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Standard Practice for Secondary Calibration of Airborne Particle Counter Using Comparison Procedures[1]

This standard is issued under the fixed designation F 649; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers procedures for adjusting the size ranges of an automatic airborne particle counter (APC) to match size-concentration data from a reference APC that has been calibrated for counting and sizing accuracy in accordance with Practice F 328 and is kept in good working order. The practice is applied in situations where time or capabilities, or both, required for carrying out procedures in Practice F 328 are not available. It is particularly useful where more than one APC may be required to observe an environment with particulate material that differs in composition from the precision spherical particulate materials used for calibration in Practice F 328.

2. Referenced Documents

2.1 *ASTM Standards:*

F 328 Practice for Determining Counting and Sizing Accuracy of an Airborne Particle Counter Using Near-Monodisperse Spherical Particulate Materials[2]

2.2 *Military Standard:*

MIL-F-51068C Military Specification, Filter, Particulate, High Efficiency, Fire Resistant[3]

3. Summary of Practice

3.1 The APC under test is used to sample from an environment containing polydisperse aerosol whose nature is similar to that anticipated where the APC will be used. At the same time the reference APC that has been calibrated in accordance with Practice F 328, and maintained in good working order, is used to sample from the same environment. The size range settings of the APC under test are adjusted so that its concentration data are essentially in agreement with the concentration data produced by the reference APC.

4. Significance

4.1 In some aerosol measurements, two or more APCs must be used. APC operators have noted that differing results can be obtained by two APCs sampling the same air parcel, even when the APCs have been recently placed in good operating condition and are operating within their design specifications.

4.2 Identical or closely similar data are not developed by the APCs as a result of several causes. The most important is the difference in the ambient aerosol and the calibration aerosol in terms of both composition and particle size distribution. Another cause is variation in design and performance between the two APCs. Another cause is normal sample variance and the effect of sample size. Thus, even with good sample handling procedure these causes may result in differences of up to an order of magnitude in concentrations reported by two or more APCs.

NOTE 1—A more detailed discussion of these factors is given in Appendix X1.

5. Interferences

5.1 Since the APC is typically a high-sensitivity device it may be affected by radio frequency or electromagnetic interference. Precautions should be taken to ensure that the test area environment does not exceed the RFE-EMI capabilities of the APC. Electronic or operational verification can be made, such as indication of acceptable background level.

6. Apparatus

6.1 *Reference APC*—This APC should have been calibrated within the last 6-month period in accordance with Practice F 328 and maintained in good operating order. It is recommended that the reference APC be retained in a standardization or calibration laboratory and used only as a standard instrument.

6.2 *Gas Flowmeter*—A flowmeter with low pressure drop characteristics is required to measure flow into the APC. Use a variable-area flowmeter with APC flow near the top of a variable area flowmeter scale. The flowmeter should be calibrated and operated for low pressure drop across the flowmeter.

6.3 *Tubing*—Smooth-walled tubing with inside diameter sized in accordance with the APC inlet section is to be used. The tubing should be no longer than 1 m and should be metal (such as stainless steel or copper), glass, or should be of plastic material that will not release plasticizer in use or build up electrostatic charge.

6.4 *Filtered Air Supply*—Compressed air that has been passed through a high-efficiency filter (see MIL-F-51068C)

[1] This practice is under the jurisdiction of ASTM Committee E-21 on Space Simulation and Applications of Space Technology and is the direct responsibility of Subcommittee E21.05 on Contamination.

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[2] *Annual Book of ASTM Standards*, Vol 15.03.

[3] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

should be available. The filtered air must be available in quantity equal to or greater than the combined flow rate of both the APC under test and the reference APC if the ambient air concentration exceeds the limits indicated in 7.2.

6.5 *Blower*,[4] with free air capacity of approximately 2m^3/min and cut off static pressure of at least 49.8 Pa is recommended. A damper for flow control is required.

6.6 *Aerosol Mixing and Sample Supply Chamber*—A chamber whose volume is 1 to 2 times the volume handled by the APC(s) in 1 min is recommended. The volume is not critical and any convenient container could be used. As an example, for a 28.3 L/min APC a commercial cylindrical fiberboard powder shipping container of 380-mm inside diameter and 460 mm long will provide a 50-L cylindrical chamber. Once the powder has been removed and the interior cleaned, the fiberboard walls can be easily drilled or manipulated, or both, for aerosol inlets and outlets.

7. Preparation

7.1 *Preparation of Aerosol Chamber*—Attach the blower to one end of the chamber, for example, if the 50-L cylinder is used, attach the blower to one end of the cylinder so that ambient air will be blown into the chamber. Next, place the filtered air supply line so that it exhausts at the center of the chamber and mixes with the air from the centrifugal blower. Next, at the other end of the chamber insert the inlet lines to the APC(s) under test and to the reference APC, as shown in the sketch below. The inlet section of the lines to the APC(s) should be close to the central portion of the chamber and the configuration of the lines to the APC(s) should be nearly identical with the line inlets as close together as possible.

NOTE 2—Any system that meets the requirements of 8.2, 9.5, and 9.10 can be used.

8. Calibration and Standardization

8.1 The APC under test should be in good operating order. Reference manufacturer's primary calibration data and standardize operating levels of the instrument in accordance with manufacturer's field standardization procedure. The reference APC should be in good operating order and have undergone primary calibration in accordance with Practice F 328 within a period of no more than 6 months previous to its use in this method.

8.2 The concentration of particles within the chamber must be below the level where coincidence errors are significant with both the reference APC and APC(s) under test withdrawing gas from the chamber. Control the flow of filtered air and the air stream from the blower supplying room air to the chamber so that the particle concentration indicated by the reference APC is never more than 10 % of the manufacturer's recommended maximum concentration.

9. Procedure

9.1 Remove the sample inlet lines from the chamber and connect these lines to the APC under test and to the reference APC. Determine the air flow into each of the APCs with a flowmeter and with the sample inlet line in the configuration that it will take within the test chamber. Record this datum.

9.2 Connect the APC(s) under test and a reference APC to the test chamber as shown in Fig. 1.

9.3 Perform the manufacturer's recommended preoperation warmup and field standardization procedures on the APC(s) under test.

9.4 Verify that the APC under test operates at a satisfactory background level. For example, actuate the APC(s) that are connected to the test chamber and start filtered air supply into the test chamber. Do not operate the blower at this time. Establish that an excess of filtered air over and above the APC withdrawal rate is flowing into the test chamber by noting that positive gas flow is present out of the blower or vents, or both.

9.5 Verify that all APC(s) record zero count after the filtered air supply has been operating for a sufficient period of time to clean out the interior of the air chamber (in most cases a time period sufficient to flush the chamber four times will be adequate).

9.6 Start the centrifugal blower and reduce the filtered air supply inlet rate until the reference APC shows a particle concentration of approximately 10 % of the manufacturer's recommended maximum concentration for the APC(s) under test.

9.7 Adjust the reference APC gain, size ranges, or channel threshold settings to the desired levels and repeat these settings for the APC(s) under test, in accordance with the manufacturer's recommended settings.

9.8 Determine the concentration of particles in each of the reference APC size range(s) for the ambient aerosol-filtered air mixture presented to the test chamber and the several APCs. Determine concentration from the particle count and flow (see 9.1) for each APC.

9.9 Adjust the sensitivity for each of the individual channels or size settings for the APC(s) under test until the number concentration is equivalent to that recorded by the reference APC within ± 20 %. During this procedure, it may be necessary to vary the filtered air supply inlet rate to keep the aerosol concentration in the test chamber at a level that does not vary by more than +/− 15 % in the smallest size range when averaging a series of measurements.

9.10 After the individual channel sensitivities have been adjusted for the APC under test, repeat the measurement at least six times (replicate measurement can be stopped when the moving average is within tolerance) to obtain replicate data comparing the concentrations in each of the size ranges for the reference APC and for the APC under test. Alternate the APC under test and the reference APC inlet tube to ensure that inlet tube bias does not affect the data. Make sure that the maximum variance to be allowed between the mean of the data obtained from the reference APC and the data obtained from the APC(s) under test is no more than twice the variance anticipated on the basis of the quantity of data available (see Appendix X1).

10. Interpretation of Results

10.1 Following the adjustments carried out in Section 88, then the APC(s) will have been adjusted to produce the same results with aerosol of the type that is being examined by the

[4] Dayton, Stock No. 4C012, shaded pole blower, has been found suitable for this purpose.