PQ200 & PQ200A
Air Sampler

INSTRUCTION MANUAL

PM$_{2.5}$ Designation RFPS-0498-116

PM$_{10}$ Designation RFPS-1298-125
NOTICE

This manual (version 1.85) applies to PQ200 samplers using firmware (internal code) v. 3.88, 3.89R, 3.91 and 3.92. The only change from V1.75 is that, the new version permits the performance air flow calibration at temperatures down to -30°C.

The version in your instrument can be assessed by turning off the instrument and restarting it. The version will be visible on the initialization screen.

If you have an earlier (lower numbered) version, contact BGI for a firmware upgrade.

All instruments returned for repair/service will be upgraded.

July 2008
Introduction

The purpose of this manual is to provide complete operational, calibration and maintenance details for the BGI PQ200 air sampler. This instrument has been specifically designed to meet or exceed the operational requirements of a Reference Method sampling device under 40 CFR Part 50, Appendix L (\textit{A}Reference Method for the Determination of Fine Particulate Matter as PM$_{2.5}$ in the Atmosphere\textit{B})\textit{C} and was designated a Federal Reference Method Sampler Number RFPS-0498-116 in April 1998. For additional guidance on sampler operation, recommended maintenance, and procedures for filter handling and weighing, refer to Section 2.12 of EPA\textit{D}’s Quality Assurance Handbook. A copy of the handbook may be downloaded from the EPA Links section of the BGI website.

The PQ200A PM$_{2.5}$ Audit Sampler

This manual has been further augmented to cover the use of the PQ200A (Appendix H) as an audit sampler. The minor changes to the PQ200 in the audit role (as the PQ200A) are covered under the original designation number as amended in August 1998. The changes in the main involve transport cases and deployment recommendations as covered in Appendix H.

The PQ200 PM$_{10}$ Sampler

The PQ200 may also be configured for PM$_{10}$ sampling. When used as a PM$_{10}$ sampler, there is one very important difference as described in detail in Appendix G. The WINS impactor is removed and replaced by a straight passage. This instrument was designated as a PM$_{10}$ sampler (December 1998) under Federal Reference designation number RFPS-1298-125.

The PQ200 PM$_{C}$ Sampler

The PQ200 may also be configured for sampling the US EPA defined PM Coarse (PM$_{C}$). PM coarse is PM$_{10}$ minus PM$_{2.5}$. This measurement requires the use of two PQ200 samplers, one set up for PM$_{10}$ and one as a PM$_{2.5}$ sampler. Specific instructions for operating instruments to perform these measurements are described in appendix O.

The PQ200 is a microprocessor-controlled, volumetric flow rate air sampling instrument which enables any facility required to do so, the ability to obtain a valid PM$_{2.5}$ $\mu$m air sample. In addition it offers the investigator the ability to perform their work in areas where no line power is available; this is accomplished via an internal battery and may be augmented with external batteries and solar power (see Appendix J). Recovered data may be handled with a Windows software suite, included with the sampler. The instrument is manufactured entirely in the U.S. in an ISO 9001-certified facility.

Appendix I of this manual details the use of the Datatrans, an external datalogger used for transferring run data from the field to the office.

Version 1.52 of the PQ 200 Job Controller Software has been superceded by version 2.3 Instructions for the earlier version have been retained in Appendix L.
About this Manual

To aid the user, different type faces and capitalization conventions are used to indicate the source of the messages shown. The styles are as follows:

- **SELECT, ON/OFF** Indicates buttons on the PQ200 sampler control panel
- **Test Menu** Indicates messages on the PQ200 sampler control panel screen
- **Job Control** Indicates text in the PQ200 Job Controller Program

In certain screens, some or all of the buttons on the PQ200 sampler control panel will have additional text displayed directly above them which modify or augment their function. For example, on the startup screen, the fifth button (the `Blank` button) has the text (MENU) above it, indicating that pressing the button will display the Main menu. In these cases, the styles will be combined, as follows:

- **SELECT (NEXT)** Indicates the fixed (augmented) function of a PQ200 control panel button

Customer Support and Technical Assistance

For technical assistance or to request repairs or replacement parts, contact BGI Incorporated at (781) 891-9380, by fax at (781) 891-8151, or by e-mail at info@bgiusa.com.
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Section 1.0
Instrument Description and Safety

1.1 DESCRIPTION [NOTE: WHEN USED AS A PM₁₀ SAMPLER, SEE APPENDIX G]

1.1.1 Inlet

The inlet is a modified version of the inlet used for PM₁₀ monitoring. It is designed to operate independently of wind direction and wind speed, with a throughput of 16.7 Lpm. This modified inlet is required according to design drawings and specifications in 40 CFR 50 Appendix L. The changes mandated by the U.S. EPA are its downward-turning flanges around the air entry, which are intended to hinder rain intrusion, and its enlarged water exit hole in the impactor plate, intended to promote water flow to the water collection hardware. In addition, the top plate and wind deflector have been redesigned to prevent water intrusion into the wind deflector.

1.1.2 Downtube

The downtube, also specified by design drawings in 40 CFR 50 Appendix L, transports the aerosol from the inlet to the WINS Impactor. It is necessary so that the inlet can maintain a specified height above the sampler case, and also can be 2 meters above the ground.

1.1.3 PM₂.₅ WINS Impactor

The PM₂.₅ Impactor, known as the WINS (which stands for "Well Impactor Ninety-Six"), is a design specified by drawings and specifications in 40 CFR 50 Appendix L. The well impactor, when properly operated with a 37 mm glass fiber filter and 1 mL of Dow 704 diffusion oil in the well, is designed to operate for several days (approximately one week, depending on the ambient concentrations) without overloading or alteration of the cutpoint or collection efficiency curve.

The WINS impactor and filter holder housings present in the PQ200 are an in-house improvement on the designs presented in 40 CFR 50 Appendix L. The housings have been shortened and combined into one piece, which has the effect of minimizing the interior volume of the sampler itself. This modification has no adverse effects and has been approved by the U.S. EPA. In addition, the housings seal by compression using "O"
rings on both the upper and lower housings, a modification allowable according to the Appendix L drawings. This compression seal ensures that the sampler may operate leak-free while allowing the operator quick, easy access to the WINS impactor and filter cassette.

1.1.4 Filter Holder

The filter holder and filter cassette are the last pieces of the sampler that must be designed according to drawings in 40 CFR 50 Appendix L. The upper filter holder housing is designed into the same piece as the lower housing of WINS impactor (see Section 1.1.3). The lower section houses the filter temperature gauge and the air hose connection which leads to the remainder of the flow system. O-rings on the upper and lower housings ensure a tight seal around the filter cassette.

The filter cassette itself is made of Delrin® and has upper and lower sections which snap together. These two halves sandwich a single 47 mm PTFE filter (for collection of the PM$_{2.5}$ particulate matter) and a stainless steel screen which serves as a backing/support plate for the filter. To ensure a tight seal, the filter cassette was designed with an interference fit which can make opening and closing the cassette difficult initially. Practice is recommended so that the cassette may be opened without damaging or dropping the filter.

1.1.5 Flow System

The flow system of the instrument is schematically illustrated in Figure 1. The configuration from the size selective inlet to the filter holder is a design standard mandated for Reference Methods under 40 CFR Part 50, Appendix L ("Reference Method for the Determination of Fine Particulate Matter as PM$_{2.5}$ in the Atmosphere"). From the filter holder, air flows through an interception water separator. The separator is fitted with a clear elastomeric tube located in the right, rear of instrument case behind the WINS/Filter Holder. The bottom of this tube is fitted with a push valve on the bottom/outside of the case to permit draining off water collected in the clear tube. The flow of air is directed through the mass flow sensor and then to a pulsation dampening (buffer) volume. The solenoid valve shown in the figure is the last item in the system prior to the pump. The sole purpose of this valve is to provide a means of sealing the far end of the system when the automatic leak check function is activated. The pump is a BGI manufactured double diaphragm unit designed especially for this instrument.

The flow system is controlled by a microprocessor. The mass flow sensor detects the mass flow rate through the unit, from which the microprocessor then computes the volumetric flow rate utilizing the current barometric pressure and ambient temperature.
The algorithm used for this process is:

\[ Q_{\text{vol}} = Q_{\text{cal}} \times \left( \frac{T_{\text{cal}}}{T_{\text{vol}}} \right) \times \left( \frac{P_{\text{vol}}}{P_{\text{cal}}} \right) \]

Where:
- \( Q_{\text{vol}} \) is the current volumetric flow rate in liters per minute
- \( Q_{\text{cal}} \) is the calibrated volumetric flow rate in liters per minute
  (calibrate at 16.67 Lpm for EPA purposes)
- \( T_{\text{vol}} \) is the current ambient temperature (K)
- \( T_{\text{cal}} \) is the calibration ambient temperature (K)
- \( P_{\text{vol}} \) is the current ambient barometric pressure in mmHg
- \( P_{\text{cal}} \) is the calibration barometric pressure in mmHg

Therefore, while the sensor is detecting the mass of air flowing, the calibration device utilized is volumetric. Consequently, the microprocessor is logging a volumetric flow rate along with barometric pressure and temperature at the moment of calibration. The firmware in the microprocessor thereafter calculates a volumetric flow rate based on current actual conditions. This calculation and control adjustment is updated every 200 milliseconds.

### 1.1.6 Temperature Measurement

Temperature measurement is accomplished with a linearized thermistor circuit:

A shunt resistor (R1) in series with a precision thermistor with a negative temperature coefficient (TH1) decreases the rate of resistance change as temperature decreases. When used as a voltage divider, this circuit will produce a linear output voltage proportional to temperature. Resistor R2 and thermistor TH2 provide compensation for the typically narrow range of this simple approach providing a total accurate range of -30° to +50° Celsius with a linearity deviation of +/- 0.16° C.
1.1.7 Pressure Measurement

Ambient barometric pressure is measured using a precision, temperature compensated, absolute pressure transducer. Its amplified output is signal conditioned to obtain a voltage that is compatible with the PQ200 A/D converter and maximizes resolution by spanning the desired range across the A/D converters input range. The inlet port of the barometric sensor is vented to outside the PQ200 case to eliminate errors due to case pressurization.

1.1.8 Unit Controls

The PQ200 control panel and screen are menu driven for ease of operation. Complete control of the sampler is achieved through only six buttons:

- ON/OFF: powers the PQ200 on and off
- SELECT: chooses the current selection
- LIGHT: lights the screen (only necessary when the sampler is using battery power)

The buttons have these typical functions:

- (arrows): moving from one menu item to the next, up or down; cycling through options
- (blank): optional; when available, its function is shown on the screen just above it

1.1.9 Power

The PQ200 was designed to operate from a nominal 12 Volt DC source and while batteries were intended to be the primary source, battery charge current/alternate power is supplied via a standard, UL listed, class II power supply. Auxiliary power can also be supplied via an external battery and/or solar panel to provide additional run times and operation in remote areas. Because the PQ200 runs from batteries, sample run loss is minimized except in extreme power loss conditions (long term power outage, no sun when using solar panel etc.) saving valuable samples that would otherwise have to be repeated.

When Operating from Batteries

If a run is initiated under internal battery power, the run is assumed to be intentionally battery powered. The unit will not show or log this event as a power failure. However, if power is then restored to the PQ200 and then lost again, a power failure event will then be logged. Also, while running from batteries, the display will show Bty xx% (where xx = 00 to 99) and indicates approximate capacity. When the Charger/External power supply is plugged in, the screen will display [DC In] or toggle between [DC In] and Charged depending on the internal battery status. While running from external batteries, the display will show EXT xx% indicating the approximate capacity of the external battery. A switching circuit within the PQ200 will automatically detect how the unit is powered and will display appropriately. If the PQ200 is run from an external...
battery, it will drain first and when external battery cut-out occurs (approximately 10.5VDC to prevent deep discharge) the internal battery will then be switched into use until such time as the external battery (possibly hooked to a solar panel) attains a high enough charge to operate the unit (approximately 50 percent charged).

1.2 STARTUP

When the BGI PQ200 sampler first arrives, please do the following before proceeding further:

- Check the invoice against the items received, making sure all pieces are accounted for: size selective inlet, downtube, sampler, legs, Gill screen temperature gauge, power supply, and documentation.
- Check all items for visible indications of damage that might have occurred during shipping.
- Notify BGI immediately if anything is damaged or missing. Do not discard packing material.
- Read this manual through in its entirety, in order to become familiar with the components and operating procedures, before assembling or operating the PQ200.

1.3 SAFETY

The PQ200 should only be operated as described and for its intended use. Because the PQ200 runs primarily from battery power, all of the typical hazards associated with high voltages and internal A.C. wiring have been reduced or eliminated. Personal injury, damage to the instrument, or fire can occur if the following electrical precautions are not observed:

- Caution should always be given when attaching the A.C. mains power connection. Do not attempt to connect main power if the plug or wire are cracked or frayed.
- Do not attempt to connect main power if the power cord, leads, or outlet are wet. Do not immerse power cords in water or other liquids.
- Place power cords away from traffic and do not allow anything to rest on them during operation.
- Do not overload AC outlets.
- Do not attach improperly wired external batteries, solar panels or power sources.
- Allow a few inches for ventilation at the rear of the instrument. Do not allow the fan opening to become clogged or blocked.
- Do not open the control panel or handle any other of the electrical parts while power is applied to the PQ200. Always disconnect the power supply first.
In addition, personal injury or damage to the instrument could occur if the following precautions are not observed:

- Always operate the PQ200 in a normal, upright position. The legs should be bolted down to prevent tipping in conditions of high winds.
- Do not operate the PQ200 if any of the parts are defective, damaged, or missing.
- Take care during the opening of the WINS and filter housing. See section 2.2.3 for further discussion.
Section 2.0  
Setup and Operation

2.1 INITIAL SETUP INSTRUCTIONS

2.1.1 Basic Assembly

It is recommended that each PQ200 sampler be assembled initially in a laboratory or other environment in which its operation can be checked prior to setup in the field.

2.1.1.1 Legs

• Attach the legs to the unit at the three hard points on the underside of the sampler (see Figure 2). The legs are identical and interchangeable. Make sure the connectors are seated properly and that the legs are securely attached.

2.1.1.2 AC Mains Supply and Options

• Attach the AC power supply to the rear of the unit underneath the fan cowling (the AC power supply unit has a plate attached that allows it to hook onto the back of the sampler case).
• Run the female three-pin connector underneath the sampler to the hole in the sampler case (near the front on the right side).
• Open the main door on the PQ200 and feed the connector through the hole and attach it securely to the upper of the two connectors.

Alternatively, the unit may be operated from the battery backup system or a solar power attachment. When fully charged, battery power is sufficient to operate the PQ200 for 24 hours in all but the most extreme concentrations (as concentrations increase, the pressure drop across the filter increases, necessitating higher power expenditure by the pump). Note that when operating from battery power, the control screen dims and it may be necessary to press the red LIGHT button to view the screen. If using the solar power attachment, the connector attaches to the PQ200 in the same fashion as the AC power supply.
2.1.1.3 Ambient Temperature Gauge

- Attach the external temperature gauge to the rear of the unit; the attachment points are on the fan cowling itself (position the temperature gauge assembly so that it sits above the top of the sampler case). Screw the connectors firmly into the attachment points.
- Run the cord with the three-pin connector underneath the sampler case and through the hole (just as with the power connector) and attach it to the lower of the two connectors.

2.1.2 Inlet Assembly

- Inspect for obvious missing pieces or damage.
- Confirm the presence of two o-rings on the bottom end of the downtube that mates with the open tube on the top of the sampler case. Ensure the interior of the tube is clean and clear of any debris. Install downtube on sampler.
- Confirm the presence of two o-rings on the bottom side of the size selective inlet that mates with the downtube. Install on top of downtube.
- The water collection hardware is packed separately to avoid shipping damage. Locate and attach to the side of the size selective inlet.

2.1.3 WINS Impactor Assembly

- The WINS (Well Impactor Ninety-Six) impactor assembly is shipped installed. Open the WINS and filter assembly inside the PQ200 sampler case by carefully rotating the handle counterclockwise using both hands. (Once the assembly has started to open, the weight of the two plates will tend to force the whole assembly open even further.)
- Inspect the impactor assembly for obvious missing pieces or damage.
- Confirm the presence of o-rings inside the upper and lower impactor housings where they contact the WINS impactor well. Ensure the interior of the housing is clean and clear of any debris.
- Confirm the presence of an o-ring between the two mating parts of the impactor well.
- Reinstall the impactor well in WINS housing.

NOTE: Under normal operating conditions, the impactor well must be installed with a 37 mm glass fiber filter and 1 mL of Dow 704 diffusion oil in the bottom.

2.1.4 Filter Holder Assembly

- The filter holder assembly is shipped installed.
- Inspect the filter housing and filter cassette for obvious missing pieces or damage.
- Confirm the presence of o-rings inside the upper and lower filter housings where they contact the filter cassette. Ensure the housing interior is clean and free of debris.
- Reinstall the filter cassette in the filter housing.

NOTE: A filter is pre-installed to reinforce the fact that the unit should never be run without a filter in place!

2.1.5 Powering Unit
• Press the **ON/OFF** button on the PQ200. The screen should light with the message:

```
PQ200 Air Sampling System
(c)Copyright 1997 BGI Incorporated
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Version: X.XX    Serial Number: XXXX
```

(the X=s will appear as numbers indicating the actual version number and serial number).

• After a few seconds, the Main screen will appear. The Main screen always displays the ambient barometric pressure, ambient and filter temperatures, date, time, power source, and any flags that may have occurred. Any error or status messages will also appear on the screen. For example:

```
READY FOR NEW RUN!    [DC IN] 999999
                       1997
                       04jul
746mmHg A28.0EC F27.5 EC (MENU) 14:53
```

• Confirm that the date and time displayed are accurate. (Note that the PQ200 operates exclusively on military time). If necessary, follow the steps in Section 2.1.6 to set the proper date and time.

• Press the blank **(MENU)** button on the PQ200 control panel to enter the Main menu.

### 2.1.6 Setting Date and Time

• From the Main menu, use the arrow keys until **Set-Ups and Download** flashes. Press **SELECT** to enter the Set-ups and Download menu.

• From the Set-Ups and Download menu, with **More Selections** flashing, press the down arrow until **Set Date and Time** flashes. Press **SELECT**.

• The **Set the current DATE and TIME** message will be displayed. The current date and time will be flashing.

• Press **SELECT (NEXT)**. The first value (date) will stop flashing (it can now be edited).

• Use the arrow **(EDIT)** buttons to increase or decrease the selected value. When done press **SELECT (NEXT)**.

• Continue to press the **SELECT (NEXT)** and arrow **(EDIT)** buttons in this fashion to enter the desired date and time. When done, press the blank **(EXIT)** button to return to the second Set-Ups and Download screen. Select **More Selections**, then

  * **Return to Main Screen** or press the blank **(EXIT)** button.

### 2.1.7 Entering Site and Filter Information (optional)

• From the Main menu, use the arrow keys until **Set-Ups and Download**
flashes. Press SELECT to enter the Set-ups and Download menu.  
- From the Set-Ups and Download menu, with * More Selections flashing, press SELECT to view the next screen of the menu.  
- From the next screen, use the arrow keys until * Enter Site and Filter Information flashes. Press SELECT.  
- The – USER INFO – message will be displayed. The data area of below this message is blank. The first character (T) of the second line has a flashing cursor on it.  
- Use the arrow (EDIT) buttons to cycle through the possible characters. To select the flashing character and move to the next character, press SELECT (NEXT). When all information has been entered, press the blank (EXIT) button to return to the Set-Ups and Download menu.

NOTE: The site and filter information may also be entered using the PQ200 computer software program. Refer to Section 4.0.

2.2 PERFORMANCE CHECKS

2.2.1 Checking for Leaks

Leak checks should be performed on a regular schedule; refer to Section 2.12 of EPA=s QA Handbook for the suggested frequency. To perform a leak check on the PQ200, follow the detailed instructions in section 3.2 of this manual.

CAUTION! Do not operate the system without a filter installed. Refer to Section 2.3.3 for instructions before proceeding with the leak check procedure.

2.2.2 Checking Temperature and Pressure

Check the readings of the ambient temperature and barometric pressure gauges against NIST-traceable devices (see sections 3.1.2 and 3.1.3 of this manual) each time the sampler is operated. Refer to 40 CFR 50 Appendix L for acceptable tolerances. If recalibration is necessary, follow the procedures in sections 3.1.2 and 3.1.3 of this manual.

2.2.3 Verifying Flow Rate (Field Calibration Check)

A verification of the sampler flow rate should be performed on a regular schedule; refer to Section 2.12 of EPA=s QA Handbook for the suggested frequency and acceptable tolerances. Section 3.1.1.2 of this manual provides instructions on how to verify the PQ200's flow rate.

CAUTION! Do not operate the system without a filter installed. Refer to Section 2.3.3 for instructions before proceeding with the leak check procedure.
2.2.4 Checking Sampler Operation

A successful field calibration check should be all that is necessary to indicate that the sampler is operating properly. If a more thorough verification of proper operation is desired, follow the instructions in section 2.3 of this manual to set up a dummy run of at least 10 to 15 minutes in length.

2.3 RUNNING THE PQ200

2.3.1 Run the Sampler from Midnight to Midnight

For most applications this is the appropriate method of operation. It complies with the EPA's requirement for Midnight to Midnight sampling. The run will commence at the next occurrence of midnight (00:00) and will stop sampling at midnight of the next day. Data from a previous run should already have been downloaded prior to use of this function. However, the instrument will alert the operator if the data has not been downloaded.

- From the Main menu, use the arrow keys until * Run Sampler from Midnight to Midnight flashes.
- Press SELECT. If the unit has been previously downloaded the following message will be displayed;

  Clearing Memory. Please Wait!

  and then;

  Time Event Triggered Run, Saving Data!

  and then;

  PQ200 Powering Down.

The PQ200 is then programmed to power itself on and begin sampling at midnight.

2.3.2 Run the Sampler with User Defined Start/Stop Times

If the procedure in Section 2.3.1 does not fit the intended sample cycle, the operator can program his/her own Start and Stop times as follows. As above, data from a previous run should be downloaded prior to use of this function. However, the instrument will alert the operator if the data has not been downloaded.

- From the Main menu, use the arrow keys until * Setups and Download flashes. Press SELECT.
• From the Set-Ups and Download menu, use the arrow keys until * Run w/ User Defined Start/Stop flashes. Press SELECT.
• The Set the sample Start Date and Time message will be displayed. The current selection will be flashing on the second line.
• Press SELECT (NEXT). The first value (Day of the Month) will stop flashing, indicating it can be edited.
• Use the arrow (EDIT) buttons to increase or decrease the selected value. When done press SELECT (NEXT).
• Continue to press the SELECT (NEXT) and arrow (EDIT) buttons in this fashion to enter the desired date and time.
• When done setting the start date and time, press the blank (EXIT) button to continue. If the unit has been previously downloaded, the following message will be displayed:

  Clearing Memory. Please Wait!

• The Set the sample STOP DATE and TIME message will be displayed. The current selection will be flashing on the second line.
• Use the same procedure to set the stop date and time. When done, press the blank (EXIT) button to return to the Set-Ups and Download screen. Select * More Selections, then * Return to Main Screen.

2.3.3 WINS and Filter Installation

• To open the WINS (Well Impactor Ninety-Six) and filter assembly inside the PQ200 sampler case, carefully rotate the handle counterclockwise using both hands. (CAUTION! Once the assembly has started to open, the weight of the two plates will tend to force the whole assembly open even further.) This will expose the WINS impactor and the filter cassette (see Figure 4).
• The filter cassette and WINS impactor should now be visible. If not, gently pull the filter cassette or WINS impactor from its respective upper housing. Take special precaution not to damage the filter in the filter cassette.
• Inspect the filter cassette and WINS impactor for damage, dirt, or oil. Clean, repair, or replace as necessary.
• Inspect the upper and lower sections of both the WINS impactor housing and filter housing for damage, dirt, or oil. Clean as necessary.
• Inspect the o-rings in the upper and lower housing of both the WINS impactor and filter holder. If the o-rings are cracked or broken, replace them.
• Place a filter cassette with an unused, undamaged 47mm filter into the filter holder. The filter surface should be facing upwards. Take care that the filter is not touched by any foreign object (fingers, rain, etc.). (Remember that filters for EPA PM$_{2.5}$ measurement must meet certain material and preparation specifications (see Appendix E).)
• If necessary, place a clean, properly prepared WINS impactor into the impactor housing. The well should be facing upwards.
• Close the assembly by slowly rotating the handle clockwise 3/4 of a turn. Watch the filter cassette and WINS impactor to ensure that they are seated properly and the assemblies close securely.
• If necessary, the compression between the upper and lower housings of the WINS assembly can be adjusted using the knurled ring.

NOTE: The PQ200 air sampling system should never be operated (or left unoperated for long periods) without a filter in the filter cassette. Operation without a filter in place allows particulate matter to enter the pump and mass flow sensor, which could reduce their operating life.

2.3.4 While the PQ200 is Running

• While the PQ200 air sampler is running, the display should appear similar to this:

```
ET000:05 TV:000.08M3 [DC In] □□□□□
Start:04jul15:00 Stop:05jul15:00 1997
Q(Vlpm):16.70 AVG:16.71 CV 0.16 04jul
749mmHg A28.6EC F27.8EC SP025cm 15:05
```

Pressing the select button will display a second screen:

```
Tmax:28.5 Tmin:28.2 Tavg:28.4 □□□□□
BPmax:750 BPmin:749 BPavg:749 1997
Q(Vlpm):16.70 AVG:16.71 CV 0.16 04jul
749mmHg A28.6EC F27.8EC SP025cm 15:05
```

Where:

- **ET**: elapsed time since the current run started
- **TV**: total volume sampled during the current run
- **[DC In]**: current power source from which the sampler is operating
- **Start**: the time and date (in military notation) the current sample started
- **Stop**: the time and date the current sample stopped (or is set to stop)
- **Q(Vlpm)**: the instantaneous flow rate (V for volumetric, M for mass) in liters per minute
- **AVG**: average flow rate, liters per minute
- **CV**: coefficient of variation of flow rate
- **mmHg**: instantaneous ambient barometric pressure, millimeters of mercury
- **A °C**: instantaneous ambient temperature in degrees Celsius
- **F °C**: instantaneous filter temperature in degrees Celsius
- **SP cm**: pressure drop across the filter, in cm H2O
- **Tmax**: the maximum ambient temperature measured during the run
- **Tmin**: the minimum ambient temperature measured during the run
- **Tavg**: the average ambient temperature
- **BPmax**: the maximum barometric pressure measured during the run
- **BPmin**: the minimum barometric pressure measured during the run
- **BPavg**: the average barometric pressure
- □□□□□: flag area -- flags which may appear are:
P indicates that a power failure has occurred
Q indicates that flow has varied more than +/- 5 percent
F indicates that a 5 degree filter overheat lasting
  more than 30 minutes has occurred
T indicates that a 24 hour sample ran less than 23 hours 50 minutes
M indicates memory overflow (max run time with 5 minute logger
  interval)

• During operation, the **SELECT (NEXT)** button provides alternate displays of minimum,
  maximum, and average ambient temperatures and barometric pressures or other run time
  data while the **ON/OFF** button will temporarily suspend the run. The run is not
  considered complete until the Sample Stop Date and Time have been attained.

### 2.3.5 Temporary Halt then Continue Sampling

According to EPA rules for PM$_{2.5}$ sampling, a 24-hour sample may be temporarily halted
for up to 10 minutes and still remain a legitimate sample. In the event that it may become
necessary to temporarily halt a sample in progress, a feature has been incorporated into the
PQ200 program that allows the sample run to be halted and later resumed.

To halt the sampler, simply press the **ON/OFF** button. The unit will jump to the Main
menu and will display the message;

```
Halted by Operator!
```

To continue with the current sample run;

• From the Main menu, use the arrow keys until **Setups and Download** flashes.
  Press **SELECT**.
• From the Set-Ups and Download menu, use the arrow keys until **Continue with
  Current Run** flashes. Press **SELECT**.

The sampler will then resume the run. However, observe that the elapsed time did not
change while the unit was halted. At the end of the 24 hour sample period, if elapsed time
is less than 23 hours 50 minutes, the **T** flag will be displayed indicating that the run did
not meet EPA requirements for run length.
2.3.6 Ending a Run

- When the PQ200 has completed its run, the display will appear similar to this:

```
SAMPLE RUN COMPLETED!  1997
05jul
751mmHg A28.1EC  F27.4 EC (MENU) 15:02
```

- The filter may now be removed. Following the same procedures as for installing a new filter.

2.4 DATA DOWNLOADING INSTRUCTIONS

2.4.1 PQ200 Job Controller Software for Windows

When the sampler has completed its run, the data may be downloaded from the memory of the PQ200. Be sure to download the most recent run before setting the sampler to start another run.

NOTE: To extract the run data from the PQ200 air sampler, a computer with the PQ200 Job Controller software loaded and a female-female serial cable are required. See Section 4.0 for supported computer hardware, installation instructions, a description of the software, and directions for use. Section 4.0 also contains greater detail about the other features of the PQ200 Job Controller software.

- Using a serial (9-pin) cable (female-female), connect the PQ200 sampler to a computer with the PQ200 Job Controller Program.
- Open the PQ200 Job Controller Program.
- Click on the “File” menu in the top menu bar, select new, and “New”. The new job screen will open. Enter the appropriate information as needed and click “Save”
- A “Save As” screen will open with a default file name of today’s date. This file name may be changed by operator if needed.
- Click “Save” and a download screen will open.
- Go to the top menu bar and click on “Download”. A new window will open. Click on “Begin”.
- When data stops scrolling the download is complete. Click on “Return”
- Data will now appear on the download sheet. At this point all data has been saved.
- If a print out is required click on “File” then “Print”. A list of printing options will appear, select the option needed.
2.4.2 Advanced Downloading

For those who wish to use standard communication software packages to retrieve data from the PQ200 sampler, the communication parameters are 9600 baud, 8 bit data word, no parity, 1 stop bit.

Open the communication software package and attach the 9 pin female-female serial cable to both the computer and the PQ200.

Select **Download Now** from the PQ200 Menu and the entire summary and logger download will be sent. To obtain just the summary data, use the software package to transmit the character string ?S to the PQ200 and the summary data will be downloaded to the computer. To obtain just the logger data, transmit the character string ?L.

2.5 MISCELLANEOUS ACTIVITIES

2.5.1 Cleaning the Inlet and Downtube

Periodic maintenance of the size selective inlet will maximize its performance and lifespan. Refer to Section 2.12 of EPA=s Quality Assurance Handbook for a recommended maintenance schedule and cleaning procedure. Since the PQ200 size selective inlet is identical to the design in 40 CFR 50 Appendix L, all assembly and cleaning instructions in Section 2.12 are appropriate.

Cleaning of the inlet and downtube may be performed in the field during daily filter retrieval and installation. Parts to be cleaned should be removed from the PQ200 sampler prior to cleaning to prevent the introduction of foreign materials or cleaning compounds into the impactor, impactor housing, filter housing, tubing, or the pump. Likewise, parts should be clean and dry before they are reinstalled.

2.5.2 Adding Oil to the Impactor

For proper operation of sampler for collection of PM$_{2.5}$, 1 mL of Dow Corning 704 diffusion oil and a 37 mm glass fiber filter must be present in the impactor well. The diffusion oil allows the impactor well to continuously collect particulate material for several 24-hour periods. The filter is necessary to prevent migration of the diffusion oil due to the force of the impactor jet, which would reduce the well=s effectiveness. This filter is not meant to be weighed.

Overloading of the impactor will alter its performance curve. Section 2.12 of EPA=s Quality Assurance Handbook contains a recommended schedule for cleaning the impactor well by replacing the filter and diffusion oil. Follow these guidelines for impactor cleaning, including any recommendations for where these procedures should be performed. The new filter should lie evenly and flat against the bottom of the impactor well and the layer of oil should just cover the filter. Be careful not to splash the oil or leave air pockets under the filter. When reassembling the well, ensure that the o-ring
between the upper ring and

impactor well is in good condition and maintains a tight fit. Replace if necessary. Wipe the exterior of the well with a clean Kimwipe. Transport the well to the sampler upright in a clean, protective container away from direct sunlight or extreme temperatures.
Section 3.0  
Calibration, Maintenance and Troubleshooting

3.1 CALIBRATION

3.1.1 Flow

3.1.1.1 Calibration

• From the Main menu, use the arrow keys until * Test & Calibration Menu flashes. Press SELECT to enter the Test Menu.
• From the Test menu, use the arrow keys until * Calibrate Flow flashes. Press SELECT to enter Flow Calibration mode.
• The next screen will display Target Q: 16.7 LPM The numeric value will be flashing. (The second and third lines display the current ambient temperature and barometric pressure, and the ambient temperature and barometric pressure for the current calibration.)
• Press SELECT (NEXT). The value preceding the decimal place will stop flashing, indicating it can be edited.
• Use the arrow buttons to increase or decrease the selected value. When done press SELECT (NEXT).
• The value following the decimal will then stop flashing. Use the arrow keys to select a new value. Press SELECT (NEXT). The calibration screen will then be displayed.
• Press (EXIT) to advance to the next screen.
• Press the ON/OFF (PUMP) button to turn on the pump. The Corrected Q: message will then be displayed. (The value for corrected Q that is shown is for reference only.)
• Use the arrow keys to adjust the pump speed to obtain the required flow rate on the calibration device. The arrow keys alone will fine adjust the speed. To coarse adjust, hold the SELECT key and the up or down arrow key simultaneously.
• When satisfied that the flow rate is sufficient and stable, press the blank (OK) button to lock the calibration into memory.

NOTE: Calibrations must be performed at 3 (15.0, 18.4 & 16.7) separate flow rate measurements, evenly spaced within the range of +/- 10 percent of the operational flow rate of 16.7 Lpm.
3.1.1.2 Verifying flow rate

- Remove the size selective inlet from the top of the downtube, leaving the downtube in place.
- Cap the downtube with a flow rate calibration instrument (a BGI deltaCal® is preferable) Devices which have a pulsatile component in their function are not suitable.
- From the Main menu, use the arrow keys until * Test & Calibration Menu flashes. Press SELECT to enter the Test Menu.
- From the Test menu, press the down arrow until * Verify Flow Calibration flashes. Press SELECT. The Check Flow Now! screen will be displayed and the sampler will then begin to pump air at the current selected flow rate.
- Use a deltaCal® (or other high accuracy calibration device) to monitor the flow rate at the inlet.

NOTE: When using automatic bubble meters, thermodynamic equilibrium must be considered when taking readings. For the most precise results, take 15 readings and ignore them. Then, take 10 readings and average them. If the flow rate is not within 2 percent of 16.67 Lpm (16.34 to 17.00 Lpm), check for leaks (see Leak Test in Section 3.2), correct, and recalibrate.

Also, it is recognized that bubble meters are not suitable for use under any but the most temperate of field conditions (10 to 20 degrees C, no direct sunlight). In conditions other than these, a venturi or orifice calibrator is recommended. Inasmuch as these devices rely on a precise and accurate measurement of differential pressure, it is vitally important to ensure that the pressure measuring device is suitable for the climatic conditions.

- When satisfied that the flow rate is as calibrated, press the ON/OFF key to exit this function.
- If any offset is observed, make note of the offset, add or subtract it from the previously observed Corrected Q value and recalibrate the flow rate accordingly.

3.1.1.3 Changing flow rate

- From the Main menu, use the arrow buttons until * Set-Ups and Download flashes. Press SELECT to enter the Setups and Download menu.
- From the Set-Ups menu, use the arrow buttons if necessary until * More Selections flashes. Press SELECT.
- Once again, use the arrow buttons until * More Selections flashes. Press SELECT.
- From the current menu, use the arrow buttons until * Set Flow Rate flashes. Press SELECT. The Volume? message will be displayed.
• The numeric value will be flashing. (The second and third lines display the current ambient temperature and barometric pressure, and the ambient temperature and barometric pressure for the current calibration.)
• Press **SELECT (NEXT)**. The value preceding the decimal place will stop flashing, indicating it can be edited.
• Use the arrow (**EDIT**) buttons to increase or decrease the selected value. When done press **SELECT (NEXT)**.
• The value following the decimal will then stop flashing. Again use the arrow keys to select a new value. Press **EXIT** to return to the Main menu.
• Return to Section 3.1.1.1 to repeat the procedure for additional flowrates.

### 3.1.2 Temperature Probes

*Note: Sections 3.1.2.1 and 3.1.2.2 are for earlier rev “D” PCBs.
See section 3.1.2.3 for later rev “T” PCBs*

#### 3.1.2.1 Equipment for rev “D” PCBs

The following apparatus is required to perform an accurate temperature calibration.

- 4&1/2 digit, precision, calibrated, volt meter (recommend B&K Precision model #2945)
- Total immersion, precision, NIST traceable thermometer
- Partial immersion, precision, NIST traceable thermometer
- A small slotted screwdriver.

#### 3.1.2.2 Procedure for rev “D” PCBs

NOTE: The filter temperature sensor board is located on the front panel and the ambient sensor board is located on a bracket that is attached to the ambient sensor gauge connector. Temperature should be calibrated indoors where temperature variations will be minimal and not abrupt.

- Hang the total immersion thermometer somewhere close to the Gill screen (preferably at about the same height) where it can be read without handling (handling will cause abrupt false readings).
- Set the PQ200 up to run for about 3 or 4 hours to attain equilibration of the sensors and the thermometer.
- When confident that the devices are equilibrated and stable, and while the unit is still running, carefully open the front panel of the PQ200 and locate JP4 on the main P.C. board.
- Set up the DVM (digital volt meter) for a range that will allow a reading of +2.389 VDC.
- Attach the negative (black) lead of the meter to the black wire connection of JP4.
- Touch the positive (red) lead to the test point labeled TP1 on the TEMP SENSOR board to be calibrated. If the voltage reads somewhere between +2.388 and +2.390, the span will not have to be set. A higher or lower reading will have to be adjusted. Use a small slotted screwdriver to adjust the "SPN" trimmer pot on the sensor board.
• Compare the displayed readings to that of the total immersion thermometer. Adjust the "OFST" trimmer pot until the readings agree +/- 0.1° Celsius.

NOTE: This procedure applies to both TEMP SENSOR boards.

3.1.2.3 Procedure for rev “T” PCBs

The temperature probe and a traceable thermometer are inserted into the copper or brass test cylinder. Check to ensure that both have stabilized before adjusting. After stabilization adjust the trimpot on the PCB to match probe to thermometer.

3.1.2.4 Verifying Temperature

The temperature probes can be removed from their housings and inserted into a bath of cold water along with a partial immersion thermometer. (Do not use ice! If a probe tip hits a piece of ice the reading will be colder than the water surrounding it and it will not be a good reading!) Then use a bath of hot water (maximum +52° C) to verify the high temperature reading.

3.1.3 Barometric Pressure

Note: Sections 3.1.3.1 and 3.1.3.2 are for earlier rev “D” PCBs, See section 3.1.3.3 for later rev “T” PCBs.

3.1.3.1 Equipment for rev “D” PCBs

The following apparatus is required to perform an accurate barometric pressure calibration.

• An accurate, NIST traceable, barometer
• An accurate, mercury, manometer with a range of 100 millimeters of mercury
• A small slotted screwdriver
• Rubber hose (proper size to secure to connections and fittings)
• A "T" adapter for the hose
• A pair of hemostats

3.1.3.2 Procedure for rev “D” PCBs

• At the Main screen, compare the PQ200 barometric reading to that of the NIST traceable barometer (If the barometer reads in inches (typical US readings) multiply by 25.4 to obtain millimeters). Adjust the "OFFSET" until they do agree.
• Remove the tubing that is attached to the P1 port of the barometric pressure sensor and attach a piece of hose to this port. At the end of the hose attach a "T" adapter and attach pieces of hose to the other two ends.
• Attach one of the hoses to the manometer negative pressure fitting.
• Apply light suction to the last hose until the manometer reads 100 mmHg. Clamp off the hose with the hemostats to prevent leakage.
• Observe the displayed value. It should be 100 mmHg less than the current, ambient, barometric pressure. If not, adjust the "GAIN". (After making a gain adjustment, the
"OFFSET" may require re-adjustment. Work back and forth a few times to obtain a 100mm span and an ambient reading that agrees with the NIST barometer.)

3.1.3.3 Procedure for rev “T” PCBs

- You will need a barometer that you know is accurate
- Using a small screwdriver turn the small screw on the BP trimpot. This screw will turn many times in either direction.
- When the BP on the display of the PQ 200 matches the barometer stop and wait 15-30 seconds to make sure it has settled.
- Repeat last step if needed.
- When both match then the BP is adjusted and you are finished.

3.1.4 Alternative (non-EPA/FRM) Calibrations (Mass Flow)

The EPA has mandated that air flow rate measurements and control be carried out on a volumetric basis rather than the previous constant mass flow rate to a (necessary) standard set of conditions (760 mmHg, 25° C). The reason for this change arises from acknowledgement of the fact that size selective devices which are based on the inertia of the aerosol being sampled require the sampling to be carried out at constant velocity. Since the dimensions of the size selective devices are fixed, this equates exactly with constant volume.

Given the wide range of diurnal and seasonal temperature and pressure variations, a fixed set of pressure and temperature values is now held to constitute poor and imprecise practice. The same is not true of setting up an instrument to values of local barometric pressure and temperature. In consideration of individuals, offshore jurisdictions, and alternative applications (high precision PM10 type sampling), mass flow calibration has been allowed.

3.2 LEAK TESTS (Serial Numbers 906 thru 1016 see Appendix P)

3.2.1 External Leak Test

On Nov. 1, 2000, EPA allowed the manual termination of a leak test in two minutes, if the decrease in pressure is less than 5cm of H2O. This change is incorporated into v. 1.91 firmware. Earlier versions will run a 10 minute leak test with an acceptable pressure drop of 10 cm. Of H2O.

- Insert an unused filter into the filter holder. (Do not use this filter for PM2.5 sampling following the leak test; however, it may be used for other flow calibration checks.)
- Remove the inlet from the downtube and place the flow audit adapter on the top of the downtube. Close the valve on the adapter to prevent air flow.
- From the Main menu, use the arrow keys until * Test Menu flashes. Press SELECT to enter the Test Menu.
• From the Test menu, press the down arrow until * Leak Test flashes. Press SELECT. The PQ200 LEAK TEST: In Progress! screen will be displayed. Ensure that the flow path is sealed (i.e., the valve on the flow audit adapter is closed) and press SELECT to begin evacuating the system.

• The PQ200 will automatically evaluate the performance of the system and report whether the system has passed or failed the leak test. This is a 2 minute test. The initial (locked) pressure is displayed on the left side of the screen. This will be a number in excess of 75 cm of water column. In order to pass the test, the actively displayed pressure (shown on the right side of the screen) must not drop by more than 5 cm of water column during the 2 minute timing interval.

• If the leak test is passed, the sampler is operating properly. If the leak test is failed, investigate and correct any malfunction:
  -- make sure the audit adapter is securely seated on the downtube and that the valve is completely closed
  -- make sure the WINS and Filter Assembly is securely closed
  -- make sure the filter cassette was securely closed and placed in the filter housing during the leak test
  -- visually inspect tubing for cracks or loose connections
  -- visually check o-rings in the flow audit adapter, WINS, and filter holder for cracks, deformation, or improper seating

If all of these items appear normal and the sampler continues to fail the leak check, contact the manufacturer.

• Turn off the sampler, remove the flow audit adapter and put the the inlet back on the downtube.

• Remove the filter. Discard the filter or retain it for future leak tests or flow calibration checks.

3.2.2 Internal Leak Test

The purpose of the internal leak test is to determine if there is bypass leakage in the filter cassette. This test is performed exactly as above with two changes. The flow audit adapter is NOT installed on the end of the down tube and an impermeable membrane is placed in the filter cassette below the filter. Use BGI part KT006, cassette fitted with membrane, or part RD006, pack of six membranes.

All test procedures and corrective actions are as in Section 3.2.1.

3.3 MAINTENANCE

The BGI PQ200 air sampling system is designed so that routine mechanical maintenance is virtually unnecessary. However, the pump should be rebuilt after between 8,000 and 9,000 hours of use.

To determine the "pump cumulative time," use the PQ200 software to obtain a download from the PQ200 sampler. Pump cumulative time is the number of actual service hours of the dual diaphragm pump and is shown when either printing or screen viewing a
download. When this time exceeds 8,000 hours the pump should be rebuilt. The rebuild is a relatively easy task and requires the replacement of diaphragms, valves, and bearings. A kit of parts is available from the factory and includes instructions. Service can also be performed by the factory.

3.4 TROUBLESHOOTING

Problem: Selecting Run the Sampler from Midnight to Midnight or Run Sampler w/ User Defined Start/Stop causes the unit to shutdown.
Answer: This indicates that the PQ200 is now powered off and ready to begin a sample run at the designated Start Date and Time. Be sure that the Start Date and Time are set correctly.

Problem: The flow rate does not seem to hold when additional pressure is added to the load (usually tested using a pinch clamp).
Answer: This is usually caused by a leak somewhere between the inlet and the calibration measuring device. Make sure that the hose adapter is firmly tightened in the inlet, check the inlet mechanism and filter holder. You can usually isolate the suspect device by starting at the inlet and working your way out. Run a leak test.

Problem: The instrument shuts down shortly after the start up screen indicates max. load exceeded.
Answer: First check the jet of the WINS impactor to ensure that it is not plugged with dirt. If it is clear, check the jets in the inlet to ensure that they are not plugged. If plugging is found, clear it and return to normal operation.

Problem: The instrument has been relocated and will not run properly, the ambient temperature indicator is excessively high.
Answer: The plug from the external temperature sensor has not been reconnected.

Problem: The backlighting on the display screen is inactive.
Answer: When running on battery power, the backlight function automatically deactivates to conserve power. It can be temporarily restored, for viewing, by pressing the righthand button in the array (the red LIGHT button).

Problem: The instrument is "locked up." Pressing buttons has no effect. The screen looks wrong.
Answer: Open the front panel and disconnect the battery and power cables from the main board. The terminals are labeled JP3 and JP4. Reconnect and the instrument will reboot.

Problem: Ambient or filter temperatures displayed are obviously incorrect by 10-30° C.
Answer: This is indicative of a loose connection. Unplug and reconnect at the thermistor, temp. board and main board. This is best accomplished by tracing the wire from the thermistor to the temp board to the main board.

Problem: The parts of the filter holder/WINS mechanism which slide on the four stainless steel rods have become "sticky".
Answer: Although the nylon bushings are self lubricating, with long use the rods can
become dirty. To clean, wet a cotton rag with a light, thin lubricating oil and use it to wipe the four stainless steel rods clean of all deposits. Then, with a clean cloth, wipe off as much of the oil as possible. **Under no circumstances should any spray lubricants be utilized.**

Flags that may appear if an error occurs are:

- **P** indicates that an A/C power failure has occurred
- **Q** indicates that flow has varied more than +/- 5 percent
- **F** indicates that a 5 degree filter overheat lasting more than 30 minutes has occurred
- **T** indicates that a 24 hour sample ran less than 23 hours 50 minutes
- **M** indicates memory overflow (max run time with 5 minute logger interval)
- **G** A/C power restored, all conditions are good
Section 4.0
PQ200 Job Controller CD Software  Version 2.0
(For Version 1.52, 16-bit Windows version see appendix L)

4.1 SUPPORTED HARDWARE

The PQ200 Job Controller software program installs into any IBM PC or compatible computer running Windows (95, 98 and 2000). The computer must have:

- CD-ROM drive
- COM1 or COM2, RS232 serial port for downloading
- Hard drive with at least 5MB free disk space

For printouts, any printer attached to or redirected from LPT1 will work.

4.2 INSTALLATION (Windows 95, 98 and 2000)

To install the software onto a C: drive (typical installation):

- Insert PQ200 v2.0 CD disk into the CD ROM drive of the PC.
- Open My Computer, Double Click on your CD ROM Icon.
- Double Click on the Setup Icon.
- Unless otherwise instructed, the installation utility will create a subdirectory called "ProgramFiles\PQ200v2.0" on the C: drive and copy all files into it. In addition, a program group called PQ200 v2.0 will be created, accessible through the "Start" button or by double clicking on the pq200 icon which will automatically be created on your desktop.
- Continue to follow the onscreen instructions for installing the PQ200v2.0 Job Controller software.
- When finished, click "Finish" to complete the installation. The setup program will then exit to Windows.
- Note the new folder and icons. Run the PQ200v2.0 Job Controller software by double-clicking on the PQ200v2.0 icon on the desktop or by clicking the Start@ button, selecting "Programs", Selecting the "PQ200v2.0" program group, Selecting the "PQ200v2.0" program.

4.3 PROGRAM OVERVIEW

The PQ200 Job Controller software is a menu-driven program that utilizes the serial communications port of the PC to download sample data from the PQ200 air sampler and to provide data logging, data manipulation, concentration calculation, and sample validation capabilities.
PQ200 Job Controller software allows the user to communicate with the PQ200 air sampler and to download run data from the PQ200 into a personal computer. The data may then at a later time be appended with the measured filter weights for concentration calculation, printed and stored for later use.

The Program has Three folders in menu bar: File, Options and Remote Control.

- **File**
  - **New**: creates a new job file.
  - **Open**: opens an existing job file.
  - **User Prefs**: allows the user to preset the default information that the PQ200 Job Controller software uses when creating a new job file, alleviating Tedious repetition

- **Options**: displays toolbar if desired.

- **Remote Control**: allows the user to program the PQ200 air sampler instead of using the Six-button interface (as shown in Section 1.1.8) on the sampler itself.

### 4.4 USING THE SOFTWARE

#### 4.4.1 To Start a Job File

- Click on **File**.
- Click on **New**.
- Enter Generic Job Information. (Click save)
- You may now change the file if desired. (Click save)
- A blank summary sheet will be displayed.
- Go to the menu bar and click on **DOWNLOAD**, make sure the PQ200 sampler is on and connected to the computer at this time. (Click Begin)
- When download is complete. (Click Return)

#### 4.4.2 MENU BAR (with job file open)

- **File**
  - **New**: Creates a new job file.
  - **Open**: Opens an existing job file.
  - **Close**: Closes job file.
  - **Save**: Saves any changes that have been made.
  - **Save as**: Saves file (in location desired (Example, A:\ - B:\, My Documents etc.)
    - (change file name)
    - (change file extension)
  - **Export**: Will save job file to any folder in .xls or .txt type.
  - **Print**: Prints job file data
    - Summary
    - Hourly Logger
    - 5 Minute Logger or (User selectable)
4.4.3 EDIT MENU

- **Copy to Clipboard:** Allows you to copy spreadsheet to another program (Excel, Lotus, etc.)

4.4.4 CHARTS

- **Temp:** Displays temperature graph only.
- **Overheat:** Displays overheat graph only.
- **Static Pressure:** Displays static pressure graph only.
- **Update Spreadsheet:** button applies the three changed graphs if you have changed them into the Summary spreadsheet.
- **Return to Spreadsheet:** returns user to summary sheet.

NOTE: Just as with the spreadsheets, the graphs can be activated by double-clicking the open window. By activating a graph, virtually any feature of the graph can be manipulated: scale, color scheme, data labels, etc. However the graphs have been optimized by the software and should not require changes.

4.4.5 Remote Control Button

The remote control button allows a variety of data to be uploaded to the PQ200 from a notebook computer. From this window you may:

- Set clock time
- Set start time
- Set start date
- Enter filter information
- Set date
- Set stop time
- Set flow rate
- Set stop date
- Set logger interval
- Enter user information

This function is useful because this information can be set in the computer in a comfortable location prior to uploading. The PQ200 may also be controlled from this screen.

4.4.6 OPTIONS

- **Toolbar:** Enables or disables toolbar menu.

4.4.7 DOWNLOAD: Downloads run from sampler.
4.4.8 WINDOW
- **Cascade**: views multiple runs in line.
- **Tile**: Views multiple runs top and bottom.

4.4.9 BOTTOM MENU BAR
- **Summary**: Displays summary sheet.
- **Hourly**: Displays hourly logger sheet.
- **Logger**: Displays 5-minute logger (User selectable)

4.5 USER ID
User 1 and User 2 fields are designated by the EPA to be controlled by the person in the field operating the PQ 200 instrument and are to be held in the memory by the instrument. The software can be used to edit this field, but changes are not saved when job file is saved.

4.5.1 NOTES 1 & NOTES 2
To provide the software user additional fields that can be edited and saved, the Field Notes 1 and Notes 2 have been added to version 2.0 of the PQ200 control software. These values can be edited and saved.

4.6 Summary Sheet

Once a job file has been created and data have been downloaded from a sampler, the Summary folder displays the basic information about the sample run as a convenience to the operator.

The "PQ200 Air Sampling System" box includes the sampler version number, the sampler serial number, and the total pump hours (refer to Section 3.3, Maintenance).

The "Timer Info" box displays the sample run start and stop time and the calculated elapsed time.

The "Filter Overheat, C" box displays the differential achieved between the filter temperature and the ambient temperature in degrees Celsius, and also the time at which this maximum differential occurred, even if it occurred after the completion of the sampling period.

The "Flowrate Info in Lpm" box shows the target flow, the average flow achieved during the sample run, the coefficient of variation of the measured flow rates, and the total volume of air sampled in actual cubic meters.

The "Pressure Info, mmHg" box contains the minimum, maximum, and average barometric pressure recorded during the sample run.

The "Temperature Info, C" box contains the, minimum, maximum and average ambient temperature measured during the sample run.
The "QCv" Box displays the Coefficient of Variance of the average flow rate. The "Flags" box displays any flags that may have been triggered during the sample run (i.e., power failure, flow rate variation beyond +/- 5 percent, filter overheat of more than 5 degrees C lasting more than 30 minutes, or that a 24 sample actually ran for less than 23 hours 50 minutes). A flag not triggered will read as OK.

The "Filter Info" box includes any filter information entered during the creation of the job file. This information may be changed in the text fields of this box. The weight gain is automatically computed if the initial and final weights are entered.

The "PM2.5 Concentration" box shows the concentration of PM2.5 in micrograms per actual cubic meter, computed as the weight gain in the "Filter Info" box divided by the total air volume sampled in the "Flowrate Info in Lpm" box.

The "Date downloaded" box gives information as to when the download of information was executed.
Section 5.0
Limited Warranty

BGI Incorporated warrants equipment of its manufacture and bearing its nameplate to be free from defects in workmanship and material. We make no warranty, express or implied, except as set forth herein.

BGI's liability under this warranty extends for a period of one (1) year from the date of BGI's shipment. It is expressly limited to repairing or replacing, at the factory, during this period and at BGI's option, any device or part which shall within one year of delivery to the original purchaser, be returned to the factory, transportation prepaid and which on examination shall in fact be proved defective. BGI assumes no liability for consequential damages of any kind. The purchaser, by acceptance of this equipment, shall assume all liability for consequences of its misuse by the purchaser, its employees or others. This warranty will be void if the equipment is not handled, installed, or operated in accordance with our instructions. If damage occurs during transportation to the purchaser, BGI must be notified immediately upon arrival of the equipment. The Equipment will be returned via collect shipment.

A defective part in the meaning of this warranty shall not, when such part is capable of being repaired or replaced, constitute a reason for considering the complete equipment defective. Acknowledgment and approval must be received from BGI prior to returning parts or equipment for credit.

BGI Incorporated makes engineering changes and improvements, from time to time, on instruments of its manufacture. We are under no obligation to retrofit these improvements and/or changes into instruments which have already been purchased.

No representative of ours has the authority to change or modify this warranty in any respect.
Appendix A
Figures

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Figure 10a. Exploded view of components installed in back of instrument
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Figure 11b. Cables
Figure 11c. Cables
Figure 11d Cables
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Figure 1. Schematic View of System
Figure 2. Drawing of Assembled PQ 200
NOTE: ALTERNATE FUNCTIONS OF BUTTONS WILL APPEAR IN DISPLAY ABOVE BUTTON

Figure 3. Control Panel
Figure 4. Drawing of WINS and Filter Holder Open
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Figure 6. Exploded View of WINS and Filter Holder Assembly
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*(OBSOLETE, PLEASE VIEW PAGE 128 FOR CURRENT CONFIGURATION)*
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Figure 10b. Exploded View of 10 Micron Inlet
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Figure 11b Cables
Figure 11c Cables

P/N A1680
AMBIENT SENSOR CABLE (OBsolete)

P/N A1681 BAROMETRIC PRESSURE CABLE (OBsolete)
P/N A1732 STATIC PRESSURE CABLE (OBsolete)
P/N A1733 FILTER TEMPERATURE CABLE (OBsolete)

P/N A1685
AMBIENT PROBE CABLE (OBsolete)
Figure 11d Cables
Figure 11e Cables

P/N A2336
BACKLIGHT TO SWITCHBOARD
(REV "T" BOARD)

P/N A2340
DRIVER BOARD CABLE
(REV "T" BOARD)

P/N 2366
RESISTOR CABLE
(REV "T" BOARD)

P/N 2338
AMBIENT ADAPTER CABLE
(REV "T" BOARD)
Appendix B
Parts List
<table>
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<th>DET. #</th>
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<th>FIG.</th>
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<td>Backlight to Switchboard Cable</td>
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Appendix C
Dimensions and Weights
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<tr>
<td>Main case</td>
<td>48 lbs</td>
<td>(21.8 kg)</td>
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<tr>
<td>Main case auditor</td>
<td>40 lbs</td>
<td>(18.1 kg)</td>
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<tr>
<td>Inlet</td>
<td>5 lbs</td>
<td>(2.3 kg)</td>
</tr>
<tr>
<td>Legs</td>
<td>8 lbs</td>
<td>(3.6 kg)</td>
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<tr>
<td>12&quot; extension tube</td>
<td>0.5 lbs</td>
<td>(1.1 kg)</td>
</tr>
<tr>
<td>Complete</td>
<td>61.5 lbs</td>
<td>(27.9 kg)</td>
</tr>
<tr>
<td>Auditor complete</td>
<td>56.5 lbs</td>
<td>(25.6 kg)</td>
</tr>
<tr>
<td>Dimensions</td>
<td>16 x 19 x 18 inches</td>
<td>(41.1 x 48 x 47 cm)</td>
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<tr>
<td>Height of inlet above ground</td>
<td>6.56 ft</td>
<td>(2 m)</td>
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Appendix D
PQ200 Sampler Menu Tree
Status Screen

Main Menu

+-------Review Last Run Data and Conditions
+-------Run Sampler from Midnight to Midnight
+-------Test and Calibration Menu
  +-------Leak Test
  +-------Select and Calibrate a Flow Rate
  +-------Verify Flow Calibration
+-------Set-Ups and Download
  +-------Run Sampler w/User Defined Start/Stop
  +-------Continue with Current Run
  +-------Download Now
  +-------Set Date and Time
  +-------Enter Site and Filter Information
  +-------Reset
  +-------Select a Flow Rate
  +-------Set Logger Interval
  +-------Display Immed. Sensor Data
Appendix E
Filters and Weighing Procedure
Filters


In brief, the filter should have the following characteristics:

**Size:** Circular, 46.2 mm diameter ± 0.25 mm. Medium. Polytetrafluoroethylene (PTFE Teflon), with integral support ring.

**Support ring:** Polymethylpentene (PMP) or equivalent inert material, 0.38 ± 0.04 mm thick, outer diameter 46.2 mm ∀ 0.25 mm, and a width of 3.68 mm (+0.00 mm, -0.51mm).

**Pore size:** 2μm as measured by ASTM F316.94.

**Filter thickness:** 30 to 50 μm.

**Maximum pressure drop (clean filter):** 30 cm H2O column @ 16.67 Lpm clean air flow.

**Maximum moisture pickup:** Not more than 10 μg weight increase after 24-hour exposure to air of 40 percent relative humidity, relative to weight after 24-hour exposure to air of 35 percent relative humidity.

**Collection efficiency:** Greater than 99.7 percent, as measured by the DOP test (ASTM D 2986-91) with 0.3 μm particles at the sampler’s operating face velocity.

**Alkalinity:** Less than 25 microequivalents/gram of filter, as measured by the guidance given in reference 2 in section 13.0 of this appendix.

One current source of these filters is Pallflex Products Corp. Of Putnam, CT, USA; Type TK15-S3M.

Filter Handling

For more complete recommendations on filter handling for PM2.5, refer to Section 2.12 of the QA Handbook. In general, filters should be handled delicately using non-serrated forceps, never using fingers (even in laboratory gloves) to touch any part of the filter. When not in use, filters should be stored in protective cartons in conditions of moderated temperature and relative humidity. Filters should from the always be transported from the laboratory to the sampling location in the filter cassette, which should be protected within a metal canister (see Section 2.12 of the QA Handbook for further description). These canisters may be ordered directly from BGI.
Filter Cassette Handling

The filter cassettes provided for use with the PQ200 are as specified in 40 CFR 50 Appendix L, Figures L-27 through L-29. The upper and lower halves of the cassette have been designed with an interference fit to prevent the cassette from coming apart easily, therefore some care must be exercised when opening and closing the cassette, especially when a filter is inside. Always maintain the cassette in an upright position, especially if the filter has already been used to collect particles. To open, place a clean, flat blade device (knife edge, screwdriver blade) against the outside edge of the cassette between the upper and lower halves and gently wedge them apart. DO NOT TWIST THEM APART, this could tear the filter. Set the upper half of the cassette aside.

Handle the filter with non-serrated forceps only.

To close the cassette, place it the upper and lower halves together and gently press them together, being careful not to twist them. When closed, the two halves should seat snugly together with the backing screen securely held in place between the two halves.

Filter Weighing

Because of the small amounts of material collected, an extremely high quality microbalance and carefully, temperature and humidity controlled filter weighing room are required. For complete EPA recommended details, consult 40 CFR 50 Appendix L8.0, Federal Register, July 18, 1997, and Section 2.12 of EPA's Quality Assurance Handbook.

The analytical balance used to weigh filters must be suitable for weighing the type and size of filters specified and have a readability of ±1μg. The balance should be calibrated as specified by the manufacturer at installation and should be recalibrated immediately prior to each weighing session.
Appendix F
Dip Switch Functions
There is an 8 pole dip switch located on the main PCB (printed circuit board) of the PQ200, in Figure 9 of this manual. It is located in the upper right hand corner of the illustration, directly below the JP12LCD socket. When standing in front of the PQ200, with the front panel swung forward for inspection, the dip switch will be found to the lower left, on the board.

**WARNING! DO NOT TURN ON SWITCHES LABELLED F.D. (Factory Diagnostic) IN FIGURE 12. FIRMWARE MAY BECOME CORRUPTED AND THE UNIT MAY NO LONGER OPERATE.**

In general, these switches will seldom, if ever, be utilized by an operator of the PQ200. However, in the event that use is required, their application is explained.

In order to utilize a switch, first shut the instrument completely off. Then move the switch to the on position and turn the unit power on and the requisite function will then be performed. The switch may be returned to the off position with power on or off.

**Switch No. 1**  Factory diagnostic use ONLY

**Switch No. 2**  Reset century. The PQ200 will automatically change to the year 2000. However, once changed to the next millennium, it will require the activation of this switch to permit resetting back to 19XX.

**Switch No. 3**  Half time running. Setting switch number 3 to "on" will cause the PQ200 to run for one minute and rest for one minute. The total elapsed hours will be correct and the accumulated volume will be one half of that expected over the elapsed time period. There are two potential reasons for utilizing this feature. When operating from battery power, it might be desirable to extend the running time for two days. When operating from battery or line power in an area of extremely heavy concentrations, it could be desirable to operate at half time to preclude premature filter loading and shut down. However, it should be noted that a sample gathered by this half-time technique may not be equivalent to the concentration discerned by full time operation.

**Switch No. 4**  Factory diagnostic use ONLY

**Switch No. 5**  Clear user information and default logger interval to five minutes. This function is only utilized when a computer is not available for connection to the PQ200. When a computer is available, it is more convenient to bring up the remote control function on the computer screen and re-set from there. If this procedure is followed, the switch need not be activated.

**Switch No. 6**  Factory diagnostic use ONLY

**Switch No. 7**  Factory diagnostic use ONLY
**Switch No. 8**  Fan constant run. In the normal configuration, the filter cooling fan only runs when a developing overheat is detected. The fan switches off when cooling air is not required. This function conserves battery power and reduces the ingress of dust to the inside surfaces of the case. However, if it is desired, in areas where volatile particulates predominate, to maintain an absolute minimum overheat, full time fan operation should be considered.
Figure 12. PQ 200 Dip Switch
Appendix G
Use of the PQ200 as a PM$_{10}$ Designated Reference Sampler
The PQ200 is an EPA designated reference sampler for PM$_{2.5}$ sampling. If it is desired to utilize it for PM$_{10}$ sampling, one change must be made to its overall configuration:

1. The WINS impactor must NOT be utilized. A PM$_{10}$ adaptor replaces this component. Externally, it is the exact configuration of the WINS impactor. Internally it is merely a continuation of the 12-inch long straight tube connecting the inlet to the instrument and engenders no particle loss prior to the filter. These two assemblies are comparatively shown (in sectioned view) in Figures G-2 and G-3. Either assembly is readily removed for cleaning, and can be installed without the use of tools. The PM$_{10}$ adaptor in the open position is depicted in Figure G-4 (corresponds to Figure 5).

The exploded view of the PM$_{10}$ adaptor and filter holder is shown in Figure G-5, which corresponds to Figure 6. The parts list covering Figure 6 when being viewed as Figure G-5 is altered accordingly:

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<th>Figure</th>
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<td>6</td>
<td>A1553</td>
<td>Impactor cup upper section</td>
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<td>5</td>
<td>1</td>
<td>6</td>
<td>B1552</td>
<td>Impactor cup lower section</td>
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<td>6</td>
<td>1</td>
<td>6</td>
<td>B1594</td>
<td>Lower impactor housing</td>
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<table>
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<th>ITEMS to be ADDED to PQ200/PM10 PARTS LIST</th>
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Figure G1. Explode View of Inlet

(January 2000: OBSOLETE. Parts subject to stock on hand. See Figure 10b)
Figure G2. Sectional View of WINS Impactor [NOT USED FOR PM10]
Figure G3. Sectional View of PM10 Adapter
Figure G4. PM10 Adapter and Filter Holder, Open
Figure G5. PM10 Adapter and Filter Holder
Deletions from Instruction Manual for PM_{10} Sampling:

Section 2.1.3. WINS Impactor Assembly -- is to be ignored when using PQ200 for PM_{10} sampling

Section 2.3.3. Ignore remarks pertaining to the WINS cup.

In all other respects, the PQ200 when used as a PM10 sampler functions in the exact same manner as when the instrument is used as a PM2.5 sampler. No changes are required to the firmware, setup or downloading procedures.
Appendix H
Audit Version -- PQ200A
Introduction

The audit version of the PQ200 (PQ200A) is identical to the standard version of the PQ200 in both form and function. However, certain details of the instrument have been enhanced to facilitate its application in the AUDIT ROLE.

- Three traveling cases have been provided for accessories.
- A lifting eye has been added to the top of the main instrument housing to facilitate hoisting by rope or cable.
- The shroud welded to the back of the main housing, which protects the fan and power supply from the weather is now removable. In the detached condition, space is provided for it within one the travel cases.

Travel Cases

Introduction

Three travel cases have been introduced to facilitate rapid and convenient deployment of the PQ200A by vehicular transport. Although, the construction of the cases is made up of compartments and readily apparent as to function, the following drawings further serve to enhance their application.

Travel Case No. 1

Travel Case No. 1 is solely intended for the transport of the legs, as shown in Figure H1. Because of the simple arrangement of the case there is ample room for other small equipment items which the field investigator may elect to carry.

Travel Case No. 2

Travel Case No. 2 is specifically for:
- PM$_{10}$ for PM$_{2.5}$ sampling inlet
- Twelve inch down tube
- 6 filter cassette transport tins
- 3 WINS impactor stage with transport tins
- One bottle of oil for WINS cup
Details of the fitting are shown in Figure H2.

Travel Case No. 3

Travel Case No. 3 is specifically fitted for:
- Gill screen
- Power supply/battery charger
- Battery complete with battery holder
- Weather shroud
Details of the fitting are shown in Figure H3.
Lifting Eye

A lifting eye has been provided on the top of the main instrument compartment to facilitate raising the main instrument housing by rope or cable, in those applications when no other means is available. NOTE: The eye is intended for lifting the main case only. All accessories should be removed before assembly. Remove: Inlet, down tube, Gill screen, legs, power supply battery complete with holder and shroud. If a guide rope is required during the lifting procedure, it may be attached to one of the side handles.

Deployment

Upon arrival of the main instrument housing and three accessory cases at the sampling site or platform, the following procedure should be followed.

1. Attach the legs to the main housing and secure the legs to the ground or platform surface as prescribed for the standard unit.

2. Remove the weather shroud from the Travel Case No. 3 and install as shown in Figure H4. There is only one possible method of installation.

3. Open the front door and remove the two thumb nuts securing the instrument panel at the top. Swing the panel forward on its hinge to expose the internal components. Lift the battery and holder from Travel Case No. 3 and install it in the compartment (see Figure 10). Remove the wing nuts from the securing studs before installing.

NOTE: Be careful during this phase to insure that the studs do not come in contact with the PCB as physical damage may occur.

Secure the battery, in its holder, to the main housing by threading the two wing nuts provided onto the studs protruding through the bottom of the main housing. Inside the main compartment, connect the COLOR CODED wires to the COLOR CODED terminals on the battery (red on red, black on black). Close the front panel and reinstall the two knurled screws. The power supply/battery charger and Gill screen are mounted in exactly the same manner as for the standard PQ200, discussed elsewhere in this manual. (See Figure 10).

Safety Concerns

The following points of safety must be strictly observed to avoid personal injury.

In deploying a PQ200A to a site which is at ground level, (platform or field) there are no additional safety concerns except as previously discussed for the PQ200 (Section 1.3).

In deploying the PQ200A to an elevated surface where access is by stairs or elevator, there are no additional safety concerns except as previously discussed for the PQ200. (Section 1.3).
Neither the PQ200A nor its accessories should be carried up a ladder. It is unsafe to use only one hand while climbing a ladder. Climbing a ladder with equipment strapped to one's body is hazardous and is to be avoided.

The PQ200A and its travel cases may be hoisted to a rooftop or elevated platform by rope or cable utilizing proper safety procedures. Inexperienced personnel should not attempt such a procedure. Correct procedure involves hoisting apparatus (such as a secure "A": frame at roof side), ground personnel on a guideline and two control personnel away from the lifting area, safety cones or barriers. Rooftop personnel of sufficient strength and experience for the task. Failure to follow good safety practices can result in serious injury or death.

The best modern practice for elevating small loads to a one or two story height is by truck mounted lifting bucket.
Figure H1. Travel Case for Legs (No. 1)
Figure H2. Travel Case for Inlet and Accessories (No. 2)
Figure H3. Travel Case for Gill Screen and Accessories (No. 3)
Figure H4. Schematic of Back of Main Housing
Appendix I
External Datalogger

Effective Oct. 10, 2003 - Datatrans Obsolete

This section is retained for reference purposes only.

Please refer to the BGI Website at:

www.bgiusa.com/aam/pocketpc.pdf

for our newer downloading equipment
Introduction

The BGI Datatrans is a "Download Data Collector" designed to extract the "Data Download" from a PQ200 at the end of its sample period and store it until it can be uploaded to a personal computer, running BGI Job Controller Software, for more permanent storage. This device facilitates rapid "Filter and Data" collection in the field while providing trouble free data collection at extended temperature range (-30°C to +60°C). The Datatrans was designed specifically to address the problem of field data collection at these extended temperatures where notebook, laptop or palmtop computers are not designed to operate below 0°C.

To Use the Datatrans

1.) Turn the unit on with the power switch on the front panel. See Figure I 1.
2.) The following light sequence should be observed: red, yellow then green.
3.) The green light will remain on. (This indicates a ready condition.) If the yellow light is also illuminated, one or more runs are currently stored in the Datatrans and it should either be downloaded or erased as described below.

NOTE: The Datatrans should be fitted with a fresh, new 9-Volt battery prior to each field use.

Downloading the PQ200

1.) Place the connection switch, located on the front panel, in the "Samp" (sampler) position.
2.) Insure the PQ200 Sampler is powered on. Downloading may be accomplished anytime the PQ200 is powered on and at any screen during the Post Sample period. However, the sampler must not be sampling (pumping air)
3.) Plug the Datatrans into the RS232 port on the front panel of the PQ200.
4.) Press and release the pushbutton on the front of the Datatrans.
5.) The red light will turn on, the green light will turn off and if communication is successful the yellow light will flash for each line of data received.
6.) When the download is complete, the yellow light will remain on, the red light will stop flashing and turn off and the green light will turn on.
7.) Repeat the above steps for each sample run that is to be collected (multiple samplers) realizing that the "Runs" are stacked up using First In, Last Out methodology.

NOTE: You must remember how many runs that you've stored in the Datatrans. 20 is the maximum. If you try to store 21 runs, the Datatrans will not accept the 21st run. You will notice that it takes a minute or two to download a typical run. When the memory is full, the Datatrans will flash the red light
briefly and will return to its idle state. This is the only indication of Full Memory.

8.) It is now safe to turn the unit off.

NOTE: The data will be retained in the Datatrans, even if the 9 volt battery fails, until it has been uploaded into a computer and the unit is erased using the data deletion procedure described below.

To Upload to the Computer

1.) Plug the Datatrans into the RS232 serial port of the computer.
2.) Turn on the power switch and observe the following light sequence: red, yellow then green. (Green light indicates unit is ready and yellow on indicates Runs are stored). Red light turns off.
3.) Place the connection switch, located on the front panel, in the (Comp) computer position.
4.) Insure the computer is running BGI PQ200 Job Controller Software (See Section 4.0) and is ready to receive data as if it were attached directly to the sampler. Point and click on BEGIN JOB and follow the instructions given on the screen by the software. Enter any applicable data to the ARun@ such as initial filter weight, user data etc.
5.) Point and click on DOWNLOAD.
6.) Point and click on BEGIN.
7.) Green light will turn off, Red Light will turn on and ARun Data@ will be stored in the Datatrans.
8.) When "END" or "MEM END" is detected on the computer screen and the Green light is lighted on the Datatrans, the "Run" has been transferred.
9.) If multiple runs have been stored in the Datatrans, the last run captured is the current resident run. While a run is resident, the Datatrans retains the characteristics of the sampler type it was captured from. To step the Datatrans to the next run, you must first download the current run and then press the pushbutton. Repeat for multiple runs pushing the Datatrans button after each sample is uploaded. You must "Begin" a new run for each sample run to be uploaded to the computer. When all runs have been uploaded, the yellow light will remain off.
10.) To use the device again for new runs from the field you must erase it as described below.
To Recycle Sample Runs

If after all runs have been downloaded, a lost file, mistake or a problem is discovered and you must download a run again, the Datatrans allows the runs to be recycled as long as it has not yet been erased as described in the Erasure Procedure below.

AFTER GREEN LIGHT GOES OFF, INDICATING ALL RUNS HAVE BEEN DOWNLOADED, PRESSING THE BUTTON WILL RETRIEVE THE SERIES OF RUNS AND REMAIN UNTIL DELETED.

THIS IS HELPFUL IF YOU ARE UNSURE OF AN UPLOADED RUN.

Erasure Procedure

TO ERASE THE DATATRANS AFTER ALL RUNS HAVE BEEN TRANSFERRED:

1.) Turn the power switch off.
2.) Hold down the pushbutton.
3.) While holding the pushbutton down, turn the power switch On.
4.) The Red light will turn on, now release the button.
5.) When erased, all three lights will flash 2 times in unison and 1 time in series.
6.) Unit is now cleared and ready for new downloads.

Maintenance

The Datatrans requires no maintenance except for replacement of the 9-Volt battery. A spare, fresh battery should always be taken to the field.

Troubleshooting

Most of the problems that occur with the device can be traced to a bad 9-Volt battery.
It is recommended that the user purchase Duracell Alkaline Batteries which come packaged with a cell tester. Follow the instructions given on the box or cell and determine if the cell requires replacement or not. It is highly recommended that the user install a brand new, fresh cell before each field use (If you forget to turn the unit off for some reason you will have about 18 full hours of battery use).
Figure I1  Datatrans Datalogger
Appendix J
Solar Panel Power Supply
Introduction

The SP32, solar panel kit is intended to permit the PQ200 or PQ200A to run for extended or, indefinite periods of time depending on the available sunlight (solar radiation) at a given location. The solar panel may only be used as the sole source of power for a U.S. EPA-designated instrument if sampling is not being performed every day (i.e., continuously).

Because of the low current draw of the instruments they are highly amenable to this technique. Given sufficient sunlight, they may be deployed in locations where no line power is available. The basic components of the solar kit are:

1. 32-watt solar panel with mounting brackets.
2. Built in voltage regulator.
3. 100+ amp hour (approx.) ballast battery. (User supplied).

The purpose of the external high capacity battery is to provide back up power on days when there is little or no sunlight. The recommended battery capacity will provide 7-8 days run time with little or no sunlight. It will recharge, almost completely, after one days use during a day of full sunlight while the instrument is non-operational. Complete recharging of a fully depleted system would require 10 days.

This type of system should not be considered for latitudes higher than 45-50°N or S, or particularly overcast regions.

Operational Considerations

While the use of solar power is highly desirable from the standard of utilizing a renewable energy source and being freed from the need to locate a source of power in difficult situations, there are some preliminary considerations. Clearly, the PQ200 is not operating directly from the received energy of the sun but rather from a battery, which has been charged by that energy. If a PQ200 were to be run continuously from the internal and (recommended) external battery, 7 to 8 days run time could be achieved. However, considering only EPA designated sampling conditions, i.e. sampling from midnight to midnight, then it would be possible to run on alternate days yielding one day to replenish the energy used. Given that this is accomplished in full sunlight while the instrument is running, the extra day recovery reduces the need for full sunlight by 50%. If the popular, one in 3 days, or one is 6 days schedule is utilized, the probability of complete replenishment is greatly increased.

Experience has shown that on cloudless days in the Boston area, 5 Kwh/M² insolation will replenish the energy used by a PQ200. In order to determine the suitability of the PQ200 solar system for a given location, Appendix A of the cited reference gives the
insolation index for 54 locations in the US and other places throughout the world. Given a one in 6 day sampling schedule; only Fairbanks Alaska is unsuitable for solar application in the months of November, December and January. These are clear sky tables and seasonal overcast must be considered in individual locals. Table J1 comprises locations at various US latitudes and indicates operational months vs. sampling schedules.
There are other factors which will reduce the energy replenishment of the system and make accurate performance predictions difficult. Amongst these are:

1. Dirt on the solar panel.
2. Extreme cold weather affecting battery performance.
3. Extremely high particulate loadings causing high filter resistance and consequent high current drain.
4. Old "used up" batteries -- more than two years old.

While all the preceding factors are to be considered in the deployment of a solar powered PQ200. They are not easy to quantitate. The effect of too little sunlight will be noticed on the "percent charge remaining" on the PQ200's main screen. Given perfect replenishment, it will always read 99%. If at any time it falls below 50% it is well to consider replacing the large battery with a fully charged one. At a minimum, given winter gloom, a fully charged battery and an every other day sampling schedule, a one month operating period is achievable at any location below 45° latitude.

Setting up

Subsequent to unpacking a new unit, it is attached to the rear leg of the PQ200 as shown in Figure J1. It is important that the board provided be located as shown in the figure with the battery placed on top of it. This serves to anchor the lower end of the panel to prevent its lifting during high winds. Failure to do so could result in damage to the solar panel and the PQ200. NOTE: In due consideration of weight, shipping expense and ready, local availability, a battery is not furnished with the solar panel kit.

However, the recommended battery is known as a "trolling motor" battery. This is a marine type battery used for low speed, electric outboard motors. They are equipped with handles and 5/16 inch binding posts with wing nuts. Because of their marine specifications, they are a "deep discharge" battery, which is also the type recommended for solar panel applications (1).

Direction

The direction of the solar panel will be with its long axis from the north to south, with the foot (low) end of the panel to the south. Inasmuch as the cell will be attached to the rear leg of the PQ200, this means that the back of the PQ200 is pointing due south and the front or door side of the instrument is due North as illustrated in Figure J2.

Tilt Angle

The tilt angle is defined as the angle of inclination of a solar collector measured from horizontal. The reason for tilt angle is because of the sun's elevation will vary over a range of 47° from winter solstice to summer solstice (1).
For the greatest annual energy production, the tilt angle should equal the latitude at the location of deployment. For best energy production, the wintertime the angle should be the latitude plus $15^\circ$. The maximum summertime production is obtained at latitude minus 15. The tilt angle and one method of setting is shown in Figure N3.

It may also be set with a user supplied protractor/bubble level.

**Wiring Connections**

On the back of the solar panel is a rectangular box from which two cables exit as shown if Figure J4. The cable with 5/16 inch ring terminals is intended to connect to the external battery described in section J 2. The white or red wire is positive (+). The black wire is negative (-) and the green wire, with the tinned end is ground. A 12-inch ground spike and terminal is provided.

The other wire emanating from the box is equipped with a CPC connector. This wire is installed through the hole in the bottom of the PQ200 enclosure normally used for the power supply cable. This wire is installed in place of the power supply cable when running on solar power.

**Overall Operation and Troubleshooting**

Prior to deploying a PQ200 with solar panel, it is prudent to ensure that the internal battery is fully charged. This is accomplished by plugging the PQ200's power supply into a source of line current for 16 hours. Full internal battery charge will be indicated on the main menu display as 99% or charged when the battery is full charged and the power supply is disconnected.

The external solar panel battery may be initially charged from any automotive battery charger. Alternatively, the PQ200 may simply set in a sunny location or the actual field sampling site and not run for 10 days. The solar panel will fully charge both batteries.

**Troubleshooting**

Battery is not maintaining at least 50% charge - caused by inclement weather or excessive current drain. Excessive current drain is caused by an excessively dirty filter or a worn out pump. After installing a new filter, if problem persists, check for worn pump valves or diaphragm.

If either battery is in excess of two years old - replace.
Reference

(1) Stand-Alone Photovoltaic Systems, A Handbook of Recommended Design Practice.
Available from National Technical Information Service
US Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
Document No. SAND87-7023

Solar Panel Parts List

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Figure</th>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>J 1</td>
<td>5PI</td>
<td>Solar panel assembly</td>
</tr>
</tbody>
</table>

TABLE J1. Clear Sky Insolation Data from Northernmost to Southernmost U.S. cities¹.

*Months wherein full charge can be maintained.*

<table>
<thead>
<tr>
<th>City</th>
<th>N. Latitude</th>
<th>Continuous Sampling</th>
<th>Every other day Sampling</th>
<th>Third day Sampling</th>
<th>Sixth day Sampling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caribou, ME</td>
<td>46° 52'</td>
<td>Mar-Aug</td>
<td>Jan-Oct</td>
<td>Jan-Dec</td>
<td>Jan-Dec</td>
</tr>
<tr>
<td>Boston, MA</td>
<td>41° 40'</td>
<td>May-Sept</td>
<td>Jan-Nov</td>
<td>Jan-Dec</td>
<td>Jan-Dec</td>
</tr>
<tr>
<td>Raleigh-Durham, NC</td>
<td>35° 52'</td>
<td>Apr-Aug</td>
<td>Jan-Dec</td>
<td>Jan-Dec</td>
<td>Jan-Dec</td>
</tr>
<tr>
<td>Miami, FL</td>
<td>25° 48'</td>
<td>Feb-Sep</td>
<td>Jan-Dec</td>
<td>Jan-Dec</td>
<td>Jan-Dec</td>
</tr>
</tbody>
</table>

NOTE: This approximation is based upon 5 Kwh/M² received, as being necessary to fully restore the PQ200 system whilst drawing 500 MA (typical).
Figure J1. Setup of Solar Panel
Figure J2. Orientation of Solar Panel
**Figure J3. Setting Tilt Angle**

Before using the chart below determine whether you have the long style (13” wide x 51” long) or the short style (21” wide x 25” long) solar panel.

<table>
<thead>
<tr>
<th>VERTICAL MEASUREMENT</th>
<th>TILT ANGLE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SHORT STYLE (21&quot;x25&quot;)</strong></td>
<td><strong>LONG STYLE (13&quot;x51&quot;)</strong></td>
</tr>
<tr>
<td>INCHES</td>
<td>CM</td>
</tr>
<tr>
<td>12.2</td>
<td>30.0</td>
</tr>
<tr>
<td>16.1</td>
<td>40.9</td>
</tr>
<tr>
<td>19.8</td>
<td>50.3</td>
</tr>
<tr>
<td>22.3</td>
<td>56.6</td>
</tr>
<tr>
<td>24.5</td>
<td>62.2</td>
</tr>
<tr>
<td>25.5</td>
<td>64.8</td>
</tr>
</tbody>
</table>
Figure J4. Wiring Connections
Appendix K
Accessories
Introduction

The operation of every air sampling instrument benefits from useful accessories. Traditionally, such accessories are developed during the lifetime of an instrument as experience with its application is obtained. This appendix is dedicated to those useful items and their application. Each has been submitted to EPA and in each case they have been approved for use or stated as to be not within their purview.

Dust Excluder

The Dust Excluder, illustrated in Figure K1, is intended to preclude the deposition of fugitive dust on the exterior of the cassette. The PQ200's inner compartment is protected by an air filter and the cooling fan only functions when an overheat is detected. Nevertheless, every effort should be made to minimize contamination wherever possible. EPA has approved the excluder as an optional accessory. (Fig K, Det #169, Part # DE-1)

To install the excluder, smear the internal Ao\@ ring with a light grease and press it upwards onto the lower impactor housing (Fig. 6, Det. #6, Part # B1594). Once installed it may remain permanently in place. If removal is ever required it may be pulled off or if necessary levered off with a thin piece of metal. The excluder is a unit and contains no serviceable parts.

Cassette Opener

EPA has mandated a very tight fitting cassette to prevent untoward separations during use and transport. (Fig. 6, Det. #34, Part # A1657, A1658). In order to prevent filter damage due to dropping or touching the filter during the cassette disassembly procedure a cassette opener has been developed to provide a gentle opening action while keeping all components on the bench top. The opener is shown in Fig K2.

In use the opener is laid flat on the bench top such that the base pad elevates the "forks" of the opener. The cassette (screen side towards the bench/filter side up) is slid between the fork legs and pushed forward with the thumb only. The top of the cassette will be gently levered upwards, free of the bottom. Remove the top of the cassette and carefully slide away the opener. The bottom of the cassette may now be lifted off the bench and the filter is freely available for removal with forceps. Usually the bottom of the fingers of one hand and a third finger of that hand is used to gently lift the screen so that the edge of the filter is presented to the forceps.

Serial Numbered Screens

Beginning in April of 1999 all screens used in cassettes will have a serial number, laser etched in the center of the perforated area. The number is alphanumeric and is preceded by the initials BGI. This is a product upgrade which has been approved for use by EPA. This screen
should always be mounted in the cassette with the numbered surface away from the filter on the outside. The general layout is shown in Fig. K3.

Cassette Transport Carrier

In further compliance with the FRM Directives, a new all metal cassette container has been produced (Part #F-21/4). Shown in Figure K4, the new container completely seals the cassette from the elements, holds it rigidly in place and when the cover is removed, permits easy access for removal. No additional bagging on containment is required.

Dual Filter Cassette C Applications and Installation

The dual filter cassette (Part #8141) is intended for those sampling applications wherein it is desired that two filters be mounted in series, each separately supported by individual screens. One typical application would be for some types of speciation sampling. The dual cassette may be used in any PQ200 by removing the lower impactor housing (Part #B1594, Figure 6, Det. 6) and replacing it with a new, shorter component (Part #B2027, Figure K5, Det. 6b). The dual filter cassette may then be inserted and used as a normal cassette. A dual cassette carrier is also available, P/N 8142.

Effective August 1, 2005 P/N=s Part #B2027 and Part #8141 were declared obsolete. They have been replaced with a new thinner cassette Part #2411 DC which utilizes the standard impactor housing.

Note: When utilizing the PQ200 with the dual cassette installed, a concentration value is only valid for EPA purposes if the first filter is an EPA specified filter for PM$_{2.5}$ sampling. The second filter may be whatever the operator desires. If non-EPA specified filters are utilized, then the concentration values obtained do not meet EPA requirements and should not be reported as PM$_{2.5}$ Information. The same applies to PM$_{10}$ measurements.
Figure K1. Drawing of WINS and Filter Holder OPEN, Showing Dust Excluder Installed (in section)
Figure K2. Cassette Opener
Figure K3. Serial Numbering of Support Screen
Figure K4. Cassette Carrier
Figure K5. Exploded View of WINS and Filter Holder Assembly for Dual Cassette
Appendix L
Superceded Software
SUPPORTED HARDWARE

The PQ200 Job Controller software program installs into any IBM PC or compatible computer running Windows (3.1, 95 or 98). The computer must have:

- At least one 3.5" floppy drive
- COM1 or COM2 RS232 serial port for downloading
- Hard drive with at least 2MB free disk space

For printouts, any printer attached to or redirected from LPT1 will work.

INSTALLATION (WINDOWS)

To install the software onto a C: drive (typical installation):

- Insert disk 1 of the supplied floppy disks into the A: or B: drive of the PC.
- Open "File Manager" (Windows 3.1) or click "Start" (Windows 95).
- Click "File", then "Open" (Windows 3.1) or click "Run" (Windows 95).
- Type "A:\setup.exe" (or B:\setup.exe if using the B: drive).
- Click "OK" to begin installation.
- Enter the operator's name and the name of the company or organization as desired and click "OK".
- Unless otherwise instructed, the installation utility will create a subdirectory called "Program\BGIIncor\PQ200" on the C: drive and copy all files into it. In addition, a program group called PQ200 will be created, accessible through the "Start" button.
- Continue to follow the onscreen instructions for installing the PQ200 Job Controller software from the rest of the supplied floppy disks.
- If the installation was successful, click "Finish" to complete the installation. The setup program will then exit to Windows.
- Note the new folder and icons. Run the PQ200 Job Controller software by double-clicking on the PQ200 icon or by clicking the "Start" button, then selecting "Programs", then the "Q200" program group, then the "PQ200" program.
PROGRAM OVERVIEW

The PQ200 Job Controller software is a menu-driven program that utilizes the serial communications port of the PC to download sample data from the PQ200 air sampler and to provide data logging, data manipulation, concentration calculation, and sample validation capabilities.

PQ200 Job Controller software allows the user to communicate with the PQ200 air sampler and to download run data from the PQ200 into a personal computer. The data may then at a later time be appended with the measured filter weights for concentration calculation, printed and stored for later use.

The Program has four folders: Job Control, Summary, Logs and Print Sheets, and Graphs.

Job Control: allows the user to create a new job file into which data may be downloaded from the PQ200 air sampler, or open an existing data file from a previous download. Basic information about the job file are presented.

Summary: presents more details about the current job file, such as the start and stop time, target and average flowrates, minimum and maximum pressure and temperature during the sampling run, any flags that may have been triggered, etc.

Logs and Print Sheets: contains three spreadsheets -- Summary, Hourly Log, and 5-min Log -- with the actual downloaded data. These sheets are easily printed by clicking on the Print Options button.

Graphs: displays easy-to-read graphs of the absolute ambient and filter temperatures, the relative filter temperature (Aoverheat®), and the static pressure.

In addition to the four folders are four buttons along the bottom of the display: Remote Control, Set Preferences, Print Options, and Exit.

Remote Control: allows the user to program the PQ200 air sampler instead of using the six-button interface (as shown in Section 1.1.8) on the sampler itself.

Set Preferences: allows the user to preset the default information that the PQ200 Job Controller software uses when creating a new job file, alleviating tedious repetition.

Print Options: allows the user to easily print out copies of any of the three spreadsheets under Logs and Print Sheets or the three graphs under Graphs.

Exit: closes the PQ200 Job Controller software.
USING THE SOFTWARE

Job Control Folder

In the Job Control folder are the buttons that allow a user to open an existing job file, begin a new job file, and download data from the PQ200 sampler.

NOTE: When first opening the PQ200 Job Controller software, do not enter information into the text fields. Either begin or open a job file first before attempting to change the information presented.

To create a new job file into which data may be downloaded from the PQ200 sampler, click Begin Job. The Generic Job Information window will appear, into which basic descriptive information may be entered as desired. This information will be stored with the download data for easy reference and cataloging. (Some of this information can be preset; refer to Section 4.4.6, Set Preferences Button.) When done, click Save to create the job file on disk. (Note that the Job Name in the first line of the screen is the actual filename into which the data will be stored on disk.) When the job file has been saved to disk, note that it becomes the active file in memory and the information just entered will be displayed in the Job Control folder.

To open an existing job file (one that has already been created, whether or not it contains any downloaded data), click Open Job. The Job Selector window will appear, and the desired job file may be selected and opened.

Click Save Changes to save any changes to the job file since it was opened or created.

The Download button is used to retrieve data from the PQ200 air sampler. Refer to Section 2.3, Data Downloading Instructions, for more detailed instructions.

If only summary information is desired when a job is open, uncheck the box next to Read in Logger in the "Options During Open Job" box.

Click Do Not Plot Graphs in the "Options During Open Job" box if no graphs are desired. This option will automatically be selected if the Read in Logger box is unchecked.

In the "Details" box, the Summary Downloaded and Logger Downloaded check boxes will be checked only if the summary data or logger data for the open job are in resident memory. Note that the Logger Downloaded box will be affected by the status of the Read in Logger box.
Summary Folder

Once a job file has been created and data have been downloaded from a sampler, the Summary folder displays the basic information about the sample run as a convenience to the operator.
The "PQ200 Air Sampling System" box includes the sampler version number, the sampler serial number, and the total pump hours (refer to Section 3.3, Maintenance).

The "Timer Info" box displays the sample run start and stop time and the calculated elapsed time.

The "Filter Overheat, C" box displays the differential achieved between the filter temperature and the ambient temperature in degrees Celsius, and also the time at which this maximum differential occurred.

The "Flowrate Info in Lpm" box shows the target flow, the average flow achieved during the sample run, the coefficient of variation of the measured flow rates, and the total volume of air sampled in actual cubic meters.

The "Pressure Info, mmHg" box contains the minimum, maximum, and average barometric pressure recorded during the sample run.

The "Temperature Info, C" box contains the minimum, maximum, and average ambient temperature measured during the sample run.

The "Flags" box displays any flags that may have been triggered during the sample run (i.e., power failure, flow rate variation beyond +/- 5 percent, filter overheat of more than 5 degrees C lasting more than 30 minutes, or that a 24 sample actually ran for less than 23 hours 50 minutes). A flag not triggered will read as OK.

The "Filter Info" box includes any filter information entered during the creation of the job file. This information may be changed in the text fields of this box. The weight gain is automatically computed if the initial and final weights are entered.

The "PM2.5 Concentration" box shows the concentration of PM2.5 in micrograms per actual cubic meter, computed as the weight gain in the "Filter Info" box divided by the total air volume sampled in the "Flowrate Info in Lpm" box.

**Logs and Print Sheets Folder**

The **Logs and Print Sheets** folder contains three spreadsheets -- Summary, Hourly Log, and 5-min Log -- that contain the actual logger data retrieved from the PQ200 sampler during a data download. These spreadsheets are set up to be easily printed for convenience. (Refer to Section 4.4.7, Print Options Button, for further instructions on printing these sheets.)

To view a spreadsheet in its entirety on the screen, it must be activated by double-clicking on it. Scroll bars will appear inside the open window.
NOTE: These spreadsheets were intended for viewing and printing only. Although activating a spreadsheet allows changes to be made to the information in the spreadsheet cells, this is not recommended. Changes made to the summary information should be made on the Job Control folder, and the other information should not be altered by the operator.

The Summary spreadsheet will contain the graphs displayed in the Graphs folder, but only after the **Update Summary Sheets** button in the Graphs folder has been clicked.

**Graphs Folder**

This folder contains three graphs based on the logger data downloaded from the PQ200 sampler.

The "Temperature" graph shows the absolute filter and ambient temperatures (TF and TA, respectively), as a function of time, as recorded by the PQ200 during the sample run.

The "Overheat" graph displays the temperature differential between the filter and the ambient. A temperature differential of more than 5 degrees C for more than 30 minutes triggers the overheat flag. The maximum temperature difference is also displayed in the Summary folder.

The "Static Pressure" graph shows the ambient barometric pressure as a function of time during the sample run.

The **Update Summary Sheets** button applies the three graphs into the Summary spreadsheet in the Logs and Print Sheets folder.

NOTE: Just as with the spreadsheets, the graphs can be activated by double-clicking the open window. By activating a graph, virtually any feature of the graph can be manipulated: scale, color scheme, data labels, etc. The graphs have been optimized by the software and should not require changes.

**Remote Control Button**

The remote control button allows a variety of data to be uploaded to the PQ200 from a notebook computer. From this window you may:

- Set clock time
- Set start time
- Set stop time
- Set flow rate
Set start date
Enter filter information
Set date
Set stop date
Set logger interval
Enter user information

This function is useful because this information can be set in the computer in a comfortable location prior to uploading. The PQ200 may also be controlled from this screen.

**Set Preferences Button**

This screen is useful for setting the information seen and stored on a file every time the instrument is downloaded. Storable data includes:

- Job code
- Site name
- Station code
- Operators
- Filter identification
- Initial filter weight
- Final filter weight

**Print Options Button**

This screen permits the selection of what available information is to be printed.

- Summary (BGI design)
- Five minute logger data (EPA design)
- Hourly average logged data (BGI design)
Appendix M

VERY SHARP CUT CYCLONE
VSCC®

INSTRUCTIONS FOR USE AND MAINTENANCE
1.0 Introduction

The BGI Very Sharp Cut Cyclone (VSCC®) is designed and manufactured only by BGI Incorporated. The VSCC® intended use is as an equivalent fine particulate matter separator in place of the US EPA WINS Impactor for PM2.5 sampling in any commercial model of the U.S. EPA Federal Reference Method (FRM) Samplers. The VSCC® is a fine-tuned US EPA verified new cyclone design, which exactly agrees with the EPA WINS penetration data. The VSCC® originated from the family of BGI Sharp Cut Cyclones (SCC®). BGI is the designer of several models of Sharp Cut Cyclone PM2.5 and PM1 inlets used for low flow photometer applications, chemical speciation and ambient particulate continuous monitor inlets. When the VSCC® is used with the BGI Model PQ200/PQ200A FRM samplers, they become designated a Federal Equivalent Method (FEM). The FEM designation number is EQPM-0202-142(7). The VSCC® has been developed, laboratory and field verified by BGI to have several operational advantages compared to the WINS, insofar as it is a dry separator and requires cleaning at infrequent intervals (1), (2), (3), (4), (5), (6). Inasmuch as ambient chemical speciation sampling for particulates is not governed by an EPA FRM sampler, the VSCC® may be freely utilized as a PM2.5 separator on a FRM type sampler and used for particulate mass, metal collection and sulfate and nitrate particulate collection. The VSCC® can be utilized as a Fine Particle separator on continuous particulate monitors such as the TEOM, BAM, Light Scatter and Beta Samplers.

BGI manufactures two versions of the VSCC®. They are the VSCCA®, which is a direct replacement for any commercial FRM system utilizing the standard WINS impactor, such as the Rupprecht & Patashnick (Partisol), Graseby/Anderson (RAAS with use of exit adapter 2302). The VSCCB® is intended for installation only in the BGI PQ200 and PQ200A FRM samplers. See Figures 1 through 4.

The flow path through a VSCC® is shown, in a cut-away view in Figure 1. PM10 "Coarse" aerosol enters tangentially after being pre-separated by the PM10 FRM inlet. Particles greater than PM2.5 (MMD-AED) are removed to the grit pot on the side of the VSCC® and the PM2.5 sample is ducted through the cyclone separator to the filter holder. Field and laboratory tests indicate the VSCC® can operate up to a period of 90 days between cleaning frequencies, even in high urban loading sites.

2.0 Installation – VSCCA® Model.

(For replacement of the EPA WINS in the Rupprecht and Patashnick Partisol_,
Graseby/Anderson RAAS and use as a PM2.5 Separator for PM2.5 Continuous Monitors)

The VSCCA® is an exact replacement for the standard WINS impactor as described in the FRM (6). It may be substituted in any commercial FRM instrument, which currently utilizes a standard WINS, except for the Graseby/Anderson RAAS which requires the additional VSCC® exit adapter, BGI p/n2302. The dimensions of the socket and tenon are identical to the WINS and the overall height is the same. Therefore, the VSCCA® may simply be "plugged in" as an exact replacement for the WINS in any instrument currently using the FRM standard WINS impactor. Additionally, all BGI VSCC® cyclones are serial and part numbered, and Verification of Manufacture marked to identify the VSCC® as an original BGI design and not an unverified copy article. The VSCC® may also be fitted to any instrument operating at 16.7-lpm, which utilizes the EPA standard socket and tenon dimensions, such as an ambient continuous fine particulate monitor. E.g. PQ100 and continuous particulate monitors. A generic installation is shown in Figure 2.

Note: The application of the VSCC® to a non-designated instrument will produce non-designated data. Also data produced by use of the BGI Sharp Cut Cyclone (SCC®) or commercial copies, are not US EPA designated and do not necessarily agree with gravimetric and fine particle separation to the BGI VSCC®. Please consult the BGI factory for details.
2.1 Installation B VSCCB® Model  
(For use in the BGI Model PQ200 and PQ200A FRM sampler)

The VSCCB® is internally identical to the VSCCA® model, but is intended to be installed only in the BGI PQ200/PQ200A, as a direct replacement for the WINS impactor. When the EPA WINS impactor is replaced with the BGI VSCC®, the sampler is no longer an EPA Reference Method and becomes an EPA Equivalent Method (EQPM-0202-142). Each VSCC® is clearly identified on its side with a part number and individual serial number. Additionally, BGI has added a (VM®) stamp, verification of manufacture to insure the unit is not a copy. Each VSCC® is supplied with a new sampler identification label which the operator should attach to the panel of the sampler and mark appropriately to identify the samplers EPA designation as configured.

The WINS removal and VSCC® installation process in a BGI PQ200 or 200A is as follows:

Step 1. Remove the FRM PM10 first stage inlet and one-foot long sample transport tube and set aside.

Step 2. Open the Impactor/Filter mechanism by turning the "T" handle counter clockwise. Remove the WINS Impactor cup and 47mm filter cassette.

Step 3. Loosen the round knurled tension knob, which secures the lower WINS/upper filter housing. Lift out the lower WINS housing and set aside.

Step 4. Firmly grasp the upper WINS housing, pull down and remove. This tenon part is sealed into the top of the sampler weather enclosure by an O ring. Care should be taken not to damage the O ring. If this "O" ring appears worn or damaged it should be replaced, to prevent entry of water into the sampler cabinet.

Step 5. Replace the upper WINS housing with the VSCC® upper adapter. (See Figure 1 and 4b). The male tenon of the VSCC® should pass through the top of the sampler weather seal.

Step 6. Install the VSCC® main body and rotate so the transfer tube is pointing outwards towards the operator. Tighten the round knurled knob to apply sealing pressure on the system.

Step 7. Install the filter cassette and close the mechanism by rotating the "T" handle clockwise.

Step 8. Adjust the clamping pressure, if required and perform a leak test as described in the PQ200 operator manual.

( The VSCCB® is shown installed in Figure 3 )

3.0 Operation.

After installation of the VSCC®, the instrument may be run in the normal manner at a flow rate of 16.67 lpm as described in the manufacturers operation manual and 40CFR Part 53 specification. It is important to note the performance and operation of the VSCC® is based on volumetric actual flow rate and not STP corrected flows.

4.0 Maintenance.

The intervals between cleaning of the VSCC® was dictated by the US EPA for designation at a frequency of not to exceed 30 days of 24 hour sampling. Testing by BGI under 40CFR part 53.65 EPA requirements for designation has demonstrated a validated cleaning interval up to 90 days(5).
However for quality assurance reasons EPA and BGI agreed to 30 days maintenance frequency. For use of the VSCC® on fine particulate "continuous monitors" i.e: TEOM, Beta attenuation monitors or light scatter units, the operator can clean the device on a 90 day continuous operation basis.

Exploded views of the VSCC® is shown in Figure 4 a-c. Recommended cleaning materials are cleaning with use of mineral free water and lint free lab wipes. In cases, where stubborn deposits are observed, ultrasonic cleaning ins soap and water is recommended.

To disassemble a BGI VSCC®:

Step 1. Remove the VSCC® from its installed position in the instrument.

Step 2. Pull off the side transfer tube. If it is too tight to remove by hand, pry it off with a rigid plastic lever. Care should be taken to not damage the two “O” ring seals.

Step 3. Remove the top cap and grit pot by unscrewing.

Step 4. Wet a lint free wipe with water and remove all visible deposits. These are most likely to be found at the bottom of the cone and inside the grit pot.

Step 5. Inspect all "O" rings for shape and integrity. If at all suspect, replace. Lubricate all "O" rings with light grease. It is important to well lubricate the transfer tube to avoid difficult disassembly.

Step 6. Assemble in reverse order and reinstall.

Step 7. Perform a leak check according to manufacturers operating manual specifications.
References:

   *J. Aerosol Science and Technology, Vol.32*: 338-358


Figure 1: BGI Very Sharp Cut Cyclone (VSCC®) Flow Path
Figure 2: Generic FRM Sampler Showing VSCC® Installed
Figure 3: Drawing of VSCCB® Installed in the BGI PQ200 or PQ200A
Figure 4a: Exploded View of VSCCA®
Figure 4b: Exploded View of VSCCB®
Figure 4c: Exploded view of VSCCA® Showing 2302 Outlet Adaptor for Graseby/Anderson RAAS™ System
Appendix N

REPLACING MAIN CONTROLLER BOARD

REV "D" TO REV "T"
Replacement of PQ200 Controller Board Rev T,
Conversion Fit P/N 10118

PARTS INCLUDED
1) 2368 Controller Board
2) 2340 Driver Board Cable
3) 2338 Ambient Adapter Cable
4) 2546 Button Board (Rev E)
5) 2335 Low Voltage Input Cable
6) 2366 Resistor Cable
7) 1676 Battery Cable (Rev E)
8) DS 2011B Display (Rev E)
9) 2358 Mounting Plate
10) HO3033 Static Pressure Hose
11) Procom Software
12) Tie wrap/nut package

REPLACEMENT STEPS  Note: Any Figs. Not shown in this appendix can be found in
The PQ 200 Manual.

1) Cut and remove all tie wraps.

2) Remove all cables to the Controller Board.

   (See Appendix A, Fig. 8 in manual for steps 3 and 4)

3) Remove 6 screws (62) holding Controller Board (61). Discard Controller Board and save
   screws, clock battery (84) and spacer.

4) Remove temperature boards (70 & 72), barometric board (68), static pressure board
   (78), button board (79), display (64) and all cables from these boards. Discard boards
   and cables. Save screws.
5) Remove Ambient Sensor cable (A1680), External Power cable (A1679), Backlight Shunt cable with resistor (A1677), and Battery Cable (A1676). Discard all cables. Save the Resistor Clamp (143). Plug the two holes from the resistor clamp using existing screws and 2 nuts provided.

6) Install new Button Board (2546), Display (DS 2011B), Resistor Clamp (143) with Mounting Plate (2358)/Resistor Cable (2366) and Main Controller Board (2368) (See figure N1). Tighten all screws.

7) Install new Ambient Adapter cable (2338), Low Voltage Input cable (2335), Driver Board cable (2340) and Battery cable (1676). (Low Voltage cable is mounted above Ambient Adapter cable, See figure N2).

8) Cable Placement to Boards.
   a) Plug in the Display (DS 2011) ribbon cable (gray) to the connector marked LCD on the Main Controller Board (2368).
   b) Plug in the Ambient Adapter cable (2338) (orange and blue wires) to the connector marked AMBIENT on the Main Controller Board.
   c) Plug in the Filter cable (purple and brown) to the connector marked FILTER on the Main Controller Board.
   d) Plug in the Flow cable (purple, black and red wires) to the connector marked FLOW on the Main Controller board.
   e) Plug in the RS232 cable (purple, brown and green wires) to the connector marked RS232 on the Main Controller board.
   f) Plug in the Resistor cable (2366) (both orange) to the connector marked RESISTOR on the Main Controller board.
   g) Plug in the Backlight cable from the Display (DS 2011) (green and blue wires) to the connector marked BKLT on the Main Controller board.
h) Plug in the Driver Board cable (2340) (red, black and green) to the connector marked VALVE on the Main Controller board.

i) Plug in the Fan cable (red and black wires) to the connector marked FAN on the Main Controller board.

j) Plug in the Pump cable (white and black wires) to the connector marked PUMP on the Main Controller board.

k) Plug in the Low Voltage cable (2335) (See figure N2) to the connector marked CHARGER on the Main Controller board.

l) Plug in the Battery cable (from the battery) to the connector marked BATTERY on the Main Controller board.

m) Install clock battery (84, Appendix A, Fig 8) and connect wire to LiBAT connector on the Main Controller board.

n) Remove old Small Solenoid Hose (126, Appendix A, Fig 10) and replace with new Static Pressure Hose (HO3033). Attach one end to the solenoid and the other to the front sensor tube marked "Static" on the Main Controller board (See figure N3)

o) Take the old Solenoid Hose (126, Appendix A, Fig 10) and install one end were the old barometric hose was mounted in the bottom of unit on barb fitting. Take the other end (You may need to shorten hose) and attach to the Sensor Tube marked "Barometric" on the Main Controller board (See figure ).

p) Tie wrap all wires in a neat form, same as was before replacing the new controller board.

q) Double check to make sure all cables are plugged in correctly.

9) Turn unit on, check to make sure of a proper boot up. The new controller will double click the Solenoid Value, this is normal. Check the display to make sure all temperature, barometric, and other readings are shown.

10) At this time you should
   a) Set the correct time and date.
   b) Calibrate temperatures, barometric pressure and flow.
   c) Program a run for 15 minutes.
11) LOAD SERIAL NUMBER

a) Turn unit off.

b) Use the S/N that was in the unit before.

c) On the Main Controller board there is a set of dip switches, you need to switch
   number 6 to the ON position (See figure N3).

d) Turn unit on.

e) Connect your computer to the RS232 connector on the front panel of the PQ200.

f) Insert the Procom disk into your computer. Start the program by clicking the Procom
   exe. Icon. If the program doe's not open you need to change the port settings. Click on
   the port set icon to change (Change port setting to the working port on your
   computer).

g) Once the program has started Press and hold the shift key and press * twice # once
   release the shift key and type the S/N in (Example 0234).

h) Turn the PQ200 on, the S/N should appear.

i) Turn dip switch 6 to the off position.

12) You are now ready to start sampling.
Figure N1. Exploded View of Instrument Panel
Figure N2. Location of Low Voltage and Ambient Cables on Inside Panel
Appendix O

Instructions for PM Coarse (PMc) Sampling

PM coarse is an administratively defined air sampling measurement designed by the US EPA to meet judicially mandated requirements for a modified sampling strategy. It is defined as a regular PM10 concentration measurement with a concurrent PM2.5 concentration measurement subtracted from it (two PQ200’s with the same firmware version being used). Both concentration measurements are to be taken simultaneously and reported on a volumetric basis, i.e. under actual (ambient temperature & barometric pressure) rather than standard conditions. Inasmuch as the PQ200’s are designed for volumetric sampling, no changes to the equipment are required.

The keynote of effective PM coarse (PMc) sampling is careful attention to synchronizing both samplers; timed event, filter media and calibrated flow rate, temperature(s) and pressures.

1. Sampler Preparation.

It is very important that both samplers be in prime operating condition. All functions should be checked to ensure that they are identical, including firmware versions. This includes any special terms or notes that have been set up to appear upon download. If brand new units are being used, this step will already be accomplished. If setting up previously used units, refer to this manual as follows:

2.1.6 Setting Date and Time 9
2.1.7 Entering Site and Filter Information 9
2.2 Performance Checks 10
  2.2.1 Checking for Leaks 10
  2.2.2 Checking Temperature and Pressure 10
  2.2.3 Verifying Flow Rate (Field Calibration Check) 10
  2.2.4 Checking Sampler Operation 11
2.4 Data Downloading Instructions 15
  2.4.1 PQ200 Job Controller Software for Windows 15
  2.4.2 Advanced Downloading 16

At this point, it is strongly recommended that each sampler be labeled to minimize confusion. A minimal recommendation is:

<table>
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<tr>
<td>Sampler SN XXXX</td>
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<td>Measuring PM2.5</td>
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</table>
In the event that a PQ200 is being converted from a PM2.5 unit the instructions provided in Appendix G of this manual should be followed:
" Use of the PQ200 as a PM10 Designated Reference Sampler Functions "

2 Sampler Operation & Site Set Up
The samplers are to be set up and run in exactly the same fashion as a pair of PM10 or PM2.5 samplers, which are simply making collocated measurements. Special care is taken as to the relative location of the two samplers and the setting of date and time. US EPA site criteria is that the sampler inlet should be placed at a height of 2 to 15 meters above ground level. When collocating PM10 and PM2.5 samplers, the spacing between sampler inlets must be >1 meter. The spacing between inlets must be no more than 4 meters apart for PM Coarse sampling. The heights of the two inlets should be within 1 meter as measured in the vertical direction.

3 Data Reporting.
Report concentrations to EPA as $\mu g/m^3$, at Actual volume. Typically PM10 methods are reported in Standard volume, however when sampling with two PQ200’s for PM Coarse, both sample volumes are reported in actual volumes.

It is strongly recommended that you check to see the start and stop times of the PM10 and PM2.5 collocated PQ200’s are within 15 minutes of each other. This will insure accurate flow rate and concentration data.

All other operating and reporting parameters for PM Coarse are covered in further detail within this Instruction Manual.
Appendix P

Leak Test Procedure for S/N’s 906 thru 1016

3.2.1 External Leak Test

On September 01, 2010 BGI changed the PQ200 External Leak Check procedure for Serial Numbers greater than S/N906. The electronic Solenoid Valve was removed and replaced with a manual valve to perform the external leak check procedure. This change requires the operator to conduct the external leak check procedure as follows:

a) Insert an unused filter into the filter holder. (Do not use this leak test filter for sampling, it is intended only for leak testing and flow rate calibration)

b) Remove the PM10 Inlet from the Inlet Downtube and set aside. Place the L-30 Flow Audit Adapter (aluminum cap with brass valve) on top of the male Downtube. This valve can be in the open position with the valve handle at the 12 o’clock position or closed in the 9 or 3 o’clock position.

c) Inside the cabinet the operator will see a manual Leak Check Valve located near the filter holder. The valve in the forward position, 9 o’clock is in the closed position and will not allow air flow. The Valve in the down 6 o’clock position is open and allows flow rate.

d) From the Keypad and Display go to the MAIN MENU. Go to TEST MENU and press SELECT to enter the TEST MENU.

e) From the TEST MENU, press the arrow key until LEAK TEST appears on the display and flashes. Press SELECT to enter LEAK TEST.

f) The screen will ask that the operator CLOSE THE INLET CAP. The operator must now manually move the brass valve handle on the L-30 Flow Audit Adapter into the 9 or 3 o’clock position. This closes the valve to the atmosphere and the PQ200 is ready to leak test.
g) When the Inlet Cap valve is closed press SELECT. The vacuum pump will slowly run and create a vacuum inside the PQ200 system.

   NOTE: It is Important for the operator to watch the lower right corner of the display and see the SP numbers increase from 000 to 095 or higher.

h) After 10 to 15 seconds the SP will rise to approximately 95 cm. When the SP reading displays 95 cm, “immediately” close the Leak Test valve near the filter holder by rotating the handle forward to the 9 o’clock position.

i) After two seconds the screen will display LEAK TEST IN PROGRESS and the SP display should remain constant at a SP number of 95 to 100 cm. An automatic timer will display on the screen starting at 0:00 minutes and count upward to 2:00. At the end of two minutes the sampler will end the Leak Test and display PASS or FAIL. A PASS indicates the sampler is ready for sampling. If FAIL is displayed the sampler is leaking air into the hardware and must be investigated to correct the problem.

j) If PASS, it is important to remember to open the two valves, the valve on top of the sampler and the Leak Check Valve must be in the open positions for sampling.

k) The PQ200 can not leak more than 5cm of Water from the initial setting of 90 to 100 cm over two minutes. If the SP drops more than 5cm over two minutes the sampler is not ready for sampling and corrective steps must be taken to correct the leak.
   1) Make sure the audit adapter is securely set and closed onto the downtube
   2) Make sure the PM2.5 VSCC® cyclone or PM10 Bypass are sealed tightly. Use the thumbwheel to increase the sealing of the O-Rings in the filter and cyclone area.

NOTE: It is important to remember to reset the Leak Check Valve, near the filter holder into the OPEN position before normal sampler operation can start. BGI designed the valve so the handle will push against the cabinet door, to help the user remember to open the valve for sampling conditions. With the Leak Check Valve in the DOWN position the sampler is ready to operate.

Note: Valves are factory set for leak tests at 70° F (21° C). If you are experiencing a leak at the valve it may be necessary to adjust the packing of the valve.

Adjustment Instructions: (see photo also)
   1) Remove the black plastic knob using a 2.5mm hex wrench.
   2) Tighten the packing nut in small increments until a leak tight seal is achieved.
   3) Reinstall black plastic knob.
Step 1: Remove Control Knob Using 2.5mm Hex Wrench

Step 2: Using a 10mm Wrench Tighten Nut in Increments as Stated in Instruction Sheet
### PQ200 Instruction Manual Revision History

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<td>Added Appendix F</td>
<td>January 1998</td>
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<td>1.3</td>
<td>Revised Figure 10</td>
<td>February 1998</td>
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<td></td>
<td>Added Figures 10a and 10b</td>
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<td>Added Designation Numbers for PM$_{10}$ use</td>
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<td>August 2000</td>
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<td>January 2001</td>
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