INTERNATIONAL STANDARD

ISO 14644-10

Second edition
2022-05

Cleanrooms and associated controlled environments —

Part 10: Assessment of surface cleanliness for chemical contamination

Salles propres et environnements maîtrisés apparentés —

Partie 10: Évaluation de la propreté chimique des surfaces

Reference number
ISO 14644-10:2022(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 209, *Cleanrooms and associated controlled environments*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 243, *Cleanroom technology*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 14644-10:2013), of which it constitutes a minor revision. The changes are as follows:

— the term class (classification, classified) changed to grade or assessment where appropriate;

— ISO 14644-1 moved from Clause 2 to the Bibliography and ISO 14644-6 removed (document withdrawn);

— minor editorial changes.

A list of all parts in the ISO 14644 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Cleanrooms and associated controlled environments —

Part 10: Assessment of surface cleanliness for chemical contamination

1 Scope

This document establishes appropriate testing processes to determine the cleanliness of surfaces in cleanrooms with regard to the presence of chemical compounds or elements (including molecules, ions, atoms and particles). This document is applicable to all solid surfaces in cleanrooms and associated controlled environments such as walls, ceilings, floors, worksurfaces, tools, equipment and devices.

NOTE 1 For the purpose of this document, consideration is only given to the chemical characteristics of a particle. The physical properties of the particle are not considered and this document does not cover the interaction between the contamination and the surface.

NOTE 2 This document does not include the contamination generation process or any time-dependent influences (e.g. deposition, sedimentation, ageing) or process-dependent activities such as transportation and handling. Neither does it include guidance on statistical quality-control techniques to ensure compliance.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
air cleanliness by chemical concentration
ACC
level, expressed as an ISO grade level *N*, which represents the maximum allowable concentration of a given chemical species or group of chemical species, expressed in grams per cubic metre (g/m^3)

Note 1 to entry: This definition does not include macromolecules of biological origin, which are judged to be particles.

3.2
contaminant category
common name for a group of compounds with a specific and similar deleterious effect when deposited on the surface of interest

3.3
chemical contamination
chemical (non-particulate) substances that can have a deleterious effect on the product, process or equipment

3.4
solid surface
boundary between the solid phase and a second phase

3.5
surface
boundary between two phases

Note 1 to entry: One of the phases is normally a solid phase and the other a gas, a liquid or another solid.

3.6
surface cleanliness by chemical concentration
SCC
<condition> condition of a surface with respect to its chemical concentration

3.7
surface cleanliness by chemical concentration
N_{SCC}
<mathematics> common logarithm (to the base of 10) of the chemical concentration on a surface in grams per square metre (g/m^2)

4 Testing and grading surface chemical levels

4.1 Principles for testing the surface chemical contamination levels of clean surfaces in cleanrooms and controlled environments

The testing and grading levels shall be determined by the use of a descriptor designated "ISO-SCC". This is used to indicate the amount of total chemical concentration measured on a surface for an individual chemical substance or group of substances. The SCC level is based upon the concentration of chemicals on a surface as calculated using Formula (1) (given in 4.2) and expressed in g/m^2. For this calculation all other units shall be converted to g/m^2. In specific cases where low concentrations need to be determined, the concentration level of chemical on a surface may be expressed in atoms per square centimetre, ISO-$SCC_{\_atomic}$, using Formula (2) in 4.4.

4.2 ISO SCC descriptor format

The SCC level shall be designated by a grading number N_{SCC}, where N_{SCC} is the common logarithm index of concentration C_{SCC}, expressed in g/m^2. The SCC grade level statement shall always be connected with a chemical substance or group of substances to which it is related. Thirteen distinct grading levels are used from 0 to −12, where level 0 is most contaminated. Intermediate concentrations may be specified, with 0,1 being the smallest permitted increment of N_{SCC}. C_{SCC} is determined from Formula (1), in terms of N_{SCC}:

$$C_{SCC} = 10^{N_{SCC}} \quad (1)$$

Therefore, $N_{SCC} = \log_{10} C_{SCC}$.

C_{SCC}, the concentration of the specified chemical substance or group of substances, is expressed in g/m^2. The measured chemical concentration on a surface shall not exceed the level of SCC, C_{SCC} to satisfy the predetermined SCC that is agreed between the customer and the supplier.

In all cases, N_{SCC} grade level numbers shall include the negative sign.

NOTE 1 An SCC grade level number is only valid in connection with a descriptor (see 4.3).

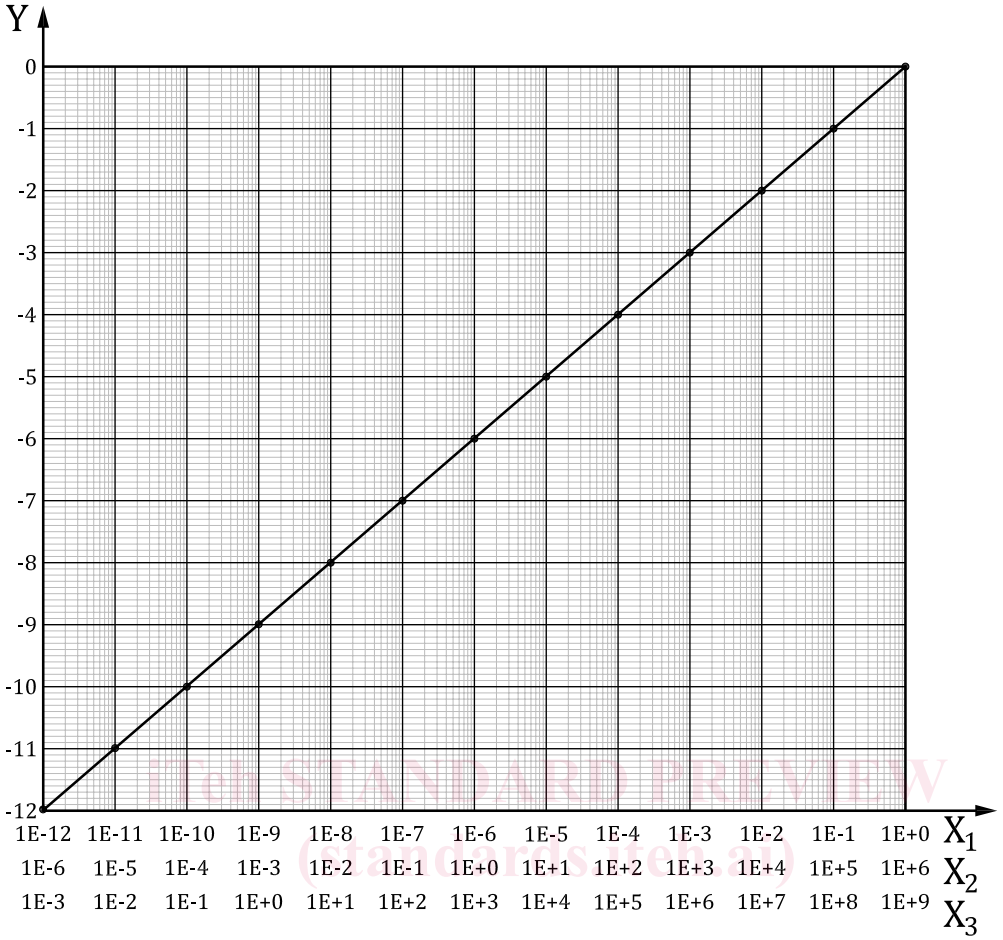
NOTE 2 For converting from gravimetric concentration (g/m^2) to numeric concentration (number of atoms, molecules or ions per unit area), see 4.4.

Table 1 and Figure 1 further illustrate the ISO-SCC designation as a function of chemical concentration on a surface.

Note also the parameters listed in Annex B that influence measured chemical levels.

Table 1 — ISO-SCC grading levels

ISO-SCC level	Concentration g/m^2	Concentration $\mu g/m^2$	Concentration ng/m^2
0	10^0	10^6	10^9
−1	10^{-1}	10^5	10^8
−2	10^{-2}	10^4	10^7
−3	10^{-3}	10^3	10^6
−4	10^{-4}	10^2	10^5
−5	10^{-5}	10^1	10^4
−6	10^{-6}	10^0	10^3
−7	10^{-7}	10^{-1}	10^2
−8	10^{-8}	10^{-2}	10^1
−9	10^{-9}	10^{-3}	10^0
−10	10^{-10}	10^{-4}	10^{-1}
−11	10^{-11}	10^{-5}	10^{-2}
−12	10^{-12}	10^{-6}	10^{-3}



Key

X_1 surface mass concentration (g/m^2)

X_2 surface mass concentration (µg/m^2)

X_3 surface mass concentration (ng/m^2)

Y ISO-SCC grade level

Figure 1 — ISO-SCC grade levels as a function of concentration

4.3 ISO-SCC grade level

An SCC grade level is only valid in connection with a descriptor that includes the chemical substance or group of substances for which this level number is valid. The ISO-SCC descriptor is expressed in the format ISO-SCC Level *N* (*X*), where *X* is a chemical substance or group of chemical substances.

EXAMPLE 1 With an N-Methyl-2-pyrrolidone (NMP) sample, the measured value of chemical contamination on a surface was 9,8E-7 g/m^2. This is within the grade level limit of 1E-6 g/m^2 for Level −6. The designation would be: "ISO-SCC Level −6 (NMP)."

EXAMPLE 2 With an organic compound sample, the measured value was 6E-5 g/m^2 of total organic compounds (TOC). This is within the grade level limit of 1E-4 g/m^2 for Level −4. The designation would be: "ISO-SCC Level −4 (TOC)."

4.4 Converter for substances into surface atomic concentration

Very low concentrations are usually measured in surface number concentrations in the units of number of molecules, atoms or ions per surface area (1/m^2). For grade level determination purposes, these

should be converted into surface mass concentrations in the unit mass per surface area (g/m^2). This conversion is made using Formula (2):

$$C_{SCC} = \frac{M(C_{SCC\_number})}{N_a} \quad (2)$$

where

C_{SCC_number} is the surface number concentration = number of molecules, atoms or ions per surface area (1/m^2);

C_{SCC} is the surface mass concentration (g/m^2);

N_a is Avogadro's number (6,02 × 10^{23}/mol);

M is the molar mass of atomic, molecular or ionic species (g/mol).

For information purposes, Figure A.4 in Annex A illustrates the relationship between chemical concentration on a surface (expressed in g/m^2) and the atomic concentration on a surface (expressed in atoms/m^2) for typical substances.

5 Measuring the cleanliness of surfaces for chemical contamination and demonstration of grade level compliance

5.1 Criteria for good cleanliness assessment

Figure D.2 in Annex D illustrates how to measure different types of contamination, showing differing sampling and measuring methods.

Tests performed to demonstrate compliance shall be conducted in a laboratory environment where the airborne chemical contaminant and the airborne particle contaminant levels do not negatively influence the grade determination. Suitable measurement methods and calibrated instruments shall be used for all tests. The environment, measurement methods and instruments shall be agreed upon between customer and supplier.

Additional test essentials are discussed in Annex C, while Annex D details measurement methods for demonstrating compliance.

The list of typical measurement methods is not exhaustive. Alternative methods that produce results with comparable accuracy may be specified by agreement between customer and supplier.

Measurement by different methods, even when those methods are correctly applied, may produce different results of equal validity.

Repeated measurements are recommended as part of the statistical approach.

Specific problems, such as concentration spikes, may occur when measuring high levels of cleanliness. Special quality-control techniques will then be required, as explained in Figure D.4 in Annex D.

Precautions should be taken to reduce electrostatic charge around the test zone, as electrostatic charge enhances chemical deposition onto surfaces. If the surface is neither conductive nor grounded or charge-neutralized, electrostatic charges can occur. Therefore, test results can vary.

For typical methods of measurement for testing surface cleanliness by chemical concentration, refer to Annex D.

5.2 Documentation and reporting

5.2.1 Principle

Compliance with surface cleanliness chemical concentration (SCC) grade level requirement, as specified by the customer, is verified by performing measurements and by providing documentation of the results and conditions of measurement. Details for demonstrating compliance shall be agreed upon between customer and supplier in advance.

5.2.2 Testing

Tests performed to demonstrate compliance shall be conducted using suitable measurement methods together with calibrated instruments whenever possible.

Measurement methods for demonstrating compliance are described in Annex D. The list of typical methods described is not exhaustive. The testing environment shall be agreed between customer and supplier. Alternative methods of comparable accuracy also may be specified by agreement between customer and supplier.

Measurement by different methods, even when correctly applied, may produce different results of equal validity.

Repeated measurements are recommended.

The testing environment should be agreed between customer and supplier.

5.2.3 Test report

The results from testing each surface shall be recorded and submitted as a comprehensive report, together with a statement of compliance or non-compliance to the required SCC grade level. The test report shall include as a minimum the following:

a) name and address of the testing organization;

b) name of the person performing the test;

c) measurement environment;

d) date, time and duration of sampling;

e) time of measurement;

f) a reference to this document, i.e. ISO 14644-10:2022;

g) clear identification of the location of the surface measured and specific designations for coordinates of the surface, if applicable;

h) surface cleanliness by chemical concentration level with designation expressed as SCC grade level *N*;

i) acceptance criteria for the clean surface if agreed between customer and supplier;

j) specified measurement method(s), equipment resolution and detection limits;

k) details of the test procedure used, with any available data describing deviations from the test procedure (if agreed);

l) identification of the instrument(s) used and current calibration certificate(s);

m) number of measurements performed;

n) test results, including chemical concentration(s) data for given substances, for all measurements performed;

o) surface condition, i.e. after final cleaning, before or after packaging, with agreement on type and quality of packaging required.

An example of how this test report may be constructed can be found in Annex E. Other variations of the test report which are agreeable to both the customer and supplier may be used.

Annex A
(informative)

Conversion between different unit expressions of surface concentration for chemical substances

A.1 Principle

In addition to the unit of surface mass concentration of g/m^2, there exist several different units to express surface number concentration of an organic compound or a group of organics such as molecules/m^2, based on a number of organic molecules, and atoms C/m^2, based on a number of atoms of carbon composing organic compound(s) under consideration for each contaminant category.

A.2 Examples

For information purposes, Tables A.1 to A.3 illustrate how the different units of surface number concentrations (molecules/m^2 or atoms C/m^2) can be converted into surface mass concentrations in terms of carbon (g C/m^2) or whole compound (g/m^2), respectively, using the examples of heptane, hexadecane and di (2-ethylhexyl) phthalate.

Table A.1 — Illustration of the relationship between unit of surface concentration [g/m^2] and surface number concentration [molecules/m^2, atoms C/m^2] for heptane (C_7H_{16}), CAS No. 142–82–5

	Symbol	Unit	M = 100,2, N_c = 7			
			Example 1	Example 2	Example 3	Example 4
Surface number molecular concentration	$C_{molecule}$	[molecules/m^2]	1,00E+19	1,42E+18	7,16E+16	6,01E+16
Surface number concentration in terms of carbon	C_{carbon_number}	[atoms C/m^2]	7,00E+19	1,00E+19	5,00E+17	4,19E+17
Surface mass concentration in terms of carbon	C_{carbon_mass}	[g C/m^2]	1,39E-3	1,98E-4	1,00E-4	8,39E-6
Surface mass concentration	C_{SCC}	[g/m^2]	1,66E-3	2,36E-4	1,19E-4	1,00E-6