Designation: E1731 – 11 (Reapproved 2018)

Standard Test Method for Gravimetric Determination of Nonvolatile Residue from Cleanroom Gloves[1]

This standard is issued under the fixed designation E1731; 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 solvent extractable nonvolatile residue (NVR) from gloves used in cleanrooms where spacecraft are assembled, cleaned, or tested.

1.2 The NVR of interest is that which can be extracted from gloves using a specified solvent that has been selected for its extracting qualities, or because it is representative of solvents used in the particular facility. Alternative solvents may be used, but since their use may result in different values being generated, they must be identified in the procedure data sheet.

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

1.4 *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.*

1.5 *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]

D1193 Specification for Reagent Water

E2217 Practice for Design and Construction of Aerospace Cleanrooms and Contamination Controlled Areas

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

G120 Practice for Determination of Soluble Residual Contamination by Soxhlet Extraction

2.2 *Federal Standards:*[3]

Fed-Std-209E Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones[4]

2.3 *Other Documents:*

IEST-RP-CC001 HEPA and ULPA Filters[5]

IEST-RP-CC005 Gloves and Finger Cots Used in Cleanrooms and Other Controlled Environments[5]

Industrial Ventilation, A Manual of Recommended Practice[6]

ISO 14644-1 Cleanrooms and Associated Controlled Environments, Classification of air cleanliness[7]

ISO 14644-2 Cleanrooms and Associated Controlled Environments, Specifications for testing and monitoring to prove continued compliance with ISO 14644-1[7]

3. Terminology

3.1 *Definitions:*

3.1.1 *contaminant, n*—unwanted molecular or particulate matter that could affect or degrade the performance of the components upon which they are deposited.

3.1.2 *contamination, n*—a process of contaminant transport or accretion, or both.

3.1.3 *environmentally controlled area, n*—cleanrooms, clean facilities, controlled work areas, and other enclosures that are designed to protect hardware from contamination. See Industrial Ventilation, A Manual of Recommended Practice for suggestions on facility operation. Cleanliness is achieved by

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

[4] Fed-Std-209E has been replaced by ISO 14644-1 and -2, but may continue to be used by mutual agreement.

[5] Available from the Institute of Environmental Sciences and Technology, 2340 South Arlington Heights Road, Suite 100, Arlington Heights, IL 60005-4516, http://www.iest.org.

[6] Available from Committee on Industrial Ventilation, American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Dr., Suite 600, Cincinnati, OH 45240, http://www.acgih.org/about/committees/c_indvnt.htm.

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

controlling airborne particulate matter, temperature, relative humidity, materials, garments, and personnel activities. Guidelines for controlled areas can be found in Practice E2217.

3.1.4 *high efficiency particulate air (HEPA), n*—a term describing filters having an efficiency of 99.97 % for removal of 0.3-µm and larger particles. For this application, filters shall meet the requirements of IEST-RP-CC001 (2.3 and 6.1 of this test method).

3.1.5 *molecular contaminant (nonparticulate), n*—may be in a gaseous, liquid, or solid state. It may be uniformly or nonuniformly distributed or be in the form of droplets. Molecular contaminants account for most of the NVR.

3.1.6 *NVR, n*—that quantity of molecular matter remaining after the filtration of a solvent containing contaminants, and evaporation of the solvent at a specified temperature.

3.1.7 *particle (particulate contaminant), n*—a piece of matter in a solid state, with observable length, width, and thickness. The size of a particle is defined by its greatest dimension and is expressed in micrometres.

4. Summary of Test Method

4.1 A glove to be tested is cut into several standard-sized pieces. The pieces are placed in a clean blanked container and a measured volume of solvent is added to the container. (See Note 1.)

4.2 The container is placed in a heated ultrasonic cleaner, or a heated water bath, and heated (and agitated if in an ultrasonic bath) for a specific length of time, after which the pieces of glove are removed from the container.

4.3 The solvent in the container is filtered into another clean container and allowed to evaporate to a low volume.

4.4 The solvent is transferred to a clean preweighed weighing dish and evaporated to a constant weight.

4.5 The results are expressed in mg/cm^2 of glove surface area or in mg/unit mass of glove sections.

4.6 A controlled blank shall be run on all solvents, filtration components, and all other equipment associated with the analysis. In the event that more than one determination is run the same day, additional blanks will not be necessary, but will rely on the value from the first test.

4.7 NVR samples thus obtained may be used for analysis such as IR or FTIR to identify contaminant species if required.

NOTE 1—Some cleanroom gloves are of a coated or layered construction or have different textures applied to the inside and outside surfaces. Because the inside and outside surfaces of these gloves may release different quantities of nonvolatile residue, results using this method may not reflect the actual potential for transfer of contamination from this type of glove to hardware surfaces.

5. Significance and Use

5.1 The NVR obtained by this test method is that amount which is available for release by the gloves onto handled surfaces.

5.2 Evaporation of solvent at the stated temperature is to quantify the NVR that can be expected to exist at room temperature, since the slight difference between room temperature and the test temperature is not likely to result in significant variances.

5.3 This method may be more aggressive than necessary to determine the suitability of cleanroom gloves that are restricted to dry operations only.

5.4 Various other methods exist for determining NVR, for example Practice G120 and IEST-RP-CC005. This test is not intended to replace test methods used for other purposes.

6. Apparatus and Materials

6.1 *Unidirectional Airflow Work Station,* 100 % exhaust, for handling solvents. Must meet the particulate air cleanliness Class 5 (100) or better in accordance with ISO 14644-1 and ISO 14644-2 (Fed-Std-209). HEPA filters in the work station must not have been tested with Di-Octyl Phthlate (DOP) at any time. Filters should conform to IEST-RP-CC001 HEPA and ULPA Filters. See Practice F50 for information on airborne particle counting methods. Temperature shall be controlled within a range of 20 to 25°C and relative humidity to less than 60 %.

6.2 *Solvent,* Acetone, Reagent grade A.C.S.

6.3 *Analytical Balance,* 0.01-mg readability, 0.1-mg precision. Capacity to be determined by the user.

6.4 *Vacuum Filtration System,* 25-mm diameter, consisting of a membrane filter funnel and vacuum pump that will provide a pressure of 250 torr (20 in. Hg vac.). Other size filtration systems may be used as needed. All items that will come in contact with solvents during analysis shall be made of glass, stainless steel, or other materials that will not affect the analysis via induced contamination. Any house vacuum system may be used.

6.5 *Solvent-Resistant Membrane Filters,* Fluorocarbon, 25-mm diameter, 0.2-µm nominal pore size. The use of supported membrane filters is not recommended because of possible adverse effects of the solvent on support media.

6.6 *Teflon-Coated Tweezers, or Hemostat,* unserrated tips.

6.7 *Beakers,* low form glass, 500 mL.

6.8 *Laboratory Detergent,* liquid.

6.9 *Methanol,* Reagent grade, A.C.S.

6.10 *Deionized Water,* organic free, Type II per Specification D1193, with a minimum resistivity of 1.0 megohm-cm.

6.11 *Gloves,* barrier type, low particle-generating, low outgassing, per IEST-RP-CC005.

6.12 *NVR Solvent,* acetone or other solvent. (See Note 2.) Must be verified to contain no more than 0.35-mg NVR per 300-mL solvent (0.12 mg/100 mL) when tested in accordance with Section 8 of this test method (See Note 3).

NOTE 2—Other solvents may be used if they are more representative of service conditions, but the actual solvent used must be reported per Section 11 of this test method.

NOTE 3—In the event that the solvent does not meet the required purity level, it may be necessary to triple distill it, keeping the temperature of the vapor phase of the distillate no more than 0.2°C higher than the boiling point of the solvent. Higher temperatures will result in the "carryover" of