

INTERNATIONAL STANDARD

ISO
14644-3

First edition
2005-12-15

Cleanrooms and associated controlled environments —

Part 3: Test methods

Salles propres et environnements maîtrisés apparentés —

Partie 3: Méthodes d'essai



Reference number
ISO 14644-3:2005(E)

© ISO 2005

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

© ISO 2005

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
3.1 General.....	2
3.2 Airborne particle measurement.....	2
3.3 Air filters and systems	4
3.4 Airflow and other physical states	5
3.5 Electrostatic measurement.....	5
3.6 Measuring apparatus and measuring conditions.....	6
3.7 Occupancy states	7
4 Test procedures	8
4.1 Cleanroom tests	8
4.2 Principle	9
5 Test reports	11
Annex A (informative) Choice of recommended tests of an installation and the sequence in which to carry them out	12
Annex B (informative) Test methods	16
Annex C (informative) Test apparatus	51
Bibliography	64

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 14644-3 was prepared by Technical Committee ISO/TC 209, *Cleanrooms and associated controlled environments*.

ISO 14644 consists of the following parts, under the general title *Cleanrooms and associated controlled environments*:

- *Part 1: Classification of air cleanliness*
- *Part 2: Specifications for testing and monitoring to prove continued compliance with ISO 14644-1*
- *Part 3: Test methods*
- *Part 4: Design, construction and start-up*
- *Part 5: Operations*
- *Part 7: Separative devices (clean air hoods, gloveboxes, isolators and mini-environments)*
- *Part 8: Classification of airborne molecular contamination*

The following part is under preparation:

- *Part 6: Vocabulary*

Introduction

Cleanrooms and associated controlled environments provide for the control of airborne contamination to levels appropriate for accomplishing contamination-sensitive activities. Products and processes that benefit from the control of airborne contamination include those in such industries as aerospace, microelectronics, pharmaceuticals, medical devices, healthcare and food.

This part of ISO 14644 sets out test methods that may be used for the purpose of characterizing a cleanroom as described and specified in other parts of ISO 14644.

NOTE Not all cleanroom parameter test procedures are shown in this part of ISO 14644. The procedures and apparatus to characterize other parameters, of concern in cleanrooms and clean zones used for specific products or processes, are discussed elsewhere in other documents prepared by ISO/TC 209 [for example, procedures for control and measurement of viable materials (ISO 14698), testing cleanroom functionality (ISO 14644-4), and testing of separative devices (ISO 14644-7)]. In addition, other standards can be considered to be applicable.

Statements in this part of ISO 14644 reference the standards of ASTM, CEN, DIN, IEST, JACA, JIS and SEMI.

Cleanrooms and associated controlled environments —

Part 3: Test methods

WARNING — The use of this part of ISO 14644 may involve hazardous materials, operations and equipment. This part of ISO 14644 does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this part of ISO 14644 to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

1 Scope

This part of ISO 14644 specifies test methods for designated classification of airborne particulate cleanliness and for characterizing the performance of cleanrooms and clean zones. Performance tests are specified for two types of cleanrooms and clean zones: those with unidirectional flow and those with non-unidirectional flow, in three possible occupancy states: as-built, at-rest and operational. The test methods recommend test apparatus and test procedures for determining performance parameters. Where the test method is affected by the type of cleanroom or clean zone, alternative procedures are suggested. For some of the tests, several different methods and apparatus are recommended to accommodate different end-use considerations. Alternative methods not included in this part of ISO 14644 may be used if based on agreement between customer and supplier. Alternative methods do not necessarily provide equivalent measurements.

This part of ISO 14644 is not applicable to the measurement of products or of processes in cleanrooms or separative devices.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7726:1998, *Ergonomics of the thermal environment — Instruments for measuring physical quantities*

ISO 14644-1:1999, *Cleanrooms and associated controlled environments — Part 1: Classification of air cleanliness*

ISO 14644-2:2000, *Cleanrooms and associated controlled environments — Part 2: Specifications for testing and monitoring to prove continued compliance with ISO 14644-1*

ISO 14644-4:2001, *Cleanrooms and associated controlled environments — Part 4: Design, construction and start-up*

ISO 14644-3:2005(E)**3 Terms and definitions**

For the purposes of this document, the following terms and definitions apply.

3.1 General**3.1.1****cleanroom**

room in which the concentration of airborne particles is controlled, and which is constructed and used in a manner to minimize the introduction, generation and retention of particles inside the room, and in which other relevant parameters, e.g. temperature, humidity and pressure, are controlled as necessary

[ISO 14644-1:1999, 2.1.1]

3.1.2**clean zone**

dedicated space in which the concentration of airborne particles is controlled, and which is constructed and used in a manner to minimize the introduction, generation and retention of particles inside the zone, and in which other relevant parameters, e.g. temperature, humidity and pressure, are controlled as necessary

NOTE This zone may be open or enclosed, and may or may not be located within a cleanroom.

[ISO 14644-1:1999, 2.1.2]

3.1.3**installation**

cleanroom or one or more clean zones, together with all associated structures, air-treatment systems, services, and utilities

[ISO 14644-1:1999, 2.1.3]

3.1.4**separative device**

equipment utilizing constructional and dynamic means to create assured levels of separation between the inside and outside of a defined volume

NOTE Some industry-specific examples of separative devices are clean air hoods, containment enclosures, glove boxes, isolators and mini-environments.

3.2 Airborne particle measurement**3.2.1****aerosol generator**

instrument capable of generating particulate matter having appropriate size range (e.g. 0,05 µm to 2 µm) at a constant concentration, which may be produced by thermal, hydraulic, pneumatic, acoustic or electrostatic means

3.2.2**airborne particle**

solid or liquid object suspended in air, viable or non-viable, sized (for the purpose of this part of ISO 14644) between 1 nm and 100 µm

NOTE For classification purposes, refer to ISO 14644-1:1999, 2.2.1.

3.2.3**count median particle diameter****CMD**

median particle diameter based on the number of particles

NOTE For the count median, one half of the particle number is contributed by the particles with a size smaller than the count median size, and one half by particles larger than the count median size.

3.2.4

macroparticle

particle with an equivalent diameter greater than 5 µm

[ISO 14644-1:1999, 2.2.6]

3.2.5

M descriptor

measured or specified concentration of macroparticles per cubic metre of air, expressed in terms of the equivalent diameter that is characteristic of the measurement method used

NOTE The M descriptor may be regarded as an upper limit for the averages at sampling locations (or as an upper confidence limit, depending upon the number of sampling locations used to characterize the cleanroom or clean zone). M descriptors cannot be used to define airborne particulate cleanliness classes, but they may be quoted independently or in conjunction with airborne particulate cleanliness classes.

[ISO 14644-1:1999, 2.3.2]

3.2.6

mass median particle diameter

MMD

median particle diameter based on the particle mass

NOTE For the mass median, one half of mass of all particles is contributed by particles with a size smaller than the mass median size, and one half by particles larger than the mass median size.

3.2.7

particle concentration

number of individual particles per unit volume of air

[ISO 14644-1:1999, 2.2.3]

3.2.8

particle size

diameter of a sphere that produces a response, by a given particle-sizing instrument, that is equivalent to the response produced by the particle being measured

NOTE For discrete-particle-counting, light-scattering instruments, the equivalent optical diameter is used.

[ISO 14644-1:1999, 2.2.2]

3.2.9

particle size distribution

cumulative distribution of particle concentration as a function of particle size

[ISO 14644-1:1999, 2.2.4]

3.2.10

test aerosol

gaseous suspension of solid and/or liquid particles with known and controlled size distribution and concentration

3.2.11

U descriptor

measured or specified concentration in particles per cubic metre of air, including the ultrafine particles

NOTE The U descriptor may be regarded as an upper limit for the averages at sampling locations (or as an upper confidence limit, depending upon the number of sampling locations used to characterize the cleanroom or clean zone). U descriptors cannot be used to define airborne particulate cleanliness classes, but they may be quoted independently or in conjunction with airborne particulate cleanliness classes.

[ISO 14644-1:1999, 2.3.1]

ISO 14644-3:2005(E)

3.2.12

ultrafine particle

particle with an equivalent diameter less than 0,1 µm

[ISO 14644-1:1999, 2.2.5]

3.3 Air filters and systems

3.3.1

aerosol challenge

challenging of a filter or an installed filter system by test aerosol

3.3.2

designated leak

maximum allowable penetration, which is determined by agreement between customer and supplier, through a leak, detectable during scanning of an installation with discrete-particle counters or aerosol photometers

3.3.3

dilution system

system wherein aerosol is mixed with particle-free dilution air in a known volumetric ratio to reduce concentration

3.3.4

filter system

system composed of filter, frame and other support system or other housing

3.3.5

final filter

filters in a final position before the air enters the cleanroom

3.3.6

installed filter system

filter system mounted in the ceiling, wall, apparatus or duct

3.3.7

installed filter system leakage test

test performed to confirm that the filters are properly installed by verifying that there is absence of bypass leakage in the installation, and that the filters and the grid system are free of defects and leaks

3.3.8

leak

⟨of air filter system⟩ penetration of contaminants that exceed an expected value of downstream concentration through lack of integrity or defects

3.3.9

scanning

method for disclosing leaks in filters and parts of units, whereby the probe inlet of an aerosol photometer or discrete-particle counter is moved in overlapping strokes across the defined test area

3.3.10

standard leak penetration

leak penetration detected by a discrete-particle counter or aerosol photometer with a standard sample flow-rate when the sampling probe is stationary in front of the leak

NOTE Penetration is the ratio of the particle concentration downstream of the filter to the concentration upstream.

3.4 Airflow and other physical states

3.4.1

air exchange rate

rate of air exchange expressed as number of air changes per unit of time and calculated by dividing the volume of air delivered in the unit of time by the volume of the space

3.4.2

average airflow rate

averaged volume of air per unit of time, to determine the air exchange rate in a cleanroom or clean zone

NOTE Airflow rate is expressed in cubic metres per hour (m³/h).

3.4.3

measuring plane

cross-sectional area for testing or measuring a performance parameter such as the airflow velocity

3.4.4

non-unidirectional airflow

air distribution where the supply air entering the clean zone mixes with the internal air by means of induction

[ISO 14644-4:2001, 3.6]

3.4.5

supply airflow rate

air volume supplied into an installation from final filters or air ducts in unit of time

3.4.6

total airflow rate

air volume that passes through a section of an installation in unit of time

3.4.7

unidirectional airflow

controlled airflow through the entire cross-section of a clean zone with a steady velocity and approximately parallel streamlines

NOTE This type of airflow results in a directed transport of particles from the clean zone.

[ISO 14644-4:2001, 3.11]

3.4.8

uniformity of airflow

unidirectional airflow pattern in which the point-to-point readings of velocities are within a defined percentage of the average airflow velocity

3.5 Electrostatic measurement

3.5.1

discharge time

time required to reduce the voltage to the level, positive or negative, to which an isolated conductive monitoring plate was originally charged

3.5.2

offset voltage

voltage that will accumulate upon an initially uncharged isolated conductive plate when that plate is exposed to an ionized air environment