



Designation: E2217 – 12 (Reapproved 2026)

Standard Practice for Design and Construction of Aerospace Cleanrooms and Contamination Controlled Areas¹

This standard is issued under the fixed designation E2217; 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 The purpose of this practice is to provide design and construction guidelines for contamination controlled facilities used in the assembly and integration of aerospace hardware. The guidelines herein are intended to ensure that the facilities, when used properly, will meet the cleanliness requirements of aerospace hardware and processes. The objective is to limit contamination due to the deposition of particulate and molecular contaminants on flight hardware surfaces.

1.2 One cleanliness classification of a facility is the airborne particle concentrations in accordance with ISO 14644-1 and 14644-2. Airborne particle concentrations in accordance with FED-STD-209E are included for reference. This simple classification is inadequate to describe a facility that will support the assembly and integration of spacecraft. The extended duration of hardware exposure during fabrication and testing, the sensitivity of the hardware to hydrocarbons and other molecular contaminants, and the changing requirements during assembly and integration must be considered in addition to the airborne particle concentrations.

1.3 The guidelines specified herein are intended to provide facilities that will effectively restrict contaminants from entering the facility, limit contamination generated by and within the facility, and continuously remove airborne contaminants generated during normal operations. Some items of support hardware, such as lifting equipment, stands, and shoe cleaners, are addressed since these items are often purchased and installed with the facility and may require accommodation in the design of the facility.

1.4 Active filtration of molecular contaminants (such as hydrocarbons, silicones, and other chemicals) is discussed. Such active filtration of molecular contaminants may be

required for the processing of highly sensitive optical devices, especially infrared and cryogenic sensors. Control of microbiological contamination is not included although HEPA (High Efficiency Particulate Air) filtration will provide some control of airborne bacteria, spores, and other viable contaminants that are typically carried on particles of sizes 0.3 μm and larger. Control of radioactive contamination and accommodation of very hazardous materials such as propellants, strong acids or caustics, or carcinogens are not addressed.

1.5 No facility will compensate for excessive contamination generated inside the facility. In addition to an effective facility design, the user must also institute a routine maintenance program (see Practice E2042) for the facility, and personnel and operational disciplines that limit the transfer of contaminants through entry doors and contaminant generation inside the facility.

1.6 This practice only addresses guidelines for contamination control in facility design. It must be implemented in compliance with all mandatory government and regulatory building and safety codes. References to related cleanroom standards and U.S. building codes and standards may be found in IEST-RP-CC012.

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

1.7.1 The values given in parentheses are provided for information only and are not considered standard.

1.8 *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.*

1.9 *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.*

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. 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
- E1216 Practice for Sampling for Particulate Contamination by Tape Lift
- E1234 Practice for Handling, Transporting, and Installing Nonvolatile Residue (NVR) Sample Plates Used in Environmentally Controlled Areas for Spacecraft
- E1235 Test Method for Gravimetric Determination of Nonvolatile Residue (NVR) in Environmentally Controlled Areas for Spacecraft
- E1548 Practice for Preparation of Aerospace Contamination Control Plans
- E2042 Practice for Cleaning and Maintaining Controlled Areas and Clean Rooms
- E2088 Practice for Selecting, Preparing, Exposing, and Analyzing Witness Surfaces for Measuring Particle Deposition in Cleanrooms and Associated Controlled Environments
- F24 Test Method for Measuring and Counting Particulate Contamination on Surfaces
- F25 Test Method for Sizing and Counting Airborne Particulate Contamination in Cleanrooms and Other Dust-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

2.2 ISO Standards:³

- 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
- ISO 14644-3 Cleanrooms and Associated Controlled Environments Part 3: Test Methods
- ISO 14644-4 Cleanrooms and Associated Controlled Environments Part 4: Design, Construction and Start-up

2.3 Institute of Environmental Science and Technology Standards:

- IEST-RP-CC001 HEPA and ULPA Filters⁴
- IEST-RP-CC006 Testing Cleanrooms⁴
- IEST-RP-CC007 Testing ULPA Filters⁴
- IEST-RP-CC012 Considerations in Cleanroom Design⁴
- IEST-RP-CC022 Electrostatic Charge in Cleanrooms and Other Controlled Environments⁴
- IEST-RP-CC034 HEPA and ULPA Filter Leak Tests⁴

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

³ Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, <http://www.iso.org>.

⁴ 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>.

IEST-STD-CC1246 Product Cleanliness Levels and Contamination Control Program⁵

2.4 U.S Government Standards:⁶

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

2.5 Other Publications:⁷

- Procedural Standards for Certified Testing of Cleanrooms, National Environmental Balancing Bureau (NEBB)

3. Terminology

3.1 Definitions:

3.1.1 *aerosol*, *n*—a gaseous suspension of fine solid or liquid particles.

3.1.2 *airfilters*:

3.1.2.1 *HEPA (High Efficiency Particulate Air) filter*, *n*—a particulate air filter having a minimum particle collection efficiency of 99.97 % of particles greater than 0.3 µm in accordance with IEST-RP-CC001.

3.1.2.2 *ULPA (Ultra Low Penetration Air) filter*, *n*—a particulate air filter having a minimum particle collection efficiency of 99.999 % of particles of sizes equal to and larger than 0.12 µm.

3.1.2.3 *prefilters*, *n*—air filters that are installed upstream of the HEPA or ULPA filters.

3.1.2.4 *Discussion*—These usually consist of rough filters and medium efficiency filters that remove larger particles than are removed by the HEPA and ULPA filters; They are used to reduce the number of particles trapped on the high efficiency filters, thereby extending the lifetimes of the HEPA and ULPA filters.

3.1.3 *airflow*:

3.1.3.1 *unidirectional airflow*, *n*—controlled airflow through the entire cross-section of a cleanroom or clean zone with a steady velocity and approximately equal streamlines.

3.1.3.2 *Discussion*—The airflow in a cleanroom may be either vertical down-flow or horizontal with air leaving the room either through nearly continuous floor or wall vents. Equipment and personnel in the room will cause air turbulence, but the airflow is still considered unidirectional.

3.1.3.3 *nonunidirectional airflow*, *n*—air distribution where the supply air entering the cleanroom or clean zone mixes with the internal air by means of induction.

3.1.3.4 *Discussion*—Air typically enters through registers distributed around the room above the working area and exits through registers at floor level.

3.1.3.5 *mixed airflow*, *n*—air distribution in a cleanroom or clean zone in which the airflow is a mixture of both unidirectional and nonunidirectional.

⁵ This replaces MIL-STD-1246C which is inactive.

⁶ This standard was cancelled 29 Nov. 2001 and is replaced by ISO 14644-1 and ISO 14644-2. Copies of FED-STD-209E are available from the Institute of Environmental Sciences and Technology, 940 East Northwest Highway, Mount Prospect, IL 60036, and from U.S. government sources.

⁷ National Environmental Balancing Bureau, 8575 Grovemont Circle, Gaithersburg, MD 20877-4121. <http://www.nebb.org/contact/>.