Designation: F 50 – 92 (Reapproved 1996)

Standard Practice for Continuous Sizing and Counting of Airborne Particles in Dust-Controlled Areas and Clean Rooms Using Instruments Capable of Detecting Single Sub-Micrometre and Larger Particles[1]

This standard is issued under the fixed designation F 50; 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 the determination of the particle concentration, by number, and the size distribution of airborne particles in dust-controlled areas and clean rooms, for particles in the size range of approximately 0.01 to 5.0 µm. Particle concentrations not exceeding 3.5×10^6 particles/m^3(100 000/ft^3) are covered for all particles equal to and larger than the minimum size measured.

1.2 This practice uses an airborne single particle counting device (SPC) whose operation is based on measuring the signal produced by an individual particle passing through the sensing zone. The signal must be directly or indirectly related to particle size.

NOTE 1—The SPC type is not specified here. The SPC can be a conventional optical particle counter (OPC), an aerodynamic particle sizer, a condensation nucleus counter (CNC) operating in conjunction with a diffusion battery or differential mobility analyzer, or any other device capable of counting and sizing single particles in the size range of concern and of sampling in a cleanroom environment.

1.3 Individuals performing tests in accordance with this practice shall be trained in use of the SPC and shall understand its operation.

1.4 Since the concentration and the particle size distribution of airborne particles are subject to continuous variations, the choice of sampling probe configuration, locations and sampling times will affect sampling results. Further, the differences in the physical measurement, electronic and sample handling systems between the various SPCs and the differences in physical properties of the various particles being measured can contribute to variations in the test results. These differences should be recognized and minimized by using a standard method of primary calibration and by minimizing variability of sample acquisition procedures.

1.5 Sample acquisition procedures and equipment may be selected for specific applications based on varying cleanroom class levels. Firm requirements for these selections are beyond the scope of this practice; however, sampling practices shall be stated that take into account potential spatial and statistical variations of suspended particles in clean rooms.

NOTE 2—General references to cleanroom classifications follow Federal Standard 209, latest revision. Where airborne particles are to be characterized in dust-controlled areas that do not meet these classifications, the latest revision of the pertinent specification for these areas shall be used.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific hazards statements, see Section 8.

2. Referenced Documents

2.1 *ASTM Standards:*

D 1356 Terminology Relating to Atmospheric Sampling and Analysis[2]

F 328 Practice for Determining Counting and Sizing Accuracy of an Airborne Particle Counter using Near-Monodisperse Spherical Particulate Materials[3]

F 649 Practice for Secondary Calibration of Airborne Particle Counter using Comparison Procedures[3]

F 658 Practice for Defining Size Calibration, Resolution, and Counting Accuracy of a Liquid-Borne Particle Counter using Near-Monodisperse Spherical Particulate Materials[3]

2.2 *U.S. Federal Standard:*

Federal Standard No. 209D, Clean Room and Work Station Requirements, Controlled Environment[4]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *dust-controlled area*—a clean room or clean work space in which airborne and deposited particulate contamination levels, or both, are controlled on the basis of a documented standard such as Federal Standard 209D.

[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 11.03.

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

[4] Available from U.S. General Services Administration, Federal Supply Service, Standardization Division, Washington, DC 20406.

3.1.2 *dynamic range*—the particle size range, expressed as a multiple of the minimum measured size, over which the SPC can measure particles with size resolution of 10 % or less.

3.1.3 *particle concentration*—the number of individual particles per unit volume of ambient temperature and pressure air, particles/m^3 or particles/ft^3.

3.1.4 *particle size*—equivalent diameter of a particle detected by an SPC.

3.1.4.1 *Discussion*—The equivalent diameter is the diameter of a reference sphere of known size and physical characteristics (for example, refractive index when using an OPC; density when using an aerodynamic particle sizer; etc) and generating the same response in the SPC sensing zone as the particle being measured. Spherical particles are used for calibration of the SPCs considered here. The SPC response is related to the size, shape, orientation and physical properties of the particle passing through the SPC sensing zone. If an optical particle counter is used, the geometry of the optical system, as well as the spectral distribution of the illuminating light influences the reported particle size. If a condensation nucleus counter with a size-fractionation device is used, the SPC operating parameters and the particle properties that affect the nucleation efficiency and, for example, the diffusion coefficient, will influence reported data. The SPC instruction manual should make the user aware of the effects of such factors on the indicated particle size data.

3.1.5 *primary calibration*—calibration with standard reference particles for particle size and (optionally) concentration. Initially carried out by the SPC manufacturer.

3.1.6 *resolution*—the capability of the SPC to differentiate between particles with small difference in size.

3.1.6.1 *Discussion*—It can be quantified as the ratio of the square root of the difference between the measured and actual variances of a monosized particle size distribution to the mean diameter of those monosize particles, using procedures as shown in Practice F 658.

3.1.7 *standardization*—secondary calibration of electronic system voltage and signal response threshold levels using the reference system built into the SPC.

3.1.7.1 *Discussion*—The SPC should be capable of carrying out this procedure with a simple, rapid manual operation or by internal timed or microprocessor controlled components.

3.2 For definitions of other terms used in this practice, see Terminology D 1356 and Federal Standard 209D.

4. Summary of Practice

4.1 Satisfactory primary calibration within the manufacturer's recommended time period and routine standardization should be verified as a first step.

4.2 A sample acquisition program is established on the basis of the cleanliness level that is to be verified or monitored. This program will include sample point identification, sample size definitions and sampling frequency, specification of the sampler inlet and sample transport system, definition of the particle size ranges to be measured, and any other parameters of concern in the dust-controlled area or clean room.

4.3 Air samples are passed through the SPC and the particle content of each sample is defined by the SPC. Particles contained in the sampled air pass through the sensing zone of the SPC. Each particle produces a signal that can be related to particle size. An electronic system sorts and counts the pulses, registering the number of particles of various sizes that have passed through the sensing zone during passage of a known gas volume. The concentration and particle size data can be displayed, printed or otherwise processed, locally or remotely.

5. Significance and Use

5.1 The primary purpose of this practice is to describe a procedure for collecting near real-time data on airborne particle concentration and size distribution in clean areas as indicated by single particle counting techniques. Implementation of some government and industry specifications requires acquisition of particle size and concentration data using an SPC.

5.2 The processing requirements of many products manufactured in a clean room involves environmental cleanliness levels so low that a single particle counter with capability for detecting very small particles is required to characterize clean room air. Real-time information on concentration of airborne particles in size ranges from less than 0.1 µm to 5 µm and greater can be obtained only with an SPC. Definition of particles larger than approximately 0.05 µm may be carried out with direct measurement of light scattering from individual particles; other techniques may be required for smaller particles, such as preliminary growth by condensation before particle measurement.

5.3 Particle size data are referenced to the particle system used to calibrate the SPC. Differences in detection, electronic and sample handling systems among the various SPCs may contribute to differences in particle characterization. Care must be exercised in attempting to compare data from particles that vary significantly in composition or shape from the calibration base material. Variations may also occur between instruments using similar particle sensing systems with different operating parameters. These effects should be recognized and minimized by using standard methods for SPC calibration and operation.

5.4 In applying this practice, the fundamental assumption is made that the particles in the sample passing through the SPC are representative of the particles in the entire dust-controlled area being analyzed. Care is required that good sampling procedures are used and that no artifacts are produced at any point in the sample handling and analysis process; these precautions are necessary both in verification and in operation of the SPC.

6. Interferences

6.1 Since the SPC is typically a high sensitivity device, it's response may be affected by internally or externally generated noise. The SPC should not be operated at a sensitivity level so high that internal noise produces more than 5 % of the data signals.

6.2 Precautions should also be taken to ensure that the test area environment does not exceed the radio frequency or electromagnetic interference capabilities of the SPC.

6.3 Operation at acceptably low levels of internal noise can be verified by drawing a sample into the SPC through a filter or other gas cleaning device that will positively remove at least 99.97 % of all particles of size equal to and greater than that which the SPC will measure. After a short stabilization period,