Thermo Environmental Model 42S Reactive Oxides of Nitrogen (NOy) – QA Plan
Section I

Electronic Calibration Branch (ECB) Responsibilities

Approval Sign-Off Sheet

I certify that I have read and approve of the contents of the "Thermo Environmental Model 42S Reactive Oxides of Nitrogen (NOy) QA Plan, Section I, Electronic Calibration Branch (ECB) Responsibilities" with an effective date of January 10, 2011. **Sign, date and return to the Ambient Monitoring Section Chief.**

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2.20.1 Oxides of Nitrogen QA Plan: ECB Responsibilities

Note: The following is a list of "significant changes" from Revision 5.5.

1) QA updated per QAP/SOP 2.39 "Standard Operating Procedure (SOP) for Preparing Quality Assurance Plans/SOPs".

2) Electronic Calibration Branch (ECB) updates.

2.20.1.1 Equipment Selection and Procurement

The Electronics and Calibration Branch (ECB) of the Ambient Monitoring Section (AMS) of the DAQ is responsible for the selection, evaluation and procurement of the NOy monitoring equipment and related accessories. Further, ECB is responsible for receipt, assembly, testing (at its facility) and installation of NOy monitors in the field, evaluation of the on-going performances of NOy monitors and related support equipment and scheduled and unscheduled system's maintenance. As a part of its responsibilities, ECB is also expected to maintain a sufficient inventory of monitors, support equipment and replacement parts to minimize loss of NOy ambient monitoring data.

Additionally, ECB staff is also responsible for procuring and maintaining dedicated traceable NOy standards for the certification of all calibrators and for the independent accuracy auditing of the ambient air quality NOy monitors. These trace standards provide a direct link to establish national standards and thus become basis for the collection of the highest quality ambient monitoring NOy data and more so in accordance with current procedures and existing Federal Regulations and Guidelines. The continual accuracy audits performed by the ECB staff provide an ongoing evaluation of NOy monitor's performance and site operator's adherence to DAQ approved operating procedures.

The ECB also maintains permanent records of all NOy standards used in the calibration and auditing of monitors and sampling equipment used in support of DAQ monitoring activities. There are permanent records at ECB for each NOy monitor and sampler used to analyze ambient air quality in the State of North Carolina. Each major component of the NOy monitoring system, such as analyzer, calibrator, zero-air supply system, etc, is assigned a dedicated logbook. These logbook records include information related to the performance evaluations and complete records detailing the instruments and equipment placed at each monitoring site. Both permanent records are updated continuously.

The ECB is also responsible for evaluating, developing and recommending changes in the equipment and operating parameters to improve the quality of data collected and procedures used in the collection of data.

2.20.1.2 Ambient Oxides of Nitrogen Monitoring

The North Carolina Ambient Air Reactive Oxides of Nitrogen Monitoring System must meet or exceed the Reference and Equivalent Method requirements in 40CFR53.1 and 40CFR58 Appendix C. The NC ambient Reactive Oxides of Nitrogen monitoring system consists of the following:

- Thermo Environmental (TEI) Model 42S NOy analyzer
- Thermo Environmental (TEI) Model 146C Dynamic Gas Calibrator
- Certified and Traceable National Institute of Standards and Testing-Standard Reference Material (NIST-SRM) NO Gas Cylinder
- Thermo Environmental (TEI) Model 111 Zero-Air Supply System
- ESC Model 8816 Data loggers (Primary, PDL and Secondary, BUDL)
- Dedicated Site PC
- Telephone Modem
- Air Compressor

Only the main components of the NOy monitoring system are discussed briefly here for their operational details. For further details of other NOy monitoring system related components refer to the "Model 42S NOy Instruction Manual, Chemiluminescence's NO-DIF-NOy Analyzer, by Thermo Electron Corporation, 12 June, 2006".

Note: minor components are not specified but included by reference.

The ECB is responsible for ensuring that all components are compatible with the measurement of ambient levels of atmospheric nitrogen. The ECB is responsible for the performance of complete system evaluation prior to the field installation and that the system is fully functional at the completion of the installation. On an ongoing basis as needed the ECB provides equipment and instrumentation maintenance and operational support to maximize the collection of the highest quality ambient air pollution data possible in accordance with accepted and approved procedures.

2.20.1.3 TEI Model 42S Certification (Pre-Site Installation Checks)

The ECB is also intimately involved in the overall monitoring system maintenance to ensure optimum continual NOy data quality. Generally, maintenance can be subdivided into two groups - preventive (scheduled) maintenance and corrective (immediate on-the-spot repair) maintenance.

Preventive Maintenance is an orderly program of cleaning, lubricating, reconditioning, adjusting, and testing equipment to prevent failure during use. An effective preventive maintenance program will increase both the data completeness and reliability of the entire monitoring system.

A) Model 42S NOy Monitor: the NOy Model 42S monitor should be tested thoroughly before deployment at the monitoring site.

Included here are the periodic maintenance procedures for some of the main components of the monitoring system that must be performed by the ECB staff to ensure proper operation. For details of any other system components maintenance procedures refer to the manufacturer's instructional manual. This testing will involve among other things:

- Pre-calibration electronic adjustment
  1) MD42S analog output adjustment for Ø and F.S.
  2) Set initial calibration factors to default
  3) Adjust PMT power supply

- NO/NO2/NOy operational test calibration and zero/span check
  1) Operational test calibration check
  2) Zero/span check
  3) Gas Phase titration
  4) Converter efficiency

The gas-phase reaction of nitric oxide (NO) and ozone (O3), specifically: NO + O3 => NO2 + O2 + hν (h = Planck's Constant (6.6260755 x 10^{-34} Joule second), ν = frequency), produces infrared light with an intensity linearly proportional to the concentration of nitric oxide. Light emission results when electronically excited NO2 molecules decay to lower energy states. NO2 in the sample must first be transformed into NO before it can be measured using the chemiluminescent reaction. The Model 42S employs a molybdenum converter heated to approximately 350^{o} C to convert NO2 to NO. For example, NO2 is converted to NO by the reaction 3NO2 + Mo => 3 NO + MoO3. The ambient air sample enters the Model 42S through a single flow control capillary and is directed to a solenoid valve. The solenoid valve directs the sample either through the NOy-to-NO converter (NOy mode) or around the converter (NO mode). The chemiluminescence measured within the reaction chamber for the sample that went through the converter represents the total NOy concentration. Bypassing the converter allows measurement of the NO level only. The signals generated in the two modes are held in the Model 42S's microcomputer where the difference between them can also be computed. The difference channel (#2) is used only to determine converter efficiency. This channel is not used in data reporting, as it represents nitrogen reactives, not NO2. The digital to analog converter then converts the three stored values into analog signals which are then output to the rear of the instrument.

Model 42S Analyzer Component Performance

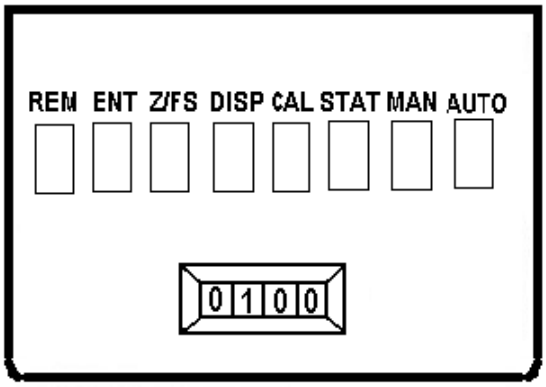


Figure 1 42S Pushbuttons / Thumbwheel

a. REM (**Remote**): This function is deactivated with PIA DIP switch #1 set OFF. When the remote option is activated (PIA DIP switch #1 ON), there will be an automatic default to the remote mode one hour after the last actuation of any pushbutton.

b. ENT (**Enter**): This pushbutton controls variables such as "Range" or "Zero/Span Settings". Variables are entered by dialing the appropriate variable on the front panel thumbwheel switches and then actuating the ENT pushbutton. Options are chosen by toggling the ENT pushbutton "ON" or "OFF".

c. Z/FS (**Zero/Full scale**) - First actuation into this mode steps the instrument to digital zero. The recorder output levels may then be adjusted to 0 volts or to some offset level. Engaging the pushbutton again sets the instrument to digital Full scale. If not in the troubleshooting mode, a third actuation would set the instrument back to digital zero. If in the troubleshooting mode, the third actuation results in the generation of a DAC ramp on the analog outputs. Entry into the DAC mode causes the display to read -23 and outputs -2.3% Full-scale on the analog outputs for 30 seconds. The DAC is then caused to change its output sequentially through all its possible states causing the digital display to count from -23 to 1000 while the analog outputs change from -2.3% Full-scale to 100% Full scale in steps of 0.1% Full scale. Engaging the pushbutton a fourth time allows the ramp to be stopped at any intermediate value.

Engaging the pushbutton again causes the ramp to continue. The ramp can be stopped at any point and then restarted any number of times until it reaches 100% Full scale. Once the Full scale output has been reached, actuation of the pushbutton will recycle to digital zero output.

d. DISP (**Display**) - First actuation of this pushbutton sets the display to read NO (#1). The second actuation sets the display to NO2 (#2). A third actuation sets the display to NOy (#3). A fourth actuation sets the display to read the prereaction zero. The "**DISP**"

button is only active if the instrument is in the CAL or AUTO modes. This pushbutton is used in combination with the "**CAL**" pushbutton during calibration.

e. CAL (**Calibration**) - This monitor pushbutton is used to calibrate the 42S by selecting the automatic mode, introducing zero gas until a stable trace is obtained and then pushing the "**CAL**" button. Set the thumbwheel switches to 0000 and push the "**ENT**" button. The computer will calculate, apply, and store zero background corrections for the NO and NOy channels (b1 and b3) based upon the 300 second running average. At this point, the LED over the CAL button will go out and the instrument will be in the normal operation mode displaying the now corrected zero concentration and outputting analog zero or the offset level. Introduction of an NO concentration of approximately 80% of the upper range limit of the NO range can be read by pressing the "**DISP**" button. Press the "**CAL**" button, set the thumbwheel switches to the NO concentration introduced, and push the "**ENT**" button. The analyzer will calculate, apply and store an NO correction (S.F.) based upon the 300 second running average.

Scroll the display to the NOy mode, push the "**CAL**" button, enter the value for NOy on the thumbwheel switches and push the "**ENT**" button. The analyzer will calculate, apply, and store a span correction (b.F.) for the NOy channel assuming a converter efficiency of 1.0. The CAL LED will go off and the instrument returns to the normal operating mode.

The NO2 channel is selected by scrolling the "**DISP**" button, and allowing the instrument response to stabilize to a known concentration of NO2 from the calibrator. Push the "**CAL**" button, set the thumbwheel switches to the generated NO2 concentration, and push the "**ENT**" button. The analyzer will calculate, apply, and store an NO2 span correction (C.E.) based upon the 300 second running average. Once the correction has been applied, the CAL LED goes off, and the instrument goes to the normal operating mode.

Note: As in the AUTO mode, the display will show the NO, NO2, NOy, or prereactor outputs. However, in the CAL mode the display represents the 300 second average of these signals whereas the AUTO display shows the output at whichever time setting is set in the STAT list. The zero calibration is done identically to the standard Model 42, however, in the case of the Model 42S three zero background corrections will be stored, b1 and b3 for the NO and NOy channels respectively, as well as b0 for the prereactor zero reading at the time of calibration. If there is a significant difference between the b0 and b1 readings, this suggests that the zero air introduced has a significant NO impurity. With true zero air, the b0, b1, and b3 values should all be within several hundredths of a ppb of each other.

f. STAT (Status) - The operating parameters set for the Model 42S are displayed upon successive engagement of the STAT pushbutton as listed in the following table:

PUSHBUTTON INFORMATION	PUSHBUTTON INFORMATION
1. Full Scale	12. NOy Zero background (b3)
2. 1. (NO) 0050/0200	13. NO Span Factor (S.F.)
3. 2. (NO2) 0050/0200	14. NOy Balance Factor (b.F.)
4. 3. (NOy) 0050/0200	15. Converter efficiency (C.E.)
5. Time Setting Average (60-300s)	16. Thumbwheel Reading
6. Troubleshoot On/Off	17. Analog Offset %
7. Cooler Temperature (Cl, ≤-16ºC)	18. DIP Switch Status
8. Converter Temperature (Ct, 350ºC)	19. DIP #1 to #8 Display
9. Reaction Chamber Temp (r.c., 50-55ºC)	20. Program Number
10. Prereactor zero (b0)	21. (P)/t ON/OFF (temp ON)
11. NO Zero background (b1)	22. Internal temperature

Time Values: Time values are chosen by setting the thumbwheels switches to the appropriate values (0060) and then press the **ENT** button.

- To check **Time Values** press "**STAT**" pushbutton - 5 times.

Units: Units are chosen by setting the DIP switch #2 to "**ON**" position (P/A Board (#42-3)).

- To check **UNITS** (PPB), press" **STAT**" pushbutton - 19 times

Ranges: Range values are chosen by setting the thumbwheels switches to the appropriate values. Press "**STAT**" pushbutton 2, 3, or 4 times, set thumbwheel (0200) and then push the "**ENT**" button.

- To check **Ranges** press "**STAT**" pushbutton 2, 3, or 4 times.

2. 1. (NO) 200 ppb
3. 2. (NO2) 200 ppb
4. 3. (NOy) 200 ppb

PMT Cooler Temperature (Cl):

- To check **PMT Cooler Temperature**, press "**STAT**" pushbutton **–** 7 times.

Converter Temperature (Ct): To set the actual temperature of the converter, set front panel dial to 325º C - 350ºC.

- To check **Converter Temperature**, press "**STAT**" pushbutton **–** 8 times.

Reaction Chamber Temperature (r.c.):

- To check **Reaction Chamber Temperature**, press "**STAT**" pushbutton **–** 9 times (50ºC to 55ºC).

Vacuum Gauge:

- Check to see that vacuum does not vary significantly during instrument operation.

External Filters:

- Check external filters located on rear panel assembly, clean/replace if needed.

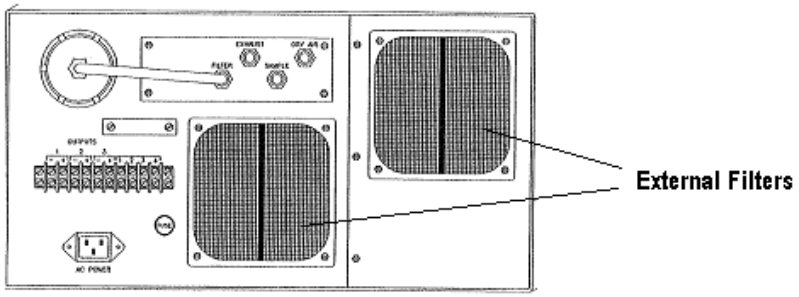


Figure 2 42S Rear Panel

Digital To Analog Converter Test

By energizing the Z/FS button three times when in the Troubleshooting mode, the analog outputs will track the digital output from -23 to 1000 going from -2.3% full scale to +100% full scale. Any excursions or discontinuities from a straight line indicate a probable lost bit. **Normally this test is only required if a problem with the analog outputs is suspected and should only be done on as needed basis.**

Inspection and Cleaning of the Thermoelectric Cooler Fins

The cooler fins on the PMT cooler should be inspected and cleaned at **six-month** intervals. This assures the performance of the cooler is at an optimum.

1) Remove cover of instrument.
2) Locate PMT cooler
3) Using clean pressurized air, blow off the cooler fins. Note that it may be more convenient for the user to vacuum the cooler fins. In either case, make sure that any particulate accumulation between the fins has been removed.
4) If necessary, employ a small brush to remove residual particulate accumulation.
5) Replace instrument cover.

Sample Filter Inspection and Replacement

The Teflon particulate filters should be inspected and, if necessary replaced. A filter that does not interact with NO or NO_2 in air should be utilized. A suitable filter should have 5 or 2 micron pore size.

Inspection and Replacement of Capillaries

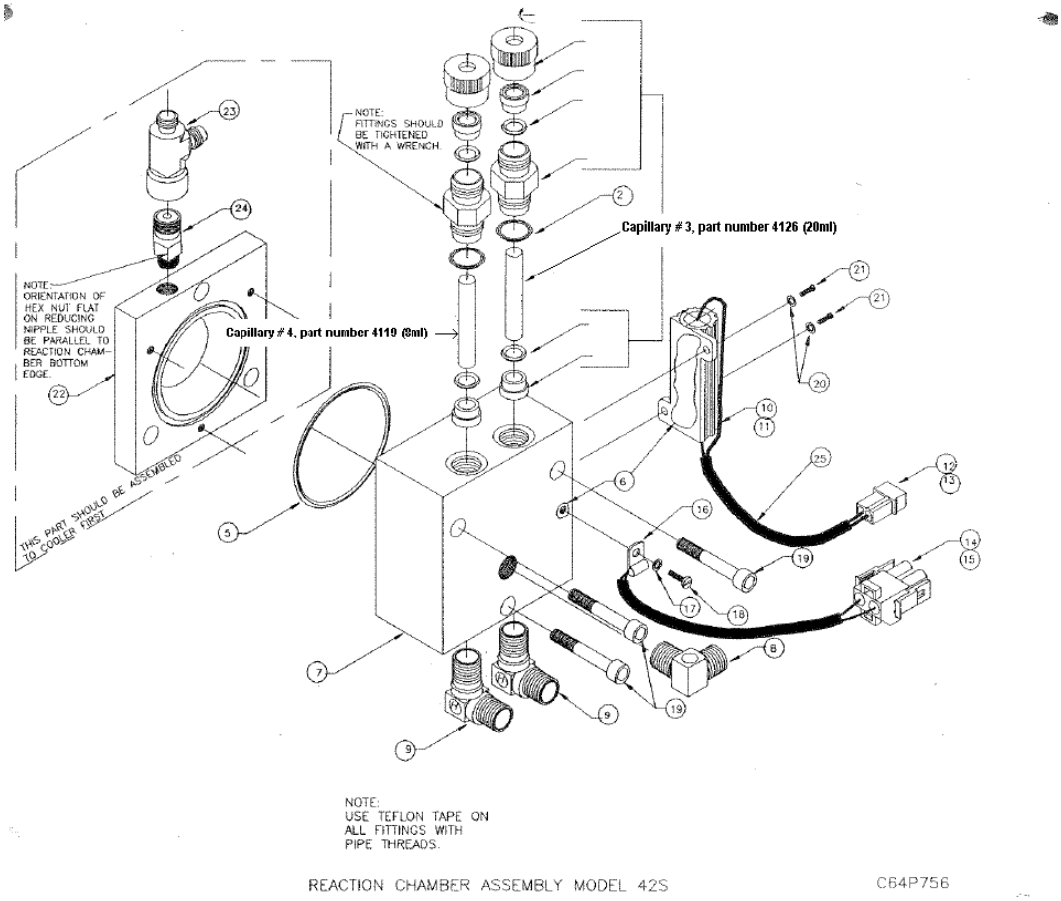


Figure 3 42S Capillary

Tools needed:
Phillips head screwdriver
$^{5}/_{8}$ wrench
Capillary # 3, part number 4126 (20ml)
Capillary # 4, part number 4119 (8ml)

1) Remove cover of the 42S and locate capillary(s).
2) Remove the Cajon fitting(s) from the reaction chamber body using a $^{5}/_{8}$ wrench.
3) Remove the glass capillary(s) (PN 4126 and 4119). Inspect o-ring for cuts or abrasion. If cut or abraded, replace.
4) Check capillary for particulate deposits. Clean or replace as necessary.
5) Replace capillary in reaction chamber body, making sure the o-ring is around the capillary before inserting it into the body.
6) Replace Cajon fitting. Note that the Cajon fitting should be replaced only hand tight.

2.20.1.4 Calibration Standards and System

Calibration Standards

The ECB shall procure certified protocol standards for the Ambient Monitoring Section. Primary NO Standards are used to calibrate and evaluate the ongoing calibration checks and audit performance of the nitrogen monitors at each site. The primary NO standards used must be certified, commercially prepared compressed gas standards with a certified accuracy of no worse than ±2 percent. Procedure for the Verification of New Cylinder Concentrations (QA/SOP 2.3.6) will be followed when primary standard calibration gases are purchased / received. Standards in the concentration range of ~20 ppm are suitable choices for dilution to prepare low concentration calibration mixtures.

a. Extreme care must be taken to ensure compatibility for all components. Flow rates and concentration outputs must meet the requirements of the monitor.

b. All primary protocol standard calibration gases must be referenced to a National Bureau of Standards (NBS) nitrogen oxide in Air Standard Reference Material (SRM) or an NBS/EPA approved gas manufacturer's Certified Reference Material (CRM). A written statement of certification should be obtained which provides the following:

   a. a brief description of the certification procedure,
   b. cylinder numbers,
   c. cylinder gas concentrations,
   d. replicate analysis data,
   e. balance gas used,
   f. NBS, SRM numbers used as standards, and
   g. last analysis date.

A copy of this certification should be available to users and should be kept on file in the ECB Unit files.

c. Re-analysis of calibration standards shall be performed every 24 months or when expired for verification of gas stability. (This 24 month period is allowed because NO is somewhat stable as shown by repeated analysis of the same cylinder and in accordance with 40CFR50 App. C.3.1. In actual practice most cylinders may be expended sooner)

d. No cylinder gas should be used below a cylinder pressure of 200 psig as shown by the cylinder gas regulator.

e. Each NO span gas cylinder shall contain the following minimum traceability information on a label or tag affixed to the cylinder or valve:

a. the concentration of cylinder gas,
b. the last analysis date,
c. the expiration date,
d. the initials of the person performing the analysis,
e. cylinder number, and
f. balance gas.

TEI Model 146C Gas Calibrator
The 42S analyzer is calibrated using a TEI 146C Calibrator, which must have the mass flow controllers certified by ECB and traceable to a primary standard according to the requirements in the QA/SOP 2.3.4 TEI 146C Calibrator.

The Model 146C Calibrator supplies the required levels of nitric oxide and nitrogen dioxide to perform zero, precision, span checks and multipoint calibrations. The Model 146C will be operated remotely from the data logger to perform zero and NO span checks.

The Model 146C is basically a combination of two devices in one convenient package: 1) an accurate mass flow controlled gas dilution system, and

2) a gas-phase titration system. NO gas from a NBS traceable Protocol II certified cylinder (connected to Gas Port A) is blended with "zero-air" to provide a desired concentration. From the known calibration of the two mass flow controllers, the exact concentration can be calculated. **Typically a dilution ratio of about 100:1 to 1000:1 is used.**

To generate the desired levels of ozone, the cylinder gas flow is turned off, the zero-air mass flow controller is set to the desired flow, and the ozone generator is activated.

The nitrogen dioxide (NO2) concentration levels are generated by mixing known amounts of NO from the cylinder with ozone. **The amount of NO2 formed is equal to the measured decrease in the NO level.** The decrease in NO level is determined using the NO channel of the Model 42S analyzer. This technique of determining pollutant concentrations is known as gas-phase titration**.** The volume of the reaction chamber (i.e., 150 cc) has been chosen to meet the dynamic parameter requirements of the U.S. EPA.

The ozone level at constant flow is changed by varying the voltage to the ozone generator lamp. The photolytic ozone generator used on the Model 146C passes all U. S. EPA qualification tests for an ozone generating transfer standard.

The Model 146C contains a LCD readout to display the actual flows measured by the mass flow controllers, one for zero air flow and one for cylinder gas flow. The sample/span solenoids for the Model 42S analyzer should be connected to the analyzer

inlet port. These solenoids can be controlled by signals from the Model 146C. Note that the plumbing should be set-up so that both sample and span gases pass through the particulate filters as required by U. S. EPA requirements. The flow of the Model 146C should be set to satisfy the flow demands of the NO analyzer connected to the calibrator. The manufacturer claims that the ozone generator can be calibrated using an ozone primary standard if it is to be used for ozone monitor calibration, and that it will pass EPA's requirements as an ozone transfer standard.

TEI Model 111 Zero-Air Supply System

The purpose of the Model 111 is to supply pollutant-free air ("zero air") for proper zeroing and to provide clean diluent air for spanning ambient air analyzers. The components to be removed are SO2, NO, NO2, O3, CO and hydrocarbons. Since many analyzers have longer response times if super-dry (dew point less than -30 ºC) is used for zero and span, and since water vapor is not a pollutant, the Model 111 does have a drying system (silica) to remove any moisture available. The dew point is also reduced as a result of compression of the ambient air. Room air enters the compressor, where it is raised to a pressure of approximately 80-90 psi (4560 mm). At 25 ºC, the saturation water vapor pressure is approximately 24 mm. Thus most of the water condenses out and falls to the bottom of the tank. Out of the 4560 mm of pressure in the tank, only 24 mm is due to water vapor. When this air is vented to atmospheric pressure (760 mm), the water vapor is reduced to approximately 4 mm. This corresponds to a dew point of slightly less than 0 ºC.

In order to keep any condensation from occurring in the tubing between the compressor and the Model 111, the output of the compressor contains a coalescing filter and a pressure regulator where the pressure is reduced to 70 psi. Inside the main case of the Model 111, the compressed air is further reduced to the final desired pressure (10-30 psi). The air then passes into a column of Purafil (potassium permanganate on alumina) that oxidizes NO to NO2. Finally, the air passes through a column of iodated or activated charcoal that removes NO2, SO2, O3, and hydrocarbons. This results in a pollutant-free air stream.

ECB Responsibilities

Zero Air Supply Start-up and Operation
Replace Model 111 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. 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. One half of the acrylic canister contains silica gel (allows detection of moisture contamination).

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 re-drying. If silica is wet, replace carulite and silica.

Notes:

- If chemicals are changed, wear a mask to guard against any dust and particulates.
- Record the chemical change(s) in the instrument logbook/file. If chemicals are changed in the site zero air pack, the zero air pack must be conditioned (purged with nitrogen at room temperature) 24 hours before use.
- Pressurize air pack and check for leaks. If leaks are present then correct.

2.20.1.5 Site Monitor Operation / Verification (Site Installation)

After the regional office has obtained permission to use a site from the site owner, and after DAQ Ambient Monitoring Project and Procedures Supervisor have approved the site, the Electronics and Calibration Branch will install the monitor and its appurtenances. Electrical circuits should be dedicated, properly sized and labeled prior to the installation of the monitor equipment. Inspect the site for integrity and safety.

The ECB staff is responsible for the installation of the State operated TEI NOy 42S monitoring system(s) across the State of North Carolina.

The monitor should be switched out for preventive maintenance every twelve (12) months; the calibrators will need to be switched out for recertification every nine (9) months. The cylinder will need to be switched out every 24 months or before it expires. All procedures should be documented on the 109 Form and instrument logbook.

The installation at the monitoring site includes:

- TEI Model 42S NOy monitor
- TEI Model 146C gas calibrator (QA/SOP 2.3.4)
- TEI Model 111 zero air pak (QA/SOP 2.3.5)
- Pretreated Teflon Sampling Line
- Computer, data logger, and modem system
- NO cylinder
- Air compressor

The 42S NOy monitor and associated accessories must be installed in a building where room temperature extremes do not fall below 20ºC (68ºF) or exceed 30ºC (86ºF). Check to ensure that the heater and air conditioner are in working order and do indeed maintain the desired temperature range, irrespective of the time of the day and season. Remove the air conditioner filter and clean, if necessary. Check any problems related to the building such as leaks, infestations, etc.

Note: To ensure the uniform collection of air quality data various sample probe-siting criteria must be followed (see 40 CFR 58 Appendix E for details). These criteria are summarized below for middle neighborhood and urban spatial scales:

- The probe should be at least 10 meters from obstructions over a range of 180º.
- The probe inlet must be at least 10 meters from the drip line of trees.
- The distance from the probe inlet to any obstacles such as buildings must be at least twice the height the obstacle protrudes above the probe inlet.
- There must be unrestricted airflow 270º around the probe inlet or 180º if the probe inlet is on the side of a building.
- The sample line should be as short as practical and should be PFA Teflon or its equivalent. The sample line must be replaced every two (2) years.

Note: the compressor must be plugged into a wall socket and not a surge suppressor.

Gas Regulator Attachment

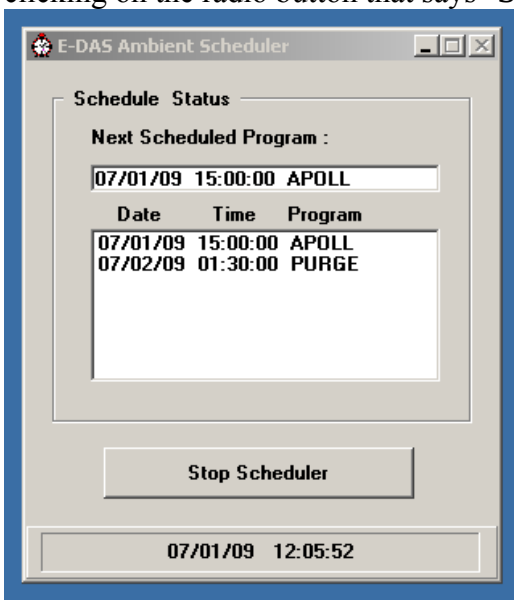
1. Set regulator valve to 30 psi.
2. Close both regulator and cylinder valves.
3. Connect vacuum pump to system.
4. Open regulator valve and evacuate system for 2 minutes. Close regulator valve.
5. Open cylinder valve and fill regulator valve.
6. Repeat steps 4 and 5 three (3) more times.
7. Close cylinder valve and regulator valve completely.
8. Turn off vacuum pump, take line off pump and connect loosely to calibrator.
9. Crack regulator valve (watch regulator gauge). As regulator valve gauge drops, tighten calibrator fitting.
10. Open cylinder and regulator valves completely.
11. Leak- check system.

B. Computer Data logger System and Modem

a. Site Polling - manually poll the Primary Data logger (PDL) and Backup data logger (BUDL) to review data and edit flags if needed.

b. Make sure poll editor and scheduler is set to poll the correct site at the next odd hour.

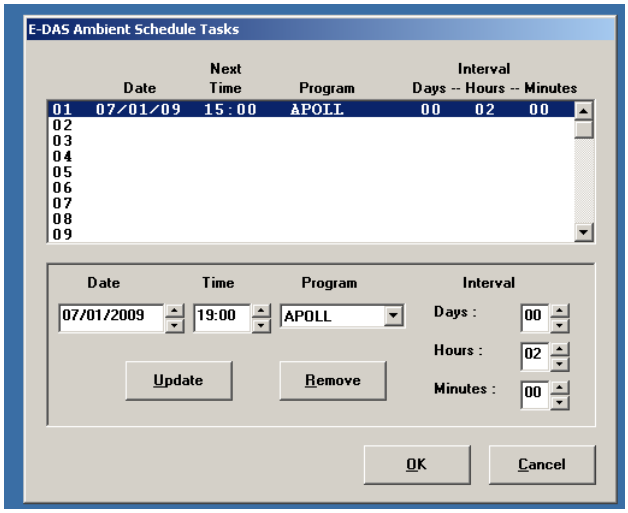
The autopoll program called "**APOLL**" automatically polls the data that is being collected on the PDL and the BUDL. Since performing a calibration check can interfere with the operation of the Auto Poll Scheduler, the Scheduler needs to first be stopped by clicking on the radio button that says "**Stop Scheduler**".



If the scheduler isn't on the screen, there should be a small red alarm clock "**icon**" down in the bottom right hand corner. Any mouse click will bring up the scheduler so that you can stop the scheduler.

The APOLL task must be set to a later odd hour time before a calibration check. To do this, we open the EDAS menu and under the "**Editors**" pull down menu there is a "**Schedule tasks**" button. Click on it…

That will bring up the E-DAS Schedule Tasks window….Highlight the ″**APOLL**″ line in the top half and set the bottom ″**Time**″ for the next odd hour or some odd hour beyond that (two or four hours later today). AND HIT "**UPDATE**" TO MAKE THE HILIGHTED LINE REFLECT THESE CHANGES.



- Configure the modem as per manual instructions to auto answer on the first ring and to operate at 2400bps. Check modem operability by calling the ECB and having someone call back the site.
- Next, the data logger must be configured and initialized by following the instructions included in the manufacturer's manual. Adjust PDL (Z1 and S1) to be

close to correct value (±5). Turn the main power "on" of all system components and ensure that components power lights are on.

- Following the installation of components of the NOy monitoring system, the ECB staff should verify the performance and proper functioning of each component. Set the computer, primary and secondary data logger's time. The times for the PDL, BUDL and computer must be Eastern Standard Times (EST).
  Note: The PDL and BUDL must have the NIST time ± 1 minute; the computer time must be 5 minutes slower than PDL/BUDL.

  Sources for setting the correct time
  1) Call ECB and ask for NIST time,
  2) Call the NIST Colorado time @ (303) 499-7111,
  3) Correct time loaded into cell phone,
  4) Correct time website, **http://nist.time.gov/**.

Disable the PDL and BUDL channels:

- Select: "**D**", real time display
- Select: "**B**", display last base average: shows the last 1 minute average only w/flag, "D", disabled and "C" calibration
- Select: "**C**", continuous average report
- Type in parameters "**NO**", "**NO2**", "**NOY**"
- Change # of flags to report from 02 to 03
- Start continuous report: this will show minute averages as they are calculated and keeps all values on screen

The BUDL mirrors the activity of the PDL. The calibration control is via the PDL. The BUDL screen is used to view the real time data either as last base average or through the continuous report.

Model 42S Analyzer Setup

a) Connect a clean, dry sample line of 1/4" Teflon to the port labeled "Sample" and to port labeled "NOy" on the rear of the instrument. The length of the tubing should be held to 10 feet or less, if possible.

b) Connect the air dryer to the bulkhead labeled "DRY AIR" on the rear of the instrument.

c) Connect the exhaust port on the rear of the instrument to the external exhaust sample pump then to the ozone scrubber. Vent to the outside (do not vent into room air). The length of the exhaust line should be 10 feet or less.

d) Connect a filter holder with 5 micron Teflon filter in the "Sample" and "NOy" lines inside the building close to the 42S inlets.

e) With the cover removed, check to see that the Display, Peripheral Interface, Processor, Memory, Digital/Analog and Counter boards are inserted properly into the appropriate connectors.

CAUTION: When removing or installing the boards, ensure that the main power switch is off.

Note: The electronic offsets should be nulled any time a new input board is installed. These offsets are nulled by setting PIA DIP switch #5 to ON and using the STAT button #6 Troubleshooting button. Toggling the "**ENT**" button to turn the #6 Troubleshooting mode ON, additional pressing of the **STAT** button 17 and 18 times to check "Dip Switch Status" and "DIP #1 to #8 Display" available. The LED over #5 DIP switch should be ON. Also DIP switch #2 should be ON for selecting the parts per billion (PPB) Units mode. The Model 42S MUST be in the AUTO mode on the test panel and the PMT voltage MUST be turned OFF. Press the **STAT** push-button 23 times to automatically null any electronic offsets generated from the input board.

f) Insert AC power cord in the connector in rear of control unit and plug into correct AC power surge suppressor outlet. Connect the data logger and back-up data logger as in to the output channels *after* adjusting the Digital/Analog board.

g) Set the converter temperature controller on the Model 42S to 325ºC ± 5ºC.

Precalibration Electronic Adjustment
Note: All gases should be delivered to the monitor at atmospheric pressure. An atmospheric vent must be used to accomplish this.

1) Release the 4 cover latches and remove cover to provide access to the internal chassis.

2) Data logger Analog Output Adjustment
Locate the Digital/Analog Board (#42-2) in the Microprocessor Section of the electronics drawer.

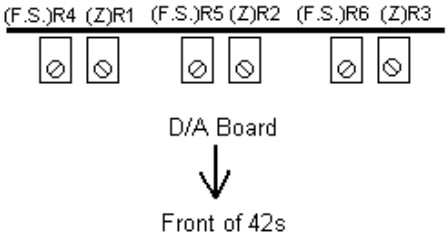


Figure 4 42S Digital/Analog Board

Locate the six multi-turn pots labeled R1 through R6. The pots are paired and correspond to:

	zero	span
NO	R1	R4
NO2	R2	R5
NOy	R3	R6

Type "**A**", press <Enter>; Answer **02**, **03**, and **04** in succession to "View which columns"; and type "**E**" for Engineering Units. This will set the data logger to output one-second updates of the Zero or Full-Scale ("Z/FS") values depending upon the active actuation of the "Z/FS" button.

3) Zero the Primary Data logger (PDL) by pressing the "**Z/FS**" button on the 42S. The first actuation of the "Z/FS" button will show "0" on the 42S display. Adjust R1, R2, and R3 until the PDL shows a zero on the computer monitor for the NO, NO2, and NOy channels. Depress the "Z/FS" button again. The second actuation of the "Z/FS" will show "F.SCALE" on the 42S display. Adjust pots R4, R5, and R6 until the PDL displays the instrument Full-Scale value (50 for 0-50ppb range, 200 for 0-200ppb range) on the computer monitor for the NO, NO2, and NOy columns.

4) Recheck the zero by depressing the "**Auto**" button to exit the current mode and depress "Z/FS" to return to zero volts. Readjust the zero pots, if needed. Recheck the span pots, and readjust if necessary.

5) Continue to adjust between zero and full scale span until no adjustments are needed and the PDL displays a "0" when in the first actuation of the "Z/FS" button and displays the Full-Scale value on the computer monitor when in the second actuation.

6) Verify the Model 42S is in the "Auto" mode with the NO concentration on the display and replace the cover.

Setting Initial Calibration Factors and Adjusting the PMT

Note: The photomultiplier tube voltage adjustments are only to be made by the ECB when

1) a new PMT has been installed, (wait for 24 hours after PMT installed)
2) new equipment is being started up, or
3) the instrument has shown a severe span drift.

- Introduce zero air into the Model 42S via the 146C:
- Wait 15 minutes for the zero response to stabilize.
- Using the "**STAT**" push-button on the front panel of the 42S, press pushbutton 11 times for "NO Zero Background" (bl). When the correct factor is displayed, set the desired value of "0000" on the thumbwheel switch below the pushbutton panel

and press "**ENT**" to enter the setting. Continue with this process by pushing "**STAT**" button once for background (b3).

- Introduce span gas with a concentration of 80-90% of Full-Scale range (0 - 200 ppb range to be 180 ppb Ca).
- The span (SPAN 1) should begin and the zero should stop.
- Set the 42S thumbwheels to 1000 and push "**STAT**" button one more time for NO Span Factor (S.F.), and one more time for the NOy Balance Factor (b.F.). Push the "**ENT**" button. Push "**STAT**" button one more time. The converter efficiency (CE) is entered as "1000" for 100% efficiency.
- Wait a minimum of 25 minutes for the calibrator to generate a level trace on the data logger. If the 42S response is not with ±10% of the span concentration, adjust the "Photomultiplier Tube (PMT) Adjust" potentiometer in quarter turn increments so that the Model 42S Display reads approximately the calculated NO span concentration generated by the Model 146C calibrator. Wait 15 minutes after every quarter turn increment to let the response stabilize and readjust if needed.
- After the final adjustment to the PMT, let the 42S sample span gas for another hour to make sure the response is stable at where you put the PMT. Readjust the PMT as above, if the 42S response moves away from ±10% of the span concentration after one hour of waiting.

Program the 146C calibrator to output span gas and the 50% and 16% calibration / precision points as follows:

1. From the Flow Controls menu choose "**AUTOMATIC SETTINGS**".
2. From AUTOMATIC SETTINGS, use ↑↓ □to choose "**GAS A DILUTION**".
3. Press <ENTER> to select or **MENU** to return to a previous menu if a mistake is made.
4. Once in GAS A DILUTION, press ↑↓ □to move the cursor to the "**SPAN1 PPM**" level.
5. Select the SPAN 1 level by pressing <ENTER>.
6. When the SPAN 1 Parameters screen is displayed, use ↑↓ □to choose "TANK PPM".
7. In the Tank PPM screen, press ←→ to move the underscore to the digit to be changed.
8. Use ↑↓ □to increment or decrement the underscored digit until the PPM matches the concentration of the NO/NOY cylinder at the site.
9. Press <ENTER> to accept the revised Tank PPM.
10. Press "**MENU**" to return to the SPAN 1 Parameters Settings screen.
11. From the SPAN 1 Parameters Settings screen, use ↑↓ □to choose "OUTPUT PPM".
12. Press <ENTER> to select.
13. To change the Output PPM setting: press ←→□ to move the underscore to the digit

to be changed. Press ↑↓ □to increment or decrement the underscored digit to 90% of the full-scale range of the 42S [for example, set the Output PPM to 1800.000 PPM (180 PPB) for a range of 0.2 PPM (200 PPB)].

14. Press <ENTER> to accept the revised output PPM.
15. Press "**RUN**" to return to the Run screen.
16. Repeat steps 6-15 to set the 50% (Span 2), and 16% (Span 3) span levels in AUTOMATIC SETTINGS, as necessary for precision checks.

Setting computer, PDL, and BUDL time/date.
The times for the PDL, BUDL, and computer must be EASTERN STANDARD TIME. The BUDL, PDL must have the same NIST time ±1 minute. The computer time must be 5 minutes slower than the PDL/BUDL time.

Check the computer time and date at the lower right hand corner of the computer screen. If the time and date are not correct; click "**START**" button, control panel, date/time or right click computer time on taskbar, select "**Adjust Date/Time**", type in changes and select "**OK** ".

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** (long distance).
3. Correct time loaded into cell phone.
4. Correct time website, **http://nist.time.gov/**

Login to 8816 Data logger: Sites are equipped with ESC Model 8816 primary and "back-up" data loggers. Both are important tools in reviewing monitor/site operations. To ensure the calibrator and monitor zero/spans are within required ranges, an automatic zero/span check can be performed.

The following sequence is used to log onto the PDL and BUDL so that calibrations can be performed via the 8816 data logger:

- Turn on the screen
- Double click on "Shortcut to Splitscreen"
- PDL and BUDL open
- Highlight PDL and type 2 letter data logger site code (located on the front of 8816 data logger) and AQM (may have to hit **{ESC}** several times before typing the site code)
- Select Login "**L**"
- Enter password ([redacted]) and this will bring up "Home Menu"
- Highlight BUDL and type 2 letter data logger site code (located on the front of 8816 data logger) and AQM (may have to hit **{ESC}** several times before typing the site code)
- Select Login "**L**"
- Enter password ([redacted]) and this will bring up "Home Menu"

- Can view "Report Current Cal Status" (tells when all Auto Cals are run)

TO MOVE BETWEEN PDL AND BUDL PRESS "**ALT**" TAB

ESC 8816 Misc. Screen/Menu Items:

- H: Help Screen
- C: Configure Menu
- D: Real Time Data Display
- R: Report Generation Menu
- G: Graph Generation Menu
- S: Status Menu

Change COZAdj Cal time

If the site has a HSCO monitor, the HSCO AutoZero needs to be re-set to run at the appropriate time. Change COZAdj Cal time (to prevent COZAdj events from triggering during calibration)

- **{ESC}** to Home Menu on PDL & select "**C**" Configuration Menu
- Select: "**C**" Configure Calibration
- Select: "**C**" Change Old Cal Program
- Select: "**COZAdj**", <ENTER>
- Highlight starting time and change to xx (odd):46
- Arrow down to "Finished Conf Now", <ENTER>
- **{ESC}{ESC}** to home menu

Configure Menu

- Configure Channels (enable/Disable Channels)
- Configure Calibrations (Start Span/Zero Air Checks)
- K: Math Constants (used in HSCO Analysis)

Real-Time Data Display Menu

- Provides a number of different ways to view data "Real-Time"
- W/units…W/flag…Base Average…Continuous Average

Various Report Generations

- Type the parameters that you need (NO, NO2 and NOy)
- Make sure that the decimal positioner is marked "Y"
- Go and view “On-Screen”

Disable Channels on Data logger

- While disabled, values are collected but flagged as "invalid data"
- Highlight PDL and scroll using arrow keys to select "C" Configuration Menu
- Select "**D**" Configure Data Channels
- Select "**M**" Disable/Mark Channel Offline
- Select "**NO**, **NO2**, **NOy**" (these are marked down separately)

- **{ESC}, {ESC}** to "Home Menu"
- Select "**D**" Real Time-Data Display
- Select: "**B**" Display Last Base Avg: This shows the last 1minute average only w/flag D: Disabled
- Highlight BUDL and follow same steps to disable the channel
- **{ESC} {ESC}** to "Home Menu" on both PDL and BUDL

2.20.1.5.1 Span Zero Check

- Highlight PDL and select "**C**" Configuration Menu
- Select: "**1**" Start a Single Phase Calibration
- Select: "**NOCAL**" <ENTER>
- Select: "**SPAN0**" <ENTER>
- Enter Phase Duration
- Select: "**Start Single Cal (NOW)**" <ENTER>
- **{ESC} {ESC}** to Home Menu

Monitor Actual Values:

- Select: "**D**" Real Time Display
- Select: "**B**" Display Last Base Avg: Shows the last 1 min average only w/flag
- "D": Disable and "C": Calibration
- Select: "**C**" Continuous Avg Report
- Type in parameters "**NO**", "**NOy**", "**NO2**"
- Change # of flags to report from 02 to 03
- Start Continuous Report (This will show the minute averages as they are calculated and keeps all values on screen)

Allow the Model 42S microprocessor to stabilize for at least 30 minutes, until the zero channels on the data logger(s) are stable.

- Using "W" command abort the SPAN0

The BUDL mirrors the activity of the PDL. The instrument control is via the PDL. The BUDL screen is used to view the Real Time Data either as Last Base Avg or through the Continuous Report.

2.20.1.5.2 Span 1 Check

Procedure to calibrate Span 1 through 8816 PDL

- Highlight PDL and Select "**C**" Configuration Menu
- Select: "**C**" Calibration Configuration
- Select: "**NOCAL**" <ENTER>
- Select: "**SPAN1**" (SPAN 2, SPAN 3)
- Enter Phase Duration
- Select: "**Start Single Cal (NOW)**"
- **{ESC}{ESC}** to Home Menu

Monitor Actual Values:

- From "Home Menu"
- Select: "**D**" Real Time Data Display
- Select: "**B**" Display Last Base Avg: Shows the last 1 min average only w/flag
- "D": Disable and "C": Calibration
- Select: "**C**" Continuous Avg Report
- Type parameters "**NO**", "**NO2**", "**NOy**"
- Change # of flags from 02 to 03, <ENTER>
- Start Continuous Report: This will show the minute averages as they are calculated and keeps all values on screen

Start SPAN 1

- Highlight PDL and Select: "**C**", Configuration Menu
- Select: "**C**", Calibration Configuration
- Select: "**NOCAL**", <ENTER>
- Select: "**SPAN 1**", <ENTER>
- Enter Phase Duration
- Select: "**Start Single Cal (NOW)** "

Calculate actual NO/NOY concentrations (Ca) of approximately 90% of full-scale range (approximately 45 PPB, 90 PPB, or 180 PPB) using the equation below. Obtain $F_{NO} + F_{zero}$ from 146C display by pushing "**Run**" button.

$[NO]_{Ca} = [F_{NO} / (F_{NO} + F_{zero})] \times [(NO_{std})]$

$[NOy]_{Ca} = [F_{NO} / (F_{NO} + F_{zero})] \times [(NO_{std}) + (NO2)_{imp}]$

Where: $F_{NO} + F_{zero}$ = Calibrated flows in sccm.

$[NO2]_{imp}$ = NO2 impurity in cylinder (on certification sheet)

$[NO]_{std}$ = Certified NO gas concentration

Note: Multiply liters by 1000 to convert to sccm; multiply PPM by 1000 to convert to PPB

$[NO]_{Ca} = [F_{NO} / (F_{NO} + F_{zero})] \times [(NO_{std})]$

i.e., if $[NO]_{std}$ = 5.0 PPM, F_{NO} = 79.11 sccm and F_{zero} = 2121 sccm (2.121 lpm) then [NO] = 0.1798 PPM (179.8 PPB).

After at least 30-45 minutes, verify that the analyzer data logger has stabilized to obtain a level span trace. Verify that the 42S display shows appropriate NO or NOy concentrations. If not press the "**DISP**" button until the NO or NOy is displayed. After stabilization, press the "**CAL**" button, set the value for NO span on the front panel thumbwheel to the calculated NO span. Press the "**ENT**" button to enter the span

concentration. Wait an additional 10 minutes for the microprocessor to stabilize, repeat the entry, if necessary. Change the display to NOy and repeat the same process for the calculated NOy span, including any impurity by pressing "**CAL**" and "**ENT**" after thumbwheel entry. Check that NO and NOy displays are reading the calculated NO and NOy spans. If you cannot obtain the appropriate span readings on the primary and backup data logger, troubleshoot the instrument. If no problem can be detected, the instrument may be malfunctioning.

The microprocessor will calculate, apply and store an NO span correction (S.F.) and an NOy balance factor (B. F.) which will automatically adjust the analog outputs to reflect the NO and NOy concentrations.

Note: Prior to "Aborting Cal" and "Enabling Channels" perform the following Span 1 gas phase titration.

2.20.1.5.3 Gas Phase Titration

From the **Gas A Dilution** run screen, check the **zero air** and **gas flow** necessary to produce the **Span 1** output, PPM.

Start the gas phase titration as follows:

While the Span 1 event is running:

- On 146C push "Menu" press <ENTER>, <ENTER>, <ENTER> until 146C is in "Local"
- On "Home Menu" push "**Run**"
- Turn "GAS A" on
- Turn SPAN 1 on
- Set bottom line to "OZON" Manual
- From "Main Menu" go to "**Ozonator**", press <ENTER>
- Go to "**Manual**", press <ENTER>
- Note your "GPT" zero air and "GPT" gas flows when you are running the "GPT". If the flows are not exactly equal to Span 1 zero air and gas flows that you recorded as noted above, phone ECB for guidance.

Once the GPT is running, use the ↑↓ arrows to adjust the O_3 "Level" (percent ozonation) to 20%, allow reading to stabilize. The stabilized NOy readings should agree with the original NOy span value, if the right amount NO2 is being converted to NO. Starting from 20% ozonation, slowly increase the O_3 level until the NO readings drop to 10-20% of the span value (e. g. if the NO span is 90 PPB, increase the percent O_3 level slowly until the monitor stabilizes at an NO reading of approximately 9-18 PPB). Usually, an O_3 level set between 20-30% accomplishes the required NO reduction. Once set, the O_3 level will work with other calibrations unless something changes such as a gas cylinder or an ozonator lamp.

Important: During the "GPT", NO reading must not be allowed to decrease by more than 90% of its original full scale span value (45 PPB for a 0-50 PPB range, 90 PPB for a 0-100 PPB range or 180 PPB for the 0-200 PPB range) so that adequate NO is available for the NO/ O_3 reaction and enough NO remains for accurate NO2 calculations. If the NO reading drops by more than 90% (e.g. below 1.8 for a NO full scale span of 180 PPB), reduce the output of the calibrator until an acceptable NO reading is achieved.
While waiting approximately 45 to 60 minutes for the NO2 trace to stabilize, verify the display is showing NO2 concentration, press the "**DISP**" button to obtain "2".

After the appropriate time period, look for a stable NO2 trace of about 10 minutes data logger duration. Calculate the actual concentration of the NO2 span using the equation below. Wait until the actual concentration is stable on the data logger.

$[NO2]_{Ca} = [NO]_{orig} - [NO]_{rem} + [F_{NO} / (F_{NO}+F_{zero})] \times [NO2]_{imp}$
i. e. $[NO2]_{Ca}$ = 180 PPB- 20 PPB + 0.7 PPB = 160.7 PPB
Where: $[NO2]_{Ca}$ = NO2 concentration at the output manifold, PPB
$[NO]_{orig}$ = Original NO concentration before titration with the O_3, PPB
$[NO]_{rem}$ = No concentration after titration with O_3, PPB
$[NO2]_{imp}$ = NO2 impurity in cylinder, PPB
NO2 impurity in cylinder = NOy – 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 (ozone flow rates included)
D = Dilution ratio $F_{NO} / (F_{NO}+F_{zero})$

$C.E. = (NO2_{Ca} / NO2_{conv}) * 100$
Where $NO2_{conv} = NO_{orig} - NO_{rem}$
= 160.7 PPB - 160.5 PPB
= 0.2 PPB
C.E. = (160.7 PPB / 160.7 - 0.2 PPB) * 100
= (160.7 PPB / 160.5 PPB) * 100
= 1.0012 * 100
= 100 %

Note: NO2 impurity may be listed as an additional factor in certified protocol NO gas received from the manufacturer. If so, this additional NO2 must be included when calculating the total NO 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 NO2 concentration measured on the data loggers is not within ± 5% of the actual concentration, $[NO2]_{Ca}$ set the instrument display to read NO2, press the "**Cal**" button, dial in the determined actual concentration of the NO2 on the thumbwheel and press the "**ENT**" button.

When the titration finishes, do the following:
- Place 146C back into "Remote"
- Calculate the Converter Efficiency
- Abort NO Span 1 on the primary data logger using "W"

Verification of Span Points via 146C "Remote Mode"
- Run SPAN 2 and SPAN 3 points
- Allow 10-15 minutes for readings to stabilize
- Abort "Span Mode" on the primary data logger using "W"

Abort Calibration Check on PDL and BUDL
Procedure:
- Highlight PDL and **{ESC}{ESC}** to Home Menu
- Select: "**C**", Configuration Menu
- Select: "**C**", Configure Calibration
- Select: "**A**" Abort a Calibration Program
- Select "**NOCAL**", press <ENTER>, this stops the calibration
- **{ESC}{ESC}** to "Home Menu"
- Highlight BUDL and follow the above instructions for enabling the 3 channels

Keep in mind that if the site has a HSCO monitor, the HSCO AutoZero needs to be re-set to run at the appropriate time.

Setting the HSCO Autozero
Change COZAdj Cal Time
- Select: PDL and then select "**C**" Configuration Menu
- Select: "**C**" Configure Calibration
- Select: "**C**" Change Old Cal Program
- Select "**COZAdj**"
- Highlight time and change XX:46 (Future odd hour: 23:46, 3:46, 7:46, 11:46, 15:46, 19:46)

Enable Channels on PDL and BUDL
- Highlight PDL and select "**C**" Configuration Menu
- Select: "**D**" Configure Data Channels
- Select: "**E**" Enable/Mark Channel Online
- Select "**NO**", "**NO2**" and "**NOy**" (do this separately) and press <ENTER>
- Highlight BUDL and repeat the steps for enabling the 3 channels

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

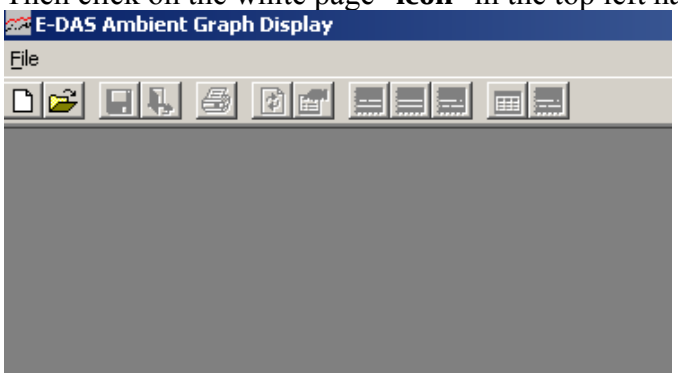
- **{ESC}{ESC}** to "Home Menu" on both PDL and BUDL
- Use arrow key to select "**O**" or hit "**O**" key to logout
- Repeat for BUDL

The Scheduler must be restarted
Restart the poll editor and scheduler by clicking on the Scheduler "**icon**".

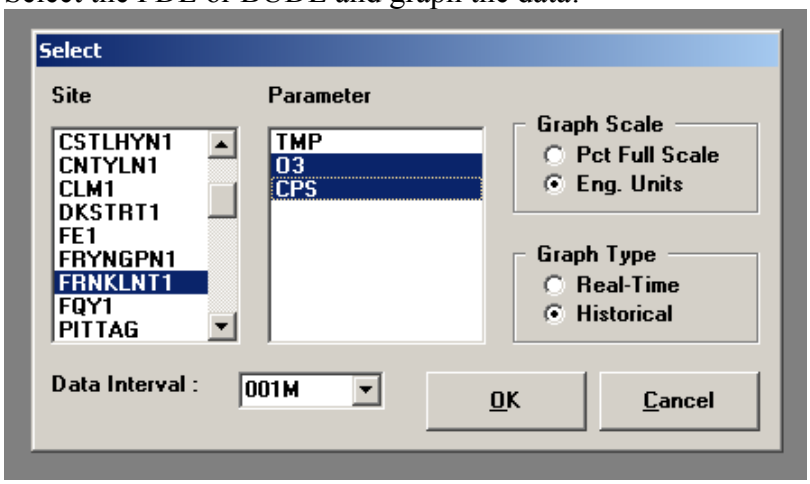
You can bring the scheduler back up and see that it's going to run 4 hours down the road.

Check to ensure that the data logger is storing minute data on the computer.
Check to make sure that we can collect the data from the data logger and store it on the computer. Check to see IF it has actually happened. Minute data only resides in the data logger for about 3 days, beyond that the minute data is overwritten and is lost FOREVER. It's real easy to see this data, just open up the graph "**icon**".

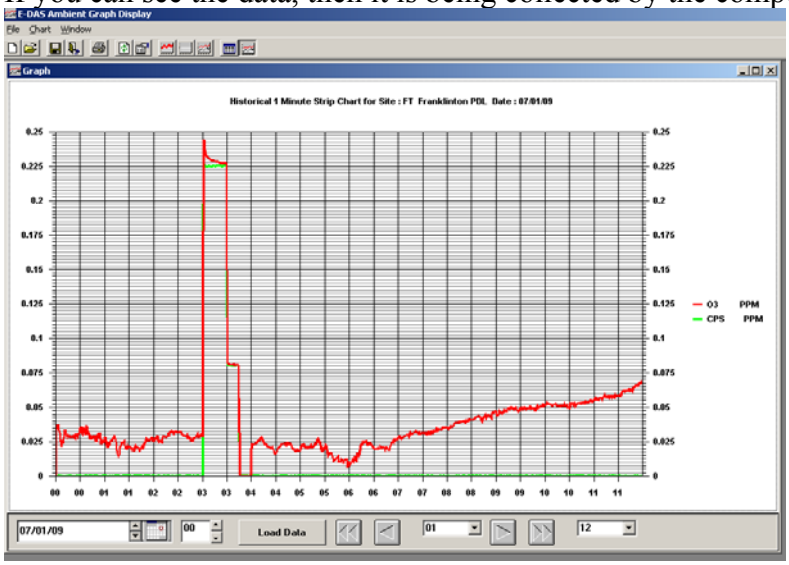
Then click on the white page "**icon**" in the top left hand corner to open the data file area.



Select the PDL or BUDL and graph the data!



If you can see the data, then it is being collected by the computer.



If you can't see the data after hitting "**Load data**"….there is a problem.

Remote Polling - check to make sure the telephone is in working order (dial tone). Call back to the ECB and request a site poll, if necessary.

Turn off Computer screen. **Note: DO NOT** close the ESC Digitrend Operating Software, **DO NOT** turn off the computer.

An instrument check should also be performed by the ECB (see pg. 25) following any one of the activities listed below:

- A new site installation
- A monitor replacement
- A calibrator replacement

Any repairs that may affect the calibration of the instrument such as particulate filters or capillaries, pump, and ozone lamp replacements

2.20.1.6 Equipment Identification

The Model 42S NOy Analyzer and converter, the Model 146C Gas Calibrator, the Model 111 Zero Air Supply System, data loggers and computer identification numbers will be documented / logged on the 109 Form.

2.20.1.7 NOy Monitoring System Maintenance

The ECB is also intimately involved in the overall monitoring system maintenance to ensure optimum continual data NOy data quality. The following are aspects of system maintenance that ECB is involved:

- Preventive Maintenance (see pg. 6)
- Corrective Maintenance

Note: ECB staff must document any and all maintenance activities, irrespective of type in the instrument logbook.

Preventive Maintenance
Included here are the periodic maintenance procedures for some of the main components of the monitoring system that must be performed by the ECB staff to ensure proper operation. For details of any other system components maintenance procedures refer to the manufacturer's instructional manual.

Caution: All Power should be turned off on the instrument before any electrical maintenance is performed.

Corrective Maintenance
The following are step-by-step procedures to be used to replace the subassembly modules in the Model 42 and 42S Addendum. [See maintenance manual for figures and illustrations.]
Caution: All Power should be turned off on the instrument before any electrical maintenance is performed.

Rebuilding Pump

1) Loosen fittings and remove both lines going to the pump.
2) Remove four screws from top plate, remove top plate, flapper valve, and bottom plate.
3) Remove clamping disk holding diaphragm and teflon protection wafer onto clamping rod, remove both diaphragm and teflon wafer.
4) Assemble pump by following above procedure in reverse, making sure not to over tighten clamping disk, and to have Teflon side of diaphragm facing up and that the flapper valves cover the holes of the top and bottom plate.
5) Check that vacuum indicated on test panel gauge reads between 24 and 28 "Hg when instrument power is reintroduced.

Photomultiplier Cooler Replacement

1) Disconnect two-pin (reaction chamber thermistor) connector from temperature control board.
2) Remove cooler fan guard at rear panel.
3) Remove four screws from cooler shroud and remove shroud.
4) Remove plumbing connections to reaction chamber.
5) Unplug signal cable to input board, high voltage cable to PMT power supply, and four-pin connector to DC power supply. Pull cables through divider panel.
6) Remove four screws holding cooler to floor plate.
7) Lift cooler assembly & reaction chamber up and slide forward to remove.
8) Install new cooler by following above procedure in reverse.

Replacement of Photomultiplier Tube (PMT)

1) If the PMT cooler needs to be removed as well as the PMT replaced, remove PMT cooler as described in section B above and then go to step 7.
2) If the PMT only needs to be removed and the rear panel is of dual piece construction, disconnect the high voltage cable to the PMT power supply and unplug the signal cable to the input board.
3) Remove cooler fan guard at rear panel.
4) Remove four screws from cooler shroud and remove shroud.
5) Remove three external #6 screws holding right panel to divider panel. Remove three internal #6 nuts holding panel to instrument frame. Remove right rear panel. **Note:** the cooler fan is attached and if necessary the fan power cord should be unplugged.
6) Pull high voltage cable and signal cable attached to PMT base through divider panel.
7) Remove three retaining screws holding PMT base to cooler.
8) Withdraw PMT base with tube attached from cooler assembly. A slight back and forth twisting motion facilitates this procedure.
9) Note that there exists two possible versions of the PMT base assembly. The Model 42S may use either version. One version consists of separate PMT and separate base assembly and cannot be disassembled from one another. The base in this version is

clearly marked with a "**CAUTION**" to this effect. The integral PMT/base version must be installed (or removed) as a single unit.

10) To install PMT, follow above procedure in reverse, making sure to backfill the cooler with dry air or nitrogen prior to replacing the PMT. If PMT is replaced, adjust the "Photomultiplier Tube (PMT)" potentiometer in quarter turn increments so that the Model 42S display reads approximately a calculated NO span concentration (80-90% of Full-Scale range). Wait 15 minutes after every quarter turn increment to let the response stabilize and readjust if needed.

Reaction Chamber Cleaning and/or Removal

1) Remove PMT cooler as described in above. Note that if the converter is removed first, as in section below, the reaction chamber can be removed without removing the entire PMT cooler by following from Step 2.
2) Disconnect the 1/8" line at the mixing tee on the back portion of the reaction chamber. This line is connected to the left 1/8" elbow at the bottom of the front portion of the reaction chamber.
3) Disconnect the 1/4" fitting from the exhaust from the exhaust elbow on the front portion of the reaction chamber.
4) Disconnect the 1/8" fitting from the right 1/8" elbow at the bottom of the front portion of the reaction chamber.
5) Disconnect two-pin (reaction chamber thermistor) connector from temperature control board.
6) Disconnect two-pin in-line connector (yellow wires) from reaction chamber.
7) Remove the three socket head screws holding front portion of reaction chamber to back portion. This should expose the inner surfaces of both portions of the reaction chamber and the quartz window. To clean these surfaces, use Q-Tips and methanol.
8) To continue removing back portion of reaction chamber, remove the three socket head screws holding it to cooler, being careful to keep quartz window and red filter in cooler body.
9) To reinstall reaction chamber, follow above procedures in reverse, making sure to backfill the cooler with dry air or nitrogen prior to installing reaction chamber.

Converter Removal

1) Allow converter to cool to room temperature to prevent contact with heated components.
2) Disconnect plumbing at inlet and exit of converter.
3) Disconnect thermocouple plugs and two-pin heater connector from their respective leads.
4) Remove four screws holding converter housing to floor plate.
5) Remove six screws holding top half of converter housing to bottom half.
6) Remove converter cartridge heater assembly from bottom half of converter.
7) Loosen heater clamp, pry heater apart and remove converter cartridge, noting proper orientation of heater wires and thermocouple probe.
8) To replace converter, follow above procedure in reverse.

Solenoid Valve Replacement
1) Disconnect solenoid from DC power supply board.
2) Remove Teflon plumbing at solenoid
3) Pull solenoid valve from divider panel mounting clip.
4) To replace solenoid, follow above in reverse.

Ozonator Replacement
1) Disconnect plumbing at inlet and outlet of ozonator.
2) Remove two screws holding plastic ozonator cover.
3) Desolder ozone transformer leads from ozonator mounting electrodes.
4) Remove two screws holding rest of ozonator assembly to divider panel.
5) To install ozonator, follow valve procedure in reverse.

Replacement of Ozone Transformer
1) Disconnect plug from ozone transformer to ozone supply board.
2) Remove cover from ozonator and desolder transformer leads.
3) Remove four screws holding transformer to floor plate.
4) To install, follow above procedure in reverse.

Microcomputer Assembly Replacement
1) Disconnect all plug-in connections from the microcomputer assembly.
2) Remove the two screws and two nuts holding the assembly onto the chassis.
3) Slide the microprocessor assembly from the chassis.
4) Install by following the above procedure in reverse.

Input Board Removal
1) Disconnect signal and ribbon cables.
2) Remove two screws and two nuts holding input board cover to divider and test panels.
3) Remove four screws holding board to divider panel.
4) Install by following above procedure in reverse.

High Voltage Supply Removal
1) Unplug high voltage supply from D.C. power supply and PMT base
2) Remove converter assembly as described in section E.4 above.
3) Remove two screws holding H.V. supply to divider panel.
4) Install by following above procedure in reverse.

D.C. Power Supply Replacement
1) Disconnect all plug-in connections from board.
2) Remove screws holding board to chassis and remove board.
3) Install by following above in reverse. Care should be taken to insure the voltage regulators fit into the plugs on the bottom of the board.

2.20.1.8 Accuracy Audits and Reporting

During the site visit for audit, ECB staff will:

1. Check site temperature.
2. Check that the probe/sample lines are connected.
3. Check that the funnel is clean and in place.
4. Check that the building is secured.
5. Check that all components of the monitoring system are operating adequately.
6. Conduct the accuracy audit and calculate percent differences while at the site.

For the continuous NOy monitors, the ECB must not perform checks or audits between 6:00 AM and 9:00AM "Local Standard Time". The cylinders and calibrators used for auditing must be a different one than the calibrator and cylinder used for calibration and spanning. The 146C "audit calibrator" must be certified one and one half quarters (18 weeks, not to exceed 126 days between consecutive certifications) and the "field calibrator" certifications are good for 9 months. The auditor must not be the same operator as the one who conducts the routine monitoring, calibrations, and analysis. The monitor must operate in its normal sampling mode, and the audit gas must pass through the existing particulate filter.

Login to 8816 Data logger: Sites are equipped with ESC Model 8816 primary and "back-up" data loggers. Both are important tools in reviewing monitor/site operations.

The following sequence is used to log onto the PDL and BUDL so that calibrations can be performed via the 8816 data logger:

- Turn on the screen
- Double click on "Shortcut to Splitscreen"
- PDL and BUDL open
- Highlight PDL and type 2 letter data logger site code (located on the front of 8816 data logger) and AQM (may have to hit **{ESC}** several times before typing the site code)
- Select Login "**L**"
- Enter password (nerothecat) and this will bring up "Home Menu"
- Highlight BUDL and type 2 letter data logger site code (located on the front of 8816 data logger) and AQM (may have to hit **{ESC}** several times before typing the site code)
- Select Login "**L**"
- Enter password (frank) and this will bring up "Home Menu"
- Can view "Report Current Cal Status" (tells when all Auto Cals are run)

TO MOVE BETWEEN PDL AND BUDL PRESS "**ALT**" TAB

Disable scheduler:

- Ensure that the poll editor and scheduler have been edited to not interfere with monitor/calibrator during the audit (pg. 17).

If the site has a HSCO monitor, the HSCO AutoZero needs to be re-set to run at the appropriate time.

Setting the HSCO AutoZero

- Select PDL and then select "**C**" Configuration Menu
- Select: "**C**" Configure Calibration
- Select: "**C**" Change Old Cal Program
- Select: "**COZAdj**"
- Highlight time and change XX:46 (Future odd hour: 23:46, 3:46, 7:46, 11:46, 15:46, 19:46)

Disable the PDL and BUDL channels: While disabled, values are collected but flagged as invalid data.

- **{ESC}** to Home Menu on PDL
- Select: "**C**" Configuration Menu
- Select: "**D**" Configure Data Channels
- Select: "**M**" "Disable/Mark Channel Offline"
- Use arrow key to select pollutant, <ENTER>
- Highlight "**NO**", " **NO2**" and " **NOY**" then press, <ENTER>
- From Home Menu repeat steps on BUDL

ECB activates the certified audit calibrator using: "**ZERO**" (± .002 ppm), "**Level 2**" (0.003 - 0.005 ppm), " **Level 3**" (0.012 - 0.032 ppm), " **Level 3**" (0.060 – 0.080 ppm), and " **Level 4**" (0.140 - 0.180 ppm) calibration points and completes the AQ 121 and AQ 109 report form, reviews the report and forwards the information to the Section Chief of Ambient Monitoring ***within 5 workdays*** of conducting the audit.

If audit results are not within the acceptable range of ± 10% of the expected values, print out the last auto-calibration, calculate percent differences and contact the ECB Supervisor. The ECB Supervisor immediately will investigate the audit results and determine the problem(s). If the problem is with the ECB equipment, the Supervisor fixes the problem with the audit equipment and notifies the staff at the site to repeat the audit. However, if the problem(s) is determined to be with site equipment, then the ECB Supervisor takes appropriate steps to either make arrangement for repair or replace the site equipment. In this case, the Supervisor informs of his action(s) to the site operator. If the problem is a major site operation problem, the ECB Supervisor informs the site operator, the Regional Chemist and the Projects and Procedures Supervisor. As a part of

the NOy system maintenance, ECB will perform accuracy audits on an as per scheduled basis.

1. Each calendar quarter (not exceeding 91 days) at least 1/4 of the NOy monitors operating in the network must be audited. Each NOy monitor in the network must be audited at least once each year. The ECB staff should perform the audit using an audit cylinder and calibrator that is different from the standards and calibrators used for calibration and spanning. The audit calibrator must be calibrated (not to exceed 126 days or 1½ quarters).

2. Connect the TEI 146C audit calibrator as per manufacturer's instruction. Secure a separate certified Protocol II cylinder of NO gas, connect and purge regulator as per manufacturer's instructions.

3. Follow the TEI 146C audit calibrator procedures.

4. At least three (3) concentrations must be introduced to the analyzer being audited and these (concentrations) must be between the following ranges:

    a. 70-90% / span point
    b. 30-40% / middle point
    c. 6-16% / precision point

5. Plug in the audit calibrator, turn the power "on" and allow audit calibrator to equilibrate till the alarm disappears.

6. **Begin a Zero:**
    - Highlight PDL and select "**C**" Configuration Menu
    - Select: "**1**" Start a Single Phase Calibration
    - Select: "**NOCAL**" <ENTER>
    - Select: "**SPAN0**" <ENTER>
    - Enter Phase Duration
    - Select: "**Start Single Cal (NOW)**" <ENTER>
    - **{ESC} {ESC}** to Home Menu

7. **Monitor Actual Values:**
    - Select: "**D**" Real Time Display
    - Select: "**B**" Display Last Base Avg: Shows the last 1 min average only w/flag
    - "D": Disable and "C": Calibration
    - Select: "**C**" Continuous Avg Report
    - Type in parameters "**NO**", "**NOy**", "**NO2**"
    - Change # of flags to report from 02 to 03
    - Start Continuous Report (This will show the minute averages as they are calculated and keeps all values on screen)

Allow the Model 42S microprocessor to stabilize for at least 30 minutes, until the zero channels on the data logger(s) are stable.

8. **Start the Span1:**
   - Highlight PDL and Select "**C**" Configuration Menu
   - Select: "**C**" Calibration Configuration
   - Select: "**NOCAL**" <ENTER>
   - Select: "**SPAN1**" (SPAN 2, SPAN 3)
   - Enter Phase Duration
   - Select: "**Start Single Cal (NOW)**"
   - **{ESC}{ESC}** to Home Menu

After at least 30-45 minutes, verify that the analyzer data logger has stabilized to obtain a level span trace. Verify that the 42S display shows appropriate NO or NOy concentrations.

Monitor Actual Values:
- From "Home Menu"
- Select: "**D**" Real Time Data Display
- Select: "**B**" Display Last Base Avg: Shows the last 1 min average only w/flag
- "D": Disable and "C": Calibration
- Select: "**C**" Continuous Avg Report
- Type parameters "**NO**", "**NO2**", "**NOy**"
- Change # of flags from 02 to 03, <ENTER>
- Start Continuous Report: This will show the minute averages as they are calculated and keeps all values on screen

9. **Gas Phase Titration**

Start the gas phase titration as follows:

While the Span 1 event is running:
- On 146C push "Menu" press <ENTER>, <ENTER>, <ENTER> until 146C is in "Local"
- On "Home Menu" push "**Run**"
- Turn "GAS A" on
- Turn SPAN 1 on
- Set bottom line to "OZON" Manual
- From "Main Menu" go to "**Ozonator**", press <ENTER>
- Go to "**Manual**", press <ENTER>
- Note your "GPT" zero air and "GPT" gas flows when you are running the "GPT".

Once the GPT is running, use the ↑↓ arrows to adjust the O_3 "Level" (percent ozonation) to 20%, allow reading to stabilize. The stabilized NOy readings should agree with the original NOy span value, if the right amount of NO2 is being converted to NO. Starting from 20% ozonation, slowly increase the O_3 level until the NO readings drop to 10-20% of the span value (e. g. if the NO span is 90 PPB,

increase the percent O_3 level slowly until the monitor stabilizes at an NO reading of approximately 9-18 PPB). Usually, an O_3 level set between 20-30% accomplishes the required NO reduction. Once set, the O_3 level will work with other calibrations unless something changes such as a gas cylinder or an ozonator lamp.

Calculate converter efficiency for required audit as follows:
Percent Converter Efficiency = $\{[NO2]_{conv} / [NO2]_{Ca}\} \times 100$
Where $[NO2]_{Ca}$ = Calculated concentration of NO2
$[NO2]_{Conv} = [NO2]_{Ca} – ([NOy]_{orig} - [NOy]_{rem})$
$[NOy]_{orig}$ = Original concentration of NOy prior to addition of O_3, PPB
$[NOy]_{rem}$ = NOy concentration remaining after addition of O_3, PPB

Document that the converter efficiency is in the acceptable range (96 to 104%).

10. **Generate Audit Points 2-4**

Generate NO/NOy audit points 2-4 as required. Use primary data logger to activate SPAN 2, SPAN 3, and SPAN 4.

- Highlight PDL and Select "**C**" Configuration Menu
- Select: "**C**" Calibration Configuration
- Select: "**NOCAL**", <ENTER>
- Select: "**SPAN 2**", <ENTER>
- Enter Phase Duration (make phase duration for four (4) hours)
- Select: "**Start Single Cal" (NOW)**", <ENTER>
- Allow 10-15 minutes for readings to stabilize, record and average the last 5 data values
- Repeat the audit for Span 3 and Span 4
- Abort "Span Mode" on the primary data logger using "W"

Stop the span mode on the primary data logger operation, press "**ESC**", enter "**C**", the six character code, and <ENTER> to "Activate Which Events"/ Answer "02" to "Deactivate Which Event" and press <ENTER>.

11. ECB completes the AQ 109 and AQ 121 forms, reviews the report and submits it to the Section Chief of Ambient Monitoring within 15 workdays of conducting the audit.

Up the PDL and BUDL channels: Go to the Home Menu (by pressing **{ESC}** several times if needed), Press "**L**" and **<**ENTER**>** the code when it asks for the password and press <ENTER>.

- **{ESC}** to Home Menu on PDL
- Select: "**C**" Configuration Menu

- Select: "**D**" Configure Data Channels
- Select: "**E**" "Enable/Mark Channel Online"
- Use arrow key to select pollutant(s), <ENTER>
- Highlight "**NO**" then press, <ENTER>
- Repeat steps on BUDL

If the site has a HSCO monitor, the HSCO AutoZero needs to be re-set to run at the appropriate time.

Setting the HSCO AutoZero

- Select PDL and then select "**C**", Configuration Menu
- Select: "**C**", Configure Calibration
- Select: "**C**", Change Old Cal Program
- Select: "**COZAdj**"
- Highlight time and change XX:46 (Future odd hour: 23:46, 3:46, 7:46, 11:46, 15:46, 19:46)

Enable Channels on PDL and BUDL

- Highlight PDL and select "**C**" Configuration Menu
- Select: "**D**" Configure Data Channels
- Select: "**E**" Enable/Mark Channel Online
- Select: "**NO**", "**NO2**" and "**NOy**" (do this separately) and press <ENTER>
- Highlight BUDL and repeat the steps for enabling the 3 channels

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

- **{ESC}{ESC}** to "Home Menu" on both PDL and BUDL
- Use arrow key to select "**O**" or hit "**O**" key to logout
- Repeat for BUDL

Enable scheduler:

- Ensure that the poll editor and scheduler have been engaged for normal operation after the audit is completed (pg. 30).

Figure 5 42S Layout