Designation: F51/F51M − 20

Standard Test Method for Sizing and Counting Particulate Contaminant In and On Clean Room Garments[1]

This standard is issued under the fixed designation F51/F51M; 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 the determination of detachable particulate contaminant 5 µm or larger, in and on the fabric of clean room garments.

1.2 This test method does not apply to nonporous fabrics such as Tyvek (trademarked) or Gortex (trademarked). It only applies to fabrics that are porous such as cotton or polyester.

1.3 This test method provides not only the traditional optical microscopic analysis but also a size distribution and surface obscuration analysis for particles on a fine-textured membrane filter or in a tape lift sample. It utilizes transmitted illumination to render all particles darker than the background for gray level detection. Particles collected on opaque plates must be transferred to a suitable membrane filter.

1.4 *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.

1.5 *This standard may involve hazardous materials, operations, and equipment. 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.*

1.6 *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]

E1216 Practice for Sampling for Particulate Contamination by Tape Lift

F25/F25M Test Method for Sizing and Counting Airborne Particulate Contamination in Cleanrooms and Other Dust-Controlled Areas

2.2 *IEST Document:*[3]

IEST-RP-CC003.2, Garment System Considerations for Cleanrooms and Other Controlled Environments

3. Terminology

3.1 *Definitions:*

3.1.1 *fiber, n*—particle longer than 100 µm and with a length-to-width ratio exceeding 10:1.

3.1.2 *micrometre* (µm)*, n*—SI unit of length which is 10^{-6} of a metre or approximately 0.00004 in.

3.1.3 *particle size (L)* (µm)*, n*—major projected dimension of a particle.

4. Summary of Test Method

4.1 Filtered air is drawn through five designated 0.01 m^2 [1.5 $in.^2$ or approximately 0.01 ft^2] areas of a single thickness of the garment fabric at a rate of 14 L/min [0.5 cfm] for a period of 1 min for each area.

4.2 The air drawn through the garment subsequently passes through a membrane filter disk, impinging the entrained particles upon the filter surface.

4.3 The filter disk is then examined microscopically for particles removed from the garment.

4.4 For particles larger than 5 µm, use optical analysis. For particles smaller than 5 µm, use automated image analysis.

[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 Institute of Environmental Sciences and Technology (IEST), Arlington Place One, 2340 S. Arlington Heights Rd., Suite 100, Arlington Heights, IL 60005-4516, http://www.iest.org.

FIG. 1 Filter Assembly

FIG. 2 Adapter

4.5 Cleaning and counting techniques are in accordance with those established in Section 10.

5. Significance and Use

5.1 The test method for particulate sizing and numbers on garments is nondestructive and may be used to evaluate the contamination levels of fibers and particles on and in clean room garments. The test may be used for evaluating the cleanliness levels of new or newly cleaned garments. It also may be used to evaluate the extent of fiber and particulate contamination on garments that have been worn, if necessary. For this application, it is necessary to sample representative areas of the garment fabric.

6. Apparatus

6.1 *Filter Assembly and Adapter,* see Fig. 1 and Fig. 2.

6.1.1 *Filter Holder,* aerosol open type having an effective filter area of 960 ± 25 mm^2.

6.2 *Vacuum Pump or Aspirator,* capable of operating at a pressure of 7 kPa [500 torr] with a flow rate of 14 L/min [0.5 cfm].

6.3 *Flowmeter or Orifice,* calibrated and having a capacity in excess of 14 L/min [0.5 cfm], or a limiting orifice calibrated with the pump, filter holder, and filter used for this test method at a flow rate of 14 ± 0.5 L/min [0.50 ± 0.02 cfm]. Ensure, visually, that the orifice is free of obstructing matter before each test.

6.4 *Membrane Filters:*

6.4.1 *Black,* 0.80 µm pore size, 47 mm diameter with 3.08 mm imprinted grid for fabric particles.

6.4.2 *White,* 0.80 µm pore size, 47 mm diameter without imprinted grid for fabric particles and automated image analyzer.

6.4.3 *White,* 5.0 µm pore size, 47 mm diameter (air prefilter used with the filters in 6.4.1 and 6.4.2).

6.4.4 *Plastic Petri Slides with Covers* ,[4] plastic petri dishes, 60 mm diameter or glass microscope slides, 50 by 75 mm.

6.5 *Binocular Microscope,* with ocular-objective combinations to obtain 40 to 45× and 90 to 150× magnifications. Latter objective shall have a numerical aperture of 0.15 min.

6.6 *Programmable Image Analyzer, a Computer-Driven Microscope Which Counts and Sizes Particles With Automated Stage and Automated Focus Interface:*

6.6.1 *Microscope,* with a large glass platform automatic stage and automated focus.

6.6.2 *Objectives and Projection Lenses,* to generate a pixel dimension of about 5 µm or less.

6.7 *Forceps,* with unserrated tips.

6.8 *Normal Counter,* (2 gang) or equivalent. See Note 1.

NOTE 1—The Veeder Root counter has been found satisfactory for this purpose.

6.9 *Microscope Lamp,* 6 V, 5 A high intensity.

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

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

6.12 *Standard Counting Specimens.*

7. Sampling Requirements

7.1 The sample shall be collected by drawing air filtered to 5 µm through the test garment, impinging the garment-borne particles on the membrane filter. The filter surface mounted in the open-type aerosol filter holder shall be placed on the outer surface of the test garment. The garment is firmly clamped to the filter holder by means of the air-filter adapter. During

[4] The sole source of supply of the apparatus (Analyslides) known to the committee at this time is Pall Corporation, Port Washington, NY. 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.

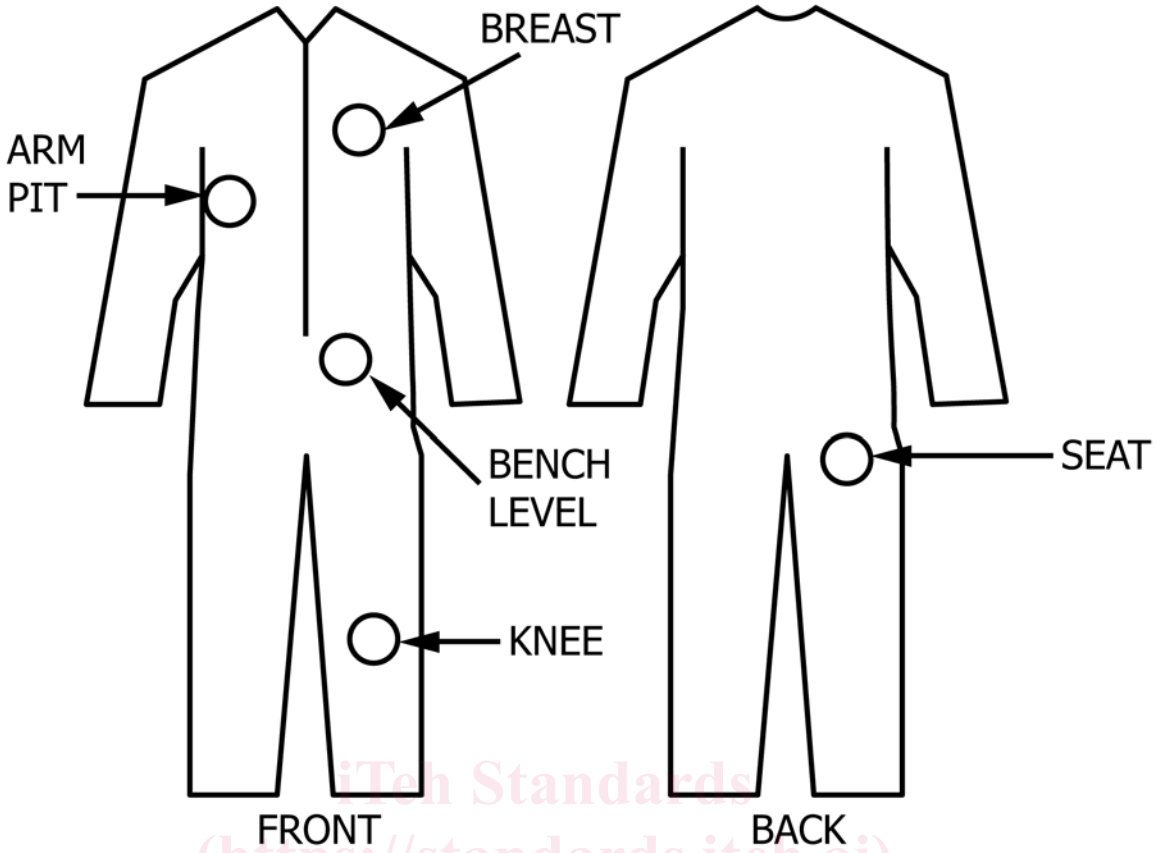

FIG. 3 Clean Room Garment Sampling Locations

sampling, the garment shall be hung or carefully positioned to minimize extraneous contamination.

7.2 The standard sample of this test method is secured with the passage of 14 L [0.5 ft^3] of air through the test fabric during a 1 min period at each of five sampling areas as shown in Fig. 3. One sampling area is adequate for caps, helmets, towels, wipers, and booties with plastic soles. Two areas are suggested for all-fabric booties.

7.3 Locations are approximate and may be modified to suit a specific design factor by agreement.

8. Preparation of Apparatus

8.1 Before sampling when using only a microscope, remove dirt and dust from the filter holder by washing in a free-rinsing detergent, ketone-free, isopropyl alcohol and submicrometer-filtered reagent grade petroleum ether (boiling range from 30 to 60 °C).

8.2 Maintain the laboratory equipment and area used for counting and sizing the particles in a condition of cleanliness parallel or superior to the area sampled. Good clean room and contamination control practices should be followed. Plastic microscope hoods have proven satisfactory as covering, in a clean room, in the absence of a laboratory clean hood.

8.3 Personnel performing sizing and counting operations shall wear garments and behave in a manner appropriate to the cleanliness conditions in which they are working.

8.4 Clean and prepare the microscope slides and petri dishes for preserving the membrane filter and specimen. Lens tissue properly used is satisfactory for this operation.

8.5 Handle hazardous chemicals used in the test method with recognized precautions.

8.6 Establish a background count on membrane filters by examining each filter used for referee purposes. Examination at 40 to 50× magnifications through the microscope will reveal low or high background count.

8.7 Make a background count (Note 2) following the microscopic methods outlined in this test method, upon any filter with a contamination level approximating 10 % or greater of the estimated test sample (Note 3). This count will be subtracted from the total count (P_t) obtained in 10.1 for each size range.

8.8 Place acceptable filters in clean petri dishes and cover. Identify the dishes for test use.

8.9 When using an automated image analyzer, preparation is similar to the preceding except that the white, ungridded 0.08 µm filter is used.

NOTE 2—For routine work, a background count on two filters per box of 100 is adequate under present rigid production methods.

NOTE 3—If the background count is estimated to be greater than 10 % of the total count from a 0.3 m^3 [10 ft^3] specimen, a larger sample 0.4 or 0.6 m^3 [15 to 20 ft^3] volume may be used to eliminate background count procedure.

FIG. 4 Inserting a Typical Orifice

FIG. 5 Placing the Filter on a Typical Screen Support

9. Sampling

9.1 With the aid of laboratory pressure tubing, connect the filter holder to a source of vacuum which has been found adequate to produce a flow rate of 14 L/min [0.5 cfm], at vacuum conditions test (pressure of 5 kPa or 350 torr). The holder may be open, may contain a limiting orifice (Fig. 4), or may be connected to the flowmeter. If a flowmeter is used between the filter holder and vacuum source, correction to the standard temperature and pressure must be made to determine actual standard temperature and pressure flow.

9.2 With clean forceps, carefully remove the appropriate membrane filter from the container and place, with grid side up, when appropriate, on the screen support of the filter holder (Fig. 5). Twist the locking ring in place after placing the tapered adapter in position. Similarly, place the 5.0 µm air filter in the top portion of the adapter by removing the O-ring from the adapter top, placing a 47 mm white filter on the support screen and replacing the O-ring. (This filter may be used for many tests.)

9.3 See IEST-RP-CC003.2 for additional recommendations on the sampling of garments.

9.4 When ready to sample, place the outer surface of the test garment over the tapered (male) adapter. Firmly lock into test position by placing the air-filter tapered (female) adapter over the test portion of fabric.

9.5 Apply vacuum at the predetermined flow rate of 14 L/min [0.5 cfm] for a period of 1 min for each area. Sample required areas (Fig. 3) by repeating 9.2.

9.6 Remove the filter from the holder with forceps and place it between the clean microscope slides, in a clean transport container (see 6.4.4) or in a clean petri dish for transport to the microscope counting area. The membrane must be cleaned before placing it in the transport container.

10. Microscope Analysis Procedure

10.1 Place the ocular micrometer in one eyepiece. Using a stage micrometer, calibrate the measuring eyepiece (ocular micrometer) for each magnification (Fig. 6). A whipple disk similarly calibrated is satisfactory for many inplant investigations.

FIG. 6 Typical Counting and Sizing Microscope and Illuminator (see Test Method F25/F25M)

10.2 Knowing the subdivisions of the stage micrometer (top), the divisions of the measuring eyepiece (bottom) may be sized from it (Fig. 7).

NOTE 4—*Example:* Stage the micrometer 100 µm per major division, 10 µm per minor division: 100 divisions of the measuring eyepiece subtend 1050 µm, one division of the measuring eyepiece = 10.5 µm.

10.3 Remove the petri dish cover, then remove the filter from the petri dish and place it, with filtering surface up, on a 50 by 76 mm [2 by 3 in.] microscope slide. Greasing the slide lightly with silicone stopcock lubricant before mounting the filter will assist in holding the filter flat in place.

10.4 Adjust the external light source to obtain maximum particle definition with an illumination angle of approximately 45°. High-intensity illumination is a critical requirement.

10.5 Use a magnification of approximately 45× for counting particles 50 µm or larger and approximately 100× for particles smaller than 50 µm. Greater magnifications may be advantageous for examination to identify particles.

NOTE 5—Analysis for particles in the 0.5 to 5.0 µm size range may be