MEASUREMENT AND ANALYSIS OF ELEMENTAL AND ORGANIC CARBON USING THE R&P EC/OC SERIES 5400 MONITOR

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MEASUREMENT AND ANALYSIS OF ELEMENTAL AND ORGANIC CARBON

USING THE R&P EC/OC SERIES 5400 MONITOR

1. PURPOSE AND APPLICABILITY

This research protocol contains the protocol for measurement and analysis of elemental and organic carbon in ambient aerosol particles at the Baltimore PM supersite using the Rupprecht and Patashnick Series 5400 ambient carbon particulate monitor. This is an evaluation version of an anticipated standard operating procedure (SOP), which will result from experiences with this RP. Due to this nature this RP is subject to changes. Every addition to this RP will be added as an Appendix during this study. This RP supplements the operating and maintenance procedures described in the manual of the EC/OC monitor.

2. DEFINITIONS

EC: elemental carbon

OC: organic carbon

3. DATA QUALITY OBJECTIVES

The objective for the Automated Particle Carbon measurements is to determine the concentration of fine particle elemental and organic carbon in ambient air with a time resolution of at least 30 minutes. Data quality assurance objectives for the carbon system are as follows:

Accuracy:	Average of carbon to agree to within a factor of two of filter measurements
Precision:	at least ±10% (= 1 sigma) as determined by replicate gaseous standards.
Lower Quantifiable Limit:	1 µg/m^3 for a 10 min sample.
Completeness:	At least 88% data completeness.

NOTE: These values have been taken from Susan Hering's ADI SOP

3.1.1 DATA QUALITIY ASSURANCE

The components to achieving data quality objectives are:

1) Written research procedure (this RP);

2) Verification of installation

3) Careful operator training

4) Daily and weekly system checks as outlined in the RP,

5) Routine collection of dynamic blanks

6) Routine calibrations,

7) Routine data review and

8) On-site audits.

4. HEALTH AND SAFTEY WARNINGS

1) Pressurized gases are used to for calibration and operation. Observe safety precautions for pressurized non-flammable gases.

2) Interior surfaces of the EC/OC monitor may be extremely hot

5. CAUTIONS

The user must take extreme care to ensure that no foreign matter is permitted to drop into the instrument by way of the sample tube inlet. *Always* cover this opening when it is not connected to sample tubing.

6. INTERFERENCES

N/A

7.   RESPONSIBILITIES

N/A

8.   EQUIPMENT AND MATERIALS

8.1   Equipment

1) R&P Series 5400 EC/OC Monitor

2) Personal computer

3) N_2 for calibration

4) 0.15 % CO_2 in N_2 for calibration

5) 0.40 % CO_2 in N_2 for calibration

8.2   Paper materials

1) Field forms to record performance in the field

2) Laboratory book EC/OC monitor

9.   PROCEDURES

9.1.   Starting and stopping sample processing

The Series 5400 monitor is in its Warm Operating Mode when first turned on by the user. It remains in this mode until its idling temperatures have reached their set points. Once this occurs, the monitor automatically enters the Ready Operating Mode, a state that permits most operating parameters to be changed using the <EDIT> key.

Entering the Run Operating mode:

Once the proper settings are selected for the Run Definition and Setup Screens, the user can set the instrument into operation. Press <RUN/STOP> when the device is in the Ready Operating Mode and displays a status of ok in the upper left corner of the screen. The operation mode indicator in the upper right corner of the main screen should switch to run. The monitor will

begin the collection phase of the first instrument cycle according to the settings entered for Base Time in the Run Definition Screen.

Main Screen

The appearance of the Main Screen changes when the instrument is in the Run Operating Mode to display information relevant to the operating unit. None of the fields in the Main Screen are editable. The following fields are added to the basic layout of the Main Screen in the right-hand column.

Main Screen		RUN	
15:03:26		04 –May– 9 5	
FiltA Temp: 31	C Beg	Time: 15:00	
ABrnA Temp: 751	C Average :	3 hr	
FiltB Temp: 30	C Coll Vol:	57.2 1	
ABrnB Temp: 749	C Coll Flow:	16.7 1/min	
StCode	Stats	RunDef	Data	Setup

Beg Time   The Beginning Time (hours:minutes) at which the current instrument cycle began. If the monitor has just entered the Run Operating Mode, this represents the time at which the first instrument cycle will be executed.

Average   The length of the instrument cycle's collection phase (hour).

Coll Vol   The Collection Volume (standard liters) increases during the collection phase. This measurement is expressed in standard liters as defined by the standard temperature and pressure parameters (Section 2.3).

Coll Flow   The Collection Flow indicates the current volumetric sample flow rate
               (volumetric 1/min) being drawn through the open collection path of the
               instrument. The soft function key definitions available in the Main Screen are the
               same whether the instrument is in the Ready or Run Operating Modes.

9.1.2 Leaving the Run Operating Mode

The user can leave the Run Operating Mode in two ways:

1) interrupt the currently executing instrument cycles in their collection and analysis phases; or

2) stop the operation of the monitor at the end of the currently executing instrument cycles. The first
   method returns the user to the Ready Operating Mode much more quickly, but results in the loss of
   data from the instrument cycles currently being executed.

3) Press <RUN/STOP> when in the Run Operating Mode to select the stop option desired. In
   response to this command, the regular soft function key line is replaced with three stop options . Press
   the appropriate soft function key:

```
OK                  Main Screen              RUN




                 Choose Stop Type


                 Please choose:


Immed  EndCyc                     Resume
```

Immed   The monitor immediately suspends the operation of the instrument cycles currently
               being executed. The instrument then enters the Stop Operating Mode to indicate that one
               or more of the collectors must be "cleaned" before the device can be operated again. Press
               <RUN/STOP> when in the Stop Operating Mode to initiate the cleaning cycle and

return the monitor to the Ready Operating Mode. During the Clean Operating Mode, the device heats collectors A and B sequentially to a temperature of 750 ℃ for a period of 300 sec each. If, for some reason, it is necessary to interrupt the cleaning sequence, press <RUN/STOP> again to return to the Stop Operating Mode.

EndCyc   The instrument ceases measurements at the end of the instrument cycles currently being executed, and automatically re-enters the Ready Operating Mode once this has occurred. The operating mode shown in the upper right-hand corner of the Main Screen is displayed as "RUN-C" to indicate that the unit will stop operating at the end of the current instrument cycles.

Resume   If the monitor is currently in the Run-C Operating Mode described above to stop instrument operations at the end of the current instrument cycles, the user can select Resume to return the device to the regular Run Operating Mode. This action has the effect of canceling the previous command to stop operating at the end of the current cycles, returning the monitor to its usual operating setting of continuous operation.

Relationships among operating modes:
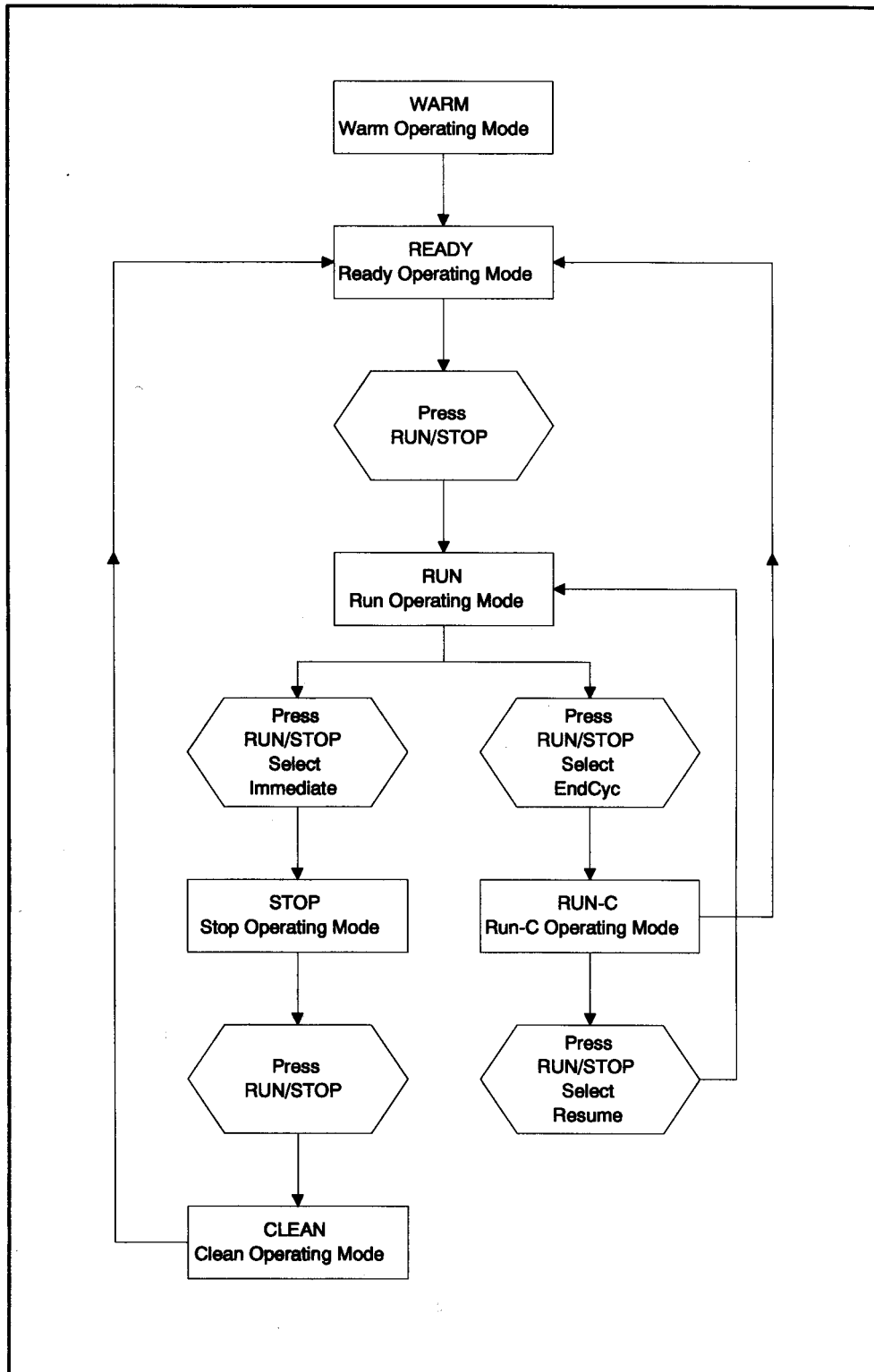
9.2 Summary of Operating Modes

The Series 5400 monitor has a number of different operating modes to indicate its current state. These are displayed in the upper right-hand corner of the Main Screen .

WARM

Indicates that the instrument is warming up after being turned on. The device automatically enters the Ready Operating Mode once its idling temperatures are reached. View the Status Codes Screen to determine the meanings of the status code displayed in the upper left-hand corner of the Main Screen.

READY

The monitor is currently idling, and is ready to begin operation. It is very important to ensure that the correct operating parameters are entered in the Run Definition and Setup Screens before leaving the Ready Operating Mode. Press <RUN/STOP> when in this mode to enter the Run Operating Mode.

RUN

This display indicates that the instrument is currently operating and executing the collection and analysis phases of instrument cycles in collectors A and B. View the Filter Statistics Screen (Section 6.2) for a summary of actions currently being performed by the device. Press <RUN/ STOP> when in this mode to enter the Stop or Ready Operating Modes .

RUN-C

When in this mode, the user has instructed the monitor to stop operating at the end of the instrument cycles currently being executed (Section 5.3.3). To reverse this state and return to the regular Run Operating Mode, press <RUN/ STOP> and select the Resume option.

STOP

This mode indicates that the user interrupted instrument operation during the execution of its instrument cycles, resulting in particulate collectors that require cleaning. To clean collectors A and B (Clean Operating Mode) and automatically return to the Ready Operating Mode, press <RUN/STOP> when in this mode . During the Clean Operating Mode, collectors A and B are cleaned in sequence for 300 sec each at a temperature of 750 °C. The user can also instruct

the instrument to clean its collectors in the Service Operating Mode. The Stop

Operating Mode can also indicate that a serious status condition exists that

requires user attention. Refer to the Status Codes Screen (Section 6.1) or the Service

Manual if this is suspected to be the case.

CLEAN   During the Clean Operating Mode, the instrument heats collectors A and B to a

temperature of 750 °C for 300 seconds each to oxidize participate matter in the

collectors. It first treats collector A before heating collector B. The user can

view the current status of the collectors during cleaning from the Filter Statistics

Screen (Section 6.2). Press <RUN/STOP> when in the Stop Operating Mode to

enter this mode. When in the Clean Operating Mode, to interrupt the cleaning

procedure prematurely and return to the Ready Mode, press

<RUN/STOP>.

SVCCLN   This mode indicates that the cleaning routine is being executed from the Service

Operating Mode (see below). This is done by selecting "Clean Cycle" from the

System Maintenance Screen of the Service Menu. The execution of this mode

is the same as that for the Clean Operating Mode described above, with the

exception that the instrument returns to the Service Operating Mode at the end of the

cleaning cycle or if the user interrupts the cleaning routine by pressing

<RUN/STOP>.

CALEB   The instrument enters the Calibration Operating Mode when the user executes

manual and automatic calibration procedures from the CO_2 Calibration Screen

.Thi mode abbreviation never appears on the display of the monitor, but is

used internally to control instrument operations.

SVC   The Service Operating Mode provides the user and technician with complete

access to instrument functions forcalibration and troubleshooting. When in

this mode, all normal temperature and flow settings are set to 0 unless overridden in

one of the screens of the Service Menu.

9.3   Turning off the Series 5400 Monitor

It is important that the instrument be in its Ready Operating Mode when it is turned off. Otherwise, if it is turned off while operating or left in the Stop Operating Mode, the monitor will enter the Stop Operating Mode when the user next turns it on. This would necessitate the execution of the cleaning cycle before the instrument is returned to the Ready Operating Mode .

Execute the following steps to turn off the Series 5400 monitor

1) If the instrument is currently in the Ready Operating Mode, skip to step 2. Otherwise, follow the instructions in the manual Section 5.3.3 to return the device to the Ready Operating Mode by pressing <RUN/STOP> and taking the appropriate follow-on actions.

2) Power down the instrument by pressing the power switch on the front face of the monitor.

3) Turn off the sample pump

9.4   Operation after Power Failure

The unit's hardware and software are designed to recover from power failures automatically.

If a power failure interrupts the collection phase of an instrument cycle, the monitor continues sample collection through its collection path once power is restored. A status condition "Z" (&H40000) indicating a power outage is stored with the other operating data of the interrupted instrument cycle. The "Z" status condition also appears on the Main Screen until the end of the current collection phase, causing the status light on the front of the unit to turn on.

If a power failure interrupts the analysis phase of an instrument cycle while the monitor is executing temperature plateaus and CO_2 measurements, the monitor aborts the analysis phase and initiates a cleaning routine for the collector in question. This prepares the collector for the collection phase of the next instrument cycle.

9.5 Audit/Calibration Procedures

Reference refers to the appropriate section of the manual

Routine Maintenance Requirements

Procedure	Interval	Reference
Cleaning Front Air Intake Filters	3 or 6 months	Section 9.1
Testing Batteries–Exchange if Necessary	6 months	Section 9.2
Exchanging Internal Large In-Line Filter	12 months	Section 9.3
Exchanging External Large In-Line Filter	12 months	Section 9.4
Exchanging Disk (Gas Input) Filters	12 months	Section 9.5
Exchanging Collectors A and B	12 months	Section 9.6
Sample Pump Rebuild	18 months	Rebuild Kit
Exchanging a Furnace Burner	As Needed	Section 9.7
Exchanging an Afterburner Burner	As Needed	Section 9.8
Exchanging Fuses	As Needed	Section 9.9

Audit/Calibration Procedures

Procedure	Interval	Reference
Analog I/O Calibration:		
Analog I/O Calibration–Software	6 months	Section 10.1
Analog I/O Calibration–Hardware	As Needed	Section 10.2
Collection Path Leak Test	6 months	Section 10.3
Flow Audit/Calibration:		
Flow Audit	6 months	Section 10.4
Flow Meter Calibration	As Needed	Section 10.5
Analysis Loop Leak Test	6 months	Section 10.6

| Temperature Circuit Calibration | 6 months | Section 10.7 |

CO2 Calibration:

CO2 Calibration–Automatic	6 months	Section 10.8
CO2 Calibration–Manual	6 months	Section 10.9
CO2 Calibration–Hardware	6 months	Section 10.10
Furnace Calibration	6 months	Section 10.11

10. Instrument maintenance

10.1 Every other day maintenance

1) Check status screen of the monitor and verify that no alarms or warnings are present

2) Check data file for completeness

3) Check computer and monitor time and date for accuracy

4) Check N_2 and CO_2 canister pressure. Order new canister if current canister is less than 50% full.

5) Check gauge readings.

6)

10.2 Weekly maintenance

1) Check sample flow rate with Gilibrator. Record sample flow in the lab book

2) Check sample inlet for pollution or clogging

11. Data storage

Time and date stamped concentration data and control parameters will be stored as comma delimited ASCII in a continous append file on the harddisk of the data acquisition computer. These raw data will be merged 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.