



SLOVENSKI STANDARD
SIST ISO 22441:2024

01-junij-2024

Sterilizacija izdelkov za zdravstveno oskrbo - Sterilizatorji s paro z nizko temperaturo in z vodikovim peroksidom - Zahteve za razvoj, validacijo in rutinsko kontrolo sterilizacijskih postopkov za medicinske pripomočke (ISO 22441:2022)

Sterilization of health care products - Low temperature vaporized hydrogen peroxide -- Requirements for the development, validation and routine control of a sterilization process for medical devices (ISO 22441:2022)

iTeh Standards

(<https://standards.iteh.ai>)

Stérilisation des produits de santé -- Vapeur de peroxyde d'hydrogène à basse température -- Exigences pour la mise au point, la validation et le contrôle de routine d'un procédé de stérilisation pour dispositifs médicaux (ISO 22441:2022)

[SIST ISO 22441:2024](https://standards.iteh.ai)

<https://standards.iteh.ai> Ta slovenski standard je istoveten z: [7ba13-e8db6488602a/sist-iso-22441-2024](https://standards.iteh.ai) **ISO 22441:2022**

ICS:

11.080.01 Sterilizacija in dezinfekcija na splošno Sterilization and disinfection in general

SIST ISO 22441:2024

en,fr,de

INTERNATIONAL
STANDARD

ISO
22441

First edition
2022-08

**Sterilization of health care products —
Low temperature vaporized hydrogen
peroxide — Requirements for the
development, validation and routine
control of a sterilization process for
medical devices**

*Stérilisation des produits de santé — Vapeur de peroxyde d'hydrogène
à basse température — Exigences pour la mise au point, la validation
et le contrôle de routine d'un procédé de stérilisation pour dispositifs
médicaux*

(<https://standards.iteh.ai>)
Document Preview

[SIST ISO 22441:2024](https://standards.iteh.ai/catalog/standards/sist/237ba1e4-e17e-403e-90d3-e8db6488602a/sist-iso-22441-2024)

<https://standards.iteh.ai/catalog/standards/sist/237ba1e4-e17e-403e-90d3-e8db6488602a/sist-iso-22441-2024>



Reference number
ISO 22441:2022(E)

© ISO 2022

ISO 22441:2022(E)

iTeh Standards (<https://standards.iteh.ai>) Document Preview

[SIST ISO 22441:2024](https://standards.iteh.ai/catalog/standards/sist/237ba1e4-e17e-403e-90d3-e8db6488602a/sist-iso-22441-2024)

<https://standards.iteh.ai/catalog/standards/sist/237ba1e4-e17e-403e-90d3-e8db6488602a/sist-iso-22441-2024>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2022

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

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.....	v
Introduction.....	vi
1 Scope.....	1
1.1 Inclusions.....	1
1.2 Exclusions.....	1
2 Normative references.....	2
3 Terms and definitions.....	2
4 Quality management system elements.....	10
5 Sterilizing agent characterization.....	11
5.1 General.....	11
5.2 Sterilant and sterilizing agent.....	11
5.3 Microbicidal effectiveness.....	11
5.4 Effects on materials.....	12
5.5 Safety and the environment.....	12
6 Process and equipment characterization.....	13
6.1 General.....	13
6.2 Process characterization.....	13
6.3 Equipment characterization.....	14
7 Product definition.....	15
8 Process definition.....	16
9 Validation.....	17
9.1 General.....	17
9.2 Installation qualification (IQ).....	18
9.2.1 General.....	18
9.2.2 Equipment.....	18
9.3 Operational qualification (OQ).....	19
9.4 Performance qualification (PQ).....	19
9.5 Review and approval of validation.....	21
10 Routine monitoring and control.....	21
11 Product release from sterilization.....	22
12 Maintaining process effectiveness.....	22
12.1 General.....	22
12.2 Recalibration.....	22
12.3 Maintenance of equipment.....	23
12.4 Requalification.....	23
12.5 Assessment of change.....	23
Annex A (normative) Factors to be considered in selection of microorganisms for demonstrating microbicidal effectiveness.....	24
Annex B (normative) Approach 1 — Process definition based on inactivation of the microbial population in its natural state (bioburden method).....	26
Annex C (normative) Approach 2 — Process definition based on inactivation of reference microorganisms and knowledge of bioburden (BI/bioburden method).....	28
Annex D (normative) Approach 3 — Conservative process definition based on inactivation of reference microorganisms (overkill method).....	30
Annex E (informative) Guidance on application of this document.....	33
Annex F (informative) Schematic example of a VH202 sterilization cycle.....	56

ISO 22441:2022(E)

Annex G (informative) Environmental aspects	57
Annex H (informative) Justification for the number of temperature sensors and biological indicators (BIs)	62
Annex I (informative) Aspects of VH202	64
Annex J (informative) Recommended validation tests	67
Annex K (informative) Recommended validation test procedures	72
Bibliography	78

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[SIST ISO 22441:2024](https://standards.iteh.ai/catalog/standards/sist/237ba1e4-e17e-403e-90d3-e8db6488602a/sist-iso-22441-2024)

<https://standards.iteh.ai/catalog/standards/sist/237ba1e4-e17e-403e-90d3-e8db6488602a/sist-iso-22441-2024>

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 198, *Sterilization of health care products*.

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.

SIST ISO 22441:2024

<https://standards.iteh.ai/catalog/standards/sist/237ba1e4-e17e-403e-90d3-e8db6488602a/sist-iso-22441-2024>

ISO 22441:2022(E)

Introduction

This document specifies the requirements for the development, validation and routine control of sterilization processes using a vaporized composition of water and hydrogen peroxide (H₂O₂) as the sterilizing agent. Vaporized hydrogen peroxide (VH2O2) sterilizers process typically below 60 °C and are primarily used for the sterilization of thermolabile or moisture-sensitive medical devices in health care facilities but can also be used for sterilization of other reusable medical devices that have been established as compatible with VH2O2 processes. The sterilizers operate automatically using pre-set cycles. VH2O2 sterilizer processes can also be used by medical device manufacturers during commercial production.

NOTE 1 Work is underway within CEN/TC 102 to develop a standard for requirements for VH2O2 sterilizers (EN 17180¹). It is intended that applicable test procedures to demonstrate conformity (e.g. type tests and works tests) will be included.

A sterile medical device is one that is free of viable microorganisms. International Standards that specify requirements for validation and routine control of sterilization processes require, when it is necessary to supply a sterile medical device, that adventitious microbiological contamination of a medical device prior to sterilization be minimized. Even so, medical devices produced under standard manufacturing conditions in accordance with the requirements for quality management systems (see, for example, ISO 13485) can, prior to sterilization, have microorganisms on them. Such medical devices are non-sterile. The purpose of sterilization is to inactivate the microbiological contaminants and thereby transform the non-sterile medical devices into sterile ones.

The kinetics of inactivation of microorganisms by physical or chemical agents used to sterilize medical devices generally can best be described by an exponential relationship between the number of microorganisms surviving and the extent of treatment with the sterilizing agent; inevitably this means that there is always a finite probability that a microorganism can survive regardless of the extent of treatment applied. For a given treatment, the probability of survival is determined by the number and resistance of microorganisms and by the environment in which the microorganisms exist during treatment. It follows that the sterility of any one medical device in a population subjected to sterilization processing cannot be guaranteed and the sterility of a processed population is defined in terms of the probability of there being a viable microorganism present on a medical device.

This document describes requirements that, if met, will provide a sterilization process by VH2O2 with appropriate microbicidal activity intended to sterilize medical devices. Furthermore, conformance with the requirements ensures that the sterilization process is both reliable and reproducible so that predictions can be made, with reasonable confidence, that there is a small probability of there being a viable microorganism present on a medical device after sterilization. Specification of this probability is a matter for regulatory authorities and can vary from country to country (see, for example, EN 556-1 and ANSI/AAMI ST67).

Generic requirements of the quality management system for design and development, production, installation and servicing are given in ISO 9001 and particular requirements for quality management systems for medical device production are provided in national and international standards (e.g. ISO 13485). The standards for quality management systems recognise that, for certain processes used in manufacturing, the effectiveness of the process cannot be fully verified by subsequent inspection and testing of the product. Sterilization is an example of such a process. For this reason, sterilization processes are validated for use, the performance of the sterilization process is monitored routinely and the equipment is maintained.

Exposure to a properly validated, accurately controlled sterilization process is not the only factor associated with the provision of reliable assurance that a processed medical device is sterile and, in this regard, suitable for its intended use. Attention should also be given to a number of factors including:

- a) the microbiological status of incoming raw materials or components;

1) Under preparation.

- b) the validation and routine control of any cleaning and disinfection procedures used on the medical device;
- c) the control of the environment in which the medical device is manufactured, assembled and packaged;
- d) the control of sterilizer and processes;
- e) the control of personnel and their hygiene;
- f) the sterile barrier system(s) including any protective packaging as applicable;
- g) the conditions under which the medical device is transported and stored;
- h) the material and design of the medical devices being processed.

The type of contaminants on a medical device to be sterilized varies, and this influences the effectiveness of a sterilization process. Medical devices used in a health care facility and that are being presented for sterilization in accordance with the manufacturer's instructions (see ISO 17664-1) should be regarded as special cases. There is the potential for such medical devices to possess a wide range of contaminating microorganisms and residual inorganic or organic contaminants in spite of the application of a cleaning process. Hence, the validation and control of the cleaning and disinfection processes used during processing are critical.

The guidance given in [Annexes E, F, G, H, I, J](#) and [K](#) on the application of this document is informative and is not provided as a checklist for auditors. The guidance provides explanations and methods in relation to the application of the document that are regarded as being a suitable means for conforming with the requirements of this document. Methods other than those given in the guidance can be used if they are effective in achieving conformance with the requirements of this document.

The development, validation and routine control of a sterilization process comprise a number of discrete but interrelated activities, e.g. calibration, maintenance, product definition, process definition, installation qualification, operational qualification and performance qualification. While the activities required by this document have been grouped together and are presented in a particular order, this document does not require that the activities be performed in the order that they are presented. The activities required are not necessarily sequential, as the programme of development and validation can be iterative. The responsibility for carrying out the activities required by this document vary from case to case. This document requires that the responsibilities of the various parties be defined (see [4.1](#)) but does not specify to whom the responsibilities are allocated. [E.4](#) provides guidance on allocation of responsibility.

Like other standardized low temperature sterilization processes such as ethylene oxide (ISO 11135) or low temperature steam and formaldehyde (ISO 25424), the VH2O2 sterilization processes are specified by physical and chemical parameters and can be verified using physical, chemical and microbiological means.

Sterilization processes to which this document applies should consider not only technical issues but also the environmental impact. Activities required by this document can contribute to an environmental burden that can be minimised by planning and combining tests. Additional information regarding environmental impact is provided in [Annex G](#).

NOTE 2 Specifications on operating safety are addressed in IEC 61010-1, IEC 61010-2-040 and are not included in this document. IEC 60204-1 can also apply.

NOTE 3 Requirements on occupational safety are not specified in this document (see [1.2.4](#)).

ISO 22441:2022(E)

This document has two distinct applications:

- for manufacturers of VH2O2 sterilizers and users of VH2O2 sterilization processes in the health care facility;
- for manufacturers of VH2O2 sterilizers and users of VH2O2 sterilization processes in the manufacture of healthcare products.

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[SIST ISO 22441:2024](https://standards.iteh.ai/catalog/standards/sist/237ba1e4-e17e-403e-90d3-e8db6488602a/sist-iso-22441-2024)

<https://standards.iteh.ai/catalog/standards/sist/237ba1e4-e17e-403e-90d3-e8db6488602a/sist-iso-22441-2024>

Sterilization of health care products — Low temperature vaporized hydrogen peroxide — Requirements for the development, validation and routine control of a sterilization process for medical devices

1 Scope

1.1 Inclusions

1.1.1 This document provides requirements for the development, validation and routine monitoring and control of a low temperature sterilization process for medical devices using vaporized hydrogen peroxide (VH2O2) as the sterilizing agent.

1.1.2 This document is intended to be applied by process developers, manufacturers of sterilization equipment, manufacturers of medical devices to be sterilized, organizations performing process validation of VH2O2 sterilization, and organizations responsible for sterilizing medical devices.

NOTE VH2O2 sterilizers can be used in both health care and industrial facilities, and this document acknowledges the similarities and differences between the two applications.

1.2 Exclusions

1.2.1 Processes that use other sterilizing agents, or hydrogen peroxide solution in combination with other chemicals as the sterilizing agent are not addressed in this document.

NOTE See ISO 14937 for guidance on validation of such processes.

1.2.2 This document does not specify requirements for development, validation and routine control of a process for inactivating the causative agents of spongiform encephalopathies, e.g. scrapie, bovine spongiform encephalopathy and Creutzfeldt-Jakob disease. Specific recommendations have been produced in particular countries for the processing of materials potentially contaminated with these agents.

NOTE Some VH2O2 sterilizers have processes that demonstrate some level of inactivation of the causative agents of spongiform encephalopathies, e.g. scrapie, bovine spongiform encephalopathy and Creutzfeldt-Jakob Disease. However, this inactivation is process, cycle, and test protocol specific, therefore this inactivation is outside the scope of this document, and no specific test methods are provided (see [14], [26], and [30] for more information).

1.2.3 This document does not specify requirements for designating a medical device as sterile.

NOTE See for example EN 556-1 or ANSI/AAMI ST67.

1.2.4 This document does not specify requirements for occupational safety associated with the design and operation of VH2O2 sterilization equipment.

NOTE For further information on safety, see examples in the Bibliography. National or regional regulations can also exist.

ISO 22441:2022(E)

1.2.5 This document does not apply to the contents of contained product, i.e. product for which the environment within the sterilizer chamber during any stage of the sterilization process does not come into direct contact with the product, such as a solution in a sealed bottle.

1.2.6 This document does not cover hydrogen peroxide decontamination systems for use in rooms, enclosures or environmental spaces.

NOTE These decontamination systems operate at ambient conditions (e.g. temperature and pressure) and in general utilise an approach that is different to that of VH2O2 sterilization processes addressed in this document.

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 10993-1, *Biological evaluation of medical devices — Part 1: Evaluation and testing within a risk management process*

ISO 10993-17, *Biological evaluation of medical devices — Part 17: Establishment of allowable limits for leachable substances*

ISO 11138-1:2017,²⁾ *Sterilization of health care products — Biological indicators — Part 1: General requirements*

ISO 11140-1, *Sterilization of health care products — Chemical indicators — Part 1: General requirements*

ISO 11607-1:2019, *Packaging for terminally sterilized medical devices — Part 1: Requirements for materials, sterile barrier systems and packaging systems*

ISO 11607-2, *Packaging for terminally sterilized medical devices — Part 2: Validation requirements for forming, sealing and assembly processes*

ISO 11737-1, *Sterilization of health care products — Microbiological methods — Part 1: Determination of a population of microorganisms on products*

ISO 11737-2, *Sterilization of health care products — Microbiological methods — Part 2: Tests of sterility performed in the definition, validation and maintenance of a sterilization process*

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 bioburden

population of viable microorganisms on or in product and/or *sterile barrier system* (3.46)

[SOURCE: ISO 11139:2018, 3.23]

2) ISO 11138-1 gives general requirements for biological indicators, including information that can be used for guidance on test microorganism selection. Specific requirements will be given in a new document, ISO 11138-6 under preparation, current stage ISO/AWI 11138-6.

3.2 biological indicator BI

test system containing viable microorganisms providing a specified resistance to a specified sterilization process

[SOURCE: ISO 11139:2018, 3.29]

3.3 calibration

operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication

[SOURCE: ISO 11139:2018, 3.31]

3.4 chamber

part of equipment in which a load is processed

[SOURCE: ISO 11139:2018, 3.36]

3.5 change control

assessment and determination of the appropriateness of a proposed alteration to product, process, or equipment

[SOURCE: ISO 11139:2018, 3.39]

3.6 chemical indicator CI

test system that reveals change in one or more pre-specified *process variables* (3.33) based on a chemical or physical change resulting from exposure to a process

[SOURCE: ISO 11139:2018, 3.43]

3.7 conditioning

treatment of product prior to the *exposure phase* (3.15) to attain a specified temperature, relative humidity, or other *process variable* (3.33) throughout the load

[SOURCE: ISO 11139:2018, 3.58]

3.8 cycle parameter

value of a *cycle variable* (3.9) including its tolerance used for control, monitoring, indication, and recording of an *operating cycle* (3.25)

[SOURCE: ISO 11139:2018, 3.72]

3.9 cycle variable

property used to control, monitor, indicate, or record an *operating cycle* (3.25)

[SOURCE: ISO 11139:2018, 3.74]

ISO 22441:2022(E)**3.10****D value****D₁₀ value**

time or dose required under stated conditions to achieve inactivation of 90 % of a population of the test microorganisms

[SOURCE: ISO 11139:2018, 3.75]

3.11**development**

act of elaborating a specification

[SOURCE: ISO 11139:2018, 3.79]

3.12**environmental control**

application of engineering and/or procedural systems to maintain conditions in a defined space within specified limits

[SOURCE: ISO 11139:2018, 3.102]

3.13**equipment maintenance**

combination of all technical and associated administrative actions intended to keep equipment at a state in which it can perform its required function, or restore it to such a state

[SOURCE: ISO 11139:2018, 3.106]

3.14**establish**

determine by theoretical evaluation and confirm by experimentation

[SOURCE: ISO 11139:2018, 3.107]

3.15**exposure phase**

cycle stage between the introduction of the sterilizing or disinfecting agent into the chamber and when the agent is removed

Note 1 to entry: For purposes of this document, VH202 is used as the sterilizing agent.

[SOURCE: ISO 11139:2018, 3.111]

3.16**fault**

situation in which one or more of the process or *cycle parameters* (3.8) is/are outside its/their specified tolerance(s)

[SOURCE: ISO 11139:2018, 3.116]

3.17**health care facility**

dedicated setting where health care professionals deliver services for care of patients

EXAMPLE Hospitals, free standing ambulatory surgical centres, nursing homes, extended care facilities, medical, dental and physician offices or clinics and other specialised treatment facilities.

3.18**health care product(s)**

medical device, including in vitro diagnostic medical device, or medicinal product, including biopharmaceutical

[SOURCE: ISO 11139:2018, 3.132]