

**Section 2.35.2: Operator Responsibilities**  
**Continuous Particulate Sulfate (SO<sub>4</sub><sup>-2</sup>) Measurement**  
**(Using Thermo Electron Model 5020 SPA)**

**QA Plan/SOP**

**Revision 0**

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## 2.35.2 Continuous Sulfate ( $\text{SO}_4^{-2}$ ) Measurement-Operator Responsibilities

### 2.35.2.1 Introduction

#### 2.35.2.1.1 Scope and Applicability

A chemical speciation program was initiated by the United States Environmental Protection Agency (USEPA) to characterize the components of fine particulate matter (PM) with an aerodynamic diameter  $< 2.5$  microns ( $\text{PM}_{2.5}$ ). The resultant speciation database is expected to, among other things, help identify the sources of  $\text{PM}_{2.5}$ , evaluate the effects of control strategies, and eventually establish trends. One of the components of  $\text{PM}_{2.5}$  to be characterized is sulfate ( $\text{SO}_4^{-2}$ ). A significant contribution to  $\text{PM}_{2.5}$  is thought to be ammonium sulfate, which is formed in the atmosphere by the chemical reaction between trace levels of sulfur dioxide ( $\text{SO}_2$ ) and ammonia. The Thermo Environmental, Inc. Model 5020 Sulfate Particulate Analyzer (TEI 5020 SPA), which measures atmospheric sulfate on a continuous basis and provides real time data, will be used to provide the information necessary to populate the database in support of the objectives listed above. In order to collect accurate and meaningful data, the monitors must be operated in a consistent manner. The goal of this document is to establish a continuous, verifiable and defensible record of procedures and events with regard to the site and the operation of the 5020 SPA instrument as required by US EPA, 40 CFR 58. This document makes references to other supporting instrumentation such as the 146C gas calibrator and ESC 8816/8832 data acquisition systems, but does not provide in depth details of their operation. Please refer to the appropriate QA Plan/SOP found on the DAQ Internal Web Site for specific separate guidance on their function and operation.

#### 2.35.2.1.2 Summary of the Method

Ambient air, potentially containing particulate matter (PM), is initially drawn through a size cut inlet that allows only PM with an aerodynamic diameter  $< 2.5$  microns to pass to the "TEI Model 5020 Sulfate Particulate Analyzer". (The 5020 SPA is comprised of two connected, but separate modules; a converter and an analyzer.) After the size cut process, the continuous sample stream first passes through a denuder that removes  $\text{SO}_2$  and other acid gases, then through a high temperature converter that converts any  $\text{PM}_{2.5}$  containing  $\text{SO}_4^{-2}$  to  $\text{SO}_2$  and finally to an analyzer that measures the resulting  $\text{SO}_2$  concentration. This analyzer is a modified version of the TEI 43C TLE  $\text{SO}_2$  analyzer and is similar in function and operation. The 5020 SPA quantifies sulfate by comparing the signal produced from an aerosol-laden sample ( $< 2.5$  microns) that is drawn directly into the converter module (**unfiltered sample/ $\text{SO}_2$  removed, referred to as the "Sample Mode"**) to a background signal (**filtered sample/ $\text{SO}_2$  removed, referred to as the "Filter Mode"**) that is produced from raw ambient air that has passed through a high efficiency particulate (HEPA) filter and the denuder before passing through the converter. (Both the unfiltered and filtered gas stream pass through the denuder.) The difference in signal between the unfiltered sample ( **$\text{SO}_2$  removed**) and the filtered sample ( **$\text{SO}_4^{-2}$  and  $\text{SO}_2$  removed**) can be attributed to  $\text{SO}_2$  that is formed from the conversion of  $\text{SO}_4^{-2}$  particles in the unfiltered sample

stream. The analyzer module is calibrated with SO<sub>2</sub> and the resulting SO<sub>4</sub><sup>-2</sup> concentration (resulting from a software mathematical calculation) is reported in units of micrograms per cubic meter (ug/m<sup>3</sup>) at local conditions of temperature and pressure. Four ug/m<sup>3</sup> of SO<sub>4</sub><sup>-2</sup> is equivalent to approximately one part per billion (ppb) of SO<sub>2</sub>. With an averaging time of 60 seconds, the 5020 SPA has the capability of detecting SO<sub>2</sub> concentrations at nominally 0.05 ppb, which corresponds to a SO<sub>4</sub><sup>-2</sup> concentration of nominally 0.20 ug/m<sup>3</sup>.

The relationship of the “sample mode” to the “filter mode” is explained as follows. The 5020 SPA can operate **continuously** to provide real time data with no background subtraction or operate **cyclically**, alternating between “filter mode” for a fixed time period and “sample mode” for a fixed time period. Operating in the cyclic fashion provides background subtraction. (The 5020 SPA has been set by the ECB to operate in the cyclic fashion.) These time periods can be varied, but have been set at the ECB to be 5 minutes for the “filter mode” and 10 minutes for the “sample mode”. Sixty-second averages of the SO<sub>2</sub> concentration are stored. An averaged value generated after the completion of each mode (filter mode, then sample mode, then filter mode and so on) is used to provide the “Cycle SO<sub>4</sub><sup>-2</sup>” concentration. This “Cycle SO<sub>4</sub><sup>-2</sup>” concentration is background corrected by averaging the two filter mode values determined before and after each sample mode and subtracting this average from the sample mode value. This background corrected SO<sub>4</sub><sup>-2</sup> concentration is updated every 15 minutes (5 minutes plus 10 minutes). Four “Cycle SO<sub>4</sub><sup>-2</sup>” concentration values per hour (one every 15 minutes) will be generated and averaged to provide an hourly average. When the 5020 SPA cycles between the filter and sample modes there is a short period of “transition” time as the SO<sub>2</sub> concentration raises or falls. This transition time (or equilibration time) is necessary to allow the instrument to reach a steady state or repeatable reading after cycling into a filter or sample mode. A transition time of 120 seconds has been set (through the instrument controls) and is automatically imposed at the end of each cycle during which time data output from the analyzer is disabled. This prevents these transition concentrations from being included in the average. (see Figures 1, 2 and 3 in Appendix A: Figure 1 and 2 show the sampling and analysis components and flow direction during each mode; Figure 3 graphically shows a time vs. concentration plot of the sample and filter mode.)

### 2.35.2.1.3 Health and Safety

**As with all electronic devices, the 5020 SPA presents the potential for hazard due to contact with electrical current if basic safety precautions are not followed. The 5020 SPA should always be powered via the AC line cord supplied by the manufacturer. Do not use extension cords as they may present a potential fire hazard if overloaded. Never operate the 5020 SPA without covers in place or while in contact with water or wet surfaces. The converter unit contains a component that operates at a very high temperature (1000° C) and will take several hours to cool after power has been turned off. Failure to observe these precautions may result in severe burns or electrical shock.**

If these units are to be rack mounted, the converter should be on top with at least a 20" spacing between the converter and the analyzer.

Over time, some of the chromium in the stainless steel catalyst could form oxides that may be deposited as particulate matter on the 47 mm diameter 1 micrometer ( $\mu\text{m}$ ) pore size filter located on the sample exit of the converter and observed as a green to yellow discoloration. Caution should be used in the handling of the spent filter. For the removal and disposal of the filter, one procedure would be to use tweezers and/or protective gloves and then place the spent filter in a zip-lock bag before disposal in the trash.

**Hearing protection is advised while performing activities in the shelter due to the noise level of the compressor.**

#### **2.35.2.1.4 Interferences**

Rapidly changing high levels of nitrogen oxides ( $> 200$  ppb/hour), reduced sulfur compounds ( $\text{H}_2\text{S}$ ,  $\text{CS}_2$ ) or organic gaseous sulfur compounds can reduce the lower detectable limit for sulfate by artificially increasing the background. Very high levels of ammonium nitrate (higher than typically found in ambient air,  $50\text{-}100$   $\mu\text{g}/\text{m}^3$ ) will be a positive interference. The method does not measure sodium sulfate.

#### **2.35.2.2 Procedures for Operation/Calibration of the 5020 SPA System**

##### Record Keeping

All original records (records documenting observations, calibrations, calibration checks, etc.) must be legible, complete, dated, and signed by the operator and retained as part of the permanent analyzer record. The operator's signature on the calibration logbook form certifies that the calibration has been performed in accordance with this QA/SOP and that the information contained on the form is accurate. All records will be reviewed and verified by the Regional Chemist and audited by a representative from the Project and Procedures Branch (PPB) of the Raleigh Central Office. An electronic logbook (E:Log) is available for documenting activities performed. An example of each of the E:Log forms can be found in Appendix E of this document.

##### Definitions

In order to apply more descriptive and common terminology across all continuous monitoring QA Plans/SOPs, the terms "*precision check*", "*adjusted calibration*", and "*unadjusted calibration*" have been replaced. The term CALIBRATION CHECK (formally "*precision check*" or "*unadjusted calibration*") is now used to describe the 14-day visit procedure where the operator performs, at a minimum, a "one point QC check (i.e., Span 3) on the current calibration

but does not change the calibration. The term CALIBRATION describes the procedure by which the instrument is set or reset to an updated calibration curve.

### **2.35.2.2.1      Instrumentation and Equipment for Continuous Sulfate Monitoring:**

The following components comprise the make-up of the sampling and analysis system:

- Thermo Environmental Model 5020 Sulfate Particulate Analyzer/Converter;
- Thermo Environmental 146C Dynamic Gas Calibrator;
- Protocol SO<sub>2</sub> cylinder (nominal concentration of 10 ppm);
- Zero Air Pack;
- ESC Model 8816/8832 Data Loggers (primary and back-up);
- A dedicated site PC;
- Modem;
- Sample Inlet System consisting of the following components:
  - BGI Sharp-cut cyclone Model 0.732 (operated at a flow rate of 0.91 lpm to obtain cut point of 2.5 microns);
  - Pump and Mass Flow Controller capable of maintaining a cyclone auxiliary flow of nominally 0.450 lpm;
  - Flow splitter; and
  - Denuder.

Note: The instrument manual provides details on the operation of the 5020 SPA, but does not cover the operation of the cyclone. The operation and maintenance of the cyclone is, however covered in this document (see Sections 2.35.2.3.6 and 2.35.2.3.12).

### **2.35.2.2.2      Summary of Topics Applicable to the Sulfate Monitoring System:**

The following is a summary of important topics that are discussed in detail in specific sections of this document.

- The proper operation of the cyclone is dependent on the sample flow rate of the analyzer, which remains fixed, and the flow rate of the cyclone auxiliary flow, which is adjustable through the external mass flow controller. Both flows are similar (nominally 0.450 lpm) and must total 0.91 lpm.
- When the high temperature converter element is replaced, it should be “burned in” for a minimum of 12 hours before reliable data can be obtained.
- When the operational cycle (sample mode/filter mode/sample mode...) is interrupted (i.e., power failure) a period of up to two hours will be required before the data logger data collection process is automatically reset. Then one cycle of “filter mode” plus one sample mode” plus “one filter mode” will need to be completed before the first “cycle SO<sub>4</sub>” value is available.
- An initial calibration must be performed during the site start-up.

- Visit the site at least once every 14 DAYS OR LESS.
- During the 14-day visit, perform a CALIBRATION CHECK. A CALIBRATION CHECK is to be performed *before* any changes are made to the system. A CALIBRATION is required when a CALIBRATION CHECK fails.
- CALIBRATION is required whenever a system's operation is interrupted (i.e. more than two days without power, physical removal/replacement of system components, or major repairs/maintenance. A "closing calibration" is required at the closure of a site. The instrument should be re-calibrated at a minimum of once every six months (even if running smoothly over that time span).
- The clock times of the components at the site are to be verified, and if needed corrected, during the 14-day visit. The PDL and BUDL should be within 5 seconds of each other and match NIST Eastern Standard clock time ( $\pm 1$  minute) as provided by the NIST time provider in Colorado. The site computer time should match the data logger time within 5 seconds. The 5020 SPA analyzer clock is automatically synchronized to the data logger every one-minute by a command from the data logger. The data logger also updates the site computer once per hour.
- The site is to be inspected every 14-days for required maintenance such as: shelter condition, shelter temperature controls, condition of plumbing/lines, compressor and silica gel condition, filter changes, calibration checks, leak testing, backup data collection, data review.
- No activities that affect data (i.e., calibration checks, calibrations, audits) are to be made during periods where sulfate concentrations are observed to be higher than normal historical levels.
- The calibration range of the instrument is 100 ppb SO<sub>2</sub>. The Span Points are as follows: Span 1, **85 ppb**; Span 2, **45 ppb**; Span 3, **7 ppb** plus Zero.
- The use of a BUDL is discussed in this document. However, if a BUDL is not used at a particular site, back up data is obtained by downloading the data directly from the 5020 SPA analyzer onto a laptop computer. In either case, data is to be downloaded to a laptop computer during each site visit.
- The cycling of the analyzer between "sample mode" and "filter mode" creates a unique problem for the timing of data collection by the datalogger. The ECB has programmed the E:DAS software to force the datalogger to retrieve data from the analyzer at specific clock times. The proper timing sequence is initiated at set up and the datalogger has been programmed to reset the sequence once every 24 hours during the auto calibration check and after any power failure. If the operator feels that this timing sequence is not operating properly, he/she should contact the ECB.

### 2.35.2.2.3 Activity Check List

The following is a check list of activities that is to be followed:

- 1) Initial Start up
  - Check all instrument parameters settings (see Section 2.35.2.3.2)

- Check all flow measurements (see Section 2.25.2.3.6)
- Perform leak check (see Section 2.35.2.3.5)
- Perform initial calibration (see Section 2.35.2.3.7)

2) 14 day Visit

- Check and record all instrument parameters settings (see Section 2.35.2.3.2)
- Perform Calibration Checks (see Section 2.35.2.3.3)
- Perform filter change and any other scheduled maintenance (see Sections 2.35.2.3.4 and 2.35.2.3.10)
- Check all flow measurements (see Section 2.35.2.3.6)
- Perform leak Check (see Section 2.35.2.3.5)
- Check/reset clock times (see Section 2.35.2.2.2)
- Clean cyclone (see Section 2.35.2.3.12)
- Perform re-calibration if required (see Section 2.35.2.3.7)
- Perform data back-up (see Section 2.35.2.3.9 and Appendix D)

3) Shut Down of 5020 SPA Operation

- Check and record all instrument parameters settings (see Section 2.35.2.3.2)
- Perform Calibration Check (see Section 2.35.2.3.3)
- Perform final Calibration if Calibration Check fails (see Section 2.35.2.3.7)
- Perform data download from PDL, BUDL and analyzer (see Section 2.35.2.3.10)

### 2.35.2.3 Operational Checks and Calibration for Sulfate Monitoring Sites

The following sections discuss in detail the procedures for performing checks and adjustments to the 5020 SPA sampling and analysis system. Remember to perform the “Calibration Check” before making any adjustments or performing any maintenance. **Document all checks and adjustments in the logbook.**

#### 2.35.2.3.1 Initial Observations

##### Shelter

Upon arrival at the site, observe the outside of the sampling building and probe, looking for vandalism or security breaches. Check the probe inlet on the roof for an intact rain hat and any insect nests inside the rain hat. If there is any evidence of vandalism contact the appropriate law enforcement department (generally this is the city police department if the monitor is within city limits, or the county sheriff’s department if outside city limits), the regional supervisor and the ECB.

##### Power On and Sample Line Check.

Observe the analyzer, calibrator, computer, and data loggers for indications of power failure, and if needed, correct the cause. If the analyzer or calibrator lost power, allow an equilibration period of at least an hour for the instrument(s) to stabilize (converter temperature may require

longer to reach 1000°C). Visually inspect all tubing, especially at any bends, to ensure that it has not been accidentally kinked, crimped, cut, or to ensure that insects have not nested in the lines. Such restrictions in the sample line can usually be determined by first disconnecting the inlet line leading to the converter unit and then observing pump performance. If pump performance (i.e., sample flow, see Section 2.35.2.3.6) is significantly improved and the inlet cyclone itself is not loaded with particulate matter, the sample line will require cleaning or replacement. Also, check the converter “zero air” inlet line that runs from a point next to the cyclone to the HEPA filter at the back of the converter.

#### Gas Cylinder and 146C Calibrator.

Verify that the calibration Protocol gas cylinder (concentrations < 40 ppm are valid for six months) and the calibrator are in certification (calibrator certification is valid for *nine months* with the certification date indicated by a label on the front panel) and document certification dates in the logbook. [If the cylinder pressure **is less than 500 psig** notify the ECB to arrange for delivery of a new cylinder. This delivery must be coordinated with the region to allow time for the region to perform a calibration check just prior to the installation of the new cylinder and to perform a calibration after the installation (see Sections 2.35.2.3.3 and 2.35.2.3.7)]. Verify that the 146C has the correct cylinder SO<sub>2</sub> concentration stored in memory.

#### Thermocouple

Verify that the type K thermocouple is securely plugged into the back of the converter unit and the sensor end is positioned next to the cyclone and not in contact with any metal surface.

### **2.35.2.3.2 Basic Operational Checks of 5020 SPA Analyzer and 146C Calibrator**

#### **Alarm Checks (5020 SPA Analyzer and Converter)**

An active alarm is indicated by an asterisk in the upper right-hand corner of the run screen display of the analyzer. If no alarms are present, record the “Alarm On” checks in the logbook as “**no**” and continue. If the screen shows an alarm, record the “Alarm On” check as “**yes**” in the logbook. View the **Alarms** menu (see Figure 4 in Appendix A) to determine the cause as follows:

- 1) Press the <MENU> button on the front of the instrument to display the main menu.
- 2) Use the ↓ menu pushbutton to select the **Alarms Submenu**.
- 3) Press the <ENTER> button.
- 4) Use the ↑ or ↓ menu pushbuttons to review each item that is in the Alarm Menu.  
**NOTE: Items that are not in alarm status are labeled “OFF”.**
- 5) Press the <ENTER> button to display actual value and upper and lower limits.
- 6) Determine the cause of the alarm. Consult with the ECB prior to performing calibrations or maintenance.
- 7) Press the <MENU> button twice to return the main menu screen.

Note: When parameter returns to proper operating condition, the status will automatically return to “OFF” and the asterisk will go away. In the “notes section” of the logbook, list the parameter causing the alarm and observed value.

**Parameter Set Points**

Verify that the following parameters in the 5020 SPA are correct. Refer to Figure 4 in Appendix A for a flow chart of the analyzer menu-driven software. Use the **Menu** button, the ↓ or ↑, the ← or → buttons and the **Enter** button to display any of these parameters. Record findings in log book.

Parameter	Set Point	Comments
Averaging Time	60 seconds	Fixed, do not change
Sample/Filter Time	10 minutes/5 minutes	Fixed, do not change
Transition Time	120 seconds	Fixed, do not change
Cal Stage Time	25 minutes	Fixed, do not change
Span Concentration	85 ppb	Fixed, do not change
Pressure Correction	ON	Fixed, do not change
Flash Lamp	ON	Fixed, do not change
Converter Temperature	1000 degrees C	900-1050 degrees C
Sample/Filter Mode	ON	Fixed, do not change
Date/Time	EST (must agree with 146C and data logger)	± 5seconds
Span Coefficient	Typically 0.90 to 1.1	Updated at time of calibration
Converter “Zero Air” Flow	At least 2.5 lpm	Flow is observed at rotometer attached to converter (in “Sample Mode” flow is at least 2.5 lpm: in “Filter Mode” flow goes to zero)

**Diagnostics Menu (View only screen)**

With the exception of the cyclone auxiliary flow, these parameters are not adjustable. However, the acceptable ranges are adjustable and have been set by the ECB. Refer to Figure 4 in Appendix A for a flow chart of menu-driven software. Use the **Menu** button, the ↓ or ↑ buttons and the **Enter** button to display these parameters. If any parameter is outside of the acceptable range, an alarm will be activated and a **flashing asterisk** will be observed on run display screen. Record in the logbook and contact the ECB if any parameter is outside of acceptable range.

Parameter	Typical Display Value	Acceptable Range
Internal Temperature	38 °C	35-40 °C
Optical Cell Temperature	45 °C	43-47 °C
Converter Temperature	± 50 °C of Conv. BTE Temp.	900-1050 °C
Converter BTE Temperature	± 50 °C of Conv. Temp.	900-1050 °C
Sample Pressure	710 mm Hg	700-800 mm Hg
Sample Flow	460 cc/min	440- 480 cc/m
Lamp Intensity	15,000 Hz	10,000-20,000 Hz
Lamp Voltage	1012 Volts	950-1200 Volts
Cyclone aux(illary) flow (note: this value is displayed on the PC screen via E:DAS as "Auxflow")	450 cc/min	Must equal 910 minus sample flow (flow is adjustable via set-pot screw on MFC)
Ambient Conditions, Press/Temp	760 mm Hg/25° C	NA
Photomultiplier Tube	-689 volts	NA

### **Zero Air Pack and Compressor Checks**

Verify that the zero air system air purification chemicals are changed at least once per year and that the silica gel is not spent as indicated by color change. When the gel is new it is a dark blue or purple color. If the gel is spent, it is a lighter blue or purple color with white crystals. If the gel is spent, replace it and return the spent gel to the ECB for regeneration. Verify that the pressure gauge on the Zero Air Supply is reading 30 psi ± 2 psig. Record reading. Verify and record that the outlet pressure on the air compressor is reading between 35 and 45 psig. If either pressure reading is outside of these ranges, contact the ECB and record corrective action. Also, check and drain any water from the compressor (do this at every site visit).

### **Cooling Fans and Filters on the 5020 SPA Analyzer/Converter and 146C**

On the back of the instruments there are cooling fans with sponge filters inside (one each on analyzer, converter, and 146C). Check to ensure the fans are running. During every site visit clean the filters. The fan housing can be popped off the back of the instrument to allow access to the filter. The sponge filter should be removed and cleaned either by rubbing with a cloth, rubbing between your hands or using a source of compressed air). After cleaning, replace the filter and the housing. Record in the logbook.

### **Time and Date Checks and Adjustments**

The times for the PDL, BUDL (if used), 5020 SPA and site computer must be EASTERN STANDARD TIME (EST). The PDL and BUDL must display the same time (± 5 seconds) *and*

be synchronized to the NIST time provider in Colorado ( $\pm 1$  minute). Sources of the NIST time include:

- cell phones (most are synchronized to local NIST time, not necessarily “standard” time);
- calling Colorado (303-499-7111);
- setting a watch to the NIST website (<http://nist.time.gov/>) within 24 hrs of visiting the site;
- calling ECB and asking for the NIST time.

In addition to the data loggers, the site computer must be set to  $\pm 5$  seconds of the data logger. The site computers are automatically synchronized by the data logger and should not be synchronized to/by the HQ polling computer, nor should they be synchronized to a region’s polling computer.

*Procedure for synchronizing clocks:*

- 1) Obtain NIST EST;
- 2) Verify/set PDL to NIST EST  $\pm 1$  minute;
- 3) Verify/set BUDL to PDL  $\pm 5$  seconds;
- 4) Verify 5020 SPA is  $\pm 2$  seconds of PDL; and
- 5) Verify/set site PC to PDL  $\pm 5$  seconds.

(Note: The data logger has been programmed to automatically update the 5020 SPA clock every 1-minute so that the PDL and analyzer times are constantly synchronized.)

To adjust the site PC, “right click” the time in the lower right corner of the windows screen and select <Adjust Date/Time> from the menu options. Correct the time/day and ensure that the time is in “EASTERN STANDARD TIME”. Click <OK> to finish.

To adjust the PDL and BUDL, open the Primary and Backup Data Logger screens on the site computer (shortcut to split screen option on Windows desktop). For the PDL, type in the two-letter site code (front of the PDL) and “AQM” (\_\_\_ AQM). For the BUDL, type in its two-letter site code (front of the BUDL) and “AQM” (\_\_\_ AQM). **Note:** the PDL and BUDL have different codes.

For the PDL, log in, <esc><esc><esc>:

- 1) Select “L”, (login)
- 2) Type password “XXXXXXXXXX” (*highest level password*, this will allow calibration options not otherwise viewable in subsequent steps)
- 3) <ENTER>
- 4) Select “C”, (configuration menu)
- 5) Select “S”, (system configuration parameters)
- 6) Select “Date-Time”
- 7) <ENTER>

If the date and time is correct continue on to the next task. If it needs to be corrected, type in the correct values and press <ENTER>.

For the BUDL, log in:

- 1) Select “L”, (login)
- 2) Type password “XXXXXXXXXX”
- 3) <ENTER>
- 4) Select “C”, (configuration menu)
- 5) Select “S”, (system configuration parameters)
- 6) Select “Date-Time”
- 7) <ENTER>

If the date and time is correct continue on to the next task. If it needs to be corrected, type in the correct values and press <ENTER>.

If a correction to the time and/or date are made for the computer, PDL, and/or BUDL, document it in the logbook by recording how far off the values were.

### 2.35.2.3.3 Calibration Check Procedure

The purpose of the Calibration Check is to correlate the output of the 5020 SPA with known, traceable concentrations of SO<sub>2</sub>. The Calibration Check is a manually initiated response check of the instrument’s calibration and is referred to as a “One Point QC Check” using the lowest concentration or SPAN 3 value. (This was formerly called an *unadjusted calibration or Precision Check*.) A “One Point QC Check” is required by the EPA, however the DAQ requires zero, SPAN 1 and SPAN 2 to be run in addition to SPAN 3.

Visit the site at least once every two weeks (EVERY 14 DAYS OR LESS) to perform a CALIBRATION CHECK. Perform a CALIBRATION CHECK prior to any maintenance, audit or scheduled interruption of monitor operation lasting more than 48 hours as discussed under Section 2.35.2.3.10. (Maintenance activities that *do not* affect calibration are cyclone cleaning, denuder change out, cooling fan filter cleaning, and 47 mm 1 µm membrane filter and HEPA particulate filter replacement.) If a CALIBRATION CHECK *fails* (see Table 1 for acceptable ranges), a CALIBRATION (formerly “adjusted calibration”) *must be* performed (see Section 2.35.2.3.7). **No checks that affect data are to be made during periods when the level of sulfate is observed to be greater than typical historical levels.**

**Make no monitor adjustments and ensure that the PDL and BUDL are “down” before performing the Calibration Check.**

Conduct a Calibration Check as follows:

NOTE: The following procedure is to be performed with the instrument **remaining** in the “automatic cycle mode”, i.e., normal operating mode for data collection. The analyzer run screen will show that the instrument is cycling between filter mode and sample mode, but the only parameter that is of concern is the “SO2 PPB” displayed on the analyzer screen.

- 1) Log into the computer if needed (type your user name, “*initials*”; and password, “XXXXXXXXXX”). If a BUDL is being used, choose “Shortcut to Split Screen” on the

Windows desktop or from the ESC main menu select “**Utilities**”. Select “**Login**”, Double Click on “**SPLIT SCREEN**”, the PDL should be displayed on the top half of the monitor and the BUDL on the lower half.

- 2) Log into the PDL.  
<Esc>  
type “site code AQM” (example **MLAQM**)  
<ENTER>  
select “**L**”  
type password “” (*highest level password*)  
<ENTER>
- 3) Down the PDL.  
<Esc> back to return to Home Menu  
select “**C**” (configuration menu)  
select “**D**” (configure data channels)  
select “**M**” (mark channels down/ off)  
highlight SO2CORR, SO4CTS, and SO4CYC  
<ENTER>
- 4) Log into the BUDL (if BUDL is being used).  
<Esc>  
type “site code AQM” (example **MLAQM**)  
<ENTER>  
select “**L**”  
type password “”  
<ENTER>
- 5) Down the BUDL.  
<Esc> back to return to Home Menu  
select “**C**” (configuration menu)  
select “**D**” (configure data channels)  
select “**M**” (mark channels down/ off)  
highlight SO2CORR, SO4CTS, and SO4CYC  
<ENTER>
- 6) View the PDL.  
<Esc> back to return to Home Menu  
select “**D**” (display real-time)  
select “**B**” (base average one minute)  
(Updated data should display a (D) indicating the “downed” channel.)
- 7) View BUDL.  
<Esc> back to return to Home Menu

select “**D**” (display real-time)  
select “**B**” (base average one minute)  
updated data should display a (D) indicating the ‘downed’ channel

- 8) Disconnect the ¼” Teflon sample line from the “Sample In” port on the rear of the analyzer. Disconnect the ¼” Teflon line (coming from the 146C calibrator) from the “Span/Zero” port on the rear of the analyzer and connect it to the “Sample In” port on the rear of the analyzer.
- 9) On the 146C calibrator, press **MENU**, press **ENTER** to display “Local Mode” then press **RUN**. Select “Gas C” and press **ENTER** then Select “Span 0” and press **ENTER**. This introduces zero gas to the analyzer. **Allow the concentration readings to stabilize** (will require at least 10 minutes) and then record in the log book the next five one-minute PDL and BUDL SO<sub>2</sub> concentration values. Also record the “True” 146C “Output PPB” concentration from the calibrator display. Calculate the average of each and record.
- 10) On the 146C calibrator, press the → button to move to “Span 1” and press **ENTER**. In the log book, record the 146C flows (push “Run” to see flows) and theoretical SO<sub>2</sub> concentration (i.e., 85 ppb). This introduces Span 1 gas to the analyzer. **Allow the concentration readings to stabilize** (will require at least 10 minutes) and then record in the logbook the next five one-minute PDL and BUDL SO<sub>2</sub> concentration values. Calculate the average of each and record.
- 11) On the 146C calibrator, press the → button to move to “Span 2” and press **ENTER**. In the logbook, record the 146C flows and theoretical SO<sub>2</sub> concentration (i.e., 45 ppb). This introduces Span 2 gas to the analyzer. **Allow the concentration readings to stabilize** (will require at least 10 minutes) and then record in the logbook the next five one-minute PDL and BUDL SO<sub>2</sub> concentration values. Calculate the average of each and record.
- 12) On the 146C calibrator, press the → button to move to “Span 3” and press **ENTER**. Span 3 is also known as the 14-day “One Point QC Check” and previously as the “Precision Point”. In the logbook, record the 146C flows and theoretical SO<sub>2</sub> concentration (i.e., 7 ppb). This introduces Span 3 gas to the analyzer. **Allow the concentration readings to stabilize** (will require at least 10 minutes) and then record in the logbook the next five one-minute PDL and BUDL SO<sub>2</sub> concentration values. Calculate the average of each and record.
- 13) Disconnect the ¼” Teflon line (coming from the 146C calibrator) from the “Sample In ” port on the rear of the analyzer and re-connect it to the “Span/Zero” port on the rear of the analyzer. Re-connect the ¼” Teflon sample line coming from the converter unit to the “Sample In” port on the rear of the analyzer.

14) On the 146C Calibrator, press **MENU**, select “Remote” and press **RUN**. This allows the 146C to be controlled by the data logger for automated daily calibration checks.

Using the average concentration value for each of the span points, calculate the difference as follows:

$$\text{Difference} = C_{DL} - C_{ACT}$$

where:  $C_{DL}$  = Average Concentration (from PDL or BUDL)  
 $C_{ACT}$  = Actual Concentration (from 146C “Output PPB” Display)

Record each result in the logbook and on the AQS-98 “Precision” form provided in Appendix E. **The zero on the PDL and BUDL must be within  $\pm 2$  ppb of 0.00. The concentration displayed on PDL and BUDL for Span 1 and Span 2 must be within  $\pm 3$  ppb of the true value and Span 3 must be within  $\pm 2$  ppb of the true value.** (See Table 1 for a Summary of the Acceptance Criteria).

**Table 1. Acceptance Criteria for Calibration and QC Checks**

Calibration Gas	Zero	Span 1	Span 2	Span 3
Span, ppb	0.00	85	45	7
Full Calibration	$\pm 1$ ppb	$\pm 3$ ppb	$\pm 3$ ppb	$\pm 2$ ppb
14 Day QC Check	$\pm 2$ ppb	$\pm 3$ ppb	$\pm 3$ ppb	$\pm 2$ ppb

If the Calibration Check is acceptable, proceed to “Filter Change Procedure”, Section 2.35.2.3.4. If the calibration check points *are not* within the required ranges of the  $C_{ACT}$  values, then conduct the required **re-CALIBRATION (See section 2.35.2.3.7) after performing a 47 mm 1  $\mu$ m filter change, flow check and leak check.** After completing all scheduled maintenance activities the channels must be enabled as follows:

15) ENABLE (up) CHANNELS ON PDL & BUDL

**Note: Before enabling the channels allow one complete cycle (filter mode, sample mode, filter mode) to be completed. This will require up to 30 minutes.**

- highlight the PDL,
- select “C” (Configuration Menu),
- select “D” Configure (Data Channels),
- Select “E” Enable/Mark Channel Online,
- highlight “SO2CORR”, “SO4CTS”, and “SO4CYC” and Press <ENTER>,
- highlight the BUDL, and repeat the above instructions to enable the BUDL channels.

#### 2.35.2.3.4 Filter Change Procedure

The 47 mm 1 µm filter, located at the converter sample outlet port, must be **replaced at a minimum of every** 14-days. Always change the filter *after* a “calibration check” and *before* performing a “re-calibration”. The filter to be used is a 1.0-micron, 47 mm diameter membrane filter and should not be substituted with a 5 micron filter that is typically used with other instrumentation. (Note: Before performing this procedure, see Health and Safety Section 2.35.2.1.3). Ensure that the channels are “downed” before performing a filter change. The filter change procedure is as follows:

1. Detach the ¼” Teflon sample line from the filter holder at the sample outlet of the converter unit and then remove the filter holder half by unscrewing counter clockwise. Note the position of the filter and Teflon filter support so that they can be replaced in the proper order. The filter has no distinct front or back and can therefore placed in any orientation;
2. Remove the existing filter and discard. Remove any extraneous material from filter housing and Teflon filter support.
3. Touching only the outer edges, place the new filter in the holder followed by the filter support.
4. Reassemble the filter holder and reconnect the ¼” Teflon sample line. **Do not over tighten the filter holder as this can tear the filter and/or damage the holder.**
5. Perform a leak check to test the integrity of the filter assembly (See Section 2.35.2.3.5).

#### 2.35.2.3.5 Leak Check Procedure

The Leak Check must be performed during each 14-day site check after performing the Calibration Check, the 47 mm filter change out, or after any component (such as denuder or HEPA filter) is changed out.

The procedure is as follows:

*Through the entire system from cyclone inlet through analyzer*

**Note: At this point the leak check procedure can only be performed with the system in the sample mode (a 10 minute window) and not in the filter mode. Ensure that the channels are “downed”.**

1. From the run screen press **menu** button, use ↓ button to display **Diagnostics**, then press **Enter** button.
2. Use ↓ button to display **Sample Pressure/Flow**, then press **Enter** (for normal operation, the flow should be between 400 and 500 cc/min and the pressure should be

- between 700 and 800 mm Hg with steady readings. A flow of less than 400 cc/min and a pressure less than 700 mm Hg indicates potential problems in the sample flow path such as a plugging 47 mm filter, or failing converter core. See Section 2.35.2.3.6 on flow measurement to help determine the cause of the problem.)
3. From the building roof, remove the rain-hat (friction fit, see Figure 1), remove the cyclone cover (using screw driver, see Section 2.35.2.3.12 and Figure 5), remove the cyclone inlet body (using the supplied Allen wrench) and seal cyclone inlet with plug provided by ECB at installation. Disconnect the cyclone auxiliary flow line from the flow splitter and cap the 3/8" flow splitter outlet.
  4. Observe the sample **pressure/flow** readout on the screen of the monitor for decreasing values. Values should be dropping toward zero. The system leak check passes when the flow drops below 200 cc/min and the pressure drops below 300 mmHg. This should require approximately 5 minutes.
    - 4a. If passing, record values, replace the cyclone inlet body, the cyclone cover and the rain-hat and reattach the cyclone auxiliary flow line to the splitter.
    - 4b. If the leak check fails, ensure that all fittings/connections are tight and repeat step 4. If leak check fails again continue on to step 5.

**Note: At this point the analyzer can be in either the "Sample Mode" or the "Filter Mode".**

5. Disconnect the 3/8" stainless steel sample inlet line from the sample inlet port on the back of the converter module and cap the inlet port with 3/8" plug supplied by ECB at installation.
6. Repeat step 4 above.
- 6a. If leak check passes, leak is in the sample inlet line between the cyclone and the sample inlet on the back of the converter unit. Disconnect both the zero air supply line (coming from the converter module) and the cyclone auxiliary flow line from the splitter and cap the two fittings on the splitter. Repeat steps 1,2 and 4 after systematically isolating each component of the sample inlet line (cyclone, splitter, denuder, etc.). If leak check continues to fail call the ECB.

#### Converter through analyzer

- 6b. If leak check fails, ensure that the connections for the 1/4" Teflon sample line running from the converter sample outlet to the analyzer sample inlet are tight, as well as the 47 mm filter holder on the converter outlet, and repeat step 4 above. If **Sample Pressure/Flow** fails to drop below 300 mm Hg and 200 cc/min respectively within approximately 5 minutes, a leak is present in either the converter unit or the analyzer unit. Proceed to step 7.
7. Disconnect the 1/4" Teflon sample line that connects the converter to the analyzer and cap the analyzer sample inlet port with the plug provided by ECB at installation. Repeat step 4 above.
- 7a. If leak check passes, the leak is in the converter unit and is most likely associated with the high temperature quartz tube. **For safety reasons, do not attempt to fix the leak.** However, do call the ECB and turn the high temperature converter oven off to

allow at least three hours for cooling. The converter oven temperature is powered down as follows: press the **menu** button one or more times as needed to reach the **main menu** screen. Use ↓ button to find **Instrument Controls**, use ↓ button to find **Converter Oven Shut Off**, then use ↓ or ↑ buttons to toggle to the off position, press the **Enter** button to accept the change. The screen should say “Converter Oven Off”.

#### Through Analyzer Only

7b. If leak check fails, the leak is in the analyzer unit. Call the ECB.

When a successful leak test has been achieved, ensure that the cyclone auxiliary flow line and the zero air line are connected to the flow splitter and document all findings in the logbook.

### 2.35.2.3.6 Flow Check

#### **Flow Check Procedure**

Air flow is generated at three locations within the 5020 SPA sampling and analysis system:

- 1) **Sample Flow** is generated by the pump in the analyzer unit, which creates a flow of nominally 460 cc/min. from the cyclone inlet through the analyzer. This flow is continually measured and monitored by the analyzer module with a readout provided by the analyzer under the **Diagnostics** menu for **Sample Pressure/Flow** display;
- 2) **Auxiliary or Cyclone By-Pass Flow** is generated by an external Thomas pump and is measured and controlled by an external mass flow controller. This flow is nominally 450 cc/min. and should be adjusted, as necessary, as discussed below. This flow reading is displayed on the site PC through a signal from the data logger and is identified as “Auxflow”.
- 3) **Zero Air Flow** is generated by a pump within the converter unit and is used in conjunction with the “Filter Mode” of the analyzer. This flow must be greater than the sum of the “sample flow” plus the “auxflow” and has been re-configured by the ECB to be nominally 2.5-3.5 lpm. This flow should not be confused with the zero air that is generated by the zero-air-pack and used for analyzer calibration and/or calibration checks with the 146C calibrator. Determining the actual value of this flow is not required, but should be at least 200-300 cc/min in excess of the total flow generated by 1 and 2 above. In the “Sample Mode”, this flow is indicated by the rotometer connected to the converter vent outlet.

#### **Sample Flow Rate Check**

The sample flow rate, as described above, is checked by placing a “Dry-Cal” flow meter (suggested flow range of 0-2 lpm) in line as part of the sample flow path. This is accomplished by first disconnecting the ¼” Teflon sample line (coming from the converter unit) from the sample inlet port on the back of the analyzer unit (see Figure 1, Point A). Then, connect the “Dry-Cal” outlet port to the analyzer sample inlet port on the back of the analyzer unit and

connect the “Dry-Cal” inlet port to the ¼” Teflon line that comes from the converter unit. These connections can be made by using short pieces of gum rubber tubing or by employing other leak tight procedures. After allowing 3-5 minutes for equilibration time, compare the “Dry-Cal” readings (averaged over 1-2 minutes) to that of the analyzer readout. These two measurements should agree within  $\pm 10$  cc/min. In addition, the analyzer reading should be within  $\pm 10$  cc/min. of 460 cc/min. (or a similar flow rate as determined and recorded at installation, immediately after any maintenance is performed on the sample flow components or the flow rate determined during the previous 14-day visit). A flow rate that is  $> 10$ cc/min. from the previously recorded value may be indicative of a leak (see Leak Check Procedure, Section 2.35.2.3.5). A flow rate that is  $< 10$  cc/min. from the previously recorded value may be indicative of a flow restriction caused by particulate in either the glass capillary in the analyzer unit or in the ⅛” Teflon line leading from the high temperature catalyst in the converter unit or a faulty pump in the analyzer unit. In the case of low flow, contact the ECB. Record results in logbook.

### **Auxiliary or Cyclone By-Pass Flow Rate Check**

The cyclone “Auxflow”, as described above, is controlled by an external mass flow controller (MFC) and the flow rate value is monitored by an analog output which is accessible by monitoring the data logger “Auxflow” channel on the On-Site PC. To measure this flow rate, first place a “Dry-Cal” flow meter (suggested flow range of 0-2 lpm) in line as part of the “Auxflow” flow path. This is accomplished by first disconnecting the ¼” Teflon line (coming from the Flow Splitter and going to the MFC) from the inlet port of the MFC. Then, connect this line to the “Dry-Cal” inlet port. Using a separate ¼” Teflon line, connect the outlet of the “Dry-Cal” to the inlet of the MFC. These connections can be made by using short pieces of gum rubber tubing or by employing other leak tight procedures (see Figure 1, Point B). After allowing 3-5 minutes for equilibration time, compare the “Dry-Cal” readings (averaged over 1-2 minutes) to that of the “Auxflow” reading on the “On-Site” PC. These two measurements should agree within  $\pm 5$  cc/min (if not see below). After determining that these two readings agree within  $\pm 5$  cc/min, this measured flow rate should be set to a value that is determined by subtracting the **analyzer sample flow rate** from **910**. (910 cc/min. is the flow rate through the cyclone that is necessary to maintain the PM cut at 2.5 microns.) For example, if the **sample flow rate** is determined to be 460 cc/min., then the required “Auxflow” should be 450 cc/min. If the observed “Auxflow” is not set at the required flow, then adjust the “Auxflow” using a screw driver to turn the “Setpoint Potentiometer” on the MFC (see Figure 6) while observing the flow readout value on the On-Site PC. This flow is independent of the operation of the analyzer/converter units and can be adjusted in either the “filter mode” or the “sample mode”. If the required flow rate cannot be achieved, contact the ECB. Observe the flow rate for 3-5 minutes to obtain a constant reading and then record the observed flow rate (and the adjusted flow rate if changes are made).

If the “Auxflow” reading from the “Dry-Cal” and the reading displayed on the “On-Site PC” do not agree within  $\pm 5$  cc/min, then the “Engineering Units” (EU) in the E:DAS program for “High Output” and “Zero Output” for the “Auxflow” channel need to be changed. This is accomplished as follows:

- 1) Press **ESC** on the Site PC until the Main Menu is displayed
- 2) Press "**C**" (Configuration Menu)
- 3) Press "**D**" (Configure Data Channels)
- 4) Press "**C**" (Change Old Configuration)
- 5) Select "Auxflow" channel and press **Enter**
- 6) Observe the current values for the "High Output" and the "Zero Output". For example, if the current values are 1000 and 0.0 respectively, and the difference between the "Dry-Cal" reading and the data logger reading is 12, the "High Output" should be changed to 1012 and the "Zero Output" changed to 12.
- 7) Select "High Output" and enter 1012
- 8) Select "Zero Output" and enter 12
- 9) Press **Enter** several times until **Finished Configuration** is highlighted and press **Enter**
- 10) Return to "Real Time Data" to verify that the two readings are now within  $\pm 5$  cc/min.

### **Zero Air Flow Rate Check**

The zero air flow is generated by the converter unit pump for use during the filter mode. (This flow should not be confused with the zero air used for calibration.) In the "sample mode", this flow is diverted into the room as exhaust and can be measured by observing the rotometer that is attached to the vent outlet on the back of the converter unit. This flow should be nominally 2.5-3.5 lpm, an excess of at least 200-300 cc/min. over that required by the sample flow plus the cyclone auxiliary flow, and is a parameter that is not adjustable in the field. In the "filter mode", this flow is directed to the splitter, where nominally 910 cc/min. is consumed by the "Sample Flow" and the "Auxiliary Flow", with the excess being directed out through the cyclone. In the "filter mode", the rotometer should indicate no flow. The responsibility of the operator is to observe and record the rotometer flow at least once for each mode of operation. If the observed flow drops below 1.5 lpm during the "Sample Mode" or flow is observed during the "Filter Mode" contact the ECB.

#### **2.35.2.3.7 Calibration (Zero and Span)**

A CALIBRATION (formally adjusted calibration) *must* be performed **after** a failed 14 day CALIBRATION CHECK, a failed DAILY AUTO CALIBRATION CHECK, a failed (and corrected) LEAK CHECK and once every six months even if calibration checks pass. Document all checks and adjustments in the logbook (see Table 2 for Calibration values). An EPA Protocol SO<sub>2</sub> Cylinder with a nominal concentration of 10 ppm is required.

A CALIBRATION *must* be performed after a major system or component has been replaced or repaired. Major systems are defined as:

- the analyzer module;
- the converter module (a new converter core will require 12 hours of "burn-in-time");
- the 146C calibrator;

- the SO<sub>2</sub> cylinder (calibration check is required immediately prior to change out); and
- the Zero Air System used for calibration (not to be confused with the zero air generated by the converter module)

The instrument response is linear over the range of 0 to 100 ppb of SO<sub>2</sub>. Therefore the internal software allows only a single span point for calibration. A Calibration consists of re-setting the instrument zero using zero air and re-setting the calibration factor using the highest calibration gas (i.e., Span 1). In doing so, the instrument calibration factor is manually adjusted and should be between 0.90 and 1.1 with a value of 1.0 being ideal. After performing a calibration, this value should be recorded in the logbook. Intermediate span points (span 2 and span 3) are introduced to the analyzer and the values simply recorded in the logbook.

A CALIBRATION must be performed when the monitoring system's operation has been interrupted for more than 2 days (as in the case of power outages, or precautionary shutdowns such as hurricanes).

*Calibration Procedure:*

**NOTE:** The PDL and BUDL (if being used) channels should be "down" before performing a Calibration.

**NOTE:** The following procedure is to be performed with the instrument **remaining** in the "automatic cycle mode", i.e., normal operating mode for data collection. The analyzer run screen will show that the instrument is cycling between filter mode and sample mode, but the only parameter that is of concern is the "SO<sub>2</sub> PPB". **DO NOT USE THE "ZERO ADJUST" OR "SPAN ADJUST" FUNCTION UNDER THE "CALIBRATION" MENU. INSTEAD USE THE "INSTRUMENT ZERO" OR "SO<sub>2</sub> SPAN COEFFICIENT" FUNCTION UNDER THE "CALIBRATION FACTORS" MENU.**

**A) Zero Set Procedure:**

- 1) Log into the computer if needed (type your user name, "*initials*"; and password, "██████"). Choose "Shortcut to Split Screen" on the Windows desktop or from the main menu select "**Utilities**". Select "**Login**", Double Click on "**SPLIT SCREEN**", the PDL should be displayed on the top half of the monitor and the BUDL on the lower half.
- 2) Log into the PDL.  
<Esc>  
type "site code AQM" (example **MLAQM**)  
<ENTER>  
select "**L**"  
type password "██████" (*highest level password*)

<ENTER>

- 3) Down the PDL.  
<Esc> to return to Home Menu  
select “C” (configuration menu)  
select “D” (configure data channels)  
select “M” (mark channels down/ off)  
highlight SO2CORR, SO4CTS, and SO4CYC  
<ENTER>
- 4) Log into the BUDL (if BUDL is being used).  
<Esc>  
type “site code AQM” (example **MLAQM**)  
<ENTER>  
select “L”  
type password “XXXXXXXXXX”  
<ENTER>
- 5) Down the BUDL.  
<Esc> to return to Home Menu  
select “C” (configuration menu)  
select “D” (configure data channels)  
select “M” (mark channels down/ off)  
highlight SO2CORR, SO4CTS, and SO4CYC  
<ENTER>
- 6) View the PDL.  
<Esc> to return to Home Menu  
select “D” (display real-time)  
select “B” (base average one minute)  
(Updated data should display a (D) indicating the “downed” channel.)
- 7) View BUDL.  
<Esc> to return to Home Menu  
select “D” (display real-time)  
select “B” (base average one minute)  
updated data should display a (D) indicating the ‘downed’ channel
- 8) Disconnect the ¼” Teflon sample line from the “Sample In” port on the rear of the analyzer. Disconnect the ¼” Teflon line (coming from the 146C calibrator) from the “Span/Zero” port on the rear of the analyzer (see Figure 1, Point C) and connect it to the “Sample In” port on the rear of the analyzer.

- 9) On the 146C calibrator, press **MENU**, press **ENTER** to display “Local Mode” then press **RUN**. Select “Gas C” and press **ENTER** then Select “Span 0” and press **ENTER**. This introduces zero gas to the analyzer.
- 10) From the “Main Menu” of the 5020 SPA analyzer, use the ↓ button to select “Calibration Factors”, use the ↓ button to select “Instrument Zero” and press **ENTER**.
- 11) Allow the “SO<sub>2</sub> ppb” readings on the analyzer display to stabilize (will require at least 10 minutes) and then use the ↑ or ↓ buttons until the average reading is  $0.00 \pm 1.0$  ppb, then press **ENTER**. Record in the logbook the next five one-minute PDL and BUDL SO<sub>2</sub> concentration values and the average. Also record the “True” 146C “Output PPB” concentration from the calibrator display.

**B) Span Set Procedure:**

- 1) From the “Main Menu” of the 5020 SPA analyzer, use the ↓ button to select “Calibration Factors”, use the ↓ button to select “SO<sub>2</sub> Span Coefficient” and press **ENTER**.
- 2) On the 146C calibrator, press the → button to move to “Span 1” and press **ENTER**. In the logbook, record the 146C flows (push “Run” to see flows) and theoretical SO<sub>2</sub> concentration (i.e., 85 ppb). This introduces Span 1 gas to the analyzer.
- 3) Allow the “SO<sub>2</sub> ppb” readings on the analyzer display to stabilize (will require at least 10 minutes) and then use the ↑ or ↓ buttons to change the “COEF” value until the average reading is  $85.0 \pm 3$  ppb, then press **ENTER**. (The Coefficient value should be close to 1.00, record value in logbook.) Record in the logbook the next five one-minute PDL and BUDL SO<sub>2</sub> concentration values and the average. Also record the “True” 146C “Output PPB” concentration from the calibrator display.

**C) Verification of Calibration (Multi-point Calibration Check):**

- 1) To verify linearity, sequentially introduce zero air, Span 1 (85 ppb), Span 2 (45 ppb) and Span 3 (7 ppb) calibration gases from the 143C calibrator **with the 5020 SPA still in the “SO<sub>2</sub> Span Coefficient” menu. DO NOT press ENTER during this process as this will reset the calibration coefficient to an erroneous value.** After allowing sufficient time for each reading to stabilize as discussed above, record five one-minute PDL, BUDL (if being used) and 5020 SPA concentration values in the logbook and then compute and record the average of those one-minute concentration values. Also record the “True” 146C “Output PPB” concentration from the calibrator display.

Using the average concentration value for each of the span points determined under “**Verification of Calibration (Multi-point Calibration Check)**”, calculate the difference as follows:

$$\text{Difference} = C_{DL} - C_{ACT}$$

where:  $C_{DL}$  = Average Concentration (from PDL, BUDL or 5020 SPA)  
 $C_{ACT}$  = Actual Concentration (from 146C “Output PPB” Display)

Record each result in the logbook and on the AQS-98 “Precision” form provided in Appendix E. **The zero on the PDL and BUDL must be within  $\pm 1$  ppb of 0.00. The concentration displayed on the PDL and BUDL for Span 1 and Span 2 must be within  $\pm 3$  ppb of the true value and Span 3 must be within  $\pm 2$  ppb of the true value.** (See Table 1 for a Summary of the Acceptance Criteria).

**NOTE:** The zero and span adjustments interact to set the instrument response and may require more than one attempt to meet the specifications given in Table 1. In most cases, the initial zero and span adjustments will be sufficient for the calibration to pass and additional adjustments will not be necessary. If several (4 or more) zero-span adjustments fail to obtain acceptable responses, call the ECB.

**NOTE:** If the BUDL value does **NOT** agree with the actual Span 1 concentration within  $\pm 3$  ppb and if the PDL and the BUDL values do not agree within  $\pm 3$  % of each other, log in to BUDL using the highest level password, then make the following BUDL adjustments:

1. Press **Esc** and **Esc**, slowly.
2. Press “**C**” (Configuration Menu), then press “**D**” (Configure Data Channels), then press “**C**” (Change Old Configuration). If these options are not available, you have not logged in with the highest password. Press **Esc** until you reach home menu, then log in again using the highest-level password. **MAKE SURE SCROLL LOCK FUNCTION IS OFF.**
3. Select “SO2CORR” channel and press **Enter**. Select “**High Output**” for span (calibration) upper range limit. The Engineering Units (or E.U.) entered here are ppb concentrations units.
4. To determine a new value to enter here consider the following example:  
If the instrument is calibrated on a 0 to 100 ppb range, the “zero” and “high” outputs on the PDL should be set to 0 and 100 respectively as well as on the BUDL. If the BUDL output, in normal running mode, displays different concentration values than the PDL, such as -4.0 and 96 for zero and span, then new E.U. values need to be entered in the BUDL. Considering the calibration range to be a sliding fixed scale, the difference between 0 and 100 is 100 as is the difference between -4.0 and 96. The difference between the two zero readings is 4.0 and the difference between the two span readings is

- 4.0. To adjust the BUDL, change the **Zero Output** from 0.0 to 4.0 and change the **High Output** from 100 to 104.
5. Press **Enter** several times until **Finished Configuration** is highlighted and press **Enter**. Turn **ON** the Scroll Lock function key on the keyboard, and press **“Page Up”** until the full “Channel Configuration Menu” is visible.
6. Press **“Scroll Lock”** to turn off the scroll lock function, then press **“Esc”** and **“Esc”**. Review and retest zero and span concentrations as needed. This BUDL adjustment may need to be repeated until the BUDL SO2CORR channel is reading the true SO<sub>2</sub> concentration. **(After several tries, call the ECB if you still do not get acceptable BUDL values.)**
7. When finished, Select **“D”** (real time data), and Press **“B”** (last base averages).

**Table 2. 5020 SPA SO<sub>2</sub> Calibration Ranges and Levels for 100 ppb Full Scale**

SPAN Level	Range, ppb	Actual, ppb
Span 1 (70-90 % of Full Scale)	70-90	85
Span 2 (40-50% of Full Scale)	40-50	45
Span 3 (16-20% of Full Scale)	10-100 <sup>A</sup>	7.0 <sup>A</sup>
Zero	0.0	0.0

<sup>A</sup> Per 40 CFR Part 58, the QC Check (i.e., Span 3) must be between 10 and 100 ppb **or** at a level that would more appropriately reflect the precision and bias at lower levels that are routinely encountered.

**D) End Calibration Procedures**

To end the calibration procedures, do the following:

- 1) Disconnect the ¼” Teflon line (coming from the 146C calibrator) from the “Sample In ” port on the rear of the analyzer and re-connect it to the “Span/Zero” port on the rear of the analyzer. Re-connect the ¼” Teflon sample line coming from the converter unit to the “Sample In” port on the rear of the analyzer.
- 2) On the 146C Calibrator, press **MENU**, select “Remote” and press **RUN**. This allows the 146C to be controlled by the data logger for automated daily calibration checks.
- 3) Press the **RUN** button on the 5020 SPA analyzer to return to the “Run Screen Display”. The analyzer display should indicate either “Mode Sample” or “Mode Filter” and values for “SO<sub>2</sub> PPB”, “SO<sub>4</sub> ug CONTS” and “SO<sub>4</sub> ug CYCLE”. If this is not the case call the EBC.
- 4) ENABLE CHANNELS ON PDL (and BUDL if used).

**Note: Before enabling the channels, allow one complete cycle (filter mode, sample mode, filter mode) to be completed. This will require up to 30 minutes.**

- highlight the PDL,
- select “C” (Configuration Menu)
- select “D” Configure (Data Channels)
- select “E” Enable/Mark Channel Online
- select “SO2CORR”, “SO4CTS”, and “SO4CYC” and Press <ENTER>
- highlight BUDL, and repeat to enable the BUDL

When finished, exit to the "Home Menu", by pressing <Esc> and <Esc>. Verify that the channels are enabled by pressing "D" and then "F". Press ESC and ESC to go back to the home menu, press “O” (Log out) and CTRL-ESC to exit. Exit the Split Screen operation (if applicable).

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

**Note:** Remember to sign out and reset the scheduler for normal operation.

#### 2.35.3.3.8 Auto Daily Calibration Check Procedure

This procedure is initiated from the data logger, which has been programmed to control both the 146C calibrator and the 5020 SPA, and is used to perform automatic daily calibration checks of “Zero”, Span 1 (85 ppb), Span 2 (45 ppb) and Span 3 (QC point, 7 ppb). Since this procedure will require approximately 1½ hours to complete, the “calibration stage time” for the analyzer unit should be set to 25 minutes (pre-set by the ECB) to ensure that all calibration points plus “flush time” have sufficient time to stabilize.

#### 2.35.2.3.9 Back-up Data and End

Every month, the Data Management and Statistical Services Branch (DMSSB) initiates a data review by printing a raw data report for each field office. Each month, the Regional Offices may be requested to down load and send specific data sets that are stored on the BUDL (if being used). These data are needed for verifying or completing certain data files originally supplied by the field offices. Any data files that are requested, will be made available, as electronic files, to the central office by the same deadline that is established for returning the raw data review. Every 14-days the data stored on the BUDL is to be downloaded to a removable data storage medium (Zip disk, CD). **Backup Data are to be stored to disk as follows:**

1. Open the BUDL window,
2. Log in, password <██████>.
3. Select <Utilities>.
4. Select <Copy File>.

5. Select <**Data Files**>.
6. Select <**Minute Data**>.
7. Select <**Range**>.
8. Select the <**Start Date**>.
9. Select the <**End Date**>.
10. Select the drive to copy the data to.
11. Insert a disk / zip disk / CD into the drive.
12. Select <**Copy**>.

Label the storage medium with the following information: site, instrument (i.e., 5020 SPA), time period covered, date backup was created and operator name.

If a BUDL is not used at a specific site, back-up data will be obtained by down loading the data directly from the serial port on the rear of the analyzer. The software named “Data Retriever” will be supplied by ECB to the Regional Site Operators. See Appendix D, “Data Retriever Procedure”.

### 2.35.2.3.10 Scheduled Maintenance

Refer to the following Table for the list of maintenance activities, when to perform the activity and the responsible party.

**Table 3 Maintenance Schedule**

<b>Activity</b>	<b>When</b>	<b>Who</b>	<b>Comments</b>
Clean Cooling Fan Filters (x2)	Every two weeks	Regional Office	One each on analyzer and converter modules: see manual Section 5
Change HEPA Filters (x2)	Every 12 months	Regional Office	Record date on new filter; discard old filter: see fig. 1
Change 47 mm 1µm Filter	Every two weeks	Regional Office	See section 2.35.2.1.3 and fig. 1
Clean Cyclone	Every two weeks	Regional Office	See Section 2.35.2.3.12
Check/adjust cyclone auxiliary flow	Every two weeks	Regional Office	Must=910-sample flow; See Section 2.35.2.3.6
Check sample flow	Every two weeks	Regional Office	See Section 2.35.2.3.6
Change Denuder	Every 2-3 months	Regional Office	See Section 2.35.2.3.11; record serial # and place date on new denuder; return spent unit to ECB ASAP
System Leak Check	After any component change or if sample flow is out side of limits	Regional Office	See Section 2.35.2.3.5

Change Hi-Temp Converter Core Components	Every 6 months	ECB	Schedule with ECB; Requires 12 hour burn-in: See Manual Section 5
Capillary Inspection (x2)	Every 12 months	ECB	One in analyzer and one in converter: see manual Section 5
Pump Rebuild (x2)	Every 12 months	ECB	One in analyzer and one in converter: see Manual Section 5
Replace AuxFlow Sintered Filter	Every 6 months	ECB	Located between splitter and cyclone auxiliary flow MFC: see Fig 1
Dynamic Zero	Every 12 months	Regional Office	See Section 2.35.2.3.13
Cleaning of Sample Line and flow splitter	Every 12 months	Regional Office	See Section 2.35.2.3.12

### 2.35.2.3.11 Denuder

The denuder is a component of the sample inlet system (see Figure 1) and its function is to remove (scrub) any ambient SO<sub>2</sub> from the sample stream when either in the “Sample Mode” or in the “Filter Mode”. The denuder has a finite life-time, which is dependent on the volume of air pulled through it and the concentration of SO<sub>2</sub> in the ambient air. This life-time is estimated to be 12,000 ppb-hours. If the average daily concentration of SO<sub>2</sub> is 5 ppb (as determined by a co-located SO<sub>2</sub> monitor) and the instrument is in continuous operation, the approximate life-time is calculated as follows:

$$12000 \text{ ppb-hrs} / (5 \text{ ppb} \times 24 \text{ hr/day} \times 30 \text{ days/month}) = 3.3 \text{ months}$$

Using this information, the denuder should be exchanged with a re-charged unit every 2½ to 3 months (or sooner if ambient SO<sub>2</sub> concentrations are consistently higher than 5 ppb). During the “filter mode”, if the SO<sub>2</sub> concentration is observed to be increasing over time (weekly/monthly average), this may be an indication that the scrubbing efficiency of the denuder is decreasing and should be replaced even if a 2½ month period has not been exceeded. The region should request a replacement denuder after approximately two months of operation to allow time for delivery. Remove the rubber end caps from the new unit and place them on the spent unit. Label the spent unit as “Spent” and record the ID number of the new unit and date changed out in the log book. Perform a systems leak check (see section 2.35.2.3.5). Spent denuders should be returned to the ECB as soon as possible for recharging. The recharging procedure is included in the 5020 SPA instrument manual and is also included as Appendix B of this document. The ECB will notify the Projects and Procedures Branch (PPB) Supervisor when denuders are available for re-charging. The PPB is responsible for re-charging of spent denuders.

### **2.35.2.3.12 Operation and Cleaning of Cyclone/Cleaning of Sample Line and Flow Splitter**

The cyclone should be inspected and the dust cup cleaned at least once every 14 days. Cleaning is accomplished by unscrewing the dust cup from the cyclone body (see Figure 5 in Appendix A) and removing any particulate matter from the cup and the cyclone body. Use a lint free wipe or soft bristle brush to dislodge any accumulation of PM and replace the dust cap until it is secured by hand tightening. Ensure that the rubber “O” rings located in the base of the unit and at the Dust Cap are in place and not damaged to make the connections leak free. **(Replace “O” rings on an annual basis.)** No additional maintenance is required. The cyclone should be operated at a flow rate of 0.91 lpm to obtain a PM cut point of 2.5 micrometers ( $\mu\text{m}$ ). Remaining within the flow acceptance criteria for the “Sample Flow” and the “Auxflow”, as given in Section 2.35.2.3.6, the cut point will range between 2.45 and 2.55 micrometers or  $\pm 2\%$  of 2.5 (see Appendix A, Figure 7).

The 3/8” stainless steel sample line and flow splitter must be cleaned on an annual basis. The two sections of sample line (sample inlet at cyclone to flow splitter and from outlet of denuder to sample inlet on back of converter module) will be cleaned to remove any materials adhering to the inside wall. This can be accomplished by using a small diameter brush with a long handle or other appropriate means. The flow splitter is clean by removing the cover plate and using a soft bristle brush to remove and visible materials.

### **2.35.2.3.13 Dynamic Zero Test**

The 5020 SPA quantifies sulfate in the sample stream by comparing the signals produced when the sample is run directly into the converter to the signal produced when the sample is run through a HEPA filter before conversion to  $\text{SO}_2$ . In order for this type of differential measurement to provide accurate results at low concentrations, it is critical that the two measurements (sample mode and filter mode) produce similar readings when the target compound is not present. The dynamic zero test is design to check this aspect of performance and is to be performed annually.

The dynamic zero test is performed as follows;

- 1) Down the data logger channels (see section 2.35.2.3.3);
- 2) Perform system leak check (see section 2.35.2.3.5);
- 3) Perform an instrument calibration with zero air and Span 1(see section 2.35.2.3.7);
- 4) Disconnect the 3/8” stainless steel sample line from the “Sample- In” port on the rear of the Converter Module. Place a high volume HEPA filter (supplied by the ECB) in the flow path by connecting the HEPA filter inlet to the 3/8” stainless steel sample line and the HEPA filter outlet to the “Sample- In” port on the rear of the

Converter Module. Disconnect the cyclone auxiliary flow line from the splitter and cap the inlet of the flow splitter;

- 5) Make sure the instrument is in the “cycle mode”.
- 6) Allow the instrument to run for at least 10-12 hours while collecting data through the data logger;
- 7) The data of interest is the “cycle sulfate” data. Calculate the average and standard deviation of 40-48 data points. The results should show an average near zero with a standard deviation of 0.20 ug/m<sup>3</sup> or less. A failed test may indicate a leak or a contaminant in the plumbing. Pre-installation tests performed at the ECB gave an average value of 0.04 ug/m<sup>3</sup> with a standard deviation of 0.11.

#### **2.35.2.3.15 Audits**

Audits will be performed by the ECB on an annual basis. Information on the ECB audit procedures can be found in a separate document as Section 2.35.1, “ECB Responsibilities”.

## **APPENDIX A**

**(Figures)**

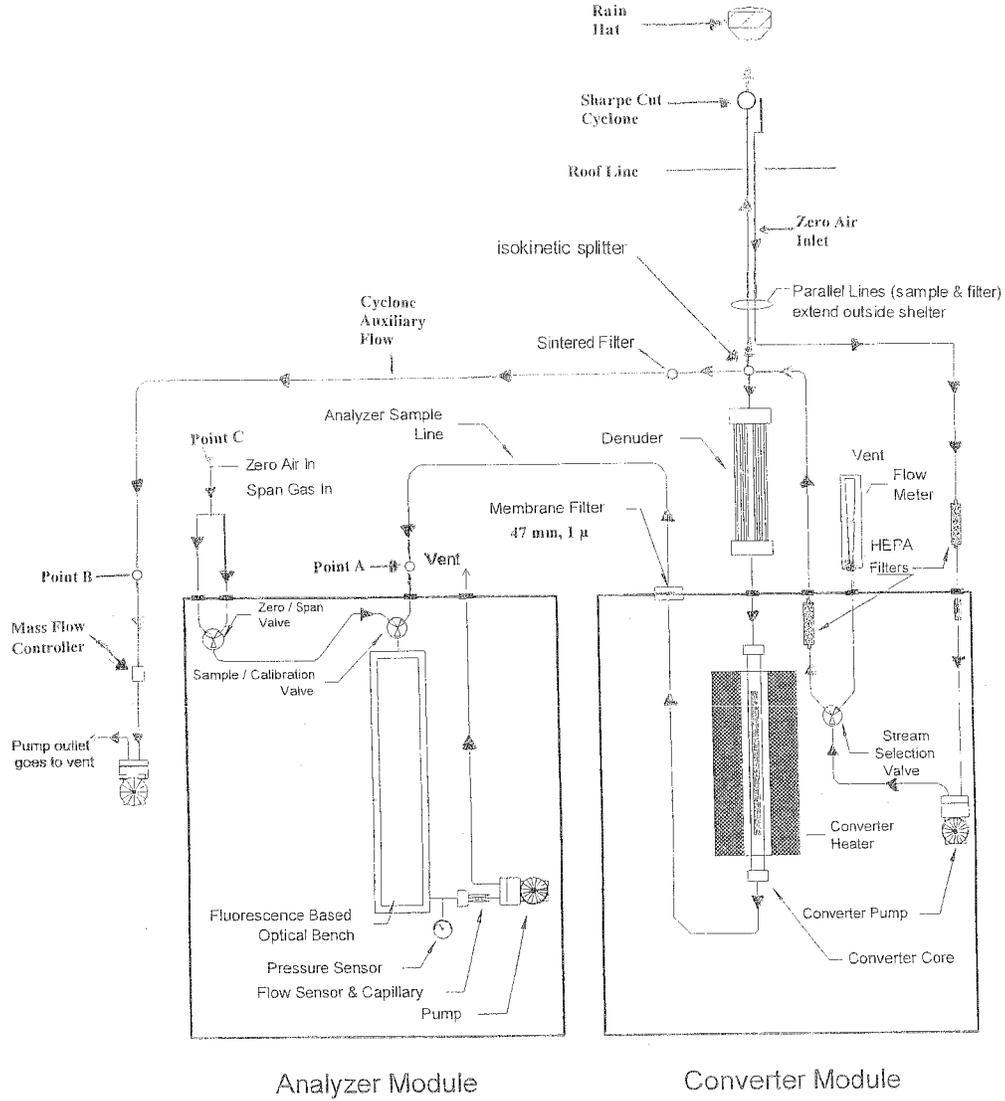


Figure 1 Filter Mode Flow



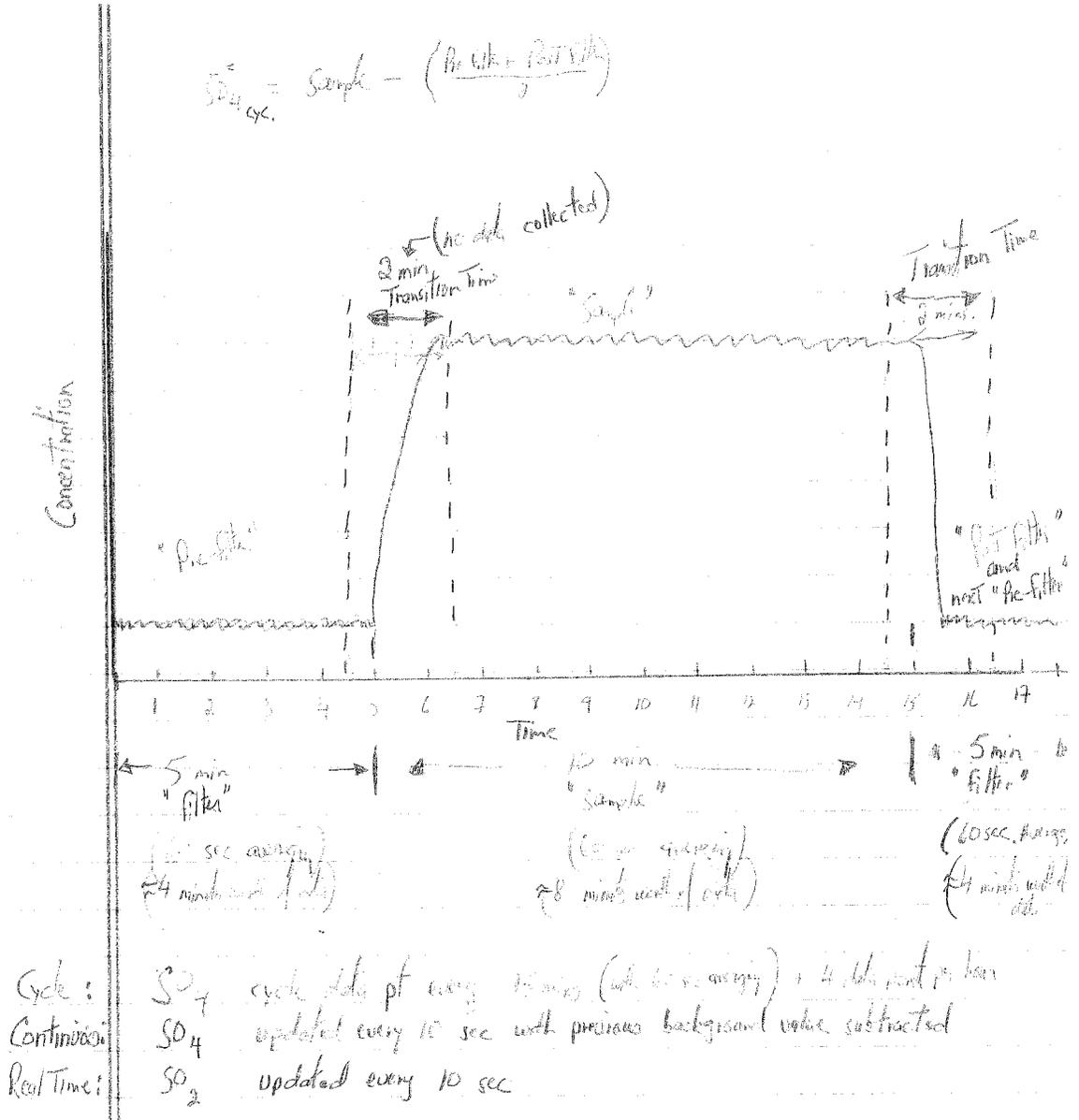


Figure 3 Time vs. Concentration

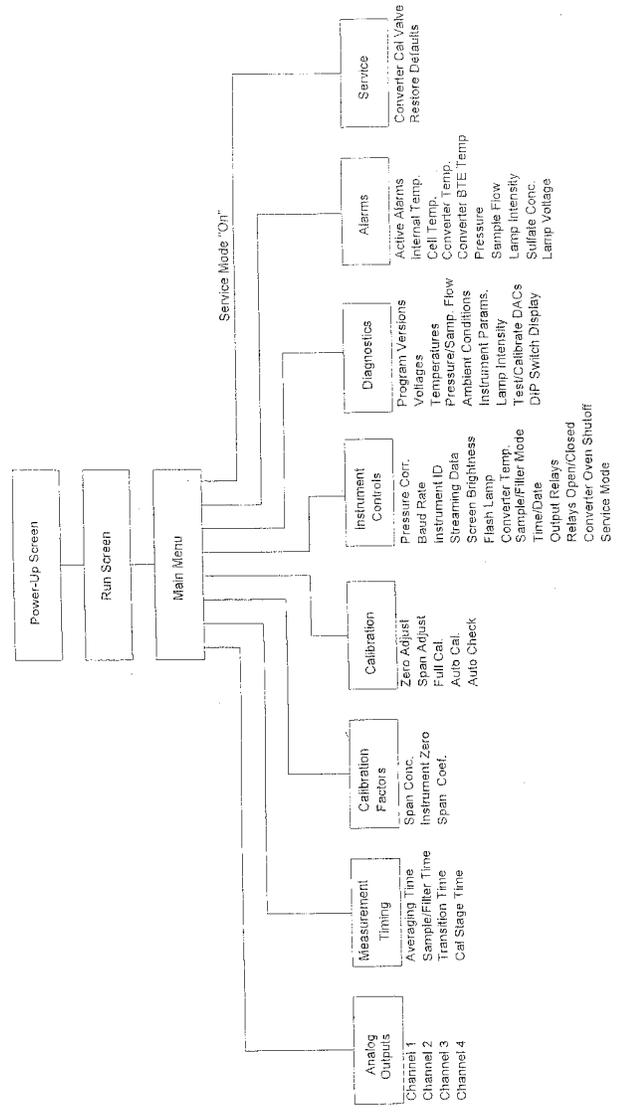


Figure 4 Flow Chart of Menu Driven Software

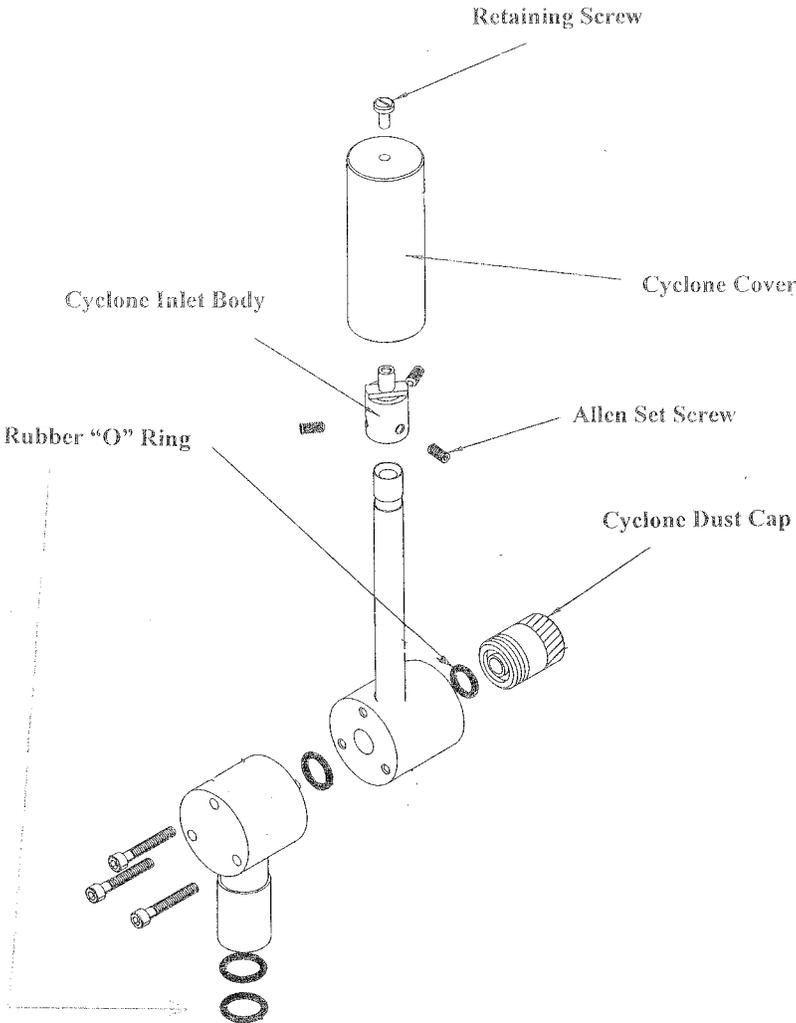


Figure 5 Cyclone Components

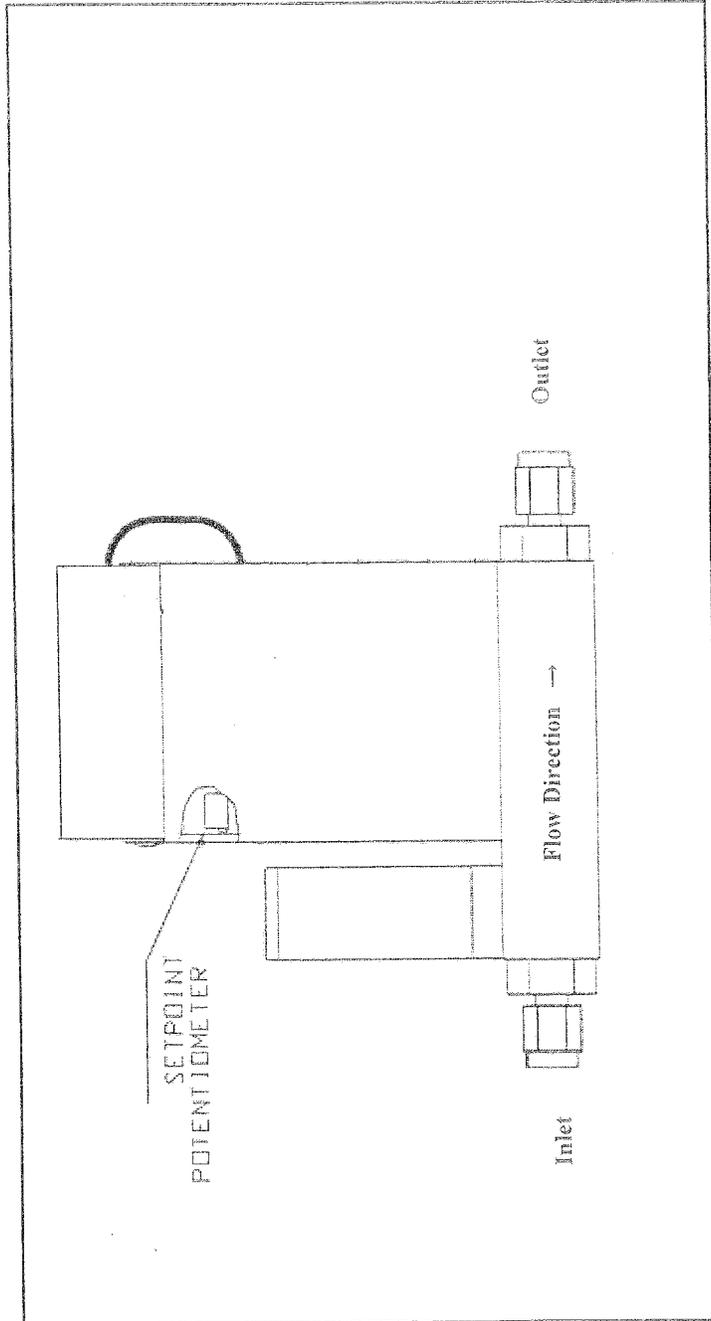
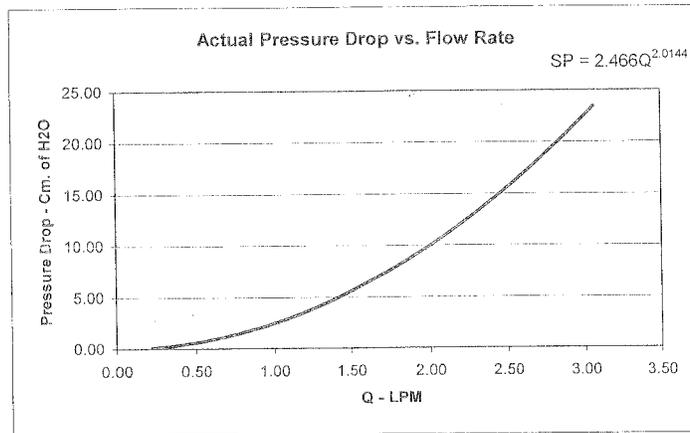
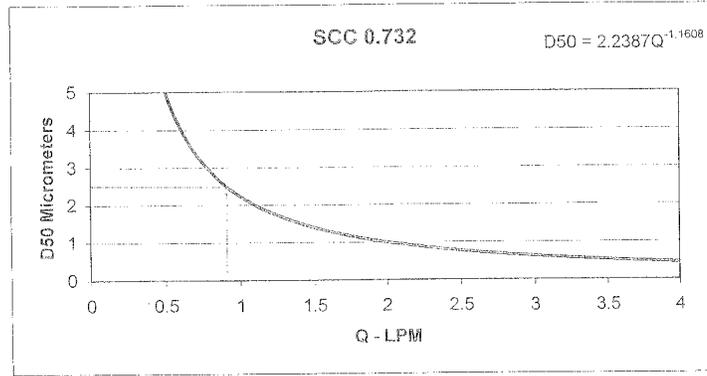


Figure 6 Mass Flow Controller



<u>Flow, cc/m</u>	<u>Cut Point,um</u>
880	2.60
895	2.55
<b>910</b>	<b>2.50</b>
925	2.45
950	2.38

Figure 7 Cyclone Cut Point vs. Flow Rate

## APPENDIX B

(Denuder Coating Procedure)

## DENUDER CLEANING AND COATING

Under normal operating conditions, the denuder will need to be cleaned and re-coated approximately once every two months. If the instrument is operated in an environment with high SO<sub>2</sub> levels or if the flow through the denuder is more than 1.5 liters per minute, this procedure should be done more frequently.

### Materials Required:

- Latex gloves
- Protective eyewear
- Mechanical
- De-ionized water
- Glycerol
- Sodium Carbonate Powder
- Vinyl Caps or Equivalent Tight Cover

1. Check unit for any dents and the inside of the tube for any apparent damage, such as, if the inner tubes are touching each other.
2. Wear gloves and perform procedure under an adequately vented hood. Prepare the cleaning solution consisting of 50% methanol and 50% water. With a vinyl cap on out end of the denuder, pour about 20 to 25 ml of the cleaning solution into the denuder. Put a vinyl cap on the open end and rinse the inside surfaces of the denuder by rotating and inverting the denuder continuously for 1 minute. Repeat three times.
3. Prepare the coating solution consisting of 50 ml of methanol, 50 ml de-ionized water, 1 ml of glycerol, and 1.2 grams of sodium carbonate in the following order. First, mix the glycerol with the methanol. Then, in a separate container, mix the sodium carbonate with the de-ionized water, and then mix both solutions together. This should be enough to coat three to five denuders. Be sure that the sodium carbonate and glycerol are completely dissolved before use.
4. With a vinyl cap on one end of the denuder, pour about 20 to 25 ml of the solution into the denuder. Put a vinyl cap on the open end and rotate and invert the denuder continuously for 1 minute. Empty the solution and let dry (ideally by flowing clean air through the denuder for 15 minutes), then cap both ends if the denuder will not be re-installed immediately.
5. Discard excess solution after completing the coating process.

## APPENDIX C

(Run Screen Readout...What to Expect)

### Run Screen Readout....What to Expect

The following examples of the “run screen” display may help the operator understand what data is being generated, how the values are determined and examples that may be typical scenarios. The run screen displays:

**Mode:** either “Filter” or “Sample”

**Clock timing:** counts down from a pre-set time to zero. Indicates time remaining for each cycle (10:00:00 down to 00:00:00 for sample mode and 05:00:00 down to 00:00:00 for filter mode)

**Asterisk:** When present indicates an alarm

**SO2 PPB:** provides real time SO<sub>2</sub> (resulting from the conversion of certain compounds, such as sulfate, to SO<sub>2</sub>) values in ppb while operating in either the sample mode or the filter mode and is updated on the screen every 10 seconds;

**SO4 ug CONTS:** Provides real time SO<sub>4</sub> values in ug/m<sup>3</sup> with only the previous filter (or background) mode value subtracted and is updated on the screen every 10 seconds;

**SO4 ug CYCLE:** Provides cyclic SO<sub>4</sub> values in ug/m<sup>3</sup> with the average of the values obtained from the most recent pre-and post- filter mode runs subtracted from the value obtained during the sample mode and is updated every 15 minutes. From a cold start, this parameter will not be displayed on the screen until one complete rotation has been completed (one filter mode plus one sample mode plus second filter mode).

#### Example 1

MODE Filter	04:23:45 *
SO2 PPB	0.000
SO4 ug CONTS	0.000
SO4 ug CYCLE	19.8

MODE Sample	09:43:15
SO2 PPB	5.00
SO4 ug CONTS	19.3
SO4 ug CYCLE	20.2

This scenario assumes no interferences present and approximately 20 ug/m<sup>3</sup> of SO<sub>4</sub> present in the sampled air. Asterisk is displayed here only for show.

The background SO<sub>2</sub> reading, in the **filter mode**, is 0.000 in real time, and assuming that the previous background reading was also 0.000, the real time continuous SO<sub>4</sub> is reading 0.000. The cyclic SO<sub>4</sub>, which is updated every 15 minutes, is reading 19.8 and assumes that the most recent pre- and post filter modes

values for SO<sub>2</sub> were both 0.000 and that the SO<sub>4</sub> concentration is the ambient air is approximately 20 ug/m<sup>3</sup>. In the **sample mode**, if there is approximately 20 ug/m<sup>3</sup> of SO<sub>4</sub> present in the ambient air, the real time SO<sub>2</sub> should read approximately 5.00 ppb and the real time continuous and cycle SO<sub>4</sub> should read approximately 20 ug/m<sup>3</sup>.

### Example 2

MODE Filter	04:23:45
SO2 PPB	2.00
SO4 ug CONTS	0.00
SO4 ug CYCLE	20.2

MODE Sample	09:43:15
SO2 PPB	7.00
SO4 ug CONTS	19.3
SO4 ug CYCLE	20.2

This scenario assumes that a 2 ppb interference is present and approximately 20 ug/m<sup>3</sup> of SO<sub>4</sub> is present in the sampled air.

The background SO<sub>2</sub> reading, in the **filter mode**, is 2.00 ppb in real time. This indicates that an interference (such as H<sub>2</sub>S) is present and, assuming that the most recent background reading was also 2.00, the real time continuous SO<sub>4</sub> is reading 0.000 (The previous background reading has been subtracted out). The cyclic SO<sub>4</sub>, which is updated every 15 minutes, is reading 20.2 and assumes that the most recent pre- and post filter modes values for SO<sub>2</sub> were both 2.00 and that the SO<sub>4</sub> concentration is the ambient air is approximately 20 ug/m<sup>3</sup>. In the **sample mode**, if there is approximately 20 ug/m<sup>3</sup> of SO<sub>4</sub> present in the ambient air and there is an interference causing a 2.00 ppb reading, the real time SO<sub>2</sub> should read approximately 7.00 ppb (2 plus 5 ppb) and the real time continuous and cycle SO<sub>4</sub> should read approximately 20 ug/m<sup>3</sup>.

**Example 3**

MODE Filter	04:23:45
SO2 PPB	2.00
SO4 ug CONTS	0.00
SO4 ug CYCLE	0.00

MODE Sample	09:43:15
SO2 PPB	2.00
SO4 ug CONTS	0.00
SO4 ug CYCLE	0.00

This scenario assumes a 2 ppb interference is present and no SO<sub>4</sub> is present in the sampled air.

The background SO<sub>2</sub> reading, in the **filter mode**, is 2.00 ppb in real time. This indicates that an interference (such as H<sub>2</sub>S) is present and assuming that the previous background reading was also 2.00, the real time continuous SO<sub>4</sub> is reading 0.000 (The previous background reading has been subtracted out). Assuming that there is no SO<sub>4</sub> present in the ambient air, the cyclic SO<sub>4</sub>, which is updated every 15 minutes, is reading 0.00 where the most recent pre- and post filter modes averaged values for SO<sub>2</sub> (both 2.00 ppb) have been subtract out. In the **sample mode**, if there is no SO<sub>4</sub> present in the ambient air and there is an interference causing a 2.00 ppb reading, the real time SO<sub>2</sub> should read approximately 2.00 ppb and the real time SO<sub>4</sub> and the cycle SO<sub>4</sub> should read approximately 0.00 ug/m<sup>3</sup> (average of most recent pre-and post- background subtracted out).

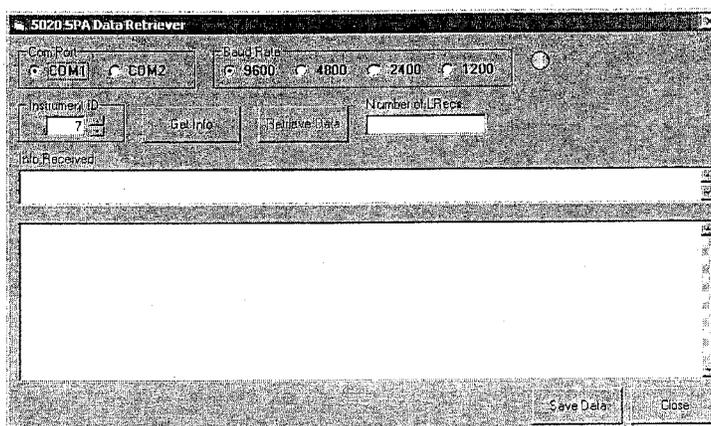
## APPENDIX D

(Data Retriever Procedure)

### Instructions for Using the Data Retriever Program

Using a laptop computer with Windows and software installed that is available from the ECB.

- 1) Plug a null-modem serial cable into the serial port on the rear of the 5020 SPA and into the serial port on the computer.
- 2) Open the "Data Retriever" software and view the Data Retriever window (see figure below).
- 3) Click (select) COM 1 or COM 2 (which ever one the cable is plugged into on the computer).
- 4) Click on "Baud Rate 9600".
- 5) Enter the number 7 for the "Instrument ID".
- 6) Click "Get Info" button. After about 20-30 seconds, the "Data Retrieve" button will be enabled. If you see an "OK" prompt, click it. If you see "Wrong Analyzer Software Continue", click "yes"
- 7) Observe the analyzer run screen and if there are less than 3 minutes left in the current cycle (either Sample or Filter mode) wait until a new cycle begins, then click the "Retrieve Data" button. The circle in the upper right portion of the screen will turn RED. After about 1 minute the data retrieval process will be complete and the circle will turn GREEN. If working properly, you should see blocks of data being retrieved in the lower portion of the screen. When the circle turns GREEN, the "Save Data" button will be enabled.
- 8) Click the "Save Data" button and save the data as a "text" file to a disk.
- 9) The resulting text file can be imported into EXCEL by choosing "space" as the only delimiter. The following 18 column headers are not included in the file, but are listed below in the order that they appear in the spread sheet from left to right.



5020 SPA Data Retriever Window

Time (hh:mm:ss)  
Date (mm-dd-yy)  
Number of alarms  
SO4 ug/m3 for the cycle  
Sample period SO2 ppb average  
Sample period SO2 ppb standard deviation (sd)  
preceding filter period SO2 ppb average  
preceding filter period SO2 ppb sd  
following filter period SO2 ppb average  
following filter period SO2 ppb sd  
number of data points in the following filter period  
ambient-in-use flag (0 = 760 mmHg/25C, 1 = actual ambient readings were used)  
sample flow (cc/min)  
cell pressure (mmHg)  
internal instrument temperature (C)  
converter temperature (C)  
instrument zero SO2 ppb  
span coefficient

## APPENDIX E

(Example Forms)

5020 Sulfate Monitor Site Set-Up

to be completed at time of Installation, Component Change, Recalibration or Calibration Check

Site	Latitude	Longitude	Nearest Road/Highway	Altitude
Use of Activity	Use of Activity	Use of Activity	Use of Activity	Use of Activity
Instrument	Serial #	Calibration Date	Calibration Type	Calibration Status
SO <sub>2</sub> Cylinder No.	SO <sub>2</sub> Cylinder Date	SO <sub>2</sub> Cylinder Pressure	SO <sub>2</sub> Cylinder Volume	SO <sub>2</sub> Cylinder Status
Zero AirPack	Zero AirPack Date	Zero AirPack Pressure	Zero AirPack Volume	Zero AirPack Status
SO <sub>2</sub> Cylinder No.	SO <sub>2</sub> Cylinder Date	SO <sub>2</sub> Cylinder Pressure	SO <sub>2</sub> Cylinder Volume	SO <sub>2</sub> Cylinder Status
SO <sub>2</sub> Cylinder Conn	SO <sub>2</sub> Cylinder Conn Date	SO <sub>2</sub> Cylinder Conn Pressure	SO <sub>2</sub> Cylinder Conn Volume	SO <sub>2</sub> Cylinder Conn Status
Qualifier	Qualifier Date	Qualifier Pressure	Qualifier Volume	Qualifier Status
Notes / Comments				

ELOG Site\_Set-Up







