California Environmental Protection Agency

COMMUNITY AIR MONITORING BRANCH

STANDARD OPERATING PROCEDURE

FOR

MET ONE MODEL BC-1054

ELEMENTAL/BLACK CARBON AND ORGANIC CARBON MONITOR

CAMB SOP 250

First Edition

Monitoring and Laboratory Division

November 2018

DISCLAIMER: Mention of any trade name or commercial product in this Standard Operating Procedure does not constitute endorsement or recommendation of this product by the Air Resources Board. Specific brand names and instrument descriptions listed in the Standard Operating Procedure are for equipment used by the Air Resources Board laboratory.

California Environmental Protection Agency

Approval of Standard Operating Procedure

Title: Met One Model BC-1054 Elemental/Black Carbon and Organic Carbon Monitor

SOP: CAMB SOP 250, First Edition

Section: Advanced Monitoring Techniques Section

Branch: Community Air Monitoring Branch

Division: Monitoring and Laboratory Division

Approval: This SOP has been reviewed and approved by

Walter Ham, Manager
Advanced Monitoring Techniques Section
Community Air Monitoring Branch

11/29/18
Date

Kenneth Stroud, Chief
Community Air Monitoring Branch

11-29-18
Date

Table of Contents

Acronyms

AT	Ambient Temperature
BAM	Beta Attenuation Monitor
BC	Black Carbon
BP	Barometric Pressure
CARB	California Air Resources Board
CAMB	Community Air Monitoring Branch
EC	Elemental Carbon
IR	Infrared
nm	nanometer
OC	Organic Carbon
OD	Outside Diameter
PM2.5	Particulate Matter with diameters≤2.5µm
Pm10	Particulate Matter with diameters≤10µm
PN	Part Number
P/T	Pressure/Temperature
RH	Relative Humidity
SCC	Sharp Cut Cyclone
UV	Ultraviolet
VDC	Volts Direct Current

1.0 GENERAL INFORMATION

1.1 Introduction:

This Standard Operating Procedure (SOP) describes procedures used by the California Air Resources Board (CARB) Community Air Monitoring Branch (CAMB) to operate the Elemental/Black Carbon and Organic Carbon Monitor (Model BC-1054, Met One Instruments, Inc.) to measure elemental/black carbon (EC/BC) and organic carbon (OC) levels in ambient air. This procedure is designed to supplement the instruction manual by describing hardware or operating procedures as implemented by CAMB. It is not the intent of this SOP to duplicate or replace the manufacture instruction manual.

1.2 Principle of Operation:

The monitor measures ambient EC/BC and OC concentrations based on the light transmission through the particle deposited filter. This instrument is able to measure the light transmission at ten separated wavelengths spanning from 370nm to 950 nm (Table 1). The BC concentration is generally considered the concentration measured at 880 nm. The OC concentration is generally considered the difference of concentrations measured at 370 nm and 880 nm. For a more detailed discussion of the monitor's measurement principle, please reference the manufacturer's user manual.

1.3 Safety Precautions:

Prior to cleaning or working on the inside of the monitor, the monitor needs to be stopped by pressing the STOP softkey. After the monitor screen displays “Stop Complete”, switch the monitor off using the power switch located in the rear of the monitor and disconnect the power cord. Always use a three-prong, grounded plug on this monitor.

The IR and UV lamps are outside the normal range for human vision and may cause a potential invisible ocular exposure hazard. Do not look at the IR and UV lamps directly when the Measurement Head Cover is removed.

Table 2.1 Instrument Specifications

Parameter	Specification
Measurement Principle	Ten wavelength optical absorption 950nm BC10; 880nm BC9; 700nm BC8; 660nm BC7; 590nm BC6; 565nm BC5; 525nm BC4; 470nm BC3; 430nm BC2; 370nm BC1
Measurement Range	0.01 μg/m³ to 100 μg/m³
Data Display Resolution	0.1 ng/m³
LLD	≤ 8 ng/m³ at 5 LPM and 1 time resolution
Flow Rate	5 LPM
Filter Tape	Proprietary treated glass fiber (PN 460211)
Operating Temperature	0 to 40 °C (inside the shelter)
Inlet Heater	13 W (setpoints from 25 to 40 °C)
Ambient Temperature	-30 to 50 °C
Ambient Sensor	Model 597 combination AT/BP/RH digital smart sensor included
Internal Data Storage	365 days of internal data storage
Mounting Options	Bench top or equipment rack mountable
Unit Weight	Approximately 40 lbs

2.0 INSTALLATION PROCEDURE

2.1 General Information:

The instrument is designed to be installed in an environmentally controlled enclosure. The instrument can be mounted in a standard 19” instrument rack and can be placed on a table. The sampling inlet is set up outside the enclosure and connected to the instrument through flexible tubing.

2.2 Physical Inspection:

The monitor is normally shipped with the following standard equipment when ordered by the CAMB:

- Universal input AC to 12 VDC power supply, with US power cord
- COMET data acquisition software CD with USB and Ethernet drivers
- RS-232 serial communications cable
- PM10 inlet
- PM2.5 Sharp Cut Cyclone

- Inlet tube kit
- Medo pump with control harness and 3/8" OD black tubing
- Ambient AT/BP/RH combination sensor with cable
- One roll of filter tape (PN 460211)
- Instruction manual

Upon receiving the monitor, confirm that the monitor is in good working order and check for damage. If any damage is observed, contact your immediate supervisor.

- Verify no apparent shipping damage.
- Check that all connectors are fully inserted.
- Check that all mechanical connections are tight.

2.3 Monitor Siting:

Although this instrument does not measure criteria pollutants, CAMB aims to site all monitors in accordance with the United States Environmental Protection Agency (U.S. EPA) Title 40, Code of Federal Regulations Part 58 and USEPA Designated Automated Equivalent Method EQOA-0992-087.

The inlet should be in the "breathing zone", between 2 and 15 meters above the ground. The inlet should also be a minimum of 1 meter and preferably 2 meters from any immediate obstructions and other sampler inlets. Large obstructions should be twice the height of the obstruction from the BC-1054 inlet.

2.4 CARBLogger Connection:

In all CARB stations, CARBLogger (a digital data logger) is used to acquire one minute, digital data. In order to use CARBLogger for this instrument, the RS-232 port should be enabled using the front control panel of the monitor. Connect an RS232 cable to the back of the monitor from the CARBLogger box to the RS-232 port. No additional connections are required. Please see Section 2.5 "Operation Verification" for BC-1054 rear panel connections. By default the following communications settings should be used:

- RS-232 ON
- BAUD RATE=9600

- Monitor ID=1054

2.5 Operation Verification:

NOTE: Prior to operation of the monitor, operators must read the respective instruction manual to familiarize themselves with the operation of the monitor.

Prior to operating the Met One BC-1054, ensure that the proper connections have been made.

- Connect the appropriate sharp cut cyclone (SCC) to the total suspend particle inlet. A PM2.5 SCC is used for this program. The sampling inlet placement follows the guidance described in 2.3 Monitoring Siting;
- The assembly of SCC and total suspend particle inlet is connected to the monitor inlet located on the back of the monitor through flexible tubing (PN: 960203; 3/8'' OD);
- Plug the 12 VDC, 8.5A power supply into the 4-pin power connector on the back of the monitor. The power supply has a universal AC voltage input to plug into an AC outlet;
- Connect the ambient AT/BP/RH sensor as follows: Red wire to DC power; Yellow wire to RS485A; White to RS485B; Black to DC power GND; Green to RS485 GND and Brown/White to Shield;
- Connect an RS-232 cable between the CARBLogger and the RS-232 port;
- Configure the monitor as needed per Section 4.0 Monitor Configuration;
- Install a roll of filter tape (PN: 460211) as described in Section 2.6 Filter Tape Loading.

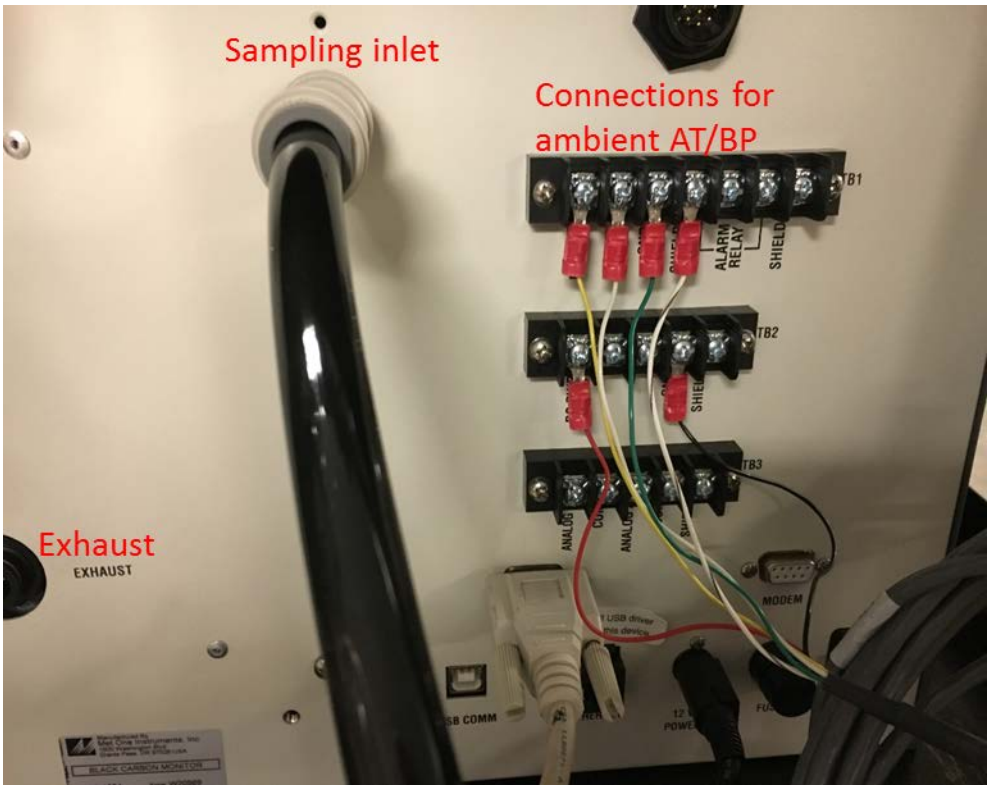

Figure 2.1 BC-1054 Rear Panel Connections.

2.6 Filter Tape Loading

This instrument runs the filter tape from left-to-right. Notice that this places the clean roll on the left side of the monitor. This is the opposite of the configuration used in the Met One instruments BAM-series monitor.

- Turn the instrument ON. Press the STOP softkey to prevent the instrument from entering SAMPLE mode. The optical measurement head will raise automatically. If necessary, the optical measurement head can be manually raised and lowered from the TEST MENU/LOAD TAPE.
- Flip down the tape load access door. Loosen the two tape reel knops and remove the reel covers.
- Install the new filter tape roll onto the left reel, with the tape coming off of the left side of the roll. Route the tape exactly as shown in Figure 2.2. The tape should go under the black idler, though the slot in the measurement head cover, under the other black idler, up over the rough encoder drum, and then down to the take-up reel on the right. Fasten the loose end of the tape to the

right edge of an empty core tube installed on the take-up reel with cellophane tape.

- Align the filter tape and take up the slack by turning the left reel. Reinstall the reel covers and flip up the Tape Load Access Door.
- Enter the TEST MENU/TAPE TEST screen. Press the MOVE softkey. Verify that the tape spools correctly. Advance at least one turn of filter tape over the take-up core, then exit to the main menu.

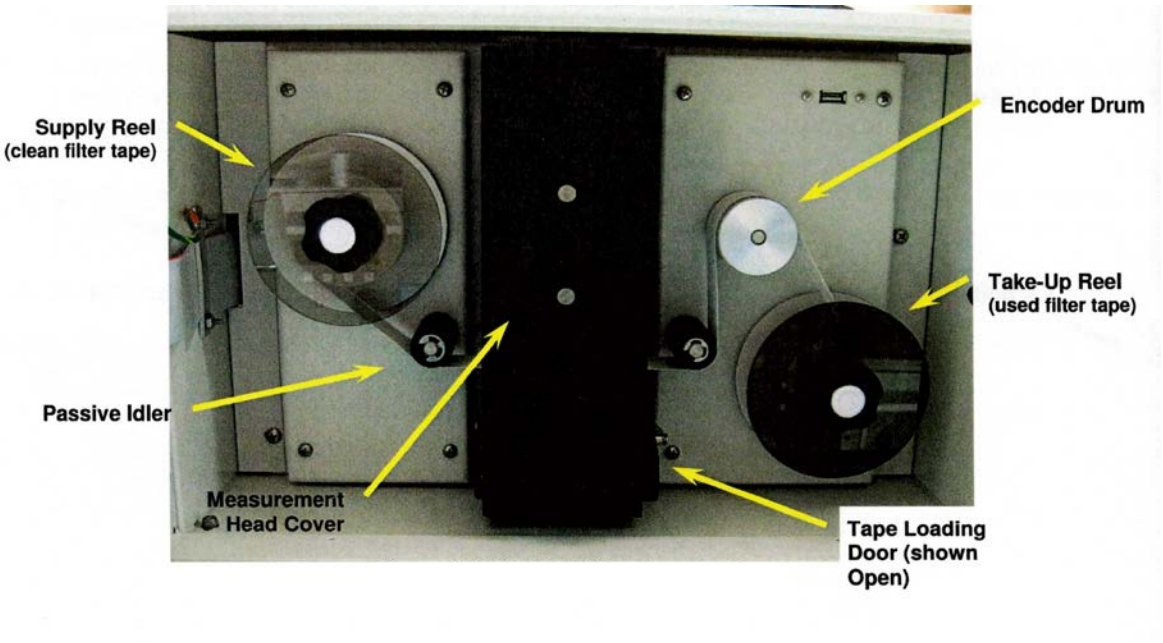

Figure 2.2 Filter tape routing

2.7 Starting Sample Operations

- The monitor will automatically start sampling approximately one minute after being turned on;
- To start sampling immediately, press the START softkey;
- To temporarily cancel sampling, enter the main menu and press the STOP softkey option.
- The unit will automatically resume sampling after 30 minutes of inactivity.
- The monitor takes 3-5 hours to warm up and equilibrate before optimal measurement stability is achieved.

2.8 Stopping Sample Operations

- Selecting STOP SAMPLE option in the main menu will turn off the internal

pump and raise the nozzle.

3.0 USER INTERFACE AND MENUS

3.1 Figure shows the user interface

- The two white keys are called “softkeys”. They are dynamic keys which change in response to a menu option directly above them on the bottom row of the display.
- The four arrow keys are used to scroll up, down, left and right, navigate the menu system.
- The MENU key is used to enter the main menu;
- The ESC key is used to escape or exist out of a menu;
- The ENTER key enters parameters in a selected field, or selects an item in a list.

3.2 Menus

3.2.1 Main Menu

Seven sub-menus are included in the main menu: Start/Stop sample, view alarm log, copy to use drive, setup menu, calibrate menu, test menu and about.

- START SAMPLE/STOP SAMPLE: this menu start or stop the sampling and measurement cycle. The unit will display a confirmation screen with the option to cancel before either action is taken. A password may need to be entered if a sample cycle is running.
- VIEW ALARM LOG: this menu allows operators to quickly view the error log entries. Scroll through the records using the left and right arrow keys.
- COPY TO USB DRIVE: This menu allows the user to copy data to a USB flash drive located inside the front door, in the upper right corner of the tape transport.
- SETUP MENU: This is the main setup menu for configuring the measurement parameters.
- CALIBRATE MENU: This menu is for diagnostic testing of the tape system, lamps, relays, etc.
- ABOUT: This menu displays the firmware version and revision.

4.0 INSTRUMENTT AND MEASUREMENT CONFIGURATION

The configuration of measurements can be made through the setup menu, which can be accessed through MAIN MENU. Table 4.1 lists the settings and parameters we use for measurements.

Table 4.1 BC-1054 Configuration Table

BC-1054 PARAMETER	CAMB's Standard	RANGE LIMITS
Time	Current PST time	+/- 1 minute
Sample Rate	1 Hour	5 or 30 Mins, & 1 Hr.
Time Stamp	Beginning	ALWAYS
Location	The last 3 of SN	3 Numeric Digits Only
Units	ng/m^3	ng/m^3 or $\mu g/m^3$
Tape Period	Auto	1 Hour More Accurate, but Uses Tape Too Fast
Spot Advance	1	1 to 2
Load Enable	On	On/Off
Load Level	100	75 to 125
Load Carbon	BC1	BC1 to BC10
Baud	9600	Up to 115000
Flow Control	None	ALWAYS
Password	0000	If Changed, Document

4.1 Location

The location setting is a simple ID number that will appear in the data files. It can be any 3-digit number from 001 to 999.

4.2 TAPE ADVANCE

The menu contains settings that determine how and when the filter tape is advanced to a fresh spot through the menus of TAPE Period and SPOT ADVANCE.

4.2.1 The TAPE ADVANCE sets the time interval at which the filter tape automatically advances to a fresh spot. The time interval can be set to 1, 2, 3, 4, 6, 8, 12, 24 hours. If the time interval is set to AUTO, the instrument will advance the tape only based on the filter loading, which is set using the TAPE LOADING.

4.2.2 The SPOT ADVANCE set how many filter spots are advanced whenever the tape is advanced. The default setting of SPOT ADVANCE is one; but it can be set to two if required.

4.3 TAPE LOADING

This menu contains more settings that determine how and when the filter tape is advanced to a fresh spot. The settings included in this menu are LOAD ENABLE, LOAD LEVEL and LOAD CARBON.

4.3.1 The LOAD ENABLE determines if the instrument will use the LOAD LEVEL setting as the threshold for advancing the filter spot based on loading. It should only be configured as OFF if automatic filter advances based on loading during the selected time interval are unacceptable.

4.3.2 The LOAD LEVEL sets the carbon loading threshold at which the tape spot will be advanced. The default setting is 100. The range of this setting is 75 to 125. The higher this setting is. The more attenuation will be allowed before the tape is advanced.

4.3.3 The LOAD CARBON sets which of the ten carbon concentrations is used in the LOAD LEVEL calculation to determine when to advance the tape based on loading. BC1 is the factory default for triggering a tape move and will result in the best overall results across all 10 wavelength channels.

4.4 Flow Setup

The flow rate for this instrument must match the flow rate required for the sharp cut cyclone used for this instrument. The flow rate needs to be calibrated if different cyclones are used.

4.5 SERIAL PORT Setup

SERIAL PORT setup contains two settings, BAUD and FLOW CTRL. These settings affect the configuration for the “COMPUTER RS232” and “ETHERNET” ports. The BAUD setting is the data transfer rate for the serial data output. The value can be set to 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200 BAUD. Set the value to the fastest rate supported by the data collection system.

4.6 MEMORY Setup

The MEMORY screen is used to clear/erase files. The FILE value can be set to the DATA LOG, ALARM LOG, or ALL LOGs. Pressing the CLEAR softkey will cause the confirmation screen to appear before the selected files are cleared.

4.7 PASSWORD Setup

The PASSWORD setup can be used to change the 4-digit numeric password.

The default password is 0000.

4.8 HEAT SET POINTS Setup

4.8.1 The HEAT SET POINTS screen provides a means of adjusting the set points of the inlet heater (FLOW TEMP) and the internal box heater (BOX TEMP).

4.8.2 The FLOW TEMP is the temperature of the sample air after it has passed through the inlet heater then through the optical measurement head. The flow temperature available range is from 25 to 40 °C. This temperature should be set to ~ 10 °C above the maximum ambient temperature in high RH conditions.

4.8.3 The BOX TEMP sets the internal temperature of the box ranging from 0 to 40 °C. The default value is 30 °C.

5.0 CALIBRATION INFORMATION

5.1 Calibration Introduction:

To ensure the quality of the data collected within the ARB's air monitoring network, the flow parameters (temperature, pressure, sampling flowrate) of this monitor must be calibrated:

- at initial field installation and every six months thereafter,
- after physical relocation,
- after any major maintenance or repair,
- after a monitor has drifted outside of acceptable QC limits identified through a bi-weekly check,

Two types of "calibration" are used, nominally referred to as "AS-IS" and "FINAL" calibrations. These calibrations apply to AT, BP and sampling flow rate. An "AS-IS" calibration is performed to assess the monitor's accuracy without making any calibration changes. A "FINAL" calibration is performed to correct the flow parameters. Typically an "AS-IS" calibration is performed during the ambient monitoring to determine if the flow parameters of the monitor drift outside of the acceptable limits. If they do, a "FINAL" calibration is performed.

5.2 Calibration Apparatus:

5.2.1 NIST Certified flow meter which is compensated by temperature and pressure.
5.2.2 NIST Certified temperature sensor, usually part of flow meter.
5.2.3 NIST Certified barometric pressure sensor, usually part of flow meter.
5.2.4 Calibration report forms

6.0 CALIBRATION PROCEDURES

Single-point calibrations of each BC-1054 parameter (Temperature, pressure and sampling flow rate) in the monitors at all stations within the CAMB network shall be performed in a consistent manner, so that all network monitoring stations in all areas of the State are calibrated in a similar fashion.

6.1 AS-IS Calibration:

An AS-IS calibration is used to check the accuracy of flow parameters and does not change any of them. Prior to beginning the AS-IS calibration disable the appropriate channels on the station data logger and record the monitor's setup parameters.

6.1.1 Connect the reference flow sensor to sampling inlet and allow both the reference sensor and the monitor to stabilize for at least ten minutes. Morning is the best time as the sun is not high enough to affect the temperature of the standard. If this is not practical you may have to shade the transfer standards measuring head/unit on the top of the PM2.5 inlet as it can become a heat sink which then affects the standard's temperature accuracy. All monitor covers should be on during the calibration, as the stability of the monitor's mass flow meters are dependent upon the internal temperature of the monitor.
6.1.2 Record the station information, monitor identification numbers, monitor settings, calibration equipment information and any other pertinent information on the calibration data sheet (Appendix A).
6.1.3 When both the monitor and the transfer standard seem stable record the temperature, pressure and flow values. If any parameter is outside of specifications (Table 6.1), a FINAL calibration for this parameter should be performed.

Table 6.1 AS-IS Specification Limits

Temperature	+/- 1.5°C
Pressure	+/- 13 mbar
5 LPM Flow	+/- 4%

6.1.4 If a final calibration is needed, the settings Report (ST######.txt) for all the setup configurations should be either written down or downloaded to a computer for comparison with post adjustment changes.

6.2 Leak Check

6.2.1 A leak check shall be performed prior to a final calibration of the sampling flow rate. In order to do the leak check, the ambient measurements needs to be stopped by pressing the “STOP SAMPLE” key and answering the displayed questions. DO NOT GET TOO INVOLVED IN ANOTHER PROJECT AFTER THE BC-1054 TIMES OUT AS IT WILL ONLY GIVE YOU 30 MINUTES BEFORE IT STARTS SAMPLING AGAIN.

6.2.2 To proceed the leak check, the flexible tubing connecting the SCC inlet to the monitor shall be removed from the back of the monitor and a vinyl cap (pn: 770025) or a leak test valve should be placed over the inlet.

6.2.3 Press the “MAIN MENU>TEST MENU” key and then the “LEAK TEST” key. Press the “Leak On” key to turn on the pump and stop the flow controller valve from attempting to regulate the flow where the vinyl cap is in place. The FLOW value should be ≤ 0.5 LPM or less for the leak test to be considered passing. Press the “PUMP OFF” key to turn off the pump. Carefully remove the vinyl cap or the leak test valve before existing this screen.

6.2.4 If the FLOW value is higher than 0.5 LPM, remove the optical light shields and the tape. Clean all surfaces that touch the tape and reinstall the tape and optical light shields. Assure that the spot on the tape being tested is after the previous spot where the last leak test was performed. Rerun the leak test.

6.2.5 If the leak test passes move on to the FINAL calibration. If the filter tape interfaces are truly clean and the leak test fails again, the monitor should be returned to the shop for corrective action.

6.3 FINAL Calibration:

6.3.1 Ambient temperature calibration. After assuring that the calibration device's measuring head/unit is at ambient temperature, click on the CALIBRATE AT menu button. The AT parameter is the current reading from the 597 temperature sensor. The STARDARD field is where the correct value from the certified sensor should be entered. The DEFAULT softkey should be pressed to clear out all previous field calibrations and restore the factory calibration for the monitor prior to beginning the calibration process. To correct the AT reading, enter the value shown on the reference sensor in the STANDARD field and then press the CALIBRATE softkey. The AT value should be change to match the STANDARD value.

6.3.2 Barometric pressure calibration. The sequence used to calibrate the barometric pressure is similar to the one for ambient temperature. Press the CALIBRATE BP and then the DEFAULT softkey, followed by entering the value from the reference sensor into the field of STANDARD, finally press the CALIBRATE softkey to complete the calibration.

6.3.3 Flow rate calibration. Prior to the flow calibration, please make sure that there are no leaks.

6.3.3.1 Press the CALIBRATE FLOW menu button to enter the calibration screen. The screen will first display the zero flow mode with the pump off. When the cursor is flashing next to the ZERO softkey, press ENTER key to open the ZERO field for editing. Use the arrow keys to scroll down to DEFAULT and press ENTER to use DEFAULT function. The flow control offset and slope can now be set to factory defaults by pressing the DEFAULT softkey.

6.3.3.2 Press ENTER to change the DEFAULT back to ZERO, press ENTER again to return to the zero flow calibration screen. Press ZERO softkey to zero the flow sensor. Then press CONTINUE to proceed to the main flow calibration screen and automatically turn the pump ON.

6.3.3.3 The SET POINT parameter is the target flow rate that the instrument should maintain. The FLOW parameter is the current flow reading from the instrument flow sensor.

6.3.3.4 The DEFAULT softkey should be pressed to clear out all

previous field calibrations and restore the factory calibration of the sensor. The STANDARD field is where the correct flow value from the reference flow meter should be entered if the instrument flow reading is not within +/- 5% of the flow reading of the reference flow meter. Then, press the CALIBRATE softkey and the FLOW value should change to match the value in the STANDARD field.

7.0 OPTICAL SPAN TEST

The optical span test is performed through the CALIBRATE AUDIT menu. This will introduce a known and consistent amount of optical attenuation into the measurement system using a Neutral Density Span Check Filter (PN 81947-3). No change to the instrument calibration are made with this process. The optical span tested is performed following the procedure described below.

7.1 Press the MENU key on the front panel display. Highlight the CALIBRATE MENU item and press the ENTER key on the keypad. Scroll to the CALIBRATE AUDIT option and press the ENTER key again.

7.2 When entering the CALIBRATE AUDIT menu, the measurement head should be in the UP position. If it is not, or if the state is unknown, press the MOVE button to raise the head and advance the tape one position.

7.3 Flip down the tape slot access door on the measurement module cover.

7.4 Loosen the tap by manually operating the tape supply reel. Pull the tap forward through the slot far enough to be able to lay the tape beneath the cover.

7.5 Loosen the two thumb screws on the measurement head module, remove the cover, and then reinstall the tape as normal.

7.6 Press the MOVE option to properly tighten the tape and advance it to a clean spot.

7.7 When the START key is pressed, the START ZERO screen will be displayed. Press CONTINUE to begin the zero test.

7.8 The measurement head will lower onto the tape and the display will show the completion time remaining for the zero test.

7.9 At the end of the ZERO portion of the test, the measurement head will raise and the display will show INSERT ND FILTER.

7.10 Insert the neutral density filter above the tape. The alignment tabs will insert

into notches on the mount plate and the filter will press squarely against it when properly inserted.

7.11 Press CONTINUE and the measurement head will lower and begin the span check. The display will show the completion time remaining.

7.12 At the end of the test, the calibration results will be displayed. The measurement head will raise and the display will indicate when it is safe to remove the neutral density filter.

7.13 Remove the neutral density filter and then press EXIT to return to the CALIBRATE menu.

7.14 The calibration results should be within 5% of the values labeled on the inside of the door of this instrument. If the calibration results fail to be within 5%, run the test again. If the test still fails, contact the Met One Instruments, Inc.

7.15 Loosen the tape supply wheel and lay the tape the bottom of the enclosure to allow room to reinstall the measurement head cover.

7.16 Reinstall the cover and reload the tape.

8.0 ROUTINE SERVICE CHECKS

8.1 General Information:

Table 7.1 lists the schedule of routine service checks and maintenance. Perform the routine service checks and maintenance at least at the prescribed intervals or more often if necessary.

The AQSB Monthly Quality Control Check Sheet (Appendix A) should be filled in weekly and submitted monthly to the station operator's supervisor. The station operator must keep a copy of the Monthly Quality Control Check Sheet in the air monitoring station.

The monitor is designed to operate unattended for long periods of time. However, maintenance requirements may vary from monitor to monitor, thus operators should refer to the monitor operating manual to become familiar with maintenance requirements.

If station operators cannot repair a monitor using procedures stated in the instruction manual, contact the Operations Support Section's Instrument Laboratory.

Table 7.1 Routine checks and maintenance schedule.

	Value	Daily*	Bi-Weekly	Monthly	Semi-Annual	Yearly
Power On	On	X				
Error Flags	None	X				
Verify tape supply	≥2 weeks		X			
Verify AT, BP and Flow	Within specs		X			
Perform a leak test (5 LPM)	≤ 0.5 LPM		X			
Fill out and submit the CAMB QC Form	None			X		
Download internal data	Month			X		
Clean SCC Inlets	Clean			X		
Perform field calibration; AT, BP and 5.0 LPM	6 months				X or as required	
Verify internal configurations	No changes				X	
Clean Debris Filter	Blow out					X
Clean inlet tubing	Clean					X
Clean optical measurement module	Clean					X
Replace main pump	≥2 years					As needed

*** Daily indicates that for each working day where the site technician visits the station, this check should be performed.**

8.2 Daily (or Each Visit) Checks:

- Review monitor data for any indication of monitor malfunction on each working day and check for any error emails.
- When performing a site visit check the monitor's front panel for any error messages.

8.3 Bi-Weekly Checks:

- Verify that there is enough tape to last until the next site visit. When the BC-1054 is operated in the "Auto" tape change mode a new tape should last just over three months.
- Perform temperature, pressure and flow (5 LPM) checks with a certified

standard. If outside of specifications listed in Table 2, proceed to the FINAL calibration section after performing a leak test.

- Perform a leak test via the TEST MENU > LEAK TEST menus. Press the LEAK ON key. This will prevent the mass flow controllers from trying to adjust the flows. Close the leak test device valve and after 1 to 3 minutes both flows should settle and not change. The flow should be 0.5 LPM or less for the leak test to considered passing.

8.4 Monthly Checks:

- Complete and submit the CAMB QC Form (Met One BC-1054) check sheet to your immediate supervisor along with the internal downloaded data.
- Download the BC-1054's internal data and submit it with the monthly quality form.
- Clean the PM2.5 inlets with ≥91% alcohol and/or deionized water.

8.5 Semiannual Checks:

- Perform a leak check and then temperature, pressure and flow (5.0 LPM) calibrations.
- Verify internal configurations are still the same as originally setup.

8.6 Yearly Checks:

- Disassemble the Debris Filter, blow out any debris and reassemble. Please see the manufacturer's operation manual.
- Clean the inlet tube. The inlet tube cleaning is the same as for a BAM and uses the Met One PN BX-344 Inlet Cleaning Kit. DO NOT SCRATCH THE INSIDE OF THE DOWN TUBE.

8.7 Every Two Year Checks:

- Replace the main pump. The replacement is determined based on whether the current pump maintains the required sampling flow.

9.0 TROUBLESHOOTING

The BC-1054 has been designed to detect possible problems and allow for their quick evaluation and repair. During operation, the monitor continuously performs self-test diagnostics, but does not provide the ability to monitor the key operating parameters of the monitor without disturbing monitoring operations. If the BC-1054 is being run with CARBLogger, an alert will be emailed to the site operator if any flows are more than 5% off of 5 lpm or if the data stream stops being collected.

Should monitor malfunctions occur and troubleshooting is required to determine the problem, operators should refer to Chapter 6.2 “Basic Problem Causes/Solutions Table” in the Met One BC-1054 operation manual.

Table 8.1 Alarm Triggers

Code	Description	Causes	Corrective action
0	No Alarm	System fully functional	None
1	Power Failure	Caused by a power cycle or a microprocessor reset	1. Power off/on event logged. 2. Ensure unit is provided with stable power
2	Digital Sensor Link Failure	Digital sensor link failure after 10 seconds of no communication with 597 sensor	1. Ensure 597 sensor connection on back of BC 1054 are correct; 2. Ensure 597 sensor connector plugged in securely on bottom of 597; 3. Possible bad 597. Obtain factory replacement
4	Tape Move Failure	1. Tape roll exhaust 2. Tape break 3. Tape loose, not turning encoder 4. Encoder wheel turns, but not measuring tape movement	1. Install new roll of tape 2. Re-attach tape to take-up spool 3. Raise nozzle, tighten tape so it’s in contract with encoder wheel 4. Optical encoder fault. Refer to qualified service technician
8	Maintenance	Stop for maintenance during normal operation	“Stop Sample” logged. Not an error condition

Code	Description	Causes	Corrective action
16	Flow Failure	Failure when the flow is less than 1.0 LPM for greater than one minute, when the flow is10% out of regulation for more than one minute, or when the flow is 5% out of regulation for more than five minutes. 1. Flow controller out of position 2. Inlet hose kinked or other blockage on inlet 3. Debris filter clogged 4. Bad pump 5. Bad flow sensor or flow controller	1. Perform flow audit and allow flow controller to regulate flow 2. Un-kink hose or remove blockage, clean cyclone, clean TSP head, replace inlet tubing 3. Clean or replace debris filter 4. Replace pump and re-calibrate flow 5. Replace Flow system and recalibrate flow
32	Automatic Tape Advance	The tape was advanced because of tape loading. Scheduled tape advances do not generate this notice	Automatic tape advance logged. Not an error message
64	Detector Failure	1. Misinstalled tape 2. Blocked reference or sample port 3. Light leak 4. Hardware Failure	1. Verify tape is installed correctly 2. Clear obstructions in the port below the tape or reference port 3. Ensure door is closed and light shield is properly installed 4. Refer to qualified service technician
256	Sensor Range	A sensor is outside its designated limits. Check error log for abbreviation WS, WD, AT, RH, BP, FLOW, DFLOW, LED T or DET T	1. AIO equipped: if WS, WD, AT, RH or BP, replace AIO 2. 597 equipped: if AT, RH or BP, replace 597 3. If FLOW, DFLOW, LED T, DET T, refer to qualified service technician

Code	Description	Causes	Corrective action
512	Nozzle Move Failure	Set when nozzle failed to move up or down	1. Lift motor not turning: verify connection in cable 2. Lift motor turning, lift arm not moving. Lift bearing slipping on shaft. Refer to qualified service technician 3. Lift motor turning, lift arm moving, nozzle not moving: lift bearing broken. Refer to qualified service technician 4. "UP" and/or "DOWN" option not functioning. Refer to qualified service technician
1024	SPI Link Failure	Internal communication failure with the Storage Processor	1. Re-connect cable between 80880 and 30030 2. Refer to qualified service technician
2048	Calibration Audit	A user calibration check was being preformed	Calibration check activity logged. Not an error condition
4096	Storage Processor Link Failure	Internal communication failure	Refer to qualified technician
65536	Tape Move	System advances the filter tape	Tape advance logged. Not an error condition

10.0 REFERENCES

Met One Instruments Beta Attenuation Mass Monitor (BAM-1020)
https://www.arb.ca.gov/airwebmanual/amwmn.php?c=4&t=sop
Met One BC-1045 Black Carbon Monitor Operation Manual, Revision C.

Appendix A

CARB MONTHLY QUALITY CONTROL MAINTENANCE CHECK SHEET
BC-1054 Monitor

Site Name: _____
Site Number: _____
Operator/Agency: _____

Month/Year: _____
Sampler Make & Model: _____
Sampler ID Number: _____
Date of Last Calibration _____

Instrument Checks:

1) Daily checks: Review station data logger values for correct operation of BC-1054.
2) Weekly checks: Check filter tape & replace when necessary.
3) Bi-Weekly checks: Perform BC-1054 flow and leak.
4) Monthly checks: Complete and submit this Monthly Quality Control Check Sheet.
   Thoroughly clean both PM2.5 SCC inlets.
   Download and submit data from BC-1054 data logger.

Sampler Flow Rate, Ambient Temp and Pressure Check Results:

	Flow Rate Standard			Temperature Standard			Pressure Standard		
Standard Make/Model:									
Std. ARB ID Number:									
Std. Certification Date:									
Standard Slope:									
Standard Intercept:									
Date Checked:									
Std. Display Reading:									
Std. 'Actual' Reading:									
BC-1054 Display:									
Design Flow % Diff.:									
Leak Check Value:									

Volumetric Flow Acceptance Criteria: ≤+/-4% of 5 LPM

Operator Comments:

_____
_____
_____

Reviewed by_____

Appendix B

ARB Calibration Report – BC-1054

Includes Mass Flow Meter (MFM), FTS Streamline and BGI Delta/Tri Calibration

ID Information:

Station Name			**As Is**	
Site location			**Final**	
Program			**Calib. Date**	
Operator/Agency			**Last Cal**	

Pressure & Temperature Transfer Standard:

	slope (m) :		Intercept (b):		
True Press. =		*** Display +**		**Flow Std. ID#:**	
True Temp. =		*** Display +**		**Flow Cert.Date:**	
MFM 30 L =		*** Display +**		**P/T Std.ID#:**	
FTS Streamline =		*** Display +**		**P/T Cert. Date:**	

Flow Device Used:

MFM	
FTS	
BGI	

Flow Controller Check	**Pass/Fail**
5 LPM:	

Temperature Sensor Calibration:

			MFM Temp:	FTS Temp K:	BGI Temp:
Temp. Display:	**Std. Temp. Display:**	**Corrected Temp:**			
		Diff. In degrees:			

Temperature = +/- 2.0 °Celsius

Pressure Sensor Calibration:

			MFM Press.:	FTS (Atm):	BGI Pressure:
Pressure Display:	**Std. Press. Display:**	**Corrected Press.:**			
		Diff. In Pressure:			

Pressure = +/- 13 mbar

Flow Calibration:

			MFM Flow:	FTS Flow:	BGI Flow :
Flow Display:	**Std. Display:**	**Corrected Flow:**			
		% Diff.:			

Flow = +/- 4.0%

Flow Verification:

			MFM Ver.:	FTS Ver.:	BGI Ver.:
Monitor display:	**Std. Display:**	**Corrected Flow:**			
		% Diff.:			

Flow = +/- 4.0%

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