calibrations
- Select: "1", Start Single Phase Cal, <ENTER>
- Select: "NOTCAL", <ENTER>
- Select: "SPAN1", <ENTER>
- Scroll down and highlight "Phase Duration", make phase duration for four (4) hours.
- Scroll down and select: "Start Single Cal (NOW)", <ENTER>
- Start SPAN1 and let it stabilize (30 to 45 minutes)
- From the CALIBRATION menu, select "CAL NO COEFFICIENT" <ENTER>



42i NO Span Screen

- edit "SPAN CONC" if necessary using \uparrow \downarrow pushbuttons, press \downarrow <ENTER>, press menu button  1X to return to the CALIBRATION menu.



42i NOy Span Screen

- Select "CALNOY" coefficient then edit "SPANCONC", if necessary using ↑ ↓ pushbuttons for any cylinder impurity. Press menu button  2X to return to the main menu.

Monitor Actual values

- Press {ESC}{ESC} to return to the Home Menu
- Select: "D", Real-Time Display Menu
- Select: "C", Continuous Average Report
- Type parameters "NOT", "NO2T" and "NOYT" <ENTER>
- Change # of flags to report from "02" to "03", <ENTER> (the "<", "D", and "C" flags will show)
- Use decimal Positioner?: "Y", <ENTER>
- Start continuous report: <ENTER> (this will show the minute averages as they are calculated and keeps all values on screen).
- Record five stable consecutive 1 minute NOT and NOYT averages in the electronic logbook

2.38.2.2.6 Titration

While the Span 1 event is running and stabilized:

- On 146C press "Menu" button, press <ENTER> until 146C is in "Local" mode
- On 146C press "Run" button to bring up "Run 1" screen
- Use ↓ ↑ arrows to select GAS option, select "GAS A"
- Turn GAS A "On" by pressing <ENTER>. Press ↓, press →, press <ENTER> to turn SPAN 1 "On", then press ↓, press →, press <ENTER>
- Set bottom line to "Ozone Manual"
- From 146C "Main Menu" press down arrow ↓ to "Ozonator", press <ENTER>
- Go to "Manual", <ENTER>
- Verify that the ozonator level is set to 0.0%
- Note your "GPT" zero air and "GPT" gas flows by pressing "RUN" button twice on 146C while you are running the "GPT". The flows should be approximately equal to **SPAN1** zero air and gas flows that you recorded as noted above, if not phone ECB for guidance.

Allow the 42i-Y monitor to stabilize (about 1 hour) and record NO and NOY responses as "NOT", and "NOYT" original (GPT tab). Once the GPT original phase is completed, use the ↑ or ↓ arrows to adjust the O₃ "Level" (percent ozonation) to 30%, allow reading to stabilize.

On 146C Main Menu press ↓ 4 times to "Ozonator", press <ENTER>, press ↓ to "Manual Adjustment %", and then "Ozonator Manual Level" <ENTER>. Starting from 30% ozonation, slowly increase the O₃ level until the "NOT" readings drop to 10-20% of the span value (e. g. if the "NOT" span is 180 PPB, increase the percent O₃ level slowly

until the monitor stabilizes at an "NOT" reading of approximately 18-36 PPB). Usually, an O₃ level set between 20-40% accomplishes the required "NOT" reduction. Once set, the O₃ level will work with future titrations unless something changes such as a gas cylinder, 146C calibrator or an ozonator lamp.

Important: During the "GPT", the "NOT" reading must not be allowed to decrease by more than 90% of its original full scale span value so that adequate "NOT" is available for the NOT/O₃ reaction and enough "NOT" remains for accurate NO₂T calculations. If the "NOT" reading drops by more than 90%, reduce the output of the calibrator until an acceptable "NOT" reading is achieved. For the example below, 18 PPB for a "NOT" full scale response of 180 PPB.

Wait approximately 45 to 60 minutes for the NO₂T trace to stabilize.

After the appropriate time period, look for a stable NO₂T trace of about 10 minutes data logger duration. Calculate the actual concentration of the NO₂T span using the equation below. Wait until the actual concentration is stable on the data logger. **If the concentrations measured on the data logger are within ± 5% of the actual concentration, enter 5 1 - minute averaged "NOT", "NO₂T" and "NOYT" remainder (GPT tab).**

$$[\text{NO}_2]_{\text{Ca}} = [\text{NO}]_{\text{orig}} - [\text{NO}]_{\text{rem}} + [\text{F}_{\text{NO}} / (\text{F}_{\text{NO}} + \text{F}_{\text{zero}})] \times [\text{NO}_2]_{\text{imp}}$$

i.e. $[\text{NO}_2]_{\text{Ca}} = 180 \text{ PPB} - 20 \text{ PPB} + 0.7 \text{ PPB} = 160.7 \text{ PPB}$

Where: $[\text{NO}_2]_{\text{Ca}}$ = NO₂ concentration at the output, PPB

$[\text{NO}]_{\text{orig}}$ = Original NO concentration before titration with the O₃, PPB

$[\text{NO}]_{\text{rem}}$ = NO concentration after titration with O₃, PPB

$[\text{NO}_2]_{\text{imp}}$ = NO₂ impurity in cylinder

NO₂ impurity in cylinder = NO_y – NO values on the cylinder certification

(i.e. 0.7 PPM = 11.7 PPM - 11 PPM or 700 PPB = 11,700 – 11,000 PPB)

F_{NO} = NO flow rate, sccm

F_{zero} = Zero air flow rate, sccm

D = Dilution ratio F_{NO} / (F_{NO} + F_{zero})

Note: NO₂ impurity may be listed as an additional factor in certified protocol NO gas received from the manufacturer. If so, this additional NO₂T must be included when calculating the total NOT concentration generated during gas phase titration.

Note: To convert liters to sccm, multiply liters by 1000. To convert PPM to PPB multiply by 1000.

If the NO₂T concentration measured on the data logger is not within ± 5% of the actual $[\text{NO}_2]_{\text{Ca}}$ concentration, press "Cal Button", use down arrow ↓ to "CAL DIFCOEFFICIENT" then press ↵ using cursor, edit SPAN Conc. to actual NO₂

concentration. Then press the "ENT" button. Wait for the microprocessor to stabilize, and enter 5 1-minute averaged "NOT", "NO2T", and "NOYT" data logger readings into the calibration section of the logbook.

When the titration finishes, do the following:

- Place 146C back into "Remote"
- Abort "SPAN1" using "C", "C", "W", "NOTCAL", <ENTER>
- The converter efficiency should be between 96-104%

Check SPAN2 / SPAN3

Make no adjustments to SPAN2 or SPAN3

- Press {ESC}{ESC} to return to the Home Menu
- Select: "C", Configuration Menu
- Select: "C", Configure Calibrations
- Select: "1", Start Single Phase Cal, <ENTER>
- Select: "NOTCAL", <ENTER>
- Select: "SPAN2", <ENTER>
- Scroll down and highlight "Phase Duration", set to ≥ 1 hour, <ENTER>
- Scroll down and select: "Start Single Cal (NOW)", <ENTER>

Monitor Actual Values

- Press {ESC}{ESC} to return to the Home Menu
- Select: "D", Real Time Display Menu
- Select: "C", Continuous Average Report
- Type in parameters "NOT" and "NOYT" <ENTER>
- Change # of flags to report from "02" to "03", <ENTER> (the "<", "D", and "C" flags will show)
- Use decimal Positioner?: "Y", <ENTER>
- Start continuous report: <ENTER> (this will show the minute averages as they are calculated and keeps all values on screen).
- Start SPAN2 and let it stabilize (30 to 35 minutes)
- Record 5 consecutive one-minute averages
- Abort SPAN2 using "C", "C", "W", "NOTCAL", <ENTER>
- Repeat all above steps for SPAN3
- Abort SPAN3 using "C", "C", "W", "NOTCAL", <ENTER>

Note: Record post Calibration Factors BKG's and COEF's (Post Cal, Logbook tab): 42i Y Main Menu, choose *Calibration Factors* <ENTER> *NO BKG, NOy BKG, NO COEF, DIF COEF & NOy COEF*, press menu button 2X to return to the main menu.

2.38.2.2.7 Review Calibration and End

Percent Tolerance Across all Full Scale (FS) Ranges (50, 100, 200 PPB)

<u>Point*</u>	<u>Calibration Tolerance</u>	<u>Converter Efficiency</u>
---------------	------------------------------	-----------------------------

Span (90%)	±3%	96 - 104%
Mid (50%)	±3%	
Precision (18%)	±10%	
Zero (O)	±0.5 PPB	
NO2T Span (titration)	±5%	

*Nominal or designated value of each point

If any of the points are greater than the calibration tolerance for the full-scale range, the calibration is unacceptable. If the calibration is unacceptable after two (2) tries, contact ECB. All points on the calibration must meet their respective calibration tolerance.

Adjustments to the 42i-Y should be based on the 42i-Y NOT meeting the tolerance criteria.

If the calibration is acceptable, proceed to "logout".

Enable Channels

- Press {ESC}{ESC} to return to the Home Menu
- Select: "C", Configuration Menu
- Select: "D", Configure Data Channels
- Select: "E", Enable/Mark Channel Online
- Select: "NOT", <ENTER>
- Select: "E", Enable/Mark Channel Online
- Select: "NO2T", <ENTER>
- Select: "E", Enable/Mark Channel Online
- Select: "NOYT", <ENTER>

The following sequence is used to logout of the data logger:

- Press {ESC}{ESC} to return to the Home Menu
- Use arrow key to select "O" or hit "O" key to logout

Turn off computer screen, **Note: DO NOT** close the AV-Trend software, **DO NOT** turn off the computer.

2.38.2.3 Calibration Check

Note: Make no monitor adjustments during calibration check

- **All Sites** - a bi-monthly calibration check (every 14 days or less) including converter efficiency calculation determines the ongoing accuracy and stability of the site-specific NOy monitoring system.
- A calibration check is to be performed before any changes are made to the monitoring system.
- A calibration is required when the span drift on the nightly autocal is $> \pm 6\%$ or when the zero drift on the nightly autocal is greater than or equal to ± 0.5 PPB for two consecutive days.

- If a failed nightly autocal is caused by a data logger issue or a power failure, a calibration check should be conducted and if it passes then there is no need for an adjusted calibration.
- A calibration is required when a calibration check (i.e. unadjusted calibration) fails. Replace the filter and perform calibration.
- With a 146C calibrator and/or gas cylinder change (if not done for a problem), a calibration check should be performed before and after change out to assess any

replacement effects. If calibration check passes then perform the calibration.

However, if calibration check fails, perform a thorough investigation of the system to find out reason(s) for the failure and then contact ECB.

- Note site temperature.
- Verify instrument and cylinder numbers and certification dates. The site operator should call Electronics and Calibration Branch (ECB) when the cylinder pressure reaches 500 psig and the cylinder should be replaced before it reaches 200 psig. Note the call to ECB in the electronic logbook.
- No calibration checks that affect the data are to be made during periods of ambient exceedances or between 6:00 AM and 9:00 AM local time.

2.38.2.3.1 Operational Checks

Upon arrival at the site, observe the outside of the sampling building and probe, looking for any vandalism or security breaches. Document all actions in the site logbook. If there is any evidence of vandalism, take pictures, contact the appropriate Law Enforcement Department (generally this one is City Police, if the site is within city limits and the County Sheriff, if it is outside city limits), the Central Office Supervisor and ECB for any necessary repairs.

Power On and Sample Line Check: observe the analyzer, calibrator, computer, and data logger for indications of power failure, and if needed, correct the cause. Verify the instrument "LCD" panel is lit and there is an audible sound from the external pump.

If the analyzer or calibrator lost power, allow an equilibration period of at least an hour for the instrument(s) to stabilize. Visually inspect the tubing, especially at any bends, to ensure that it has not been accidentally kinked, crimped, cut, or insects are nested in the lines. Particulate matter may also load the sample line ahead of the inlet filter. Such restrictions can usually be determined by disconnecting the inlet line of the sample pump. If pump performance is significantly improved and the inlet filter itself is not loaded with particulate matter, the sample line may require replacement. Record all events in the comments section of the e-log. Notify supervisor and call the ECB for instructions on length of stabilization period and recycling the data logger if necessary.

The operator will inspect the outside portion of the probe to ensure the probe is in the right place that the candy cane support has not been damaged, and that there is nothing on the end of the filter holder obstructing the flow. The operator will check indoor portion of the probe to insure that the line does not have any low spots where moisture might

accumulate, that there is no condensation in the line, and that there are no dark spots or places where particles have been collecting inside the line. Visually inspect the tubing, especially at any bends, to ensure that it has not been accidentally kinked, crimped, cut, or insects are nested in the lines.

Shelter Temperature: Measure the internal temperature of the building in °C using a NIST traceable thermometer placed next to the shelter temperature sensor. Allow

sufficient time for the reading to stabilize and compare the two temperature readings. Record this reading in the e-log. If the shelter temperature sensor is reading greater than $\pm 2^\circ$ of the reference contact the ECB. Adjust the site thermostat as necessary to maintain the shelter temperature within a 20° to 30°C range. If the temperature cannot be stabilized and controlled within this range, notify the Regional Ambient Monitoring Coordinator and the ECB that corrective action is required.

Note: The shelter temperature should remain fairly constant and not vary more than $\pm 2^\circ$ C standard deviation over 24 hours. The Statistician in the Central Office tracks this statistic. The Regional Ambient Monitoring Coordinator will be notified if an issue arises.

Check on NO Gas Cylinder and 146C Calibrator: verify the gas cylinder and calibrator are in certification (calibrator certification sticker on front panel) and document certification dates in logbook. (If the cylinder pressure is less than 500 psig arrange with ECB when the Region will do a calibration check before delivery of the cylinder.

Calibrate after the new cylinder is installed per **2.38.2.1 Calibration**. Verify that the 146C has the correct cylinder concentration stored in memory.

146C Calibrator

- Main Menu
- Gas A, <ENTER>
- Tank Conc., <ENTER>

Model 111 Zero Air Pak and Compressor Checks:

The Model 111 Zero Air Supply has been designed with ease of maintenance as an important criterion. Components and sub-assemblies have been selected for high performance, excellent stability, and long life. The exact lifetimes of the scrubbing material is hard to predict. It is dependent upon flow, pressure, and level of contaminate. For most applications the following recommendation should be followed by the Electronics and Calibration Branch (ECB):

Annually

ECB will replace site Model 111 zero air pack with a certified zero air pack annually or:

Replace the Purafil. Fresh Purafil is purple. It becomes brown when it is used up. Replace when the purple color represents less than 20% of the volume. To replace, shut

off the air supply so that the Model 111 pressure drops to 0.0 psig. Remove the cartridge holding Purafil. Slowly unscrew the cap, allowing any remaining pressure to vent, empty out the used Purafil into a zip lock bag and discard. Replace with fresh Purafil. Screw on cover and replace cartridge.

PURAFIL[®] media is a non-toxic, non-flammable substance. Filtration of contaminants through PURAFIL[®] media causes molecular changes within the media to occur, and the

resulting product is usually not harmful to the environment and does not require special disposal.

Replace the charcoal. The procedure is the same as replacing Purafil, outlined above.

Replace the carulite. The procedure is the same as replacing Purafil, outlined above.

Replace the silica gel. Old silica gel is returned to the ECB for drying and reuse.

Record any chemical change(s) in the e-log.

Verify and record that the outlet pressure on the air compressor is reading between 40 and 50 psi. Verify and record that the ZAP is reading between 30 psi. If either pressure reading is outside of these ranges, contact the ECB and record corrective action. Also, check and drain any water from the compressor (do this at every site visit).

Teledyne Model 701 Zero Air Generator

The Teledyne Model 701 Zero Air Generator is a pure air generator system that is capable of continuous delivery of up to 20 standard liters per minute (SLPM), 30 pounds per square inch (PSI) of dry, contaminant-free air. The air is suitable for use as: a zero reference calibration gas, ultra-pure combustion air for flame ionization detector, and service air for pneumatically operated valves. The system is capable of delivering air free from water vapor, particulates, sulfur dioxide (SO₂), Hydrogen Sulfide (H₂S), Oxides of

Nitrogen (NO), Nitrogen Dioxide (NO₂), Ozone (O₃), and Carbon Monoxide (CO) and hydrocarbons.

Model 701 Zero Air Generator Checks:

- The pollution scrubber/converter media should be replaced yearly by the ECB.
- Verify that the delivery pressure is set to 30 ± 2 psi. (If the delivery pressure is outside of ± 2 psi range, adjust the pressure using pressure adjust control knob.)
- Check the drain from the air generator.
- Record all events in the electronic e-log.

TEI 146C Dynamic Gas Calibrator Operational Checks

Check the TEI 146C Run Screen

- a. Press the "**MENU**" button on the front of the instrument. (Make sure the 146C is in "**Remote**" mode, the 146C has to be in the "**REMOTE**" mode in order to activate the internal span solenoid inside the 42i-Y TLE)

Check for "**Alarm**" on the displays. If no alarms are present, record the "Alarm On" checks in the logbook as "**no**" and continue. If either screen shows an alarm, record the "Alarm On" check as "**yes**" in the logbook for the appropriate instrument(s).

NOTE: Items that are not in alarm status are labeled "OK"

View the Alarm menu to determine the cause:

- b. Use the ↑ or ↓ menu pushbuttons to select the **Alarm Submenu**, <ENTER>
- c. Use the ↑ or ↓ menu pushbuttons to select the item that is in Alarm Status.
- d. Determine the cause of the alarm. Consult with the ECB prior to performing calibrations or maintenance.
- e. Press the <MENU> button twice to return to the main menu screen.

The following Alarm Limit is used in the NOy operation of the TEI 146C Calibrators:

<u>Parameter</u>	<u>Min.</u>	<u>Max.</u>
Internal Temperature	18.5°C	47°C

Thermo Environmental Model 42i-Y NOy Analyzer Operational Checks

- Verify the analyzer "**POWER**" light is lit and there is audible sound from the external pump. Observe the chamber pressure (200 to 450 mm Hg). If the analyzer does not have any power, determine the cause and time of failure. Invalidate data for a 20-minute period after the power comes back. Correct the cause and verify zero and span. Record all events in the electronic logbook and notify Supervisor and the ECB.
- Verify that the NOYT concentration range is set at correct setting i.e. 200 PPB for NOT, NO2T and NOYT by using: **Main Menu**, choose **Range**
- Verify reactor chamber pressure is between 200 and 450 mmHg. **Main Menu**, choose **Diagnostics > Pressure**
- NO sample and NOy sample flow readings should be between 0.75 to 2.0 LPM. **Main Menu**, choose **Diagnostics > Flow**

If sample flow is low or if there is an alarm, verify low sample flow:

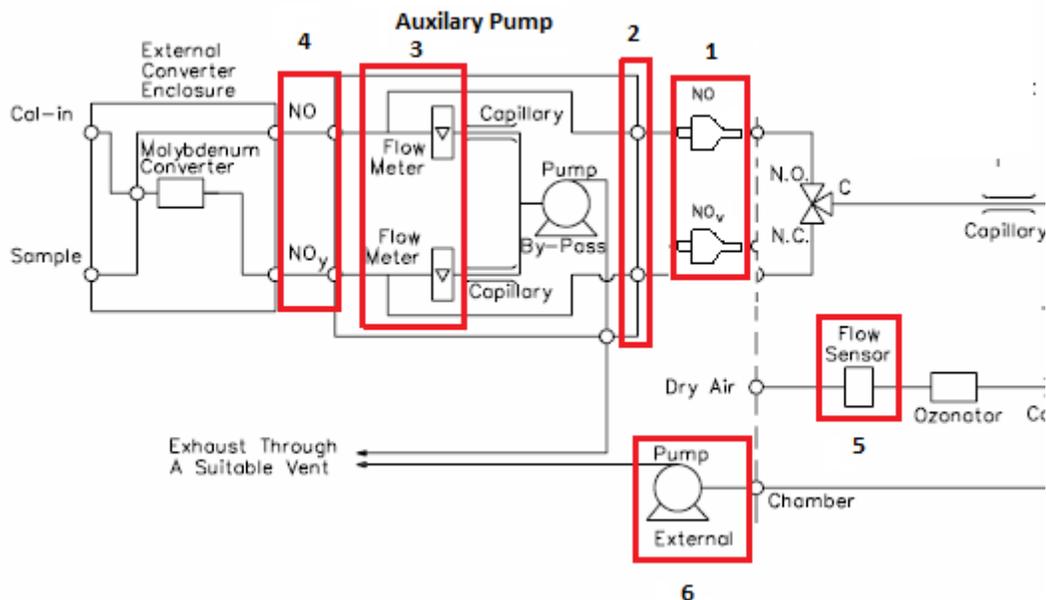
From the 42i Y Main Menu, select **Alarms > Flow** (check "**ACTUAL**")

FLOW:	
ACTUAL	1.331 LPM
>MIN	0.750 LPM
MAX	1.500 LPM
RANGE	AVG
DIAGS	ALARM

42i Y Alarm Flow Screen

Alarm – Low Sample Flow

1. If using sample particulate filter, make sure it is not blocked. Disconnect sample particulate filter going into monitor, if flow increases, replace the filter.
2. Clog in sample line. If monitor reading has reduced/low flow, disconnect sample line going into filter and bypass the auxiliary pump, if flow increases (leak or clogged sample line upstream), contact ECB.
3. Check auxiliary pump if any of the rotameter(s) indicates reduced/zero sample flow, leak or clogged sample line from external converter assembly, contact ECB.
4. Disconnect sample lines (NO/NOy In) going into auxiliary pump, if flow increases (leak or clogged sample line upstream), contact ECB.
5. Flow sensor out of calibration, if reading has reduced/zero flow, contact ECB.
6. Ruptured vacuum pump diaphragm, if monitor reading has reduced/zero flow, contact ECB.



- The PMT cooler temperature should be between -1°C to -20°C . If not contact ECB. **Main Menu**, choose *Diagnostics > Temperatures > Cooler*
- The reaction chamber temperature should be between 47°C to 51°C . If not contact ECB. **Main Menu**, choose *Diagnostics > Temperatures > Chamber*

Maintenance and Trouble Shooting Documentation

Document any other site related suspected mechanical problems for preventive and routine maintenance in the logbook and notify ECB.

Setting computer, data logger time/date.

The times for the data logger, computer, and AV-Trend must be EASTERN STANDARD TIME. Also, must be synched to the NIST time provider in Colorado (± 1

minute). This task is accomplished by clicking on the date and time in the lower right corner of the computer screen. Select "**Change date and time settings**". Select "**Internet Time**" tab, and "**Change settings**". Check the box that states "**Synchronize with an Internet time server**". From the Server drop down menu, select "**time.nist.gov**". Press "**Update Now**". Select "**OK**" twice to exit. Then create a task scheduler in AV-Trend to sync the data logger and computer time.

If the data logger time is not within 1 minute of NIST time but it matches the computer time, then there is a problem with the computer time. Either the computer is not

synchronizing properly with the NIST time or the clock is drifting too much and needs to be synchronized more often or the computer needs to be replaced. Call the ECB and they will help identify the issue and tell you what to do to correct it.

If the data logger time is not within 1 minute of NIST time and it does not match the computer time and the computer matches NIST time, then there is a problem with the synchronization of the data logger time with the computer. Call the ECB and they will give you instructions on how to synchronize the data logger to the computer.

Data logger time and date:

- Select the AV-Trend icon, enter the username followed by the password, hit "**OK**"
- Select: "**Utilities**"
- Select: "**Link to Logger**"
- Select the site
- Select: "**Connect**"
- Select: "**L**", LOGIN Menu, enter password <ENTER>
- Select: "**C**", configuration menu
- Select: "**S**", configuration systems parameters menu
- Select: "**Logger Time**", <ENTER>
- Type in correct time in the format of: **HH:MM:SS** <ENTER>

Sources for getting the correct time:

1. Call the ECB and ask for the NIST time.
2. Call the NIST Colorado time @ **(303) 499-7111**.
3. Correct time loaded into cell phone.
4. Correct time website, <http://tycho.usno.navy.mil/>

Disable Channels on Data Logger

- Press **{ESC}{ESC}** to return to the Home Menu
- Select: "**C**", Configuration Menu
- Select: "**D**", Configure (Data) Channels
- Select: "**M**", Disable/Mark Channel Offline
- Select: "**NOT**", <ENTER>
- Select: "**M**", Disable/Mark Channel Offline
- Select: "**NO2T**", <ENTER>
- Select: "**M**", Disable/Mark Channel Offline

- Select: "NOYT", <ENTER>

2.38.2.3.3 Span Zero Calibration Check

- Press {ESC}{ESC} to return to the Home Menu
- Select: "C", Configuration Menu
- Select: "C", Configure Calibrations
- Select: "1", Start Single Phase Cal, <ENTER>
- Select: "NOTCAL", <ENTER>
- Select: "SPAN0", <ENTER>
- Scroll down and highlight "Phase Duration", set to ≥ 1 hour, <ENTER>
- Scroll down and select: "Start Single Cal (NOW)", <ENTER>

Monitor Actual Values

- Press {ESC}{ESC} to return to the Home Menu
- Select: "D", Real Time Display Menu
- Select: "C", Continuous Average Report
- Type in parameters "NOT" and "NOYT" <ENTER>
- Change # of flags to report from "02" to "03", <ENTER> (the "<", "D", and "C" flags will show)
- Use decimal Positioner?: "Y", <ENTER>
- Start continuous report: <ENTER> (this will show the minute averages as they are calculated and keeps all values on screen).
- Record five (5) 1 minute stable averages in the electronic logbook

Abort SPAN0

- Press {ESC}{ESC} to return to the Home Menu
- Select: "C", Configuration Menu
- Select: "C", Configure Calibrations
- Select: "W", Abort Calibrations
- Select: "NOTCAL" <ENTER>

2.38.2.3.4 Span Calibration Check

- Press {ESC}{ESC} to return to the Home Menu
- Select: "C", Configuration Menu
- Select: "C", Configure Calibrations
- Select: "1", Start Single Phase Cal, <ENTER>
- Select: "NOTCAL", <ENTER>
- Select: "SPAN1", <ENTER>
- Scroll down and highlight "Phase Duration", set to 4 hours, <ENTER>
- Scroll down and select: "Start Single Cal (NOW)", <ENTER>
- Start continuous report: This will show minute averages as they are calculated and keeps all values on screen
- Start SPAN1 and let it stabilize (about 30 to 45 minutes)

Monitor Actual values

- Press {ESC}{ESC} to return to the Home Menu
 - Select: "D", Real-Time Display Menu
 - Select: "C", Continuous Average Report
 - Type in parameters: "NOT" and "NOYT" <ENTER>
 - Change # of flags to report from "02" to "03", <ENTER> (the "<", "D", and "C" flags will show)
 - Use decimal Positioner?: "Y", <ENTER>
-
- Start continuous report: <ENTER> (this will show the minute averages as they are calculated and keeps all values on screen).
 - Record five (5) 1 minute stable averages in the electronic logbook

2.38.2.3.5 Titration

Use the following procedure to check the converter efficiency:

While the Span 1 event is running and stabilized:

- On 146C press "Menu" button, press <ENTER> until 146C is in "Local" mode
- On 146C press "Run" button to bring up "Run 1" screen
- Use ↓↑ arrows to select GAS option, select "GAS A"
- Press → turn GAS A "On" by pressing <ENTER>. Press ↓, press →, press <ENTER> to turn SPAN 1 "On", then press ↓, press →, press <ENTER>
- Set bottom line to "Ozone Manual"
- From 146C Main Menu press down arrow ↓ to "Ozonator", press <ENTER>
- Go to "Manual", <ENTER>
- Verify that the ozonator level is set to 0.0%
- Note your "GPT" zero air and "GPT" gas flows by pressing "RUN" button twice on 146C while you are running the "GPT". The flows should be approximately equal to **Span 1** zero air and gas flows that you recorded as noted above, if not phone ECB for guidance.

Allow 42i-Y monitor to stabilize (about 1 hour) and record NO and NOY responses as "NOT", and "NOYT" original (GPT tab). Once the GPT original phase is completed use the ↓↑ arrows to adjust the O₃ "Level" (percent ozonation) to 30%, allow reading to stabilize.

146C Main Menu press ↓ 4 times to "Ozonator", press <ENTER>, press ↓ to "Manual Adjustment %", and then "Ozonator Manual Level" <ENTER>. Starting from 30% ozonation, slowly increase the O₃ level until the NOT readings drop to 10-20% of the span value (e. g. if the NOT span is 180 PPB, increase the percent O₃ level slowly until the monitor stabilizes at an NOT reading of approximately 18-36 PPB). Usually, an O₃

level set between 20-40% accomplishes the required NOT reduction. Once set, the O₃ level will work with future titrations unless something changes such as a gas cylinder, 146C calibrator or an ozonator lamp.

Important: During the "GPT", the "**NOT**" reading must not be allowed to decrease by more than 90% of its original full scale span value so that adequate "**NOT**" is available for the NOT/O₃ reaction and enough "**NOT**" remains for accurate NO₂T Calculations.

If the "**NOT**" reading drops by more than 90%, reduce the output of the calibrator until an acceptable "**NOT**" reading is achieved. For the example below, 18 PPB for a "**NOT**" full scale response of 180 PPB.

Wait approximately 45 to 60 minutes for the NO₂T trace to stabilize.

After the appropriate time period, look for a stable NO₂T trace of about 10 minutes data logger duration. Calculate the actual concentration of the NO₂T span using the equation below. Wait until the actual concentration is stable on the data logger. **If the concentrations measured on the data logger are within ± 5% of the actual concentration, enter 5 1 - minute averaged "NOT", "NO₂T" and "NOYT" remainder (GPT tab).**

$$[\text{NO}_2]_{\text{Ca}} = [\text{NO}]_{\text{orig}} - [\text{NO}]_{\text{rem}} + [\text{F}_{\text{NO}} / (\text{F}_{\text{NO}} + \text{F}_{\text{zero}})] \times [\text{NO}_2]_{\text{imp}}$$

i.e. $[\text{NO}_2]_{\text{Ca}} = 180 \text{ PPB} - 20 \text{ PPB} + 0.7 \text{ PPB} = 160.7 \text{ PPB}$

Where: $[\text{NO}_2]_{\text{Ca}}$ = NO₂ concentration at the output manifold, PPB

$[\text{NO}]_{\text{orig}}$ = Original NO concentration before titration with the O₃, PPB

$[\text{NO}]_{\text{rem}}$ = NO concentration after titration with O₃, PPB

$[\text{NO}_2]_{\text{imp}}$ = NO₂ impurity in cylinder

NO₂ impurity in cylinder = NO_y – NO values on the certification sheets

(i.e. 0.7 PPM = 11.7 PPM- 11 PPM or 700 PPB = 11,700 – 11,000 PPB)

F_{NO} = NO flow rate, sccm

F_{zero} = Zero air flow rate, sccm

D = Dilution ratio F_{NO} / (F_{NO} + F_{zero})

Note: NO₂ impurity may be listed as an additional factor in certified protocol NO gas received from the manufacturer. If so, this additional NO₂T must be included when calculating the total NOT concentration generated during gas phase titration.

Note: To convert liters to sccm, multiply liters by 1000. To convert PPM to PPB multiply by 1000.

When the titration finishes, do the following:

- Place 146C back into "Remote"
- Abort "SPAN1", press "C", "C", "W", "NOTCAL" <ENTER>
- The converter efficiency should be between 96-104%.

2.38.2.3.6 Check SPAN2/ SPAN3

Note: make no adjustments to SPAN 2 or SPAN 3

- Press {ESC}{ESC} to return to the Home Menu
- Select: "C", Configuration Menu
- Select: "C", Configure Calibrations
- Select: "1", Start Single Phase Cal, <ENTER>
- Select: "NOTCAL", <ENTER>
- Select: "SPAN2", <ENTER>
- Scroll down and highlight "Phase Duration", set to ≥ 1 hour, <ENTER>
- Scroll down and select: "Start Single Cal (NOW)", <ENTER>

Monitor Actual Values

- Press {ESC}{ESC} to return to the Home Menu
- Select: "D", real time display
- Select: "C", continuous average report
- Type in parameters: "NOT" and "NOYT" <ENTER>
- Change # of flags to report from "02" to "03", <ENTER> (the "<", "D", and "C" flags will show)
- Use decimal Positioner?: "Y", <ENTER>
- Start continuous report: <ENTER> (this will show the minute averages as they are calculated and keeps all values on screen).
- Record 5 consecutive one-minute stable averages
- Abort SPAN2 using "C", "C", "W", "NOTCAL" <ENTER>
- Repeat all above steps for SPAN3
- Abort SPAN3 using "C", "C", "W", "NOTCAL" <ENTER>

Note: SPAN3 NOT and NOyT concentrations are reported to AQS (Indicated/Monitor)

2.38.2.3.6 Filter Conditioning

Replace and condition the Teflon particulate matter filter after performing a calibration check. To replace the filter, unscrew the filter holder and replace the old filter with a new one. While changing the filters, touch only its outer edges. Check for leaks associated with the filter holder (run Zero and SPAN1). Record changes in the e-log.

To condition a filter:

- Press {ESC}{ESC} to return to the Home Menu
- Select: "C", Configure Menu
- Select: "C", Configure Calibration Menu
- Select: "1", start Single Phase Calibration, <ENTER>
- Select: "Level 1", <ENTER>
- Scroll down and highlight "Phase Duration", enter "20 Minutes".
- Scroll down to "Start Single Cal (NOW)", <ENTER>
- Run Zero and SPAN1, if they pass it is then this is considered a leak check. Record Zero / SPAN1 results in the e-log (Filter tab).

2.38.2.3.7 Review Calibration Check and End

Percent Tolerance Across all Full Scale (FS) Ranges (50, 100, 200 PPB)

<u>Point*</u>	<u>Calibration Check Tolerance</u>	<u>Converter Efficiency</u>
Span (90%)	±6%	96 - 104%
Mid (50%)	±8%	
Precision (18%)	±15%	
Zero (O)	±0.5 PPB	
NO2T Span (titration)	±5%	

*Nominal or designated value of each point

If any of the points are greater than the calibration check tolerance for the full-scale range, the calibration check is unacceptable. If the calibration check is unacceptable after two (2) tries, contact ECB. All points on the calibration check must meet their respective tolerance. **Adjustments to the 42i-Y should be based on the 42i-Y NOT meeting the tolerance criteria.**

If the calibration check is acceptable, "logout".

Enable Channels on Data Logger

- Press {ESC}{ESC} to return to the Home Menu
- Select: "C", Configuration Menu
- Select: "D", Configure Data Channels
- Select: "E", Enable/Mark Channel Online
- Select: "NOT", <ENTER>
- Select: "E", Enable/Mark Channel Online
- Select: "NO2T", <ENTER>
- Select: "E", Enable/Mark Channel Online
- Select: "NOYT", <ENTER>

The following sequence is used to logout of the data logger:

- Press {ESC}{ESC} to return to Home Menu
- Use arrow key to select "O" or hit "O" key to logout

Turn off computer screen, **Note: DO NOT** close the AV-Trend software, **DO NOT** turn off the computer.

2.38.2.4 Site Calls

(See *Section III: Regional Office Responsibilities: AvTrend set-up; Retrieval, Review, Correction and Storage of Data; Report Submission*, for site operator's duties between visits.)

To minimize travel some site operational checks must be made by remote access or daily e-mail from Regional Office or Central Office.

Review the Reports For Flagged Data.

Flags are assigned to data to indicate its validity. If no flag follows a value, the data is assumed accurate and valid. These data are used in all appropriate averages. Compare any flagged data with what is expected to occur such as nightly auto-calibrations. If any of the flagged data appears unusual make a note to check the primary data collected during the next site visit. If several values are invalid, a site visit may be needed. If a channel is incorrectly marked "D" (down) the data may be valid and you will need to notify headquarters of any valid data to be reported.

Compare the monitor zero results to the zero for each day. Compare the monitor span results to the known calibrator output for each day. Review the power failure report.

Review the log for temperature inside the building. See **Section III** on "polling" for complete flag and review procedures.

2.38.2.4.1 Remote Calibration Check Procedure

Note: Do not perform remote Calibration Checks between 6:00 AM and 9:00AM "Local Standard Time".

Note: Use the latest Calibration Check e-log for the Remote Calibration Check Procedure

Note: A Calibration is required after two (2) consecutive failed nightly autocal (including weekends).

Login to site from Regional Office and disable the channel.

- Select the AV-Trend icon, enter the username followed by the password, hit "**OK**"
- Select: "**Utilities**"
- Select: "**Link to Logger**"
- Select the site
- Select: "**Connect**"
- Press "**L**" to log onto the site data logger (use site password)

Disable Channels on Data Logger

- Press **{ESC}{ESC}** to return to the Home Menu
- Select: "**C**", Configuration Menu
- Select: "**D**", Configure Data Channels,
- Select: "**M**", Disable/Mark Channel Offline
- Select: "**NOT**", <ENTER>
- Select: "**M**", Disable/Mark Channel Offline
- Select: "**NO2T**", <ENTER>
- Select: "**M**", Disable/Mark Channel Offline
- Select: "**NOYT**", <ENTER>

Run SPAN0, 0 ppb

- Press **{ESC} {ESC}** to return to the Home Menu

- Select: "C", Configuration Menu
- Select: "C", Configure Calibration
- Select: "1", Start a Single Phase Cal, <ENTER>
- With down arrow key, select: "NOTCAL", <ENTER>
- Select: "SPAN0", <ENTER>
- Scroll down and highlight "Phase Duration", set to ≥ 1 hour, <ENTER>
- Scroll down and select: "Start Single Cal (NOW)", <ENTER>

Monitor Actual Values

- Press {ESC} {ESC} to return to the Home Menu
- Select: "D", Real Time Display
- Select: "C", Continuous Average Report
- Select: "Show Channels", <ENTER>
- Type in parameters: "NOT" and "NOYT" <ENTER>
- Change # of flags to report from "02" to "03", <ENTER> (the "<", "D", and "C" flags will show)
- Use decimal Positioner?: "Y", <ENTER>
- Start continuous report: <ENTER> (this will show the minute averages as they are calculated and keeps all values on screen).
- Record five stable 1- minute "NOT" and "NOYT" averages

Point*

Calibration Check Tolerance

Zero (O)

± 0.5 PPB

Abort the SPAN0 after 5 1- minute "NOT and NOYT" averages have been recorded.

- Press {ESC} {ESC} to return to the Home Menu
- Select: "C", Configuration Menu
- Select: "C", Configure Calibration
- Select: "W", Abort Calibration
- Select: "NOTCAL" <ENTER>

Span Check Procedure

Run Calibration Check SPAN1

- Press {ESC} {ESC} to return to the Home Menu
- Select: "C", Configuration Menu
- Select: "C", Configure Calibration
- Select: "1", Start a Single Phase Cal, <ENTER>
- Select: "NOTCAL" <ENTER>
- Select: "SPAN1", <ENTER>
- Scroll down and highlight "Phase Duration", set to ≥ 1 hour, <ENTER>
- Scroll down and select: "Start Single Cal (NOW)", <ENTER>

Monitor Actual Values

- Press {ESC} {ESC} to return to the Home Menu
- Select: "D", Real Time Display
- Select: "C", Continuous Average Report

- Select: "**Show Channels**", <ENTER>
- Type in parameters: "**NOT**" and "**NOYT**" <ENTER>
- Change # of flags to report from "**02**" to "**03**", <ENTER> (the "<", "**D**", and "**C**" flags will show)
- Use decimal Positioner?: "**Y**", <ENTER>
- Start continuous report: <ENTER> (this will show the minute averages as they are calculated and keeps all values on screen).
- Start SPAN1 and let it stabilize
- Record five stable 1- minute "**NOT**" and "**NOYT**" averages
- Abort the SPAN1, press "**C**", "**C**", "**W**", "**NOTCAL**" <ENTER>
- Check/record results for SPAN2 and SPAN3.
- Abort the SPAN3, press "**C**", "**C**", "**W**", "**NOTCAL**" <ENTER>

Review each NOT-NOYT Calibration Check point result from the data logger. For each point calculate the % difference.

Enable Channels

- Press {**ESC**} {**ESC**} to return to the Home Menu
- Select: "**C**", Configuration Menu
- Select: "**D**", Configure Data Channels
- Select: "**E**", Enable/Mark Channel Online
- Select: "**NOT**", <ENTER>
- Select: "**E**", Enable/Mark Channel Online
- Select: "**NO2T**", <ENTER>
- Select: "**E**", Enable/Mark Channel Online
- Select: "**NOYT**", <ENTER>

The following sequence is used to logout of the data logger:

- {**ESC**}{**ESC**} to "Home Menu"
- Use arrow key to select "**O**" or hit "**O**" key to logout
- Select: "**Exit**" and then "**Exit**" on the popup menu to disconnect AV-Trend from the monitoring site.

<u>Point*</u>	<u>Calibration Check Tolerance</u>
Span (90%)	±6%
Mid (50%)	±8%
Precision (18%)	±15%

*Nominal or designated value of each point

If any of the points are greater than the calibration check tolerance for the full-scale range, the calibration check is unacceptable. If the calibration check is unacceptable after two (2) tries, a calibration is required. All points on the calibration must meet their respective calibration tolerance. Adjustments to the 42i-Y should be based on the 42i-Y **NOT** meeting the calibration check tolerance criteria.

2.38.2.5 Data Reporting and Validation for Regional Offices
(See **Section IV: Continuous Monitor QA Plan Section, Headquarters Responsibilities.**)

Data Validation for Regional Offices: The regional office is responsible for data validity.

Verify that all periods of missing or invalid data have been accounted for, and the reasons have been identified for missing or invalid data on the Monthly File Listing.

Each month, the Statistician initiates a data review by creating a raw data report for each field office. Each month, the Regional Offices will be requested to send selective sets of data that are needed beyond what is already needed by the Statistician for verifying the missing value imputations supplied by the field office.

All monthly data should be submitted to headquarters within 15 days OR 10 days from date of report distribution to the Regional Office.

All data, including logbooks and supporting printouts must be kept for five years.

2.38.2.6 Quality Assurance Procedures

The Quality Assurance Program requires strict adherence to approved procedures including the performance of specific tasks and activities. The determination of adherence to the approved procedures and the quality of ambient air data collected at each site includes the biweekly precision point analysis performed by the site operators, the monitor accuracy audits performed independently by the ECB, and a complete systems audit performed by the staff of the Ambient Monitoring Section of the Division of Air Quality of each monitoring site and the ECB. This approach provides the essential ongoing and independent evaluation of data quality and reliability for the entire ambient air quality data set collected at each site and statewide. **Strict adherence to the established approved procedures is required to enable the Division of Air Quality to certify that the data collected is true and representative of the ambient levels of reactive oxides of nitrogen in the State of North Carolina.** Certain information must be available to the auditor. Even though this information can be provided through access to the instrument logbook, use a Continuous Monitor Quality Assurance Report form (AQ121 / CMQAR) to give a better overview of each audit. (See Appendix B for the CMQAR example.)

Site Operator Responsibilities

The critical part of the site operator's role in the Quality Assurance Program is the adherence to approved operating procedures, performing the required precision point analysis, and maintaining accurate records of all monitoring site activities. It is the site operator's responsibility to notify the Regional Ambient Monitoring Coordinator of the performance of each reactive oxides of nitrogen monitoring system during and/or immediately following each monitoring site visit. The site operators and the Regional

Ambient Monitoring Coordinator are jointly responsible for timely data validation and reporting.

Precision Point Analysis

Every two weeks (**EVERY 14 DAYS OR LESS**) – SPAN3 checks (SPAN3 NO and NOy concentrations are reported to AQS) along with the SPAN1 conversion efficiency check must be performed on each TLNOy analyzer as part of the Calibration Check procedure. Data validation must be conducted by the operator on a routine basis according to **Section IV** of this QA plan.

The Regional Ambient Monitoring Coordinator (RAMC) should verify that all site visits and precision point analysis / conversion efficiency checks are conducted as required.

Accuracy Audits

The ECB performs all TLNOy monitoring sites accuracy audits. The operator shall assist if requested by ECB auditor in conducting accuracy audits.

Interagency Auditing

Interagency audits may take place between the DAQ and Local Programs. Also, U.S.E.P.A. Region IV may schedule audits for various parameters, including TLNOy, throughout the year.

Audit Evaluation and Corrective Action

For the precision audit and the accuracy audit, corrective action should be initiated by the Project and Procedures Branch supervisor, and documented at the bottom of the AQ121

Audit Form. An investigation must be undertaken to determine the cause of unusually poor audit results when any result exceeds a $\pm 10\%$ difference. Documentation of the correction will be provided to the Section Chief, with the QA report.

Data Verification

The Regional Ambient Monitoring Coordinator is responsible for all data verification activities.

Systems Auditing

The Regional Ambient Air Monitoring Staff shall participate and assist in the Annual Systems Audit performed by the Ambient Monitoring Section. All records and documentation must be available for review.

2.38.2.7 Monitor Shutdown Procedure

1. Select the AV-Trend icon, enter the username followed by the password, hit "**OK**"
2. Select: "**Utilities**"
3. Select: "**Link to Logger**"
4. Select the site
5. Select: "**Connect**"

6. Select: "**L**" to log onto the site data logger (use site password).
7. Down the associated parameter(s) "**NOT**", "**NO2T**" and "**NOyT**".
8. Disable the associated calibrations on the data logger by selecting "**Configure Calibrations, Change Old Cal Program**". From the list choose "**NOTCAL**" for TLNOy. Change the dates of the next auto cal on the "**Starting Time**" to a future date.
9. Turn the TLNOy monitor power off. Pull the power plugs out for protection from lightning.
10. Shut off the cylinder valve(s) and the outlet valve(s) on the regulator(s).
11. Submit the site shutdown form.