

AETHALOMETER™ STANDARD OPERATING PROCEDURES SECTION I

ELECTRONICS CALIBRATION BRANCH RESPONSIBILITIES

Approval Sign-Off Sheet

I certify that I have read and approve of the contents of the "Aethalometer - QA Plan, Section I, Electronic Calibration Branch (ECB) Responsibilities" with an effective date of October 27, 2010. **Sign, date and return to the Ambient Monitoring Section Chief.**

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2.32.1 Aethalometer QA Plan: ECB Responsibilities

Note: The following is a list of "significant changes" from Revision 1.2.

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

2.32.1.1 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 (computers, analyzers, and data loggers) 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.

2.32.1.2 Ambient Carbon Particulate Monitoring

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

1. Magee Scientific Aethalometer™ Ambient Carbon Particulate Monitor
2. Sharp Cut Cyclone with 2.5µm cut-off for the inlet
3. Teflon Sampling Line
4. Computer/ESC 8816 Data Logger/Modem System
5. 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 particulate. 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.

2.32.1.3 Receipt, Testing and 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.

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

The most recent EPA Reference or Equivalent method list should be reviewed to determine the makes and models of monitors acceptable for network monitoring (as of May 20, 2004 no reference or equipment method has been designated for carbon black).

2.32.1.4 Aethalometer™ Certification (Pre-Site Installation Checks)

- Insert a diskette/flash card and verify that the power line voltage matches the voltage on the rear panel label.
- Remove the red cap plug from the sample inlet port on the back of the instrument and use a connection adapter to the tubing.
- Install connector on back of instrument in sample line to avoid having to pull sample line completely out of instrument when doing flow checks.

- Turn on the power switch in the rear and make sure that it is in the 'ON' position (this rear switch should only be used in case of emergencies, otherwise, turn the instrument on and off using the main power switch on the front panel inside the door).
- Remove the clear plastic filter protection strip from the optical analysis head by flipping the 'TAPE ADVANCE' switch in the upwards direction and pulling right gently. Do not tear the tape.
- Switch the front power switch to the Aethalometer 'ON'. The display screen will illuminate: for the first half-minute the computer is performing its program loading and initialization procedure and the screen will only show a flashing cursor block. After a while, the screen will display the opening dialog.

The instrument can (in principle) begin operation automatically from this point, and will do so after 60 seconds if none of the keypad keys are pressed. If any key is pressed before the 60 seconds is up, the Main Menu screen starts at the top of the list. Press **STOP** key, watch screen. Press **STOP** key again. Enter Security Code of "111" (before clock countdown expires) and press **ENTER**. This should present you back at the Main Menu. If the code entered is not correct, or is not entered fast enough, measurement operations simply continue as normal.

The **Main System Menu** starts at the top of the list (i.e. *Operate*). The *Main Menu* offers the following selections:

1. **Operate**
2. **Change Settings**
3. **Signals + Flow**
4. **Self Test**
5. **Calibrate Flowmeter**
6. **Software Upgrade**
7. **Optical Test**
8. **Install New Tape**

- Operate *Main Menu* > *Operate* <**ENTER**>
 - This option of the *Main Menu* allows for automatic operation or for manual input while preparing the instrument to run. The first screen display asks "**Go To Auto Mode?**". The default response **Y** is displayed. If **ENTER** is pressed, the instrument immediately proceeds with fully automatic operation, and no further operator interaction is required.

If **N** is selected with the down-arrow key, and then **ENTER** is pressed, the program provides the following interactions:

- The program asks the user if new titles should be read from the floppy disk (e.g. for a new experiment name). These titles will appear in the 'MF' message files. To enter new titles, use any plain-ascii text editor to write two separate lines title1 and title2 in a text file TITLES.TXT, and insert into the floppy disk drive at the prompt. These titles will be saved for future runs of the same experiment.

-The program prompts the user whether the data disk should be replaced, even if it is not full yet. Note that the option Overwrite Old Data, if set to “YES” in the Change Settings menu, will simply overwrite the oldest data when the disk becomes full (see also Overwrite Old Data menu).

- The screen will show a Flowrate display. This allows the operator to verify the air flow rate desired for the experiment or sequence of measurements.

Aside from these user inputs, operation is identical as for *automatic mode* described below. The *manual input mode* features simply allow the user to check parameters before running the instrument.

Firstly, the air flow rate is checked after a 30-second countdown that allows the flowmeter to stabilize. If (for example) the instrument was configured for ‘External Pump’, yet this was not connected or working, an error message would be given “WARNING .. FLOW < 1 LPM”.

- Titles confirmation, “Title 1”; “Title 2”.. “Retain Old Titles” / “Read New Titles”. This allows new titles to be uploaded to designate new experiment, location, etc.

- Flowrate Display This provides an opportunity for the flowrate to be adjusted by the user to suit the needs of the measurements. **After the flowrate is accepted, press any key.**

- Disk Data Space checking This checks the free space remaining on the diskette and provides an opportunity to insert a fresh disk. “Continue” / “New disk entered” / “Delete oldest files”

After this question, no further user input is necessary.

Measurements will start automatically after the following two screen displays:

- “Advancing tape, wait”
- “Waiting for start time”

The screen displays a countdown to the start of the next integral timebase period.

- Change Settings *Main Menu*> *Change settings*>*Time & Date* <**ENTER**>:

- **Time & Date:** If date is changed, time must be reset. Use the → or ← keys to move the blinking cursor over each number. Use the ↑↓ keys to change the numbers so that the date and time are correct, press **ENTER** when done. When asked whether to ‘Write Settings?’ press **YES**. To return to the Main Screen showing the flow reading, press **ENTER** three times (once in the ‘Operate’ window, once in the ‘UV Mode’ window, and once when asked to enter ‘Auto Mode’).

The Aethalometer must be "stopped" to change the time, but does not need to be taken offline, since the -5 volt output during this time automatically flags the data as void in the

data logger. If there is a continual trend of system time error (for example, a system generally gains 2 minutes each week), set the time somewhat off in the opposite direction of the trend to reduce the need for frequent system time changes. For the fast clock example above, set it 4 or 5 minutes slow each clock reset.

- **Flow Rate Main Menu** > *Change settings* > *Flow Rate* <ENTER>:
This allows the user to set the sample air flow rate in Liters Per Minute (LPM). The computer and electronics automatically control the variable-speed pump to maintain the desired flow rate based on the signal from the air mass flow meter. (Usable range 1 – 6 LPM) select "**5LPM**"
- **Timebase Main Menu** > *Change settings* > *Timebase* <ENTER>: (Valid values: 1 sec - 60 min.) select "**5min**"
- **Tape Saver Main Menu** > *Change settings* > *Tape Saver* <ENTER>: (Selections: 'OFF', 'X3', 'X10') select "**OFF**"
- **Analog Output Port/Alarm Main Menu** > *Change settings* > *Analog Output Port/Alarm* <ENTER>: Selections: SIGNAL OUTPUT / ALARM.
 - If SIGNAL OUTPUT is selected:
Output Scale Factor: Valid values:
1 - 10,000 (ng BC /m3) / V, when the BC Display Unit is set to **ng/m3**, (Use this setting)
1 - 1000 (µg BC /m3) / V, when the BC Display Unit is set to **ug/m3**.
1 - 10,000 (ng UV /m3) / V, when the BC Display Unit is set to **ng/m3**, (Use this setting)
1 - 1000 (µg UV /m3) / V, when the BC Display Unit is set to **ug/m3**.
 - If ALARM is selected: *Alarm On/Off* allows the alarm function to be enabled or disabled. select **OFF**
Alarm Set point allows for entering the *Alarm Value Limit*. Valid values are 0.01 - 10,000 µg/m3, enter "**10**"
- **Warm Up Wait**: Selections: 0...YES, 1... NO, select "**0**"
- **Communication Parameters**: *Main Menu* > *Change settings* > *Communication Parameters* <ENTER>: COM mode, COM settings. The COM Settings sub-menu sets the communications parameters
- **COM mode**: *Main Menu* > *Change settings* > *Communication Parameters* > *Com mode* <ENTER>:
The COM Mode sub-menu selects the type of data transmission: 1...OFF, 2... DATALINE, 3...GESYTEC' or 'GPS', select "**DATALINE**"

- **COM Settings:** *Main Menu> Change settings>Communication Parameters>Com Settings <ENTER>*:

The COM Settings sub-menu sets the communications parameters

	Default settings
BAUD (9600, 4800, 2400, 1200);	9600
DATA bits (8 or 7);	8
STOP bits (1 or 2);	1
PARITY (None, Even, Odd),	None

Note: If DATA BITS is set to **8** then PARITY **must** be set to "**None**"

- **Overwrite Old Data:** Selections: (1...YES, 2...NO): select "**1**"
- **Filter Change At:** Valid values: 0-30 hours. (**Important!** - set value to **0** to allow automatic filter tape advancing).
- **Security code:** *Important -remember this code! It is the password for access to the following protected functions:*
 - Upload a software upgrade.
 - Change certain 'protected' setup parameters.
- **Date Format:** Selections: (0..US, 1..EU): select "**0**"
- **Data Format:** Selections: (0..Extended, 1..Compressed): select "**0**"
- **Expanded Data Format:** *"date", "time", BC concentration 1 (ng/m3), UV concentration 2 (ng/m3), sensing zero signal(1), sensing beam signal(1), reference zero signal(1), reference beam signal(1), sensing zero signal(2), sensing beam signal(2), reference zero signal(2), reference beam signal(2), air flow (LPM), bypass fraction, optical attenuation.*

A typical line in the data file might look like:

"01-may-99", "09:40", 866, 888, .0214, 3.2805, .0214, 2.0763, 0214, 1.8055, .0214, 1.446, 0.0214, 1.00, 1.974

Note that the recorded time corresponds to the starting time of the measurement cycle.

- **BC Display Unit:** Selections: (Nanograms / Micrograms), select "**Nanograms**"
- **Instrument Serial Number:**

The first three digits of the instrument's serial number must be entered before a software upgrade can be performed. This is a precaution that ensures that the software will operate correctly with the electronics hardware, which is routinely improved and enhanced at the circuit board level. This parameter identifies the hardware to the software, and is set at the factory to the correct value. Verify that it is indeed equal to the serial number printed on the instrument. If this is correct, **do not change it** unless specifically advised.
- **Instrument Type (Optics):** Selections are:
 - 'AE1x – Standard' (AE16 single wavelength, BC only), *'AE2x - UV+LED' (e.g. AE21 combination BC + UV absorption), and 'AE3x - 7 x LED', select "**AE2x**"

- **Spot Size:** Choices are: ‘Extended Range’ (“larger” 1.67 cm² spot) and ‘Standard Range’ (“smaller” 0.5 cm² spot for higher sensitivity), select "**Extended Range**"
- **Sigma for Lamps:** Selections: (Magee BC / Harvard EC), select "**Magee BC**"
This permits changes to the proportionality constant ‘sigma’ that is used to convert optical attenuation to a mass of absorbing material. This may be used to ‘tailor’ the optical response, or to switch between ‘Magee BC’ and ‘Harvard EC’ calibrations.
- **Spots Per Advance:** Selections: (1 / 2), select "**1**"
This allows the user to control the spacing of the spots collected on the filter tape. If ‘1’ is selected, the spots will be close together and essentially touching. This minimizes the use of filter tape. It is possible that the spots may actually overlap by a very small amount: this does **not** affect the accuracy of the measurement, due to the nature of the algorithm.

However, there may be situations in which the spots are to be collected afterwards for analysis or archiving. If touching of spots would be unacceptable for these requirements, select the value of ‘2’ for this parameter. In this case, the tape advance mechanism will perform two complete cycles each time a tape spot advance is called for.

- **Maximum Attenuation:**
This allows the user to specify the maximum value of optical attenuation that defines the point at which an automatic tape advance is triggered. The attenuation setting is set to **125** for the AE-21 instrument. If the attenuation setting must be altered, select ‘*Change System Settings*’ from the main menu and then ‘*Maximum Attenuation*’. The scaling factor for the instrument should be set to: "**125**"

$$1000 \text{ ng/m}^3/\text{V} \rightarrow 1\text{V}=1 \text{ }\mu\text{g/m}^3$$

The ESC 8816 Data Logger uses the following settings for the Aethalometer:

FS = 5V

High Input = 5V

Low Input = 0V

High Output EU = 4.99

Low Output EU = -0.01

Units = $\mu\text{g/m}^3$

- Signal and Flow
 - **Signals & Flow Display**
The **lamp(s)** may be turned ON and OFF by toggling the UP/DOWN arrow keys. The lamp condition is shown on the right-hand side of the top line of the display screen as follows.
AE2- and AE3- series instruments allow for testing of the additional lamps:
“Lamp=0”: lamp(s) OFF
“Lamp=1”: 880-nm lamp turned ON: “wavelength 1” BC measurement
“Lamp=2”: 370-nm UV lamp turned ON: “wavelength 2” UV measurement in AE-2 series instruments
“Lamp=3” to “Lamp=7”: other wavelength lamps turned ON for testing AE-3 s instruments.

- The **bypass valve** may be turned ON and OFF by toggling the LEFT/RIGHT arrow keys. The airflow path is shown on the right-hand side of the second line of the display screen as “Filter” or “Bypass”. Press **ESC** to exit this selection and return to the *Main Menu*.
- Return to Main:
This selection exits from the *Change Settings* menu.
- Self Test *Main Menu*> *SelfTest* <**ENTER**>
This selection activates a sequence of tests of the instrument hardware. The series of tests are performed automatically: any error messages are shown on the screen.
 - Lamp test: The lamp(s) are turned on and off, and measurements are made of the optical signals in the sensing and reference detectors. For multiple-source instruments, this procedure is repeated. Comparison of the signals allows for the following fault analyses:
 - LAMP is burned out (OFF all the time)
 - LAMP is ON all the time (electronics fault)
 - TAPE torn or ended (signals too large)
 - LAMP TEST PASSED.
 - Pump & bypass test: This test measures the airflow: the user is prompted to connect the pump (in case the instrument is configured for ‘External Pump’). The airflow is calculated using the flowmeter zero voltage and the flow scale factor that were set by the Calibrate Flowmeter routine. If the flow rate is smaller than 1 LPM, an error message is displayed. The flow rate is compared for both positions of the bypass valve, to make sure that it is not blocked in either position.
 - Analog output test: The analog output connector on the rear panel is presented with a sequence of voltages to allow an external data logger or alarm relay to be tested. The sequence is: V = 0; +1VDC; +2 VDC; +5 VDC
 - COM port test: This routine allows the user to test the transmission of RS232 code from the COM port on the rear of the instrument, in order (for example) to test communications with a data logger or other receiver. This routine first allows the user to change COM parameters (baud rate, etc.) if desired. The screen then prompts, "ENTER to send data". Press **ENTER** to transmit one data line using the COM parameters. This may be repeated as often as desired. Press "**ESC**" to escape.
 - Screen test: This routine tests the display screen as follows:
 - All LED's are turned ON.
 - All LED's are FLASHED.
 - All LED's are turned OFF.
 - The screen is filled with characters.
 - The screen backlight is turned OFF.
 - The screen backlight is turned ON.
 - Tape advance test: The tape feeder is activated: the user is prompted to watch the mechanism to verify correct operation. A countdown timer indicates the approximate duration of the test.

- Calibrate Flowmeter *Main Menu*> *Calibrate Flowmeter* <**ENTER**>

The program first allows the user to switch between ‘Standard’ and ‘Volumetric’ flow units. (If ‘Volumetric’ flow units are selected, it is necessary to input the barometric pressure and ambient air temperature). This function is not password protected. The program next allows the user to re-calibrate the flowmeter: this function *is* protected.

- Flow Volume Units:

The program allows the flow to be expressed in terms of either Standard Units or Volumetric Units.

Standard Units report the air flow rate as SLPM, i.e. volume occupied by a given mass of air at a temperature of 20°C and a pressure of 1013 mb. This mass flow rate is the signal that is provided by the mass flow meter in the instrument. The Aethalometer data is reported as ng/m³ or µg/m³, where the “m³” is understood to be a *standard* cubic meter.

Volumetric Units convert the *mass* of air to a *volume* calculated at certain specified ambient conditions of *temperature* and *pressure*. These conditions must be entered by the user – they are not measured by the instrument. The mass flow rate signal provided by the mass flow meter is scaled by proportionality factors for *temperature* (input in degrees C) and *pressure* (input in millibars). When *volumetric* units are selected for the flow, the flow rate display on the screen is shown as vLPM, and the BC calculation is presented as ng/vm³ or µg/vm³.

The *volumetric* calculation requires user input of ambient *temperature* and *pressure*. These factors may be entered without going through the flowmeter re-calibration procedure. This allows for entering different mean ambient temperatures, or different pressures if the instrument is moved to a location of different elevation, without disturbing the fundamental calibration of the mass flow meter response.

- Optical Test *Main Menu*> *Optical Test* <**ENTER**>

Perform optical strip test – there is an optical test strip (neutral density filter) provided with the Aethalometer instrument for the purpose of this test. The following procedure may be used for performing the optical strip check:

1. Press **STOP** key, watch screen. Press **STOP** key again. Enter Security Code of ‘111’ before expiration of clock countdown. This should return you to the Main Menu, where you can press the down-arrow to get the menu item ‘Optical Test’ and press **ENTER**. Enter the security code again. The automated test procedure will then give you a series of prompts.

You do not necessarily have to do the operation directly after each prompt. However, at the close of the test, each prompt must have been answered in order for the test to be complete.

2. The Optical Test Strip has a serial number printed at one end that should match the serial number of the instrument. Enter this number when prompted. Check that there is a floppy disk/ flash drive in the drive.

3. Open the door and remove the two thumbscrews that secure the rectangular metal cover over the sampling chamber in the center of the instrument. This provides access to the area where the filter tape passes through the optical system.
 4. Cut the filter tape on the left side of the chamber with scissors. Press **ENTER**, when prompted. Lift up the optical chamber (by pressing the "Tape Advance" button) to pull the tape out. Take off the round banana clip sticking outward for better access. The remaining tape will be pulled out onto the right-hand spool. Take the clear cover off the tape roll on the right side and unwind all the remaining tape on the spool. Save the spool for later use.
 5. When prompted, insert the optical test strip from the left-hand side. Its printed serial number should be facing upwards on the right-hand side. Push it in from the left until the tip of the arrow printed on it is just visible in alignment with the edge of the base block. Press **ENTER**, when ready.
 6. The first phase of the test will proceed automatically. The lamp will turn ON and OFF to determine the optical transmission signals for the 'front' portion of the test strip
 7. At the end of the first set of measurements, the transmission values will be displayed. It is not necessary to write them down, as they are saved to disk. Press **ENTER** to proceed.
- The mechanism will go through three tape-advance cycles in order to pull the test strip forward. It takes approximately 5 minutes (because readings are taken in five minute increments).
8. The second phase of the test will cycle the lamps again and measure the optical transmission signals for the 'rear' portion of the test strip. The program will then calculate the quantities 'S Density', 'R Density', and 'Balance'. The signals, results and other information will be written to a file on the disk under file name 'Otxxxxxx.TXT' where 'OT' represents Optical Test, and 'xxxxxx' is the date coded in either 'US' or 'EURO' format, i.e. MMDDYY or DDMMYY. This text file should be printed out and saved in the site logbook. If there is no printer at the site, copy this text file to the hard drive of the laptop and print it out in the office.
 9. The display screen will then prompt the user to re-insert the filter tape from the left-hand side. Press "Tape Advance" button to lift optical chamber and pull the strip through. After pulling it through, re-attach it to the tape on the right-hand take-up spool. Replace the rectangular metal cover with its two thumbscrews.
 10. After optical strip test, allow at least 10 minutes for the machine to stabilize before trusting readings again (By that time, the machine would have taken 2 five-minute measurements).

- **Install New Tape** *Main Menu* > *Install New Tape* <**ENTER**>

Verify and adjust, if necessary, the Aethalometer operational parameters. If system fails to achieve required operational parameters investigate causes and correct per manufacturer's recommendations.

- **Software Upgrade Main Menu** > *Software Upgrade* <ENTER>

This is a 'protected' function and requires the Security Code as a password. The *Software Upgrade* selection provides a convenient means to load new software from floppy disk. This software may be derived from a disk physically provided by the factory or Magee Scientific, or from files sent either by e-mail or downloaded from the Magee Scientific website, and copied onto a diskette.

2.32.1.5 ECB Site Installation Criteria for the Aethalometer Carbon Particulate Monitors

- The probe or at least 80 percent of the monitoring path must be located between 2 and 15 meters above ground level for neighborhood scale $PM_{2.5}$ sites. Middle scale $PM_{10-2.5}$ sites are required to have sampler inlets between 2 and 7 meters above ground level. Microscale $PM_{2.5}$ sites are required to have sampler inlets between 2 and 7 meters above ground level.
- Distance from horizontal or vertical structure must be greater than 2 meters.
- Distance from trees must be greater than 10 meters.
- Air flow must be unrestricted in a 270-degree arc (180 degrees if on a side of a building, with the wind direction during the season of greatest particulate concentration included in the arc.
- For neighborhood sites, the distances from the nearest traffic lane depends on the traffic flow. Refer to **Figure E-1**.

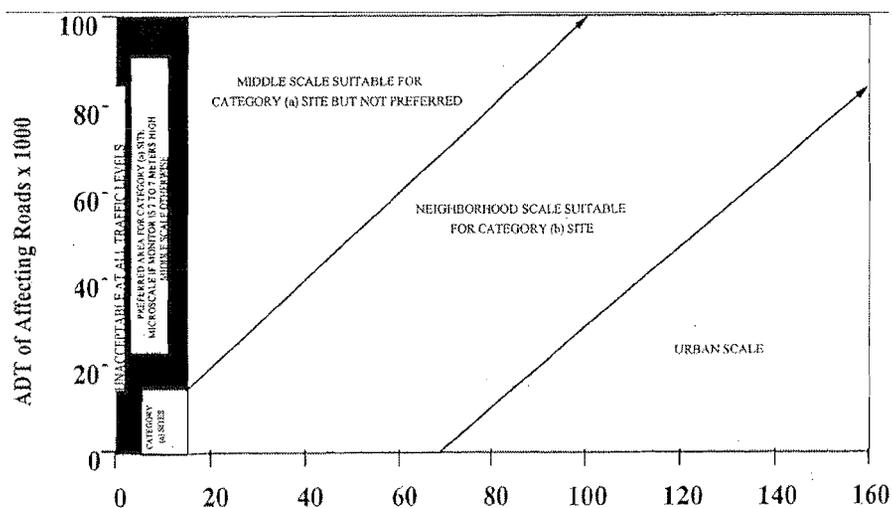


Figure E-1. Distance of PM samplers to nearest traffic lane (meters)

- Exact placement of the particulate matter probe must come from the Projects and Procedures Branch Supervisor.

2.32.1.6 Site Monitor / Verification (Site Installation)

After the regional office has obtained permission to use a site from the site owner, and after the DAQ Ambient Monitoring Project and Procedures Supervisor has 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.

The ECB is responsible for the installation of all State operated ambient air carbon particulate monitoring sites across the state each year.

The installation of the carbon particulate monitoring sites includes; the Aethalometer Particulate Monitor, stainless, copper or aluminum tubing, computer, data logger, and modem system.

- Inspect the cyclone with the 2.5 μ m cut-off inlet, and sample probe line. Visually inspect the condition of the sample delivery systems. The inlet and the sample line or their equivalent, must be clean, and must have a sample residence time of less than one minute. The length of the tubing should be held to a minimum. Care should be taken to ensure that dirty, wet, or incompatible materials in the sample lines do not contaminate the sample.
- The inlet tube on the top of the instrument should run directly upwards through the ceiling of the monitoring building. The inlet tubing should be as straight as possible and should not have any severe dents in it. Irregularities in the tubing may result in particles depositing on the tube walls.
- Attach 3/8" OD stainless steel tubing to the top of the instrument and connect the cyclone to the top of the inlet. The cyclone should sample the ambient air at approximately six feet above the top of the roof.
- Standard: Under hot, humid conditions, condensation can occur in the sampling line as the sample gas passes through the air conditioned environment of an air monitoring station. As a precaution, the inlet tubing will be insulated. Pipe insulation is commonly available at hardware stores.
- The Aethalometer will be placed on a sturdy table near a 110-volt power receptacle. The table should be at least 36" deep to permit the instrument bulkhead to be extended for maintenance and calibrations.
- On-site connection of equipment to data acquisition system. The Aethalometer is connected to the DAS using the RS232 port located in the lower left of the front of the instrument. The instrument has a nine-pin female port, and thus requires a nine pine male connector.

Site Installation

A) Electrical

1. Connect the keyboard and mouse to the computer.
2. Connect the data logger to the output channel of the computer.
3. Install the power cord to the rear of the instruments. Plug the male end into an appropriate outlet.

B) Initial Start-Up

1) Computer, Primary Data logger (PDL), UV/BC Analog Module

The standard rule for a valid hour is to contain at least 45 minutes of valid data. For the Aethalometer data logger channel, this must be reduced to 40 minutes to avoid an invalid hour report every time the filter changes. This does not really violate the 45-minute rule, since no more than 15 minutes of data are lost when the filter changes. However, since the data logger and Aethalometer clocks are unlikely to be exactly synchronized; the data logger's 1-minute data capture might be only 43 valid minutes.

The data logger's input range and the Aethalometers analog output range must be set to [a] provide sufficient data resolution and [b] not go 'off scale' during short term [5-minute] events that may be well below the 1-hour mean. For some sites this could be as high as 40 to 50 $\mu\text{g}/\text{m}^3$; many sites can use 20 $\mu\text{g}/\text{m}^3$ as a full-scale limit.

Checking and Setting Time on Computer and Data logger:

The times for the computer and PDL must be EASTERN STANDARD TIME.

NOTE!! The PDL must have the same NIST time ± 1 minute; the computer time must be 5 minutes slower than the PDL time.

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. Correct time website, <http://nist.time.gov/>.

a. Computer - 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".

b. Data logger

- Double click "Shortcut to Splitscreen"
- Open PDL
- Select "Utilities" and "Split Screen", press ENTER
- Highlight PDL and type Site ID Code (e.g.) "GR AQM" hit ENTER (located on front of data logger) and AQM (may have to hit ESC a couple of times before typing)

- Select Login "L"
- Type password "nerothecat": this brings up Home Menu
- Type: "C" configuration menu
- Type: "S" configure System Parameters
- Highlight "Logger Time", press ENTER
- Type in correct time in the format of: HH:MM:SS
- Press {ESC}{ESC}{ESC}
- 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 logger can be accessed by pressing CTRL and ESC to access the TASK list, you can log onto the data logger by highlighting the data logger and pressing ENTER.

Check Aethalometer Date/Time – The Aethalometer must be "stopped" to change the time, but does not need to be taken offline, since the -5 volt output during this time automatically flags the data as void in the data logger. If there is a continual trend of system time error (for example, a system generally gains 2 minutes each week), set the time somewhat off in the opposite direction of the trend to reduce the need for frequent system time changes. For the fast clock example above, set it 4 or 5 minutes slow each clock reset.

- a. Press STOP key, watch screen. Press STOP key again. Enter "Security Code" of 111 (before clock countdown expires). Should present you back at the Main Menu. If the code entered is not correct, or is not entered fast enough, measurement operations simply continue as normal.
- b. Press ↓ arrow key to get next menu item, 'Change Sys. Settings', press ENTER.
- c. The first item is *Date & Time*, press ENTER. Use the →, ←-arrow keys to move the blinking cursor over each number.
- d. Use the ↑↓ arrow keys to change the numbers so that the date and time are correct. Press ENTER when done. When asked whether to 'Write Settings?' press YES. To return to the Main Screen showing the flow reading, press ENTER three times (once in the "Operate" window, once in the "UV Mode" window, and once when asked to enter "Auto Mode").

Check the sample flow and attenuation setting on the display – For correct operation at the inlet, the flow rate should be within the range of 4.5-5.5 lpm. Adjust with the valve on the pump if necessary, and record the new adjustment value on the log sheet. If the flow cannot be adjusted to the correct setting, perform an external flow check. The attenuation setting is set to 125 for the AE-21 instrument. If the attenuation setting must be altered, select 'Change System Settings' from the main menu and then 'Maximum Attenuation'. The scaling factor for the instrument should be set to:

$$1000 \text{ ng/m}^3/\text{V} \rightarrow 1\text{V}=1 \text{ } \mu\text{g/m}^3$$

The ESC 8816 Data Logger settings for the Aethalometer example:

FS = 5V
High Input = 5V
Low Input = 0V
High Output EU = 4.99
Low Output EU = -0.01
Units = $\mu\text{g}/\text{m}^3$

Check the Aethalometer display for normal operation – Check for reasonable readings, no error messages, proper lights on, etc.

If the colored light on the control panel is green, operation is okay (After a tape advance, during re-initialization, the light will be *flashing green*).

If the colored light on the control panel is a flashing yellow, the instrument needs attention but is still running, and the data is okay (flashing yellow light could mean that the data disk is almost full, the tape is almost all used, or the air flow rate has changed more than 10%). See the troubleshooting guide in the manufacturer manual for flashing yellow and red lights.

A constant yellow light indicates that the instrument has been paused by the operator and is ready for measurement.

If the light is red, there is a problem and the instrument has stopped. If the tape has become hung up, bend back the small wire on the feeder spool (left-hand side). This should fix the tension problem and will avoid having to shut the instrument off and on again for a long reboot cycle.

Check the filter tape supply –Visually inspect the tape roll to ensure no physical damage or frayed areas and that all fibers are intact. Visually inspect the used filter tape spots for distinct and uniform borders between the exposed and unexposed areas. Re-tension the tape roll spool if needed. Pressing the "**Tape Advance**" button, or simply turning the instrument off and then on again, can tighten the tension of the filter tape.

Check Instrument Environment – Check Aethalometer instrument area to ensure that there are no insects, moisture, dust, or other particles in or around the instrument. Perform visual inspection of BGI PM_{2.5} Sharp Cut Cyclone[®] intake area to ensure that the intake is not clogged by any flow obstructions.

Clean the cyclone – The cleaning interval for the cyclone is dependent upon the environment it is in. In harsh industrial environments, daily attention may be required. In normal ambient environments, a once a month cleaning is generally sufficient. To clean, the following method must be taken:

- a. Unscrew the grit pot at the top of the cyclone and remove it.
- b. Dispose of the contents and clean and dry it.
- c. Remove the three screws from the side of the cyclone and remove the side. The parts can now be cleaned, thoroughly. The cleaning method of first choice is immersion in an ultrasonic cleaner with water and mild soap. Usually hand wiping with a water-dampened lint free cloth will suffice.

Change the Aethalometer data disk – The Aethalometer does not need to be interrupted to do this as long as the change is done during the first three minutes of any five-minute measurement cycle [based on the Aethalometer's internal clock]. Before changing the disk, start by labeling a new disk with the site and start date/time (local standard time). Remove the old disk and insert the new disk. Immediately put the write protect tab on the old disk, and record the end date/time on the disk label. Return the disk to the main office. If the monitor has a flash drive, copy the files to a computer file and label with date/time.

2.32.1.7 Site Visits

Whenever the ECB technicians visit a site, they will:

1. Document the 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).

2.32.1.8 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.

2.32.1.9 Bios Dry Cal/ Tetracal

The Bios Dry-Cal/ Tetracal used for the Aethalometer Flow Calibration is recertified by the ECB meeting current EPA recommendations that flow measurement units be recertified at least annually.

2.32.1.10 Accuracy Audits and Reporting

The Electronics and Calibration Branch does not audit the Aethalometer.

2.32.1.11 Troubleshooting

Error Message "Instrument being controlled by.... via com2" (on front panel). This generic message means that the front display panel is not receiving communications from the main computer board. This is a hardwired message in the display board itself.

- a) Problem with the drives, if the computer has problems writing to the floppy disk or Flashcard drive it will eventually shut down the computer and the message will appear on the front panel. Run through the solutions to error code #1 in relation to the drives.
- b) Problem with the power connections going into the computer board. Check the power cable which is a white connector about an inch long that plugs into the main computer board. Unplug it and reseal it to see if this helps.

- c) Filter tape stuck underneath the optical cylinder. If the tape gets stuck it will eventually turn black and no more signal can be read. That will shut the system down after an error message. Try lifting the optical cylinder by hand and advancing the tape. You will be able to feel the tape if it is stuck and is suddenly released.
- d) This can also be caused by a problem with the main power distribution board in the newer units. In order to properly diagnose and repair this problem the unit needs to be sent in to Magee Scientific.
- e) Check to make sure the software settings are set for the proper # of wavelengths. (1,2,7) If it is set for 2 wavelengths and the unit only has one wavelength then it will give you a "lamp low error" then the being "controlled by error". You can check the software settings by going into the *Change Settings* submenu and going to the **Hardware** settings submenu. Under **Instrument Type** you can choose a 1, 2 or 7 channel instrument. Make sure it matches the actual number of physical channels your unit has.
- f) It can also be caused by a bad front display panel that needs to be replaced.

2.32.1.12 Maintenance

Every other year perform an optical chamber cleaning, see **Attachment A** (pg. 21)

2.32.2.13 AE-SETUP.TXT

Created : 06-nov-07 15:00:20

Instrument serial number: XXX

Software version: 984v9

Instrument type (0..U (1X), 1..UV+LED (2X), 2..7xLED (3X)): 1

Instrument (Portable/Stationary): Stationary

Selected Pump Flow: 5.1 LPM

Flow scale factor: 1.65 LPM/V

Flow zero: .136V

Date format (0=US, 1=EU): 0

Tape saver: 0

Spots per advance: 1

Filter change interval: 0

Maximum attenuation: 125

Over old data: 1

Warm up wait: 0

Spot size: Extended Range

BC Unit (0..ng, 1..ug): 0

Serial Comm.. Mode (1..OFF, 2..Dataline, 3..Gesyttec): 2

Serial communication parameters:

Speed (bps): 9600

Data bits: 8

Parity bits: N

Stop bits: 1

Gesytec parameters:

Network Scale Factor: 1

Instrument ID for Gesytec: 333

Dataline parameters:

Alarm mode (0..Analog out, 1..Alarm): 0

Alarm ON/OFF : 1

Alarm value limit: 10

Alarm channel selection (channel number): 1

Data format (0..Extended, 1..Compressed): 0

UV channel OFF (0..UV ch. **ON**, 1..UV ch. **OFF**): 0

Sigma values:

Sigma 1 : 16.6

Sigma 2 : 39.5

Sigma 3 : 0

Sigma 4 : 0

Sigma 5 : 0

Sigma 6 : 0

Sigma 7 : 0

Volumetric unit settings:

Volumetric units (0..Standard, 1..Volumetric): 0

Air Pressure (mbars): 995

Temperature©: 25

Appendix 1 Optical Source Cleaning

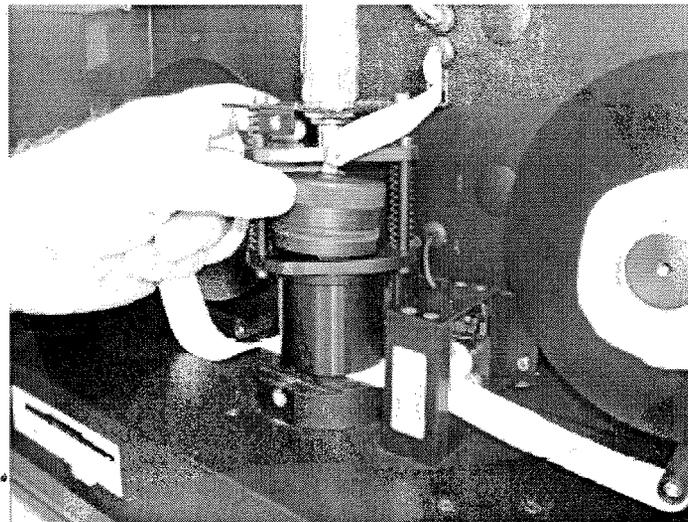
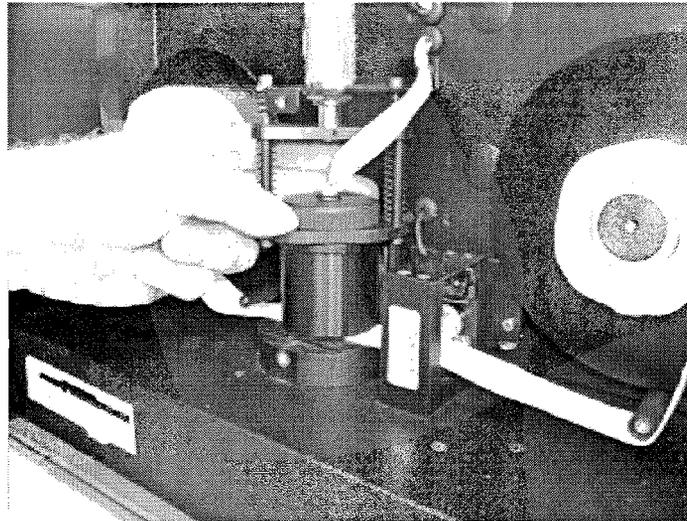
Routine Servicing: Cleaning

Disconnect power cord from monitor.

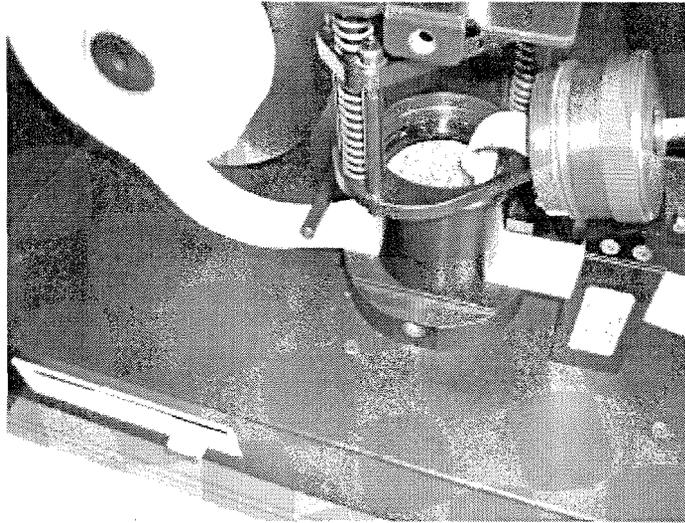
Remove top cover and open front door to get to the optical source.

Remove Top Cap of Analysis Cylinder, to get access to the Optical Source.

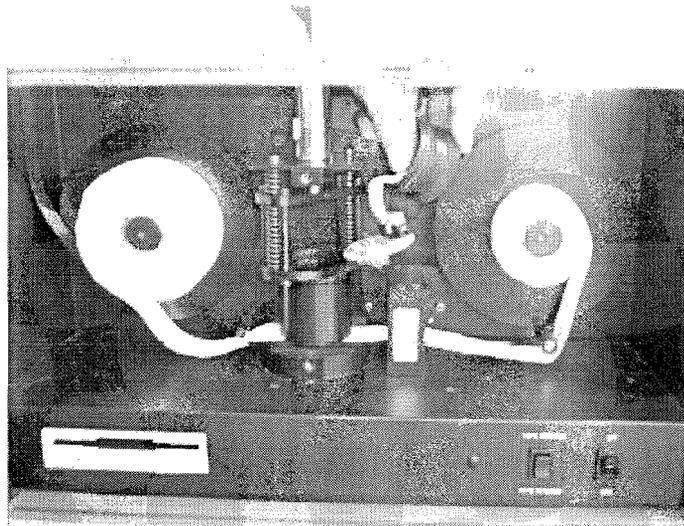
Un-screw top cap of Analysis Cylinder and remove Cylinder Top Cap carefully.



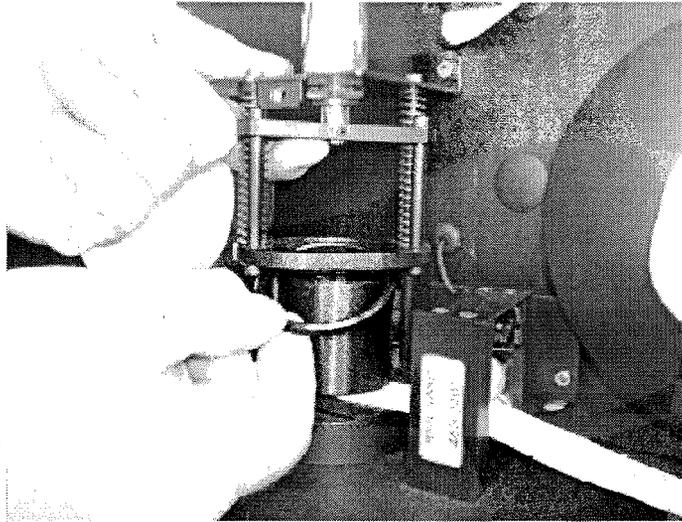
View on top of Optical Source



Remove Optical Source; Cable; Top Cap



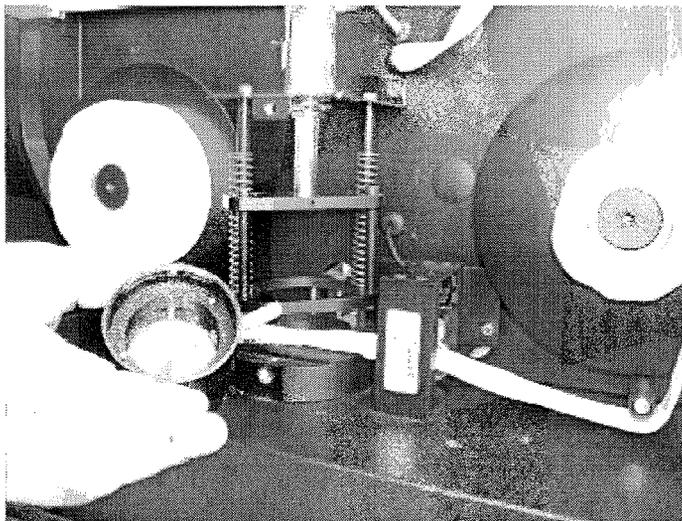
Hold frame up: remove Spacer Ring



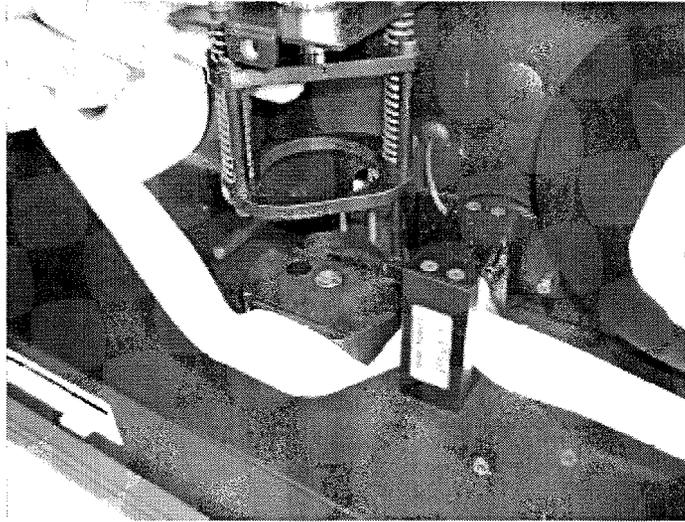
Routine Servicing: Cleaning

With one hand inside the rear chassis, hold the sample inlet tube, behind the Analysis Cylinder. With the other hand, pull the Analysis Cylinder forwards. The sample inlet tube will disconnect.

Pull Analysis Cylinder forward, detach from sample inlet tubing.



Make sure Cylinder Base is clean.



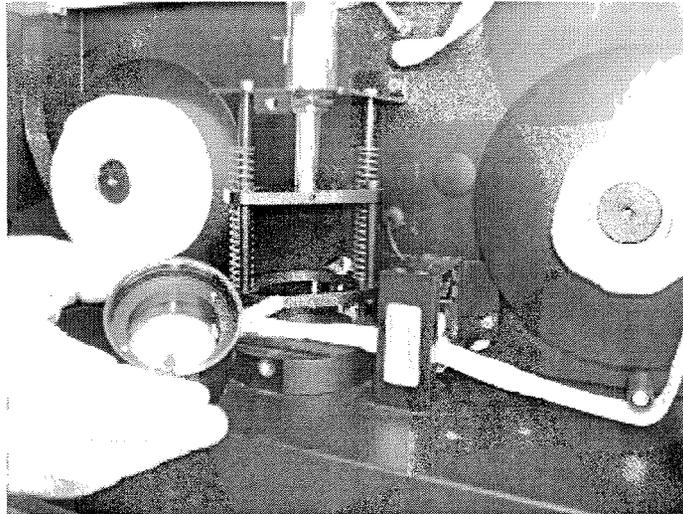
Clean the Inlet Cylinder to remove dust.



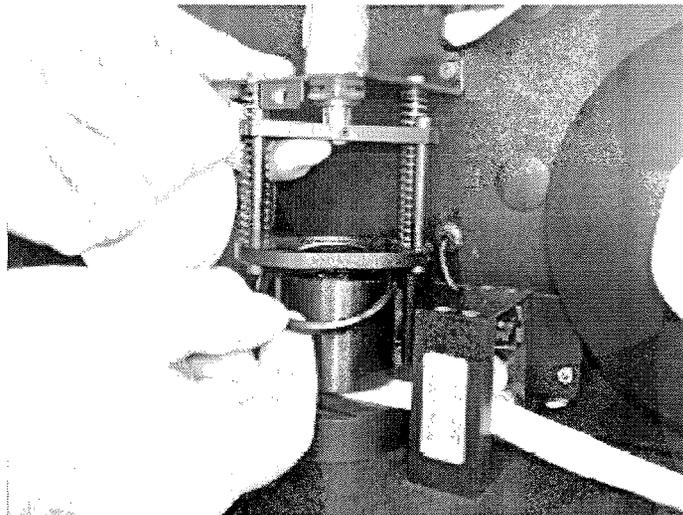
Re-Assembly:

Be sure to push the **Sample Inlet Tube** over the barbed fitting on the side of the **Analysis Cylinder**.

Push the Analysis Cylinder, while holding the Sample Inlet Tubing from inside the rear upper area. Make sure the fitting is pushed into the sample inlet tubing.



Re-insert the Spacer Ring (attach to Optical Source with tape).



Re-Assembly of Optical Source

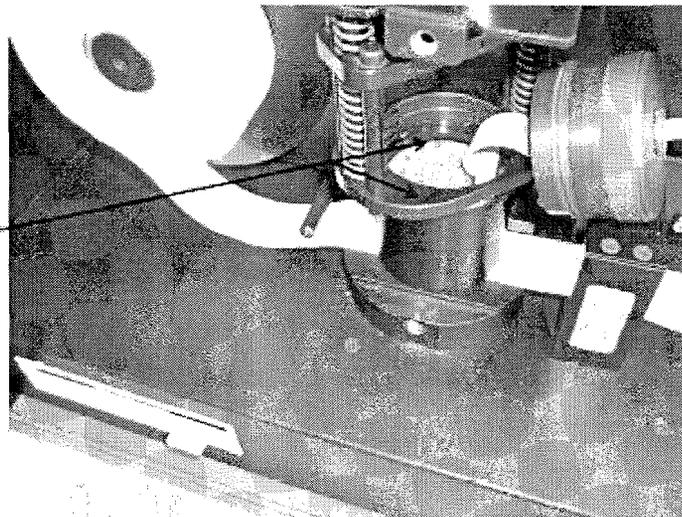
MAKE SURE that the circular board is correctly installed. There are 2 holes in the circular board that holds the optical sources; and 2 pins that come up from inside the Analysis Cylinder.

MAKE SURE that the circuit board is firmly located on these 2 pins.

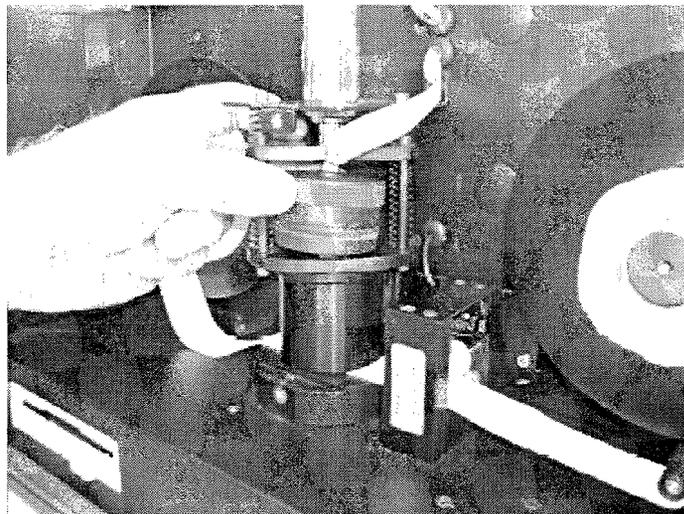
View on top of Optical Source

Pins in the cylinder must fit through the two holes in the board

Pins in the
cylinder
must fit
through
the two
holes in
the board

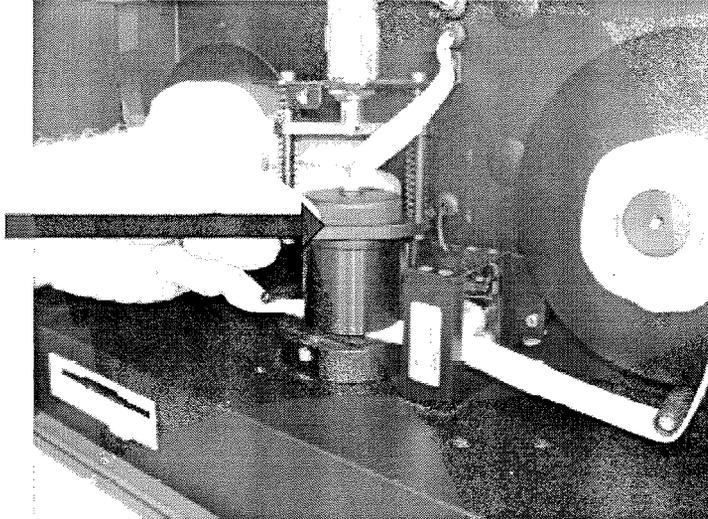


Replace Cylinder Top Cap carefully



Tighten the Analysis Cylinder Top Cap

When properly installed there should be no gap between the bottom of the screw on cap and the metal piece of the frame.



When properly installed there should be no gap between the bottom of the screw on cap and the metal piece of the frame.

Reinstall optical shield (if there is one), reinstall top cover and reconnect power cord. Reboot instrument to ensure proper operation of the monitor.