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Biocompatibility evaluation of breathing gas pathways in healthcare applications —

Part 4: Tests for leachables in condensate

Évaluation de la biocompatibilité des voies de gaz respiratoires dans les applications de soins de santé —
Partie 4: Essais concernant les substances relargables dans le condensat

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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 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 on the voluntary nature of ISO 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 the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 121, *Anaesthetic and respiratory equipment*, Subcommittee SC 3, *Lung ventilators and related equipment*.

A list of all parts of the ISO 18562 series can be found on the ISO website.

Introduction

This document is intended to protect PATIENTS connected to MEDICAL DEVICES from excessive amounts of harmful substances that might be contained in water that has condensed in the GAS PATHWAYS of those MEDICAL DEVICES. This document represents the application of the best-known science by addressing the RISKS from potentially hazardous substances in the condensate being conveyed to the PATIENT by the GAS PATHWAY. The condensate itself will be distilled water, having condensed from the vapour phase, but liquid water present in the breathing system might be able to leach or absorb other substances from within the MEDICAL DEVICE. This contamination might be from the original manufacturing PROCESS or be generated by the MEDICAL DEVICE itself during use.

This document is intended to cover the biological evaluation of GAS PATHWAYS of MEDICAL DEVICES within a RISK MANAGEMENT PROCESS, as part of the overall MEDICAL DEVICE evaluation and development. This approach combines the review and evaluation of existing data from all sources with, where necessary, the selection and application of additional tests.

In general, the ISO 10993 series is intended to cover the biological evaluation of MEDICAL DEVICES. However, the ISO 10993 series does not appropriately address the biological evaluation of the GAS PATHWAYS of MEDICAL DEVICES.

It is not within the scope of this document to address contamination arising from the source of the breathing gases entering such MEDICAL DEVICES, but rather only address the potential contamination generated from within the MEDICAL DEVICE itself. This contamination might be from the original manufacturing PROCESS or generated by the MEDICAL DEVICE itself during use.

This document is concerned with substances that could be conveyed to the PATIENT by liquid condensate forming in the MEDICAL DEVICE and then subsequently reaching the lungs of the PATIENT. Potentially harmful substances that could be found in condensate include salts and metals. Condensate management is part of most healthcare institution protocols, with the primary aim of preventing the condensate reaching the PATIENT in the first place. The absolute volume of liquid reaching a PATIENT by this route should therefore be low, but it might happen. This document outlines tests for substances contained in the liquid.

The methods to determine the acceptable levels of contamination are contained in ISO 18562-1.

In this document, the following print types are used:

— requirements and definitions: roman type;

— informative material appearing outside of tables, such as notes, examples and references: in smaller type. Normative text of tables is also in a smaller type;

— *test specifications: italic type*;

— terms defined in Clause 3 of this DOCUMENT or as noted: small capitals type.

In this document, the conjunctive "or" is used as an "inclusive or" so a statement is true if any combination of the conditions is true.

The verbal forms used in this document conform to usage described in Annex H of the ISO/IEC Directives, Part 2. For the purposes of this document, the auxiliary verb:

a) "shall" means that compliance with a requirement or a test is mandatory for compliance with this document;

b) "should" means that compliance with a requirement or a test is recommended but is not mandatory for compliance with this document;

c) "may" is used to describe a permissible way to achieve compliance with a requirement or test.

An asterisk (*) as the first character of a title or at the beginning of a paragraph or table title indicates that there is guidance or rationale related to that item in Annex A.

The attention of Member Bodies is drawn to the fact that equipment manufacturers and testing organizations may need a transitional period following publication of a new, amended or revised ISO publication in which to make products in accordance with the new requirements and to equip themselves for conducting new or revised tests. It is the recommendation of the committee that the content of this publication be adopted for implementation nationally not earlier than 3 years from the date of publication for equipment newly designed and not earlier than 5 years from the date of publication for equipment already in production.

Biocompatibility evaluation of breathing gas pathways in healthcare applications —

Part 4: Tests for leachables in condensate

1 Scope

This document specifies tests for substances leached by liquid water condensing into GAS PATHWAYS of a MEDICAL DEVICE, its parts or ACCESSORIES, which are intended to provide respiratory care or supply substances via the respiratory tract to a PATIENT in all environments. The tests of this document are intended to quantify hazardous water-soluble substances that are leached from the MEDICAL DEVICE, its parts or ACCESSORIES by condensate and then conveyed by that liquid to the PATIENT. This document establishes acceptance criteria for these tests.

This document addresses potential contamination of the gas stream arising from the GAS PATHWAYS, which is then conducted to the PATIENT.

This document applies over the EXPECTED SERVICE LIFE of the MEDICAL DEVICE in NORMAL USE and takes into account the effects of any intended processing or reprocessing.

This document does not address biological evaluation of the surfaces of GAS PATHWAYS that are in direct contact with the PATIENT. The requirements for direct contact surfaces are found in the ISO 10993 series.

MEDICAL DEVICES, parts or ACCESSORIES containing GAS PATHWAYS that are addressed by this document include, but are not limited to, ventilators, anaesthesia workstations (including gas mixers), breathing systems, oxygen conserving devices, oxygen concentrators, nebulizers, low-pressure hose assemblies, humidifiers, heat and moisture exchangers, respiratory gas monitors, respiration monitors, masks, mouth pieces, resuscitators, breathing tubes, breathing systems filters, Y-pieces and any breathing ACCESSORIES intended to be used with such devices. The enclosed chamber of an incubator, including the mattress, and the inner surface of an oxygen hood are considered to be GAS PATHWAYS and are also addressed by this document.

This document does not address contamination already present in the gas supplied from the gas sources while MEDICAL DEVICES are in NORMAL USE.

EXAMPLE Contamination arriving at the MEDICAL DEVICE from gas sources such as MEDICAL GAS PIPELINE SYSTEMS (including the non-return valves in the pipeline outlets), outlets of pressure regulators connected or integral to a medical gas cylinder, or room air taken into the MEDICAL DEVICE is not addressed by ISO 18562 series.

This document does not address contact with drugs or anaesthetic agents. If a MEDICAL DEVICE is intended to be used with anaesthetic agents or drugs, then additional testing can be required.

This document is intended to be read in conjunction with ISO 18562-1.

NOTE This document has been prepared to address the relevant essential principles of safety and performance as indicated in Annex B.

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 7396-1:2016, *Medical gas pipeline systems — Part 1: Pipeline systems for compressed medical gases and vacuum*

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

ISO 10993-5, *Biological evaluation of medical devices — Part 5: Tests for in vitro cytotoxicity*

ISO 10993-10, *Biological evaluation of medical devices — Part 10: Tests for irritation and skin sensitization*

ISO 10993-12:2012, *Biological evaluation of medical devices — Part 12: Sample preparation and reference materials*

ISO 14971:2007, *Medical devices — Application of risk management to medical devices*

ISO 18562-1:2017, *Biocompatibility evaluation of breathing gas pathways in healthcare applications — Part 1: Evaluation and testing within a risk management process*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7396-1, ISO 14971 and ISO 18562-1 apply.

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

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

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

NOTE For convenience, an alphabetized index of all defined terms and their sources used in this document are given in Annex C.

4 General principles

4.1 TYPE TESTS

The tests described in this document are TYPE TESTS. TYPE TESTS are performed on the final MEDICAL DEVICE, a component of the MEDICAL DEVICE or a representative sample of the MEDICAL DEVICE, part or ACCESSORY being evaluated. If representative samples are used, (i.e. manufactured and processed by equivalent methods), consideration should be made regarding whether or not the differences between the representative sample and the final MEDICAL DEVICE or component could affect the results of the test. Testing of representative samples (manufactured and processed by equivalent methods) instead of the final MEDICAL DEVICE should be supported by a description of any differences between the representative sample and the final MEDICAL DEVICE, and a detailed rationale for why each difference is not expected to impact the BIOCOMPATIBILITY of the final MEDICAL DEVICE.

NOTE Some AUTHORITIES HAVING JURISDICTION evaluate these differences and rationales.

4.2 General

All GAS PATHWAYS from which the PATIENT inspires gas shall be evaluated using the strategy detailed in ISO 18562-1.

5 LEACHABLE SUBSTANCES in condensate

5.1 General

A MEDICAL DEVICE, part or ACCESSORY shall not add to the condensate LEACHABLE SUBSTANCES at levels that create an unacceptable RISK to the PATIENT. All GAS PATHWAYS from which the PATIENT inspires gas in NORMAL CONDITION, where

— gas in the GAS PATHWAY can reach 100 % saturation with water at some point in the GAS PATHWAY,

— condensate can form on the GAS PATHWAY surfaces, and

— liquid condensate can reach the PATIENT,

shall be evaluated for condensate emissions. The evaluation should use the RISK MANAGEMENT PROCESS to assess if testing is required.

NOTE 1 Condensate can form in GAS PATHWAYS and can take the form of liquid drops or a film of water on the GAS PATHWAY walls. This liquid water can extract substances from the materials of the walls that would not be extracted by the breathing gas alone. If this liquid condensate can reach the PATIENT, it could potentially convey harmful substances to the PATIENT.

NOTE 2 The evaluation of some components, which are identical in FORMULATION, processing and preparation for use to an existing component of a MEDICAL DEVICE that has been previously tested, might conclude that no further testing is required. Refer to ISO 18562-1:2017, Figure 2.

Sections of the GAS PATHWAY from which the PATIENT cannot be exposed to condensate need not be tested.

If the RISK MANAGEMENT PROCESS determines that testing is required, the tests of 5.2 shall be performed.

If the MEDICAL DEVICE under evaluation has already been evaluated as an external communicating MEDICAL DEVICE with contact to tissue/bone/dentin according to ISO 10993-1, then the following tests need not be performed.

EXAMPLE A tracheal tube, because of its direct contact with the PATIENT, is evaluated according to ISO 10993-1. In this case, the tests of this document are not required.

NOTE 3 Some AUTHORITIES HAVING JURISDICTION might require these tests if the MEDICAL DEVICE is intended for use on particularly vulnerable PATIENT populations, such as neonates.

5.2 * Test method

Test for LEACHABLE SUBSTANCES in condensate is as follows.

a) To collect a sample, either

   1) produce and collect condensate under clinically relevant conditions, or

   2) circulate the water over the surface of the sample at a temperature representative of clinical use, or

   3) * perform an aqueous extraction on the internal gas contact surfaces according to the method of ISO 10993-12:2012, Clause 10, with the extract at clinically relevant temperatures, for a clinically relevant duration of time.

   EXAMPLE There is no clinical relevance to performing a 24-h extraction on a MEDICAL DEVICE that is only intended to be used on a PATIENT for 20 min. However, the underlying principle remains "what is the dose to the PATIENT in 24 h". If a MEDICAL DEVICE could be used multiple times in a 24-h period, then the maximum likely cumulative time is considered. Additionally, if the MEDICAL DEVICE is consumable and replaced consecutively, the 24-h exposure can be higher due to additive effects.

   NOTE 1 See the rationale in Annex A for further considerations if performing an aqueous extraction.