

INSTITUTE OF ENVIRONMENTAL SCIENCES AND TECHNOLOGY

Contamination Control Division Recommended Practice 006.3

IEST-RP-CC006.3

Testing Cleanrooms

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CONTENTS

SECTION

1	SCOPE AND LIMITATIONS	7
2	REFERENCES	7
3	TERMS AND DEFINITIONS	8
4	BACKGROUND AND PURPOSE	9
5	CHOICE OF TESTS FOR CERTIFICATION	9
6	TESTING PROCEDURES.....	11

TABLE

1	INDEX OF TESTS BY CLEANROOM (OR CLEAN ZONE) AIRFLOW TYPE	10
B1	VALUES OF K FOR VARIOUS DEGREES OF CONFIDENCE	23
C1	SUGGESTED GRIDS FOR DIAGNOSTIC AIRBORNE PARTICLE COUNTING	25

APPENDIX

A	METHOD FOR THE USE OF K_v FACTORS FOR AIRFLOW MEASUREMENT.....	21
B	A STATISTICAL METHOD FOR DETERMINING THE UNIFORMITY OF VELOCITY, TEMPERATURE, AND HUMIDITY	23
C	DIAGNOSTIC AIRBORNE PARTICLE COUNTING.....	25
D	BIBLIOGRAPHY	26

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1 SCOPE AND LIMITATIONS

1.1 Scope

This Recommended Practice (RP) covers testing methods for characterizing the performance of cleanrooms. It is intended to assist planners, designers, manufacturers, and customers in preparing detailed specifications for cleanroom procurement and for assuring cleanroom operational compliance. Performance tests are recommended for cleanrooms and clean zones in three operational phases (see Table 1). The tests are used to evaluate and characterize the overall performance of the cleanroom or clean zone system.

The test methods provide recommended test equipment and testing procedures for determining performance parameters. Where the test method is affected by the type of cleanroom, alternative procedures are defined. For some of the tests, alternative methods and instrumentation are described, so that different end-use considerations can be accommodated. Alternative methods are not necessarily equivalent, however.

In contractual agreements, the customer selects the specific tests appropriate to the cleanroom under consideration. Specific acceptance limits are also defined in contractual agreements.

The test methods may also be used or adapted for periodic monitoring of cleanroom or clean zone performance.

1.2 Limitations

This Recommended Practice does not recommend acceptance limits, but it does provide standard terminology for specifying appropriate limits. This RP does not cover all of the tests that may be used to characterize the operating parameters of cleanrooms, such as, but not limited to, particle deposition rates, airborne molecular deposition rates, microorganisms, and electrostatic discharge (ESD); refer to appropriate RPs in the *IEST Handbook of Recommended Practices* for details on the parameters of interest.

NOTE: Testing in accordance with this Recommended Practice may involve hazardous materials, operations, and equipment. This RP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use of this RP.

2 REFERENCES

The following documents are incorporated into this Recommended Practice to the extent specified herein. Users should apply the most recent editions of the references.

2.1 American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)

ASHRAE Handbook - Fundamentals

2.2 ASTM International

ASTM F50: Standard 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

2.3 Institute of Environmental Sciences and Technology (IEST)

IEST-RP-CC007: Testing ULPA Filters

IEST-RP-CC012: Considerations in Cleanroom Design

IEST-RP-CC024: Measuring and Reporting Vibration in Microelectronics Facilities

IEST-RP-CC034: HEPA and ULPA Filter Leak Tests

2.4 International Organization for Standardization (ISO)

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

NOTE: *ISO 14644-1* and *ISO 14644-2* supersede *Federal Standard 209, Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones*, but *FED-STD-209* may be in use if specified by active contractual obligation.

2.5 Sources and addresses

ASHRAE

American Society of Heating, Refrigerating, and Air-Conditioning Engineers
1791 Tullie Circle, N.E.
Atlanta, Georgia 30329, USA
www.ashrae.org

ASTM

ASTM International
100 Barr Harbor Drive
West Conshohocken, Pennsylvania 19428-2959, USA
www.astm.org

IEST

Institute of Environmental Sciences and Technology
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Schaumburg, IL 60173 USA
www.iest.org

ISO

U.S. Member Body for document orders:

IEST

1827 Walden Office Square, Suite 400 | Schaumburg, IL 60173 USA

www.iest.org

Outside the United States: Documents available from representative ISO member body organization

Federal Standards

Federal Supply Service Bureau
Specification Section, Suite 8100
470 East L'Enfant Plaza, S.W.
Washington, D.C. 20407, USA
www.gsa.gov

3 TERMS AND DEFINITIONS

The following terms have special meaning in the context of this Recommended Practice.

as-built cleanroom

A cleanroom that is complete and ready for operation, with all services connected and functional, but without equipment or operating personnel.

at-rest cleanroom

A cleanroom that is complete, with all services functioning and with equipment installed and operable or operating, as specified, but without operating personnel.

calibrated equipment

Test equipment that has been calibrated in accordance with the equipment manufacturer's recommendations or accepted industry practices.

cleanroom

A room in which the air supply, air distribution, filtration of air supply, materials of construction, pressure gradients, and operating procedures are regulated to control airborne particle concentrations to meet established air cleanliness levels, as defined by *ISO 14644-1*.*

clean zone

A defined space in which the concentration of airborne particles is controlled to a specified airborne particulate cleanliness class, as defined by *ISO 14644-1*.*

discrete-particle counter (DPC)

A light-scattering instrument or other instrument with display or recording means to count and size discrete particles in air, as defined by *ASTM F50*.

HEPA (high efficiency particulate air) filter

An extended-medium, dry-type filter in a rigid frame, having minimum particle-collection efficiency of

* If applicable, *FED-STD-209*

99.97% (i.e., a maximum particle penetration of 0.03%) for 0.3- μm particles of specified aerosol.

nonunidirectional airflow cleanroom

A cleanroom in which the filtered air entering the room or passing through the work zone is characterized by nonuniform velocity or turbulent flow.

Such rooms exhibit nonuniform, random airflow patterns throughout the enclosure.

operational cleanroom

A cleanroom in normal operation, with all services functioning and with equipment and personnel, if applicable, present and performing their normal work functions.

temperature control zone

A cleanroom, or portion thereof, in which temperature is uniquely controlled.

ULPA (ultra-low penetration air) filter

An extended-medium, dry-type filter in a rigid frame, having a minimum particle-collection efficiency of 99.999% for particles in the size range of 0.1 μm to 0.2 μm when tested in accordance with the methods of *IEST-RP-CC007*.

unidirectional airflow

Airflow with a demonstrated deviation of not more than 14 degrees from straight line flow through the work zone.

unidirectional airflow cleanroom (formerly referred to as laminar airflow cleanroom)

A cleanroom in which the filtered air entering the room makes a single pass through the work area in a parallel-flow pattern, with a minimum of turbulent-flow areas.

Unidirectional airflow rooms typically have coverage of 80% or more of the area of the ceiling (for vertical flow) or one wall (for horizontal flow) with the HEPA or ULPA filter medium or free-flow area.

uniform airflow

A unidirectional airflow pattern in which the point-to-point readings are within a relative standard deviation of 15% of the average airflow velocity for the total area of the unidirectional flow work zone.

work zone

The volume within the cleanroom that is designated for clean work and for which testing is required.

The work zone volume is defined by an entrance plane and an exit plane normal to the airflow (where there is unidirectional airflow).

4 BACKGROUND AND PURPOSE

This Recommended Practice provides a set of recognized, standardized test procedures for determining cleanroom and clean zone performance.

The principal purpose of cleanroom and clean zone performance testing is characterization of airborne particulate cleanliness in accordance with *ISO 14644-1*.^{*} Additional tests, such as those related to airflow characteristics, sources of particles, room pressurization, and environmental issues, provide a more complete characterization.

Data gathered through testing can be used to establish baselines, track trends, determine current operational status, and justify repairs or modification.

5 CHOICE OF TESTS FOR CERTIFICATION

The detailed test procedures provided in section 6 may be used for demonstrating compliance with user-specified cleanroom or clean zone performance criteria and for performing periodic retesting. These tests may not be all-inclusive, nor may all of the tests be required for any given certification project. Selected tests can also be repeated on a regular basis as part of a routine facility monitoring program.

The choice of tests may be based in part on factors such as the design of the cleanroom or clean zone, its operational status, and the required level of air cleanliness. These factors are further classified in the paragraphs that follow. Table 1 lists tests appropriate to certification of cleanrooms and clean zones of two principal design types in three phases of operation.

NOTE: Some testing applications may require the customer or supplier to specify the use of procedures from national agency documentation, such as the examples listed in Appendix D, Bibliography.

5.1 Cleanroom (or clean zone) design types

Two distinct types of design are included:

- a) Unidirectional airflow
- b) Nonunidirectional airflow

The choice of tests and test methods may be affected by the type of design used in the cleanroom or clean zone to be tested (see Table 1).

^{*} If applicable, *FED-STD-209*