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Standard Practice for Cleaning and Maintaining Controlled Areas and Clean Rooms[1]

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1. Scope

1.1 This practice covers the procedures to be followed for the initial cleaning and normal maintenance of cleanrooms and controlled areas. This practice is applicable to aerospace clean areas where both particles and molecular films (NVR) must be controlled.

1.2 The values stated in SI units are to be regarded as the standard.

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

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 1193 Specification for Reagent Water

E 1234 Practice for Handling, Transporting, and Installing Nonvolatile Residue (NVR) Plates Used in Environmentally Controlled Areas for Spacecraft

E 1235 Test Method for Gravimetric Determination of Nonvolatile Residue (NVR) in Environmentally Controlled Areas for Spacecraft

E 1549 Specification for ESD Controlled Garments Required in Cleanrooms and Controlled Environments for Spacecraft for Non-Hazardous and Hazardous Operations

E 1560 Test Method for Gravimetric Determination of Nonvolatile Residue from Cleanroom Wipers

E 2352 Practice for Aerospace Cleanrooms and Associated Controlled Environments—Cleanroom Operations

F 24 Method for Measuring and Counting Particulate Contamination on Surfaces

F 25 Test Method for Sizing and Counting Airborne Particulate Contamination in Clean Rooms and Other Dust-Controlled Areas Designed for Electronic and Similar Applications

F 50 Practice for Continuous Sizing and Counting of Airborne Particles in Dust-Controlled Areas and Clean Rooms Using Instruments Capable of Detecting Single Sub-Micrometer and Larger Particles

2.2 *IEST Standards:*[3]

IEST-RP-CC007 Testing ULPA Filters

IEST-RP-CC016 The Rate of Deposition of Nonvolatile Residue in Cleanrooms

IEST-RP-CC0018 Cleanroom Housekeeping and Monitoring Procedures

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

IEST-RP-CC026 Cleanroom Operations

IEST-STD-CC1246D Product Cleanliness Levels and Contamination Control Program[4]

2.3 *US Federal Standards:*[5]

FED-STD-209E Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones[6]

TT-I-735 Isopropyl Alcohol

O-A-51 Acetone[5]

2.4 *US Department of Defense Standards:*[5]

MIL-D-16791 Detergents, General Purpose (Liquid, Non-Ionic)

2.5 *International Standards:*[7]

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

ISO 14644-2 Cleanrooms and Associated Controlled Environments—Part 2: Specifications for Testing and Monitoring to Prove Continued Compliance with ISO 14644-1

[1] This practice is under the jurisdiction of ASTM Committee E21 on Space Simulation and the 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 Science and Technology (IEST), 5005 Newport Dr., Suite 506, Rolling Meadows, IL 60008-3841.

[4] IEST-STD-CC1246D replaced MIL-STD-1246.

[5] Available from Superintendent of Documents, US Government Printing Office, Washington, DC 20402.

[6] Cancelled Nov. 29, 2001 and replaced with ISO 14644-1 and 14644-2. FED-STD-209E may be used by mutual agreement between buyer and seller. Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401. FS209E cleanroom classes are given for reference in parentheses after the ISO classes.

[7] Available from International Organization for Standardization (ISO), 1 rue de Varembé, Case postale 56, CH-1211, Geneva 20, Switzerland.

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *clean zone*, *n*—a defined space in which the concentration of airborne particles is controlled to specified limits.

3.1.2 *cleanroom*, *n*—a room in which the air filtration, air distribution, utilities, materials of construction, equipment, and operating procedures are specified and regulated to control airborne particle concentrations to meet appropriate airborne particulate cleanliness classifications, as defined by ISO 14644-1.

3.1.3 *cleanroom, as-built*, *n*—a cleanroom that is complete and ready for operation, with all services connected and functional, but without equipment or operating personnel in the room.

3.1.4 *cleanroom, at-rest*, *n*—a cleanroom that is complete, with all services functioning and with equipment installed and operable or operating, as specified, but without operating personnel in the room.

3.1.5 *cleanroom, operational*, *n*—a cleanroom in normal operation, with all services functioning and with equipment and personnel, if applicable, present and performing their normal work functions in the room.

3.1.6 *clean facility*, *n*—the total real property required to accomplish the cleanroom functions.

3.1.6.1 *Discussion*—In addition to the cleanroom and associated clean areas, this includes utility rooms, storage areas, offices, lockers, wash-rooms, and other areas that do not necessarily require precise environmental control.

3.1.7 *controlled area*, *n*—an environmentally controlled area, operated as a cleanroom, but without the final stage of HEPA filters. Controlled areas would meet ISO Class 8.5 (FED-STD-209E equivalent to Class 300 000) per Table 1.

3.1.7.1 *Discussion*—Only rough filters (50 to 60 % efficiency) and medium efficiency filters (80 to 85 % efficiency) are required for a controlled area. The maximum allowable airborne particle concentrations in a controlled area are 11 100 000/m^3 per ISO Class 8.5 for particles ≥0.5 µm and 92 500/m^3(2620 particles/ft^3 per Class 300 000/ft^3 FED-STD-209E) for particles ≥5.0 µm.

3.1.8 *DI water*, *n*—deionized water.

3.1.9 *discrete-particle counter (DPC)*, *n*—an instrument, such as an optical particle counter or condensation nucleus counter, capable of resolving responses from individual particles.

3.1.10 *HEPA filter*, *n*—(high-efficiency particulate air filter) a throwaway, extended-medium, dry-type filter in a rigid frame, having a minimum particle-collection efficiency of 99.97 % (that is, a maximum particle penetration of 0.03 %) for 0.3-µm particles of thermally generated DOP of specified alternative aerosol.

3.1.11 *HVAC*, *n*—heating, ventilating, and air conditioning.

3.1.12 *nonvolatile residue (NVR)*, *n*—matter remaining after solvent containing such matter has been evaporated or cleaned.

3.1.13 *ULPA filter*, *n*—(ultra-low-penetration air filter) a throwaway, extended-medium, dry-type filter in a rigid frame, having a minimum particle-collection efficiency of 99.999 % (that is, a maximum particle penetration of 0.001 %) for particles in the size range of 0.1 to 0.2 µm, when tested in accordance with the methods of IES-RP-CC007.1.

4. Significance and Use

4.1 This practice identifies methods for cleaning and maintaining controlled areas and clean rooms as defined by ISO 14644-1 and ISO 14644-2. Cleaning procedures are described,

TABLE 1 Comparison of ISO 14644-1 and FED-STD-209E Cleanliness Classes

ISO Class N Nominal FS209E Class	Particle Concentrations Maximum Number of Particles per Cubic Meter / Cubic Foot of Air for Particle Sizes Equal to or Greater than the Stated Size					
	0.1 µm	0.2 µm	0.3 µm	0.5 µm	1 µm[A]	5 µm
ISO Class 1	10	2	—	—	—	—
ISO Class 2	100	24	10	4	—	—
FS209E Class 0.1	3	1	—	—	—	—
ISO Class 3	1000	237	102	35	8	—
FS209E Class 1	35	7	3	1	—	—
ISO Class 4	10 000	2370	1020	352	83	—
FS209E Class 10	350	75	30	10	2	—
ISO Class 5	100 000	23 700	10 200	3520	832	29
FS209E Class 100	3500[B]	750	300	100	24	—
ISO Class 6	1 000 000	237 000	102 000	35 200	8320	293
FS209E Class 1000	35 000[B]	7500[B]	3000[B]	1000	236	7
ISO Class 6.7[C]	—	—	—	176 000	41 700	1470
FS209E Class 5000[B]	—	—	—	5000	1180	42
ISO Class 7	—	—	—	352 000	83 200	2930
FS209E Class 10 000	—	—	—	10 000	2360	70
ISO Class 8	—	—	—	3 520 000	832 000	29 300
FS209E Class 100 000	—	—	—	100 000	23 600	700
ISO Class 8.5[C]	—	—	—	11 100 000	2 630 000	92 500
FS209E Class 300 000[D]	—	—	—	300 000	74 500	2620
ISO Class 9	—	—	—	35 200 000	8 320 000	293 000
FS209E Class 1 000 000[D]	—	—	—	1 000 000	236 000	8280

[A] No 1 µm designation is listed in FS209E Table 1 for particulate classes. The values shown are equivalents of the ISO values.

[B] These values were not directly listed in FS209E. Allowances are made in FS209E for intermediate classes and associated calculations have been shown. If used, a notation should be made indicating that they have been derived.

[C] ISO 14644-1 does not include Class 6.7 or 8.5. The values shown are equivalent to those derived for FED-STD-209E Class 5000 and 300 000.

[D] FS209E does not include Class 300 000 and 1 000 000. The values shown are equivalents of the ISO values for ISO Class 8.5 and 9.