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DICHOTOMOUS (PM-10) AUDIT

by

Andrew Reinhardt

ManTech Environmental Technology, Inc.
Research Triangle Park, NC

CAUTION

Disclaimer: This Standard Operating Procedure has been developed for use by ManTech Environmental Technology, Inc. in support of the National Performance Audit Program (NPAP) under contract to the U.S. Environmental Protection Agency and may not be applicable to the activities of other organizations.

Approved by:

Kenneth J. Caviston, Manager
ManTech Environmental Technology, Inc.

Date

Joe Elkins
EPA NPAP Coordinator

Date

Effective: When approved

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1.0 SCOPE AND APPLICATION

This procedure is for use in certifying dichot audit devices used in the National Performance Audit Program (NPAP). The objective is to determine the operational status and to conduct certifications of the dichot audit device components. The full calibration consists of an annual full-range certification of the LFE and a check of the other audit components. The quick check described permits a quick turn-around of the audit device.

2.0 SUMMARY

Dichot audit devices are sent to air monitoring agencies to audit their dichotomous (Dichot) samplers. Before these devices can be sent, checks must be conducted to assess their reliability and calibration. Upon its return from the field, the device is opened and inspected for cleanliness, completeness of parts, and any obvious damage. The Laminar Flow Element (LFE), Ultimeter[®] or dial-type altimeter/barometer, and dial thermometer are then compared to an NIST certified LFE, barometer, and thermometer, respectively. If any component of the audit device fails the calibration criteria, adjustments are made, if possible, or the component is replaced. When the entire device passes the check, it is packed for shipment to another NPAP participant.

3.0 SAFETY PRECAUTIONS

1. Always handle a mercury thermometer carefully to insure it does not break and cause a hazardous mercury spill.
2. Always handle the LFEs carefully as they are heavy and may cause injury or damage to equipment if dropped or carried carelessly.

4.0 FACILITIES REQUIREMENTS

This procedure requires a laboratory equipped with 120 volt electricity, sufficient bench space for apparatus set-up, and LFE flow check capabilities.

5.0 INTERFERENCES

Dirt in the laminar tubes of the LFE can interfere with flow.

6.0 APPARATUS

1. Type 9 LFE, NIST traceable
2. Electronic manometer, resolution of 0.1 mm of H₂O
3. NIST thermometer, scale divisions of 0.1 °C
4. Mercury barometer, NIST traceable
5. Computer or calculator with LFE flow program installed
6. PM-10 Audit Kit
 - P Electronic temperature sensor, resolution of 0.1 °C
 - P ½" Teflon tubing with ½" Female Stainless Steel Quick Connect on one end and an aluminum PM-10 (Dichot) adaptor on the other
 - P Brass ¼" Swagelok cap
 - P Air filter with ½" male Swagelok fitting
 - P Inclined oil manometer with a stability adaptor
 - P Ultimeter[®] Model 12⁺ or dial-type altimeter/barometer (for barometric pressure readings)
 - P Type 9 LFE

7.0 REAGENTS/MATERIALS

1. Insulated aluminum block with slots to hold thermometer and temperature sensor probe
2. Red gauge oil
3. Glass or acrylic surface cleaner

8.0 CALIBRATION/STANDARDIZATION

Ultimeters[®] or dial-type altimeter/barometers are checked against an NIST traceable barometer and the temperature sensor is checked against an NIST traceable thermometer prior to and following each audit as described in **Section 9.0 Quick Check Procedures**. In addition, LFEs are checked annually against NIST LFEs.

9.0 QUICK CHECK PROCEDURES

The Quick Check procedure for the Dichot Audit consists of the pre-audit check of the components in the audit kit. All components are removed from the kit, checked for damage and cleanliness. The LFE, temperature sensor, Ultimeter[®] or dial-type barometer are checked as described below.

9.1 Summary of Quick Check

1. Unpack the audit kit upon its return from the field and check the contents for completeness. Check all apparatus for damage.
2. Check the Teflon tubing for cleanliness and for loose fittings. Clean and fix if necessary.
3. Clean the air filter. Tighten loose fittings if necessary.
4. Conduct the post-audit check on the LFE. If it fails, clean it and repeat the check. If it fails again, replace it with another certified Type 9 LFE.
5. Set up the manometer as shown in figure 1. Clean with glass or acrylic cleaner, if necessary, and check for loose fittings. Level the manometer, open the molded nylon connectors 1½ turns, and allow the oil to come to a steady level. If the manometer cannot be zeroed, add enough oil so that it can be zeroed easily.
6. Place the probe of the temperature sensor and the certified thermometer in the aluminum block.

CAUTION

To prevent damage to the Ultimeter[®], always plug the power adaptor into a standard outlet BEFORE plugging the

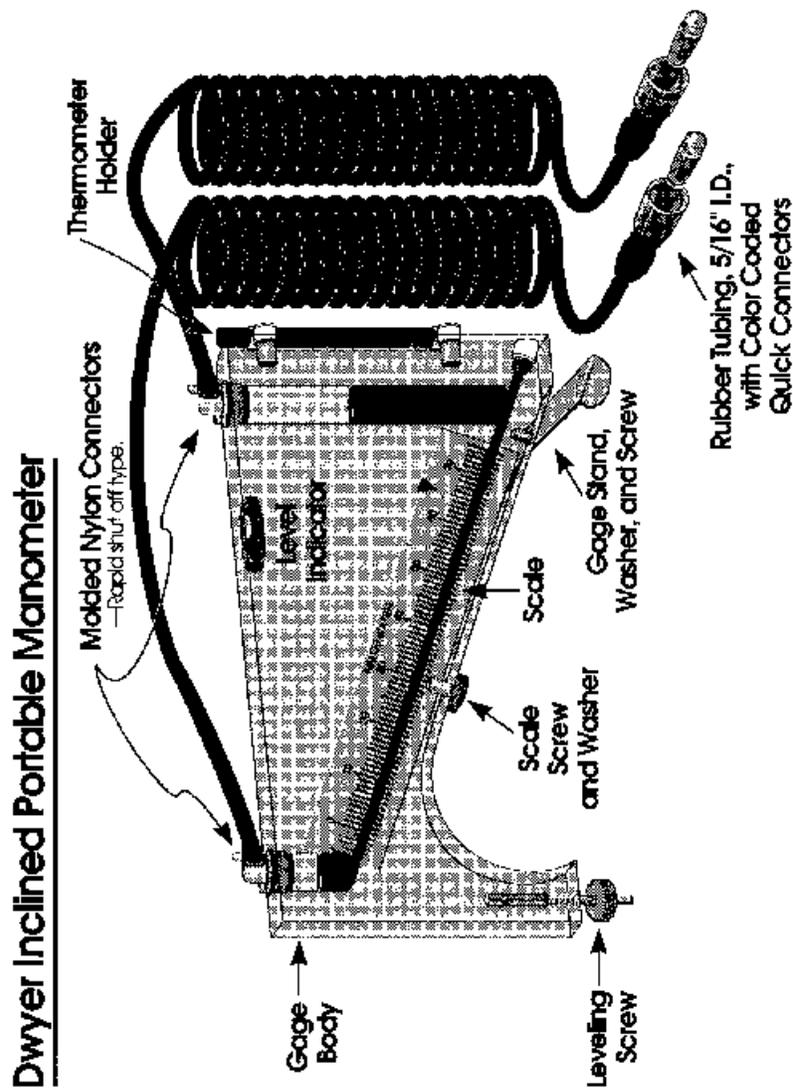


Figure 1. Dwyer Inclined Portable Manometer

7. If the audit kit contains an Ultimeter[®] Model 12⁺, plug the power adaptor into a standard outlet, **then** plug the other end of the adaptor into the Ultimeter[®]. Change all six alkaline batteries in the battery compartment on the back of the Ultimeter[®].

9.1.1 Temperature Sensor Quick Check

1. Allow at least 20 minutes for the certified thermometer and the probe of the temperature sensor to reach equilibrium with the aluminum block.
2. Record the respective serial numbers and temperature readings on the "Dichot Audit Device Check Sheet."
3. Determine the difference between the temperature readings.
4. If the temperature difference is $\neq 2^{\circ}\text{C}$, note on the check sheet that the sensor passed the check.
5. If the temperature difference is $>2^{\circ}\text{C}$, check to assure that both instruments are seated properly in the aluminum block. Allow another 10 minutes for equilibrium.
6. If, after the additional time, the temperature difference $>2^{\circ}\text{C}$, replace the temperature sensor with a new one. Note on the check sheet that the original sensor failed the check.

9.1.2 Barometer Quick Check

This procedure may be performed with the Ultimeter[®] before the batteries are replaced as long as the Ultimeter[®] is plugged into an electrical outlet.

1. Read the local barometric pressure in millimeters of mercury using the audit kit barometer:

Dial-type altimeter/barometer: Look in the window above "km." There will be a color showing in the window that will indicate what scale to read for the barometric pressure. If two colors are showing, refer to the pointer above "km" for the correct color range. The three center-most scale rings of the altimeter/barometer are color coded to match the range color just determined. Read the barometric pressure from the scale that matches this color range. Record the reading in mm Hg on the check sheet. Record the dial barometer serial number.

Ultimeter[®]: Press the button on the panel labeled "BAROM-AB/SEA" **once**. The 'n' on the left side of the display should be flashing while the pressure is displayed. If the 'n' is not flashing, press the button once more. This will start the 'n' flashing

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and display the local barometric pressure. Record the reading in mm Hg on the check sheet. Also record the Ultimeter[®] serial number.

2. Read the local barometric pressure on the laboratory NIST traceable mercury barometer. Record the pressure and the serial number of the mercury barometer on the check sheet.
3. Calculate the percent difference between the two pressure readings using the equation in **Section 10.0 Calculations**. Record the percent difference on the check sheet.
 - A. If the difference is $\neq 1\%$, record on the check sheet that the barometer passed the check, and proceed with **Section 9.1.3.1 (LFE) Quick Check**.
 - B. If the difference $> 1\%$, the barometer fails the check. Note this on the check sheet.
 - (1) If the barometer is the dial type, replace it with another and proceed with **Section 9.1.3.1 (LFE) Quick Check**.
 - (2) If the barometer is the Ultimeter[®], the calibration factors (slope and offset) stored in the Ultimeter[®] should be checked with those provided by the manufacturer. These are kept in each individual audit device's folder.
 - (a) If the values stored in the Ultimeter[®] differ from those provided by the manufacturer, enter the correct calibration factors and re-check the Ultimeter[®] beginning with **Step 1**.

Note: Incorrect values may be stored if the unit loses battery power.

- (b) If the device has failed and the correct manufacturer calibration factors are stored, the Ultimeter[®] should be sent back to the manufacturer for recalibration.

9.1.3 LFE

9.1.3.1 Quick Check

1. Select a type 9 NIST certified LFE.
2. Place the type 9 dichot audit LFE next to the NIST LFE.
3. Record the local barometric pressure in the Certification of Dichot LFE section of the check sheet.
4. Attach the vacuum line to the NIST LFE and using the in-line metering valve, adjust the pressure differential across the LFE to approximately 20 mm H₂O as read on the electronic manometer. Record this setting and the LFE temperature in degrees Celsius on the data sheet.
5. Disconnect the vacuum and manometer leads from the NIST LFE, connect them to the audit device LFE, and record this pressure drop across the LFE on the data sheet.
6. Repeat **Steps 4 and 5** for pressure drop settings of 25, 30, 35, and 40 mm of H₂O.
7. Access the LFE flow program on the laboratory computer. Enter the parameters as requested by the program. The computer calculates the flow at standard temperature and pressure conditions (STP = 760 mm Hg and 25°C) based on the LFE, temperature, and pressure. For each **setting**, record the flows in liters per minute (Lpm) in their respective columns on the data sheet.
8. Calculate the percent difference between the STP flows for the NIST LFE and audit device LFE at each setting and record on the data sheet. See **Section 10.0 Calculations**. Average the five differences and record the value on the data sheet.
 - a. If the average percent difference is # 2%, record this on the check sheet and that the LFE passed.
 - b. If the difference is >2%, clean and re-certify the LFE. If it fails the certification a second time, replace the LFE with another NIST certified type 9 LFE.

9.1.3.2 Calibration/Annual Recertification

1. When new, calibrate LFEs following **EMSL/RTP-SOP-QAD-003**.

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2. Recertify LFEs annually against an NIST traceable LFE
 - a. Randomly select five to eight points between 15 and 200 mm of water pressure differential (P_{H_2O})
 - b. Record the parameters requested on the check sheet.
 - c. Access the LFE program on the computer.
 - d. Enter the data and have the program construct a calibration curve.
 - (1) If the percent difference between the current check and the calibration curve is $\neq \pm 2\%$, the LFE is considered recertified and retains its calibration constants.
 - (2) If the percent difference $> \pm 2\%$,
 - (a) Use an air hose to blow out the LFE and recheck.
 - (b) Disassemble the LFE and place the LFE body in the Ultra Sonic bath for 30 minutes. Use an air hose to blow out the LFE and then let it air dry for 24 hours. Recertify using the 6-point procedure above.
 - (c) If the percent difference remains $> \pm 2\%$, perform a full calibration following **EMSL/RTP-SOP-QAD-003**. After review and approval by the Project Manager, have the new calibration constants entered into the LFE Data Base by Computer Personnel.

9.2 Dichot Control Charts Using *Quality Analyst*

Note: Maintain a hand-drawn control chart for each Dichot Kit.

1. Open *Quality Analyst* by clicking on the icon in Program Manager and then double-clicking on the *Quality Analyst* icon.
2. From the bar menu, click on File. The last four files accessed are listed at the bottom of the pull-down menu. If "**DICHOT.DAT**" is listed, double click on it to open the file. Otherwise, select "Open an existing Data Set" from the main menu of *Quality Analyst*. On the "Open" screen, click on "e:\VECTRA\FOX" from the Drive menu and then doubleclick on "qa" from the Directories menu. Double click on "**DICHOT.DAT**" to open the file.

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3. Press Ctrl-End, then Enter to move to the last line of the spreadsheet. Enter the data as listed. Be sure to note if a component failed in column six and the action taken as a result of the failure in column seven.
4. Select the diskette icon to save the data entered.
5. Print the
 - C Entire spreadsheet by clicking on the printer icon. The program default is to print all rows and columns. However, there is an option for selecting rows and columns to be printed. Click on "OK."
 - C Spreadsheet for a specific dichot by clicking on "Data" on the menu bar and then clicking on "Filter." Under "Column," click on "Device." Beside "Match," enter the number of the dichot kit. Click on "OK." Click on the printer icon and then "OK."
6. Generate a control chart for the spreadsheet generated in **Step 5** by clicking on "Variable" on the menu bar, then clicking on "Individual" or click on the "I" icon.
7. From the "Individuals" screen, click on "Diff_LFE," then "OK."
8. Click on "OK" to accept the "Graphics Comment" which appears if data has been filtered. If Cancel is selected, the program returns to the spreadsheet.
9. Minimize the chart produced by clicking on the down arrow in the upper right-hand corner of the Graphics screen. If only this chart is to be printed, click on the "Print" icon, then "OK."
10. Repeat **Steps 7 through Step 9**, for "Diff_Bar."
11. Repeat **Steps 7 and 8** for "Diff_Tem." When the "Diff_Tem" graph is shown, select the "Group" option from the bar menu of the Graphics Menu or click on the "Group" icon. A Group Layout screen appears.
12. Select the chart with three equal-size plots on one page. Select "OK."
13. Drag 1.plt (Diff_Lfe) to the plot at the top of the chart, 2.plt (Diff_Bar) to the middle, and 3.plt (Diff-Tem) to the bottom.
14. Select the printer icon, then "OK" to print the page entitled "Group 1."

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15. Close the *Quality Analyst Graphics* section by clicking on "File" on the menu bar and then clicking on "Exit" or double-clicking on the upper left-hand corner icon.
16. Close Quality Analyst by clicking on "File" on the menu bar and then clicking on "Exit" or double-clicking on the upper left-hand corner icon.

10.0 CALCULATIONS

$$\% \text{ Difference} = \frac{(\text{Device Reading} - \text{Standard Reading})}{\text{Standard Reading}} \times 100$$

where Device Reading = data from audit kit component
Standard Reading = data from NIST, or NIST traceable component

11.0 METHOD PRECISION AND ACCURACY

LFEs are checked annually against NIST LFEs following EMSL/RTP-SOP-QAD-003. Audit devices are checked for accuracy and completeness of parts each time they return from the field. We have established that percent differences of $\pm 2\%$ for LFE flows, $\pm 1\%$ for barometer readings, and ± 2 degrees for the temperature readings provide a realistic range for optimal accuracy of data.

12.0 QUALITY CONTROL (QC)

12.1 QC Checks

PROCEDURE	SELECTION CRITERIA
Tubing Check	No leaks, cracks, or damaged fittings
Oil Manometer Check	No leaks or damaged fittings on the equipment Maintain proper fluid level
Air Filter Check	Clean and no damaged fittings
LFE Check	Average flows are $\pm 2\%$ of the certified flows
Temperature Probe Check	± 2 degrees of the NIST thermometer value
Barometer Check	$\pm 1\%$ of the NIST traceable barometer reading

12.2 Quality Control

Quality control on the system includes control charts on each device. These track trends in the audit device components. Performance and systems audits are also conducted by the EPA.

Any data which exceeds the QC limits set forth above results in a careful and thorough inspection of the complete system. If a question remains on the reliability of the system, it is not shipped to an audit participant until all questions are resolved.

13.0 CORRECTIVE ACTION

13.1 Temperature Sensor

If selection criteria are not met:

1. Re-seat sensor probe in aluminum block.
2. Replace defective temperature sensor.

13.2 Barometer

If the selection criteria are not met for the dial-type altimeter/barometer:

Replace the defective unit.

If the selection criteria are not met for the Ultimeter[®]:

1. Check the calibration factors stored in the Ultimeter[®] with those provided by the manufacturer.
2. Return the defective Ultimeter[®] to the manufacturer for recalibration.

13.3 LFE

If the selection criteria are not met:

1. Clean the LFE.
 - a. Air hose
 - b. Ultrasonic bath
2. Replace the LFE.

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14.0 SHIPPING

Check the audit kit for completeness of parts. Select the next participant from the audit list. Prepare a data packet with the following:

- Cover letter
- Instructions for conducting the audit
- Data sheets
- Return instructions with return address labels
- Data return envelope
- Questionnaire

Enclose the packet in the shipping box with the audit kit. Apply the participant address label to the shipping box and ship using the appropriate carrier. Enter the shipment into the NPAP database.

15.0 DATA REPORTING

Audit data is sent directly to the Data Entry personnel and handled according to **NPAP-SOP-005: Computer Data Entry, Report Printing, and System Maintenance for the NPAP.**

16.0 REFERENCES

EMSL/RTP-SOP-QAD-003, Procedures for Calibration of a Laminar Flow Element Against an NBS Calibrated LFE, Revision 1, January 14, 1985.