Designation: F25/F25M – 21

Standard Test Method for Sizing and Counting Airborne Particulate Contamination in Cleanrooms and Other Dust-Controlled Areas[1]

This standard is issued under the fixed designation F25/F25M; 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 test method covers counting and sizing airborne particulate matter 5 µm and larger (macroparticles). The sampling areas are specifically those with contamination levels typical of cleanrooms and dust-controlled areas.

1.2 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.3 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F50 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

2.2 *ISO Standard:*[3]

ISO 14644-1 Cleanrooms and Associated Controlled Environments—Part 1: Classification of Air Cleanliness

2.3 *IEST Document:*[4]

IEST-G-CC1003 Measurement of Airborne Macroparticles (1999)

2.4 *SAE Document:*[5]

SAE Abstract ARP-743, Procedure for the Determination of Particulate Contamination of Air in Dust-Controlled Spaces by Particle Count Method, August 1962

3. Terminology

3.1 *Definitions:*

3.1.1 *airflow, n—*

3.1.1.1 *unidirectional airflow, n*—air flow which has a singular direction of flow and may or may not contain uniform velocities of air flow along parallel lines.

NOTE 1—Formerly known as laminar airflow.

3.1.1.2 *non-unidirectional airflow, n*—air distribution where the supply air entering the room mixes with the internal air by means of induction.

3.1.2 *critical pressure, n*—for an orifice with a constant upstream pressure, the downstream pressure at which the flow will not increase when the downstream pressure decreases.

3.1.3 *critical pressure ratio, n*—the ratio of the critical pressure of an orifice to the entrance pressure.

3.1.4 *customer, n*—organization, or the agent thereof, responsible for specifying the requirements of a cleanroom or clean zone.

3.1.5 *fiber, n*—particle having an aspect (length-to-width) ratio of 10 or more.

3.1.6 *macroparticle, n*—particle with an equivalent diameter greater than 5 µm.

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

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[4] Available from Institute of Environmental Sciences and Technology (IEST), 1827 Walden Office Square, Suite 400, Schaumburg, IL 60173, http://www.iest.org.

[5] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

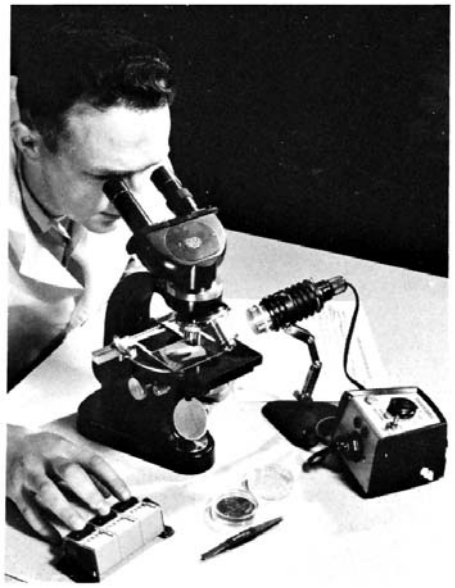

FIG. 1 Suitable Microscope: Inclined Binocular Body; Mechanical Stage; Triple Nosepiece; Ocular-Objective Combination to Obtain 40 to 45× and 90 to 150× Magnification

3.1.7 *M descriptor, n*—measured or specified concentration of macroparticles per cubic metre of air, expressed in terms of the equivalent diameter that is characteristic of the measurement method used.

3.1.7.1 *Discussion*—The M descriptor may be regarded as an upper limit for the averages at sampling locations (or as an upper confidence limit, depending upon the number of sampling locations used to characterize the cleanroom or clean zone). M descriptors cannot be used to define airborne particulate cleanliness classes, but they may be quoted independently or in conjunction with airborne particulate cleanliness classes.

3.1.8 *occupancy states, n—*

3.1.8.1 *as-built, n*—condition where the installation is complete with all services connected and functioning but with no additional equipment, materials, or personnel present.

3.1.8.2 *at-rest, n*—condition where the installation is complete with equipment installed and operating in a manner agreed upon by the customer and supplier, but with no personnel present.

3.1.8.3 *operational, n*—condition where the installation is functioning in the specified manner, with the specified number of personnel present and working in the manner agreed upon.

3.1.9 *particle size, n*—major projected dimension of the particle.

4. Summary of Test Method

4.1 The test method is based on the microscopical examination of particles impinged upon a membrane filter with the aid of a vacuum. The number of sampling points is proportional to the floor area of the enclosure to be checked. The apparatus and facilities required are typical of a laboratory for the study of macroparticle contamination. The operator must have adequate basic training in microscopy and the techniques of particle sizing and counting.

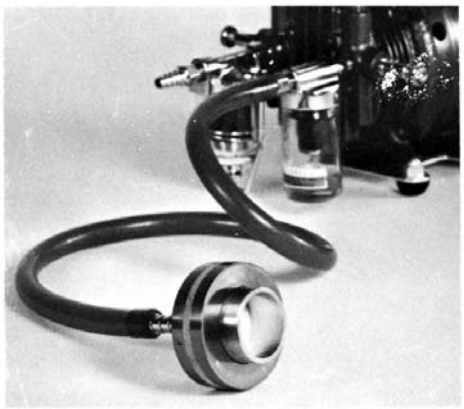

FIG. 2 Typical Air Sampling-Filtration Apparatus

5. Apparatus

5.1 *Filter Holder,*[6] aerosol open type having an effective filtering area of 960 ± 25 mm^2.

5.2 *Adapter.*[7]

5.3 *Flow-Limiting Orifice,*[8] 10 L/min.

5.4 *Membrane Filters,*[9] black, 0.80 µm mean pore size, 47 mm diameter, with imprinted grid squares having sides 3.10 ± 0.08 mm. Pressure drop across the filter used shall be no greater than 50 torr for an air flow rate of 1 L/min·cm^2.

5.5 *Forceps,* with unserrated tips.

5.6 *Vacuum Pump,* capable of producing a pressure of 34 kPa [260 torr] [vacuum of 500 torr] downstream of the orifice at a flow rate of 10 L/min through the orifice.

5.7 *Flowmeter,* calibrated and having a capacity in excess of 10 L/min.

5.8 *Glass Microscope Slides,* 50 mm by 75 mm, or 47 mm plastic disposable petri dishes.

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[6] The sole source of supply of the apparatus known to the committee at this time is 47 mm Stainless Steel, Millipore XX5004710, available from MilliporeSigma Headquarters, 400 Summit Drive, Burlington, MA 01803, https://www.emdmillipore.com/US/en. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

[7] The sole source of supply of the apparatus known to the committee at this time is Luer slip to ¼ in. -⅜ in. ID hose Stainless Steel, XX6200004, available from MilliporeSigma Headquarters, 400 Summit Drive, Burlington, MA 01803, https://www.emdmillipore.com/US/en. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

[8] The sole source of supply of the apparatus known to the committee at this time is Limiting Orifice Set (5 orifices including 10 L/min), XX5000000, available from MilliporeSigma Headquarters, 400 Summit Drive, Burlington, MA 01803, https://www.emdmillipore.com/US/en. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

[9] The sole source of supply of the apparatus known to the committee at this time is AABG04700, Black Grid, 0.80 µm, available from MilliporeSigma Headquarters, 400 Summit Drive, Burlington, MA 01803, https://www.emdmillipore.com/US/en. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

5.9 *Binocular Microscope,* (Fig. 1) with ocular-objective combinations to obtain 40 to 45× and 90 to 150× magnifications. Latter objective shall have numerical aperture of 0.15 min.

5.10 *Normal Counter,*[10] (2 gang) or equivalent.

5.11 *Microscope Lamp,* 6 V, 5 A, high-intensity.

5.12 *Ocular Micrometer Scale,* 5 mm linear scale with 100 divisions.

5.13 *Stage Micrometer,* standard 0.01 mm to 0.1 mm scale.

6. Sampling Apparatus

6.1 The airborne particles shall be collected, with the aid of a vacuum source, on a membrane filter of 960 mm^2 effective filtering area.

6.2 The apparatus specified in 5.1, 5.2, and 5.3 or equivalent shall be used.

6.3 Fig. 2 is picture of a typical sampler.

6.4 Fig. 3 is a drawing of a typical sampler assembly.

6.5 Sampler airflow is maintained using the vacuum pump, specified in 5.6, connected to the sampler and either a flowmeter to measure flow or a calibrated orifice to control flow.

6.5.1 The flow rate may be adjusted using a flowmeter and valve downstream of the sampler with filter and other elements installed.

6.5.2 A calibrated orifice, 5.3, may be used to control the airflow rate. The specified flow rate for the orifice depends on critical pressure ratio of less than 0.53 for air at room temperature and pressure. The limiting orifice shall be calibrated with the pump, filter holder, and filter used for this test method. The required flow rate is 10 ± 0.5 L/min.

6.6 Inspect the sampler, including the orifice, to ensure that it is free of restricting matter before each test. Clean if required.

7. Sampling in a Cleanroom, Clean Zone, or Other Controlled Areas

7.1 *Sampling Plan:*

7.1.1 A sampling plan shall be provided.

7.1.2 ISO 14644-1 and IEST-G-CC1003 may be used as guides for the plan.

7.2 The filter surface may be vertical or horizontal with respect to the floor.

7.2.1 The orientation of the filter depends on airflow direction for unidirectional airflow areas.

7.2.1.1 Sampling in a unidirectional airflow shall be as close to isokinetic as is possible.

7.2.1.2 IEST-G-CC1003 provides additional information on isokinetic sampling.

7.2.2 For nonunidirectional airflow areas, the customer may specify an orientation or the process being monitored in the cleanroom may indicate which orientation would be preferred.

7.2.2.1 In nonunidirectional airflow, airflow directions and velocities vary with location and time.

7.2.2.2 IEST G-CC1003 recommends a sample inlet probe, with an inlet diameter of at least 20 mm, facing upward. This will collect larger particles that tend to settle out of the air.

7.3 The standard sample for this test method shall be 300 L [10 ft^3].

7.3.1 The sample size may be adjusted for specific conditions.

7.3.2 The number of particles sampled shall meet statistical criteria of ISO 14644-1 or other accepted statistical sampling criteria.

7.4 The sample shall be taken at waist level (0.9 to 1.0 m [36 to 40 in.] from the floor), at bench level, or at other points as specified by the customer. The sample points may be selected for relevance to and sensitivity of the operations being performed in the cleanroom.

7.5 The number and location of sampling points shall be as designated in the sampling plan.

7.5.1 The minimum number of sample locations, as specified in ISO 14644-1, Annex B, may be used:

$$N_L = \sqrt{A} \quad (1)$$

where:

N_L = minimum number of sampling locations (rounded up to a whole number), and

A = area of the cleanroom or clean zone in square metres.

In the case of unidirectional horizontal airflow, the area A may be considered as the cross section of the moving air perpendicular to the direction of the airflow.

7.5.2 The nature of the operations or the customer may select the number of sampling points.

8. Sampling in a Duct or Pipe

8.1 The sampling of a moving gas stream in a duct or pipeline requires isokinetic sampling.

[10] The sole source of supply of the apparatus known to the committee at this time is the Veeder-Root counter, available from Veeder-Root, 25 Powder Forest Drive, PO Box 2003, Simsbury, CT 06070, https://www.veeder.com. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

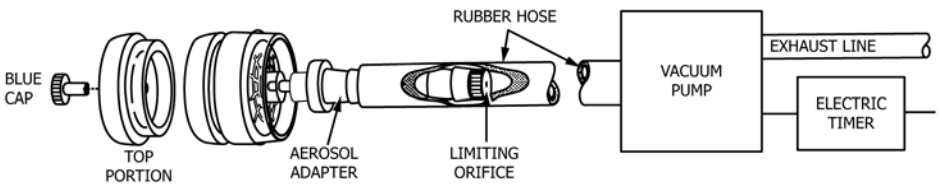

FIG. 3 Typical Aerosol Monitor Sampling System