Thermo Environmental 48S High Sensitivity Carbon Monoxide (5 PPM) QA Plan Section I

Electronic Calibration Branch Responsibilities

Approval Sign-Off Sheet

I certify that I have read and approve of the contents of the "Thermo Environmental 48S High Sensitivity Carbon Monoxide QA Plan, Section I, Electronic Calibration Branch (ECB) Responsibilities" with an effective date of August 1, 2011. **Sign, date and return to the Ambient Monitoring Section Chief.**

Joette Steger, PPB Supervisor: Joette Steger 9/7/2011

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Table of Contents

List of Figures

2.16.1 High Sensitivity Carbon Monoxide QA Plan: ECB Responsibilities

Note: The following is a list of "significant changes" from Revision 4.1.

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

2) Project and Procedures Branch updates.

2.16.1.1 Selection and Procurement

The Electronics and Calibration Branch (ECB) of the Ambient Monitoring Section of the Division of Air Quality is responsible for the evaluation and procurement of ambient pollution monitoring equipment; installation of monitoring instrumentation, samplers, and support equipment; evaluation of the on-going performance of all state operated air pollution sampling and monitoring systems; and scheduled and unscheduled system maintenance. The ECB maintains a sufficient inventory of monitoring system instrumentation, support equipment, and replacement parts to minimize the loss of ambient air monitoring data for all ambient air monitoring equipment of the Ambient Monitoring section.

The ECB is responsible for procuring and maintaining dedicated traceable standards for the certification of all calibrators and the independent accuracy auditing of ambient air quality monitoring systems. These standards provide a direct link to established national standards and are the foundation for the collection of the highest quality ambient air pollution data possible in accordance with current procedures and existing Federal Regulations and Guidelines. The accuracy audits performed by ECB provide an ongoing evaluation of monitoring equipment performance and site operator adherence to approved operating procedures. The ECB maintains permanent records on all standards used in the calibration and auditing of all instrumentation and sampling equipment used in support of Division of Air Quality (DAQ) monitoring activities.

The ECB maintains permanent records for each monitor and sampler used to analyze ambient air quality in the state of North Carolina. Each significant component of the ambient air monitoring system (calibrators, analyzers, and zero air supplies) is assigned a dedicated unique logbook. These logbook records include performance evaluations and the complete repair records for the instrumentation. ECB also maintains monitoring site records detailing the instrumentation and equipment placed at each site. Both of these permanent records are updated continuously.

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

2.16.1.2 Ambient Carbon Monoxide Monitoring

The North Carolina Ambient Air Carbon Monoxide Monitoring System must meet or exceed the Reference and Equivalent Method requirements in 40CFR53.1. The NC ambient carbon monoxide monitoring system consists of the following:

1. Thermo Environmental Model 48S Carbon Monoxide Monitor
2. Thermo Environmental (TEI) Model 146C Gas Calibrator (see Section 2.3.4)
3. Thermo Environmental (TEI) Model 111 zero air pak (see Section 2.3.5)
4. Teflon Sampling Line
5. Computer/ESC 8816 Data Logger/Modem System
6. Temperature Controlled Monitoring Shelter

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 carbon monoxide. 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.

2.16.1.3 Inventory

Upon approval of the tested unit, the unit shall be added to the fixed asset system. For each monitor, apply an inventory decal and complete an inventory load sheet showing the planned monitor location. Submit the inventory load sheet to the unit supervisor.

2.16.1.4 TEI Model 48S Certification (Pre-Site Installation Checks)

a. **Optical Bench (Figure 1)** - The optical bench is of the White Cell design. The use of the White Cell multipass optical bench allows one to achieve a long path length, with a large acceptance angle, in a small physical package. The bench has been designed for easy disassembly for cleaning. The source, detector, correlation wheel, and chopper motor mount rigidly to the bench. No realignment should be necessary after routine cleaning.

b. **Correlation Wheel and Chopper Motor** - The correlation wheel consists of two hemispherical cells, one filled with CO and the other with N_2. Integral with the correlation wheel is the chopper pattern necessary to produce the high frequency (360 Hz) chop necessary for the infrared detector. The correlation wheel is rotated by a synchronous motor.

c. **Source and Power Supply** - The infrared source is a special wire wound resistor. It is heated by passing a highly regulated DC voltage through the resistor. Replacement, when necessary, is straightforward.

d. **Detector, Preamplifier, and Bias Supply** - The detector used on the Model 48S is a solid-state device with an integral cooler. It is mounted directly onto the optical bench. The output of the detector is fed into a preamplifier (Figure 1) prior to its transmission to the input signal conditioning board. The bias voltage necessary to operate the detector is generated by a separate bias voltage power supply.

e. **Input Signal Conditioning Board** - The input signal conditioning board takes the output signal from the preamplifier, and separates the signal into two components, one component being the signal coming from the CO half of the correlation cell, the other due to the N2 half of the correlation cell. This board includes the sensors and associated circuitry for determination of the wheel position, as well as an AGC (automatic gain control) circuit. Finally, it contains two V-F's (voltage to frequency) converters to digitize the two signals.

f. **DC Power Supplies** - The DC power supply board generates the necessary regulated DC voltages. In addition, it contains the driving circuitry for the solenoids.

g. **Microcomputer** - The microcomputer is based upon the Motorola 6800 family. The pulse train outputs of the input signal conditioning board feed directly into computer controlled counters. In addition, the pulse train output of the pressure transducer and the temperature transducer system are fed directly to the same computer controlled counter. The software operates on this information to determine the CO concentration, to output diagnostic data, and to output the computed CO concentration to the front panel digital display and rear panel analog recorder jacks. The software contains sophisticated algorithms to minimize noise, increase sensitivity, insure that the output is linear, to correct for changes in ambient temperature and pressure, and to check for malfunctions.

h. **Temperature Controller** - The Model 48S contains a temperature transducer to measure the temperature and to correct for ambient temperature changes. However, in order to insure that the optical bench is above the dew point to avoid water condensation, the optical bench is operated at a temperature slightly above ambient. Meaningful output data will be generated even if the bench has not stabilized.

i. **Flow Components** - The Model 48S operates at nominal atmospheric pressure. Figure 2 summarizes the flow schematic. A downstream pump and capillary control the sample flow through the optical bench, which is monitored by a rotameter. The nominal flow is 1 liter per minute, with values between ½ - 2 liters per minute acceptable. The span, zero, and sample solenoids are operated by successive engagements of the RUN push-button on the front panel. The control signals for the solenoids go through the microcomputer.

j. **Temperature and Pressure Transducer** - Temperature and pressure must be measured if one wants to compensate for changes in ambient values. A strain gauge pressure transducer measures the pressure. The temperature is measured by a thermistor.

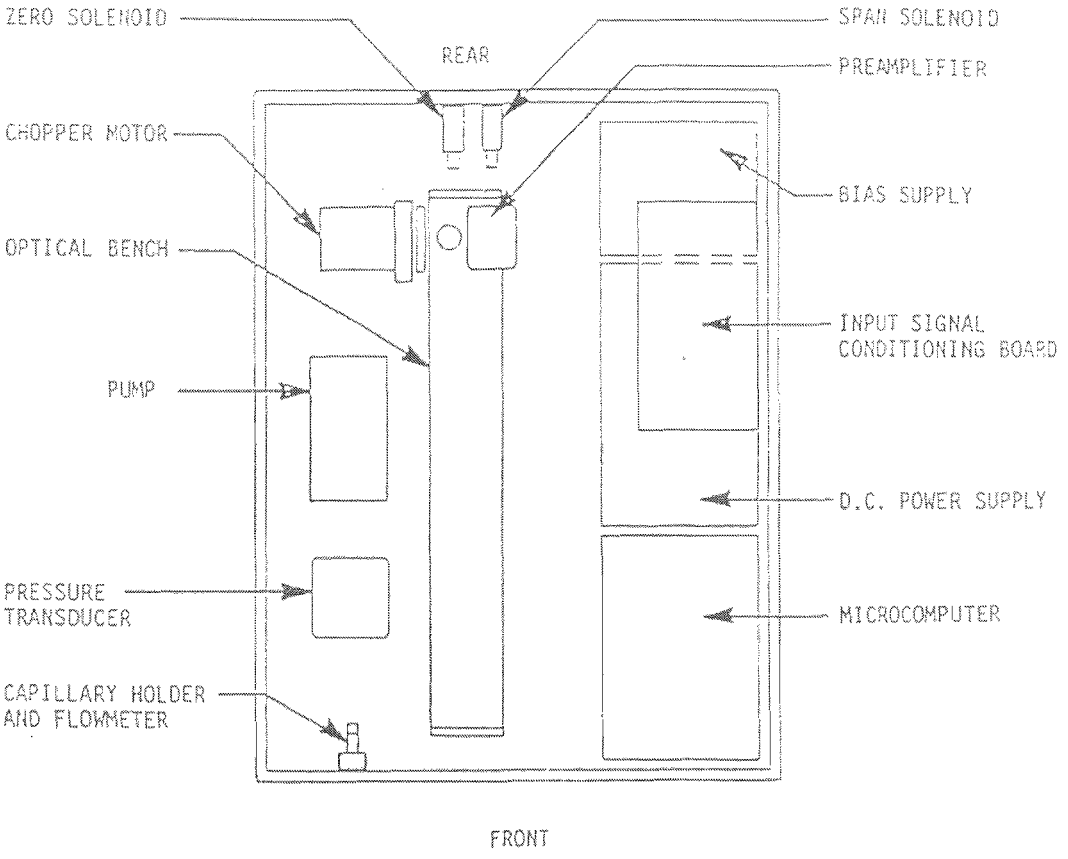


Figure 1 Model 48S Layout

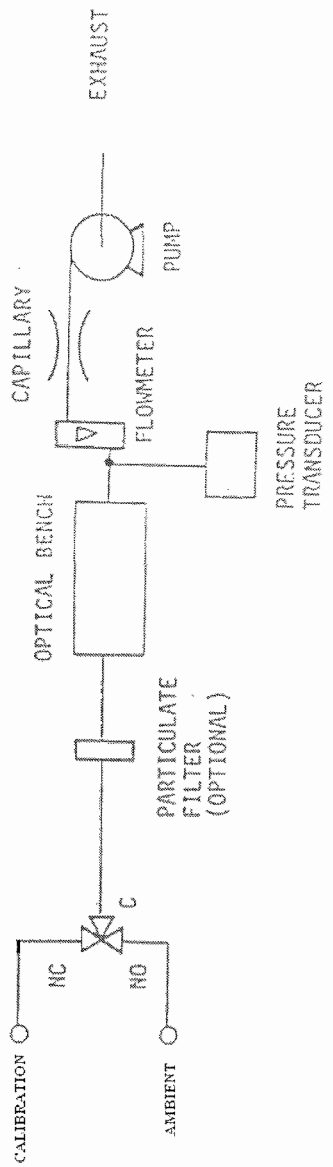


Figure 2 Model 48S Flow Schematic

2.16.1.4.1 Model 48S Laboratory Instrument Checks

1) Test Z/FS (Zero/Full Scale)

a. Press **Z/FS** once. First actuation into this mode sets the instrument to digital zero. Attach voltmeter to analog (1) outputs at rear of instrument. Adjust output to 0v by adjusting R21 on the D/A board.

b. Press **Z/FS** again. Second actuation into this mode sets the instrument to digital fullscale. Adjust output to 1.000 v by adjusting R23 on the D/A board.

2) Test DAC (Digital to Analog Converter)

a. Press Test DAC once. This results in the generation of a "ramp" on the analog outputs. The initial display will be a **-23 ppm**. Analog output will be a **-2.3%**. The DAC will change its output 30 seconds later. The display will count from **-23 to 1000 ppm**. The analog outputs will change from -2.3% full scale to 100%. This will take approximately **7** minutes and will show a straight-line ramp on the recorder chart, which indicates proper functioning of both the instrument and recorder. If not, the analog outputs and/or recorder are not functioning properly.

3) Test INT (Intensity)

a. Press the Test **INT** button once. This will display the intensity as digitized by the first voltage to frequency converter. Press the **INT** button again. This will display the intensity as digitized by the second voltage to frequency converter. Both readings should be approximately the same and at least 10,000 Hz. If not, the IR source is weak or the optics is dirty. Clean or replace as necessary.

4) Test P/T (Pressure/Temperature)

a. Press the Test P/T button once. Pressure in millimeters Hg will be displayed. This should be approximately ambient pressure. If not, the pressure transducer is not operating properly.

b. Press the Test P/T button again. Temperature in degrees Celsius will be displayed. This is the temperature of the optical bench.

5) Cleaning of the Optics

To check the cleanliness of the mirrors, press the "INT " button. The frequency should read >10,000 Hz. If not, clean the mirrors as follows:

1) Turn off the power and disconnect the power line. Remove cover.
2) Remove the field mirror (rear mirror). Do this by removing the four allen head screws holding it to the main bench.

3) Remove the relay mirror (front mirror). Open the front door and remove the allen-head screws holding it to the main bench.
4) Carefully clean each mirror using a "Q-tip " and methanol. Rinse with distilled or deionised water Dry by blowing clean dry air over the mirror.
5) Replace the mirrors and tighten the allen-head screws securely.

6) Source Replacement

Replace the source on an annual basis or if one of the following occurs:

a) No light output.
b) If after cleaning the optics, the Test INT frequencies remain below 10,000 Hz.
   1) Disconnect power and remove cover.
   2) Disconnect the source cable from the source cover.
   3) Remove the two screws holding the source cover to the motor plate and remove the source cover.
   4) Loosen both clamp screws from the brass stand-off and remove the source.
   5) Install the new source by replacing the source then replacing both clamp screws holding the source cover. Replace the cover and reconnect power.

7) Pump Diaphragm Replacement

Inspect or replace the pump diaphragm annually or as needed.

1) Disconnect power and remove cover.
2) Loosen fittings and remove both lines going to the pump.
3) Remove the four screws from the top plate. Remove the top plate, flapper valve, and the bottom plate.
4) Remove the screw holding the diaphragm onto the piston and remove the diaphragm.
5) Replace with a new diaphragm if worn or torn. Make sure the teflon side (white) of the diaphragm is facing up and that the flapper valves cover the holes of the top and bottom plate.
6) Assemble the pump by replacing the screw holding the diaphragm on to the piston. Replace the bottom plate, flapper valve, and top plate, and then replace the four screws to the top plate. Replace both lines going to the pump and tighten the fittings. Replace the cover and connect power.

2.16.1.4.2 Cleaning the Capillary

1) Disconnect power and remove cover.
2) Remove knurled nut on capillary holder located behind the rotameter.
3) Remove capillary and clean with a wire less than .015" in diameter or replace.
4) Replace knurled nut on capillary holder.
5) Replace the cover and reconnect the power

9) Test STAT (Status)

a. Press the Test STAT button once, then again. This will show the full-scale ranges of analog outputs #1 and #2. (FS 1.50 represents output #1 on a 5-ppm scale; FS 2.50 represents output #2 on a 5-ppm scale)

b. Press the Test STAT button again. This will show the time responses of analog outputs #1 and #2. (SEC 1.30 represents output #1 on a 30 second continuous running scale, and SEC 2.30 represents output #2 on a 30 second continuous running scale).

c. Press the Test STAT button again and then sequentially. This will show the on/off status of the eight internal SPST DIP switches on PIA board 48S.

48S	1. ON	5. OFF
	2. OFF	6. OFF
	3. OFF	7. ON
	4. OFF	8. OFF

F Panel 0 .650 (zero)
SP.652 (span)
P.6005 (pgm. software #)

2.16.1.4.3 Model 48S Leak Check

Equipment Required:
Teflon caps - 1/4"

a) **Sample Route thru Solenoid:** In order to test for the presence of external leaks around the fittings, plug the Ambient inlet fitting on the solenoid with a cap. Press the Test P/T button once. Pressure in millimeters Hg will be displayed. This should be approximately ambient pressure. The flow on the Model 48S rotameter should gradually decrease to zero if no leak is present. The pressure on the LED (Light Emitting Diode) display should drop to below 250 mmHg. If the pump diaphragm is in good condition and the capillary is not blocked, it should take less than one minute from the time the inlet is plugged to the time the reading below 250 mmHg is obtained. If this takes longer than one minute, check the integrity of the pump diaphragm and check for blocking of the capillary. If no leak is found, remove cap on solenoid.

b) **Cal/Span Gas Route thru Solenoid:** Press the Test P/T button once. Pressure in millimeters Hg will be displayed. This should be approximately ambient pressure. Plug the **Calibration** gas inlet fitting on the solenoid with a cap. The flow on the Model 48S rotameter should gradually decrease to zero if no leak is present. The pressure on the LED (Light Emitting Diode) display should drop to below 250 mmHg. If the pump diaphragm is in good condition and the capillary is not blocked, it should take less than one minute from the time the inlet is plugged to the time the reading below 250 mmHg is obtained. If this takes longer than one minute, check the integrity of the pump diaphragm and check for blocking of the capillary. If no leak is found, remove cap on solenoid.

2.16.1.5 CALIBRATION STANDARDS AND SYSTEM

a. ECB shall procure calibration standards for the Air Quality Section.
b. Extreme care must be taken to ensure compatibility for all components. Flow rates and concentration outputs must meet the requirements of the monitor.
c. Purchasing procedures are done through a blanket purchase order.
d. All calibration gases must be referenced to a National Bureau of Standards (NBS) carbon monoxide in Standard Reference Material (SRM) following EPA Protocol II procedures. 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 Ambient Monitoring Unit files.

e. Reanalysis of calibration standards shall be performed every 36 months for verification of gas stability. (This 36 month period is allowed because CO is very stable as shown by repeated analysis of the same cylinder and in accordance with 40CFR50 App. C.3.1. In actual practice most cylinders are expended before 6 months).
f. No cylinder gas should be used below a cylinder pressure of 200 psig as shown by the cylinder gas regulator.
g. Each CO 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.

2.16.1.6 On-site Installation

After the regional office has obtained permission to use a site from the site owner, and after the site has been approved by the Network Coordinator and EPA, the Electronics and Calibration Branch will install the monitor and its appurtenances. Electrical power should be secured by the regional office, including new wiring, etc., prior to the installation of the monitor equipment. The approved site location must meet the requirements of Section 2.2 of 'Procedures for Standard Operation and Quality Assurance'.

The ECB is responsible for the installation of all State operated ambient air carbon monoxide Monitoring sites across the state each year. For seasonal sites, the sites are required to be setup prior to the May 15 start date of the EPA mandated carbon monoxide monitoring season.

The installation of the carbon monoxide monitoring sites includes the Certified Primary Standard, the Model 48S Carbon Monoxide Monitor, the Model 111 Zero Air Pak, the Pretreated Teflon Sampling Line, and the computer, data logger, and modem system.

a. **Inspect the Inverted Funnel, Wire Screen, Sample Probe Line, and Calibration Line**: visually inspect and document the condition of the sample delivery and calibration tubing systems. This inspection should also be performed during each site visit. The probe should be turned down, an undamaged inverted funnel on the end, the wire screen must be in place to protect the sampling probe from insects and foreign material, and the Teflon line must be visible inside the funnel screen.

The sampling probe and lines must be either borosilicate glass, FEP Teflon, or their equivalent, must be clean, and must have a sample residence time of less than one minute. Care should be taken to ensure that dirty, wet, or incompatible materials in the sample lines do not contaminate the sample. The length of the tubing should be held to a minimum. For best results the tubing between the manifold and the analyzer should be less than ten (10) feet. The inlet line should be wrapped with removable polyurethane insulation and if humidity problems occur, wrapped with heat tape or similar device to maintain 100° F to 120° F, in order to prevent condensation. Probe lines are replaced every two (2) years.

Site Installation

A) Plumbing

1. The monitor must be installed in a building where the room temperature extremes do not exceed **20°C to 30°C** (68°F to 86°F). The location must be generally unavailable to the public.
2. Connect the monitor, zero air supply, modem, data logger, back-up data logger, computer as shown in Figure(s) 3 & 4 "Wiring Diagram" and in Figure 5 "Plumbing Connections".

WARNING: Do not plug in the monitor, modem, data logger, zero air supply, and computer until all cables are connected. ELECTRICAL SHOCK AND/OR EQUIPMENT DAMAGE MAY OCCUR OTHERWISE.

3. Connect the 70-ppm span gas output to the inlet port **GAS B** on the 146C. Bleed cylinder regulators and attached lines to purge out any residual air; crack gas line, open the main cylinder valve all the way counter-clockwise, set the regulator pressure at 35 psi, close the main cylinder valve all the way, fully open the needle valve. Repeat several times. Reconnect gas line.

4. Connect the 146C (zero/span gas) output to NC (NORMALLY CLOSED) port on the Model 48S input solenoid.

Note: SAMPLE AND CALIBRATION GAS MUST BE DELIVERED TO THE INSTRUMENT AT ATMOSPHERIC PRESSURE. IT MAY BE NECESSARY TO EMPLOY AN ATMOSPHERIC DUMP BYPASS PLUMBING ARRANGEMENT TO ACCOMPLISH THIS.

5. Connect air from compressor to the inlet port on the Model 111 zero air pak. Connect the line from the zero air supply to the canisters of silica gel and then connect the output from the silica to the "in" port on the 111. This provides dried air to the Permapure dryer to aid in removing moisture from the sample gas stream. Connect the 111 "outlet " to the ZERO AIR "inlet " on the 146C (see Figure 6, 146C Rear View).
6. The Model 48S must be operated with a Teflon filter-holder with a 5-10 micron Teflon particulate filter. Connect the particulate filter outlet to the sample port at the rear of the instrument. Connect the inlet of the particulate filter to common input port on solenoid. Install one end of a short piece of vent line (any type of 1/4" tubing) to the monitor exhaust fitting and place the other end out of a window or some other opening to vent the instrument. Connect the port labeled "AMBIENT" on the solenoid to the sample probe line.
7. Connect the source of zero air to the inlet port labeled "**ZERO AIR**".
8. Connect the 48S rear panel fitting labeled "EXHAUST" and the 146C "vent" fitting to exhaust manifold. Take care to verify that there is no restriction in these lines.

B) Electrical

1. Connect the keyboard and mouse to the computer.
2. Connect both data loggers to the output channel of the computer. PDL = J1, BUDL = J2
3. Install the power cord to the rear of the instruments. Plug the male end into an appropriate outlet.
4. Set thumb wheel switches on front of instrument on **2** for **range** and **22** for **time**.

Initial Start-Up

1) Model 48S: Press **Power Switch** on. This turns on the source, all electronics, the detector cooler, the chopper motor, the sample pump, and the heater in the pressure transducer. The program will initialize itself.

Check the LED display for the word "HELLO" followed by the word "CO".

The instrument will automatically go into "Run-Sample" mode. Allow instrument to stabilize for one hour.

Range Check: verify that the range switch is at the correct setting of **5** ppm for CO engagement of the STAT pushbutton #2 option.

Test **Z/FS (Zero/Full Scale)**

a. Press Test Z/FS once. First actuation into this mode sets the instrument to digital zero. Attach voltmeter to analog (1) outputs at rear of instrument. Adjust output to 0v by adjusting R21 on the D/A board.
b. Press Test Z/FS again. Second actuation into this mode sets the instrument to digital full-scale. Adjust output to 1.000v by adjusting R23 on the D/A board.

Test DAC (Digital to Analog Converter)

a. Press Test DAC once. This results in the generation of a "ramp" on the analog outputs. The initial display will be a **-23 ppm**. Analog output will be a **-2.3%**. The DAC will change its output 30 seconds later. The display will count from **-23 to 1000 ppm**. The analog outputs will change from -2.3% full scale to 100%. If not, the analog outputs and/or recorder are not functioning properly.

2) Computer, Primary Data Logger (PDL) and Back-up Data Logger (BUDL)

Press **Power Switch** on for computer, primary data logger (PDL) and back-up data logger (BUDL).

Checking and Setting Time On Data Systems (as necessary):
The times for the PDL, BUDL, and computer must be EASTERN STANDARD TIME.
NOTE!! The BUDL, and PDL must have the same time ±1 minute, the computer time must be 5 minutes slower than the PDL/BUDL. Manually poll the Primary Data Logger (PDL) and Backup Data Logger (BUDL) to review data and remove flags if needed.

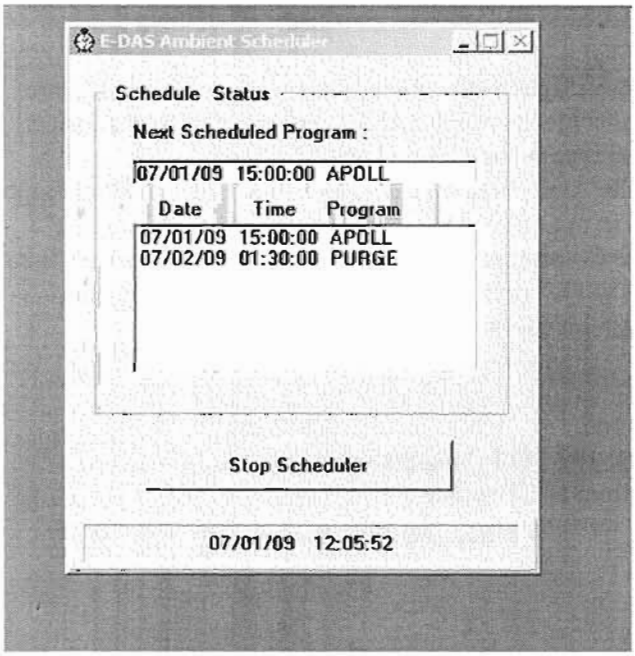
Check the computer time and date at the lower right hand corner of the computer screen. If the time and date are correct, type "**M**" and <ENTER> password. If the time and date ***is not*** correct, from the system mode screen, type "**M**" and type in the highest level password
< > and **<ENTER>**. On ESC Main Menu select **Quit**. Select "**exit to DOS**" and press **<ENTER>**. (If "**exit to DOS**" is not an option, you have not logged in with the highest password, call ECB). This will bring up the C> prompt. Type, "TIME" and enter the correct time (hh:mm:ss) and press **<ENTER>**. Type, "DATE" and enter the correct date (mm:dd:yy) and press **<ENTER>**. To return back to the main menu, type, "A" and press **<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** (long distance).
3. Correct time loaded into cell phone from NIST source.
4. Setting a watch to the correct time website, **http://nist.time.gov/**, within 24 hours of visiting the site.

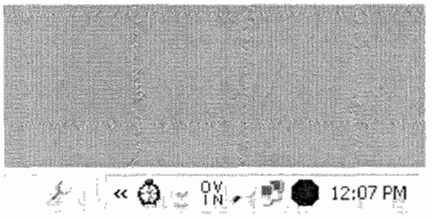
a. Turn on the screen.
- Double click 'Shortcut to Splitscreen'
- PDL & BUDL open

- Highlight PDL and type 2 letter data logger site code (located on front of data logger) and AQM (may have to hit **{ESC}** a couple of times before typing)
- Select: "**L**", log in
- Password ( ): this brings up Home Menu
- Select: "**C**" configuration menu
- Select: "**S**" configure System Parameters
- Highlight **Logger Time** <ENTER>
- Type in correct time in the format of: **HH:MM:SS**
- **{ESC}{ESC}{ESC}**
- Highlight BUDL and type the 2 letter data logger site code (located on front of data logger) and AQM (may have to hit ESC a couple of times before typing)
- Select: "**L**", Login
- Type password ( )
- Select: "**C**", configuration menu
- Select: "**S**", configure System Parameters
- Highlight "**Logger Time**" <ENTER>
- Type in correct time in the format of: **HH:MM:SS**
- **{ESC}{ESC}{ESC}**

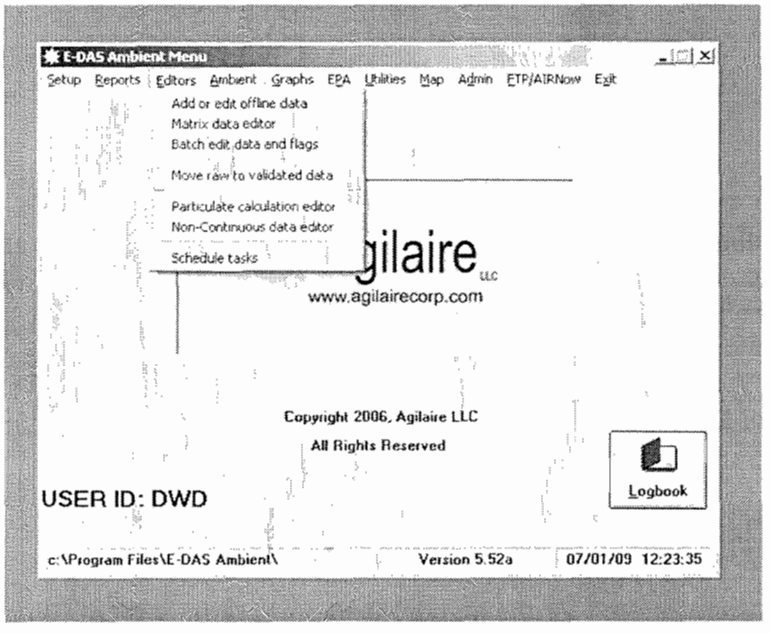
The autopoll program called "APOLL" automatically polls the data that is being collected on the PDL and the BUDL. Since performing a calibration check can interfere with the operation of the Auto Poll Scheduler, the Scheduler needs to first be stopped by clicking on the radio button that says "**Stop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



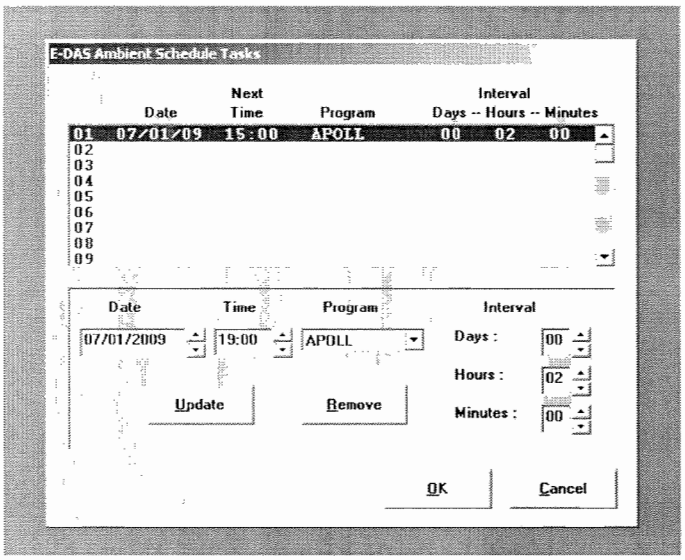
If the scheduler isn't on the screen, there should be a small red alarm clock "**icon**" down in the bottom right hand corner. Any mouse click will bring up the scheduler so that you can stop the scheduler.



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.



3. 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.

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

3) **146C**: Press **Power Switch**. The program will initialize itself.

Gas Flow and **Zero Air Flow** set points are entered for the highest span point (80 – 90% of full scale).

To Program 146C:
Set flow controller to 90% of full scale, then wait until flow meter reading stabilizes.

- To display the Main Menu, start at the Run screen and press **MENU**
- Select **Mode**, <ENTER>, press the ↑or ↓ pushbuttons to change mode to "**Service**" <ENTER>
- Press **Menu,** from the Main Menu use ↑↓ to choose **GAS B**, <ENTER>
- In Gas B screen, use ↑↓ to select **NAME**, <ENTER>, use the ← or → pushbuttons to move the cursor left or right and the ↑or ↓ pushbuttons to move the letter up or down assign a name, <ENTER> <MENU>
- In Gas B screen, use ↑↓ to select **SOLENOID**, <ENTER>, assign solenoid **B**, <ENTER><MENU>
- In Gas B screen, use ↑↓ to select **TANK CONC**, <ENTER>
- In the Tank Conc Screen, use ←→ to move the underscore to the digit to be changed,

use ↑↓ to increment or decrement the underscored digit until the PPM matches the concentration of the CO cylinder, 70.000 <ENTER><MENU>

- In Gas B screen, use ↑↓ to select **SPAN 0 FLOW**, <ENTER>
- In the Span 0 Flow screen, use ←→ to move the underscore to the digit to be changed, use ↑↓ to increment or decrement the underscored digit, 000.000 <ENTER><MENU>
- In Gas B screen, use ↑↓ to select **SPAN 1**, <ENTER>
- In Span Menu screen, use ↑↓ to select CONC PPB, <ENTER>
- In Span Concentration screen, use ←→ to move the underscore to the digit to be changed, use ↑↓ to increment or decrement the underscored digit to change SETTING to 4 ppm, <ENTER>
- In Span Flow screen, use ←→ to move the underscore to the digit to be changed, use ↑↓ to increment or decrement the underscored digit to change SETTING to 04000 ppm, <ENTER><MENU>
- In Gas B screen, use ↑↓ to select **SPAN 2**, <ENTER>
- In Span Menu screen, use ↑↓ to select "**CONC PPB**", <ENTER>
- In Span Concentration screen, use ←→ to move the underscore to the digit to be changed, use ↑↓ to increment or decrement the underscored digit to change SETTING to 2 ppm, <ENTER>
- In Span Flow screen, use ←→ to move the underscore to the digit to be changed, use ↑↓ to increment or decrement the underscored digit to change SETTING to 02000 ppm, <ENTER><MENU>
- In Gas B screen, use ↑↓ to select **SPAN 3**, <ENTER>
- In Span Menu screen, use ↑↓ to select "**CONC PPM**", <ENTER>
- In Span Concentration screen, use ←→ to move the underscore to the digit to be changed, use ↑↓ to increment or decrement the underscored digit to change SETTING to 00.300 ppm, <ENTER>
- In Span Flow screen, use ←→ to move the underscore to the digit to be changed, use ↑↓ to increment or decrement the underscored digit to change SETTING to 00300 ppm, <ENTER><MENU>
- Press **Menu**, from main menu
- Select: "**FLOW CONTRL FSCALES**", <ENTER>
- Select: **GAS SCCM XXX**, <ENTER>
  Press the ← or → pushbuttons to move the cursor left or right and the ↑or ↓ pushbuttons to move the letter up or down, change to 90.00 <ENTER>
- Press **RUN** (Run screen 1), select "**GAS OFF SCCM**", press <ENTER> to turn gas on.
- Press **Menu,** from the Main Menu use ↓ to choose **Mode**, <ENTER>
- Instrument will show either **Service, Remote** or **Local** mode.
- Set 146C to **LOCAL** mode (if not already in LOCAL mode), <ENTER>
- Press **RUN** to start span
- Scroll with ↓ to select **SPAN Ø**, <ENTER>
- Scroll with → to select **SPAN Ø**, <ENTER>

Select "**Utilities**" and "**Split Screen**", press **<ENTER>**

a. Log in to data logger:

- Double click "Shortcut to Splitscreen"
- Select PDL and hit "**ESC**" then type Site ID Code (e.g.) "**GR** AQM" hit **<ENTER>**
- Select: "**L**", Login
- <ENTER> " " as the password.
- Select BUDL and hit "**ESC**" then type Site ID Code (e.g.) "**UG** AQM" hit **<ENTER>**
- Select: "**L**", Login
- <ENTER> " " as the password

b. Calibration Check

- Change COZAdj Cal time
  - Select PDL & select "**C**" Configuration Menu
  - Select: "**C**" Configure Calibration
  - Select: "**C**" Change Old Cal Program
  - Highlight **COZADJ** and press <ENTER> using down arrow key highlight " Starting Time"
  - Change starting time to minimum of 4 hours in advance odd hour: 46
  - Highlight "**Configure Now**" then press, <ENTER>
- Check K_1 Math Constant in PDL and BUDL
  - ESC to Home Menu
  - Select: "**C**" Configuration Menu
  - Select: "**K**" Configure Math Constants
- Disable Channels on PDL and BUDL Data Logger
  - ESC to Home Menu on PDL
  - Select: "**C**" Configuration Menu
  - Select: "**D**" Configure Data Channels
  - Select: "**M**" "Disable/Mark Channel Offline"
  - Highlight "**COA**" then press, <ENTER>
  - Highlight "**COUA**" then press, <ENTER>
  - Repeat steps on BUDL

Check Zero

- Run Calibration Check (Span Ø), **0.000 ppb**
  - Select PDL & select "**C**" Configuration Menu
  - Select: "**C**" Calibration Configuration
  - Select: "1" Start a Single Phase Calibration
  - Select: "**COZADJ**"
  - Select: "**SPAN 0**"
  - under "Phase Duration" <ENTER> "60m"
  - Select "**Start Single Cal (NOW)** ",
  - Escape to Home Menu of PDL
  - Select: "**D**" Real Time Display
  - Select: "**B**" Display Last Base Average, <ENTER>
  - Select BUDL and start Display Last Base Average
  - 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 as Last Base Avg.

- Average the five (5) 146C Display, PDL, and BUDL values for each event. Compare the 146C "True Carbon monoxide" to the corresponding PDL and BUDL values as follows:

146C	PDL /BUDL	
	COUA	COA
0	< .150 ppm	.020 - .075 ppm

To View Zero Data from BUDL

- **Click** in BUDL Display window
- Press the **{ESC}** key, Press the **{ESC}** key again
- Select "**D**" Realtime Display Menu
- Select "**B**" Display Last Base Average
- Scroll Down to " **Display Last Base Average** ", press <ENTER>
- Abort the Zero Span after 5 minute averages have been recorded.
- Escape **{ESC}** to Home Menu of PDL
- Select: "**C**", Configuration Menu
- Select: "**C**", Calibration Configuration
- Select: "**W**", Abort Calibration
- Select "**COZADJ**" using down arrow key, press <ENTER>

Span Calibration Check Procedure

Run Span1, Span 2, & Span 3

- Select PDL & select "**C**", Configuration Menu
- Select: "**C**", Calibration Configuration
- Select: "**1**", Start a Single Phase Calibration
- Select: "**COCAL**"
- Select "**SPAN1**"
- Under "**Phase Duration**" <ENTER> "60m"
- Select "**Start Single Cal (NOW)**"
- Escape **{ESC}** to Home Menu of PDL
- Select: "**D**", Real Time Display
- Select: "**B**", Display Last Base Average, <ENTER>
- Average the five (5) 146C Display, PDL, and BUDL values for each event. Compare the 146C "True Carbon monoxide" to the corresponding PDL and BUDL values

146C	PDL /BUDL	
	COUA	COA
4 - 5 ppm	< .520ppm	± .320ppm

- Abort the Span 1 after 5 minute averages have been recorded.
- Escape to Home Menu of PDL
- Select PDL & select "**C**", Configuration Menu
- Select: "**C**", Calibration Configuration

- Select: "**W**", Abort Calibration
- Select "**COCAL** "
- Repeat above steps for "SPAN2" & "SPAN3"

146C	PDL /BUDL	
	COUA	COA
2 – 2.5 ppm	< .360 ppm	± .160 ppm
.250 - .500 ppm	< .224 ppm	± .024 ppm

The Data Logger Channels must be "Upped" (brought back on line) to collect ambient air carbon monoxide concentration data.

5. Abort Calibration on PDL
   - Procedure
   - Highlight PDL, press **{ESC}{ESC}** to Home Menu
   - Select: "**C**", Configuration Menu
   - Select: "**C**", Configure Calibrations
   - Select: "**A**", Abort a Calibration Program
   - Select "**COCAL**" press <ENTER>: this stops the calibration

{ESC}{ESC} to Home Menu (If access is denied, Log on again by pressing **ESC** and type the two character site code and **AQM** (with no spaces)

6. **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>). Choose "**C**" (the Configuration Menu). Select **"D"** to configure the data channels. Press "**E**" to Enable/Mark Channel online. Select "**CO**" to up the CO channel and press **<ENTER>**. When finished, exit to the "**Home Menu**", by pressing **{ESC}{ESC}**. Verify the flags are cleared and the channel is enabled by pressing "**D**" and then "**F**". If the flags are cleared, press **{ESC}{ESC}** to go back to the home menu, press **"O"** to Log out and **CTRL-ESC** to exit. Exit the Split Screen operation.

Note: In the split screen operation, the data loggers can be accessed by pressing **CTRL** and **ESC** to access the **TASK** list, you can <ENTER> onto either of the two data loggers by highlighting the data logger and pressing <ENTER>.

7. Return 146C Calibrator to Remote Mode
   - On 146C press the MENU button to display >MODE "Local"
   - Press <ENTER> to display Set to Remote?
   - Press <ENTER>
   - Press MENU button to display >MODE "Remote"

8. **Computer Data Logger System and Modem**

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

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

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

2.16.1.7 Routine Maintenance

TEI 48S Analyzer

Periodic maintenance procedures should be performed when necessary to ensure proper operation of the 48S. Maintenance includes preventive, routine, and corrective tasks. ECB is expected to be entirely responsible for the corrective maintenance issues and to assist with preventative and routine maintenance that may fall outside the regions' comfort levels or capabilities.
Step-by-step procedures for all maintenance activities should be followed as presented by the manufacturer in the instrument's operation manual (Chapter 5, "Preventive Maintenance" and Chapter 8, "Corrective Maintenance", 2/6/1993 version). Always down / disable the PDL and BUDL data channels.

Items requiring maintenance by ECB are:

- Cleaning the optics (checked on a regular calendar basis and replaced if necessary)
- IR source replacement (checked on a regular calendar basis and replaced if necessary)
- Detector frequencies (checked on a regular calendar basis and replaced if necessary)
- Pressure transducer (checked on a regular calendar basis and replaced if necessary)
- Temperature transducer (checked on a regular calendar basis and replaced if necessary)
- Replacing the printed circuit boards (performed when operational problem is traced to a particular component)
- Leak Checks (performed after filter changes or when sample flow drops below 0.35 lpm as determined during bi-weekly QC checks)

TEI 146C Calibrator

Periodic maintenance and/or adjustment for the Model 146C is required to ensure proper operation. Refer to the "146C Calibrator" QA Section/Operation guidelines for details and the instrument manual (Chapter 4, "Preventive Maintenance" and Chapter 7, "Servicing", 11/20/98 version). Except for mass flow controller re-certification, which occurs every 9 months, the following maintenance activities are performed only when the calibrator malfunctions as determined by the site operator. Items requiring ECB maintenance are:

- Leak Checking
- Solenoid Replacement
- Circuit Board Replacement
- Mass Flow Controller Replacement
- Replacement of DVM
- Internal Adjustments
- Certification of Mass Flow Controllers (see section 2.3.4 of 146C Calibrator QA Manual)

Zero Air Pack and Compressor Checks

Periodic maintenance and/or adjustment for the Zero Air Pack is required to ensure proper operation. The ECB shall re-certify the zero air system once per year by:

- Replacing the silica gel with re-generated material (dark blue or purple color).
- Verifying that the pressure gauge on the Zero Air Supply is reading 30 psi ± 2 psi.
- Verifying that the outlet pressure on the air compressor is reading 80 psi. (If pressures are outside of the specifications, check and tighten all fitting and/or rebuild the compressor by replacing the pump diaphragms.)
- Draining any water from the compressor.

After conducting any maintenance up the PDL and BUDL channels (enable/mark channels online), document the work done in the site logbook (and instrument logbook if appropriate), and flag the data.

2.16.1.8 Heating / Cooling

The monitor must be installed in a building where the room temperature extremes do not exceed **20°C to 30°C** (68°F to 86°F). Connect all heaters and air conditioning equipment power cords to an 115v AC, 60 Hz grounded receptacle. Check to make sure the equipment is in working order. Remove the air conditioning filter and clean if necessary.

2.16.1.9 Site Visits

Whenever the ECB technicians visit a site, they will:

1. Document the date, time and reason for the visit in the site logbook.
2. Check that the site building temperature is between 20° C and 30° C.
3. Check that the probe and sample line are connected and secure.
4. Check that the funnel is clean, in place and not damaged. If so replace.
5. Check that the building is secure. Vandalism is reported to the ECB Supervisor.
6. Check that all monitoring systems are operating within normal ranges (unless the reason for the visit is site start-up).
7. Down any channels for monitors being repaired, replaced, or audited during the repair, replacement, or audit.
8. Up any channels after monitors are repaired, replaced, or audited during the repair, replacement, or audit.
9. Ensure that the scheduler has been engaged before leaving the site.

2.16.1.10 Accuracy Audits and Reporting

Accuracy audits for continuous gaseous monitors are performed and reported to Headquarters' by ECB staff using an AQ 121 form. 40 CFR 58 Appendix A requires at least one quarter of the monitors running in a network to be audited each quarter and every monitor to be audited at least once each year.

a. For the continuous CO trace level monitors, the ECB must not perform checks or audits between 6:00 AM and 9:00AM "Local Standard Time". The calibrators used for auditing must be a different than the calibrator used for calibration and spanning. The audit calibrator must be calibrated quarterly (not to exceed 92 days between consecutive calibrations). The auditor must not be the same operator as the one who conducts the routine monitoring, calibrations, and analysis. The audit is conducted before making any monitor or data logger adjustments. The

monitor must operate in its normal sampling mode, and the audit gas must pass through the existing particulate filter.

b. ECB activates the audit calibrator using: "**ZERO**" (< 0.150 ppm COUA, 0.020-0.075 ppm COA), "**Span 1**" (4.000 ppm), "**Span 2**" (0.750 ppm), and "**Span 3**" (0.100 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 15 workdays*** of conducting the audit.

c. When the audit values are more than ± 10 % ppb, call the ECB Supervisor and inform him of the situation and print out a copy of the last auto calibration checks. The ECB Supervisor will investigate suspicious audits to determine if there is a problem and if so, where the problem is and how to solve the problem. If the problem is with the ECB equipment, the ECB supervisor generally fixes the audit equipment and repeats the audit. If the problem is with the site equipment, the ECB supervisor takes appropriate action to either repair or replace the site equipment. 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.

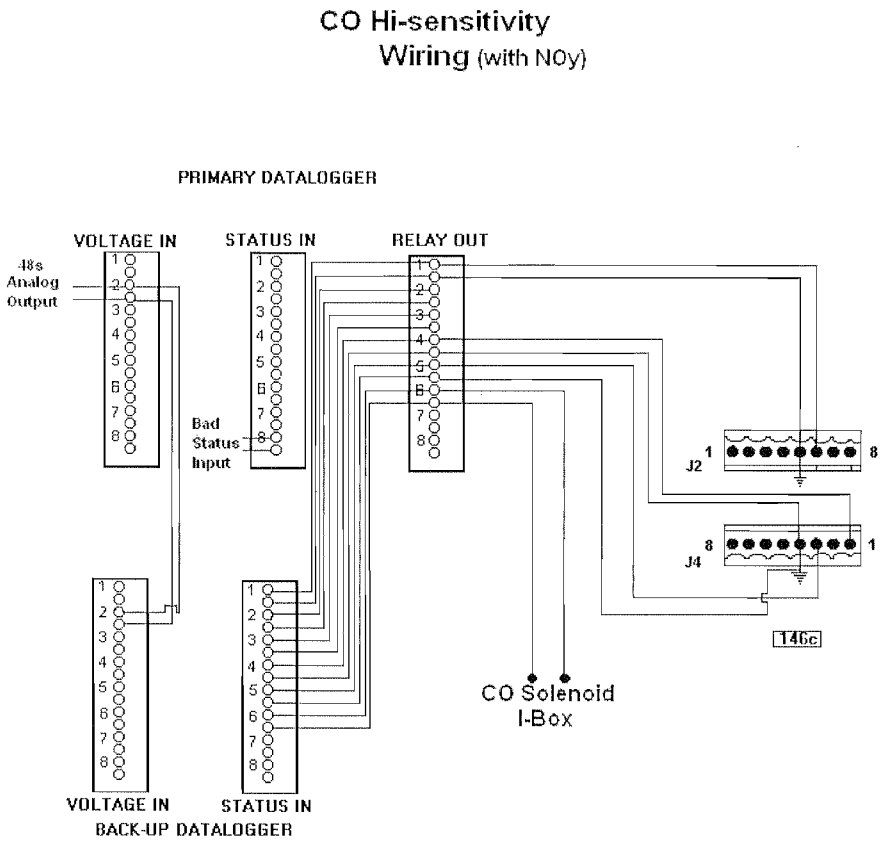


Figure 3 Wiring Diagram w/ NOy

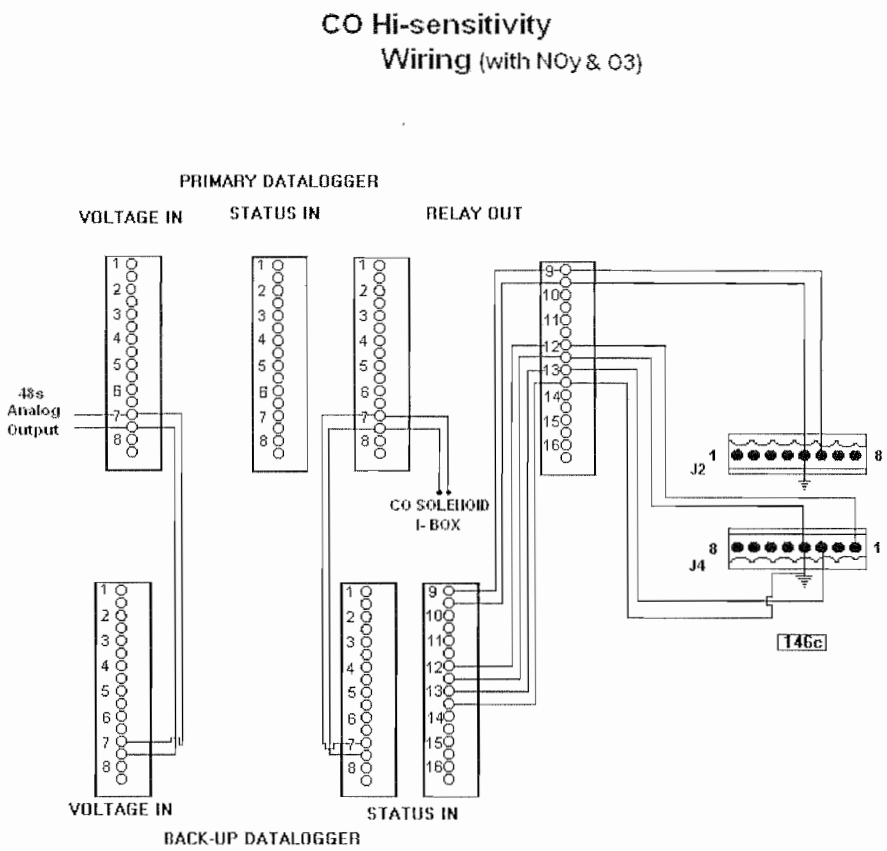


Figure 4 Wiring Diagram w/ NOy & O3

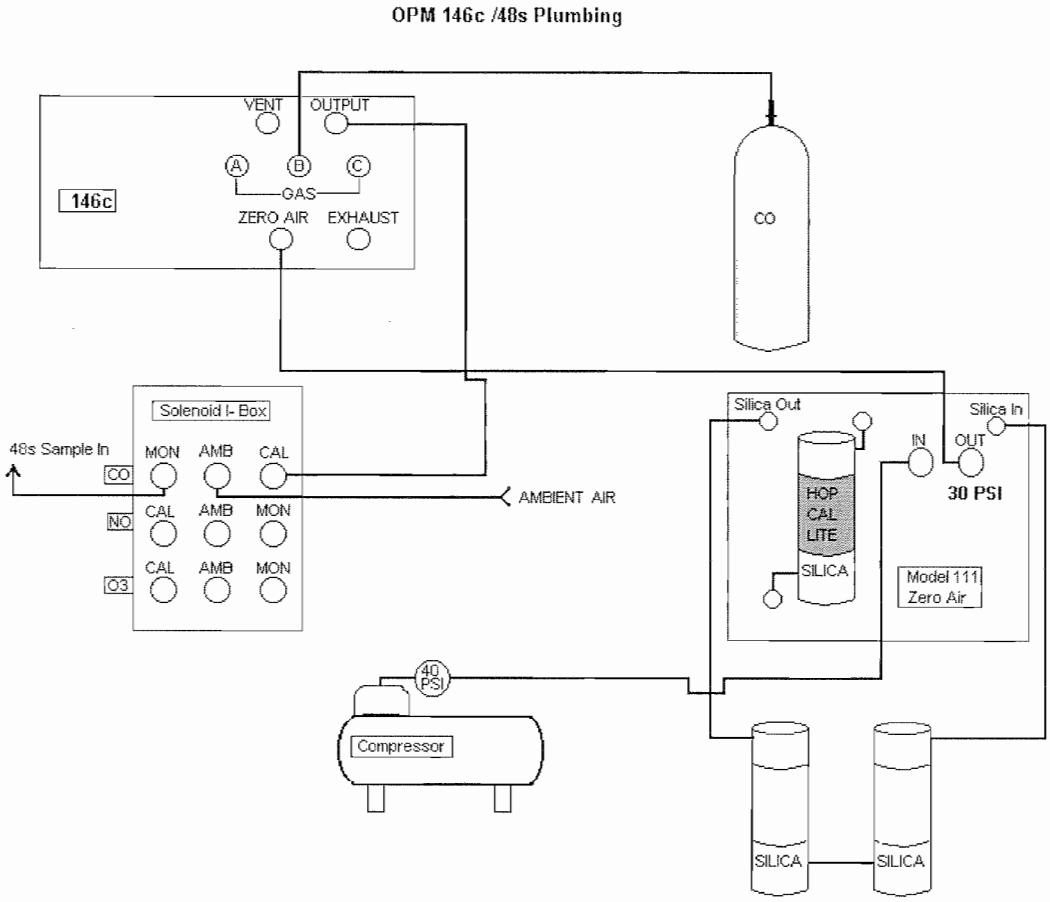


Figure 5 Plumbing Connections

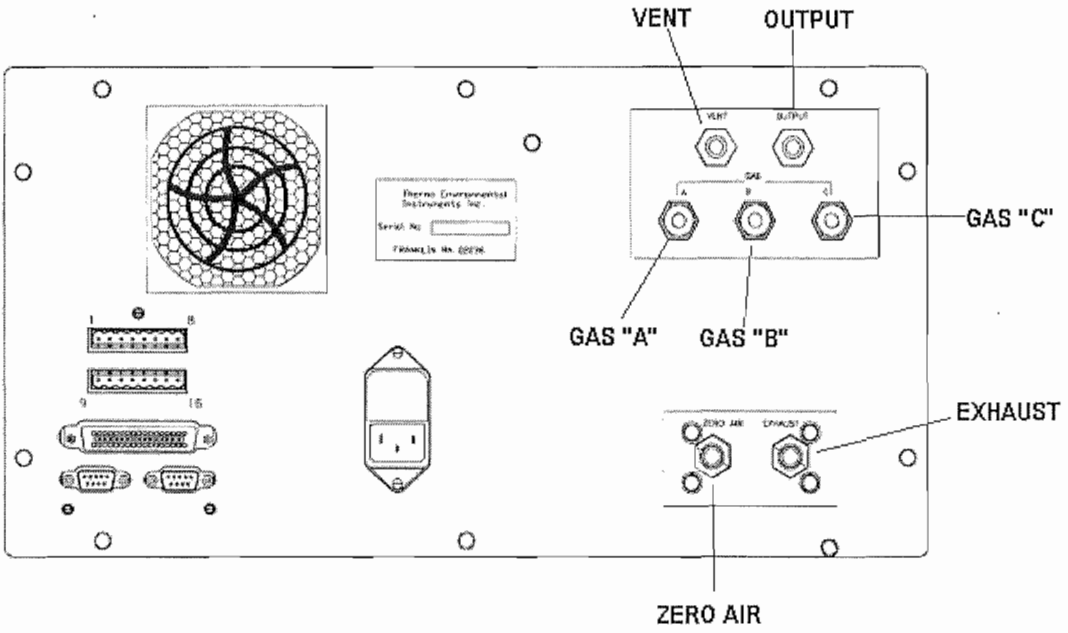


Figure 6 146C Rear View

Sign-Off Sheet

I certify that I have read, understand and agree to follow the contents of Revision 4.2 of the "Thermo Environmental 48S High Sensitivity Carbon Monoxide (5 PPM) QA PLAN, Section I, Electronic Calibration Branch Responsibilities" with an effective date of August 1, 2011. **Sign, date and return to the Ambient Monitoring Section Chief.**

ECB Technician: Mark Yuba

ECB Technician:

ECB Technician:

ECB Technician: