



International  
Standard

**ISO 14644-13**

**Cleanrooms and associated  
controlled environments —**

Part 13:  
**Cleaning of surfaces to achieve  
defined levels of cleanliness in  
terms of particle and chemical  
concentration**

*Salles propres et environnements maîtrisés apparentés —*

*Partie 13: Nettoyage des surfaces afin d'obtenir des niveaux  
de gradation de la propreté par rapport à la concentration  
particulaire et chimique*

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# Contents

	Page
<b>Foreword</b> .....	<b>v</b>
<b>Introduction</b> .....	<b>vi</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>2</b>
<b>3 Terms and definitions</b> .....	<b>2</b>
<b>4 General methodology</b> .....	<b>3</b>
4.1 Overview.....	3
4.2 Methodology.....	4
<b>5 Object description</b> .....	<b>5</b>
<b>6 Cleanliness specifications</b> .....	<b>6</b>
<b>7 Determination of initial contamination level</b> .....	<b>6</b>
7.1 General.....	6
7.2 Determination of initial contamination level with respect to particle concentration.....	6
7.3 Determination of initial contamination level with respect to chemical concentration.....	6
<b>8 Other requirements</b> .....	<b>7</b>
<b>9 Selection of a cleaning methodology</b> .....	<b>7</b>
9.1 Selection procedure.....	7
9.2 Cleaning methodologies.....	7
9.2.1 Cleaning method.....	7
9.2.2 Categories of cleaning techniques.....	7
9.3 Cleaning process.....	8
<b>10 Material compatibility check</b> .....	<b>8</b>
<b>11 Cleaning validation</b> .....	<b>8</b>
11.1 General.....	8
11.2 Cleaning efficiency.....	9
11.2.1 Evaluation.....	9
11.2.2 Cleaning efficiency with respect to particle concentration.....	10
11.2.3 Cleaning efficiency with respect to chemical contamination.....	11
11.3 Cleaning appropriateness.....	11
11.3.1 Assessment.....	11
11.3.2 Cleaning appropriateness with respect to particle concentration.....	12
11.3.3 Cleaning appropriateness with respect to chemical concentration.....	13
<b>12 Measurement methods</b> .....	<b>14</b>
12.1 General.....	14
12.2 Direct measurement methods.....	14
12.2.1 General.....	14
12.2.2 Direct measurement methods with respect to SCP.....	14
12.2.3 Direct measurement methods with respect to SCC.....	14
12.3 Indirect measurement methods.....	14
12.3.1 General.....	14
12.3.2 Indirect measurement methods with respect to SCP.....	15
12.3.3 Indirect measurement methods with respect to SCC.....	15
<b>13 Documentation</b> .....	<b>15</b>
<b>Annex A (informative) Aspects of cleaning</b> .....	<b>17</b>
<b>Annex B (informative) Cleaning methods</b> .....	<b>18</b>
<b>Annex C (informative) Material compatibility with cleaning agents</b> .....	<b>25</b>
<b>Annex D (informative) Cleanliness measurement</b> .....	<b>27</b>

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## 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 document 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](http://www.iso.org/directives)).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at [www.iso.org/patents](http://www.iso.org/patents). ISO shall not be held responsible for identifying any or all such patent rights.

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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](http://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 14644-13:2017), of which it constitutes a minor revision. The changes are as follows:

- term class (classification, classified) changed to levels or assessment where appropriate;
- updated document titles and issue dates where appropriate;
- minor editorial changes;
- removed references not cited in the document.

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](http://www.iso.org/members.html).

## Introduction

The term surface refers to the interface between two phases. For the purpose of this document, the surface is a solid. A “clean surface” is where one or more of the contamination categories (particles, chemical) are under control due to cleaning/decontamination. The degree of cleanliness is specified in the corresponding surface cleanliness levels (see ISO 14644-9 and ISO 14644-10). Different cleaning methods are necessary depending on the degree of cleanliness (cleanliness level) required. This document gives guidance on the selection of cleaning methods to achieve specified cleanliness levels. For the selection procedure, the aspects of surface description, cleanliness specifications, types of contamination, cleaning techniques, material compatibility, and assessment methodology are taken into consideration. Most of the methods are suitable for removal of more than one contamination category at the same time; therefore, a common standard for the selection of a cleaning method for both particles, as well as chemical contamination, is needed.

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# Cleanrooms and associated controlled environments —

## Part 13:

# Cleaning of surfaces to achieve defined levels of cleanliness in terms of particle and chemical concentration

## 1 Scope

This document gives guidelines for cleaning to a specified degree on cleanroom surfaces, surfaces of equipment in a cleanroom and surfaces of materials in a cleanroom. Under consideration are all surfaces (external or internal) that are of interest. It provides guidance on the assessment of cleaning methods for achieving the required surface cleanliness by particle concentration (SCP) and surface cleanliness by chemical concentration (SCC) levels and which techniques should be considered to achieve these specified levels.

The appropriateness of cleaning techniques will make reference to the cleanliness levels and associated test methods found in ISO 14644-9 and ISO 14644-10.

The document gives general guidance on the following:

- expected surface cleanliness levels;
- suitability of cleaning methods;
- compatibility of surfaces with the cleaning technique;
- assessment of cleaning appropriateness.

The following are excluded from this document:

- classification of cleaning methods;
- product produced within a cleanroom;
- specific surface-related cleaning methods;
- detailed description of cleaning mechanisms, methods and procedures of various cleaning methods;
- detailed material characteristics;
- description of damage mechanisms by cleaning processes and time-dependent effects;
- references to interactive bonding forces between contaminants and surfaces or generation processes that are usually time-dependent and process-dependent;
- other characteristics of particles such as electrostatic charge, ionic charges, etc.;
- chemical reactions between molecular contaminants and surfaces;
- microbiological aspects of surface cleanliness;
- radioactive aspects of contamination;
- health and safety considerations;
- environmental aspects such as waste disposal, emissions, etc.;

- selection and use of statistical methods.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 14644-8, *Cleanrooms and associated controlled environments — Part 8: Assessment of air cleanliness by chemical concentration (ACC)*

ISO 14644-9, *Cleanrooms and associated controlled environments — Part 9: Assessment of surface cleanliness for particle concentration*

ISO 14644-10, *Cleanrooms and associated controlled environments — Part 10: Assessment of surface cleanliness for chemical contamination*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14644-9, ISO 14644-10 and the following 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 cleanliness

<of a solid surface> condition of a solid surface where the amount of *contamination* (3.4) (particle, chemical) is controlled to a specific level

### 3.2 cleaning appropriateness

relation between the required *cleanliness* (3.1) and the accomplished cleanliness under controlled conditions

Note 1 to entry: In some languages, the term cleaning efficacy is used to indicate cleaning appropriateness.

Note 2 to entry: In case of real operational conditions or monitoring, the term cleaning effectiveness is used.

### 3.3 cleaning efficiency

fraction of specific contaminants removed from a surface by a cleaning process

Note 1 to entry: The fraction is determined by the accomplished surface cleanliness in respect to the initial surface cleanliness.

### 3.4 contamination

unwanted matter in an undesirable location

### 3.5 particle

minute piece of matter with defined physical boundaries

[SOURCE: ISO 14644-1:2015, 3.2.1]

### 3.6 particle contamination

*particles* (3.5) having the potential to affect the process, the product, the personnel or the facilities

3.7

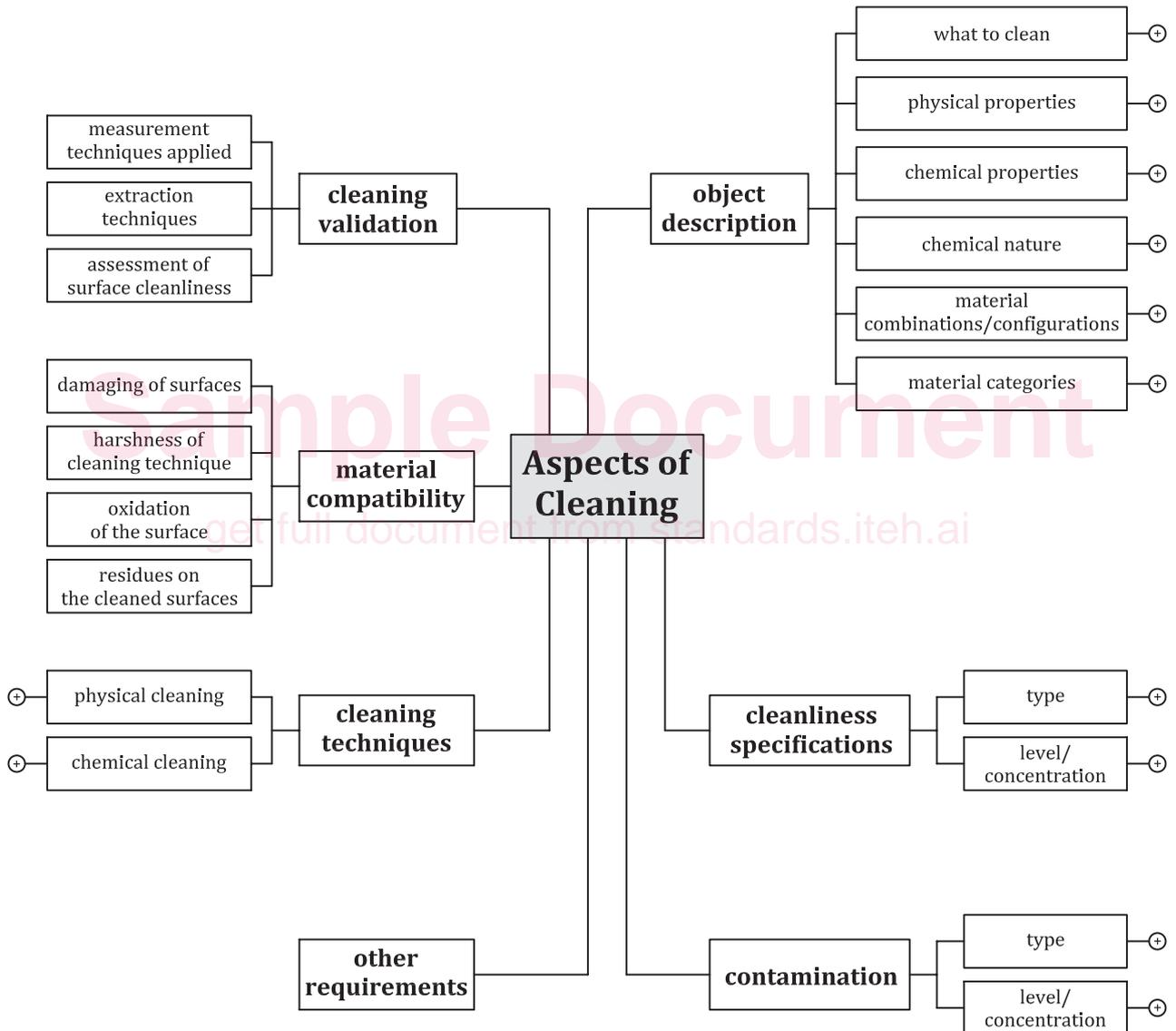
**particle size**

diameter of a sphere that produces a response, by a given particle-sizing instrument, that is equivalent to the response produced by the *particle* (3.5) being measured

**4 General methodology**

**4.1 Overview**

Multiple aspects need to be considered for cleaning. [Figure 1](#) provides an overview of the factors that contribute to the suitability of cleaning methods to achieve a defined level of surface cleanliness. For more details, see [Annex A](#).



**Key**

⊕ more details in [Figure A.1](#)

**Figure 1 — Overview of cleaning aspects (non-exhaustive)**

4.2 Methodology

Appropriateness of a cleaning technique for an application depends on many factors. For complex objects, it is advised to follow the sequence described in this clause and in the decision tree (see Figure 2). By using this procedure, it can be assured that all important issues are covered. For simple objects or surfaces, deviations from the sequence are allowable, as long as the critical information is documented.

The approach starts with describing the object that has to be cleaned. The description should cover, among others, composition of materials, chemical characteristics, surface finish and shape factors like geometrical complexity and size (step 1). In the second step, the objective of the cleaning procedure is to be specified in terms of the desired cleanliness of the object. To have a starting point, the initial contamination level should be assessed (step 3) and other requirements shall be listed (step 4). Based on type of contaminants and the required removal efficiency, a cleaning technique or a combination of techniques can be selected (step 5). The cleaning methodology shall be checked against the materials from the first step in order to avoid material compatibility issues (step 6). At the last step, a validation method shall be carried out (step 7). The validation shall at least comprise methods for determination of the cleaning performance and material compatibility. The performance of the cleaning shall be checked against the specification.

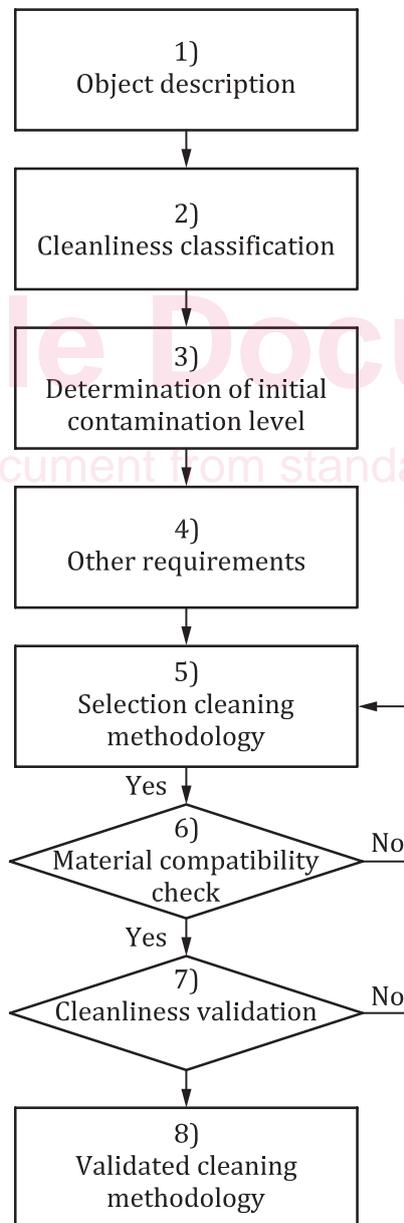


Figure 2 — Decision tree

## 5 Object description

In the object description, the following aspects shall be considered.

a) Physical properties of the object:

- physical dimensions;
- form/shape/complexity of the object;
- critical surfaces.

A general description of the object shall be given. Size, shape, complexity and identification of the critical surfaces set many boundary conditions for a cleaning method.

b) Surface(s):

- material composition of the object surface(s);
- complexity;
- materials/critical materials (sensitive to cleaning agents);
- thin/atomic surface layers (e.g. protective layers);
- other physical properties (e.g. electrostatic).

The composition of the object can be simple (one or more similar material(s)) or a system consisting of a range of different materials (e.g. metal/plastic/glass composition). Each individual material should be taken into account when choosing a cleaning method. Some combinations of materials can be very difficult to clean as one cleaning method may be suitable for one material but not the other. The selection of the cleaning method shall be the best compromise between minimal damage of the materials at maximum cleaning efficiency.

c) Chemical properties of the surface(s):

- chemical composition;
- state of the surface (hydrophobic, hydrophilic, lipophobic, lipophilic, etc.);
- energetic state of the surface (zeta potential).

Physical and chemical properties of a surface have a large influence on the choice of a cleaning method. Choice of a method shall take into account all involved materials/chemical composition of the surface(s) and the combination of materials undergoing cleaning.

The activity of the surface is determined by the chemical configuration of the final atomic layer. This is an important parameter in determining the choice of method. These layers may be hydrophilic (water wettable-lipophobic) or hydrophobic (water repellent but oil-wettable-lipophilic). The cleaning method used can influence the surface activity. The surface activity also influences the electrostatic properties of a material — a hydrophilic surface will have fewer tendencies to electrically charge.

d) Morphology:

Cleaning is influenced by the morphological aspects of a surface such as shape, size, structure, surface roughness or porosity. Morphological aspects may further complicate cleaning due to the accessibility of the surfaces to be cleaned and to the retention of cleaning agents and materials used for cleaning.

e) Object specific requirements:

- intended use of the object;
- environmental conditions, both pre- and post-cleaning;

- critical surfaces, surfaces with either high importance in the application or sensitive to cleaning.

## 6 Cleanliness specifications

The rationale of determining appropriateness of the cleaning method should include the contaminants of concern, as well as acceptable levels of contamination for the application.

The required cleanliness shall be specified in terms of particle concentration according to ISO 14644-9 and/or in terms of the concentration of a specific group of chemicals according to ISO 14644-10.

The specification of the targeted cleanliness level can be determined in various ways:

- cleanliness level required by customer;
- common cleanliness level required for similar objects;
- by performing an analysis on the impact of contamination of the surface in the (future) function of a product or process where the cleaned surface will be used;
- by performing tests or simulations with various cleanliness levels of the considered surface and/or;
- by performing an analysis of the contamination that caused failure or quality loss.

## 7 Determination of initial contamination level

### 7.1 General

To select the cleaning procedure for achieving a required surface cleanliness level, the initial surface cleanliness shall be established. The initial surface cleanliness by chemical and/or particle concentration shall be determined for the surfaces of interest. This can be determined qualitatively or quantitatively.

Qualitative evaluation is a non-numerical assessment (e.g. a visual inspection).

Where the quantitative surface cleanliness is determined, it can be related to the efficiency of the cleaning procedure in respect to the required surface cleanliness by particle concentration and/or chemical concentration. The quantified contamination (particle and/or chemical) shall be related to the area of the representative surface. This evaluation allows determination of the initial cleanliness level.

### 7.2 Determination of initial contamination level with respect to particle concentration

The initial surface cleanliness by particle concentration shall be determined for the different surfaces. Depending on the required cleanliness level, a qualitative assessment of the initial cleanliness level may be sufficient. For quantitative assessment, the number and size of particles shall be characterized by a measurement method as described in [Clause 12](#). The surface cleanliness grading level as outlined in ISO 14644-9 shall be applied.

The quantified particle concentration shall be related to the area of the representative surface. This evaluation allows determination of the initial cleanliness level.

### 7.3 Determination of initial contamination level with respect to chemical concentration

The initial surface cleanliness by chemical concentration shall be determined for the different surfaces. Depending on the specific application, a qualitative assessment (e.g. water break test) of the initial cleanliness level might be sufficient. For quantitative assessment of the mass and nature of the chemical contaminants, a measurement technique according to [Clause 12](#) and ISO 14644-10 shall be applicable.

The quantified chemical contamination shall be related to the area of the representative surface. This evaluation allows determination of the initial cleanliness level.