~~Designation:E1216–06~~ Designation: E1216 – 11

Standard Practice for Sampling for Particulate Contamination by Tape Lift[1]

This standard is issued under the fixed designation E1216; 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 sampling surfaces to determine the presence of particulate contamination, 5 μm and larger. The practice consists of the application of a pressure-sensitive tape to the surface followed by the removal of particulate contamination with the removal of the tape. The tape with the adhering particles is then mounted on counting slides. Counting and measuring of particles is done by standard techniques.

1.2 This practice describes the materials and equipment required to perform sampling of surfaces for particle counting and sizing.

1.3 The criteria for acceptance or rejection of a part for conformance to surface cleanliness level requirements shall be determined by the user and are not included in this practice.

1.4 This practice is for use on surfaces that are not damaged by the application of adhesive tape. The use of this practice on any surface of any material not previously tested or for which the susceptibility to damage is unknown is not recommended. In general, metals, metal plating, and oxide coatings will not be damaged. Application to painted, vapor deposited, and optical coatings should be evaluated before implementing this test.

1.5 This practice provides three methods to evaluate tape lift tests, as follows:

	Sections
Practice A—This method uses light transmitted through the tape and tape adhesive to detect particles that adhere to it.	4 to 6
Practice B—This method uses light transmitted through the tape adhesive after bonding to a base microscope slide, dissolving the tape backing, and a cover slide. The particles are embedded in the adhesive, and air bubbles are eliminated with acrylic mounting media.	7 to 9
Practice C—This method uses light reflected off the tape adhesive to detect particles that adhere to it.	10 to 12

~~1.6The values stated in SI units are to be regarded as the standard. The inch-pound units given in parentheses are for information only.~~

1.6 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.6.1 *Exception*—The inch-pound units given in parentheses are for information only.

1.7 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E595 Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment

F312 Test Methods for Microscopical Sizing and Counting Particles from Aerospace Fluids on Membrane Filters

2.2 *Federal Standard:*

[1] This practice 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.

Federal Standard 595 Color[3]

3. Significance and Use

3.1 The tape lift provides a rapid and simple technique for removing particles from a surface and determining their number and size distribution.

3.2 By using statistically determined sample size and locations, an estimate of the surface cleanliness level of large areas can be made. The user shall define the sampling plan.

3.3 The sampling plan shall consider the importance of surface geometry and surface orientation to gas flow, gravity, obstructions, and previous history of hardware. These factors influence particle fallout and entrapment of particles on the surface. The geometry of joints, recessed areas, fasteners, and the correspondence of particle-count data to area can be maintained.

3.4 The selection of tape and the verification of its effect on the cleanliness of the hardware is very important. The tape adhesive should have sufficient cohesion to avoid transfer of the adhesive to the surface under test. The impact of adhesive transfer should be evaluated by laboratory testing before using the tape on the hardware. Since potential for adhesive transfer exists, cleaning to remove any adhesive might be required. In addition, the tape should have low outgassing characteristics, and as a minimum, it should meet the requirements of less than 1.0 % total mass loss (TML) and 0.1 % collected volatile condensable materials (CVCM), as measured by Test Method E595.

3.5 Care should be exercised in deciding which surfaces should be tested by this practice. The tape can remove marginally adhering paint and coatings. Optical surfaces should not be tested until verification has been made that the surface coating will not be damaged. Rough surface finishes result in low removal efficiencies. Surface finishes up to approximately 3.20 µm (125 µin.) have been tested and found to give satisfactory results.

3.6 This practice has been tested only on surfaces at room temperature. Evaluation of temperature effects must be conducted prior to using the test on surfaces other than room temperature.

3.7 Only personnel experienced in microscopic particle-counting techniques should be used to count and size the particles.

PRACTICE A—TRANSMITTED LIGHT MICROSCOPY

4. Apparatus

4.1 *Counting Slide*:

4.1.1 Optical glass, polished on both sides, with beveled edges and etched with low reflectance chrome to provide a 7.62- by 7.62-cm (3.0- by 3.0-in.) area consisting of 256 (16 by 16) individual numbered squares. Each square has 0.23 cm^2 (0.015 $in.^2$) of area and is cleaned to remove all particles equal to or greater than 5 µm in size.

4.1.2 *Background Color*—For ease of distinguishing light particles from the background, slides colored Green No. 14062 or Magenta Red No. 21158 in accordance with Federal Standard 595 may be used. Other background colors may be used if corresponding accuracy is achieved.

4.2 *Pressure-Sensitive Tape,*[4] nominal (50-mm) (2-in.) wide clear film backing with a transparent adhesive. Tape to be supplied on a plastic roll.

4.2.1 Tape flexibility should be sufficient to allow taping of areas with 90° angles.

4.2.2 Tape backing and adhesive shall be clear, smooth, free of tape bubbles, flow lines, and imperfections that would interfere with the counting of particles.

4.3 ~~*Nonlinting Gloves,* specially cleaned having a reversible thumb.~~ Nonlinting Gloves, specially cleaned Nitrile gloves.

5. Procedure

5.1 *Technique*:

5.1.1 The tape shall be slowly removed directly from the roll to avoid static charge effects and applied immediately to minimize exposure to the air.

5.1.2 The tape must be removed immediately after application to the surface being tested with a slow and steady force. Fast or jerky removal reduces particle retention efficiency and increases the possibility of leaving tape residues. Prolonged contact of the tape to the surface develops stronger binding and a higher probability for tape residues to be left on the surface.

5.1.3 Apply the tape to a clean slide as described in 5.2.2. The color of the filter slide must be specified because the number of translucent and contrasting particles detected will vary depending on the background medium.

5.1.4 The outside edges, 6 mm (0.25 in.), shall not be used. This is the area most likely to be contaminated during tape manufacture, handling, and shipping. The static charges on the tape may draw contaminants to the area from outside the test area.

5.1.5 Excessive pressure in applying tape may crush the particles.

5.2 *Preparation of the Test Specimen*:

[3] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://dodssp.daps.dla.mil.

[4] The sole source of supply of the apparatus known to the committee at this time is 3M No. 480 polyethylene tape with an acrylic pressure-sensitive backing. If you are aware of alternative suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.

5.2.1 Prepare a 12-mm (0.5-in.) tab of the free end of the tape. Remove a minimum of 12 cm (5.0 in.) under tension to prevent buckling and apply to one end of the surface. Press a 10-cm (4-in.) length firmly to the surface. There shall be no creases or folds. Nonlinting gloves must be worn to prevent the introduction of skin particles into the sample.

5.2.1.1 Do not crush particles on the surface when applying the tape. A roller device has been found to work well.

5.2.2 Immediately after applying the tape to the surface, lift the tape from one end using an even force. The tape must be kept taut during the removal. Apply the tape to the etched side of a clean glass counting slide using the same technique described in 5.2.1.

5.3 *Counting*—Place the glass slide on a colored background stage of the microscope with the unetched side up. Size and count the particulate contamination in accordance with Methods F312. Squares falling within 6 mm (0.25 in.) of the tape edge shall not be used. The total number of particles should be sufficiently large to provide the statistical reliability required by Methods F312.

5.4 Perform the blank analyses or tares to establish the background level of particles in the tape. The background particle count of the blank shall be no more than 10 % of the allowable value for the surface under test.

6. Precision and Bias

6.1 Precision and bias are intended to be adequate for use as a standard practice, or monitoring method.

6.1.1 *Repeatability*—Repeatability of the counting method shall be defined in Methods F312.

6.1.2 *Effectiveness*—The minimum effectiveness of particle removal from smooth surfaces and angles down to 90° is 90 % for particles larger than 5 µm.

6.2 *Bias*:

6.2.1 No absolute standard nor one traceable to the National Institute of Standards and Technology is available, and therefore, the bias of this practice cannot be determined at this time.

6.2.2 The sizing and counting bias is being established for particles larger than 5 µm.

PRACTICE B—TRANSMITTED LIGHT MICROSCOPY

7. Apparatus

7.1 *Counting Slide:*[5]

7.1.1 Optical glass, polished on both sides, with beveled edges, providing a 25- by 75-mm (1- by 3-in.) area. Each slide is cleaned to remove all particles equal to or greater than 5 µm in size.

7.1.2 *Background Color*—For ease of distinguishing light particles from the background, slides colored Green No. 14062 or Magenta Red No. 21158 in accordance with Federal Standard 595 may be used. Other background colors may be used if corresponding accuracy is achieved.

7.2 *Pressure-Sensitive Tape,*[6] nominal 19-mm (0.75-in.) wide clear film backing with a transparent adhesive. Tape to be supplied on a plastic roll.

7.2.1 Tape flexibility should be sufficient to allow taping of areas with 90° angles.

7.2.2 Tape backing and adhesive should be clear, smooth, free of tape bubbles, flow lines, and imperfections that would interfere with the counting of particles.

7.3 ~~*Nonlinting Gloves,* specially cleaned having a reversible thumb.~~ Nonlinting Gloves, specially cleaned Nitrile gloves.

7.4 *Microscope Staining Jar or Dish.*[7]

7.5 *Acetone*—The acetone must be filtered to eliminate particles over 5.0 µm in length and should have no more than 10-ppm nonvolatile residue; HPLC grade acetone meets this requirement.

7.6 *Isopropyl Alcohol (IPA)*—The IPA must be filtered to eliminate particles over 5.0 µm in length and should have no more than 10-ppm nonvolatile residue; HPLC grade IPA meets this requirement.

7.7 *Acrylic Mounting Medium*[8]—Low-viscosity (~0.6-Pa·s or ~60-centipoise) mounting medium will allow for quick flow with a minimum of air bubbles.

7.8 *Hexane*—The hexane must be filtered to eliminate particles over 5.0 µm in length and should have no more than 10-ppm nonvolatile residue; HPLC grade hexane meets this requirement.

~~[5] The sole source of supply of the apparatus known to the committee at this time is Cadinol No. 172 gloves. If you are aware of alternative suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.~~

[5] These slides are available from many scientific supply houses as plain microscope slides.

~~[6] These slides are available from many scientific supply houses as plain microscope slides.~~

[6] The sole source of supply of the apparatus known to the committee at this time is 3M No. 810 Magic Tape. If you are aware of alternative suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.

~~[7] The sole source of supply of the apparatus known to the committee at this time is 3M No. 810 Magic Tape. If you are aware of alternative suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.~~

[7] Wheaton No. 900200 is an example of a staining dish with a glass slide rack and cover.

~~[8] The sole source of supply of the apparatus known to the committee at this time is Cadinol No. 172. If you are aware of alternative suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.~~

[8] Acrylic mounting medium is available from many scientific supply houses; some supply prethinned material with a viscosity of approximately 60 centipoise. Thicker media can be thinned with hexane or xylene.