California Environmental Protection Agency

AIR RESOURCES BOARD

AIR QUALITY SURVEILLANCE BRANCH

STANDARD OPERATING PROCEDURES

FOR

TSI MODEL 3781 WATER-BASED CONDENSATION PARTICLE COUNTER (WCPC)

AQSB SOP 409

First Edition

MONITORING AND LABORATORY DIVISION

July 2009

California Environmental Protection Agency
AIR RESOURCES BOARD

Approval of Standard Operating Procedures (SOP)

Title:	TSI Water-based Condensation Particle Counter – Model 3781 CPC
SOP:	AQSB SOP 409, First Edition
Section:	Special Purpose Monitoring Section
Branch:	Air Quality Surveillance Branch (AQSB)
Division:	Monitoring and Laboratory Division (MLD)
Prepared by:	Neil Adler
Approval:	This SOP has been reviewed and approved by:

_____ _____
Reginald L. Smith, Manager Date
Operation Support Section
Air Quality Surveillance Branch

_____ _____
Kenneth R. Stroud, Chief Date
Air Quality Surveillance Branch

TABLE OF CONTENTS

TSI MODEL 3781
WATER-BASED CONDENSATION
PARTICLE COUNTER

		Page(s)	Date
1.0	**GENERAL INFORMATION**	6-8	07/09
1.1	Introduction	6	
1.2	Principle of Operation	6-8	
1.3	Safety Precautions	9	
1.4	Interferences/Limitations	9	
2.0	**INSTALLATION PROCEDURE**	10-15	07/09
2.1	List of Tools/Supplies	10	
2.2	Physical Inspection	10	
2.3	Siting	10	
2.3.1	Exterior Inlet Radius Clearance	10	
2.3.2	Exterior Inlet Height	10	
2.4	Installing TSI Model 3781	10-11	
2.4.1	Attach Water Source	10	
2.4.2	Attach Power Cord	11	
2.4.3	Warm-up the Instrument	11	
2.4.4	Connect the Sample Inlet	11	
2.4.5	Positioning the Instrument	11	
2.5	Transporting	12	
2.5.1	Shipping and Storage	12	
2.5.2	Drying	13	
2.6	Serial/USB Connection	13	
2.6.1	Serial Standard RS-232 Communications	13	
2.6.2	USB Universal Serial Buss Communications	13	
2.6.3	USB Driver Software	14	
2.6.4	Communications Parameters	14	
2.7	Analog Output	14-15	
3.0	**CONFIGURATION**	16-20	07/09
3.1	Terminal Communications	16-19	
3.2	Internal Data Logging	19-20	

TABLE OF CONTENTS (CONT.)

4.0	**FLOW CALIBRATION**	21-22	07/09
5.0	**ROUTINE SERVICE CHECKS**	23	07/09
5.1	General Information	23	
5.2	Daily Check	23	
5.3	Bi-Weekly Check	23	
5.4	Monthly Check	23	
5.5	Tri-Monthly Check	23	
5.6	Semi-annual Check	23	
6.0	**MAINTENANCE PROCEDURES**	24-25	07/09
6.1	Maintenance Kits	24	
6.2	Wick Replacement	24-25	
7.0	**TROUBLESHOOTING**	26-28	07/09
7.1	Water in Sample Inlet	26	
7.2	Rapidly Flashing Status Indicator	26	
7.3	Double Flashing Flow – Flow Error	26-27	
7.4	Double Flashing Status Indicator – Water Level Error	28	
7.5	WCPC Will Not Fill	28	
7.6	Flooded Optics	28	

TABLE OF CONTENTS (CONT.)

TSI MODEL 3781
WATER-BASED CONDENSATION
PARTICLE COUNTER

Page

FIGURES

FIGURE 1	3781 WCPC Flow Schematic	8
FIGURE 2	WCPC Connector Locations	12
FIGURE 3	Connection Description	16
FIGURE 4	Connect To Communications (COM) Port	17
FIGURE 5	(COM) Port Properties	17
FIGURE 6	ASCII Setup	18
FIGURE 7	Capture Text	19
FIGURE 8	Internal Data Logging - HyperTerminal	20

TABLES

TABLE 1	Flow Adjustment	22

APPENDICES

AQSB Monthly Quality Control Maintenance Check Sheet .... Appendix A
AQSB Calibration Report..... Appendix B

1.0 GENERAL INFORMATION

1.1 Introduction:

The purpose of this Standard Operating Procedure (SOP) is to document the TSI Incorporated, Model 3781 Water-based Condensation Particle Counter (WCPC) procedures used by the Air Quality Surveillance Branch of the California Air Resources Board (ARB). The goal of this SOP is two fold: to formalize WCPC installation, configuration and operation procedures in order to ensure comparability among all WCPC data, and to describe supplemental information and modifications to the WCPC Operation Manual necessary to successfully integrate the WCPC into California's air monitoring network. The WCPC Operation Manual contains a significant source of information pertinent to the operation, maintenance and understanding of this instrument, and therefore the AQSB highly recommends a thorough review of the WCPC Operation Manual.

1.2 Principle of Operation:

The WCPC uses a laser and optical detector to detect the particles, passing the sampled flow through a viewing volume illuminated by a laser. It detects airborne particles down to six (6) nanometers in diameter. Using single particle detection with live-time coincidence correction, the Model 3781 covers a wide concentration range up to 5 × 105 particles/cm_3.

This WCPC features small size and light weight and is an ideal choice for monitoring temporal and spatial variations of various environments with multiple units. It is well suited for a wide range of applications, including indoor air-quality measurements, environmental monitoring, atmospheric and climate-change studies, and mobile aerosol studies.

The instrument relies on a condensation technique to deposit a working fluid on the particle to grow or "amplify" their size to a value that can be detected readily with a conventional optical system. This instrument utilizes a technology that allows water to be used as the working fluid without the requirement of mixing or adiabatic expansion techniques.

The aerosol sample is uninterrupted and follows a laminar-flow path from the sample inlet to the optical detector. The nominal total flow rate for the WCPC is 0.60 liters per minute (L/min). The sampler splits this flow into transport and aerosol flow. The transport flow rate is 0.48 L/min and is used to minimize particle loss at the inlet. The aerosol flow rate is 0.12 L/min and immediately enters a region surrounded with wetted media. A simplified flow schematic is shown in Figure 1, 3781 WCPC Flow Schematic..

The 0.12 L/min aerosol stream is saturated with water vapor and is temperature equilibrated. The sample then passes to a growth section where the wetted walls

are heated to produce an elevated vapor pressure. The high diffusivity of water vapor allows the vapor to reach the center of the sample stream at a faster rate than the thermal diffusivity of the vapor can equilibrate to the higher temperatures near the walls. This results in a supersaturated condition along the radius of the flow stream.

Particles in the flow stream act as nuclei for condensation. Water continues to condense on the particles as it passes up the growth tube and the enlarged particles are then detected by the optical detector.

A variety of communication options for computer data acquisition are available. The WCPC also includes an internal data memory chip for internal data logging and storage.

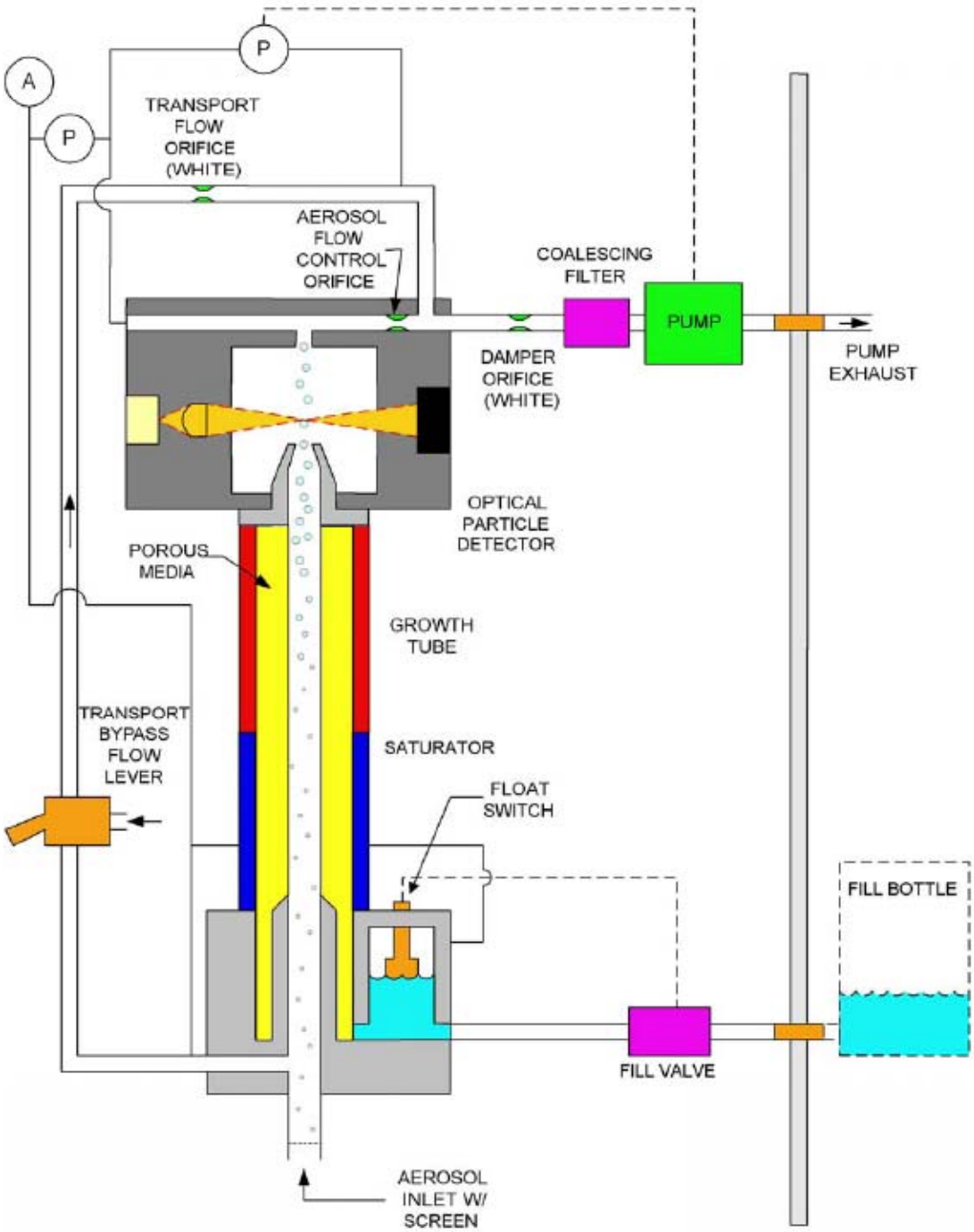

Figure 1
3781 WCPC Flow Schematic

1.3 Safety Precautions:

Only properly trained personnel should perform WCPC testing, installation, operation, maintenance and calibration procedures. As with all monitoring equipment, precautions should be taken when working around electricity, power tools and above ground. This section provides instructions to ensure safe and proper operation and handling. There are no user-serviceable parts inside the instrument. Refer all repair and maintenance to a qualified technician. All maintenance and repair information in this manual is included for use by a qualified technician.

Take the following precautions:

Do ***not*** remove any parts from the WCPC unless you are specifically told to do so in this manual.

Do ***not*** remove the WCPC housings or covers while power is supplied to the instrument.

1.4 Interferences/Limitations:

The WCPC can be transported over short distances such as across a lab, down the hall on a cart or a short drive in a vehicle, as long as the instrument is turned off, not subjected to tipping of more than 45 degrees, or subjected to prolonged freezing temperatures.

2.0 INSTALLATION PROCEDURE

2.1 List of Tools/Supplies:

Certified flow standard capable of measuring 1.0 L/min.

2.2 Physical Inspection:

Upon receipt of a WCPC, inspect equipment and accessories for completeness and for shipping damage. If shortage or damage is found, immediately notify your supervisor, and/or your agency's shipping department.

List of TSI Model 3781Components:

1 Model 3781 Water-based Condensation Particle Counter
1 Model 3781 Accessory Kit with the following parts:
- 1 Model 3781 WCPC Operation and Service Manual
- 1 Serial Cable, RS-232 (9-pin, M/F)
- 1 USB Cable, I/O, A/B
- 3 WCPC Wick*
- 1 Fill Bottle Assembly
- 1 Desktop Power Supply
- 1 Aerosol Instrument Manager® Software CD and Manual

2.3 Siting:

Siting of the WCPC will depend on the type of monitoring being conducted. When choosing the location for WCPC, it may help to consider the following items:

1) Exterior inlet radius clearance: These distances are Federal EPA requirements (40 CFR Part 58), and are designed to limit inlet airflow interference. The inlet should be installed with an unobstructed radius of six (6) inches.

2) Exterior inlet height: The inlet height should be four (4) to six (6) feet above the roof line.

2.4 Installing WCPC:

Perform the following steps to set up a new WCPC or a unit that has been dried for shipment or storage:

1) Attach the Water Source Fill water source bottle with distilled water (D.I.). Place water source bottle into the bottle bracket on the back of the WCPC. Insert connector from the source bottle into the "Water" connector on the

back panel of the WCPC.

NOTE: The AQSB recommends only the use of D.I. water in the WCPC.

2) Attach Power Cord Attach power cord to the AC power supply and connect the DC connector from this supply to the connector on the recess handle on the side of the WCPC. Refer to Figure 2, WCPC Connector Locations, for the location of the DC power connector.

Connect the AC power cord to an AC source. There is no power switch on the instrument. The WCPC is on when the power is applied.
The AC power supply converts AC power to 12 VDC power. This power supply accepts a variety of input voltages.
Input Power 100 – 240 VAC, 50/60 Hz, 100 VA

3) Warm-up the Instrument. After power up the display will show a moving hyphen and the difference between set operating temperatures and actual measured temperatures which will tick down to 5.0°C before the instrument leaves warm-up mode. The "Status" light on the front panel will slowly blink until the final operating temperatures are reached, and then will be steady green. If the "Flow" light on the front panel is off, turn on the pump by pressing the Pump button on the front panel. The last sampling condition remains in memory when it is powered off.

3) Connect the Sample Inlet Connect the Sample Inlet to an aerosol source to be measured to begin measurement of the aerosol sample.

Size Selective Inlet - Follow the manufacturer's procedures for installation and optimum sample flow rate, when using a size selective inlet.

5) Positioning the Instrument. Place the WCPC on a level surface. Ensure the cooling fan on the side panel of the WCPC is exposed to ambient air.

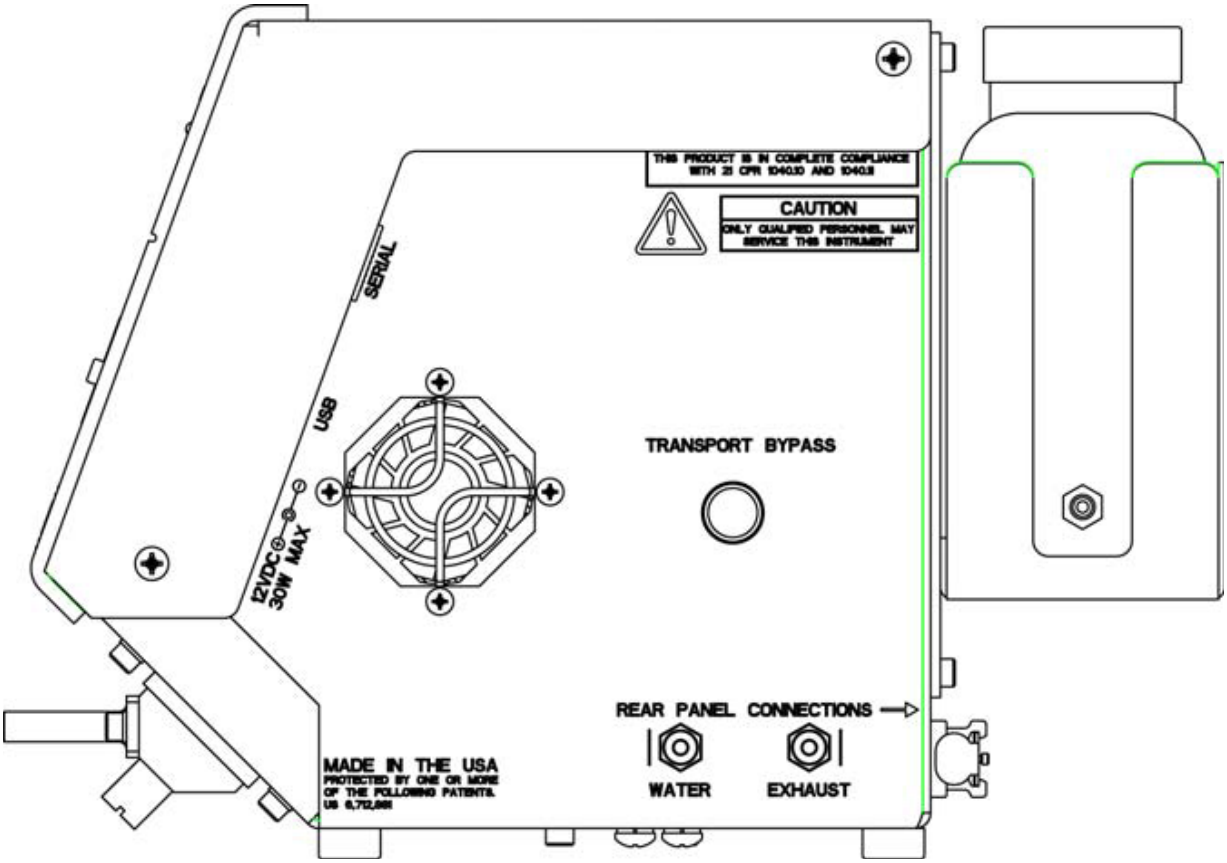

Figure 2
WCPC Connector Locations

2.5 Transporting

1) Shipping and Storage. The following procedure must be used in cases where the WCPC must be shipped, stored, or subjected to freezing temperatures. The instrument must be "dried" using the following procedure.

1. Disconnect any connections to the Sample Inlet.
2. Remove the source water bottle and empty the bottle.
3. Turn off the WCPC and remove the power cord.

The WCPC is ready for shipping/storage.

Prior to shipping, operate the instrument for at least an hour with the pump ON. The instrument can be considered dry enough for shipping when the display is reading zero concentration with particles present at the inlet. For long term storage: Let the instrument run at least overnight to completely dry the internal components to avoid mold during storage.

2) Drying. Connect the empty fill bottle to the Water fill connector on the

back panel of the instrument and keep the bottle lower than the level of the WCPC. In this case, the bottle acts like a drain bottle for the internal water reservoir of the WCPC.

Connect power cord and apply power to the WCPC. Once warm-up cycle is complete, make sure pump is turned on. When the WCPC detects the need for water, the fill valve opens and water remaining in the internal reservoir is allowed to drain out into the empty bottle. After water is drained out from the internal reservoir, remove and dry the bottle.

2.6 Serial/USB Connection:

The Aerosol Instrument Manager software is a very convenient tool to collect particle concentration data from the 3781 WCPC. It can also be used to control data logging and download data through the internal memory chip in the WCPC. The software is available through both RS-232 and USB ports. Installation of the software starts automatically by inserting the software CD included in the accessory kit into the computer or you can run autorun.exe to install. Refer to the software manual for details on software usage for data collection and download.

The WCPC provides several data interfaces allowing for flexible data collection and instrument control. There are two data connectors on the recess handle on the side of the WCPC.
These connectors are:

1) Serial Standard RS-232 communications.

The pin-out of the 9-pin D-Sub connector is a Serial RS-232 Connector Signal Connection. The pin numbers and signal direction are:

Pin Number	Signal Direction
2	RXD Input to WCPC
3	TXD Output from WCPC
5	GND —
9	ANALOG Output from WCPC

2) USB Universal Serial Bus communications.

This interface provides an alternate path for the serial RS-232 interface mentioned above. To a host computer, this interface acts like an additional serial port to the computer. Data can be sent and received on either data port, but they are not independent. Confusing results can occur if simultaneous communications are attempted through both USB and Serial RS-232 ports.
The USB LED indicator will light once a USB connection is established.

On power-up, the WCPC is setup to send a data record to the Serial interface once every five seconds. The USB link light will flash whenever data is transmitted by the WCPC. When the USB interface is connected to a host device, the link light will turn on and then will momentarily blink off each time data is transmitted.

3) USB Driver Software.

USB driver software must be installed on the host computer before using the USB port. This driver software is automatically installed when the Aerosol Instrument Manager software is installed.

Perform the following steps to install the Windows USB driver:

1. Download the driver (VCP FT232BM).
2. Extract (unzip) the driver into a blank folder.
3. Connect the computer to the WCPC USB port.
4. Follow the “Add New Hardware” Wizard steps and browse to the folder containing the extracted driver.
5. If the Wizard does not start, use the “Add Hardware” function from the “Control Panel.”

4) Communications Parameters

All serial communications with the WCPC are accomplished using the following communications parameters:
Baud Rate 115,200
Bits/Character 8
Stop bits..... 1
Parity..... None
Flow Control..... None

2.7 Analog Output.

A 0-to-4.00-volt analog output provides an indication of the displayed particle concentration. Connection to the analog output can be made from pins 9 and 5 of the Serial RS-232 D-Sub connector listed in section 2-6-1. The output voltage is a logarithmic function of concentration which allows a large range of particle concentrations to be mapped to the 0–4 volt span. The particle concentration can be determined from the output voltage by the following formula:

Concentration (particle/cm^3) = $10^{voltage+2}$

The analog output voltage is updated once per second based on the current

displayed value. Note the analog output can not be used for particle concentrations below100 particles/cm3 as the minimum concentration value is100 particles/cm3 when voltage is 0 V.

3.0 CONFIGURATION

3.1 Terminal Communication: Once the Serial or USB connection is made between the WCPC and a host computer, a terminal program may be used to communicate with the instrument. Use terminal emulation software such as HyperTerminal, which is included in most MS-Windows operating systems. Below are the steps to follow when using a HyperTerminal program.
See Figure 2, WCPC Connector Locations, for the location of the Serial or USB connections.

Connect to the Model 3781 WCPC and Open the HyperTerminal program by selecting:

Start|Programs|Accessories|Communications|HyperTerminal.

Enter a name for the connection, for example, TSI-3781. (Figure3)

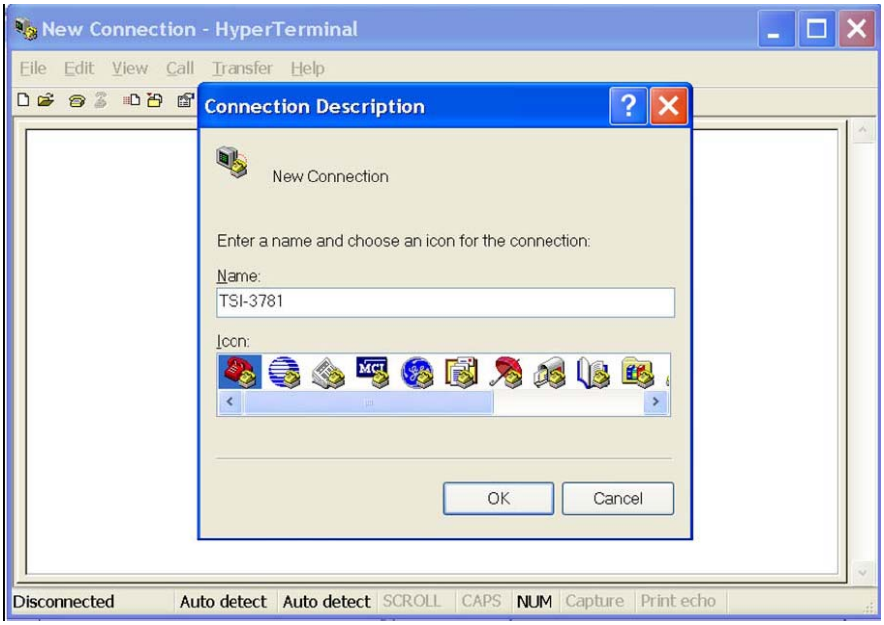

Figure 3
Connection Description

Enter the communications (COM) port, for example (COM1). (Figure 4)

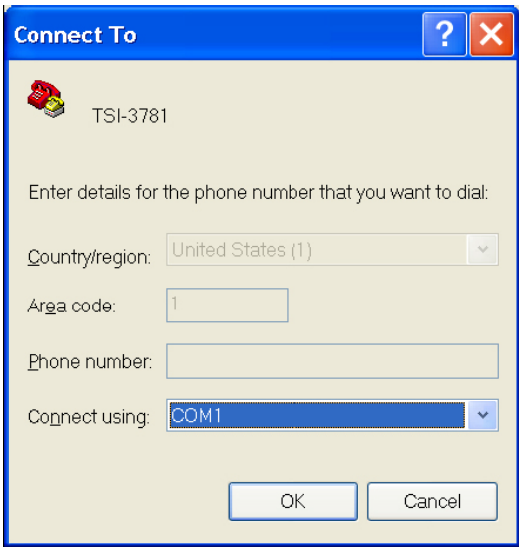

Figure 4
Connect to Communications (COM) Port

Enter the port settings, like the ones described below and click OK. (Figure 5)

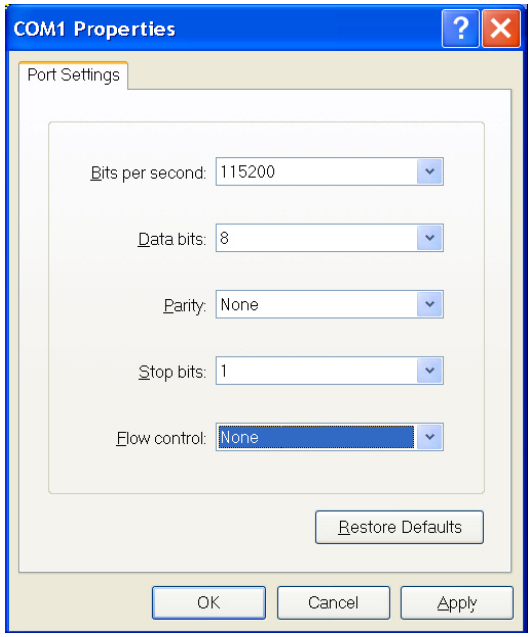

Figure 5
(COM) Port Properties

Under the settings tab, pick the ASCII Setup button and check the boxes shown below. It is recommended that the terminal software be set up to translate incoming carriage returns <CR> to carriage return/line feed <CR/LF> sequences so the data returned from the WCPC does not overwrite the previous written line piling all the data on a single line on the screen. It is also convenient to enable local echoing of characters so data typed on the keyboard is shown on the screen as well. (Figure 6)

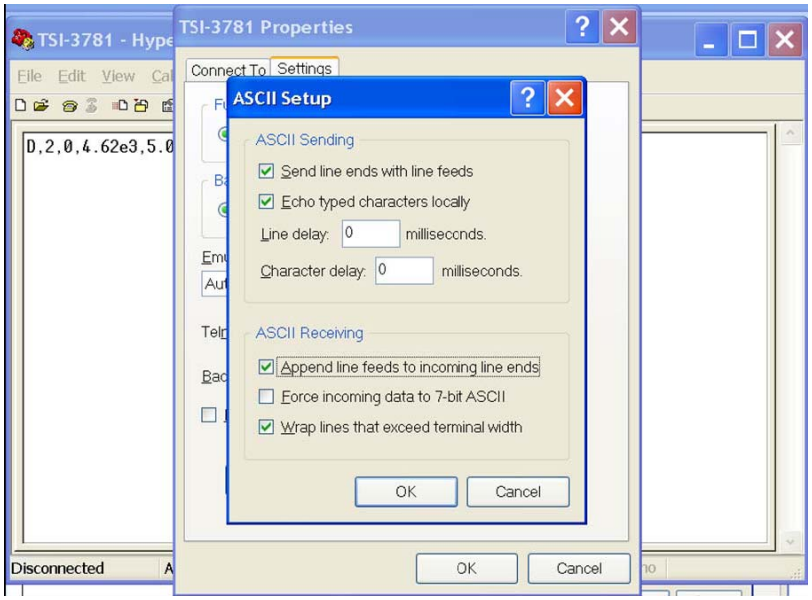

Figure 6
ASCII Setup

Once connected and running, pressing the **Enter** key within the terminal software will elicit a response of “ERROR” from the WCPC. This indicates that the WCPC and computer are in communication, but the WCPC didn’t acknowledge an input. Data records beginning with the character “D” will also be displayed once every five seconds as the WCPC reports from its power-up default condition.

Now select **File|Save As** and save the HyperTerminal file to the desktop for easy access. Close the program and start it again from the desktop. HyperTerminal should automatically open a connection to the instrument. (A set of firmware commands can be used through this connection. Data is reported to the screen of the terminal program too. This data can either be cut-and-paste as needed or turned on for the software’s logging capability to capture the data.)

If using a HyperTerminal program, select T**ransfer|Capture Text**… put in a file name, and press **Start** to save the data. Press **Stop** to stop the data collection. Data in this comma delimited form is easy to be imported to other programs such as Microsoft Excel for analysis and graphing. (Figure 7)

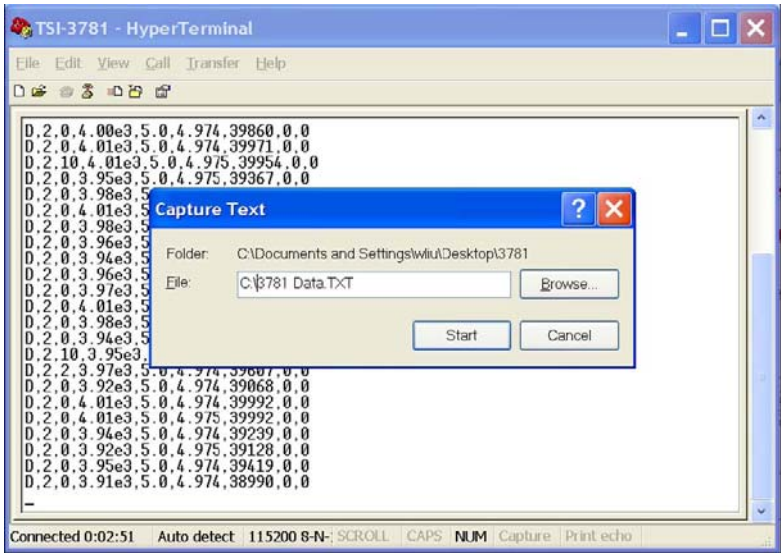

Figure 7
Capture Text

3.2 <u>Internal Data Logging</u>: The 3781 WCPC has a 4MB internal memory chip for logging data. The sample interval can be set from 1 to 300 seconds. For example, a five minute sample, the logging mode interval is set to 300 seconds. It is capable of logging two weeks of one-minute data. Each data record includes a time stamp, flag information, concentration, sample interval (or data averaging interval), live time, total counts, ambient pressure and aerosol flow rate.

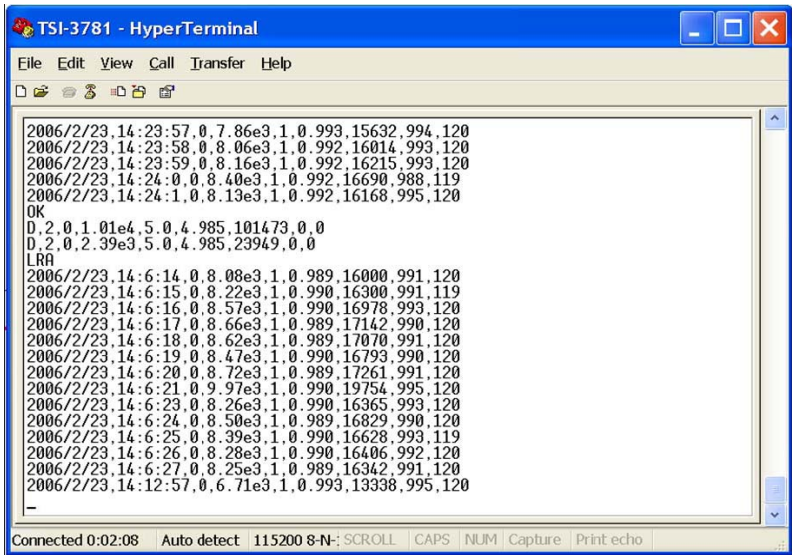

Figure 8
Internal Data Logging - HyperTerminal

Aerosol Instrument Manager Software and terminal programs can be used to log data with the internal memory chip in the WCPC. The programs can also download data from the memory. See Aerosol Instrument Manager Software manual for details on how to log data internally and how to download the data. Firmware commands for data logging and downloading are listed in Appendix C of the WCPC Operations and Service Manual.

4.0 FLOW CALIBRATION

General Information: Perform the following checks on the WCPC at the intervals specified in the service schedule. The checks may be performed more frequently but should be performed at least within the prescribed intervals. Document and check information and maintenance on the CARB Monthly Quality Control Maintenance Check Sheet (Appendix A).

The 0.12 L/min aerosol flow of the WCPC is feedback-controlled to a set point value stored in a non-volatile memory. To check the flow, connect a flow meter to the sample inlet, turning on the pump and lift the Transport Bypass flow lever on the side panel of the instrument. The indicated flow value should be 0.12 L/min ± 5% (0.114 – 0.126 L/min). The total inlet flow can be checked by releasing the Transport Bypass flow lever and the flow meter reading should be 0.6 L/min ±15% (0.51 – 0.69 L/min). The flow measurement should be made only when the instrument has been warmed-up and running for at least 30 minutes. Also, the instrument must be operating with a water supply and the wick is fully wetted.

To change the sample flow calibration, the internally stored calibration set point must be changed. A computer running a terminal emulation program as described in Section 2 must be connected to the WCPC. Entering the command SFS (Set Flow Set Point) will echo the current set point value to the terminal screen. The flow set point value can be changed by entering a new value using the same command followed by a comma and the value. Increasing the set point value will increase the flow. Changes of 10 or more to the value may be necessary to see changes in the flow meter reading depending on its sensitivity. For example, changing the SFS from 1250 to 1260. See Table 1, Flow Adjustment.

The set point value of the aerosol sample inlet flow should be adjusted until a flow standard reading of 0.12 L/min ± 5% is obtained, when the Transport Bypass flow lever is lifted. The total inlet flow can be checked by releasing the Transport Bypass flow lever and the flow standard reading should be 0.6 L/min ±15%.

Command	Response
SFS	1250,3287 WCPC returns current flow set point value and associated absolute pressure bit value.
SFS,1260	OK WCPC accepts new set point and increases flow rate. A new absolute pressure bit value is taken at this instant.
SFS	1260,3292 WCPC returns new flow set point and the new absolute pressure value.

Table 1
Flow Adjustment

5.0 ROUTINE SERVICE CHECKS

5.1 General Information: Perform the following checks on the WCPC at the intervals specified in the service schedule. At a minimum, instrument checks must be performed within the prescribed intervals. Document any pertinent information and maintenance performed on the Monthly Quality Control Maintenance Check Sheet (Appendix A).

5.2 Daily Check: Review station datalogger values for correct operation status of the WCPC.

Check water level of source water bottle.

5.3 Bi-Weekly Checks: Perform WCPC flow check. The set point value of the aerosol sample inlet flow should be adjusted until a flow standard reading of 0.12 L/min ± 5% (0.114 – 0.126 L/min) is obtained, when the Transport Bypass flow lever is lifted. The total inlet flow can be checked by releasing the Transport Bypass flow lever and the flow standard reading should be 0.6 L/min ±15% (0.51 – 0.69 L/min).

Download data.

5.4 Monthly Checks: Complete and submit Monthly Quality Control Check Sheet.

Thoroughly clean Model 3781 WCPC inlets.

Download and submit data from Model 3781 WCPC data logger.

5.5 Three-month Checks: ARB recommends that a new wick be installed in the 3781 WCPC a minimum of every three months. See Section 6-2 of this SOP, “Replacing Wick” instructions.

5.6 Semi-Annual Checks: Calibrate WCPC flow with station semi-annual checks.

6.0 MAINTENANCE PROCEDURES

6.1 Maintenance Kits: The following maintenance kits are available to order for the 3781 WCPC:

Power Supply, P/N 1200020.

Maintenance kit including (5 wicks, 1 inline air filter, 1 inlet particle retention screen (25 micron), 1 transport flow orifice, and 1 pump silencer), P/N 1031545.

Fill Bottle Kit (250 ml), P/N 1031544.
Inlet Cyclone Kit (3.0 µm at 0.6 L/min), P/N 1031558.
Large Fill Bottle Kit (4 Liter), P/N 1031557.

6.2 Wick Replacement: The AQSB recommends replacement of the 3781 WCPC wick, a minimum of every three months. To change the wick use the flowing steps:

CAUTION

Do not attempt to remove a wet wick. Removal of the wick must be done when the wick is completely dry. A wet wick will disintegrate if attempted to be removed before it is dry and potentially leave behind fragments which could clog the nozzle or aerosol flow control orifice.

Disconnect sample sources from inlet, drain the internal reservoir, and run the WCPC for **at least one hour** until concentration reading decreases to zero.

Loosen the two thumbscrews located at the Sample Inlet.

Remove the Sample Inlet assembly.

If the wick slips out with the inlet assembly just slide the wick off the end, otherwise the wick has remained lodged inside the WCPC and must be carefully removed with a tweezers or long nose pliers. Once removed, the wick can be discarded.

Using a 7⁄64 hex driver remove the four #6 screws that secure the inlet port fitting on the front panel.

Remove the screen and clean any accumulated material.

Replace screen and reattach the inlet port.

Slip a new wick over exit end of the Sample Inlet assembly.

Slide wick into the WCPC and press the Sample Inlet assembly to seat the ring seal.

Tighten the thumbscrews securing the Sample Inlet assembly.

To completely dry the wick, follow the drying for shipping procedures in Chapter 2.5 of this SOP “Transporting” section.

Find additional information in the 3781 WCPC Operation and Service Manual.

7.0 TROUBLESHOOTING

7.1 Water in the Sample Inlet

Water flowing out of the sample inlet or gurgling inside the inlet may result from several situations including:

Tipping of the WCPC beyond ten degrees during operation or a warm humid aerosol sample is condensing within the cooled inlet.
The water is best cleared by removing connections to the Sample Inlet and disconnecting the water fill bottle and letting the WCPC operate with the pump on until water is cleared. Usually less than an hour is required.

7.2 Rapidly Flashing Status Indicator - Laser

A rapidly flashing Status indicator occurs whenever the laser is not operating at its set-point value. This will happen under the following conditions:
The laser has been turned off using the SL,0 command through a emulation software such as HyperTerminal. If the response to SL command is 0, the laser has been turned off. Enter SL,1 to turn on the laser.

On power-up the WCPC detected that the laser set-point value exceeded the maximum allowed laser power. The WCPC leaves the laser off when this condition is detected.

The laser is no longer able to provide the power necessary for proper operations and needs to be replaced. **The laser diode is not a field replaceable part**. Firmware commands for data logging and downloading are listed in Appendix C of the WCPC Operations and Service Manual.

7.3 Double Flashing Flow Indicator – Flow Error

The Flow indicator will blink twice and pause repeatedly if the WCPC detects a problem with the flow system. This occurs when the WCPC detects a mismatch between the pressure drop measured across the nozzle and the pressure drop across the aerosol flow control orifice. This mismatch typically indicates some blockage of one or both of the two. The most probable cause is a small amount of material deposited on the nozzle. It may be possible to dislodge the material by operating the instrument with the pump running and then plugging the sample inlet with a finger for about 5 seconds and then releasing. This surge of flow may clear the obstruction.

Further investigation can be accomplished, by using a terminal program connected to the serial port and entering the RN (Read Nozzle) command. This should be done with pump operating. The nominal value is 100 and the Flow LED will flash double blinking pattern if this value is above 125 or below 75. A high

value is an indication of an obstruction in the nozzle. A low value would result if there was an obstruction in the aerosol flow control orifice.

In this case, a measurement of the aerosol flow with a flow meter at the inlet should also read low. The Transport Bypass flow lever needs to be lifted for aerosol flow measurement. If a nozzle obstruction cannot be cleared with a simple pressure pulse described above (blocking the Sample Inlet for 5 seconds), the nozzle can be cleaned as described below.

WARNING

Hazardous laser radiation is present if the optical assembly is opened and the instrument is powered. The optical assembly is not user serviceable.

CAUTION

The following procedure requires disassembly of portions of the instrument. Improper disassembly or reassembly can result in leaks or changes that affect the calibration of the product or cause damage to the product. The following procedure should be performed by a qualified technician.

IMPORTANT

Before using compressed air, disconnect the tubing from the optics assembly to pressure transducers to prevent compressed air from damaging pressure transducers. Do not remove the nozzle from the optics. Removing and replacing the nozzle will affect the optical alignment of the unit and the ability to measure high particle concentrations.

Remove power from the instrument.

Disconnect water fill bottle.

Remove the instrument cover (5 screws on sides of cabinet).

Remove optical assembly (4 screws top of the assembly).

Tip the optical assembly to the side to gain access to the nozzle.

Inspect and clean the nozzle. The nozzle opening is very small and delicate. Do not poke sharp objects down into the orifice. Drip a few drops of water onto the nozzle, remove three pieces of tubing from the Optics Assembly prior to using dry compressed air to blow water through the nozzle. Find additional information in the 3781 WCPC Operation and Service Manual

When reassembling the unit, tighten the four cap screws holding the optical assembly carefully making sure the optics housing is seated and aligned straight. Inspect cables and verify their full insertion. Reinstall instrument cover and attach fill bottle. Measure the aerosol flow rate at the Sample Inlet with the Transport Bypass flow lever lifted.

7.4 Double Flashing Status Indicator – Water Level Error

The Status indicator will repeatedly blink twice and pause if the WCPC fill system detects a call for water but is unable to fill. Typically this means the water bottle is empty or disconnected. When the WCPC is filled with water it can operate over two hours before requiring more water. About an hour into this time, the Status indicator will begin to double-blink as it senses the drop in liquid level. The particle concentration data is unaffected if more water is added within an hour.

7.5 WCPC Will Not Fill

There may not be enough water in the water fill bottle. The water level in the bottle needs to be above the water exit port on the bottle. Another likely cause of this symptom is positive pressure on the Sample Inlet which inhibits water flow into the internal reservoir from the gravity fed fill system.

7.6 Flooded Optics

If the instrument has been tipped more than 10º during operation or the particle concentration reading is unreasonably low, the optics of the WCPC might be flooded. Follow the drying procedure Section 2.5 to drain and dry the WCPC. Run the instrument for at least 24 hours with the fill bottle disconnected and the pump running. After the optics is completely dry, reconnect the fill bottle and turn on the instrument.

AQSB MONTHLY QUALITY CONTROL MAINTENANCE CHECK SHEET

Model 3781 Water-based Condensation Particle Counter (WCPC)

Site Name: _____ Month/Year: _____

Site Number: _____ Sampler Make & Model: _____

Operator/Agency: _____ Sampler ID Number: _____

Date of Last Calibration: _____

Instrument Checks:

1) Daily checks: Review station data logger values for correct operational status of the WCPC. Check water level of source water bottle.
2) Bi-Weekly Checks: Perform Model 3781 WCPC flow check. Download data.
3) Monthly checks: Complete and submit this Monthly Quality Control Check Sheet. Thoroughly clean Model 3781 WCPC inlets. Download and submit data from Model 3781 WCPC data logger.
4) Three month Checks: Install a new wick in the 3781 WCPC a minimum of every three months.
5) Semi-Annual Checks: Calibrate WCPC flow with station semi-annual checks

Sampler Flow Rate Check Results:

	Flow Rate Standard		
Standard Make/Model:			
Std. ARB ID Number:			
Std. Certification Date:			
Standard Slope:			
Standard Intercept:			
Date Checked:			
Std. Display Reading:			
Std. 'Actual' Reading:			
Model 3781 WCPC Display:			
Design Flow % Diff.:			

Standard Flow Acceptance Criteria: Last Wick Change_____

Lifting the Transport Bypass flow lever, the indicated flow value should be 0.12 L/min ±~5% (0.114 - 0.126L/min).

The total inlet flow can be checked by releasing the Transport Bypass flow lever and the flow meter reading should be 0.6 L/min ±15% (0.51 – 0.69 L/min).

Operator Comments:

_____

_____

_____

Reviewed by_____

Appendix A

AQSB Monthly Quality Control Maintenance Check Sheet

AQSB QC FORM 409 (WCPC) 07/09

AQSB Calibration Report - Model 3781 WCPC

TSI Water-based Condensation Particle Counter

ID Information:

Station Name:	**Lodi DSS**	**As Is:**	**X**
Site #:	**JR-1**	**Final:**	
Property #:	**20026996**	**Calib. Date:**	**03/26/07**
Agency:	**ARB**	**Last Cal:**	**NA**

Flow Calibration with Flow Lever Lifted (0.12 L/min +/- 5% = 0.114 to 0.126 L/min):

					MFM Flow:
WCPC Flow Display:	**Std. Display:**	**Corrected Flow:**			**0.12**
0.12	**0.12**	**% Diff.:**			**0.00%**

Flow Calibration with Flow Lever Released (0.6 L/min +/- 15% = 0.51 to 0.69 L/min)

					MFM Flow:
WCPC Flow Display:	**Std. Display:**	**Corrected Flow:**			**0.60**
0.60	**0.60**	**% Diff.:**			**0.00%**

Flow Verification with Flow Lever Lifted (0.12 L/min +/- 5% = 0.114 to 0.126 L/min):

					MFM Flow:
WCPC Flow Display:	**Std. Display:**	**Corrected Flow:**			**0.12**
0.12	**0.12**	**% Diff.:**			**0.00%**

Flow Verification with Flow Lever Released (0.6 L/min +/- 15% = 0.51 to 0.69 L/min

					MFM Flow:
WCPC Flow Display:	**Std. Display:**	**Corrected Flow:**			**0.60**
0.60	**0.60**	**% Diff.:**			**0.00%**

Comments:			
Calibrated by:		**Checked by:**	

Appendix B

AQSB Calibration Report - Model 3781 WCPC

AQSB QC FORM 409 (WCPC) 07/09