TSI APS 3320

SOP -DRAFT

MEASUREMENT OF THE AMBIENT AIR PARTICLE SIZE DISTRIBUTION AT LOW RELATIVE HUMIDITIES USING THE TSI APS 3320

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1. PURPOSE AND APPLICABILITY

This Standard Operating Procedure contains the protocol for measurement size distribution of ambient aerosol particles in the size range from 0.5 to 30 µm at relative humidity < 60 % using the TSI Aerodynamic particle sizer model 3320.

2. DEFINITIONS

APS : Aerodynamic Particle Sizer

$ANC_{xxx-yyy}$: APS derived particle number concentration in the size range from xxx µm to yyy µm in cm^{-3} where

xxx = midpoint of size bin – binwidth/2

yyy = midpoint of size bin + binwidth/2

SOP : Standard Operating Procedure

3. DATA QUALITY OBJECTIVES

The objective for the size distribution measurements is to obtain highly time resolved data of the particle size distribution of ambient aerosol particles in four overlapping size ranges from 0.5 µm to 30 µm. **Data** Quality objectives for the spectrometer are as follow:

Accuracy: Average of the particle number concentration within
30 % of CSAS derived concentrations between 0.5 and 2.5 µm;
within
50 % of CSAS derived concentrations between 2.5 and 10 µm, and
within 100 % of CSAS derived concentrations for larger particles.

	Sizing accuracy for PSL particles +- one channel in the lowest applicable size range.
Precision:	integral particle number concentration should be within at least ±20% for replicate measurements of a nebulized salt solution.
Lower Limit:	< 10 cm^{-3} for a 5 min sample with absolute filter attached.
Completeness:	At least 80% data completeness.

4. DATA QUALITY ASSURANCE:

The components to achieving the data quality objectives are:

1. Written standard operating procedure (this SOP);
2. Verification of installation
3. Careful operator training
4. Daily and weekly system checks as outlined in the SOP,
5. Routine collection of dynamic blanks
6. Routine calibrations,
7. Routine data review and
8. On-site audits.

5. HEALTH AND SAFTEY WARNINGS

N/A

6. CAUTIONS

Avoid touching of the inlet nozzle of the APS. This nozzle may easily be misaligned leading to modified sizing characteristics

7. INTERFERENCES

N/A

8. RESPONSIBILITIES

N/A

9. EQUIPMENT AND MATERIALS

9.1 Equipment

1. TSI APS 3320 sampling from the common aerosol inlet in the trailer
2. Personal computer
3. TSI Aerosol Instrument Manager Software Version 4.2
4. Standard bubble flow meter (Gilibrator)

9.2 Paper materials

1. Field forms to record performance of the APS in the field
2. Laboratory book forward scattering aerosol spectrometer

10. PROCEDURES

10.1 Setting up the Sensor Hardware

This sections describes how to set up and operate the APS 3320 at the sensor using the control knob and LCD display. You can perform the same operations from your computer using the Aerosol Instrument Manager Software and APS 3320 module.

In most cases you will want to set up initial sampling parameters at the sensor and then, once you

have verified that sampling conditions are as desired, use the computer to collect, store, interpret, and print the sample data.

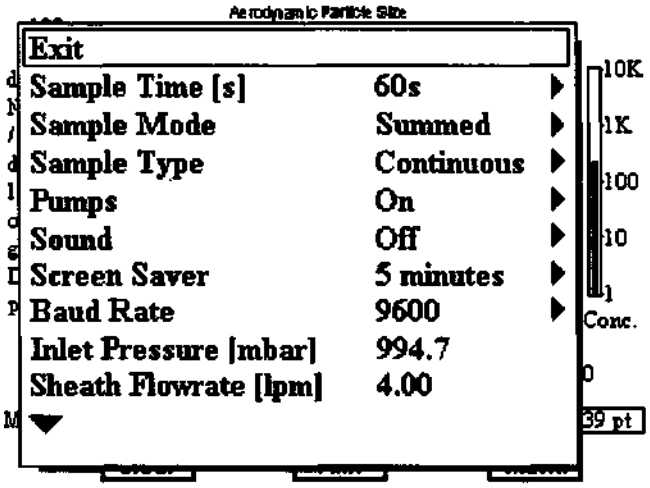
The APS software (as described later) will start up with the default parameters for the supersite measurements. These software settings will under normal conditions override any hardware settings of this subchapter.

Note: Default values are not yet determined. They will be added to this SOP later.

Note: Although you can set up parameters and begin sampling at the APS sensor, the data shown on the LCD display is not stored, nor can it be sent to a printer. To save or print data, you must collect it using the computer interface and the Aerosol Instrument Manager™ Software.

These instructions assume that the APS is connected to an appropriate power source and the power on/off switch on the back panel is switched to the on position.

1. Turn the control knob clockwise until the cursor runs off the right side of the display and the CLEAR, START, and MENU buttons appear. Continue turning the control knob until Menu button is highlighted; then press the control knob. The menu shown below appears.



2. Turn the control knob clockwise until the cursor falls on the Sample Time[s] command. Press the control knob once. Turn the control knob clockwise or counterclockwise until the sample

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time is set as desired. Then press the control knob to lock in that time.

3. Turn the control knob to select other commands or verify other settings. All of the items on the menu are described in the Table below the menu. When you are finished using the menu, turn the control knob until the cursor stops on the Exit command at the top or bottom of the menu and press the control knob to return to the graphical display.

4. After you exit the Menu, turn the control knob to highlight the START button and press the control knob. The APS will immediately begin sampling according to the parameters set on the menu.

5. Monitor the display to verify that sampling is progressing as you intended. You can monitor the display until the sample period ends or go to the computer to begin a sample from there.

To inspect the sample data that has been collected for a specific channel, turn the control knob until the cursor falls on the channel you want to inspect. The channel's particle diameter and concentration in particles per centimeter^3 are displayed below the graph. Inspect other channels in the same manner.

6. Return to the Menu to modify the sample time or set other parameters as necessary until you are satisfied that sampling is set up as desired.

Description of Menu Items:

Command	Function
Exit	Exit the Menu and display graphical information.
Sample Time [s]	Set the total sample time. Can be set from 1 to 64,800 seconds (18 hours) in summed mode and from 1 to 300 seconds in average mode. Default is 20 seconds.
Sample Mode	Select Summed 1 Averaged 1 Sum.Corr. Summed displays the total number of particles sampled for each channel. Averaged displays a calculated average number of particles sampled for each channel. Sum. Corr will not show useable data at the sensor's

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	LCD display. Use the APS software to interpret. The default is Summed.
Sample Type	Continuous 1 Single. Continuous sampling begins a new sample immediately following the end of the previous sample. Single sample takes one sample for the set sample time and then stops.
Pumps	Turn pumps on and off. Default is on.
Sound	Turn on and off the beeping sound that is activated when the Hi-Conc, limit is exceeded. The default is on.
Screen Saver	Set the screen saver time delay. To extend the life of the fluorescent lamp in the backlit screen, the display turns dark if left for the specified period without any operator interaction. Use the control knob to select: off, 5, 10, 15, or 30 minutes. Touching the control knob even briefly will illuminate the screen. Default is off.
Baud Rate [bps]	Select the baud rate at which the sensor will communicate with your computer. Use the control knob to select: 38400, 19200, or 9600. The default is 9600.
Inlet Pressure [mbar]	Displays the current inlet pressure of the sample. This value should correspond to atmospheric pressure. No default value.
Sheath Flowrate [1pm]	Displays the flowrate of the outer nozzle (sheath) aerosol. This reading will approximate 4.0 liters (±0. 1) per minute. No default value.

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Aerosol Flowrate [1pm]	Displays the flowrate of the inner nozzle (sample) aerosol. This reading will approximate 1.0 (±0.1) liter per minute. No default value.
Total Flowrate [1pm]	Displays the total flow rate of the sample aerosol. This reading will approximate 5 (±0.2) liters per minute (unless sheath or sample flow has been modified). Used to verify proper sensor operation. No default value.
Optics Temperature l°C]	Displays the temperature of the optics components. Used to verify proper sensor operation. No default value. Note: This is also the APD detector temperature.
Cabinet Temperature [°C]	Displays the temperature inside the APS. No default value.
Laser Current [mA]	Displays the laser current in milliamps. Range should be between 0 and 100 mA. This value rises as the laser ages. Used for diagnostic purposes.
Laser Power [%]	Displays the percent of laser power used from 0 to 100%. Default is 75%. This value is field selectable but should not be changed except for diagnostic purposes. Changing this setting will alter the calibration. Refer to Chapter 5 or Appendix C of the manual.
Laser	Turn the laser on and off. Default is on. Generally, the laser is on whenever the instrument is running. You might want to turn it off for diagnostic purposes.
APD Voltage [V]	Displays the voltage of the Avalanche Photodetector (APD). Changing the APD voltage with this setting disables APD autocalibration (see below).

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APD Max V_{op} [V]	When the APS is powered up, the APD voltage is set to APD Max V_{op} based on the temperature of the APD. This temperature compensated setting should give the APS the maximum sensitivity to small particles.
APD Autocalibration	Enables the APD temperature compensation algorithm when set to On. When set to OS, the APD voltage will not change with APD temperature. This setting will always be enabled when the instrument is first powered on.
Alarm Level [pt/cm3]	Level of total particle concentration at which the APS will issue a high concentration alarm. The HI CONC led on the front panel will be turned on and the high concentration flag (see RF command) will be set; and if the sound is turned on, the APS will beep. Default is 1000.
End of Sample Pause	When enabled, this setting freezes the display for 4 seconds at the end of a sample when in continuous sample mode. This gives you a chance to view the sample or to select Pause from the main menu. Default is off.
Display Image	Set the image Positive/Negative for the LCD display. Positive is black letters on light background. Negative is white letters on dark background.
Firmware Version	• Displays the version number of the firmware installed in the APS.
Exit	Exit the Menu and display graphical information.

After the Model 3320 APS is set up and operating as desired, use the computer and Aerosol

Instrument Manager Software to collect, save, interpret, and print sample data.

10.2 SETTING UP THE DATA ACQUISITION SOFTWARE:

1) Start the TSI Aerosol manager software

2) Open a new file

3) Check the operation parameters as follows

With an APS data file active on the desktop, access the Properties dialog box by selecting File I Properties.

Note: An APS window must be active on the Aerosol Instrument Manager desktop to access the Properties menu item,

The properties displayed in the Properties dialog box are either:

* The initial default properties as set by TSI or

* The default properties set by a user who selected File I Save Properties as default after making changes to the Properties dialog box.

The Properties dialog box contains four tabs: Data Settings, Scheduling, Data Types, and Communications. Each is described below. Their contents will differ slightly for each APS model.

10.2.1 APS Data Settings Tab

The Data Settings tab lets you specify parameters that are applied to the data when you view it or export it. The actual data in the file is not affected by these parameters.

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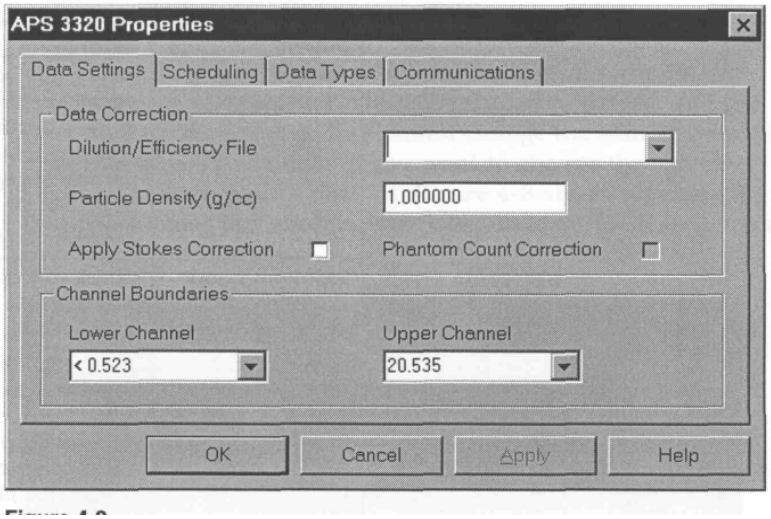

Description of Data Setting Parameters for an APS

Setting	Description
Dilution/ Efficiency File	Use this list box to select an efficiency file that you want to use to condition sample data. This efficiency file is automatically loaded and used in calculating sample data. The file must be located in the folder created during program setup where the software is installed (usually Aerosol Instrument Manager). The file must also have an extension of ".exx" where xx reflects the instrument the file is used with. (For example, 00001 to I.e20 is an efficiency file for the 3320 APS). The dilution files provided with the software are for use with TSI 3302A Diluters).
Particle Density (g/cm^3)	Enter the particle density (in g/cm^3) you want the software to use when calculating the surface area and mass concentrations. The default is 1.000000. (The geometric diameter is calculated first and then the surface area and mass are derived, assuming spherical particles). If you enter a value other than 1.000000, you

	particles). If you enter a value other than 1.000000, you are changing the Y axis on the graphs; the shape of the distribution remains the same.
Apply Stokes Correction	Check this box if you want Stokes correction to be applied to the samples as they are collected. If you entered a value other than 1.00 for density, then applying this correction will Improve the accuracy of particle sizing. Stokes correction is described In Appendix D of the software manual.
Lower Channel	This parameter can be used to narrow the sampling range. Use the pull-down window to select the lowest channel number from which data is to be viewed. The software always stores data from the entire range.
Upper Channel	This parameter can also be used to narrow the sampling range. Use the pull-down window to select the highest channel number from which data is to be viewed. (The software always stores data from the entire range.)

10.2.2 APS Scheduling Tab

The Scheduling tab lets you select the number of samples, the length of each sample, how often samples are collected, and the start time for the sample. You cannot change the sample length for a file that already has data. If you want to change the sample length, you must start a new file. A description of each parameter follows.

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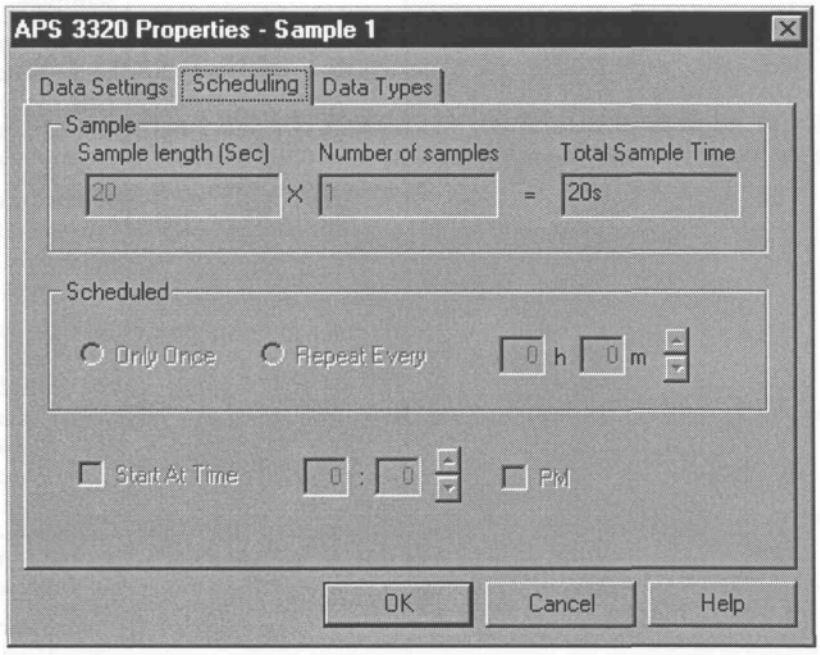


Description of Scheduling Parameters for an APS

Parameter	Description
Sample length (Sec)	This is the amount of time (in seconds) that data will be collected from the TSI sensor for each sample. The maximum value allowed is 65535 (18 hours, 12 min., 15 sec.).
Number of Samples	This is the total number of samples you want to collect. The maximum value allowed is 65535.
Total Sample Time	This field Is calculated by the software and shows the total sample time based on the values you entered In the Sample Length and Number of Samples boxes. The value Is displayed in hours, minutes, and seconds.
Scheduled	Select Only Once to collect one set of samples. For continuous monitoring, select Repeat Every and then select the hours and minutes between samples.

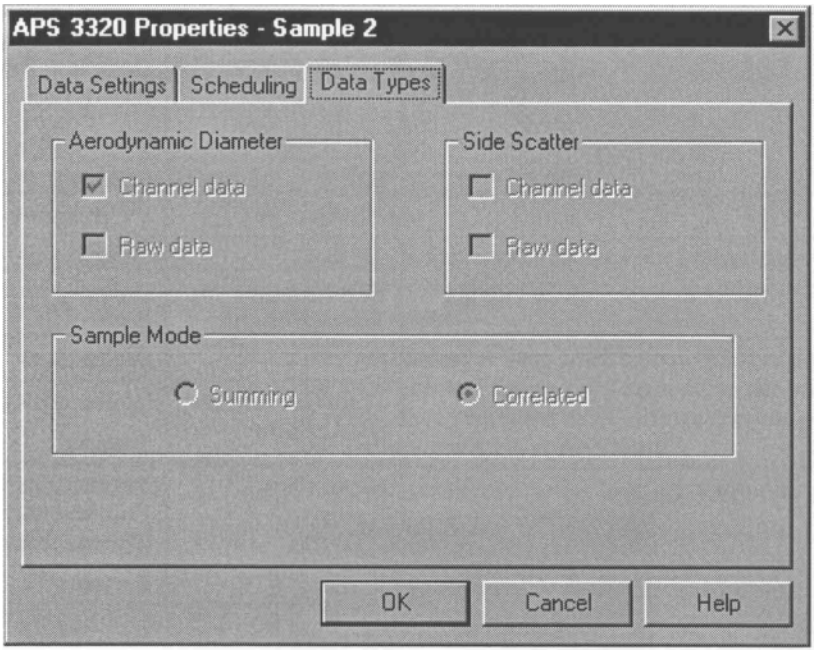
	select the hours and minutes between samples.
Start At Time	

Files of Sample Sessions That Run Past Midnight:

The files for sample sessions that run past midnight (or run for more than 24 hours) are handled differently than those that start and stop on the same date. In this case a sequence of files is created, with each file in the sequence given a unique filename extension identifying its proper order. Appendix F of the software manual provides a complete description of sequence files including how to access a file|that is part of a sequence.

10.2.3 APS Data Types Tab

The Data Types tab lets you set up the type of data to be collected. The type of data that can be collected varies depending on which TSI sensor you are using.

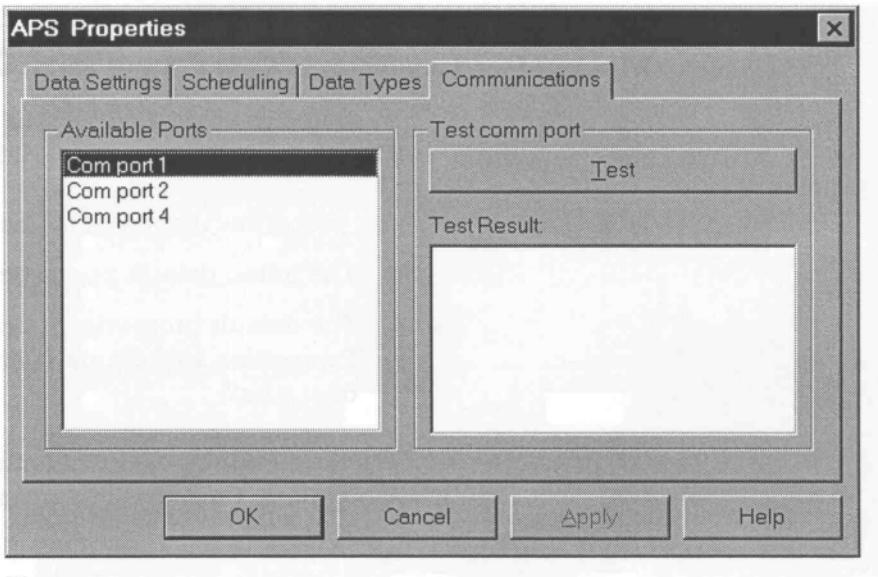


Description of the data type parameters of the APS

Type	Description
Aerodynamic Diameter	Select the data you want collected. You can collect channel data, raw data or both.
Side Scatter	You can have the program display channel data, raw data or both.
Sample Mode	Select the sampling mode you want to use: Summing or Correlated. You may only select one. Correlated mode does not collect raw data for aerodynamic or side scatter.
Side Scatter vs. Time of Flight	Collect Side Scatter vs. Time of Flight correlated data.

10.2.4 APS Communications Tab

The Communications tab lets you set up and test the communications port and is only available when you open a new file.



Description of Communications Parameters for an APS

Property	Description
Available Ports	Lists the ports available on your computer system and lets you select the port that is connected to the TSI sensor.
Test Button	After you select a Com Port, press this button and the software will try to read data from the sensor to verify that you have selected the correct port and have a working connection.
Test Results	Reports the results of the test

4) After all parameters have been set correctly start measurement cycle by selecting Run/Start Data Collection using the menus.

11 Routine Operation of the Instrument

NOTE: ANY MANIPULATIONS OTHER THAN THOSE EXPLICITELY STATED IN THIS SOP BY ANY OPERATOR WILL CAUSE MORE PROBLEMS. PLEASE DON'T TRY TO FIX PROBLEMS YOURSELF UNLESS YOU ARE ABSOLUTELY SHURE WHAT YOUR ARE DOING.

11.1 Every other day checks of the APS

1. Check system for any visible irregularities.
2. Check both sheath air and sample flow rate and record values in the field form.
3. Check all settings on the control unit. Reset to standard positions and mark in the lab book if necessary.
4. Stop the data acquisition program.

5. Save data file on the harddisk of the data acquisition computer and copy files via network to main computer.
6. Restart data acquisition program.
7. Check data file for completeness, note any down times with possible reasons in the lab book.
8. Visually check particle size distribution display for any inconsistencies (Note this requires basic knowledge on what it should look like, if you think that there is something wrong describe the possible problem in the lab book along with date and time of the observation. This will allow reevaluation of the questionable time period later. Sometimes size distributions look nice and are complete nonsense and there are times, when the size distribution look awkward but is correct anyway).

11.2 Weekly checks of the Instrument

1. Check the flow rate of the sample inlet with the Reference flow meter. Record the sample flow in the lab book. If the sample flow differs from the set point by more than 10 % inform the primary operator. Data can be used if the deviations are larger than 10 %, however, large deviations tend to indicate an upcoming problem with the blower of the probe.
2. Check the sizing capabilities of the probe with 2 Latex sizes in the overlap of the size ranges (Preferably 2.5 µm and 5.0 µm). Indicated sizes should be within one adjacent size bin to the nominal size bin. Record the actual size bin in the lab book.
3. Compare the number concentrations indicated by the instrument using nebulized salt solutions with respective CSAS measurements. Number concentrations should be comparable within 30 %.

Report any discrepancies between standard operating and performance parameters to Thomas Tuch. Please do not try to fix problems yourself.

12. Data storage

Time and date stamped size distribution data will be stored initially in the internal data format of the TSI software on the hard disk of the data acquisition computer. Raw data for aerodoynamic diameter and light scattering diameter will be exported every other day into a continuous EXCEL spreadsheet. Missing data, suspicious data and calibration data will be flagged in this spreadsheet along with a written plain language explanation for the reason of the flagging. Raw Data and Spreadsheet data will be copied every other day to the hard disk of the main computer of the super site. All data raw data files and spreadsheet files collected on the harddisk of the main computer will be copied every other day (daily during intensives) to two CD-Rs labeled with the date of the copy. One CD-R will remain at the supersite, the other copy will be transported to the UMCP campus in College Park.

All original lab books with information on the performance will be kept at the supersite during the measurement period. A scanned version of each page will be stored along with the data set in a separate file. These scanned pages will be stored along with the data files in a separate subdirectory of the Data CDs.

Further evaluation and manipulation of the data will follow the procedures defined in the Data Management/Storage SOP.